FGDC Digital Cartographic Standard for Geologic Map Symbolization (PostScript Implementation)

Prepared in cooperation with the Geologic Data Subcommittee of the Federal Geographic Data Committee

By the U.S. Geological Survey

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Federal Geographic Data Committee

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1. INTRODUCTORY MATERIAL

1.1 OBJECTIVE

This document provides a single national standard for the digital cartographic representation of geologic map features. This standard is intended to support the Nation's producers and users of geologic map information by providing line symbols, point symbols, and colors and patterns that can be used to portray the various features on geologic maps. The objective of this standard is to aid in the production of geologic maps and related products, as well as to help provide geologic maps and products that are more consistent in both their appearance and their underlying database content.

A geologic map is a cartographic product that expresses information about the geology of a particular area. The map uses graphical elements such as line symbols, point symbols, and colored or patterned areas to portray complex geological information such as the composition, age, genesis, and extent of an area's geologic materials, as well as the geometry, orientation, and character of the geologic structures that have deformed them.

Geologic maps generally are intended for use by both the geoscience professional and the general public; however, designing and preparing a geologic map that will inform such an audience can be a daunting task because of the complexity of both the mapping concepts and the geologic information. The imperative for clear communication of geologic map information to a diverse audience was outlined early in the history of the U.S. Geological Survey (USGS) by then-Director John Wesley Powell, who stated that "the maps are designed not so much for the specialist as for the people, who justly look to the official geologist for a classification, nomenclature, and system of convention so simple and expressive as to render his work immediately available alike to the theoretic physicist or astronomer, the practical engineer or miner, and the skilled agriculturist or artisan" (Powell, 1888, p. 229).

The consistent, unambiguous expression of geologic map information is even more critical now because such information increasingly is compiled, stored, manipulated, and exchanged in digital files and geospatial databases. In the digital files, the cartographic representation of each feature on a geologic map must have a unique and explicit meaning, and it also must be compatible with the feature's attributes in the geologic map database. To that end, the preparers of this standard reviewed existing formal and informal USGS geologic map symbolization standards and adapted them for implementation with modern digital mapmaking systems and geospatial databases.

This standard attempts to facilitate geologic map communication and comprehension by providing clear and familiar symbology, thereby ensuring that the lines, points, and areas on the map convey the same meaning to all information producers and users. This standard also endeavors to clarify some of the concepts of geologic mapping, as well as to standardize some of the terminology used to describe the various features on a geologic map.

Although this standard is herein formalized, it is not intended to be used inflexibly or in a manner that will unduly restrict a geologist's ability to communicate the observations and interpretations gained from geologic mapping. On the contrary, this standard recognizes that, in certain situations, an existing symbol or its usage might need to be modified to fit a particular geologic situation or setting. Likewise, this standard recognizes that a new symbol or set of symbols may need to be created to more fully express local geologic conditions or to keep pace with evolving geologic mapping concepts and practices. Accordingly, such new or modified symbols, if found to be of wide applicability, will be incorporated into this standard through planned, periodic revisions.

1.2 SCOPE

This standard contains descriptions, examples, cartographic specifications, and notes on usage for a wide variety of symbols that may be used on typical, general-purpose geologic maps and related products such as cross sections. However, the standard also can be used for different kinds of special-purpose or derivative map products and databases that may be focused on a specific geoscience topic (for example, slope stability) or class of features (for example, a fault map). The standard is scale-independent, meaning that the symbols are appropriate for use with geologic mapping compiled or published at any scale. It is designed for use by anyone who either produces or uses geologic map information, whether in analog or digital form.

1.3 APPLICABILITY

This document establishes standards that are applicable to all geologic map information (in other words, geologic maps and databases) published by the Federal Government and its Federally funded contractors and collaborators. Non-Federal agencies and private firms that produce geologic map information also are urged to adopt the standard.

The standard applies to all forms of geologic map publications, whether they are released as (1) hard-copy products, in either offset-print or plot-on-demand format, or (2) digital products, either as files for spatial analysis in Geographic Information Systems (GIS), as Portable Document Format (PDF) files in online publications, or as browse-graphic files for display on the World Wide Web. In particular, the standard applies to all geologic map products archived within the National Geologic Map Database (NGMDB), which is administered by the USGS: geologic map products submitted to and incorporated within the NGMDB will conform to this standard.

1.4 RELATED STANDARDS

The USGS traditionally has established nationally applicable cartographic standards for the production of geologic map information, both explicitly, through various formal and informal standards documents (see Section 2.1 below, entitled "Relation to Previous U.S. Geological Survey Standards"), and implicitly, through the cartographic content of its publications. This standard supersedes any existing USGS formal or informal cartographic standards for geologic maps.

During preparation of this standard, its relation to other standards or standards-development activities was assessed, and no significant conflicts were found. For example, the International Organization for Standardization (ISO) Standard 710, Parts 1–4, describes a general schema for graphical display of a selected set of geologic map symbols. Although similar to some that are included in this standard, they were found to have limited applicability. In addition, similar standards have been developed in other agencies of the Federal Government, including the U.S. Forest Service (in the geology component of their Terra database), the U.S. Army Corps of Engineers (in the geology component of their Spatial Data Standard for Facilities, Infrastructure, and the Environment [SDSFIE]), and the U.S. Bureau of Reclamation (in their Engineering Geology Office Manual). These were found to be somewhat specialized and limited in their coverage of geologic map features. Conversely, this standard provides comprehensive coverage of symbology for a broad range of geologic map features.

1.5 STANDARDS DEVELOPMENT PROCEDURES

This standards document represents only the latest milestone in a long history of geologic map standards development in the United States, which, within the USGS, began prior to 1881. As then-Director John Wesley Powell noted in 1888, in reference to geologic map standards under development at that time within the USGS, "While it is not professed that this [cartographic] system is final, or even unobjectionable, it represents the present state of knowledge and opinion" (Powell, 1888, p. 230). Although the present standards document draws heavily on previously established formal and informal cartographic standards of the USGS, it has undergone substantial revisions that reflect current geologic mapping practices and modern digital mapmaking methods. Accordingly, the standards-development procedures outlined in this section will address only the most recent development history of this standard (for a more complete historical background, see Section 2.1 below, entitled "Relation to Previous U.S. Geological Survey Standards").

This standards document was developed by members of the USGS Geologic Discipline's Western Publications Group and the National Geologic Map Database (NGMDB), with guidance and contributions from members of the Map Symbol Standards Committee (see below; see also, Section 2.3, entitled "Preparers of This Standard"). In addition, this standards document has benefited from the broad, modern-day perspective gained from the many thoughtful responses from reviewers of the Federal Geographic Data Committee's (FGDC) Public Review Draft of the standard (Federal Geographic Data Committee, 2000; see also, U.S. Geological Survey, 2000). The preparers of this standard gratefully acknowledge all current and prior participants and appreciate their invaluable contributions to the development of both this standards document and all preceding works.

In 1995, a proposed cartographic standard for geologic map information was informally released by the USGS as the "Cartographic and Digital Standard for Geologic Map Information" (U.S. Geological Survey, 1995a, 1995b). In 1996, this proposed standard was formally reviewed by geologists and cartographers from the USGS, as well as from the Association of American State Geologists (AASG), which represents the State geological surveys, and from the FGDC Geologic Data Subcommittee, which is composed of representatives from Federal agencies that produce or use geologic map information. That review (Soller, 1996) indicated the need for some revision to the proposed standard prior to its consideration by the FGDC for formal adoption as a Federal standard.

In 1996, plans were outlined to create a revised and updated Federal standard, and an early standards-development group was formed (see Section 2.3 below, entitled "Preparers of This Standard"). A proposal to develop the revised standard was submitted by the FGDC Geologic Data Subcommittee (see *http://ngmdb.usgs.gov/fgdc_gds/mapsymbprop.php*), and the FGDC accepted that proposal in 1997. Later that year, the standards-development group produced a preliminary version of the draft standard, which was circulated among selected USGS and State geological survey personnel for review. Comments were incorporated and, in 1999, the revised draft standard was submitted (as the "Working Draft") to the FGDC Geologic Data Subcommittee for consideration. Upon review and subsequent approval by the Subcommittee, the Working Draft was submitted to the FGDC Standards Working Group, which, in 2000, approved the document for public review as the "Public Review Draft" (see below), pending adoption of minor changes.

The Public Review Draft of this standard was finalized and then published in April 2000 (Federal Geographic Data Committee, 2000; see also, U.S. Geological Survey, 2000). In May 2000, the public was invited to review the draft standard and to provide comments and suggestions for revision (see *http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/prd/index.php*). At the end of the 120–day public review period (May 19 through September 15, 2000), all comments and suggestions pertaining to the Public Review Draft were compiled, and a plan was developed to address the comments and make the necessary changes. Under this plan, a standing Map Symbol Standards Committee was formed to assist in the resolution of the public's review comments and suggestions, as well as in the long-term maintenance of the standard. Committee members were drawn from the geologic mapping community in the State geological surveys, academia, and the USGS (see Section 2.3 below, entitled "Preparers of This Standard").

Revisions to the standards document began in 2001. In July 2005, the revised standard was approved by the Map Symbol Standards Committee, and then it was submitted to the FGDC Geologic Data Subcommittee to begin the final approval process. After review and subsequent approval by the Geologic Data Subcommittee, as well as by the FGDC's Standards Working Group, Coordination Group, and Steering Committee, the final standard (this document) was formally approved as an FGDC standard in August 2006.

This standard will be managed as a "living" standard—that is, it will be maintained and revised as needed to reflect new mapping concepts or evolving usage conventions. The initial release of this FGDC-approved standard is available as an offset-printed document, supplemented by an online (PDF) version. However, all future updates to this standards document will be released online in PDF format only. To help maintain an up-to-date hard-copy version of the standards document, this initial offset-printed release has been designed in a "loose-leaf" format. Subsequent updates to this standards document may be downloaded as PDF files from the FGDC Geologic Data Subcommittee website (*http://ngmdb.usgs.gov/fgdc_gds/*) and then printed out and inserted where appropriate into a loose-leaf binder. These online updates will be the authoritative reference.

Because this standard is intended for use with digital applications, a PostScript implementation of the Public Review Draft was informally released as a USGS Open-File Report (U.S. Geological Survey, 2000). This early PostScript implementation enabled reviewers to directly apply the standard to geologic maps and illustrations prepared in desktop illustration and (or) publishing software. The PostScript implementation has been updated to reflect changes found in the now-approved standard and has been released as a USGS Techniques and Methods report (U.S. Geological Survey, 2006). Additionally, preliminary work on an ArcGIS implementation may be completed in the future and released as a USGS report. Information regarding these implementation efforts will be posted on the FGDC Geologic Data Subcommittee website (*http://ngmdb.usgs.gov/fgdc_gds/*).

Questions and comments about, or suggested additions to, this standard may be submitted by email to *mapsymbol@flagmail.wr.usgs.gov* or mailed to Geologic Map Symbol Standard, c/o David R. Soller, National Geologic Map Database, U.S. Geological Survey, 926A National Center, Reston, Virginia, 20192.

1.6 MAINTENANCE AUTHORITY

On behalf of the FGDC, the USGS will maintain this Federal standard. The responsibility for coordinating Federal geologic mapping information is stipulated by Office of Management and Budget Circular A–16 (see *http://www.whitehouse.gov/omb/circulars/a016/a016.html*). The Geologic Mapping Act of 1992 (see *http://ncgmp.usgs.gov/ncgmpabout/ngmact/ngmact1992* and subsequent reauthorizations) stipulates a requirement for standards development under the auspices of the National Geologic Map Database (NGMDB). Under this authority, the NGMDB will function on behalf of the USGS as coordinator of this maintenance activity (see *http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/maintenance.php*). Maintenance will be conducted in cooperation with the AASG, which is the USGS's partner in the Geologic Mapping Act. The NGMDB will continue to rely on the Map Symbol Standards Committee to assist in its maintenance efforts. The Committee membership comes from the NGMDB, the USGS scientific staff and Publications Groups, the AASG, and the academic community (see Section 2.3 below, entitled "Preparers of This Standard"). The Committee will, as needed, review comments and suggestions for revisions, additions, and deletions to the standard.

2. BACKGROUND

2.1 RELATION TO PREVIOUS U.S. GEOLOGICAL SURVEY STANDARDS

Soon after the USGS was established in 1879, USGS geologists began to map and assess the Nation's lands, including many areas previously unexplored by Europeans. A new publication series, the Geologic Atlas (or "Folio") series, was created to publish many of these maps. Beginning prior to 1881, the USGS, then under the direction of John Wesley Powell, began to identify geologic and cartographic standards and conventions necessary to uniformly portray the geology in this series: "In providing for the publication of this large body of material, it seemed wise to adopt a common system of general nomenclature, a uniform color scheme for geographic geology, a system of conventional characters for diagrams, and a form for geologic and topographic charts and atlases" (Powell, 1882a, p. XL; see also, Powell, 1882b, for an elaboration on the proposed standards). Following an 1889 Conference on Map Publication, these standards were articulated in more detail and then were published (Powell, 1890).

The standards that were adopted by the USGS in the 1880s served as a strong foundation for the Nation's geological science. Paramount to systematized geologic mapping was the adoption of a standard rock stratigraphic nomenclature, a naming convention for geologic formations, and the subdivisions of geologic time. Another significant contribution was the adoption of a standardized color scheme for displaying geologic map units. This scheme used pure, single-ink colors, usually a different one for each geologic time period; to achieve this, a practical and informative system of overprint patterns also was developed, which served to differentiate the various mapped units within a single time period. Although this single-ink color scheme did not persist intact in the twentieth century because of the emergence of more modern printing technologies (for example, the combining of CMYK—cyan, magenta, yellow, and black—inks to produce a greater variety of colors), many of the overprint patterns that were developed then are still in use today.

In the following decades, as the geological sciences advanced, the concepts of geologic processes and historical geology became more complex, and new insights and refinements required more map symbols and precise scientific cartographic methods to convey details of geology. In 1920, the USGS published a manual on the preparation of illustrations (Ridgway, 1920). By that time, the need for standardization had become urgent: "More than 200 symbols have been used on maps to express 25 different kinds of data, a fact indicating at once a notable lack of uniformity and a need of standardization" (Ridgway, 1920, p. 20). The manual addressed various issues associated with geologic cartography, including standard symbology for geologic maps and cross sections (for example, geologic line and point symbols, water wells, oil and gas wells, coal seams, mine workings, and topographic and other base-category information) and stratigraphic columns (for example, lithologic patterns).

After 1920, and throughout much of the twentieth century, the maintenance of USGS standards for geologic map symbolization and cartography was an internal and somewhat informal process enacted through official USGS policy. For example, USGS Chief Geologist W.H. Bradley (written commun., 1956) adopted recommendations and a list of symbols from the Map Symbol Committee (E.N. Goddard, Chairman), and USGS Chief Geologist D.L. Peck (written commun., 1978) adopted recommendations from the committee for

Standards for General Purpose Geologic Maps (J.C. Reed, Chairman).

In the mid-1970s, the USGS outlined the technical specifications for geologic symbology in its informal "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975). This informal standard, which was maintained until the mid-1980s, was available to USGS cartographers and editors as a set of green, loose-leaf notebooks that allowed pages to be replaced as the standard evolved. The technical specifications at that time were devised to serve the needs of cartographers who prepared maps for offset-print publication using hand-placed type, hand-scribed linework, and peelcoat color-separation techniques. This informal standard served the USGS well, but it was not available to other producers or users of geologic maps, nor was it formally recognized as a standard by the Nation's geoscience community. However, the cartographic details of this standard were clearly displayed on USGS geologic maps. And so, drawing from the cartographic content of USGS maps, others have published manuals on geologic map standards that have (unofficially) incorporated parts of this informal standard: for example, the American Geological Institute's "AGI Data Sheets for Geology in the Field, Laboratory, and Office" (Dietrich and others, 1982 [2nd ed.]; Dutro and others, 1989 [3rd ed.]) includes many symbols commonly shown on USGS geologic maps (see also, "Suggestions to Authors of the Reports of the United States Geological Survey" [7th ed.], Hansen, 1991).

Beginning about the mid-1980s, digital-cartographic and GIS (Geographic Information System) technologies rapidly evolved and became more widely available. The gradual adoption of digitally based mapmaking methods made clear the need to develop new cartographic standards that would satisfy the requirements of the latest technologies for the preparation of digital files, whether they are to be used for geospatial databases, for plot-on-demand or online map publications, or for the production of negatives for offset printing of maps.

In response to this steady increase in digital mapmaking and the accompanying concern about preparing consistent, high-quality, digitally produced geologic maps and geologic map databases, the USGS informally released in 1995 a proposed standard entitled "Cartographic and Digital Standard for Geologic Map Information" (U.S. Geological Survey, 1995a). As noted above, subsequent review of that document by the USGS, the AASG, and the FGDC Geologic Data Subcommittee (Soller, 1996) indicated the need for some revision prior to its consideration by the FGDC for formal adoption as a Federal standard, which led to the development of this standard (see discussion in Section 1.5 above, entitled "Standards Development Procedures").

2.2 CHANGES FROM PREVIOUS STANDARDS

In this new standard (contained in [normative] appendix A), descriptions, examples, cartographic specifications, and notes on usage are provided for a wide variety of symbols that may be used on typical digital geologic maps or related products such as cross sections. In the preparation of this standard, every effort was made to retain the original symbols and their specifications from the 1995 USGS proposed standard (U.S. Geological Survey, 1995a); however, many updates have been incorporated into this new version. The number of symbols has increased significantly, from about 800 to over 2300. Symbols are more logically grouped; some sections have been combined with others, and a few new sections have been added.

Many symbols, particularly lines, have been redesigned slightly so that they would more successfully translate to digital applications. For instance, in the old "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975), as well as in the 1995 USGS proposed standard (U.S. Geological Survey, 1995a), the lineweight for contacts was specified as .005 inches (.125 millimeters). However, experience has shown that .005–inch lines do not always plot well when digitally output by high-resolution imagesetters. Therefore, the minimum lineweight for contacts, as well as for most other stroked-line symbol elements, has been increased to .006 inches (.15 millimeters) in this new standard. In addition, the dash and gap lengths for many line symbols have been adjusted so that their dash-gap templates can be more easily defined electronically.

A chart showing a wide range of CMYK colors ("CMYK Color Chart") has been included; an offset-print version of this chart has been in use at the USGS for many years, and the variety of colors has proved to be sufficient for portraying complex geology shown on most maps, regardless of the output medium. In addition, a chart that shows commonly used geologic patterns ("Pattern Chart") has been added; the patterns themselves are similar to what was in the old "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975), as well as in the 1995 USGS proposed standard (U.S. Geological Survey, 1995a), but most have undergone lineweight changes to facilitate digital output at high resolutions. The old pattern numbers have been revised and the patterns are now organized into seven geologically relevant series. A few new patterns have been added, and some have been eliminated. In addition, each pattern in the Pattern Chart, as well as each color in the CMYK Color Chart, has associated with it a generic lookup-table number that, if desired, may be used to access the pattern (or color) from within digital applications.

Also included in this new standard is a diagram showing suggested ranges of map-unit colors for stratigraphic ages of sedimentary and metamorphic rocks, as well as for volcanic and plutonic rocks. In addition, a new geologic age symbol font ("FGDCGeoAge") has been added. Three new sections that address map marginalia have been included: (1) quadrangle location maps for each of the 50 states (and District of Columbia, Guam, Puerto Rico, and U.S. Virgin Islands), as well as a map of the 48 conterminous states (so that quadrangle locations covering more than one state can be shown); (2) a variety of bar scales, as well as calculation tables that show how to convert between inches, miles, and kilometers; and (3) a series of mean declination arrows, showing magnetic north both east and west of true north.

A few new informational sections have been added to the introductory material in this standard. The section entitled "Guidelines for Map Color and Pattern Selection" provides useful information on color selection and the use of patterns. The section entitled "Guidelines for Map Labeling" provides recommendations on placement of text on a map.

The most significant update to this standard is the addition of two important sections to the introductory material. The section entitled "Geologic Mapping Concepts and Definitions" provides basic information about some of the fundamental concepts of geologic mapping, as well as defines and categorizes the various types of geologic map features. The section entitled "Scientific Confidence and Locational Accuracy of Geologic Features" clarifies the concepts of, and establishes new terminology for, the levels of scientific confidence and locational accuracy of geologic map features.

In response to reviewer's comments (Soller, 1996), much of the first part of the 1995 USGS proposed standard has been abandoned because it was either not pertinent to this standard (for example, the sections on geologic map content, metadata, and geocoding) or not widely applicable to the full range of mapping situations (for example, the specification of a "1.0 mm accuracy standard"). In addition, no attempt has been made in this new standard to provide detailed definitions for the geologic features represented by the various symbols. For such information, please refer to one of a number of reference books available; an excellent source is the American Geological Institute's Glossary of Geology (Jackson, 1997 [4th ed.]; Neuendorf and others, 2005 [5th ed.]).

2.3 PREPARERS OF THIS STANDARD

Principal contributors[1] to the preparation of this FGDC Digital Cartographic Standard for Geologic Map Symbolization include the following individuals:

David R. Soller (USGS; Chief, National Geologic Map Database)—Coordinator, editor, and author, FGDC Digital Cartographic Standard for Geologic Map Symbolization; coordinator, Map Symbol Standards Committee.

Taryn A. Lindquist (USGS; Digital Map Specialist and Geologic Map Editor, Western Publications Group)—Editor, author, and compiler, FGDC Digital Cartographic Standard for Geologic Map Symbolization; designer, line symbols and point symbols, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

Map Symbol Standards Committee: Thomas Berg (State Geologist, Ohio); Jay Parrish (State Geologist, Pennsylvania); Mark Jirsa (Minnesota Geological Survey); Robert Hatcher (University of Tennessee, Knoxville); Steven Reynolds (Arizona State University); and Byron Stone, Jack Reed, Jonathan Matti,

[1] Unless otherwise noted, persons listed as contributors to the "FGDC Digital Cartographic Standard for Geologic Map Symbolization" participated in the preparation of the following versions of the standard: Working Draft; Public Review Draft (Federal Geographic Data Committee, 2000) and its PostScript implementation (U.S. Geological Survey, 2000); and the now FGDC-approved standard (this document) and its PostScript implementation (U.S. Geological Survey, 2006).

Taryn Lindquist, and David Soller (all USGS)—Referees and reviewers of public comments and subsequent revisions, Public Review Draft (Jonathan Matti is especially noted for his guidance on issues of scientific confidence and locational accuracy).

Sara Boore (USGS; Publication Graphics Specialist, Western Publications Group)—Book designer, FGDC Digital Cartographic Standard for Geologic Map Symbolization; designer, point symbols, line symbols, color charts, and patterns, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

F. Craig Brunstein (USGS; Geologic Map Editor, Central Publications Group)—Technical reviewer, Working Draft.

Alessandro J. Donatich (USGS; Geologic Map Editor, Central Publications Group)—Technical reviewer, Working Draft.

Carolyn Donlin (USGS; Online Publications Specialist and Geologic Map Editor, Western Publications Group)—Preparer, online publication of Public Review Draft (PostScript implementation).

Michael F. Diggles (USGS; CD-ROM Publications Specialist and Online Publications Specialist, Western Publications Group)—Preparer, CD-ROM publications of PostScript implementations; preparer, online publication of FGDC-approved standard (PostScript implementation).

Kevin Ghequiere (USGS; Cartographer, Western Publications Group)—Designer, patterns, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

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Glenn Schumacher (USGS; Publication Graphics Specialist, Western Publications Group)—Designer, bar scales, mean declination arrows, and quadrangle location maps, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

Stephen L. Scott (USGS; Publication Graphics Specialist, Western Publications Group)—Designer, point symbols and line symbols, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

Will Stettner (USGS; Cartographer, Eastern Publications Group)—Technical reviewer, Working Draft.

José F. Vigil (USGS; Motion Graphics Specialist, Western Publications Group)—Designer, geologic age symbol font, FGDC Digital Cartographic Standard for Geologic Map Symbolization.

Jan L. Zigler (USGS; Geologic Map Editor, Western Publications Group)—Technical reviewer, Working Draft.

3. GEOLOGIC MAPPING CONCEPTS AND DEFINITIONS

3.1 GEOLOGIC MAPS

A *geologic map* is a cartographic product that portrays information about the geologic character of a specific geographic area. It is a two-dimensional representation of real-world, three-dimensional geologic features. To achieve this, a geologic map uses graphical elements to express detailed information about the different kinds of earth materials, the boundaries that separate them, and the geologic structures that have subsequently deformed them. For example, a typical general-purpose geologic map may consist of *lines* that trace contacts, faults, and folds; *points* that locate bedding attitudes, minor fold orientations, and sample localities; *areas* that represent geologic units, landslides, and areas of alteration; and *labels* that identify geologic map units, sample-locality numbers, and fault names. Thus, an appropriately symbolized and labeled geologic map can portray comprehensive information about the composition, age, and genesis of the geologic materials and the nature of their boundaries, as well as the character and three-dimensional geometry of the geologic structures that have deformed them. In addition, such geologic map information usually is drawn onto a base map that also uses graphical elements to represent the topography, drainage, and cultural features of an area, and so a geologic map also can depict the spatial relation of the various geologic features to the physical landscape. Other things that may be shown on a geologic map include information about the geomorphology, pedology, paleontology, rock alteration and mineralization, geophysics, geochemistry, or geochronology of an area.

3.2 GEOLOGIC MAP DATABASES

A *geologic map database* is a digitally compiled collection of spatial (geographically referenced) and descriptive geologic information about a specific geographic area. The information in the geologic map database consists of (1) the geographic location and the orientation, length, shape, and (or) area (in other words, the geometry) of each geologic feature or object (for example, an outcrop or a fault), and (2) many different types of descriptive geologic information about each feature or object.

A geologic map database also may contain extensive amounts of additional qualitative and quantitative geologic information. For example, a geologic map database may include geochemical analyses, radiometric ages, soil-horizon information, and geophysical contours, as well as information on the weathering of surface exposures of geologic features, the subsurface geometry of geologic map units, and the glacial landforms or other types of geomorphic features.

Fundamental data elements of a geologic map database are *lines* (for example, contacts and faults), *points* (for example, bedding attitudes and fossil localities), and *areas* or *polygons* (for example, map-unit areas and zones of alteration). In addition, each feature or object in the geologic map database has several associated *feature attributes*. The most basic feature attributes may simply identify the feature (for example, "thrust fault" or "overturned anticline") and express its scientific confidence and locational accuracy (for example, "identity certain" or "location inferred"). Other feature attributes may consist of detailed descriptions of each feature (for example, the lithologic characteristics of a map unit, the dip of a mapped fault, or the identification and age determination of a fossil specimen).

When a geologic map is generated as a cartographic product from a geologic map database, each geologic feature is represented by a specific *geologic map symbol*. The attributes in the database provide the information needed to symbolize each feature. In addition, *annotation* is added to the geologic map wherever necessary to identify the various features (for example, map-unit labels and fault names) and to provide essential quantitative information (for example, dip values and fossil-locality numbers).

3.3 GEOLOGIC MAP UNITS

A *geologic map unit* is a cartographic representation of a volume of geologic materials that share enough characteristics (for example, the composition, areal extent, age, and (or) genesis) to be considered a single entity (a single geologic unit). On a typical geologic map, most geologic units are represented by polygons that are filled with colors and (or) patterns. Geologic units can also be represented by lines (for example, dikes) or points (for example, blueschist blocks).

The *formation*, whether formal or informal, is the lithostratigraphic unit most commonly depicted on a geologic map. A formation can be subdivided into lower rank stratigraphic units (for example, members, tongues, lentils, or beds) or assembled with other formations to make up more generalized, higher rank stratigraphic units (for example, groups or supergroups), depending on the scale of the map or the focus of the geologist (see guidelines for the recognition and naming of geologic units by the North American Commission on Stratigraphic Nomenclature, 1983).

3.3.1 Geologic Time, the Ages of Rock Units, and Geologic Age Symbols

The USGS has published a scheme for the major divisions of *geologic time*, the age estimates of the boundaries, and the specialized *geologic age symbols* to be used on geologic maps (Hansen, 1991). This particular scheme was formally adopted after a 1980 meeting of the Geologic Names Committee of the USGS (Hansen, 1991). In addition, several other schemes of geologic time boundaries have been published (see, for example, Harland and others, 1982, 1989; Palmer, 1983; Snelling, 1985; Berggren and others, 1995; Gradstein and Ogg, 1996; Haq and van Eysinga, 1998; International Union of Geological Sciences, 1998; Palmer and Geissman, 1999), each of which is based on different assumptions, techniques, and (or) data. Any formally published age scheme may be used for a particular map, as long as which scheme was used is specified on the map and in the geologic map database.

3.3.2 Map-Unit Labels

A *map-unit label* is an alphanumeric symbol that identifies the geologic map unit on the map. The map-unit symbol is an abbreviated acronym that usually is made up of, in the following order, (1) either capital letters or geologic age symbols indicating the age of the geologic unit (see Appendix A, Section 32), and (2) lower case letters denoting the name or the lithologic characteristics of the geologic unit. In some cases, numerical subscripts are added to designate different subunits (for example, members or individual lava flows) within a geologic unit.

Map-unit labels are added to the geologic map wherever necessary to clearly identify the various geologic map units. In addition, map-unit labels are included among the feature attributes in the geologic map database, thereby designating each mapped area as belonging to a particular geologic map unit.

3.4 PLANAR GEOLOGIC FEATURES

A *planar geologic feature* is a two-dimensional geologic surface, which may be either a real-world, physical surface (for example, a contact between two geologic units) or a hypothetical surface (for example, an axial surface of a fold). The geometry of the geologic surface may be flat, curved, or crenulated, and its orientation may be horizontal, inclined, vertical, or overturned.

The intersection of a planar geologic feature with the ground surface forms a real or perceived (projected) linear trace. When these linear traces are mapped in the field and then plotted as lines on a base map, they become the most basic and fundamental elements of a typical geologic map: they may delineate simple map-unit areas, or they may define complex patterns of structural deformation. The various types of linear traces are portrayed on a geologic map by unique line symbols (Appendix A), each of which has a different width, pattern, ornamentation, or color; thus, a particular line symbol conveys specific information about the character and (or) geometry of each planar geologic feature.

3.4.1 Contacts

A *contact* is a planar surface that bounds a geologic unit (except where that bounding surface is a fault; see discussion below in Section 3.4.3, entitled "Faults"). A contact is intrinsic to the genesis of each geologic unit; that is, the contact delineates the stratigraphic position where, owing to changing environmental conditions or other genetic factors at the time of origin, the properties and characteristics of one geologic unit change, either abruptly or gradually, to those of another geologic unit.

Discussion of contacts in this standard primarily pertains to those that have been mapped in the field (for example, contacts that bound formations, members, beds, lava flows, or intrusions). Contacts can also exist between higher rank units, although these contacts typically are not mapped in the field; instead, they are concepts that may arise later when lower rank stratigraphic units are combined into higher rank stratigraphic units (see discussion of lithostratigraphic boundaries by the North American Commission on Stratigraphic Nomenclature, 1983, p. 856–58).

Contacts can be classified as one of a number of types, depending on the nature or origin of the contact and the geologic units that it separates. Examples of such contact types include the following: sedimentary (conformable; unconformable, etc.); alluvial; landslide; residual; igneous (intrusive, extrusive, pyroclastic); metamorphic; and high-strain (cataclastic, mylonitic, tectonic). If available, supplemental information about a contact's type is added as a feature attribute to the geologic map database; however, specialized line symbols usually are not used to represent these various contact types. In general, unless otherwise stated on the geologic map or in the geologic map database, contacts should be considered generic; that is, they have no particular type or identity.

The geologic age of a contact also may be specified as a feature attribute in the geologic map database, but rarely is this characteristic symbolized on the geologic map; if desired, such information can be communicated by the addition of geologic point data or annotation placed along the trace of the contact. In addition, specific information collected about a contact's local surface exposure, orientation or character can be added as geologic point data and annotation placed along the trace of the contact where the observation was made.

3.4.1.1 Discrete versus Gradational Contacts

In the field, a contact between two geologic units is a transition zone whose width can range from very narrow to very broad. Examples of transition zones include the following:

- a single surface, as sharply delineated as a knife-edge, between two lithologically distinct geologic units;
- a single surface that zigzags between two intertonguing geologic units;
- a narrow zone, a few centimeters to a few decimeters wide, in which the lithologic character changes from one geologic unit to another;
- a diffuse zone, a few meters to many meters wide, in which the lithologic character of one geologic unit gives way gradually to that of another geologic unit.

Despite the differences inherent in each of these examples, contacts generally can be classified as either one of two types of transition zones: *discrete* or *gradational*. A precise definition of the width of a discrete versus a gradational contact, however, is difficult because of (1) different scales of mapping (for example, a contact that is gradational at a scale of 1:24,000 would probably be considered discrete at a scale of 1:100,000); (2) differing interpretations that can arise between geologists whose mapping primarily focuses on either sedimentary, igneous, or metamorphic rocks (for example, contact relations that are considered gradational by a geologist who maps sedimentary rocks may be viewed as discrete by a geologist who maps plutonic rocks); and (3) differences in individual biases that may arise from different geologic-mapping traditions in geologically dissimilar parts of the Nation. Because of these and other factors, this standard makes no attempt to delimit the precise width of a discrete or a gradational contact. Nevertheless, this standard provides the following general definitions:

A *discrete* contact is a map-unit boundary that is individually distinct; that is, the transition between geologic units is abrupt enough to be recognized and delineated easily on the map. A discrete contact may be a sharp, knife-edged surface, or it may be transitional across a zone as wide as a meter or more, depending on the scale of the map.

A *gradational* contact is a map-unit boundary that is diffuse; that is, the transition between geologic units is gradual enough that it cannot be recognized or delineated easily on the map. A gradational contact is so diffuse across the transition zone (the width of which will vary at different map scales) that delineation of its exact position can be difficult.

The discrete versus gradational character of a contact is specified as a feature attribute in the geologic map database. In addition, if the map scale allows, gradational contacts can be represented on the geologic map by a specialized line symbol (see Appendix A, Section 1). Unless otherwise stated on the map or in the geologic map database, however, a generic contact (that is, one not represented by a specialized line symbol) should be considered discrete at the scale of the map.

3.4.2 Key Beds

A *key bed* is an easily identifiable stratigraphic marker bed within a geologic unit. Although a key bed is a three-dimensional volume rather than a two-dimensional surface, commonly it is too thin to depict as a map-unit area at most map scales, and so it usually is classified as a planar geologic feature.

Key beds are identified on the basis of their lithologic character and, in most cases, their relation to the surrounding rock materials. Examples of various types of key beds include the following:

- a coal bed;
- a fossiliferous horizon;

- a cross-cutting dike;
- a clay bed in a dominantly coarse-grained sedimentary sequence;
- a gravel bed in a dominantly fine-grained sedimentary sequence;
- a marine sedimentary bed in a dominantly nonmarine sedimentary sequence;
- a nonmarine sedimentary bed in a dominantly marine sedimentary sequence;
- a sandstone bed in a dominantly carbonate sedimentary sequence;
- a limestone bed in a dominantly dolomitic sedimentary sequence;
- a volcanic-ash bed or flow in a dominantly nonvolcanic sequence.

The type of key bed can be specified as a feature attribute in the geologic map database. In addition, some types of key beds are portrayed on the geologic map by specialized line symbols (see Appendix A, Section 1). In some cases, if the map scale allows, key beds are represented by colored or patterned areas. Map-unit labels are added to the geologic map to identify the various types of key beds shown on the map. In addition, map-unit labels are included among the feature attributes in the geologic map database to identify each key bed.

3.4.3 Faults

A *fault* is a planar surface of rupture along which geologic units have been fractured and then displaced. Faults can be geometrically complex structures that juxtapose map units over great distances, or they can be simple fracture planes along which the amount of offset is very small.

Discussion of faults in this standard primarily pertains to those that have been mapped in the field. Faults also can be required conceptually when lower rank stratigraphic units are grouped into higher rank units or tectonostratigraphic terranes, although these faults may not have been observed in the field.

Faults can be classified as one of a number of types, depending on the nature of their geometry and (or) sense of offset. Examples of fault types include the following: normal (low-angle, listric); reverse; thrust; overturned thrust; vertical; strike-slip (right-lateral, left-lateral); oblique-slip; detachment; or some combination of the above. Information about a fault's type is specified as a feature attribute in the geologic map database. When the map scale allows, such information also is represented on the geologic map by a specialized line symbol and (or) line-symbol decoration. A particularly robust set of specialized line symbols and line-symbol decorations has evolved to represent the various fault types (see Appendix A, Section 2). In general, unless otherwise stated on the map or in the geologic map database, faults that lack such specialized symbology should be considered generic; that is, their geometry or sense of offset either is not known or has not been specified.

The age of a fault also can be specified as a feature attribute in the geologic map database, but rarely is this characteristic symbolized on the geologic map; if desired, such information can be communicated through the addition of geologic point data or annotation placed along the trace of the fault. In addition, specific information collected about a fault's local orientation can be added as geologic point data and annotation placed along the trace of the fault where the observation was made.

Some faults are relatively minor structures whose traces are mapped within single geologic units until the faults can no longer be observed or they no longer exist. More commonly, faults are mapped as larger, thoroughgoing structures that can produce a significant amount of offset between one or more geologic units, so that the rupture surfaces form new map-unit boundaries. In addition, faulting sometimes can take place at the stratigraphic position where a contact would normally exist between two stratigraphically coherent geologic units. But because faulting is not a process intrinsic to a geologic units' genesis (in these cases, faulting has occurred through already-formed geologic units), these bounding surfaces do not meet the criteria to be called contacts (see discussion above in Section 3.4.1, entitled "Contacts"). Therefore, although they may form boundaries between geologic units, such structures are classified as "faults," not "fault contacts" or "faulted contacts."

3.4.3.1 Discrete Faults versus Fault Zones

In the field, a fault forms a zone of offset whose width can range from very narrow to very broad. Examples of such zones of offset include the following:

- a single offset-fracture surface, as sharply delineated as a knife-edge;
- a narrow zone of offset, a few centimeters to a few decimeters wide;
- a diffuse zone, a few meters to many meters or as much as a kilometer or more wide, within which offset has been distributed among a few or many shear planes.

Despite the differences inherent in each of these examples, faults generally can be described in either one of two ways: as a *discrete fault* or as a *fault zone*. A precise definition of the width of a discrete fault versus a fault zone, however, is difficult for a number of reasons (see related discussion above in Section 3.4.1.1, entitled "Discrete versus Gradational Contacts"), and this standard makes no attempt to do so. Nevertheless, this standard provides the following general definitions:

A *discrete fault* is a zone of offset that is individually distinct; that is, the zone is narrow enough to be recognized and delineated easily on the map. A discrete fault may be a sharp, knife-edged surface of offset, or it may be a zone of offset as wide as a meter or more, depending on the scale of the map.

A *fault zone* (also called a *shear zone*) is a diffuse zone within which offset has been distributed among a few or many shear planes, commonly resulting in a zone of crushed and sheared or ductily deformed rock. In some cases, a fault zone can be mapped as an area bounded by discrete fault planes.

The character of a fault (discrete fault versus fault zone) is specified as a feature attribute in the geologic map database. In addition, a fault zone can be portrayed either by a specialized line symbol or, if the map scale allows, by a colored or patterned area (see Appendix A, Section 2). Unless otherwise stated on the map or in the geologic map database, a generic fault (that is, one not portrayed as an area or by a specialized line symbol) should be considered discrete at the scale of the map.

3.4.4 Folds

In its simplest sense, a *fold* is a geologic structure that results when a flat-lying or otherwise undeformed geologic surface is warped and deformed into an undulating geologic surface. In reality, many fold structures further deform bodies of rock that may already be highly deformed and (or) metamorphosed. Thus, folds may form simple, symmetric structures, or they may form complex, multidimensional and multigenerational fold systems.

The *fold axis* or *hinge line* of a fold is a hypothetical line that traces the locus of maximum curvature of the fold structure. The *axial surface* or *axial plane* of a fold is a hypothetical planar surface that connects the fold axes or hinge lines of folded strata.

Folds can be classified as one of a number of fold types, depending on the geometry of the fold's axial surface and the geometry and the relative ages of the folded strata. Examples of fold types include the following: anticline, syncline, monocline; antiform, synform; symmetrical, asymmetrical, overturned, inverted, isoclinal, recumbent, and plunging.

Information about a fold's type is specified as a feature attribute in the geologic map database. In addition, such information is portrayed on the geologic map by specialized line symbols and line-symbol decorations (see Appendix A, Section 5). On a geologic map, a fold is mapped as a line where the trace of its axial surface intersects the ground surface. In some cases, the trace of a fold's *crest line* (highest point on a fold's crest) or *trough line* (lowest point in a fold's trough) can also be mapped.

The age of a fold also can be specified as a feature attribute in the geologic map database, but rarely is this characteristic symbolized on the geologic map; if desired, such information can be communicated through the addition of geologic point data or annotation placed along the trace of the fold. In addition, specific data collected about a fold's local orientation can be added as geologic point data and annotation placed along the trace of the fold where the observation was made.

3.5 LINEAR GEOLOGIC FEATURES

A *linear geologic feature* is a one-dimensional geologic or geomorphic line, which may be either a real-world, physical line (for example, a moraine, lineament, or outcrop-scale lineation) or a hypothetical line (for example, a hinge line of a fold or a paleocurrent direction). The geometry of the line may be straight, curved, or crenulated, and its orientation may be horizontal, inclined, or vertical.

The orientations of linear geologic features are mapped in the field and then plotted as lines on a base map. Information about the various types of linear geologic features is specified as a feature attribute in the geologic map database. In addition, such information is represented on a geologic map by a unique line symbol (Appendix A), each of which has a different width, pattern, ornamentation, or color; thus, a particular line symbol conveys specific information about the character and (or) geometry of each linear geologic feature.

3.6 GEOLOGIC POINT FEATURES

A *geologic point feature* consists of geologic or geomorphic information that has been collected at a particular point of observation in the field (except when that point feature is a line-symbol decoration; see discussion below in Section 3.6.3.2, entitled "Line-Symbol Decorations"). In some field situations, more than one observation can be taken at a single locality.

Geologic point data may pertain to a planar feature (for example, the orientation of bedded strata), a linear feature (for example, the plunge of a fold axis), or a single locality (for example, a fossil locality). Geologic point data also can be added as line-symbol decorations (for example, anticline arrows) that provide supplemental information about a particular part of a line on a geologic map.

Geologic point data are recorded in the field and then plotted as points on a base map. Information about the various types of geologic point data is specified as a feature attribute in the geologic map database. In addition, such information usually is represented on a geologic map by specialized point symbols and associated annotation (Appendix A).

3.6.1 Planar-Feature Geologic Point Data

Planar-feature geologic point data consist of quantitative information about the character and the orientation of a geologic surface, which may be a physical surface (for example, a fault plane or bedded strata) or a hypothetical surface (for example, an axial surface of a fold or a plane of foliation). The geologic surface may be horizontal, inclined, vertical, or overturned.

Two measurements, the *strike* and the *dip*, define the orientation of a geologic surface in three-dimensional space:

- the *strike* of a surface is the azimuthal direction of a hypothetical line formed by the intersection of the surface with an imaginary horizontal surface, as measured in the direction that the observer is facing when the surface dips down to the right (this method of directional measurement follows the *right-hand rule* convention);
- the *dip* of a surface is the angle of departure of that surface downward from horizontal, as measured perpendicular to the line of strike.

Information about the type of observation, as well as the values of strike and dip, is specified as feature attributes in the geologic map database. Such information also is represented on the geologic map by specialized point symbols and associated annotation: the strike value and the direction of dip are implicit in the orientation of the point symbol; the dip value is added as annotation.

3.6.1.1 Point Symbols for Planar Features, and Their Placement Relative to Point of Observation

The point symbols for inclined or overturned planar features typically are made up of two parts: a long shaft oriented in the strike direction, and a short tick (or ornamentation such as a triangle) pointing in the downdip direction. The point symbol is placed on the map so that the intersection of its long shaft and short tick (or ornamentation) is at the point of observation. When data have been collected about the local orientation of a planar feature that has been represented on the map by a line symbol (for example, the dip of a contact or a fault), the point symbol is placed directly on the line symbol at the point of observation.

The point symbols for vertical planar features are similar to those for inclined surfaces, except that two short ticks (or ornamentations), not one, point away from the long shaft. The point symbol is placed on the map so that the intersection of its long shaft and short ticks (or ornamentations) is at the point of observation.

The point symbols for horizontal planar features, which display no directional information, are simply placed on the map at the point of observation.

3.6.1.2 Specialized Planar-Feature Point Symbols for Multiple Observations at One Locality

In situations where more than one observation has been taken at a single locality, point symbols for planar features can be combined with other point symbols at the point of observation. In these cases, specialized point symbols may be used to avoid the overprinting of information. These specialized point symbols have the short ticks (or ornamentations such as triangles) moved down near the end of the long shafts; the symbols are joined at their endpoints (opposite the ticks or ornamentations) at the point of observation.

3.6.2 Linear-Feature Geologic Point Data

Linear-feature geologic point data consist of quantitative information about the orientation of a geologic or geomorphic linear feature, which may be a physical line (for example, a fault-plane groove or slickenline) or a hypothetical line (for example, the intersection of two surfaces of deformation). The geologic or geomorphic linear feature may be horizontal, inclined, or vertical.

Two measurements, the *bearing* and the *plunge*, define the orientation of a geologic or geomorphic line in three-dimensional space:

- the *bearing* of a line is the azimuthal direction of the trend of that line, as measured in its direction of plunge;
- the *plunge* of a line is the angle of departure of that line downward from horizontal.

Information about the type of observation, as well as the values of bearing and plunge, is specified as attributes in the geologic map database. Such information also is represented on the geologic map by specialized point symbols and associated annotation: the bearing value and the direction of plunge are implicit in the orientation of the point symbol; the plunge value is added as annotation.

3.6.2.1 Point Symbols for Linear Features, and Their Placement Relative to Point of Observation

The point symbols for inclined linear features typically are made up of two parts: a shaft oriented in the bearing direction, and an arrowhead pointing in the plunge direction. The symbol is placed on the map so that the end of its shaft opposite the arrowhead is at the point of observation. When data have been collected about the local orientation of a linear feature that has been represented on the map by a line symbol (for example, a lineation on a fault), the point symbol is placed directly on the line symbol at the point of observation.

The point symbols for horizontal linear features are similar to those for inclined linear features, except that arrowheads are at both ends of the long shaft. The symbol is placed on the map so that the middle of its shaft is at the point of observation.

The point symbols for vertical linear features, which display no directional information, are simply placed on the map at the point of observation.

In situations where more than one observation has been taken at a single locality, point symbols for linear features can be combined with other point symbols at the point of observation. When a single linear-feature observation and a single planar-feature observation are taken at a single locality, the symbols are combined so that the end of the arrow that represents the linear feature is placed at the intersection of the planar-feature point symbol's long shaft and short tick (or ornamentation). When more than two such observations are taken at a single locality, the point symbols for linear features are joined at their endpoints with the specialized point symbols for planar features (see Section 3.6.1.2 above, entitled "Specialized Planar-Feature Point Symbols for Multiple Observations at One Locality") at the point of observation.

3.6.3 Informational Geologic Point Data

Informational geologic point data consist of geologic information that is supplemental to a typical geologic map or its features. Informational geologic point data are divided into two types: *locality-information point data*, and *line-symbol decorations*.

3.6.3.1 Locality-Information Point Data

Locality-information point data record information collected at a particular locality (for example, fossil localities or sample localities). The type of data collected at the locality is specified as a feature attribute in the geologic map database. In addition, such information commonly is represented on the geologic map by a specialized point symbol placed at the point of observation. Sample numbers or other identifying labels are added as annotation near the point symbols.

3.6.3.2 Line-Symbol Decorations

Line-symbol decorations are specialized point symbols that convey qualitative information about the character of a particular line or line segment (for example, anticline arrows or ball-and-bar symbols). The type of line-symbol decoration is specified as a feature attribute in the geologic map database. Line-symbol decorations are not placed at a specific point of observation because they do not represent information collected at a particular locality; instead, they should be placed at a strategic location (or locations) along the trace of a line symbol in order to clearly communicate information about the nature of that line.

4. SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY OF GEOLOGIC FEATURES

Another important concept in geologic mapping is a geologist's level of confidence in the interpretation of features observed in the field. Many factors can adversely affect a geologist's level of confidence when mapping, and field situations often arise in which the interpretation of a feature may be in question, as indicated by the following examples:

- a planar feature is well-exposed in outcrop, but it is not easily identifiable as either a contact or a fault;
- a contact is clearly exposed in a roadcut, but its trace cannot be followed away from that roadcut;
- a fault's trace is obscured by vegetation, and so both its location and its sense of offset cannot be definitively determined;
- a fault's trace is completely concealed beneath valley fill.

As these examples show, uncertainties can exist in either the scientific interpretation or the mapped location of a feature (or in both). Therefore, not only is it important to communicate to the map user the level of confidence in each geologic map feature, but also which type of uncertainty (scientific and (or) locational) may be associated with that feature.

Traditionally, a system of solid, dashed, dotted, or queried line symbol styles (see, for example, Ridgway, 1920, plate 2) has been used on geologic maps to show levels of locational accuracy of planar and linear geologic features observed in the field. This convention followed USGS Director Powell's 1888 policy, which stipulated that "fault lines (particularly when they are formation boundaries) shall be indicated when actually traced by somewhat heavy full lines in black; and when not actually traced, by similar broken lines" (Powell, 1890, p. 76). More guidance was provided in 1956 by USGS Chief Geologist W.H. Bradley, who, in a memorandum to USGS personnel regarding geologic map standards, stated, "The accuracy of location of faults and contacts should be shown by appropriate symbols … Solid lines should be used to indicate accurate locations of features that are geologically identifiable within the plottable limits of the map … Features that are only approximately located should be shown by long dashed lines; those that are indefinite or inferred, by short dashed lines; and those that are concealed, by dotted lines" (W.H. Bradley, written commun., 1956). To further encourage the use of such symbology, Bradley added, "The use of many dashed contacts or faults on a map is not to be construed as a detraction from the quality of the map, and for many maps, it may be undesirable or impossible to achieve sufficiently accurate locations to permit use of solid lines. The quality of the map is not impaired so long as the reader can interpret the accuracy of location" (W.H. Bradley, written commun., 1956).

In conjunction with these traditional line symbol styles, geologists at various times have used terms such as "known," "probable," "certain," "uncertain," "accurately located," "approximately located," "inferred," "projected," "concealed," and "queried" to express the levels of confidence of planar and linear geologic features. However, these terms and their associated line symbol styles have not been used consistently from region to region or from map to map. Also, it has not been always clear whether they reflect uncertainty in a feature's scientific interpretation, its mapped location, or both.

To facilitate the communication of geologic map information, this standard clarifies the concepts of, and establishes the attributes for, the levels of scientific confidence and locational accuracy of geologic map features. In addition, to facilitate the cartographic representation of geologic map information, this standard establishes new terminology that expresses both these concepts.

4.1 SCIENTIFIC CONFIDENCE

Scientific confidence expresses a geologist's level of certainty regarding the nature, origin, geometry, identity, and even the existence of a geologic feature. The characteristics of the geologic materials and structures, the number of outcrops, and the availability of subsurface or geophysical data directly affect the level of scientific confidence in any area. Experience and resources available to a geologist also affect scientific confidence. These fundamental characteristics of geologic features can be grouped into two distinct but related concepts, *identity* and *existence*.

4.1.1 Identity

Identity expresses whether or not the observations and data support the stated nature, origin, or geometry of a mapped geologic feature (for example, a contact versus a fault, or a normal fault versus a thrust fault). The concept of identity is communicated in the following two ways:

- in the geologic map database, the attribute describing the confidence in a feature's identity is specified as either *certain* or *questionable*;
- on the geologic map, the confidence in a feature's identity is communicated in the symbol explanation and (or) the map unit description (see Section 4.1.3 below, entitled "Levels of Scientific Confidence") and also, for some types of geologic map features, conveyed cartographically (see Section 4.1.4 below, entitled "Cartographic Representation of Scientific Confidence").

4.1.2 Existence

Existence expresses whether or not the observations and data support the continuity or existence of a concealed or an otherwise unseen geologic feature (for example, a postulated fault or a subsurface fault). The concept of existence is communicated in the following two ways:

- in the geologic map database, the attribute describing the confidence in a feature's existence is specified as either *certain* or *questionable*;
- on the geologic map, the confidence in a feature's existence is communicated in the symbol explanation and (or) the map unit description (see Section 4.1.3 below, entitled "Levels of Scientific Confidence") and also, for some types of geologic map features, conveyed cartographically (see Section 4.1.4 below, entitled "Cartographic Representation of Scientific Confidence").

4.1.3 Levels of Scientific Confidence

A geologic map must communicate to the map user the level of scientific confidence associated with each mapped feature (both its identity and its existence). In a geologic map database, this information is contained in two attribute fields, identity (*certain*, *questionable*), and existence (*certain*, *questionable*). To facilitate the communication of the two concepts of identity and existence on a geologic map, this standard sets forth the following new terminology, which expresses clearly yet concisely the levels of scientific confidence of geologic features (see Figure 1 for the relation of this new terminology to historically used terminology):

"*Identity and existence certain*" Both the identity and the existence of a feature can be determined using relevant observations and scientific judgment; therefore, one can be reasonably confident in the scientific credibility of this interpretation. These criteria are met, for example, when a geologist reasons, "*I am* *certain that the planar feature I see in this outcrop is a fault.*" This is the default condition for all geologic map features unless otherwise stated on the geologic map or in the geologic map database.

"*Identity or existence questionable*" Either the identity or the existence of a feature cannot be determined using relevant observations and scientific judgment; therefore, one cannot be reasonably confident in the scientific credibility of this interpretation. These criteria are met, for example, when a geologist reasons, "*I can see some kind of planar feature in this outcrop, but I cannot be certain if it is a contact or a fault*," or, "*My interpretation requires that a thrust fault be present to account for incongruities in the stratigraphy of these rocks, but I can't be certain because I haven't yet seen one here*."

This new terminology is intended to be used when choosing a particular style of symbol to represent a feature on a geologic map (Fig. 2), as well as when describing that feature in the symbol explanation (see Preface to Appendix A) and (or) the map unit description. If a feature is symbolized or described as "identity or existence questionable," the map user should consult the geologic map database for more complete information.

4.1.4 Cartographic Representation of Scientific Confidence

For most types of geologic map features, queries are used to communicate the lack of scientific confidence in a feature. A queried line symbol indicates that either the identity or the existence of a planar or linear feature may be in question (Figs. 1,2; see also, Appendix A); the map user should consult the geologic map database for more complete information. In contrast, a line symbol without a query most likely indicates that both the identity and the existence of a planar or linear feature are certain, unless otherwise stated in the geologic map database.

For geologic point data, queries are not added to point symbols to indicate that the scientific confidence of a feature may be in question. However, a limited amount of specialized symbology has evolved to express the scientific confidence of certain types of geologic point information; for example, to indicate that the direction of stratigraphic top is known, a small ball may be added to bedding and foliation symbols (see Appendix A, Sections 6 and 8, respectively). In addition, queries may be added to dip or plunge values, both on the geologic map and in the geologic map database, if those measurements are questionable.

A queried map-unit label indicates that either the identity or existence of the geologic map unit may be in question.

4.2 LOCATIONAL ACCURACY

Locational accuracy is based on the relation between a mapped feature's location in the field and its position on the base map. Information about the locational accuracy of mapped features is important to all disciplines, even those in which mapped features commonly are directly observable and can be positioned with a significant degree of accuracy (for example, roads or utilities). It is especially critical in the natural sciences, however, because many mapped features are either interpretive or not directly observable.

The process of locating a feature in the field and then positioning it on a base map is complex, and the locational accuracy of a mapped feature is not easily described or quantified. To evaluate the locational accuracy of a mapped feature, a geologist must consider the following three factors:

- the nature of the feature and its degree of exposure (for example, a contact may be gradational or sharp, and either poorly exposed or well-exposed);
- the quality of the base map (for example, whether the cultural or topographic features on the base map are positioned accurately, according to the geologist’s observations);
- the confidence in accurately positioning the feature relative to the base-map information.

Together, these factors determine a geologist's confidence in the locational accuracy of the features on the map. Locational accuracy is expressed by two distinct but related concepts, *locatability* and *positioning*.

4.2.1 Locatability

Locatability expresses whether or not a geologist can clearly observe a feature *in the field*, as indicated by the following examples:

- a planar or linear feature is observable in several outcrops along its trace;
- a planar or linear feature is not defined by a distinctive physical trace and so is not observable beneath either vegetation, a thin veneer of unmapped geologic material (colluvium, eolian deposits, or residual soil), or man-made features, therefore its location must be inferred by indirect means;
- a planar or linear feature is not observable because it is concealed by an overlying geologic map unit, water, or ice, although it may be observable nearby (for example, a thrust fault is visible on both sides of a glacial valley, but its location within the valley is concealed by glacial deposits), and so its location must be projected beneath the overlying map unit.

As the above examples show, uncertainty in a feature's locatability can arise in a number of geologic situations. The concept of locatability is communicated in the following two ways:

- in the geologic map database, the attribute describing the confidence in a feature's locatability is specified as either *observable*, *inferred*, or *concealed*;
- on the geologic map, the confidence in a feature's locatability is communicated in the symbol explanation and (or) the map unit description (see Section 4.2.3 below, entitled "Levels of Locational Accuracy") and also, for some types of geologic map features, conveyed cartographically (see Section 4.2.4 below, entitled "Cartographic Representation of Locational Accuracy").

4.2.2 Positioning

Positioning expresses the degree of confidence with which a feature is plotted *on the base map*. Commonly, a feature can be accurately plotted on the map because the base-map information is accurate, detailed, and distinctive. However, in some field situations, a feature cannot be confidently plotted on the base map, as indicated by the following examples:

- a feature is observable, but its position on the map cannot be plotted accurately because topographic contours, drainage lines, or cultural information on the base map is insufficiently detailed for the feature to be confidently located relative to the various base-map features (for example, a contact is observable in outcrop, but its location in relatively featureless terrain prevents its position from being plotted accurately on the base map);
- a feature is observable, and its geographic coordinates can be determined in the field by either triangulation or a Global Positioning System (GPS) device or in the laboratory by using a georeferenced aerial photographic stereopair; however, the geographic relation between these coordinates and the topographic or cultural setting shown on the base map is not compatible (for example, a feature was mapped on a hillside, but the GPS-derived coordinates, when plotted on the base map, place its position in a valley bottom).

In such situations, either a feature can be plotted relative to the indistinct or incompatible base-map features, or the locations of topographic contours or other base-map features can be adjusted (the latter approach is not encouraged unless it is done systematically and is well-documented). In either case, the inherent uncertainty in a feature's positioning must be communicated to the map user, both on the geologic map and in the geologic map database (see discussion in Section 4.2.2.1 below, entitled "Specifying Positional Accuracy with the Zone of Confidence").

In the USGS, stringent policies for the accuracy with which an observable feature can be positioned on the base map have been put forth in the past. For example, Chief Geologist W.H. Bradley's 1956 memorandum to the staff advocated a geologic map accuracy standard based on the United States National Map Accuracy Standards (NMAS) for topographic and other types of base maps. The geologic map adaptation of the NMAS stipulated that "features that … can be located from exposures or other evidence [should be positioned] within 1/25 inch [on the map] of their true map position" (W.H. Bradley, written commun., 1956; see also, U.S. Geological Survey, 1995a, Part 1, p. 1.0-4). These earlier efforts to quantify the positional accuracy of geologic features were not widely adopted by the geoscience community, likely in part because of (1) the difficulty in translating to geologic mapping a concept designed for topographic and other types of base maps, (2) the impracticality of requiring that all geologic map information meet the same accuracy criteria uniformly across the Nation, in all types of geologic and topographic settings, and (3) the need to convert ground distance to publication-scale cartographic units before evaluating if a feature is plotted accurately on a base map.

In contrast, this standard advocates a more flexible and conceptually simpler approach in which the accuracy criteria can be defined for each project so that the specified positional accuracy takes into account the character of the geologic setting and other factors (see below). In addition, if the geologic map adaptation of the NMAS (1/25 inch on the map) has been used when mapping, this value can be specified (1/25 inch on the map must first be converted to ground units).

4.2.2.1 Specifying Positional Accuracy with the Zone of Confidence

When a feature is drawn or digitized onto a base map, a geologist commonly has some sense of confidence regarding whether or not the feature is positioned accurately, depending on the quality of the base map and the ability to position features on that base map. This positioning confidence can be characterized as the likelihood that the feature actually occurs within a certain, roughly defined distance from where it is positioned on the base map. This hypothetical distance, which extends outward from a feature’s position on the map, is herein defined as the *zone of confidence*, and its numerical value quantifies a feature’s positional accuracy as follows:

- for planar and linear geologic features, the *zone of confidence* borders the feature along both sides, forming what is described in GIS terminology as a buffer zone, and its numerical value is specified as the approximate distance in ground units (feet or meters) from the feature to the edge of the buffer zone (Fig. 3);
- for geologic point features, the *zone of confidence* is concentric around the feature, forming a circle, and its numerical value is the approximate radius of that circle (Fig. 3).

For any geologic map or mapped area, the numerical value of the zone of confidence will depend on a number of factors: the area's geology, landscape terrain, vegetation cover, and (or) cultural features; the scale of mapping; the quality and nature of the base map used; and (or) a particular project's allotted field-mapping time or other logistical constraints. Because this standard recognizes that the factors affecting the value of the zone of confidence will vary from region to region (and from map to map), and because different agencies have differing mapping needs and mandates, a single, universally applicable value for the zone of confidence is not herein established. Instead, this standard advocates that the responsibility for setting the value of the zone of confidence for a particular geologic map or mapped area lies with each geoscience organization and each mapping geologist.

In the geologic map database, the attributes describing positioning confidence, which are expressed in terms of the zone of confidence, are as follows:

- a numerical value for the zone of confidence is specified (for example, *5 meters*);
- a feature's positioning is specified as being either "*within zone of confidence*" or "*may not be within zone of confidence*" (note that this standard does not stipulate that a feature whose positioning is specified as "may not be within zone of confidence" must *necessarily* be located outside the zone of confidence, but simply that it *may* be).

On the geologic map, positioning confidence is communicated in the symbol explanation and (or) the map unit description (see Section 4.2.3 below, entitled "Levels of Locational Accuracy") and also, for some types of geologic map features, conveyed cartographically (see Section 4.2.4 below, entitled "Cartographic Representation of Locational Accuracy"). In addition, the numerical value of the zone of confidence is indicated, either in a general statement (if one value applies to the entire mapped area) or shown in an index map (if different values apply to different mapped areas; see Section 4.2.2.2 below, entitled "Accommodating Different Values of the Zone of Confidence"). Likewise, if the geologic map adaptation of the NMAS (1/25 inch on the map, converted to ground units) has been used during field mapping as a measure of positioning confidence, or if a zone of confidence was not used during field mapping or map compilation, this also is indicated.

Symbol style[1]	Examples of historically used terminology	Newly revised FGDC standard terminology	Scientific confidence		Locational confidence	
			Identity …	**Existence …**	**Location (in field) …**	**Position (on map) …**
————————	certain; known; accurately located	identity and existence certain, location accurate[2]	certain	certain	observable	within zone of confidence[6]
————?————	[not available for newly defined symbol]	identity or existence questionable, location accurate	may be questionable	may be questionable	observable	within zone of confidence
— — — — — —	approximately located	identity and existence certain, location approximate[3]	certain	certain	observable	may not be within zone of confidence
— — —?— — —	approximately located, queried	identity or existence questionable, location approximate	may be questionable	may be questionable	observable	may not be within zone of confidence
– – – – – – – – – – – – –	inferred; probable; projected	identity and existence certain, location inferred[4]	certain	certain	inferred (between outcrops or beneath rubble or vegetation)	may not be within zone of confidence
– – –?– – –?– – –?– – –	inferred, queried	identity or existence questionable, location inferred	may be questionable	may be questionable	inferred (between outcrops or beneath rubble or vegetation)	may not be within zone of confidence
- - - - - - - - - - - - - - - - - - -	concealed; projected	identity and existence certain, location concealed[5]	certain	certain	concealed (beneath overlying map unit, ice, or water)	may not be within zone of confidence
- - - - -?- - - - -?- - - - -?- - - - -	concealed, queried	identity or existence questionable, location concealed	may be questionable	may be questionable	concealed (beneath overlying map unit, ice, or water)	may not be within zone of confidence

[1] Queries are added to symbols to indicate that a feature's scientific confidence (that is, either its identity or its existence) may be in question.

[2] The term "location accurate" is used when a feature is observable, and its plotted position on the map is within the zone of confidence.

[3] The term "location approximate" is used when a feature is observable, but its plotted position on the map may not be within the zone of confidence.

[4] The term "location inferred" is used when a feature's location must be inferred between outcrops or beneath rubble or vegetation, and so its plotted position on the map may not be within the zone of confidence.

[5] The term "location concealed" is used when a feature is concealed beneath an overlying map unit, ice, or water, and so its plotted position on the map may not be within the zone of confidence.

[6] The zone of confidence for a particular map or mapped area is specified by the mapping geologists and their agencies.

Figure 1. Diagram showing relation of new FGDC standard terminology to historically used terminology and to traditional line symbol styles.

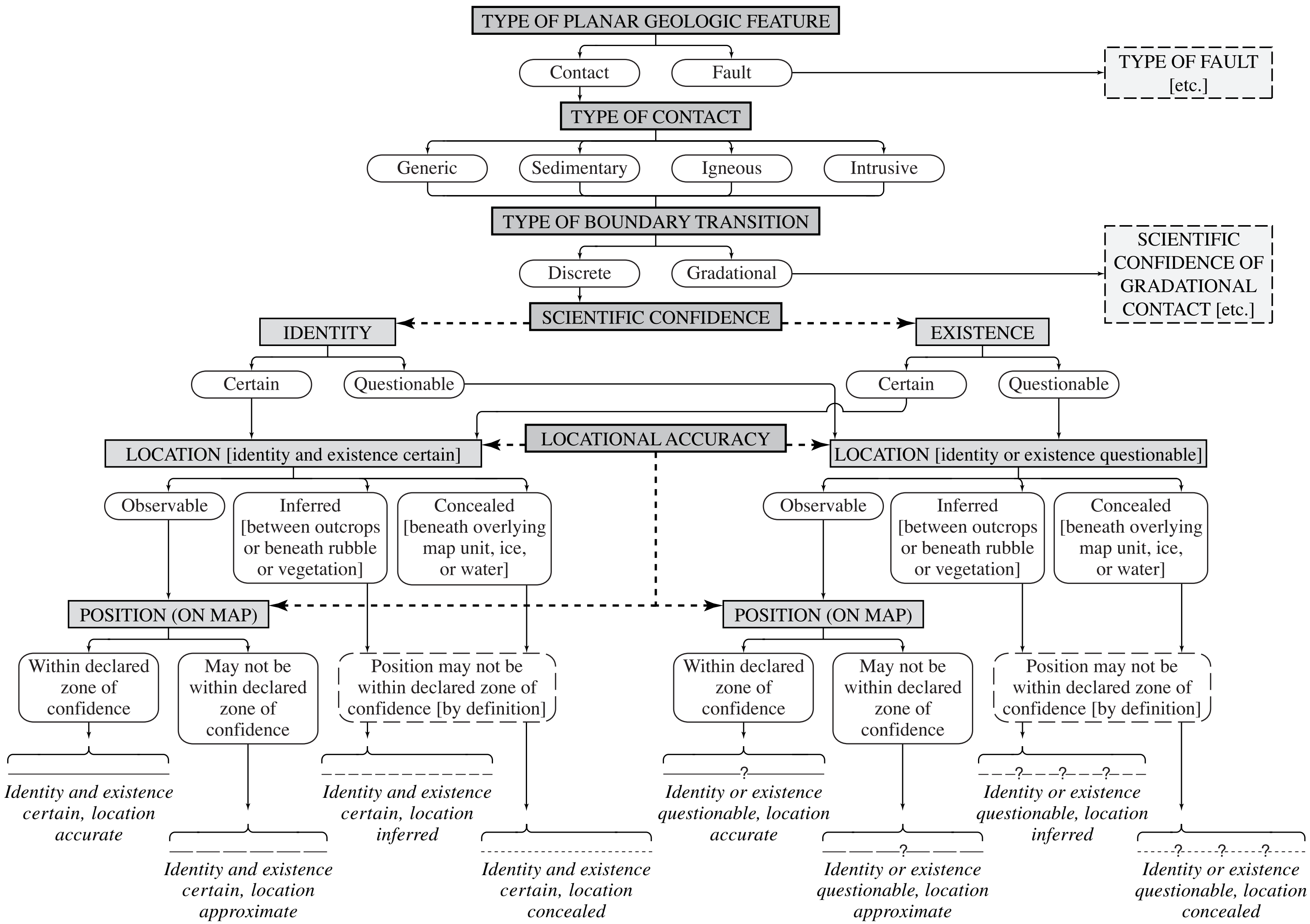

Figure 2. Flowchart showing example of logical steps that might be used to determine appropriate line symbol styles and associated terminology (in italics).

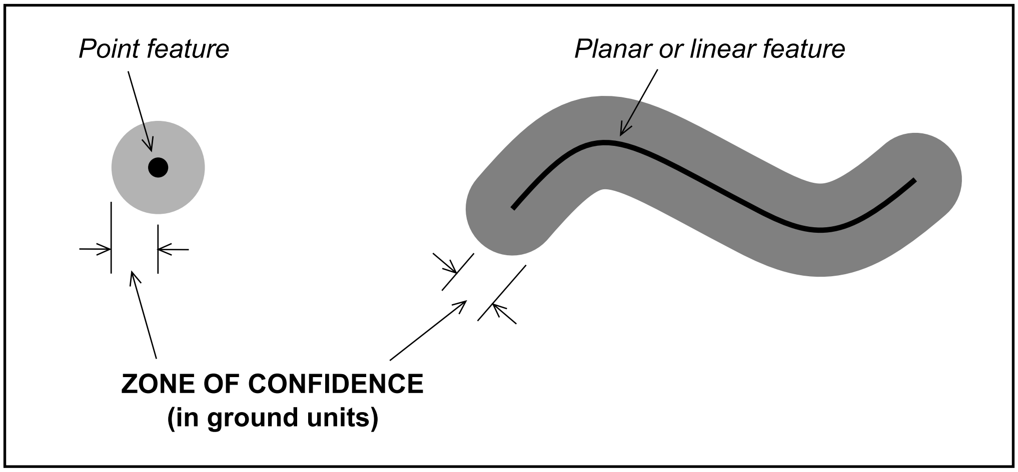

Figure 3. Figure showing examples of the zone of confidence for planar, linear, and point features. The region within which a *point* feature can be considered to be accurately positioned (on a base map) is a circle (light-shaded area above) around the point, and the value of the zone of confidence is the radius of that circle, in ground units. For a *planar* or *linear* feature, the region is a buffer zone (dark-shaded area above) surrounding the line, and the value of the zone of confidence is the distance from the line to the edge of the buffer zone, in ground units.

• a planar or linear feature is observable in only a few outcrops along its trace, but its physical characteristics permit locating it between outcrops by indirect methods;

4.2.2.2 Accommodating Different Values of the Zone of Confidence

For many geologic maps or mapped areas, especially those that are defined by latitude and longitude (for example, quadrangle maps) or political boundaries (for example, state or county maps), one map may contain areas of vastly contrasting geology, topography, vegetation cover, and (or) societal infrastructure, and so different positional accuracy criteria can exist within a single map. For example, a geologic map may include both a mountain range underlain by well-bedded sedimentary rocks and a broad alluvial valley underlain by mostly surficial deposits. In the mountains, clear distinction among the sedimentary rocks, as well as their high relief, may provide a geologist with a significantly higher sense of confidence in the position of contacts than in the adjacent valley, where few topographic landmarks or contours exist and where contacts may be gradational and obscured by vegetation and soil cover. In geologic settings as diverse as these, the levels of confidence in positional accuracy will be different, and so a geologist has the following two choices:

• express the differences in positioning confidence solely by differences in symbology (for example, specify one zone of confidence value for both areas, which might result in mostly solid-line contacts in the mountains and mostly dashed- or dotted-line contacts in the valley);

• express the differences in positioning confidence by specifying different values of the zone of confidence for each area (for example, specify the zone of confidence value as 5 meters in the mountains and 15 meters in the valley).

The choice might depend on the magnitude of the difference between the areas, or on the geologist's level of confidence in the positional accuracy of features across the map area.

Map compilations represent another example where different positional accuracy criteria can exist within a single map. A map compilation is made up of several source maps or mapped areas, each of which may have had a different value specified for the zone of confidence (or perhaps no value had been specified). These variations in the specified value of the zone of confidence should be preserved in the map compilation as well.

In situations in which the numerical values of the zone of confidence are different for different areas across the geologic map, the differences must be communicated to the map user. In the geologic map database, variations in the value of the zone of confidence can be readily accommodated because each feature is assigned (as an attribute in the database) the value of the zone of confidence that has been specified for a particular area. On the geologic map, areas that have different values of the zone of confidence should be shown in an index map.

4.2.3 Levels of Locational Accuracy

A geologic map must communicate to the map user the level of locational accuracy associated with each mapped feature (both its locatability in the field and its positioning on the base map). In the geologic map database, this information is contained in the following three attribute fields: (1) locatability (*observable*, *inferred*, *concealed*); (2) positioning (*within zone of confidence*, *may not be within zone of confidence*); and (3) the numerical value of the zone of confidence (for example, *5 meters*).

To facilitate the communication of the two concepts of locatability and positioning on a geologic map, this standard sets forth the following revised terminology, which expresses clearly yet concisely the levels of locational accuracy of geologic features (see Figure 1 for the relation of this revised terminology to historically used terminology):

"*Location accurate*" A feature is observable, and its plotted position on the map is within the declared zone of confidence. These criteria are met, for example, when a geologist reasons, "*I can clearly see this contact in outcrop, and I can accurately plot its position on the map.*" This is the default condition for all geologic map features unless otherwise stated on the geologic map or in the geologic map database.

"*Location approximate*" A feature is observable, but its plotted position on the map may not be within the declared zone of confidence. These criteria are met, for example, when a geologist reasons, "*I can see this contact in outcrop, but I can't tell exactly where it is located because I am surrounded by trees*," or, "*I can see this contact in outcrop, but the poor quality of my base map prohibits me from accurately plotting its position*," or, "*I can see that the width of the gradational contact between these two map units exceeds my value of the zone of confidence, and so, although my base map is of high quality, my confidence in the accuracy of its plotted position is not high.*"

"*Location inferred*" A feature is not directly observable between outcrops or beneath rubble or vegetation, so its location must be inferred by indirect means; by definition, its plotted position on the map may not be within the declared zone of confidence. These criteria are met, for example, when a geologist reasons, "*I can see by the change in debris materials visible around these gopher holes that a contact runs through here, but I can't locate it very precisely*."

"*Location concealed*" A feature is not observable because it is completely concealed beneath an overlying map unit or body of water or ice (although it may be observable nearby); by definition, its plotted position on the map may not be within the declared zone of confidence. These criteria are met, for example, when a geologist reasons, "*I can see that a contact is present on both sides of this lake, but I can't tell where it is located beneath the water*."

This revised terminology is intended to be used when choosing a particular style of symbol to represent a feature on a geologic map (Fig. 2), as well as when describing that feature in the symbol explanation (see Preface to Appendix A) and (or) the map unit description.

4.2.4 Cartographic Representation of Locational Accuracy

A system of solid, dashed, dotted, and queried line symbols has long been used on geologic maps to convey the uncertainty of planar and linear geologic features (Fig. 1), but it has not always been clear whether these line symbol styles reflect uncertainty in a feature's scientific interpretation, its mapped location, or both. This standard clarifies the use of these line symbols (Figs. 1,2) by applying its revised terminology for locational accuracy (see Section 4.2.3 above, entitled "Levels of Locational Accuracy") to the following line symbol styles[2]:

- a solid, continuous line symbol indicates that the location of a feature is accurate; that is, its location in the field either is readily observable in outcrop or is revealed by the characteristic geomorphic expression of its trace, without extensive cover of thin overlying surficial deposits, and is verifiable by shallow excavations; in addition, it can be accurately plotted because base-map information is accurate, detailed, and distinctive, and so its position on the base map is within the declared zone of confidence.
- a long-dashed line symbol indicates that the location of a feature is approximate; that is, its location in the field either is readily observable in outcrop or is revealed by the characteristic geomorphic expression of its trace, without extensive cover of thin overlying surficial deposits, and is verifiable by shallow excavations; however, it cannot be accurately plotted because base-map information is inaccurate, indistinct, or incompatible with the location of the geologic feature, and so its position on the base map may not be within the declared zone of confidence.
- a short-dashed line symbol indicates that the location of a feature is inferred; that is, its location in the field generally is obscured by overlying (unmapped) surficial deposits, debris materials, or vegetation that may cover exposures and the geomorphic expression of its trace, and has therefore been projected between few outcrops; by definition, its position on the base map may not be within the declared zone of confidence.
- a dotted[3] line symbol indicates that the location of a feature is concealed; that is, its location in the field is covered by a mapped overlying geologic unit or a mapped body of ice or water; by definition, its position on the base map may not be within the declared zone of confidence.

These types of line symbol styles (solid, long-dashed, short-dashed, and dotted) are intended to convey the various levels of locational accuracy of planar geologic features and certain types of linear geologic features.

The locational accuracy of a geologic map unit is not expressed by a specialized symbol but, instead, by the style of line symbols representing the planar features (contacts and faults) that bound it.

In most cases, specialized point symbols are not used to indicate that the locational accuracy of a geologic point feature may be in question. One exception is the specialized symbols that are used to portray bedding attitudes that have been determined using aerial photographs (see Appendix A, Section 6); however, these symbols also may be used to indicate that the scientific confidence (the measurement of dip) is in question, and so, when these types of symbols are used on a geologic map, the map user should consult the geologic map database for more complete information.

5. GUIDELINES FOR MAP COLOR AND PATTERN SELECTION

The goal in color design is to enhance the legibility of the map, as well as to lend meaning to the data presented by helping to focus attention on a particular map feature or group of features. Colors and patterns should not, however, be so visually dominant as to distract from the purpose of the map. A well-balanced color design can greatly improve the presentation of scientific information.

5.1 FACTORS THAT INFLUENCE COLOR AND PATTERN SELECTION

5.1.1 Purpose of Map

Color is used differently on different types of maps. For example, on geologic maps, color is primarily determined by age and type of rock, although other rules may apply for terrane maps or maps that portray only a

[2] Note that this standard restricts the use of queries to represent the lack of scientific confidence only (see discussion in Section 4.1.4 above, entitled "Cartographic Representation of Scientific Confidence").

[3] In reality, dotted line symbols that are thinner than a certain lineweight are difficult to produce with some software applications; therefore, this standard substitutes a very-short-dashed line symbol as the cartographic standard (see Figures 1,2; see also, Appendix A).

limited range of ages or types of rocks. In addition, some map units, because of their geologic or economic importance, may need to be emphasized by selected colors.

Geophysical maps use several color schemes, depending on the purpose of the data being shown; usually a range of colors from dark to light is used. One such scheme is a graduated set of hues of similar value (for example, purple and magenta to orange and red). Another is a rainbow of hues in which the values alternate between full color and lightly screened color.

On slope-stability maps, the brightest colors are used on areas of highest instability. Similarly, on volcanic- or earthquake-hazard maps, areas of greatest hazard usually are shown in red, whereas areas of lowest hazard are shown in yellow or green.

Data on hydrologic maps are frequently shown in two or three colors. On maps showing depth to water table, color ranges from light blue at the shallowest depths to dark blue at the greatest depths. On maps showing dissolved-solids concentrations, color ranges from dark blue where concentration is lowest to dark red where concentration is highest.

5.1.2 Age and Type of Rock

Whenever possible, colors for ages and rock types on geologic maps should follow the scheme presented in the diagram showing "Suggested Ranges of Map-Unit Colors for Volcanic and Plutonic Rocks and for Stratigraphic Ages of Sedimentary and Metamorphic Rocks" (see Appendix A, Section 33). However, it may not always be feasible to show map units in the suggested color; in these cases, other characteristics should be emphasized with color.

On surficial maps, for example, it may be desirable to show all glacial deposits in one color, landslide deposits in another, lacustrine deposits in another, and alluvial deposits in yet another. On terrane maps, color may be used to show lithotectonic relations between various groups of rocks.

On maps that are mostly one age group, it is best to distinguish sedimentary rocks from volcanic rocks (usually shown in reds or other bright colors) and plutonic rocks (usually shown in pinks). On maps that are mostly one type of rock, differentiation between different rock sequences can be shown through the use of different colors.

On maps that cover a broad range of ages and rock types, relations between rocks within one age group can be shown by using similar colors, whereas relations between the same type of rock in different age groups can be shown by using patterns (for example, all volcanic rocks may have the same "v" pattern). Patterns should be used sparingly, however, as their use can create an overly busy appearance; use them only when the complexity of the map requires the diversity achieved by the use of patterns.

Although it is preferable to follow the aforementioned guidelines, some rock types defy such guidelines because they traditionally have been shown in a particular color. For example, serpentinite and other ultramafic rocks characteristically are shown in purple; limestone usually is shown in bright blue; and glacial till often is shown in light green.

5.1.3 Size of Map-Unit Areas

In general, small map-unit areas should be shown in darker colors and large areas should be shown in lighter colors. An exception to this may be in situations when numerous small bands of map units are shown; in this case it may be best to alternate light and dark colors. In the case of map units that consist of both large and small areas, add labels and leaders to the smaller map units to avoid confusion. For guidelines and recommendations on the placement of map-unit labels and leaders, see Section 6 below, entitled "Guidelines for Map Labeling."

Because it is more difficult to clearly distinguish color in small areas, it is very important to choose as unique a color as possible for map units that are present only in small areas. The minimum size of map-unit area that can show color is about two square millimeters; anything smaller will need to be labeled. In addition, exercise caution when using patterns in small areas because small areas may fail to show enough of the pattern to adequately identify a map unit; about one square centimeter is the minimum size to clearly show patterns. If there can be any ambiguity in a map-unit area's identification, it is safest to add a label and leader.

5.1.4 Contrast

Adequate contrast enhances readability. A key factor is not so much the difference in hue, such as blue or green, but the difference in intensity. Contrast should not, however, be so great as to be glaring, but it should be significant enough for easy legibility. Map units that need to be emphasized should be assigned colors that stand out and contrast well with the colors of less important units. In addition, greater contrast is required for small areas, whereas a more subtle contrast is sufficient for larger areas.

5.2 SPECIFYING COLOR FOR MAP-UNIT AREAS

To maintain control of color output, color on maps and illustrations should always be specified using process-color (CMYK, cyan/magenta/yellow/black) inks, regardless of the intended output medium. If another non-ink color scheme such as RGB (red/green/blue) or HSV (hue/saturation/value) is used, then the output device (be it printer, plotter, or imagesetter) will automatically convert the non-CMYK values to CMYK during output, and unwanted color shifts often will take place. To aid in the selection of color fill for map units, a chart showing a wide variety of CMYK colors ("CMYK Color Chart") has been included herein.

Color values must be high enough to provide adequate contrast but not so great that they prevent the map-unit labels, structure symbols, and topographic base from showing clearly. Except in small areas, magenta and cyan should be used in intensities of 50% or less. A greater intensity of cyan might obscure drainage features (commonly shown in cyan), and a greater intensity of magenta might obscure magenta fold axes and dikes. As a general rule, use a combination of CMYK color values that, when added together, totals 100 or less (for example, 30% cyan/40% magenta/20% yellow; 30/40/20 = 30+40+20 = 90), especially in larger areas.

To maintain enough contrast between two colors, keep at least a 20% difference between the values of one of the CMYK colors (for example, 30% cyan/8% magenta/20% yellow and 30% cyan/8% magenta/40% yellow).

Avoid using 8% yellow because it is too light and cannot easily be distinguished from white. In addition, it may be wise to avoid using 13% or 20% cyan, as these colors may look like a body of water.

On maps that are to be offset printed, it may be best to use a solid (100%) single-ink color such as cyan, magenta, or yellow in very small map-unit areas to avoid misregistration problems. For example, 100% cyan may be used to show small limestone blocks in melange, or 100% magenta may be used to show thin rhyolite intrusions.

5.3 USE OF PATTERNS

Patterns can be printed either in black, in color, or as a dropout. Ideally, patterns should be used sparingly and only when necessary for clarification, as they can add unnecessary complexity to a map. To select appropriate patterns for a map, both the type of rock and the size and (or) orientation of map-unit areas must be considered. To aid in the selection of patterns for map units, a chart showing a wide variety of geologic patterns ("Pattern Chart") has been included herein.

Although some flexibility exists in the use of patterns, some patterns are traditionally and exclusively used for certain rock types: for example, "+" patterns are used for plutonic rocks, and irregular "v" patterns represent volcanic rocks. For map units that are present only in small areas, a tight, random pattern will fit more of the pattern elements into a particular area. Exercise caution, however, when choosing metamorphic patterns that display a strong directionality, as their use may imply a general orientation of metamorphic fabric that in reality is much more varied than the pattern may indicate.

5.3.1 Overprint Patterns

Color overprint patterns are usually specified in either cyan or magenta, but sometimes a spot color such as red is used. For offset printing, it is best to specify only one color for overprint patterns, as using more than one color can cause misregistration problems. Color overprint patterns can be screened to reduce their intensity.

Black overprint patterns are less effective than color in most situations, as they can conceal base-map information or interfere with type or structure symbols. Thus, it may be best to restrict the use of 100% black patterns to small, uncluttered areas; if a map-unit label is needed, it can be placed outside the area and leadered in. Black overprint patterns also can be screened to reduce their intensity.

5.3.2 Dropout Patterns

Dropout patterns cause to be transparent one or more of the CMYK colors that combine to make a map-unit color, thus allowing the remaining color(s) to show through. Their use can be especially effective on a map that has a large amount of labeling or many structure symbols.

For offset printing, only one color should be dropped out, as dropping out more than one might lead to misregistration problems; in general, the most dominant color (the one with the highest value) other than yellow should be the one dropped out. For output to a single-pass inkjet plotter, a dropout pattern may be applied to all of the CMYK colors that make up a map-unit color; the dropout pattern would then show as white. Be aware, however, that doing so may cause that map unit to stand out more than is desired.

5.4 SPECIFYING COLOR FOR LINE AND POINT SYMBOLS

Color commonly is specified for many line and point symbols because it highlights these features. Whenever possible, color for line and point symbols should be specified as either 100% cyan or 100% magenta, two of the standard four process-color (CMYK, cyan/magenta/yellow/black) inks that are used for offset printing and in most inkjet plotters (other non-ink color schemes such as RGB or HSV should be avoided so that unwanted color shifts during output are prevented). In some cases, however, it may not be practical or preferable to specify cyan or magenta; for example, mineral resource assessment areas traditionally have been outlined in red.

Although it is possible to make a non-process color such as red from two or more process-color inks, this should be avoided if the map is to be offset printed because of the difficulties in registering large, CMYK-separated negatives. For maps that are to be offset printed, a Pantone color (single-ink spot color) should be specified. Each Pantone color is imageset onto a separate piece of film, thereby avoiding misregistration problems caused when a color is converted to CMYK and then is color separated onto more than one piece of film.

6. GUIDELINES FOR MAP LABELING

Map-unit labels are the most common labels on geologic maps. Other labels may include base-map information, feature names, and data items such as dip values, gold concentrations, well depths, radiometric ages, and sample locality numbers.

Before the advent of digital technologies for mapmaking, labels were either drawn by hand or applied using stick-up type. Nowadays, using digital mapmaking techniques, labels (and leaders) can be automatically plotted from information in a database; however, this often results in labels overprinting other map features, requiring them to be interactively repositioned or deleted. Regardless of the method employed, effective label placement is an important factor in producing a useful map.

6.1 STRATEGIES FOR MAP LABELING

Enough features on the map should be labeled so that the reader can identify all the various map elements; no unlabeled feature should leave the reader guessing. Labels (and leaders) should not, however, create an overly "busy" or cluttered appearance, which makes recognition of map patterns, shapes, and map-element distribution difficult to discern. For a map to be easily read, labels and leaders should be placed where they are clear and legible, taking care to avoid overprinting of linework, symbols, or other labels. In addition, they should not obscure base-map features that are mentioned in the text or that may be useful in locating places on the map.

Commonly, color or pattern can be used to identify an unlabeled map-unit area if a nearby area of the same map unit is labeled. Therefore, the color and pattern selection is critical when deciding whether or not to label a particular map-unit area, and so it is important to complete the color and pattern design of the map before attempting to place and move map-unit labels, especially for complex maps or those that have many map units.

There are no precise rules for which and how many of the map-unit areas on a map should be labeled, but the following are some general guidelines. If a map unit has a unique and clearly distinguishable color or pattern, it is not necessary to label every area of that map unit. Color and pattern can carry the identification of a group of areas of the same unit as long as some of them are labeled. Use judgment when deciding whether the color for that map unit is distinctive enough and (or) whether a particular unlabeled map-unit area can be visually or logically associated with any nearby labeled areas of the same unit. In small map-unit areas, however, even the most distinctive color or pattern may be difficult to discern. If there might be any doubt, add a label and leader.

At least one area of every map unit within a "normal field of view" should be labeled. This field of view is the area in focus when the map is viewed at a comfortable, readable distance. In uncluttered areas of the map or in areas of relatively simple geology, this field of view might have a radius of about two or three inches; in geologically complex or cluttered areas, however, it may be much smaller. The reader should not need to search across the map trying to find a labeled map-unit area that has a color that matches an unlabeled map-unit area.

In addition, maps that are to be downloaded from the Web will be sent to a plotter of unknown type, and there is no guarantee that colors that appear distinct when plotted on your plotter will also be distinguishable when plotted on other plotters. The more map-unit areas that are labeled, the less chance of ambiguity and confusion.

6.2 FONT SELECTION

For most type on a map (for example, unit labels, dip values, and fault names), a sans-serif font such as Helvetica (or FGDCGeoAge; see Appendix A, Section 32) should be used. Other sans-serif fonts such as Univers or Arial also may be used, but consider that not all fonts will plot correctly on all output devices. Also consider that combining FGDCGeoAge with Univers or Arial will result in odd-looking character strings because the character size and kerning (spacing of letters) of FGDCGeoAge is based on that of Helvetica; therefore, using Helvetica with FGDCGeoAge is recommended. For base-map information, use a combination of sans-serif (for example, Helvetica or Univers) and serif (for example, Times or Times New Roman) fonts; the general rule is to follow the styles used on a published topographic map sheet.

When placing labels digitally, it is important to use the same font that will be used for final publication because the size and kerning of characters are different for different fonts, even those having the same point size. If labels are placed carefully in tight areas using one font, but then another font is used for final publication, the labels may overprint linework or other features because the new font may have longer character heights and string lengths. Therefore, for best results, choose fonts early in a project, and then stay with that choice throughout the project. In addition, the use of PostScript fonts may result in more consistent final output for both print and digital publications.

6.3 TYPE SIZE AND STYLE

The ideal size for map-unit labels is 8 pt, although labels as small as 6 pt may be substituted in places where space is tight. Fractional font sizes may be used if needed, and different sizes can be mixed on the same map. If unit labels contain subscripts or superscripts, the minimum unit-label size should be 7 pt; then the size for the subscript or superscript character would be 5 pt, two point sizes smaller.

Other sizes and styles are used to label different features. In general, use 8 pt type (all caps) for names of faults and major structures, for sample locality numbers and radiometric ages, and for fault (U/D, A/T) and contact (Y/O) ornamentation. Use 6 pt italic type for dip or plunge values. Use 12 pt italic type for cross-section labels. For labels of larger features, type size and (or) kerning (letter spacing) may be increased to improve legibility.

6.4 LABEL PLACEMENT

Map-unit labels and dip values should always be oriented horizontally. They should not overprint other map elements such as linework, point symbols, or any other dip values and labels, nor should they obscure base-map features that are referenced in text or are needed to orient the map in the field. Single labels can be used to identify more than one map-unit area; use multiple leaders where necessary.

Map-unit labels should not be placed in dark-colored map-unit areas or in densely patterned areas, both of which would make the labels hard to read; instead, move labels outside such areas and add leaders. If a label must be placed in a dark-colored or densely patterned map-unit area, it may be necessary to mask out the color or pattern around the label to help make it more legible.

Labels for linear map features should be aligned along those features. Other labels should have a logical or comfortable orientation relative to the map. In rare cases it might be desirable to have labels run parallel to lines of latitude, but in general they should be oriented horizontally.

6.5 LEADER PLACEMENT

Leaders should be drawn as straight lines, not bent or curved. They should cross map-unit area boundaries at as high an angle as possible, and they should not stop at the boundary but should extend well into the map-unit area. Leaders should not cross through other map-unit areas to reach a particular map unit unless absolutely necessary. Multiple leaders emanating from a single label should not be joined at their "label" ends.

7. TECHNICAL SPECIFICATIONS USED IN THE PREPARATION OF THIS STANDARD

This new standard (contained in Appendix A) consists of geologic line and point symbols, geologic map-unit colors and patterns, a geologic age symbol font, and related map marginalia. This section provides some technical discussion regarding preparation of the standard and its implementations.

7.1 UNITS FOR LINEWEIGHTS, LENGTHS, AND DISTANCES

In previous standards, lineweights were specified in thousandths-of-an-inch, which corresponded to the widths of the engraving tools used to scribe the linework. Most lengths and distances also were given in inches. In this standard, the cartographic specifications are given in millimeters, in accordance with the Federal standard for metrification.

When preparing this standard, the old thousandths-of-an-inch specifications were converted to millimeters (Table 1), and then most were rounded to the nearest .05 mm or .025 mm, for ease of use. Whenever possible, cartographic specifications for lengths and distances were given in whole- or half-integer values. However, when designing the symbol graphics in this standard document, as well as the symbols in its PostScript implementation, lineweights, lengths, and distances were specified electronically as points, and the exact conversion values (from inches to points; see Table 1) were retained.

As an example of the unit-conversion process, consider the symbol for faults, which in previous standards had a lineweight of .015" specified. This original lineweight was converted to millimeters (.015" = .381 mm; Table 1) and then rounded to .375 mm, which is the value given as the cartographic specification in this standard (see p. A–2–1, Appendix A). However, when preparing the fault symbol for inclusion in this standard document (and in its PostScript implementation), the exact .015" lineweight was retained and directly converted to points (.015" = 1.08 pt; Table 1), and so the symbol lineweight was defined electronically as 1.08 pt.

Complications from unit conversion can arise not just when designing line symbols but also when creating point symbols and patterns, as most symbols are made of stroked lines. When creating symbols for a particular application, the user should choose the unit of measure most easily used in an application and then use the conversion table (Table 1) to convert to those units.

7.2 TYPE SPECIFICATIONS

Most type in this standard is specified as either Helvetica (sans-serif) or Times (serif), two fonts that are commonly used and widely available (see Table 2 for abbreviations for type faces used in this standard); type sizes are given in points. Other fonts such as Univers, Arial, or Times New Roman may be substituted, but consider that they may not be installed on all common output devices and thus may not plot correctly.

Geologic age characters have been specified as FGDCGeoAge, a specialized sans-serif font designed by the U.S. Geological Survey (see Appendix A, Section 32). The character size and kerning (spacing of letters) of FGDCGeoAge is based on that of Helvetica; therefore, using Helvetica with FGDCGeoAge is recommended.

7.3 COLOR SPECIFICATIONS FOR LINE AND POINT SYMBOLS

Color has been specified as the cartographic standard for many line and point symbols in this standard, either because of adherence to a long-established color convention or because using color for features such as folds and dikes may help them to stand out better from other full-black linework such as contacts and faults. In most cases, another color or black may be substituted if the color specified as the standard would not be visible when printed over an underlying map-unit color.

Whenever possible, color has been specified as either cyan or magenta, two of the four process-color (CMYK, cyan/magenta/yellow/black) inks that are used both in inkjet plotters and for offset printing. However, in some cases it was not practical or preferable to specify cyan or magenta as the standard; for example, mineral resource assessment areas traditionally have been outlined in red (see p. A–19–1, Appendix A).

Although it is possible to make a non-process color such as red from two or more process-color inks, this should be avoided if the map is to be offset printed because of the difficulties in registering large, CMYK-separated negatives. Thus, in some cases a spot color (a single-ink, non-CMYK color) has been specified as the cartographic standard.

As a simple, general way of specifying spot colors, generic color names (for example, "red" and "green") have been used in this standard. Specifying color as these generic color names, however, may not be appropriate for use with certain output media. Therefore, the user must choose a method of specifying color that is appropriate for a particular output device; Table 3 shows suggestions for conversions of spot colors to other color models.

For maps that are to be offset printed, a Pantone color (single-ink spot color) should be specified (Table 3). Each Pantone color is imageset onto a separate piece of film, thereby avoiding misregistration problems caused when a color is converted to CMYK and then is color separated onto more than one piece of film. For output to an inkjet plotter, however, specifying a spot color as one of the generic color names is satisfactory because, during the plotter's RIP[4] of the file, the color will automatically be converted to the proper amounts of CMYK inks that will combine to make the CMYK equivalent of that color. Misregistration is not a problem with single-pass inkjet-plotter output.

If simple, graphical map elements are to be published as part of a web page on the World Wide Web, it may be best to choose colors from a "Web-safe" color palette[5] to avoid unwanted dithering on monitors that display only 256 colors (Weinman, 1996). As an aid in doing so, an attempt was made to provide "Web-safe" color equivalents of the Pantone spot colors used in this standard (Table 3). These "Web-safe" color equivalents are made up of the RGB (red/green/blue) values that are as close as possible to the directly converted RGB-equivalent colors (Table 3). Note, however, that it was impossible to exactly reproduce the directly converted RGB-equivalent colors because, to make "Web-safe" colors, there are only six possible RGB values (000, 051, 102, 153, 204, and 255) from which to choose.

7.4 COLOR SPECIFICATIONS FOR MAP-UNIT AREAS

To aid in the selection of color fill for geologic map units, a chart showing a wide variety of CMYK colors ("CMYK Color Chart") has been included in this standard. The CMYK Color Chart was designed in Adobe Illustrator 8.0.1 to closely replicate the colors on the offset-printed color chart entitled "Printing Colors and Screens in Use by the U.S. Geological Survey for Geologic and Hydrologic Maps" [yellow/magenta/cyan version], which has been in use for many years at the USGS. The new color chart contains the same colors that were in the original offset-printed USGS chart; however, the old color codes indicating the YMC (yellow/magenta/cyan) values have been updated to show CMYK (cyan/magenta/yellow, with K=0) values, to conform to industry standards. In addition, each color in the CMYK Color Chart has associated with it a generic lookup-table number that, if desired, may be used to access the color from within digital applications.

In addition, a diagram showing "Suggested Ranges of Map-Unit Colors for Volcanic and Plutonic Rocks and for Stratigraphic Ages of Sedimentary and Metamorphic Rocks" (see Appendix A, Section 33) has been included in this standard. This diagram was designed in Adobe Illustrator 8.0.1 to reproduce a similar diagram in the old USGS Technical Cartographic Standards volume (U.S. Geological Survey, ca. 1975). In this new version, however, the range of colors was modified slightly, a few new colors were added, and the old color codes were updated to show CMYK (cyan/magenta/yellow, with K=0) values.

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[4] RIP = raster-image processing, a process that runs on all plotters, printers, and imagesetters and converts data (in either raster or vector format) to printer dots to produce an image.

[5] Industry opinions on using "Web-safe" colors (8-bit, 216 colors) are changing, owing to the large number of monitors now in use that can display more than 256 colors; Chris MacGregor (*in* Dennis, 1999) stated that using non–"Web-safe" colors may be acceptable to use in detailed areas, although she still recommends using "Web-safe" colors in large areas.

7.5 PATTERN SPECIFICATIONS

The old USGS Technical Cartographic Standards volume (U.S. Geological Survey, ca. 1975) contained no cartographic specifications (lineweights, dot sizes, or size and spacing of pattern elements) for its patterns. The volume dates back to a time when maps were conventionally prepared using hand-scribed linework and peelcoats. In those days, patterns were preprinted onto large sheets of film, which were photomechanically combined with the various peelcoats to make the CMYK negatives.

For this standard, the patterns (see "Pattern Chart") were recreated by scanning the old pattern sheets and then tracing the pattern elements in Adobe Illustrator 8.0.1. For most patterns, black, cyan, and magenta versions, as well as dropout versions, were created; yellow versions were not created because yellow patterns are not visible over color fill. Also, red and (or) brown versions were created if red or brown patterns were specified as the cartographic standard for a particular feature. Glacial and hydrologic patterns were created only in cyan and black, as it is unlikely that magenta or other colors would be used for these types of patterns.

To facilitate digital output, lineweights and dot sizes were in many cases increased. A few pattern tiles were scaled to accommodate the increased lineweights, and some of the lined patterns were dropped because an increased lineweight would fill in the pattern and because an increase in scale would cause the pattern to be too similar to other patterns. The lineweights and dot sizes for the color and dropout versions were increased even more than for the black versions, to help them show more clearly on maps.

All patterns were renumbered, and suffixes indicating color were added so that all versions of the same pattern are referenced by the same number. In addition, each pattern in the Pattern Chart has associated with it a generic lookup-table number that, if desired, may be used to access the pattern from within digital applications.

7.6 GEOLOGIC AGE SYMBOL FONT

A digital font named FGDCGeoAge (see Appendix A, Section 32) has been created, in which 16 special geologic age characters have been substituted into positions of normal keyboard characters. These characters can be typed either directly or with the Shift key; no Option, Control, or Alt keys are needed to type these characters (they are all in lower-order ASCII positions that have character ID numbers below 128), allowing the same character positioning to work on different computer platforms without interfering with special control key sequences.

8. ACKNOWLEDGMENTS

This standard owes its existence mostly to the well-established history and traditions of geologic map cartography by the USGS. In particular, the editors, authors, and compilers of this standard wish to thank the many cartographers, editors, and geologists who contributed to the informal USGS "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975), as well as Mitchell Reynolds, James Queen, Richard Taylor, and others who were responsible for preparing the earlier (1995) USGS proposed standard (U.S. Geological Survey, 1995a,b), from which this standard has evolved. We especially wish to thank the many members of the USGS Geologic Discipline's Western Publications Group who have made substantial contributions to the design and preparation of this standard (see Section 2.3 above, entitled "Preparers of this Standard").

We also want to thank the numerous geologists, cartographers, graphics specialists, GIS specialists, editors, and others who provided invaluable comments and suggestions for revisions to this standard during their review(s) of the previous versions of this standard: the 1995 USGS proposed standard (see Soller, 1996); the preliminary, beta version of this standard; the Working Draft of this standard; and, most importantly, the Public Review Draft of this standard. In addition, we gratefully acknowledge the intellectual contributions of members of the standing Map Symbol Standards Committee (see section 2.3 above, entitled "Preparers of This Standard"), and especially Jonathan Matti (USGS) for his guidance on issues of scientific confidence and locational accuracy. We also thank Jack Reed, Ron Wahl, Will Stettner, and Nancy Stamm (all USGS) for providing insight and access to USGS historical documents and standard cartographic practices.

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APPENDIX A. GEOLOGIC MAP SYMBOLS, COLORS, AND PATTERNS

This [normative] appendix contains the geologic map symbols and their descriptions, their cartographic specifications, and notes on their usage. Also included are the CMYK Color Chart and the Pattern Chart (enclosed in sleeve on inside back cover), which contain colors and patterns for use on geologic maps.

CONTENTS OF APPENDIX A

PREFACE TO APPENDIX A

In this preface to Appendix A, we include some general guidelines for using the "FGDC Digital Cartographic Standard for Geologic Map Symbolization," as well as some basic information on the newly implemented standard for the scientific confidence and the locational accuracy of geologic features. For more specific information, please refer to the following sections in the accompanying introductory text: "Geologic Mapping Concepts and Definitions" (Section 3); "Scientific Confidence and Locational Accuracy of Geologic Features" (Section 4); "Guidelines for Map Color and Pattern Selection" (Section 5); "Guidelines for Map Labeling" (Section 6); and "Technical Specifications Used in the Preparation of this Standard" (Section 7).

ABOUT THIS VERSION OF THE STANDARD

This now formally approved version of the standard incorporates revisions that reflect reviewers' responses to the "Public Review Draft — Digital Cartographic Standard for Geologic Map Symbolization" (Federal Geographic Data Committee, 2000). We thank all the reviewers for their contributions, and we are pleased that most of the comments and suggestions could be accommodated (see *http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/development.php*). Note, however, that we were able to fully address suggestions for the inclusion of new symbols only if examples of the proposed symbol additions were provided.

We intend this standard to be a "living standard" — that is, we recognize that an existing symbol's usage may need to be modified, or a new symbol or set of symbols created, to more fully express local geologic conditions or to keep pace with evolving geologic mapping concepts and practices. Accordingly, such new or modified symbols, if found to be of wide applicability, will be incorporated into this standard through planned, periodic revisions. You are invited to submit comments and suggestions for updates or other improvements to this standard by email to *mapsymbol@flagmail.wr.usgs.gov*.

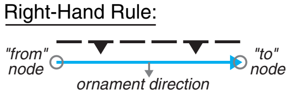
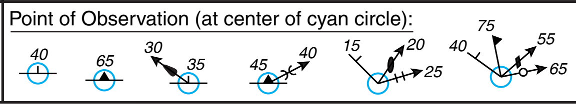
In response to reviewers' comments, we tested various cartographic specifications for dashed and ornamented line symbols in several different software packages (Adobe Illustrator v.8.0.1, ArcInfo v.7x, and ArcGIS v.8x) to ensure that symbols would render correctly and consistently. As a result, we found it necessary to modify the cartographic specifications (dash/gap lengths and ornament spacings) of many line symbols in this standard from the specifications found in previous versions of the standard.

HOW TO USE THIS STANDARD

The contents of this standard are not intended to be used inflexibly or in a manner that will limit one's ability to communicate the observations and interpretations gained from geologic mapping. On the contrary, we recognize that, in certain situations, a symbol or its usage might need to be modified in order to better represent a particular feature on a geologic map or cross section.

To that end, we emphasize that this standard allows the use of any symbol that doesn't conflict with others in the standard, provided that it is clearly explained on the map and in the database. In addition, modifying the size, color, and (or) lineweight of an existing symbol to suit the needs of a particular map or output device also is permitted, provided that the modified symbol's appearance is not too similar to another symbol on the map. Be aware, however, that reducing lineweights below .125 mm (.005 inch) may cause symbols to plot incorrectly if output at higher resolutions (1800 dpi or higher). For more information, please refer to Section 7 ("Technical Specifications Used in the Preparation of this Standard") in the accompanying introductory text.

To facilitate the use of this standard, we include in this preface tables showing conversion values from inches to points to millimeters (Table 1), abbreviations used (Table 2), and spot color specifications and their equivalent colors in other color models (Table 3). We also offer the following illustrations of a few key terms and concepts used when preparing this standard:

LINE SYMBOLS	POINT SYMBOLS	TYPE EXAMPLES	
Right-Hand Rule: 	Point of Observation (at center of cyan circle): 	Sans-Serif Font: TRv Qls HAYWARD FAULT	Serif Font: Triassic volcanic rocks *Columbia River*

THE NEWLY IMPLEMENTED STANDARD FOR THE SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY OF GEOLOGIC MAP FEATURES

In response to reviewers' comments, we have implemented a new standard (concepts and terminology) for the scientific confidence and the locational accuracy of geologic map features (note that, at this time, we have applied these new concepts only to line features). Scientific confidence expresses a geologist's level of certainty about the identity or perhaps even the existence of a feature. Locational accuracy is based on the relation between a feature's location in the field and its position on the base map. For a more detailed discussion of these concepts and their associated terminology, please refer to Section 4 ("Scientific Confidence and Locational Accuracy of Geologic Features") in the accompanying introductory text.

FEATURE ATTRIBUTES FOR SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY

The following is a list of the feature attributes (in italics) that are used to express these concepts:

- Scientific Confidence:
  - Identity — '*certain*' or '*questionable*'
  - Existence — '*certain*' or '*questionable*'
- Locational Accuracy:
  - Locatability — '*observable*,' '*inferred*' (between outcrops or beneath rubble or vegetation), or '*concealed*' (beneath overlying map unit, ice, or water)
  - Zone of Confidence — [*value, in ground units*]; [*unit of measurement*]
  - Positioning Confidence — '*within zone of confidence*' or '*may not be within zone of confidence*'

LEVELS OF SCIENTIFIC CONFIDENCE AND LOCATIONAL ACCURACY

Discrete levels of scientific confidence and locational accuracy have been developed to use as a terminology that can clearly yet concisely communicate the identity, existence, locatability, and positioning of geologic map features. These levels are directly derived from, or are closely associated with, the feature attributes (for more information, see Figures 1 and 2 in the accompanying introductory text). The following diagram shows how the various levels of scientific confidence and locational accuracy relate to the feature attributes; it also shows examples (in italics) of geologic situations to which the levels may be applied.

SCIENTIFIC CONFIDENCE		
Feature Attributes for Scientific Confidence		Levels of Scientific Confidence
Identity: • certain • questionable	Existence: • certain • questionable	Identity and existence certain *("I am certain that the planar feature I see in this outcrop is a fault")* Identity or existence questionable *("I can see some kind of planar feature in this outcrop, but I cannot be certain if it is a contact or a fault")*
LOCATIONAL ACCURACY		
Feature Attributes for Locational Accuracy		Levels of Locational Accuracy
Locatability: • observable • inferred • concealed	Zone of Confidence: • [value, in ground units] • [unit of measurement] Positioning Confidence: • within zone of confidence • may not be within zone of confidence	Location accurate *("I can clearly see this contact in outcrop, and I can accurately plot its position on the map")* Location approximate *("I can see this contact in outcrop, but I can't tell exactly where it is located because I am surrounded by trees")* Location inferred *("I can see by the change in debris materials visible around these gopher holes that a contact runs through here, but I can't locate it precisely")* Location concealed *("I can see that a contact is present on both sides of this lake, but I can't tell where it is located beneath the water")*

The levels of scientific confidence and locational accuracy have been used to identify and describe the line symbols in this standard. The following example is extracted from Appendix A (see p. A-1-1).

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Contact—Identity and existence certain, location accurate	________________	Contact—Identity and existence certain, location inferred	_ _ _ _ _ _ _ _ _ _
Contact—Identity or existence questionable, location accurate	_______?_______	Contact—Identity or existence questionable, location inferred	_ _ _ _ _?_ _ _ _
Contact—Identity and existence certain, location approximate	__ __ __ __ __ __	Contact—Identity and existence certain, location concealed	- - - - - - - - - - - - - - - - -
Contact—Identity or existence questionable, location approximate	__ __ __?__ __ __	Contact—Identity or existence questionable, location concealed	- - - - - - - - ? - - - - - - - -

In the symbol explanation on a published map, the levels of scientific confidence and locational accuracy also are used to identify and describe the various types and styles of line symbols that appear on the map; however, not every style of a particular line symbol needs to be listed individually in the explanation, as the following two examples show.

Contact—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable

Fault—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable

Thrust fault—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable. Sawteeth on upper plate

Folds—Solid where location is accurate; long-dashed where location is approximate; dotted where location is concealed. Queries added where identity or existence may be questionable. Showing direction of plunge where appropriate

Anticline

Syncline

The example on the left shows how the descriptions of all styles of a particular line type are grouped into one explanatory paragraph (if the symbol explanation directly follows the Description of Map Units, a separate title is not added).

The example below shows a more condensed alternative in which the descriptions of all line-symbol styles are summarized in a bracketed headnote (a separate title usually is added).

SYMBOL EXPLANATION

[For all line symbols: lines are solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred; dotted where location is concealed. Queries added where identity or existence may be questionable]

Contact

Fault

Thrust fault—Sawteeth on upper plate

Folds—Showing direction of plunge where appropriate

Anticline

Syncline

Table 1. *Chart showing conversion values from inches (in) to points (pts) to millimeters (mm).*

in	pts	mm	in	pts	mm	in	pts	mm	in	pts	mm
0.001	0.072	0.025	0.051	3.672	1.295	0.101	7.272	2.565	0.151	10.872	3.835
0.002	0.144	0.051	0.052	3.744	1.321	0.102	7.344	2.591	0.152	10.944	3.861
0.003	0.216	0.076	0.053	3.816	1.346	0.103	7.416	2.616	0.153	11.016	3.886
0.004	0.288	0.102	0.054	3.888	1.372	0.104	7.488	2.642	0.154	11.088	3.912
0.005	0.360	0.127	0.055	3.960	1.397	0.105	7.560	2.667	0.155	11.160	3.937
0.006	0.432	0.152	0.056	4.032	1.422	0.106	7.632	2.692	0.156	11.232	3.962
0.007	0.504	0.178	0.057	4.104	1.448	0.107	7.704	2.718	0.157	11.304	3.988
0.008	0.576	0.203	0.058	4.176	1.473	0.108	7.776	2.743	0.158	11.376	4.013
0.009	0.648	0.229	0.059	4.248	1.499	0.109	7.848	2.769	0.159	11.448	4.039
0.010	0.720	0.254	0.060	4.320	1.524	0.110	7.920	2.794	0.160	11.520	4.064
0.011	0.792	0.279	0.061	4.392	1.549	0.111	7.992	2.819	0.161	11.592	4.089
0.012	0.864	0.305	0.062	4.464	1.575	0.112	8.064	2.845	0.162	11.664	4.115
0.013	0.936	0.330	0.063	4.536	1.600	0.113	8.136	2.870	0.163	11.736	4.140
0.014	1.008	0.356	0.064	4.608	1.626	0.114	8.208	2.896	0.164	11.808	4.166
0.015	1.080	0.381	0.065	4.680	1.651	0.115	8.280	2.921	0.165	11.880	4.191
0.016	1.152	0.406	0.066	4.752	1.676	0.116	8.352	2.946	0.166	11.952	4.216
0.017	1.224	0.432	0.067	4.824	1.702	0.117	8.424	2.972	0.167	12.024	4.242
0.018	1.296	0.457	0.068	4.896	1.727	0.118	8.496	2.997	0.168	12.096	4.267
0.019	1.368	0.483	0.069	4.968	1.753	0.119	8.568	3.023	0.169	12.168	4.293
0.020	1.440	0.508	0.070	5.040	1.778	0.120	8.640	3.048	0.170	12.240	4.318
0.021	1.512	0.533	0.071	5.112	1.803	0.121	8.712	3.073	0.171	12.312	4.343
0.022	1.584	0.559	0.072	5.184	1.829	0.122	8.784	3.099	0.172	12.384	4.369
0.023	1.656	0.584	0.073	5.256	1.854	0.123	8.856	3.124	0.173	12.456	4.394
0.024	1.728	0.610	0.074	5.328	1.880	0.124	8.928	3.150	0.174	12.528	4.420
0.025	1.800	0.635	0.075	5.400	1.905	0.125	9.000	3.175	0.175	12.600	4.445
0.026	1.872	0.660	0.076	5.472	1.930	0.126	9.072	3.200	0.176	12.672	4.470
0.027	1.944	0.686	0.077	5.544	1.956	0.127	9.144	3.226	0.177	12.744	4.496
0.028	2.016	0.711	0.078	5.616	1.981	0.128	9.216	3.251	0.178	12.816	4.521
0.029	2.088	0.737	0.079	5.688	2.007	0.129	9.288	3.277	0.179	12.888	4.547
0.030	2.160	0.762	0.080	5.760	2.032	0.130	9.360	3.302	0.180	12.960	4.572
0.031	2.232	0.787	0.081	5.832	2.057	0.131	9.432	3.327	0.181	13.032	4.597
0.032	2.304	0.813	0.082	5.904	2.083	0.132	9.504	3.353	0.182	13.104	4.623
0.033	2.376	0.838	0.083	5.976	2.108	0.133	9.576	3.378	0.183	13.176	4.648
0.034	2.448	0.864	0.084	6.048	2.134	0.134	9.648	3.404	0.184	13.248	4.674
0.035	2.520	0.889	0.085	6.120	2.159	0.135	9.720	3.429	0.185	13.320	4.699
0.036	2.592	0.914	0.086	6.192	2.184	0.136	9.792	3.454	0.186	13.392	4.724
0.037	2.664	0.940	0.087	6.264	2.210	0.137	9.864	3.480	0.187	13.464	4.750
0.038	2.736	0.965	0.088	6.336	2.235	0.138	9.936	3.505	0.188	13.536	4.775
0.039	2.808	0.991	0.089	6.408	2.261	0.139	10.008	3.531	0.189	13.608	4.801
0.040	2.880	1.016	0.090	6.480	2.286	0.140	10.080	3.556	0.190	13.680	4.826
0.041	2.952	1.041	0.091	6.552	2.311	0.141	10.152	3.581	0.191	13.752	4.851
0.042	3.024	1.067	0.092	6.624	2.337	0.142	10.224	3.607	0.192	13.824	4.877
0.043	3.096	1.092	0.093	6.696	2.362	0.143	10.296	3.632	0.193	13.896	4.902
0.044	3.168	1.118	0.094	6.768	2.388	0.144	10.368	3.658	0.194	13.968	4.928
0.045	3.240	1.143	0.095	6.840	2.413	0.145	10.440	3.683	0.195	14.040	4.953
0.046	3.312	1.168	0.096	6.912	2.438	0.146	10.512	3.708	0.196	14.112	4.978
0.047	3.384	1.194	0.097	6.984	2.464	0.147	10.584	3.734	0.197	14.184	5.004
0.048	3.456	1.219	0.098	7.056	2.489	0.148	10.656	3.759	0.198	14.256	5.029
0.049	3.528	1.245	0.099	7.128	2.515	0.149	10.728	3.785	0.199	14.328	5.055
0.050	3.600	1.270	0.100	7.200	2.540	0.150	10.800	3.810	0.200	14.400	5.080

Table 2. *Abbreviations used in this standard.*

Abbreviation	Meaning	Example of usage
B	brown [ink]	422-B (pattern)
C	cyan [ink]	132-C (pattern)
CMYK	cyan/magenta/yellow/black	CMYK color model
DO	dropout [pattern]	204-DO (pattern)
FG-8	FGDCGeoAge [font], 8 pt type	₮g (unit label containing geologic age character)
H-8 [1]	Helvetica [font], 8 pt type	GOLDEN FAULT (name of fault)
HB-8 [1]	Helvetica Bold [font], 8 pt type	**?** (query indicating "identity or existence questionable" fault)
HI-6 [1]	Helvetica Italic [font], 6 pt type	*40* (dip value)
HSV	hue/saturation/value	HSV color model
K	black [ink]	134-K (pattern)
M	magenta [ink]	313-M (pattern)
R	red [ink]	405-R (pattern)
RGB	red/green/blue	RGB color model
T-9 [2]	Times [font], 9 pt type	UNITED STATES (label on national boundary)
TBI-12 [2]	Times Bold Italic [font], 12 pt type	***A——A'*** (cross section labels)
TI-8 [2]	Times Italic [font], 8 pt type	*Bass Lake* (name of lake)
Y	yellow [ink]	CMYK color model

[1] Although Helvetica has been specified, any sans-serif font (such as Univers or Arial) may be used. Note, however, that if other fonts are used, their appearance will not match that of FGDCGeoAge, whose character size and spacing is based on Helvetica.
[2] Although Times has been specified, any serif font (such as Times New Roman or Souvenir) may be used.

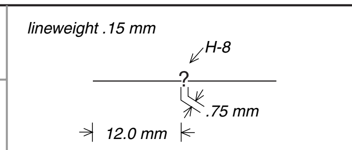
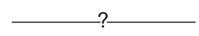
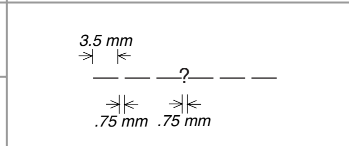
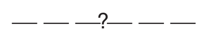
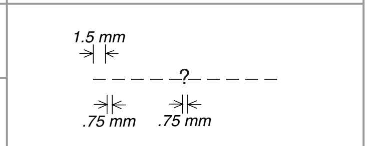
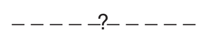
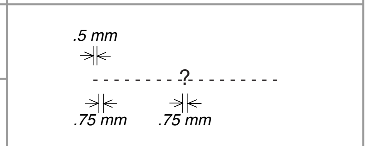
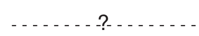
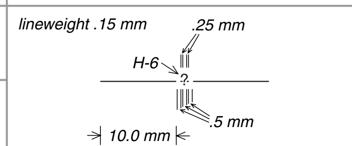
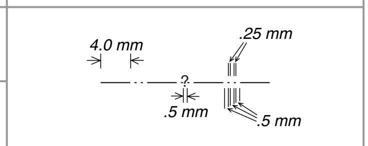
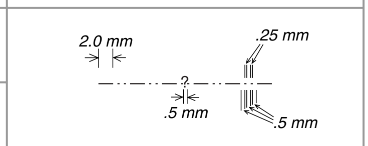
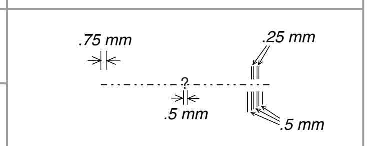
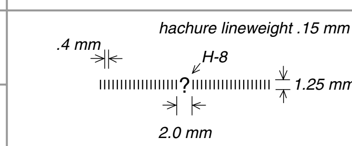
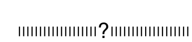
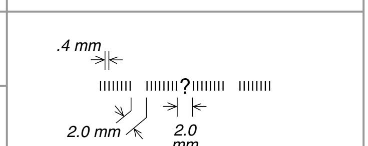
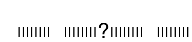
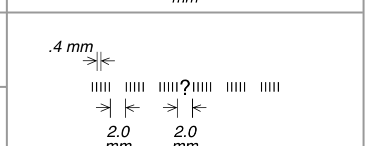
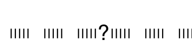
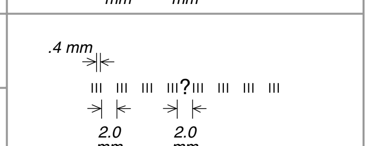
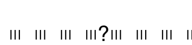
Table 3. *Spot color specifications used in this standard, and their equivalent colors in other color models.*

[Abbreviations: C, cyan; M, magenta; Y, yellow; K, black (standard process-color inks combined during offset printing). CMYK, cyan/magenta/yellow/black color model. R, red; G, green; B, blue (primary colors transmitted by computer monitors and televisions). RGB, red/green/blue color model.]

Spot color [1]	Pantone color [2]	Directly converted CMYK color [3]	Color on CMYK Color Chart [4]	Directly converted RGB color [5]	"Web-safe" RGB color [6]
red	485 U	0/100/91/0	0/100/100	254/0/12	255/0/0
50% red	485 U (screened 50%)	0/50/45.5/0	0/50/40	251/128/104	255/102/102
green	354 U	91/0/83/0	100/0/100	24/150/76	51/153/102
50% green	354 U (screened 50%)	45.5/0/41.5/0	40/0/40	139/207/144	153/204/153
violet	253 U	47/91/0/0	50/100/0	136/22/135	153/0/153
purple	2735 U	100/94/0/0	100/100/0	18/12/128	0/0/153
brown	470 U	0/56/94/34	30/70/100	168/74/9	153/51/0
orange	1585 U	0/56/87/0	0/60/100	254/112/24	255/102/0

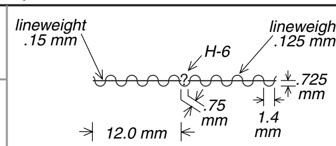
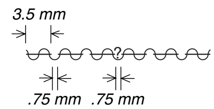
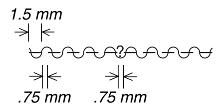
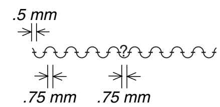
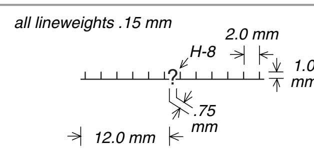
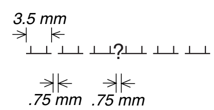
[1] Generic name of spot color, as specified in this standard (note that cyan, magenta, yellow, and black are process-color inks, not spot colors, and so they have not been included in this table).
[2] Suggested Pantone color for offset printing on uncoated paper.
[3] Color value after direct conversion of suggested Pantone color to CMYK (C/M/Y/K) by Adobe Illustrator 8.0.1.
[4] Closest color on CMYK Color Chart (in pocket) to directly converted CMYK color value.
[5] Color value after direct conversion of suggested Pantone color to RGB (R/G/B) by Adobe Illustrator 8.0.1.
[6] Closest "web-safe" color (see discussion in Section 7.3, entitled "Color Specifications for Line and Point Symbols," in the introductory text) to directly converted RGB color value.

1—CONTACTS, KEY BEDS, AND DIKES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		1.1—Contacts		
1.1.1	Contact—Identity and existence certain, location accurate			
1.1.2	Contact—Identity or existence questionable, location accurate			
1.1.3	Contact—Identity and existence certain, location approximate			
1.1.4	Contact—Identity or existence questionable, location approximate			
1.1.5	Contact—Identity and existence certain, location inferred			
1.1.6	Contact—Identity or existence questionable, location inferred			
1.1.7	Contact—Identity and existence certain, location concealed			
1.1.8	Contact—Identity or existence questionable, location concealed			
1.1.9	Internal contact—Identity and existence certain, location accurate			Use to delineate individual debris flows, landslide blocks, alluvial fans, etc., within the same geologic map unit.
1.1.10	Internal contact—Identity or existence questionable, location accurate			
1.1.11	Internal contact—Identity and existence certain, location approximate			
1.1.12	Internal contact—Identity or existence questionable, location approximate			
1.1.13	Internal contact—Identity and existence certain, location inferred			
1.1.14	Internal contact—Identity or existence questionable, location inferred			
1.1.15	Internal contact—Identity and existence certain, location concealed			
1.1.16	Internal contact—Identity or existence questionable, location concealed			
1.1.17	Gradational contact—Identity and existence certain, location accurate			Use to indicate a gradual or continuous lithologic change from one geologic map unit to another.
1.1.18	Gradational contact—Identity or existence questionable, location accurate			
1.1.19	Gradational contact—Identity and existence certain, location approximate			
1.1.20	Gradational contact—Identity or existence questionable, location approximate			
1.1.21	Gradational contact—Identity and existence certain, location inferred			
1.1.22	Gradational contact—Identity or existence questionable, location inferred			
1.1.23	Gradational contact—Identity and existence certain, location concealed			
1.1.24	Gradational contact—Identity or existence questionable, location concealed			

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	1.1—Contacts (continued)			
1.1.25	Unconformable contact—Identity and existence certain, location accurate			May be used to show paraconformaties or disconformaties. Not intended for use to show angular unconformities or nonconformities. Boundary of geologic map unit is center line (solid or dashed), not "sine-wave"-style line.
1.1.26	Unconformable contact—Identity or existence questionable, location accurate			
1.1.27	Unconformable contact—Identity and existence certain, location approximate			
1.1.28	Unconformable contact—Identity or existence questionable, location approximate			
1.1.29	Unconformable contact—Identity and existence certain, location inferred			
1.1.30	Unconformable contact—Identity or existence questionable, location inferred			
1.1.31	Unconformable contact—Identity and existence certain, location concealed			
1.1.32	Unconformable contact—Identity or existence questionable, location concealed			
1.1.33	Incised-scarp sedimentary contact—Identity and existence certain, location accurate. Hachures point downscarp			Use to show where a younger surficial geologic unit has been deposited on an erosional scarp that has been incised into an older surficial geologic unit.
1.1.34	Incised-scarp sedimentary contact—Identity or existence questionable, location accurate. Hachures point downscarp			
1.1.35	Incised-scarp sedimentary contact—Identity and existence certain, location approximate. Hachures point downscarp			
1.1.36	Incised-scarp sedimentary contact—Identity or existence questionable, location approximate. Hachures point downscarp			

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	1.2—Key beds			
1.2.1	Key bed—Identity and existence certain, location accurate		*lineweight .2 mm* *H-8* *.75 mm* *12.0 mm*	Use to show key beds that are too narrow to map as an area at map scale. Add name of geologic map unit if more than one type of key bed is shown on map (see Section 1.4). May also be shown in color.
1.2.2	Key bed—Identity or existence questionable, location accurate	?		
1.2.3	Key bed—Identity and existence certain, location approximate		*3.5 mm* *.75 mm* *.75 mm*	
1.2.4	Key bed—Identity or existence questionable, location approximate	?		
1.2.5	Key bed—Identity and existence certain, location inferred		*1.5 mm* *.75 mm* *.75 mm*	
1.2.6	Key bed—Identity or existence questionable, location inferred	?		
1.2.7	Key bed—Identity and existence certain, location concealed		*.5 mm* *.75 mm* *.75 mm*	
1.2.8	Key bed—Identity or existence questionable, location concealed	?		
1.2.9	Clay bed—Identity and existence certain, location accurate		*lineweight .3 mm* *color 100% green* *HB-8 (100% green)* *.75 mm* *12.0 mm*	Use to show clay beds that are too narrow to map as an area at map scale. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.10	Clay bed—Identity or existence questionable, location accurate	?		
1.2.11	Clay bed—Identity and existence certain, location approximate		*3.5 mm* *.75 mm* *.75 mm*	
1.2.12	Clay bed—Identity or existence questionable, location approximate	?		
1.2.13	Clay bed—Identity and existence certain, location inferred		*1.5 mm* *.75 mm* *.75 mm*	
1.2.14	Clay bed—Identity or existence questionable, location inferred	?		
1.2.15	Clay bed—Identity and existence certain, location concealed		*.5 mm* *.75 mm* *.75 mm*	
1.2.16	Clay bed—Identity or existence questionable, location concealed	?		
1.2.17	Bed of economically important commodity—Identity and existence certain, location accurate		*lineweight .3 mm* *HB-8* *.75 mm* *12.0 mm*	Use to show such economically important beds as gypsum, salt, bentonite, phosphate, or limestone that are too narrow to map as an area at map scale. Do not use to show coal beds (see Section 1.2, ref. nos. 1.2.25-40). Add name of commodity if more than one type is shown on map (see Section 1.4). May also be shown in color.
1.2.18	Bed of economically important commodity—Identity or existence questionable, location accurate	?		
1.2.19	Bed of economically important commodity—Identity and existence certain, location approximate		*3.5 mm* *.75 mm* *.75 mm*	
1.2.20	Bed of economically important commodity—Identity or existence questionable, location approximate	?		
1.2.21	Bed of economically important commodity—Identity and existence certain, location inferred		*1.5 mm* *.75 mm* *.75 mm*	
1.2.22	Bed of economically important commodity—Identity or existence questionable, location inferred	?		
1.2.23	Bed of economically important commodity—Identity and existence certain, location concealed		*.5 mm* *.75 mm* *.75 mm*	
1.2.24	Bed of economically important commodity—Identity or existence questionable, location concealed	?		

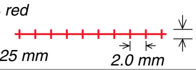
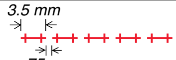
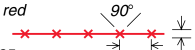
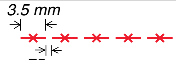
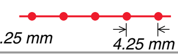
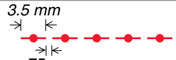
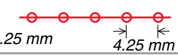
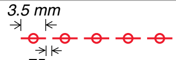
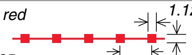
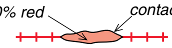
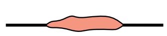
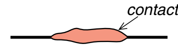
*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	1.2—Key beds (continued)			
1.2.25	Coal bed—Identity and existence certain, location accurate		lineweight .3 mm; color 100% red; HB-8 (100% red); .75 mm; 12.0 mm	Use to show coal beds that are too narrow to map as an area at map scale. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.26	Coal bed—Identity or existence questionable, location accurate			
1.2.27	Coal bed—Identity and existence certain, location approximate		3.5 mm; .75 mm; .75 mm	
1.2.28	Coal bed—Identity or existence questionable, location approximate			
1.2.29	Coal bed—Identity and existence certain, location inferred		1.5 mm; .75 mm; .75 mm	
1.2.30	Coal bed—Identity or existence questionable, location inferred			
1.2.31	Coal bed—Identity and existence certain, location concealed		.5 mm; .75 mm; .75 mm	
1.2.32	Coal bed—Identity or existence questionable, location concealed			
1.2.33	Clinkered coal bed—Identity and existence certain, location accurate		H-8 (100% red); .375 mm; 90°; .8 mm; 2.0 mm; lineweight .2 mm; color 100% red	Use to show clinkered coal beds that are too narrow to map as an area at map scale. Tops of V's follow trace of bed; V's point downward stratigraphically. Add name if more than one type is shown on map (see Section 1.4). May also be shown in black or other colors.
1.2.34	Clinkered coal bed—Identity or existence questionable, location accurate			
1.2.35	Clinkered coal bed—Identity and existence certain, location approximate		.375 mm; 2.0 mm; 2.0 mm	
1.2.36	Clinkered coal bed—Identity or existence questionable, location approximate			
1.2.37	Clinkered coal bed—Identity and existence certain, location inferred		.375 mm; 2.0 mm; 2.0 mm	
1.2.38	Clinkered coal bed—Identity or existence questionable, location inferred			
1.2.39	Clinkered coal bed—Identity and existence certain, location concealed		2.0 mm; 2.0 mm	
1.2.40	Clinkered coal bed—Identity or existence questionable, location concealed			
1.2.41	Area of clinkered coal bed		contact [lineweight .15 mm]; pattern 317-R	Add name if more than one type is shown on map (see Section 1.4).
1.2.42	Outcrop area of key bed or bed of economically important commodity (1st option)		scratch boundary [lineweight 0.0]; 100% black	Outcrop areas may either overprint other geologic map units or be used as stand-alone geologic map units. Each type of outcrop area may also be shown in other values of black or in other colors; add name(s) if more than one type is shown on map (see Section 1.4).
1.2.43	Outcrop area of key bed or bed of economically important commodity (2nd option)		scratch boundary [lineweight 0.0]; 30% black	
1.2.44	Outcrop area of clay bed		scratch boundary [lineweight 0.0]; 100% green	
1.2.45	Outcrop area of coal bed		scratch boundary [lineweight 0.0]; 100% red	

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		1.3—Dikes		
1.3.1	Dike (1st option)—Identity and existence certain, location accurate		color 100% red lineweight .25 mm	Use when dike is too narrow to show as an area at map scale. Add map-unit labels to dikes if needed (see Section 1.4); use a queried label if identity of dike is questionable. May also be shown in black or other colors.
1.3.2	Dike (1st option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.3	Dike (2nd option)—Identity and existence certain, location accurate		color 100% red  1.25 mm lineweight .25 mm 2.0 mm	
1.3.4	Dike (2nd option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.5	Dike (3rd option)—Identity and existence certain, location accurate		color 100% red 90°  1.0 mm lineweight .25 mm 4.25 mm	
1.3.6	Dike (3rd option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.7	Dike (4th option)—Identity and existence certain, location accurate		color 100% red dot diameter 1.125 mm  lineweight .25 mm 4.25 mm	
1.3.8	Dike (4th option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.9	Dike (5th option)—Identity and existence certain, location accurate		color 100% red circle diameter 1.175 mm  lineweight .25 mm 4.25 mm	
1.3.10	Dike (5th option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.11	Dike (6th option)—Identity and existence certain, location accurate		color 100% red 1.125 mm  lineweight .25 mm 4.25 mm	
1.3.12	Dike (6th option)—Identity and existence certain, location approximate		3.5 mm  .75 mm	
1.3.13	Dike of variable thickness		50% red contact [lineweight .15 mm] 	Although only "dike (2nd option)" is shown here, any type of dike symbol may be used. Add map-unit labels to dikes if needed (see Section 1.4). Thick dikes may also be shown in other colors.
1.3.14	Dike intruding fault (1st option)		fault [lineweight .375 mm] 	
1.3.15	Dike intruding fault (2nd option)		contact [lineweight .15 mm] 	

*For more information, see general guidelines on pages A-i to A-v.

1—CONTACTS, KEY BEDS, AND DIKES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
1.4—Line-symbol decorations and notations for contacts, key beds, and dikes				
1.4.1	Inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)—Showing dip value and direction	35	tick length 1.75 mm; lineweight .15 mm; 35; HI-6	Line-symbol decorations may be added to any type or style of contact, as well as to any type or style of key bed or dike (use proper lineweights, etc., to show clay beds, coal beds, dikes, etc.). Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
1.4.2	Inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)—Showing dip value and direction	15	tick length 1.375 mm; lineweight .15 mm; 15; .875 mm; 30°	
1.4.3	Vertical or near-vertical contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)		tick length 2.5 mm; lineweight .15 mm	
1.4.4	Vertical or near-vertical contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)	90	90; HI-6	
1.4.5	Overturned contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (1st option)—Showing dip value and direction	85	tick length 1.75 mm; lineweight .15 mm; 85; HI-6; .625 mm radius	
1.4.6	Overturned contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity (2nd option)—Showing dip value and direction	75	tick length 1.375 mm; lineweight .15 mm; 75; .875 mm; .625 mm radius; 30°	
1.4.7	Lineation on surface of contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity—Showing bearing and plunge	65	6.0 mm; 65; HI-6; lineweight .175 mm; 25°; 1.5 mm	
1.4.8	Lineation on surface of inclined contact, dike, key bed, clay bed, coal bed, or bed of economically important commodity—Tick shows contact dip value and direction; arrow shows bearing and plunge of lineation	25 35	tick length 1.75 mm; lineweight .15 mm; HI-6; 25; 35	
1.4.9	Contact—Showing relative age of intrusive or extrusive units where known: Y, younger; O, older	Y O	H-7; Y; H-7; O	
1.4.10	Contact—Showing location where contact is particularly well exposed in field		20°; 1.75 mm; .75 mm	
1.4.11	Key bed, clay bed, coal bed, bed of economically important commodity, or dike—Showing thickness and location where measured	1.5	1.5; H-6	Use proper lineweights, etc., to show clay beds, coal beds, dikes, etc.
1.4.12	Key bed—Showing name	ds	ds; HI-8	
1.4.13	Clay bed—Showing name	sc	sc; HI-8 (100% black)	
1.4.14	Bed of economically important commodity—Showing name	gyp	gyp; HI-8	
1.4.15	Coal bed—Showing name	lg	lg; HI-8 (100% black)	
1.4.16	Clinkered coal bed—Showing name	m	m; HI-8 (100% black)	
1.4.17	Area of clinkered coal bed—Showing name	bg	HI-8 (100% black); bg	
1.4.18	Dike—Showing name	Km	Km; H-8; leader lineweight .175 mm	Although only "dike (2nd option)" is shown labeled here, map-unit labels may be added to any type of dike symbol. Use a queried map-unit label if identity of dike is questionable.
1.4.19	Dike of variable thickness—Showing name	KJd KJd?	KJd; H-8; KJd?; leader lineweight .175 mm	
1.4.20	Dike intruding fault (1st option)—Showing name	Km	Km; H-8; leader lineweight .175 mm	
1.4.21	Dike intruding fault (2nd option)—Showing name	Td	H-8; Td; leader lineweight .175 mm	

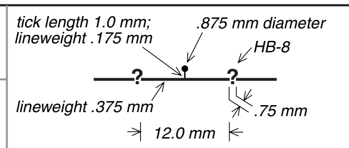
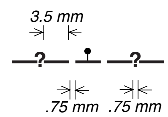
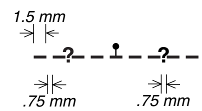
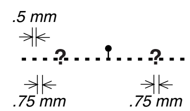
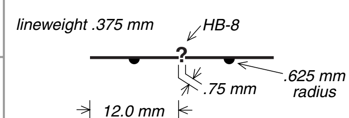
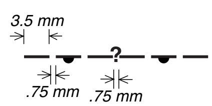
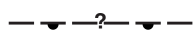
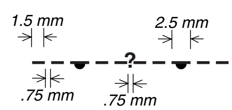
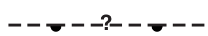
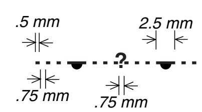
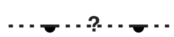
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.1—Faults (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)				
2.1.1	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location accurate		*lineweight .375 mm* *HB-8* ? *.75 mm* *12.0 mm*	Use generic, nonspecific (non-ornamented) fault symbols when orientation or sense of slip is not known or not specified; use also on small-scale maps to show regional fault patterns. If orientation or sense of slip is known and if scale allows, use more specific types of ornamented fault symbols to indicate fault geometry and (or) relative motion.
2.1.2	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location accurate	?		
2.1.3	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location approximate		*3.5 mm* ? *.75 mm* *.75 mm*	
2.1.4	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location approximate	?		
2.1.5	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location inferred		*1.5 mm* ? *.75 mm* *.75 mm*	
2.1.6	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location inferred	?		
2.1.7	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location concealed		*.5 mm* ? *.75 mm* *.75 mm*	
2.1.8	Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location concealed	?		

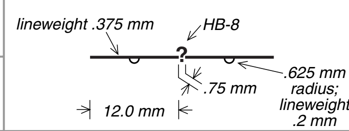
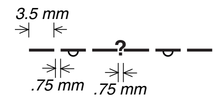
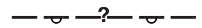
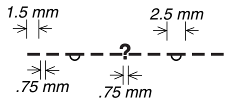
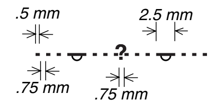
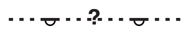
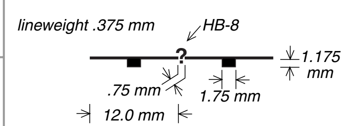
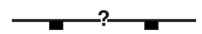
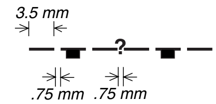
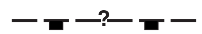
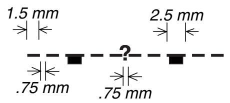
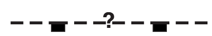
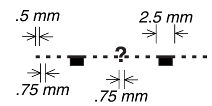
**For more information, see general guidelines on pages A-i to A-v.*

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		2.2—Normal faults		
2.2.1	Normal fault—Identity and existence certain, location accurate. Ball and bar on downthrown block			Ball and bar symbols are placed along a fault to indicate its overall fault type (normal fault). Ball and bar symbols may also be placed along other types of faults at specific localities where observations of normal (or apparent normal) offset have been made (see Section 2.11). Ball and bar symbols may be combined with paired arrows to show oblique offset (see Sections 2.7, 2.11). In cross section, use paired arrows to show relative motion of normal faults (see Section 2.11).
2.2.2	Normal fault—Identity or existence questionable, location accurate. Ball and bar on downthrown block			
2.2.3	Normal fault—Identity and existence certain, location approximate. Ball and bar on downthrown block			
2.2.4	Normal fault—Identity or existence questionable, location approximate. Ball and bar on downthrown block			
2.2.5	Normal fault—Identity and existence certain, location inferred. Ball and bar on downthrown block			
2.2.6	Normal fault—Identity or existence questionable, location inferred. Ball and bar on downthrown block			
2.2.7	Normal fault—Identity and existence certain, location concealed. Ball and bar on downthrown block			
2.2.8	Normal fault—Identity or existence questionable, location concealed. Ball and bar on downthrown block			
2.2.9	Low-angle normal fault—Identity and existence certain, location accurate. Half-circles on downthrown block			Half-circles indicate overall fault type (low-angle normal fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of low-angle normal faults (see Section 2.11).
2.2.10	Low-angle normal fault—Identity or existence questionable, location accurate. Half-circles on downthrown block			
2.2.11	Low-angle normal fault—Identity and existence certain, location approximate. Half-circles on downthrown block			
2.2.12	Low-angle normal fault—Identity or existence questionable, location approximate. Half-circles on downthrown block			
2.2.13	Low-angle normal fault—Identity and existence certain, location inferred. Half-circles on downthrown block			
2.2.14	Low-angle normal fault—Identity or existence questionable, location inferred. Half-circles on downthrown block			
2.2.15	Low-angle normal fault—Identity and existence certain, location concealed. Half-circles on downthrown block			
2.2.16	Low-angle normal fault—Identity or existence questionable, location concealed. Half-circles on downthrown block			

*For more information, see general guidelines on pages A-i to A-v.

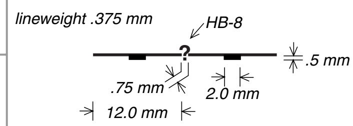
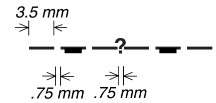
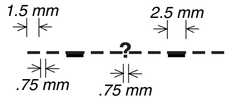
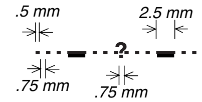
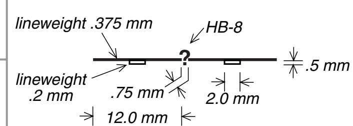
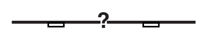
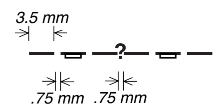
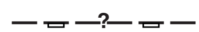
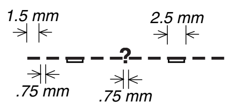
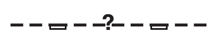
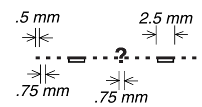
2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.3—Low-angle faults (unknown or unspecified sense of slip)				
2.3.1	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location accurate. Half-circles on upper plate			Use to show faults that exhibit low-angle geometry but for which relative motion cannot be (or has not been) specified. Half-circles indicate overall fault type (low-angle fault, unknown or unspecified sense of slip); they are not placed at specific localities where observations have been made.
2.3.2	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location accurate. Half-circles on upper plate			
2.3.3	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location approximate. Half-circles on upper plate			
2.3.4	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location approximate. Half-circles on upper plate			
2.3.5	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location inferred. Half-circles on upper plate			
2.3.6	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location inferred. Half-circles on upper plate			
2.3.7	Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location concealed. Half-circles on upper plate			
2.3.8	Low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location concealed. Half-circles on upper plate			
2.4—Reverse faults				
2.4.1	Reverse fault—Identity and existence certain, location accurate. Rectangles on upthrown block			Rectangles indicate overall fault type (reverse fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of reverse faults (see Section 2.11).
2.4.2	Reverse fault—Identity or existence questionable, location accurate. Rectangles on upthrown block			
2.4.3	Reverse fault—Identity and existence certain, location approximate. Rectangles on upthrown block			
2.4.4	Reverse fault—Identity or existence questionable, location approximate. Rectangles on upthrown block			
2.4.5	Reverse fault—Identity and existence certain, location inferred. Rectangles on upthrown block			
2.4.6	Reverse fault—Identity or existence questionable, location inferred. Rectangles on upthrown block			
2.4.7	Reverse fault—Identity and existence certain, location concealed. Rectangles on upthrown block			
2.4.8	Reverse fault—Identity or existence questionable, location concealed. Rectangles on upthrown block			

*For more information, see general guidelines on pages A-i to A-v.

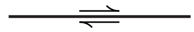
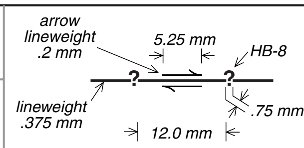
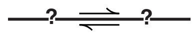
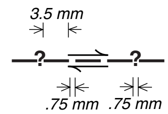
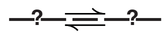
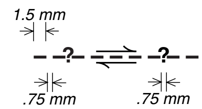
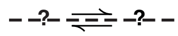
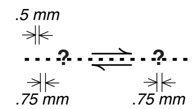
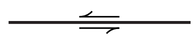
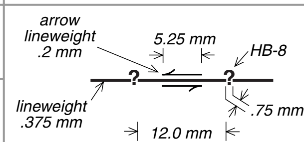
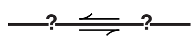
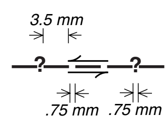
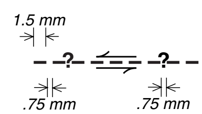
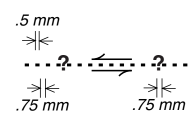
2—FAULTS (continued)

2.5—Rotational or scissor faults

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.5.1	Rotational or scissor fault, reverse-slip offset—Identity and existence certain, location accurate. Rectangles on upthrown block			Rectangles indicate overall fault type (rotational or scissor fault, reverse-slip offset); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of rotational or scissor faults (see Section 2.11).
2.5.2	Rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location accurate. Rectangles on upthrown block			
2.5.3	Rotational or scissor fault, reverse-slip offset—Identity and existence certain, location approximate. Rectangles on upthrown block			
2.5.4	Rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location approximate. Rectangles on upthrown block			
2.5.5	Rotational or scissor fault, reverse-slip offset—Identity and existence certain, location inferred. Rectangles on upthrown block			
2.5.6	Rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location inferred. Rectangles on upthrown block			
2.5.7	Rotational or scissor fault, reverse-slip offset—Identity and existence certain, location concealed. Rectangles on upthrown block			
2.5.8	Rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location concealed. Rectangles on upthrown block			
2.5.9	Rotational or scissor fault, normal-slip offset—Identity and existence certain, location accurate. Rectangles on downthrown block			Rectangles indicate overall fault type (rotational or scissor fault, normal-slip offset); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of rotational or scissor faults (see Section 2.11).
2.5.10	Rotational or scissor fault, normal-slip offset—Identity or existence questionable, location accurate. Rectangles on downthrown block			
2.5.11	Rotational or scissor fault, normal-slip offset—Identity and existence certain, location approximate. Rectangles on downthrown block			
2.5.12	Rotational or scissor fault, normal-slip offset—Identity or existence questionable, location approximate. Rectangles on downthrown block			
2.5.13	Rotational or scissor fault, normal-slip offset—Identity and existence certain, location inferred. Rectangles on downthrown block			
2.5.14	Rotational or scissor fault, normal-slip offset—Identity or existence questionable, location inferred. Rectangles on downthrown block			
2.5.15	Rotational or scissor fault, normal-slip offset—Identity and existence certain, location concealed. Rectangles on downthrown block			
2.5.16	Rotational or scissor fault, normal-slip offset—Identity or existence questionable, location concealed. Rectangles on downthrown block			

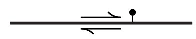
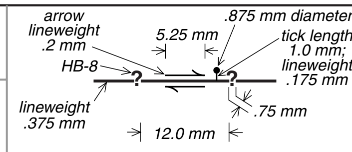
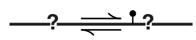
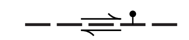
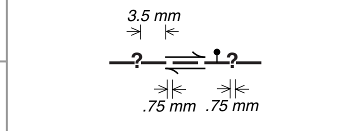
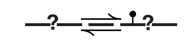
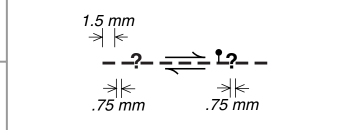
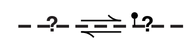
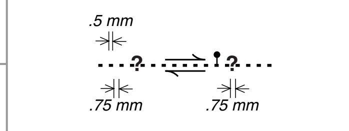
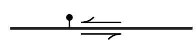
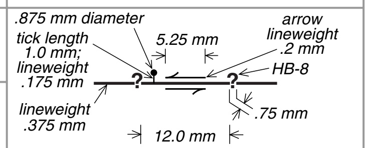
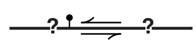
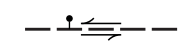
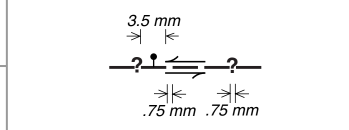
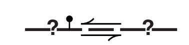
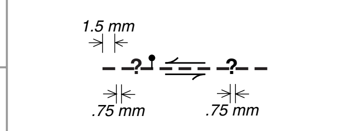
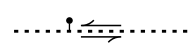
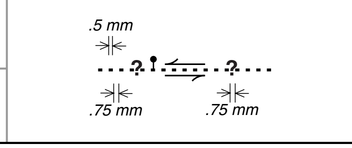
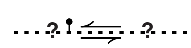
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		2.6—Strike-slip faults		
2.6.1	Strike-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion			Paired arrows are placed along a fault to indicate its overall type (strike-slip fault) and its relative motion. Paired arrows may also be placed along other types of faults at spec ific localities where observations of strike-slip (or apparent strike-slip) offset have been made (see Section 2.11). Paired arrows may be combined with ball and bar symbols to show oblique offset (see Sections 2.7, 2.11). In cross section, use either A/T or +/– notation to show relative motion of strike-slip faults (see Section 2.11).
2.6.2	Strike-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion			
2.6.3	Strike-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion			
2.6.4	Strike-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion			
2.6.5	Strike-slip fault, right-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion			
2.6.6	Strike-slip fault, right-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion			
2.6.7	Strike-slip fault, right-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion			
2.6.8	Strike-slip fault, right-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion			
2.6.9	Strike-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion			
2.6.10	Strike-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion			
2.6.11	Strike-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion			
2.6.12	Strike-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion			
2.6.13	Strike-slip fault, left-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion			
2.6.14	Strike-slip fault, left-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion			
2.6.15	Strike-slip fault, left-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion			
2.6.16	Strike-slip fault, left-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion			

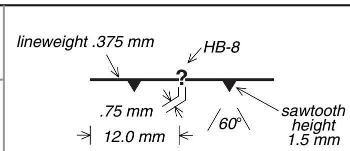
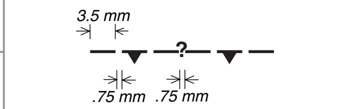
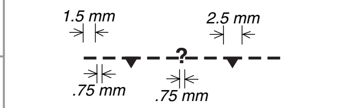
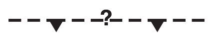
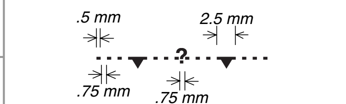
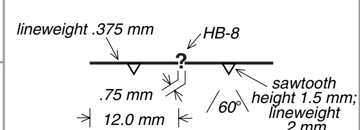
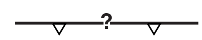
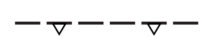
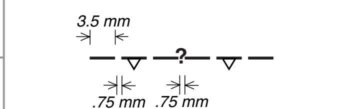
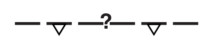
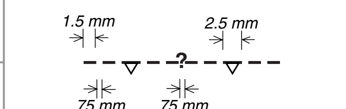
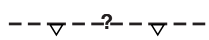
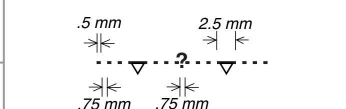
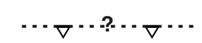
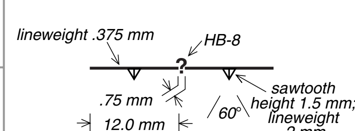
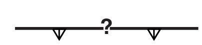
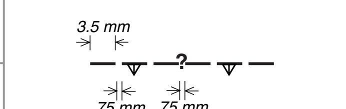
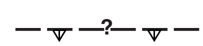
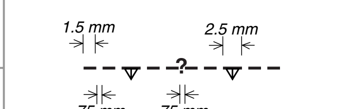
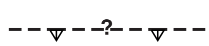
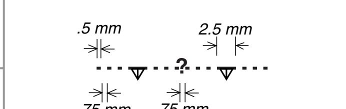
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.7—Oblique-slip faults			
2.7.1	Oblique-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block			Sets of paired arrows and ball and bar symbols are placed along a fault to indicate its overall type (oblique-slip fault) and its relative motion. Sets of paired arrows and ball and bar symbols may also be placed along other types of faults at specific localities where observations of oblique-slip (or apparent oblique-slip) offset have been made (see Section 2.11). In cross section, use paired arrows with either A/T or +/– notation to show relative motion of oblique-slip faults (see Section 2.11).
2.7.2	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.3	Oblique-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.4	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.5	Oblique-slip fault, right-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.6	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.7	Oblique-slip fault, right-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.8	Oblique-slip fault, right-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.9	Oblique-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.10	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block			
2.7.11	Oblique-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.12	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block			
2.7.13	Oblique-slip fault, left-lateral offset—Identity and existence certain, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.14	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location inferred. Arrows show relative motion; ball and bar on downthrown block			
2.7.15	Oblique-slip fault, left-lateral offset—Identity and existence certain, location concealed. Arrows show relative motion; ball and bar on downthrown block			
2.7.16	Oblique-slip fault, left-lateral offset—Identity or existence questionable, location concealed. Arrows show relative motion; ball and bar on downthrown block			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.8—Thrust faults			
2.8.1	Thrust fault (1st option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			Sawteeth indicate overall fault type (thrust fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of thrust faults (see Section 2.11). If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of thrust faults.
2.8.2	Thrust fault (1st option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.3	Thrust fault (1st option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.4	Thrust fault (1st option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.5	Thrust fault (1st option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.6	Thrust fault (1st option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.7	Thrust fault (1st option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.8	Thrust fault (1st option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.9	Thrust fault (2nd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.10	Thrust fault (2nd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.11	Thrust fault (2nd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.12	Thrust fault (2nd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.13	Thrust fault (2nd option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.14	Thrust fault (2nd option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.15	Thrust fault (2nd option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.16	Thrust fault (2nd option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.17	Thrust fault (3rd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.18	Thrust fault (3rd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate			
2.8.19	Thrust fault (3rd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.20	Thrust fault (3rd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate			
2.8.21	Thrust fault (3rd option)—Identity and existence certain, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.22	Thrust fault (3rd option)—Identity or existence questionable, location inferred. Sawteeth on upper (tectonically higher) plate			
2.8.23	Thrust fault (3rd option)—Identity and existence certain, location concealed. Sawteeth on upper (tectonically higher) plate			
2.8.24	Thrust fault (3rd option)—Identity or existence questionable, location concealed. Sawteeth on upper (tectonically higher) plate			

*For more information, see general guidelines on pages A-i to A-v.

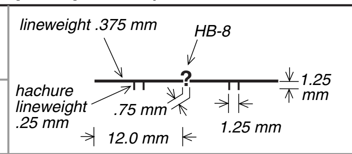
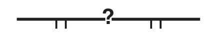
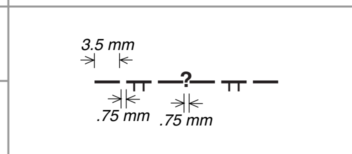
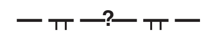
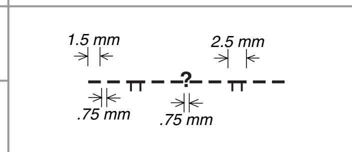
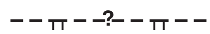
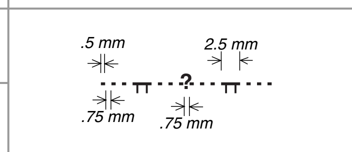
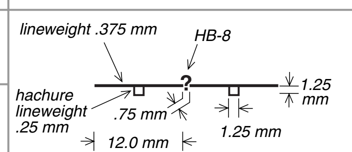
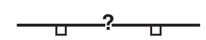
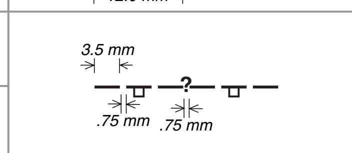
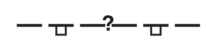
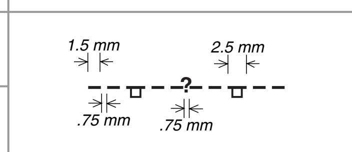
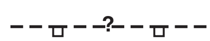
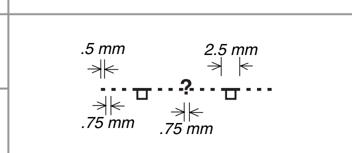
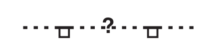
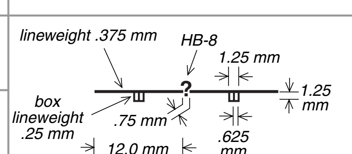
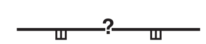
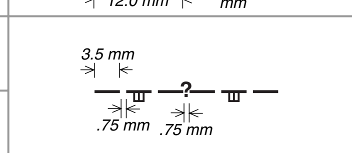
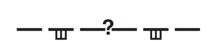
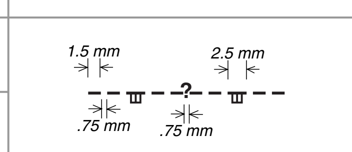
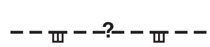
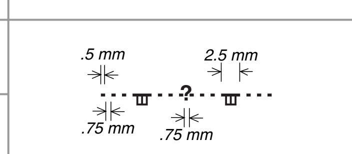
2—FAULTS (continued)

2.9—Overturned thrust faults

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.9.1	Overturned thrust fault (1st option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		lineweight .375 mm; HB-8; 3.0 mm; 2.25 mm; .5 mm; ?; .75 mm; 40°; 60°; sawtooth height 1.5 mm; 12.0 mm	Bars and sawteeth indicate overall fault type (overturned thrust fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of overturned thrust faults (see Section 2.11). If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of overturned thrust faults.
2.9.2	Overturned thrust fault (1st option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.3	Overturned thrust fault (1st option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		3.5 mm; ?; .75 mm; .75 mm	
2.9.4	Overturned thrust fault (1st option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.5	Overturned thrust fault (1st option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		1.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.6	Overturned thrust fault (1st option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.7	Overturned thrust fault (1st option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.8	Overturned thrust fault (1st option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.9	Overturned thrust fault (2nd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		lineweight .375 mm; HB-8; 3.0 mm; 2.25 mm; .5 mm; ?; .75 mm; 40°; 60°; sawtooth height 1.5 mm; lineweight .2 mm; 12.0 mm	
2.9.10	Overturned thrust fault (2nd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.11	Overturned thrust fault (2nd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		3.5 mm; ?; .75 mm; .75 mm	
2.9.12	Overturned thrust fault (2nd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.13	Overturned thrust fault (2nd option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		1.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.14	Overturned thrust fault (2nd option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.15	Overturned thrust fault (2nd option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.16	Overturned thrust fault (2nd option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.17	Overturned thrust fault (3rd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		lineweight .375 mm; HB-8; 3.0 mm; 2.25 mm; .5 mm; ?; .75 mm; 40°; 60°; sawtooth height 1.5 mm; lineweight .2 mm; 12.0 mm	
2.9.18	Overturned thrust fault (3rd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.19	Overturned thrust fault (3rd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		3.5 mm; ?; .75 mm; .75 mm	
2.9.20	Overturned thrust fault (3rd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.21	Overturned thrust fault (3rd option)—Identity and existence certain, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		1.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.22	Overturned thrust fault (3rd option)—Identity or existence questionable, location inferred. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		
2.9.23	Overturned thrust fault (3rd option)—Identity and existence certain, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip		.5 mm; 3.5 mm; ?; .75 mm; .75 mm	
2.9.24	Overturned thrust fault (3rd option)—Identity or existence questionable, location concealed. Bars on tectonically higher plate (footwall); sawteeth in direction of dip	?		

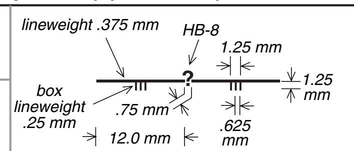
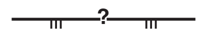
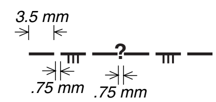
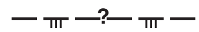
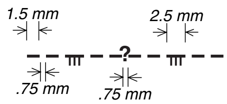
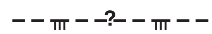
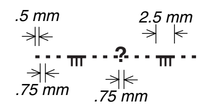
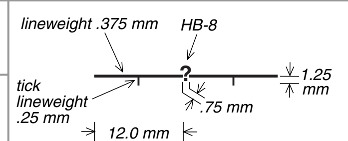
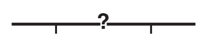
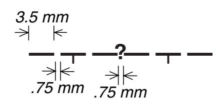
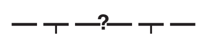
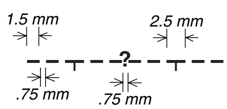
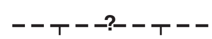
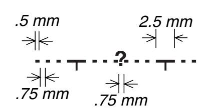
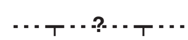
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.10—Detachment faults (sense of slip unspecified)			
2.10.1	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location accurate. Hachures on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Hachures indicate overall fault type (detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of detachment faults (see Section 2.11). If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of detachment faults.
2.10.2	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location accurate. Hachures on upper plate			
2.10.3	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location approximate. Hachures on upper plate			
2.10.4	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location approximate. Hachures on upper plate			
2.10.5	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location inferred. Hachures on upper plate			
2.10.6	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location inferred. Hachures on upper plate			
2.10.7	Detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location concealed. Hachures on upper plate			
2.10.8	Detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location concealed. Hachures on upper plate			
2.10.9	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location accurate. Boxes on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Boxes indicate overall fault type (detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of detachment faults (see Section 2.11). If desired, "2nd option" and "3rd option" symbols may be used to show other types or generations of detachment faults.
2.10.10	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location accurate. Boxes on upper plate			
2.10.11	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location approximate. Boxes on upper plate			
2.10.12	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location approximate. Boxes on upper plate			
2.10.13	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location inferred. Boxes on upper plate			
2.10.14	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location inferred. Boxes on upper plate			
2.10.15	Detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location concealed. Boxes on upper plate			
2.10.16	Detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location concealed. Boxes on upper plate			
2.10.17	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location accurate. Boxes on upper plate			
2.10.18	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location accurate. Boxes on upper plate			
2.10.19	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location approximate. Boxes on upper plate			
2.10.20	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location approximate. Boxes on upper plate			
2.10.21	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location inferred. Boxes on upper plate			
2.10.22	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location inferred. Boxes on upper plate			
2.10.23	Detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location concealed. Boxes on upper plate			
2.10.24	Detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location concealed. Boxes on upper plate			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.10—Detachment faults (sense of slip unspecified) (continued)			
2.10.25	Master detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Hachures on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Hachures indicate overall fault type (master detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of master detachment faults (see Section 2.11).
2.10.26	Master detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Hachures on upper plate			
2.10.27	Master detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Hachures on upper plate			
2.10.28	Master detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Hachures on upper plate			
2.10.29	Master detachment fault (sense of slip unspecified)—Identity and existence certain, location inferred. Hachures on upper plate			
2.10.30	Master detachment fault (sense of slip unspecified)—Identity or existence questionable, location inferred. Hachures on upper plate			
2.10.31	Master detachment fault (sense of slip unspecified)—Identity and existence certain, location concealed. Hachures on upper plate			
2.10.32	Master detachment fault (sense of slip unspecified)—Identity or existence questionable, location concealed. Hachures on upper plate			
2.10.33	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Ticks on upper plate			May be used to show either normal (extensional) or thrust (compressional) offset. Ticks indicate overall fault type (listric fault at head of detachment fault); they are not placed at specific localities where observations have been made. In cross section, use paired arrows to show relative motion of listric faults at head of detachment faults (see Section 2.11).
2.10.34	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Ticks on upper plate			
2.10.35	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Ticks on upper plate			
2.10.36	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Ticks on upper plate			
2.10.37	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location inferred. Ticks on upper plate			
2.10.38	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location inferred. Ticks on upper plate			
2.10.39	Listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location concealed. Ticks on upper plate			
2.10.40	Listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location concealed. Ticks on upper plate			

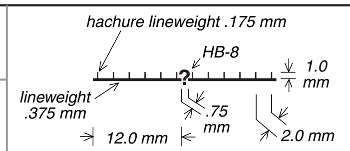
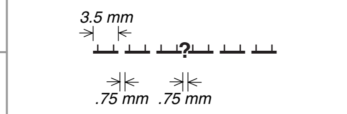
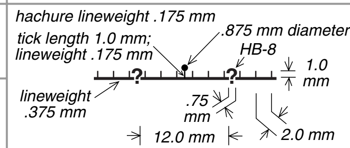
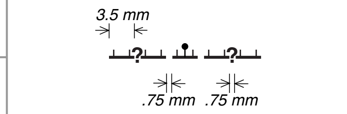
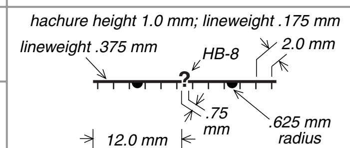
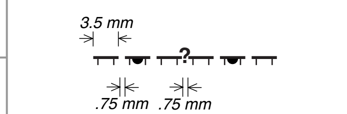
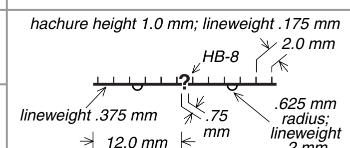
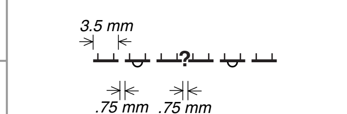
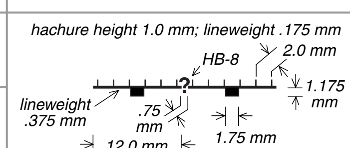
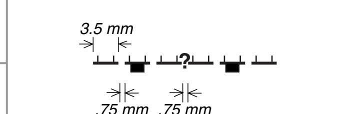
**For more information, see general guidelines on pages A-i to A-v.*

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
2.11—Line-symbol decorations and notations for faults				
2.11.1	Fault showing local normal offset (1st option)—Ball and bar on downthrown block		tick length 1.0 mm; lineweight .175 mm; .875 mm diameter; lineweight .375 mm	Place line-symbol decorations where observations have been made. Line-symbol decorations may be added to any type or style of fault to show local relative motion or geomorphic relations. Line-symbol decorations may also be added to faults in places where local geomorphic features may indicate an apparent offset but where true sense of displacement is unknown.
2.11.2	Fault showing local normal offset (2nd option)—U, upthrown block; D, downthrown block	U D	U H-7 D H-7	
2.11.3	Fault showing local reverse offset—Showing dip value and direction. U, upthrown block; D, downthrown block	U 65 D	65 HI-6 U D tick length 1.75 mm; lineweight .225 mm	
2.11.4	Fault showing local right-lateral strike-slip offset—Arrows show relative motion		5.25 mm; arrow lineweight .2 mm	
2.11.5	Fault showing local left-lateral strike-slip offset—Arrows show relative motion		5.25 mm; arrow lineweight .2 mm	
2.11.6	Fault showing local right-lateral oblique-slip offset—Arrows show relative motion; ball and bar on downthrown block		.875 mm diameter; tick length 1.0 mm; lineweight .175 mm	
2.11.7	Fault showing local left-lateral oblique-slip offset—Arrows show relative motion; ball and bar on downthrown block		.875 mm diameter; tick length 1.0 mm; lineweight .175 mm	
2.11.8	Inclined fault (1st option)—Showing dip value and direction	35	tick length 1.75 mm; lineweight .225 mm; 35 HI-6	Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
2.11.9	Inclined fault (2nd option)—Showing dip value and direction	15	tick length 1.375 mm; lineweight .225 mm; 15; .875 mm; 30°	
2.11.10	Vertical or near-vertical fault (1st option)		tick length 2.5 mm; lineweight .225 mm	
2.11.11	Vertical or near-vertical fault (2nd option)	90	90 HI-6	
2.11.12	Lineation on fault surface—Showing bearing and plunge	65	6.0 mm; 65 HI-6; lineweight .225 mm; 25°; 1.5 mm	
2.11.13	Lineation on inclined fault surface—Tick shows fault dip value and direction; arrow shows bearing and plunge of lineation	25 35	tick length 1.75 mm; lineweight .225 mm; HI-6 25 35	
2.11.14	Fault—Showing amount of local displacement	68	68 H-6	Place displacement value where measurement was made.
2.11.15	Fault—Showing name	GOLDEN FAULT	GOLDEN FAULT H-8	Letter size or spacing may be increased on longer fault segments.
2.11.16	Normal fault (in cross section)—Arrows show relative motion		5.25 mm; arrow lineweight .2 mm	
2.11.17	Thrust fault or reverse fault (in cross section)—Arrows show relative motion			
2.11.18	Detachment fault, movement of upper plate to left (in cross section)—Arrows show relative motion		5.25 mm; arrow lineweight .2 mm	
2.11.19	Detachment fault, movement of upper plate to right (in cross section)—Arrows show relative motion			
2.11.20	Strike-slip fault (in cross section) (1st option)—A, away from observer; T, toward observer	A T	H-7 A T H-7	May be combined with paired arrows to show oblique-slip offset.
2.11.21	Strike-slip fault (in cross section) (2nd option)—minus, away from observer; plus, toward observer	⊖ ⊕	circle diameters 1.75 mm; crossbar lengths 1.75 mm; lineweights .2 mm; ⊖ ⊕	
2.11.22	Normal fault (on small-scale maps or figures)—Tick on downthrown side		lineweight .3 mm; tick length .8 mm; lineweight .25 mm	Usually reserved for use on page-size illustions or on maps at scales of 1:1,000,000 or smaller.
2.11.23	Reverse fault (on small-scale maps or figures)—R on upthrown block	R	R H-6 (rotate parallel to fault)	
2.11.24	Thrust fault (on small-scale maps or figures)—T on upper (tectonically higher) plate	T	T H-6 (rotate parallel to fault)	

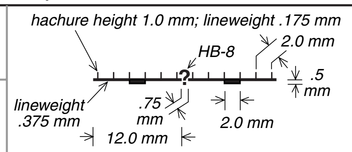
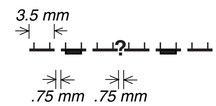
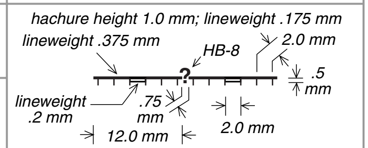
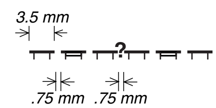
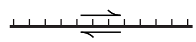
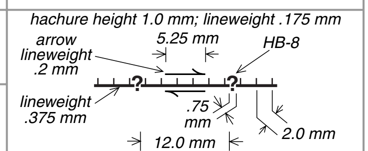
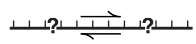
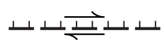
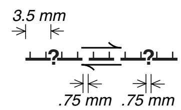
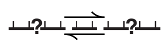
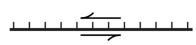
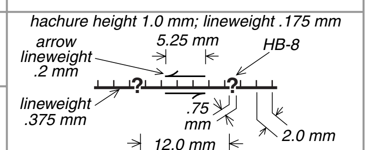
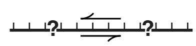
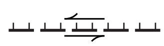
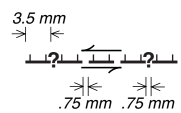
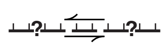
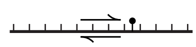
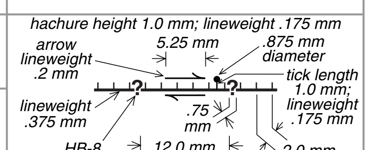
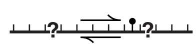
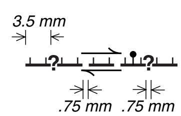
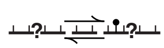
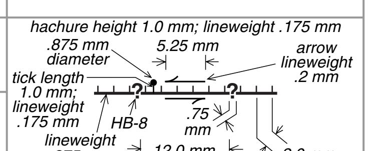
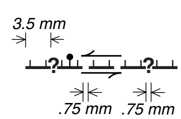
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.12—Fault scarps			
2.12.1	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location accurate. Hachures point downscarp			
2.12.2	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location accurate. Hachures point downscarp			
2.12.3	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence certain, location approximate. Hachures point downscarp			
2.12.4	Scarp on fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence questionable, location approximate. Hachures point downscarp			
2.12.5	Scarp on normal fault—Identity and existence certain, location accurate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.6	Scarp on normal fault—Identity or existence questionable, location accurate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.7	Scarp on normal fault—Identity and existence certain, location approximate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.8	Scarp on normal fault—Identity or existence questionable, location approximate. Ball and bar on downthrown block. Hachures point downscarp			
2.12.9	Scarp on low-angle normal fault—Identity and existence certain, location accurate. Half-circles on downthrown block. Hachures point downscarp			
2.12.10	Scarp on low-angle normal fault—Identity or existence questionable, location accurate. Half-circles on downthrown block. Hachures point downscarp			
2.12.11	Scarp on low-angle normal fault—Identity and existence certain, location approximate. Half-circles on downthrown block. Hachures point downscarp			
2.12.12	Scarp on low-angle normal fault—Identity or existence questionable, location approximate. Half-circles on downthrown block. Hachures point downscarp			
2.12.13	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location accurate. Half-circles on upper plate. Hachures point downscarp			
2.12.14	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location accurate. Half-circles on upper plate. Hachures point downscarp			
2.12.15	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location approximate. Half-circles on upper plate. Hachures point downscarp			
2.12.16	Scarp on low-angle fault (unknown or unspecified sense of slip)—Identity or existence questionable, location approximate. Half-circles on upper plate. Hachures point downscarp			
2.12.17	Scarp on reverse fault—Identity and existence certain, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.18	Scarp on reverse fault—Identity or existence questionable, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.19	Scarp on reverse fault—Identity and existence certain, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.20	Scarp on reverse fault—Identity or existence questionable, location approximate. Rectangles on upthrown block. Hachures point downscarp			

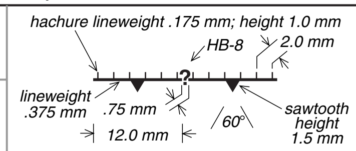
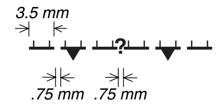
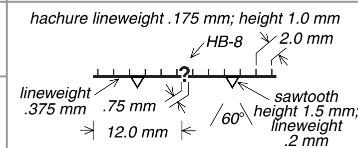
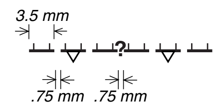
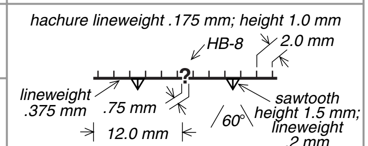
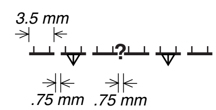
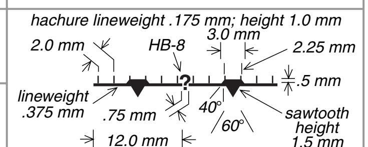
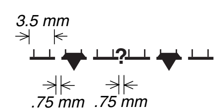
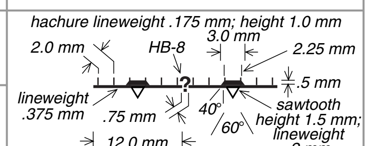
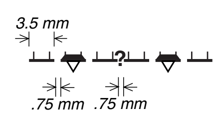
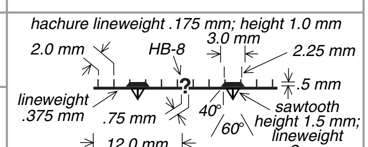
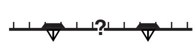
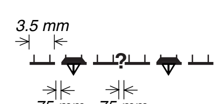
For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.12—Fault scarps (continued)			
2.12.21	Scarp on rotational or scissor fault, reverse-slip offset—Identity and existence certain, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.22	Scarp on rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location accurate. Rectangles on upthrown block. Hachures point downscarp			
2.12.23	Scarp on rotational or scissor fault, reverse-slip offset—Identity and existence certain, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.24	Scarp on rotational or scissor fault, reverse-slip offset—Identity or existence questionable, location approximate. Rectangles on upthrown block. Hachures point downscarp			
2.12.25	Scarp on rotational or scissor fault, normal-slip offset—Identity and existence certain, location accurate. Rectangles on downthrown block. Hachures point downscarp			
2.12.26	Scarp on rotational or scissor fault, normal-slip offset—Identity or existence questionable, location accurate. Rectangles on downthrown block. Hachures point downscarp			
2.12.27	Scarp on rotational or scissor fault, normal-slip offset—Identity and existence certain, location approximate. Rectangles on downthrown block. Hachures point downscarp			
2.12.28	Scarp on rotational or scissor fault, normal-slip offset—Identity or existence questionable, location approximate. Rectangles on downthrown block. Hachures point downscarp			
2.12.29	Scarp on strike-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.30	Scarp on strike-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.31	Scarp on strike-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.32	Scarp on strike-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.33	Scarp on strike-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.34	Scarp on strike-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion. Hachures point downscarp			
2.12.35	Scarp on strike-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.36	Scarp on strike-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion. Hachures point downscarp			
2.12.37	Scarp on oblique-slip fault, right-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.38	Scarp on oblique-slip fault, right-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.39	Scarp on oblique-slip fault, right-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.40	Scarp on oblique-slip fault, right-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.41	Scarp on oblique-slip fault, left-lateral offset—Identity and existence certain, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.42	Scarp on oblique-slip fault, left-lateral offset—Identity or existence questionable, location accurate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.43	Scarp on oblique-slip fault, left-lateral offset—Identity and existence certain, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			
2.12.44	Scarp on oblique-slip fault, left-lateral offset—Identity or existence questionable, location approximate. Arrows show relative motion; ball and bar on downthrown block. Hachures point downscarp			

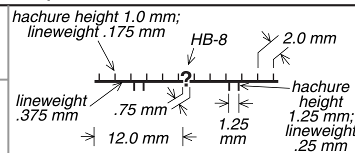
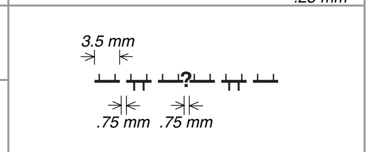
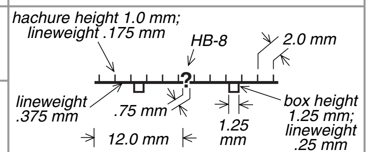
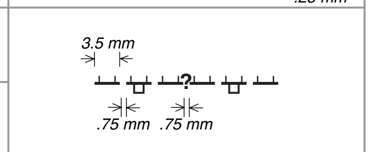
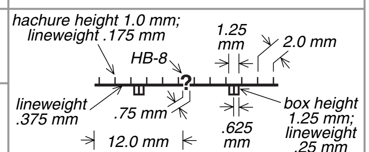
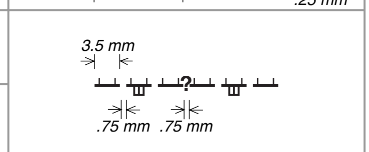
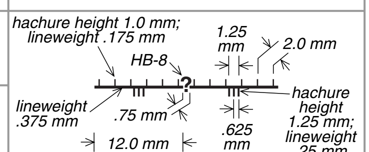
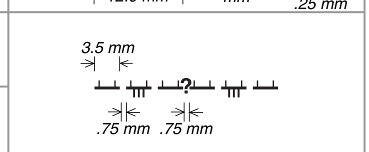
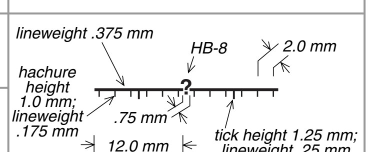
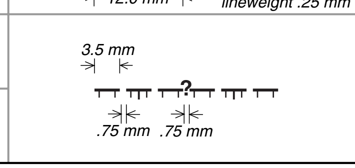
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.12—Fault scarps (continued)			
2.12.45	Scarp on thrust fault (1st option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.46	Scarp on thrust fault (1st option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.47	Scarp on thrust fault (1st option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.48	Scarp on thrust fault (1st option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.49	Scarp on thrust fault (2nd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.50	Scarp on thrust fault (2nd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.51	Scarp on thrust fault (2nd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.52	Scarp on thrust fault (2nd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.53	Scarp on thrust fault (3rd option)—Identity and existence certain, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.54	Scarp on thrust fault (3rd option)—Identity or existence questionable, location accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.55	Scarp on thrust fault (3rd option)—Identity and existence certain, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.56	Scarp on thrust fault (3rd option)—Identity or existence questionable, location approximate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp			
2.12.57	Scarp on overturned thrust fault (1st option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.58	Scarp on overturned thrust fault (1st option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.59	Scarp on overturned thrust fault (1st option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.60	Scarp on overturned thrust fault (1st option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.61	Scarp on overturned thrust fault (2nd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.62	Scarp on overturned thrust fault (2nd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.63	Scarp on overturned thrust fault (2nd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.64	Scarp on overturned thrust fault (2nd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.65	Scarp on overturned thrust fault (3rd option)—Identity and existence certain, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.66	Scarp on overturned thrust fault (3rd option)—Identity or existence questionable, location accurate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.67	Scarp on overturned thrust fault (3rd option)—Identity and existence certain, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			
2.12.68	Scarp on overturned thrust fault (3rd option)—Identity or existence questionable, location approximate. Bars on tectonically higher plate (footwall); sawteeth in direction of dip. Hachures point downscarp			

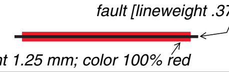
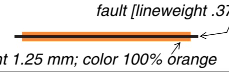
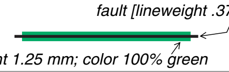
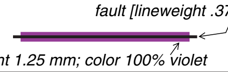
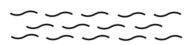
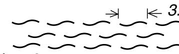
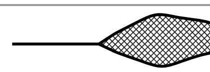
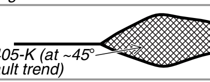
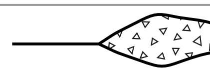
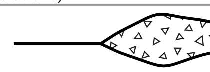
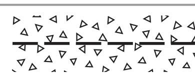
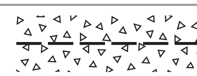
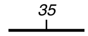
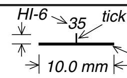
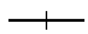
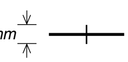
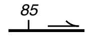
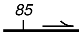
*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.12—Fault scarps (continued)			
2.12.69	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location accurate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.70	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location accurate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.71	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity and existence certain, location approximate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.72	Scarp on detachment fault (sense of slip unspecified) (1st option)—Identity or existence questionable, location approximate. Long-hachure pairs on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.73	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location accurate. Boxes on upper plate. Hachures point downscarp			
2.12.74	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location accurate. Boxes on upper plate. Hachures point downscarp			
2.12.75	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity and existence certain, location approximate. Boxes on upper plate. Hachures point downscarp			
2.12.76	Scarp on detachment fault (sense of slip unspecified) (2nd option)—Identity or existence questionable, location approximate. Boxes on upper plate. Hachures point downscarp			
2.12.77	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location accurate. Boxes on upper plate. Hachures point downscarp			
2.12.78	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location accurate. Boxes on upper plate. Hachures point downscarp			
2.12.79	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity and existence certain, location approximate. Boxes on upper plate. Hachures point downscarp			
2.12.80	Scarp on detachment fault (sense of slip unspecified) (3rd option)—Identity or existence questionable, location approximate. Boxes on upper plate. Hachures point downscarp			
2.12.81	Scarp on master detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.82	Scarp on master detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.83	Scarp on master detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.84	Scarp on master detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Long-hachure triplets on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.85	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location accurate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.86	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location accurate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.87	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity and existence certain, location approximate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp			
2.12.88	Scarp on listric fault at head of detachment fault (sense of slip unspecified)—Identity or existence questionable, location approximate. Single (longer) ticks on upper plate. Shorter, widely spaced hachures point downscarp			

*For more information, see general guidelines on pages A-i to A-v.

2—FAULTS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	2.13—Quaternary faulting			
2.13.1	Fault showing displacement during historic time (includes areas of known fault creep)		fault [lineweight .375 mm]  lineweight 1.25 mm; color 100% red	Although only shown here on "identity and existence certain, location accurate," generic faults, color may be added to any type or style of fault to highlight where geomorphic evidence indicates displacement during Quaternary time.
2.13.2	Fault showing displacement during Holocene time		fault [lineweight .375 mm]  lineweight 1.25 mm; color 100% orange	
2.13.3	Fault showing displacement during late Quaternary time		fault [lineweight .375 mm]  lineweight 1.25 mm; color 100% green	
2.13.4	Fault showing displacement during Quaternary time (undifferentiated)		fault [lineweight .375 mm]  lineweight 1.25 mm; color 100% violet	
	2.14—Shear zones; mylonite zones; fault-breccia zones			
2.14.1	Ductile shear zone or mylonite zone—May or may not be associated with mappable faults		 3.75 mm; all lineweights .2 mm	Orient S-shaped symbols to indicate linear trend of zone; spacing may be varied to show intensity of shear. Width of zones may vary. Patterns may either overprint other map units or be used as stand-alone map units (if zones have well-defined boundaries).
2.14.2	Zone of sheared rock within fault		 pattern 405-K (at ~45° to fault trend)	
2.14.3	Fault-breccia zone or zone of broken rock within fault		 pattern 401-K	
2.14.4	Fault-breccia zone or zone of broken rock around fault		 pattern 401-K	
	2.15—Small, minor faults			
2.15.1	Small, minor inclined fault—Showing strike and dip	 35	 HI-6; 35; tick lineweight .2 mm; 1.425 m; 10.0 mm; lineweight .375 mm	Use to show small, minor faults that are observed in outcrop but that cannot be traced away from that outcrop.
2.15.2	Small, minor vertical or near-vertical fault—Showing strike		2.5 mm 	
2.15.3	Small, minor shear fault—Showing dip. Arrow shows direction of relative horizontal displacement	85 	85  arrow lineweight .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

3—BOUNDARIES LOCATED BY GEOPHYSICAL SURVEYS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
3.1—Boundaries located by geophysical methods				
3.1.1	Boundary located by aeromagnetic survey	AM	*lineweight .2 mm* AM *H-8* *3.5 mm* *.5 mm*	Use for boundaries that have been defined by measured contrasts in rock properties but that may not be definitively identifiable as either a contact or a fault by survey methods. May be shown in red or other colors.
3.1.2	Boundary located by ground magnetic survey	M	M	
3.1.3	Boundary located by gravity survey	G	G	
3.1.4	Boundary located by radiometric survey	RM	RM	
3.1.5	Boundary located by seismic reflection survey	S	S	
3.1.6	Boundary located by induced polarization survey	IP	IP	
3.1.7	Boundary located by electromagnetic survey	EM	EM	
3.1.8	Boundary located by resistivity survey	R	R	
3.1.9	Boundary located by magnetotelluric survey	MT	MT	
3.2—Faults located by geophysical methods				
3.2.1	Fault located by aeromagnetic survey	AM	*lineweight .375 mm* AM *H-8* *3.5 mm* *.5 mm*	Use for boundaries that have been defined by measured contrasts in rock properties and that also can be identified as faults by geophysical survey or by other evidence that contributes to survey. May be shown in red or other colors.
3.2.2	Fault located by ground magnetic survey	M	M	
3.2.3	Fault located by gravity survey	G	G	
3.2.4	Fault located by radiometric survey	RM	RM	
3.2.5	Fault located by seismic reflection survey	S	S	
3.2.6	Fault located by induced polarization survey	IP	IP	
3.2.7	Fault located by electromagnetic survey	EM	EM	
3.2.8	Fault located by resistivity survey	R	R	
3.2.9	Fault located by magnetotelluric survey	MT	MT	
3.3—Geophysical survey lines and stations				
3.3.1	Geophysical data collection line—Accurately located		*lineweight .15 mm* *dash length 3.75 mm; spacing 3.75 mm*	May be shown in red or other colors.
3.3.2	Geophysical data collection line—Located by aerial survey		*lineweight .15 mm* *dash length 7.5 mm; spacing 7.5 mm*	
3.3.3	Cross ticks showing location and orientation of data collection lines crossing geophysical boundary		*tick lineweight .15 mm* *1.25 mm*	
3.3.4	Horizontal control point	△	*dot diameter .3 mm* *lineweight .2 mm* *60°* *1.75 mm*	
3.3.5	Survey station	+	*lineweight .2 mm* + *1.75 mm* *1.75 mm*	

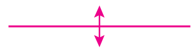
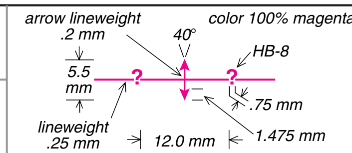
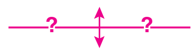
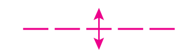
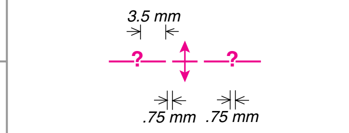
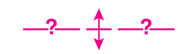
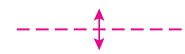
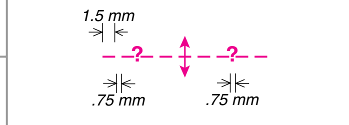
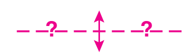
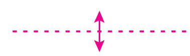
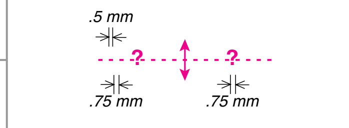
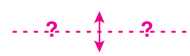
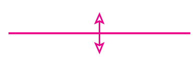
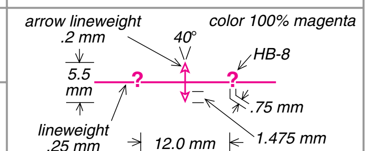
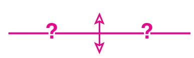
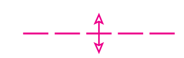
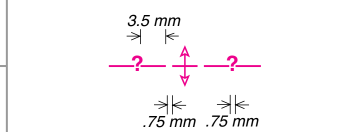
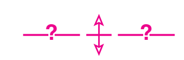
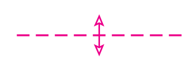
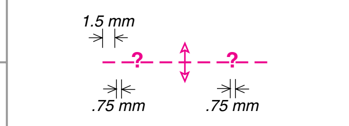
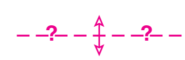
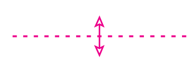
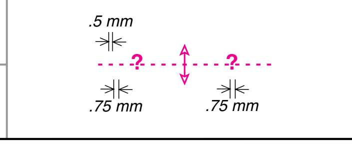
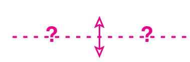
*For more information, see general guidelines on pages A-i to A-v.

4—LINEAMENTS AND JOINTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	4.1—Lineaments			
4.1.1	Lineament		lineweight .375 mm; 4.5 mm; 1.25 mm; .75 mm	Use to show linear features that have been determined from aerial photographs or remotely sensed imagery but not identified on the ground.
4.1.2	Lineament—Showing name	OLYMPIC-WALLOWA	OLYMPIC-WALLOWA; H-7	
	4.2—Joints			
4.2.1	Joint—Identity and existence certain, location accurate		lineweight .3 mm	Use to show regional joint patterns or single joints that are mappable beyond outcrop. May also be shown in red or other colors.
4.2.2	Joint—Identity and existence certain, location approximate		2.0 mm; .5 mm	
4.2.3	Inclined joint (1st option)—Showing dip value and direction	35	tick length 1.75 mm; lineweight .2 mm; 35; HI-6	Place tick where observation was made. Add arrowhead or '90' to tick if necessary for clarity.
4.2.4	Inclined joint (2nd option)—Showing dip value and direction	15	tick length 1.375 mm; lineweight .2 mm; 15; .875 mm; 30°	
4.2.5	Vertical or subvertical joint (1st option)		tick length 2.5 mm; lineweight .2 mm	
4.2.6	Vertical or subvertical joint (2nd option)	90	90; HI-6	
	4.3—Small, minor joints			
4.3.1	Small, minor horizontal joint (1st option)		lineweight .2 mm; 1.125 mm; 1.125 mm; circle diameter 2.5 mm	Use to show small, minor joints that are observed in outcrop but that cannot be traced away from that outcrop. For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding). May also be shown in red or other colors.
4.3.2	Small, minor inclined joint (1st option)—Showing strike and dip	60	1.125 mm; 60; HI-6; .5625 mm; lineweight .2 mm; 5.0 mm	
4.3.3	Small, minor vertical or near-vertical joint (1st option)—Showing strike		1.125 mm; 1.125 mm; 5.0 mm	
4.3.4	Small, minor inclined (dip direction to right) joint, for multiple observations at one locality (1st option)—Showing strike and dip	60	5.5 mm; 60; HI-6; 1.125 mm; .5625 mm	
4.3.5	Small, minor inclined (dip direction to left) joint, for multiple observations at one locality (1st option)—Showing strike and dip	60	60	
4.3.6	Small, minor vertical or near-vertical joint, for multiple observations at one locality (1st option)—Showing strike		5.5 mm; 1.125 mm; 1.125 mm	
4.3.7	Small, minor horizontal joint (2nd option)		all lineweights .2 mm; 1.125 mm; 1.125 mm; circle diameter 2.5 mm	
4.3.8	Small, minor inclined joint (2nd option)—Showing strike and dip	70	1.125 mm; 70; HI-6; .5625 mm; all lineweights .2 mm; 5.0 mm	
4.3.9	Small, minor vertical or near-vertical joint (2nd option)—Showing strike		1.125 mm; 1.125 mm; 5.0 mm	
4.3.10	Small, minor inclined (dip direction to right) joint, for multiple observations at one locality (2nd option)—Showing strike and dip	70	5.5 mm; 70; HI-6; 1.125 mm; .5625 mm	
4.3.11	Small, minor inclined (dip direction to left) joint, for multiple observations at one locality (2nd option)—Showing strike and dip	70	70	
4.3.12	Small, minor vertical or near-vertical joint, for multiple observations at one locality (2nd option)—Showing strike		5.5 mm; 1.125 mm; 1.125 mm	

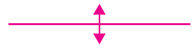
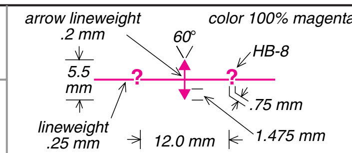
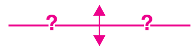
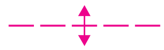
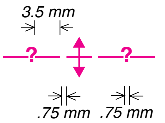
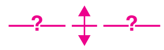
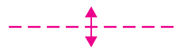
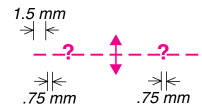
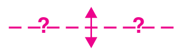
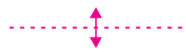
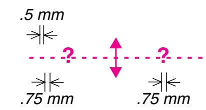
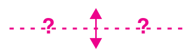
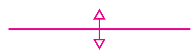
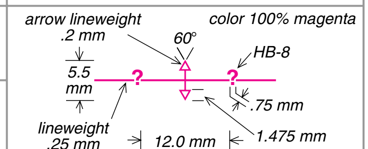
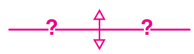
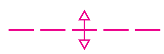
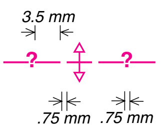
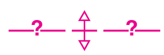
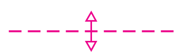
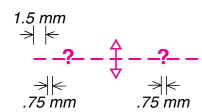
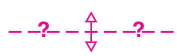
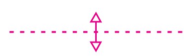
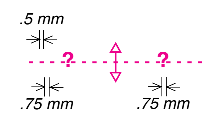
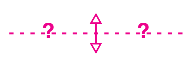
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.1—Anticlines				
5.1.1	Anticline (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.1.2	Anticline (1st option)—Identity or existence questionable, location accurate			
5.1.3	Anticline (1st option)—Identity and existence certain, location approximate			
5.1.4	Anticline (1st option)—Identity or existence questionable, location approximate			
5.1.5	Anticline (1st option)—Identity and existence certain, location inferred			
5.1.6	Anticline (1st option)—Identity or existence questionable, location inferred			
5.1.7	Anticline (1st option)—Identity and existence certain, location concealed			
5.1.8	Anticline (1st option)—Identity or existence questionable, location concealed			
5.1.9	Anticline (2nd option)—Identity and existence certain, location accurate			
5.1.10	Anticline (2nd option)—Identity or existence questionable, location accurate			
5.1.11	Anticline (2nd option)—Identity and existence certain, location approximate			
5.1.12	Anticline (2nd option)—Identity or existence questionable, location approximate			
5.1.13	Anticline (2nd option)—Identity and existence certain, location inferred			
5.1.14	Anticline (2nd option)—Identity or existence questionable, location inferred			
5.1.15	Anticline (2nd option)—Identity and existence certain, location concealed			
5.1.16	Anticline (2nd option)—Identity or existence questionable, location concealed			

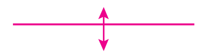
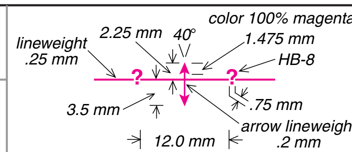
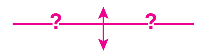
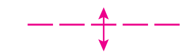
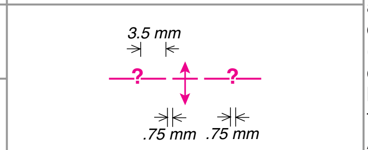
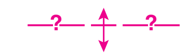
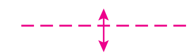
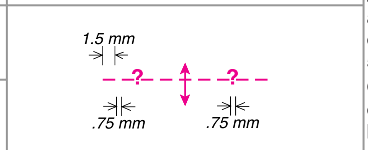
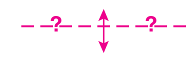
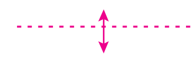
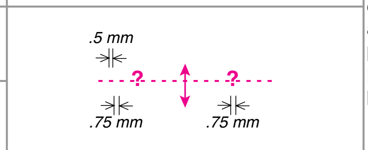
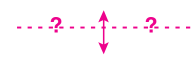
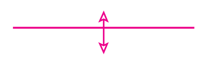
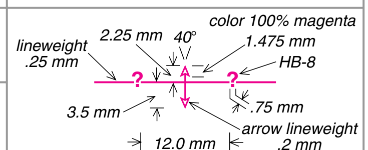
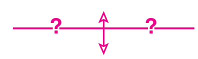
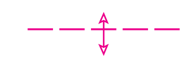
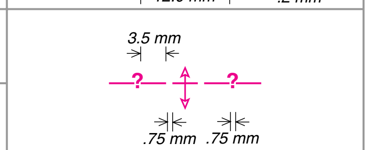
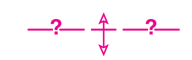
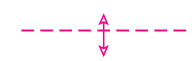
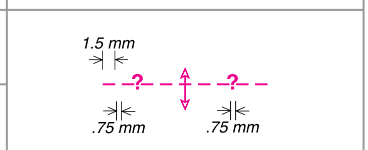
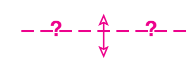
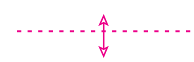
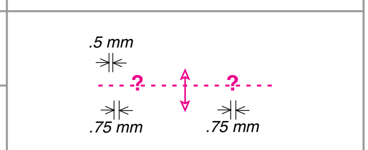
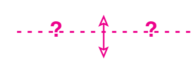
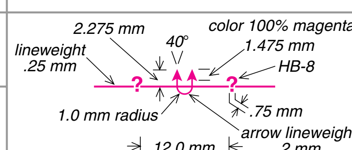
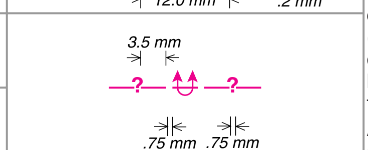
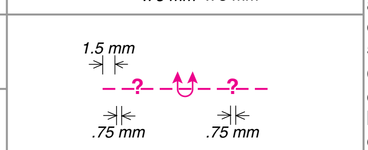
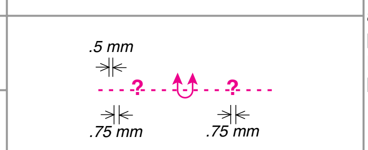
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		5.2—Antiforms		
5.2.1	Antiform (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of antiform intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (antiform); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.2.2	Antiform (1st option)—Identity or existence questionable, location accurate			
5.2.3	Antiform (1st option)—Identity and existence certain, location approximate			
5.2.4	Antiform (1st option)—Identity or existence questionable, location approximate			
5.2.5	Antiform (1st option)—Identity and existence certain, location inferred			
5.2.6	Antiform (1st option)—Identity or existence questionable, location inferred			
5.2.7	Antiform (1st option)—Identity and existence certain, location concealed			
5.2.8	Antiform (1st option)—Identity or existence questionable, location concealed			
5.2.9	Antiform (2nd option)—Identity and existence certain, location accurate			
5.2.10	Antiform (2nd option)—Identity or existence questionable, location accurate			
5.2.11	Antiform (2nd option)—Identity and existence certain, location approximate			
5.2.12	Antiform (2nd option)—Identity or existence questionable, location approximate			
5.2.13	Antiform (2nd option)—Identity and existence certain, location inferred			
5.2.14	Antiform (2nd option)—Identity or existence questionable, location inferred			
5.2.15	Antiform (2nd option)—Identity and existence certain, location concealed			
5.2.16	Antiform (2nd option)—Identity or existence questionable, location concealed			

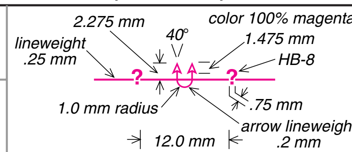
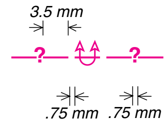
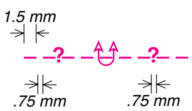
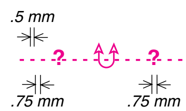
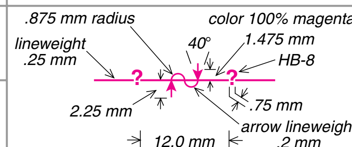
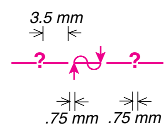
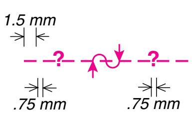
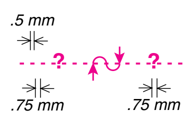
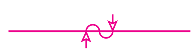
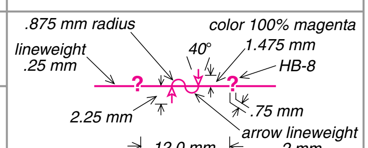
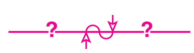
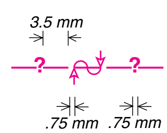
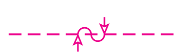
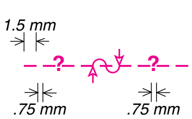
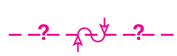
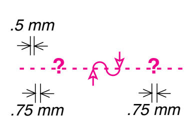
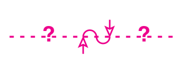
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.3—Asymmetric, overturned, and inverted anticlines			
5.3.1	Asymmetric anticline (1st option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			Place fold trace where axial surface of asymmetric anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (asymmetric anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.3.2	Asymmetric anticline (1st option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.3	Asymmetric anticline (1st option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.4	Asymmetric anticline (1st option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.5	Asymmetric anticline (1st option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.6	Asymmetric anticline (1st option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.7	Asymmetric anticline (1st option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.8	Asymmetric anticline (1st option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.9	Asymmetric anticline (2nd option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.10	Asymmetric anticline (2nd option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.3.11	Asymmetric anticline (2nd option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.12	Asymmetric anticline (2nd option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.3.13	Asymmetric anticline (2nd option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.14	Asymmetric anticline (2nd option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.3.15	Asymmetric anticline (2nd option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.16	Asymmetric anticline (2nd option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.3.17	Overturned anticline (1st option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of overturned anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.3.18	Overturned anticline (1st option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.19	Overturned anticline (1st option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.20	Overturned anticline (1st option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.21	Overturned anticline (1st option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.22	Overturned anticline (1st option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.23	Overturned anticline (1st option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.24	Overturned anticline (1st option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			

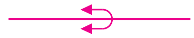
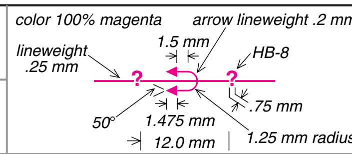
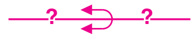
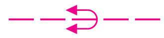
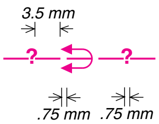
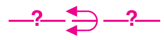
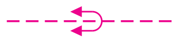
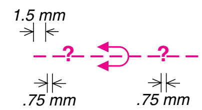
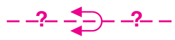
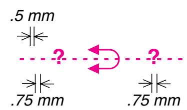
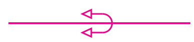
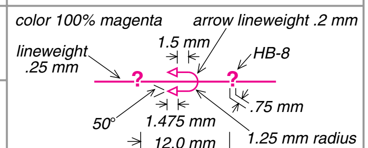
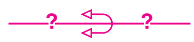
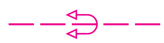
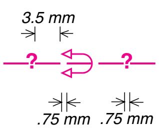
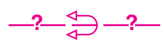
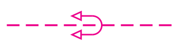
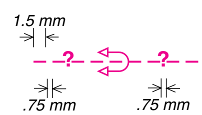
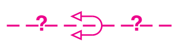
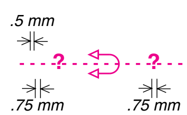
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.3—Asymmetric, overturned, and inverted anticlines (continued)				
5.3.25	Overturned anticline (2nd option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of overturned anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.3.26	Overturned anticline (2nd option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.27	Overturned anticline (2nd option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.28	Overturned anticline (2nd option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.29	Overturned anticline (2nd option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.30	Overturned anticline (2nd option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.31	Overturned anticline (2nd option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.32	Overturned anticline (2nd option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.3.33	Inverted anticline (1st option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of inverted anticline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (inverted anticline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.3.34	Inverted anticline (1st option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.35	Inverted anticline (1st option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.36	Inverted anticline (1st option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.37	Inverted anticline (1st option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.38	Inverted anticline (1st option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.39	Inverted anticline (1st option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.40	Inverted anticline (1st option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.41	Inverted anticline (2nd option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.42	Inverted anticline (2nd option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.43	Inverted anticline (2nd option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.44	Inverted anticline (2nd option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.45	Inverted anticline (2nd option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.46	Inverted anticline (2nd option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.47	Inverted anticline (2nd option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.3.48	Inverted anticline (2nd option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			

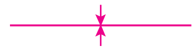
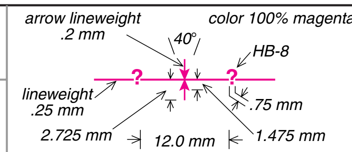
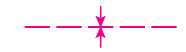
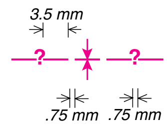
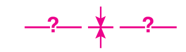
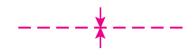
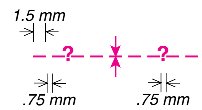
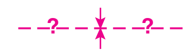
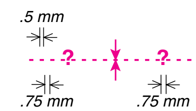
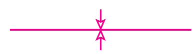
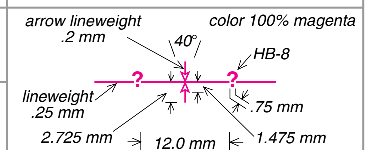
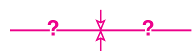
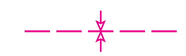
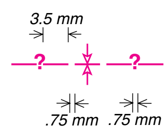
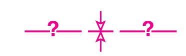
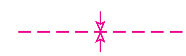
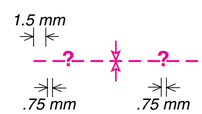
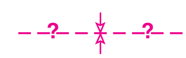
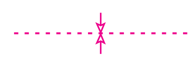
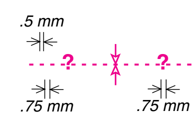
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

<table>
<tr><th>REF NO</th><th>DESCRIPTION</th><th>SYMBOL</th><th>CARTOGRAPHIC SPECIFICATIONS*</th><th>NOTES ON USAGE*</th></tr>
<tr><td colspan="5">5.4—Antiformal sheath folds</td></tr>
<tr><td>5.4.1</td><td>Antiformal sheath fold (1st option)—Identity and existence certain, location accurate</td><td></td><td rowspan="2"></td><td rowspan="16">Place fold trace where axial surface of antiformal sheath fold intersects the ground surface.
Place arrows at places along fold trace to indicate overall fold type (antiformal sheath fold); do not place at specific locality where observation was made.
Arrowheads may be added to show direction of plunge (see Section 5.10).
Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type.
May also be shown in black or other colors.</td></tr>
<tr><td>5.4.2</td><td>Antiformal sheath fold (1st option)—Identity or existence questionable, location accurate</td><td></td></tr>
<tr><td>5.4.3</td><td>Antiformal sheath fold (1st option)—Identity and existence certain, location approximate</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.4</td><td>Antiformal sheath fold (1st option)—Identity or existence questionable, location approximate</td><td></td></tr>
<tr><td>5.4.5</td><td>Antiformal sheath fold (1st option)—Identity and existence certain, location inferred</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.6</td><td>Antiformal sheath fold (1st option)—Identity or existence questionable, location inferred</td><td></td></tr>
<tr><td>5.4.7</td><td>Antiformal sheath fold (1st option)—Identity and existence certain, location concealed</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.8</td><td>Antiformal sheath fold (1st option)—Identity or existence questionable, location concealed</td><td></td></tr>
<tr><td>5.4.9</td><td>Antiformal sheath fold (2nd option)—Identity and existence certain, location accurate</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.10</td><td>Antiformal sheath fold (2nd option)—Identity or existence questionable, location accurate</td><td></td></tr>
<tr><td>5.4.11</td><td>Antiformal sheath fold (2nd option)—Identity and existence certain, location approximate</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.12</td><td>Antiformal sheath fold (2nd option)—Identity or existence questionable, location approximate</td><td></td></tr>
<tr><td>5.4.13</td><td>Antiformal sheath fold (2nd option)—Identity and existence certain, location inferred</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.14</td><td>Antiformal sheath fold (2nd option)—Identity or existence questionable, location inferred</td><td></td></tr>
<tr><td>5.4.15</td><td>Antiformal sheath fold (2nd option)—Identity and existence certain, location concealed</td><td></td><td rowspan="2"></td></tr>
<tr><td>5.4.16</td><td>Antiformal sheath fold (2nd option)—Identity or existence questionable, location concealed</td><td></td></tr>
</table>

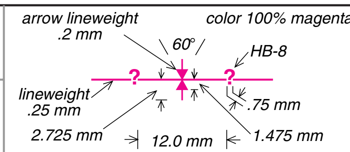
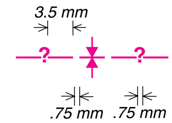
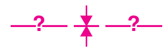
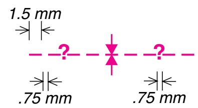
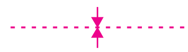
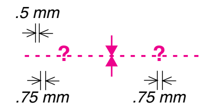
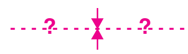
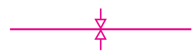
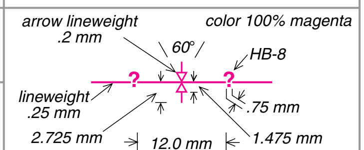
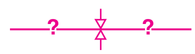
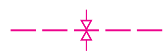
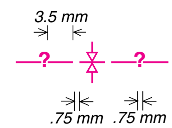
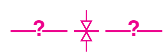
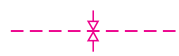
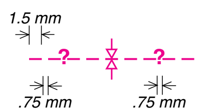
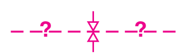
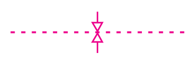
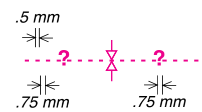
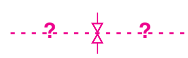
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.5—Synclines			
5.5.1	Syncline (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.5.2	Syncline (1st option)—Identity or existence questionable, location accurate			
5.5.3	Syncline (1st option)—Identity and existence certain, location approximate			
5.5.4	Syncline (1st option)—Identity or existence questionable, location approximate			
5.5.5	Syncline (1st option)—Identity and existence certain, location inferred			
5.5.6	Syncline (1st option)—Identity or existence questionable, location inferred			
5.5.7	Syncline (1st option)—Identity and existence certain, location concealed			
5.5.8	Syncline (1st option)—Identity or existence questionable, location concealed			
5.5.9	Syncline (2nd option)—Identity and existence certain, location accurate			
5.5.10	Syncline (2nd option)—Identity or existence questionable, location accurate			
5.5.11	Syncline (2nd option)—Identity and existence certain, location approximate			
5.5.12	Syncline (2nd option)—Identity or existence questionable, location approximate			
5.5.13	Syncline (2nd option)—Identity and existence certain, location inferred			
5.5.14	Syncline (2nd option)—Identity or existence questionable, location inferred			
5.5.15	Syncline (2nd option)—Identity and existence certain, location concealed			
5.5.16	Syncline (2nd option)—Identity or existence questionable, location concealed			

*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		5.6—Synforms		
5.6.1	Synform (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of synform intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synform); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.6.2	Synform (1st option)—Identity or existence questionable, location accurate			
5.6.3	Synform (1st option)—Identity and existence certain, location approximate			
5.6.4	Synform (1st option)—Identity or existence questionable, location approximate			
5.6.5	Synform (1st option)—Identity and existence certain, location inferred			
5.6.6	Synform (1st option)—Identity or existence questionable, location inferred			
5.6.7	Synform (1st option)—Identity and existence certain, location concealed			
5.6.8	Synform (1st option)—Identity or existence questionable, location concealed			
5.6.9	Synform (2nd option)—Identity and existence certain, location accurate			
5.6.10	Synform (2nd option)—Identity or existence questionable, location accurate			
5.6.11	Synform (2nd option)—Identity and existence certain, location approximate			
5.6.12	Synform (2nd option)—Identity or existence questionable, location approximate			
5.6.13	Synform (2nd option)—Identity and existence certain, location inferred			
5.6.14	Synform (2nd option)—Identity or existence questionable, location inferred			
5.6.15	Synform (2nd option)—Identity and existence certain, location concealed			
5.6.16	Synform (2nd option)—Identity or existence questionable, location concealed			

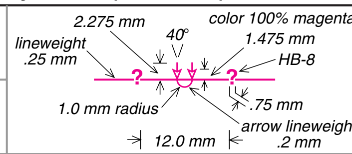
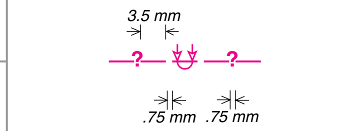
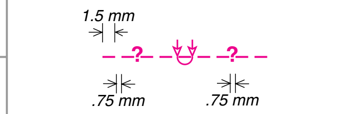
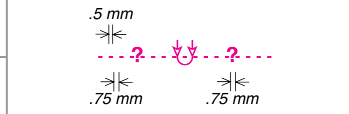
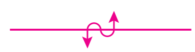
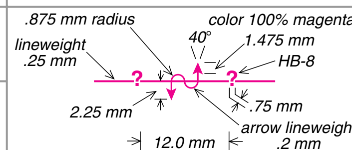
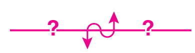
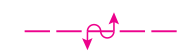
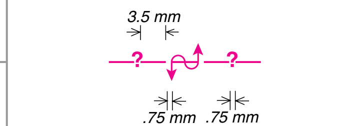
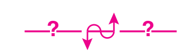
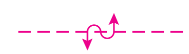
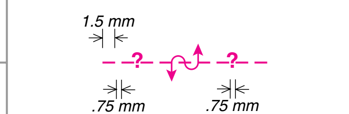
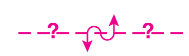
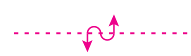
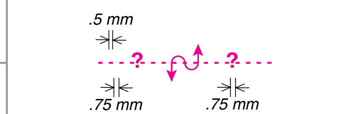
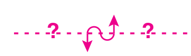
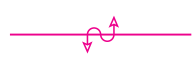
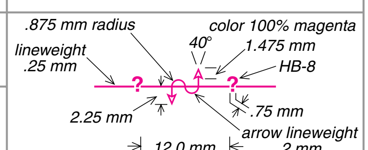
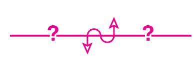
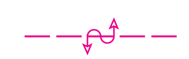
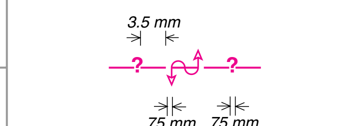
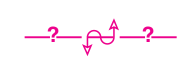
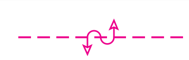
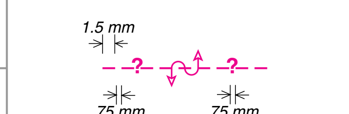
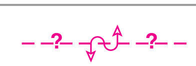
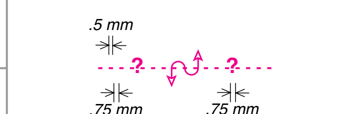
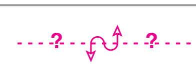
**For more information, see general guidelines on pages A-i to A-v.*

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.7—Asymmetric, overturned, and inverted synclines				
5.7.1	Asymmetric syncline (1st option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb		color 100% magenta; lineweight .25 mm; 2.25 mm; 40°; 1.475 mm; HB-8; 3.5 mm; .75 mm; arrow lineweight .2 mm; 12.0 mm	Place fold trace where axial surface of asymmetric syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (asymmetric syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.2	Asymmetric syncline (1st option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.7.3	Asymmetric syncline (1st option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb		3.5 mm; .75 mm; .75 mm	
5.7.4	Asymmetric syncline (1st option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.5	Asymmetric syncline (1st option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb		1.5 mm; .75 mm; .75 mm	
5.7.6	Asymmetric syncline (1st option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.7	Asymmetric syncline (1st option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb		.5 mm; .75 mm; .75 mm	
5.7.8	Asymmetric syncline (1st option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.9	Asymmetric syncline (2nd option)—Identity and existence certain, location accurate. Beds are upright; shorter arrow on steeper limb		color 100% magenta; lineweight .25 mm; 2.25 mm; 40°; 1.475 mm; HB-8; 3.5 mm; .75 mm; arrow lineweight .2 mm; 12.0 mm	
5.7.10	Asymmetric syncline (2nd option)—Identity or existence questionable, location accurate. Beds are upright; shorter arrow on steeper limb			
5.7.11	Asymmetric syncline (2nd option)—Identity and existence certain, location approximate. Beds are upright; shorter arrow on steeper limb		3.5 mm; .75 mm; .75 mm	
5.7.12	Asymmetric syncline (2nd option)—Identity or existence questionable, location approximate. Beds are upright; shorter arrow on steeper limb			
5.7.13	Asymmetric syncline (2nd option)—Identity and existence certain, location inferred. Beds are upright; shorter arrow on steeper limb		1.5 mm; .75 mm; .75 mm	
5.7.14	Asymmetric syncline (2nd option)—Identity or existence questionable, location inferred. Beds are upright; shorter arrow on steeper limb			
5.7.15	Asymmetric syncline (2nd option)—Identity and existence certain, location concealed. Beds are upright; shorter arrow on steeper limb		.5 mm; .75 mm; .75 mm	
5.7.16	Asymmetric syncline (2nd option)—Identity or existence questionable, location concealed. Beds are upright; shorter arrow on steeper limb			
5.7.17	Overturned syncline (1st option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs		color 100% magenta; lineweight .25 mm; 2.275 mm; 40°; 1.475 mm; HB-8; 1.0 mm radius; .75 mm; arrow lineweight .2 mm; 12.0 mm	Place fold trace where axial surface of overturned syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.18	Overturned syncline (1st option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.19	Overturned syncline (1st option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs		3.5 mm; .75 mm; .75 mm	
5.7.20	Overturned syncline (1st option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.21	Overturned syncline (1st option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs		1.5 mm; .75 mm; .75 mm	
5.7.22	Overturned syncline (1st option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.23	Overturned syncline (1st option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs		.5 mm; .75 mm; .75 mm	
5.7.24	Overturned syncline (1st option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			

*For more information, see general guidelines on pages A-i to A-v.

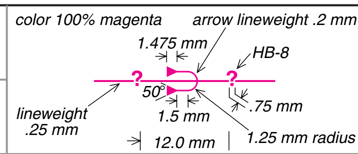
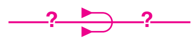
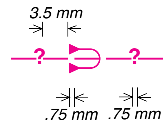
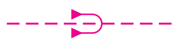
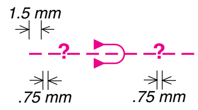
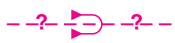
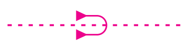
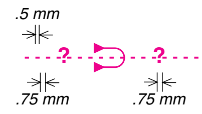
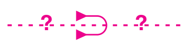
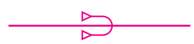
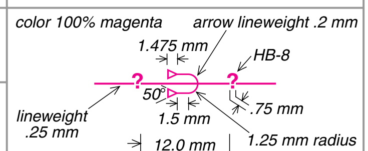
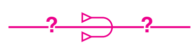
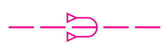
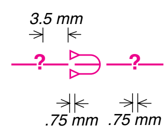
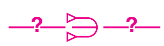
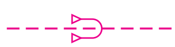
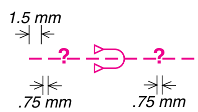
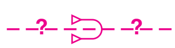
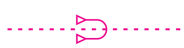
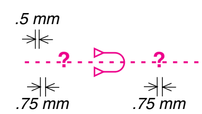
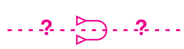
5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.7—Asymmetric, overturned, and inverted synclines (continued)			
5.7.25	Overturned syncline (2nd option)—Identity and existence certain, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of overturned syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (overturned syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.26	Overturned syncline (2nd option)—Identity or existence questionable, location accurate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.27	Overturned syncline (2nd option)—Identity and existence certain, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.28	Overturned syncline (2nd option)—Identity or existence questionable, location approximate. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.29	Overturned syncline (2nd option)—Identity and existence certain, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.30	Overturned syncline (2nd option)—Identity or existence questionable, location inferred. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.31	Overturned syncline (2nd option)—Identity and existence certain, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.32	Overturned syncline (2nd option)—Identity or existence questionable, location concealed. Beds on one limb are overturned; arrows show dip direction of limbs			
5.7.33	Inverted syncline (1st option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			Place fold trace where axial surface of inverted syncline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (inverted syncline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.7.34	Inverted syncline (1st option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.35	Inverted syncline (1st option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.36	Inverted syncline (1st option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.37	Inverted syncline (1st option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.38	Inverted syncline (1st option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.39	Inverted syncline (1st option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.40	Inverted syncline (1st option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.41	Inverted syncline (2nd option)—Identity and existence certain, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.42	Inverted syncline (2nd option)—Identity or existence questionable, location accurate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.43	Inverted syncline (2nd option)—Identity and existence certain, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.44	Inverted syncline (2nd option)—Identity or existence questionable, location approximate. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.45	Inverted syncline (2nd option)—Identity and existence certain, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.46	Inverted syncline (2nd option)—Identity or existence questionable, location inferred. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.47	Inverted syncline (2nd option)—Identity and existence certain, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			
5.7.48	Inverted syncline (2nd option)—Identity or existence questionable, location concealed. Beds on both limbs are overturned; arrows show dip direction of limbs			

For more information, see general guidelines on pages A-i to A-v.

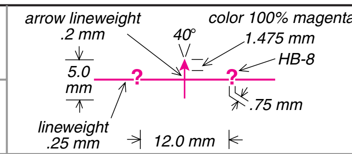
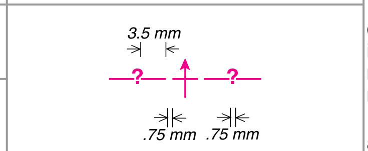
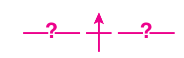
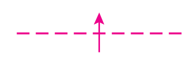
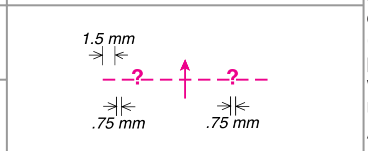
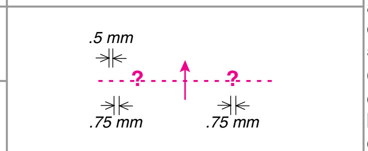
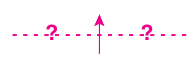
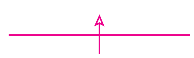
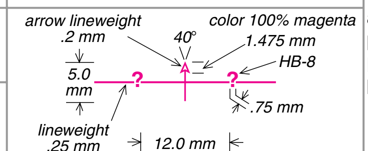
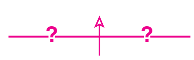
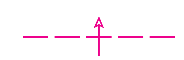
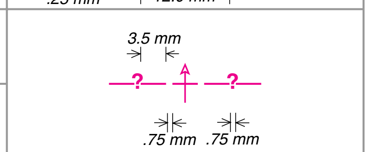
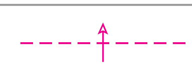
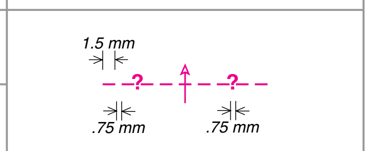
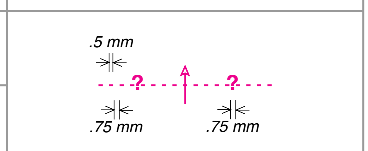
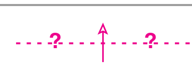
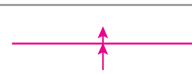
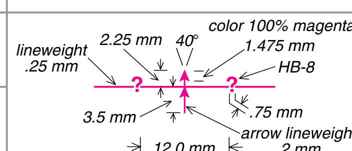
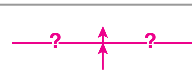
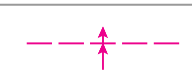
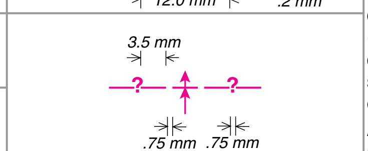
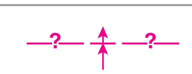
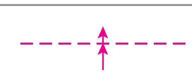
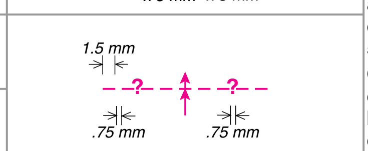
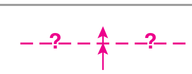
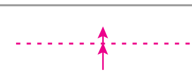
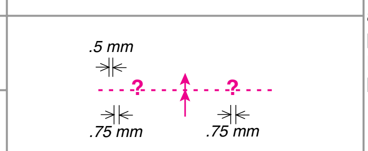
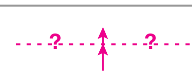
5—FOLDS (continued)

5.8—Synformal sheath folds

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
5.8.1	Synformal sheath fold (1st option)—Identity and existence certain, location accurate			Place fold trace where axial surface of synformal sheath fold intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synformal sheath fold); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.8.2	Synformal sheath fold (1st option)—Identity or existence questionable, location accurate			
5.8.3	Synformal sheath fold (1st option)—Identity and existence certain, location approximate			
5.8.4	Synformal sheath fold (1st option)—Identity or existence questionable, location approximate			
5.8.5	Synformal sheath fold (1st option)—Identity and existence certain, location inferred			
5.8.6	Synformal sheath fold (1st option)—Identity or existence questionable, location inferred			
5.8.7	Synformal sheath fold (1st option)—Identity and existence certain, location concealed			
5.8.8	Synformal sheath fold (1st option)—Identity or existence questionable, location concealed			
5.8.9	Synformal sheath fold (2nd option)—Identity and existence certain, location accurate			
5.8.10	Synformal sheath fold (2nd option)—Identity or existence questionable, location accurate			
5.8.11	Synformal sheath fold (2nd option)—Identity and existence certain, location approximate			
5.8.12	Synformal sheath fold (2nd option)—Identity or existence questionable, location approximate			
5.8.13	Synformal sheath fold (2nd option)—Identity and existence certain, location inferred			
5.8.14	Synformal sheath fold (2nd option)—Identity or existence questionable, location inferred			
5.8.15	Synformal sheath fold (2nd option)—Identity and existence certain, location concealed			
5.8.16	Synformal sheath fold (2nd option)—Identity or existence questionable, location concealed			

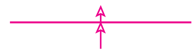
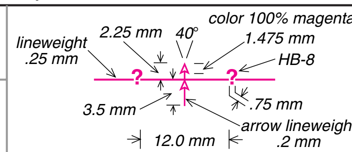
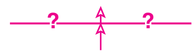
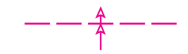
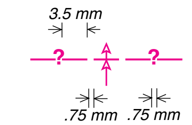
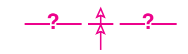
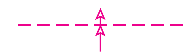
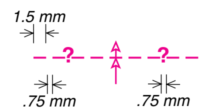
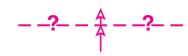
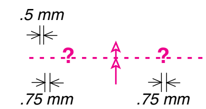
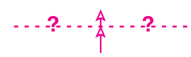
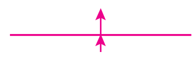
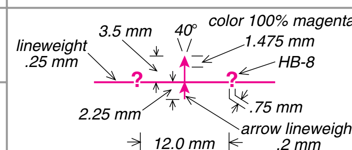
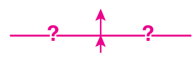
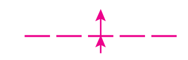
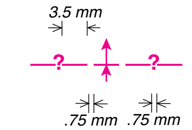
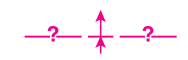
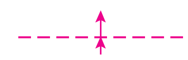
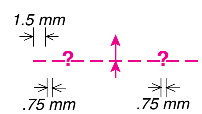
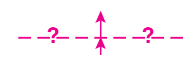
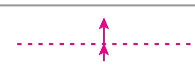
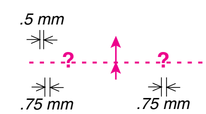
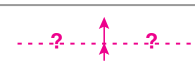
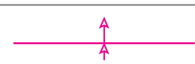
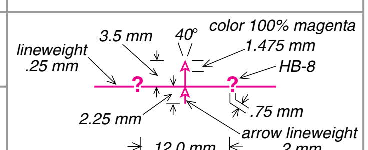
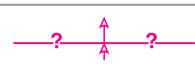
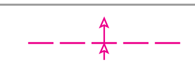
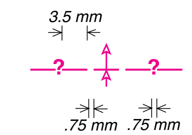
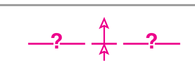
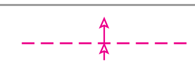
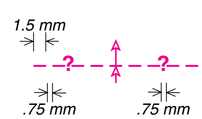
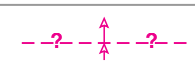
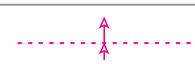
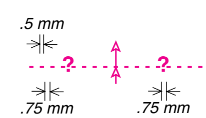
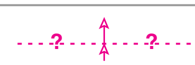
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
		5.9—Monoclines		
5.9.1	Monocline (1st option)—Identity and existence certain, location accurate. Arrow shows direction of dip			Use to show monocline whose anticlinal and synclinal bends are too close together at map scale to show as separate fold traces. Place fold trace where dip of surface connecting anticlinal and synclinal bends is at its maximum angle. Place arrow at places along fold trace to indicate overall fold type (monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.2	Monocline (1st option)—Identity or existence questionable, location accurate. Arrow shows direction of dip			
5.9.3	Monocline (1st option)—Identity and existence certain, location approximate. Arrow shows direction of dip			
5.9.4	Monocline (1st option)—Identity or existence questionable, location approximate. Arrow shows direction of dip			
5.9.5	Monocline (1st option)—Identity and existence certain, location inferred. Arrow shows direction of dip			
5.9.6	Monocline (1st option)—Identity or existence questionable, location inferred. Arrow shows direction of dip			
5.9.7	Monocline (1st option)—Identity and existence certain, location concealed. Arrow shows direction of dip			
5.9.8	Monocline (1st option)—Identity or existence questionable, location concealed. Arrow shows direction of dip			
5.9.9	Monocline (2nd option)—Identity and existence certain, location accurate. Arrow shows direction of dip			
5.9.10	Monocline (2nd option)—Identity or existence questionable, location accurate. Arrow shows direction of dip			
5.9.11	Monocline (2nd option)—Identity and existence certain, location approximate. Arrow shows direction of dip			
5.9.12	Monocline (2nd option)—Identity or existence questionable, location approximate. Arrow shows direction of dip			
5.9.13	Monocline (2nd option)—Identity and existence certain, location inferred. Arrow shows direction of dip			
5.9.14	Monocline (2nd option)—Identity or existence questionable, location inferred. Arrow shows direction of dip			
5.9.15	Monocline (2nd option)—Identity and existence certain, location concealed. Arrow shows direction of dip			
5.9.16	Monocline (2nd option)—Identity or existence questionable, location concealed. Arrow shows direction of dip			
5.9.17	Monocline, anticlinal bend (1st option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of anticlinal bend of monocline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (anticlinal bend of monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.18	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.19	Monocline, anticlinal bend (1st option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.20	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.21	Monocline, anticlinal bend (1st option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.22	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.23	Monocline, anticlinal bend (1st option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.24	Monocline, anticlinal bend (1st option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			

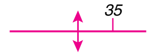
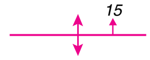
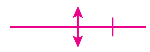
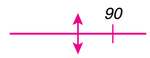
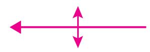
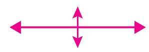
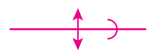
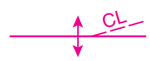
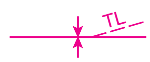
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.9—Monoclines (continued)			
5.9.25	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of anticlinal bend of monocline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (anticlinal bend of monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.26	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.27	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.28	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.29	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.30	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.31	Monocline, anticlinal bend (2nd option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.32	Monocline, anticlinal bend (2nd option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.33	Monocline, synclinal bend (1st option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			Place fold trace where axial surface of synclinal bend of monocline intersects the ground surface. Place arrows at places along fold trace to indicate overall fold type (synclinal bend of monocline); do not place at specific locality where observation was made. Arrowheads may be added to show direction of plunge (see Section 5.10). Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.9.34	Monocline, synclinal bend (1st option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.35	Monocline, synclinal bend (1st option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.36	Monocline, synclinal bend (1st option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.37	Monocline, synclinal bend (1st option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.38	Monocline, synclinal bend (1st option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.39	Monocline, synclinal bend (1st option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.40	Monocline, synclinal bend (1st option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.41	Monocline, synclinal bend (2nd option)—Identity and existence certain, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.42	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location accurate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.43	Monocline, synclinal bend (2nd option)—Identity and existence certain, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.44	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location approximate. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.45	Monocline, synclinal bend (2nd option)—Identity and existence certain, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.46	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location inferred. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.47	Monocline, synclinal bend (2nd option)—Identity and existence certain, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			
5.9.48	Monocline, synclinal bend (2nd option)—Identity or existence questionable, location concealed. Arrows show direction of dip; shorter arrow on steeper limb			

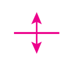
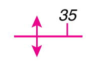
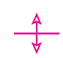
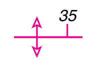
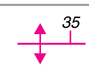
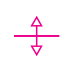
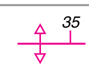
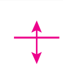
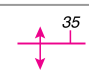
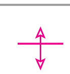
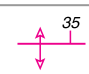
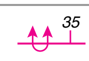
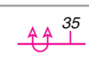
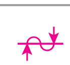
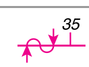
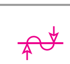
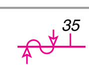
*For more information, see general guidelines on pages A-i to A-v.

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.10—Line-symbol decorations and notations for folds			
5.10.1	Fold having inclined axial surface (1st option)—Tick shows dip value and direction		*HI-6 (100% black)* *35* *tick length 1.75 mm; lineweight .175 mm; color 100% magenta*	Although only shown here on anticlines, line-symbol decorations and notations may be added to any type or style of fold. Add arrowhead or '90' to ticks showing dip if necessary for clarity. Place where observation was made.
5.10.2	Fold having inclined axial surface (2nd option)—Tick shows dip value and direction		*HI-6 (100% black)* *.875 mm* *15* *30°* *tick length 1.375 mm; lineweight .175 mm; color 100% magenta*	
5.10.3	Fold having vertical or near-vertical axial surface (1st option)		*tick length 2.5 mm; lineweight .175 mm; color 100% magenta*	
5.10.4	Fold having vertical or near-vertical axial surface (2nd option)		*HI-6 (100% black)* *90*	
5.10.5	Plunging anticline—Large arrowhead shows direction of plunge		*1.5 mm* *60°* *color 100% magenta*	Although only shown here on anticlines abd synclines, line-symbol decorations and notations may be added to any type or style of fold. Place arrowhead(s) showing plunge at end(s) of, or along, any type or style of fold to indicate general plunge direction(s); do not add plunge angle.
5.10.6	Doubly plunging anticline		*1.5 mm* *color 100% magenta* *60°*	
5.10.7	Plunging syncline—Large arrowhead shows direction of plunge		*1.5 mm* *60°* *color 100% magenta*	
5.10.8	Doubly plunging syncline		*1.5 mm* *color 100% magenta* *60°*	
5.10.9	Fold having near-vertical fold limbs—Half-circle shows direction of closure		*radius 1.25 mm; lineweight .2 mm; color 100% magenta*	Although only shown here on anticlines abd synclines, line-symbol decorations and notations may be added to any type or style of fold.
5.10.10	Crest line (CL) of fold where it diverges from axial surface of anticline		*H-7* *CL* *dash length 2.0 mm; spacing .5 mm; lineweight .2 mm* *line and text color 100% magenta*	
5.10.11	Trough line (TL) of fold where it diverges from axial surface of syncline		*H-7* *TL* *dash length 2.0 mm; spacing .5 mm; lineweight .2 mm* *line and text color 100% magenta*	
5.10.12	Fold—Showing name		PIKE ANTICLINE *H-8* *text color 100% magenta*	Letter size or spacing may be increased on longer fold segments.

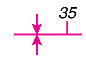
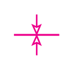
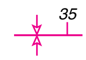
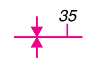
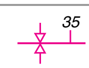
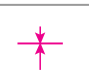
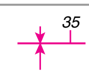
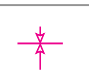
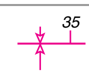
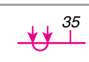
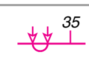
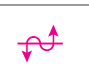
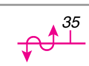
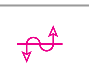
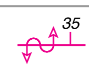
**For more information, see general guidelines on pages A-i to A-v.*

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
			5.11—Small, minor folds	
5.11.1	Small, minor fold, horizontal axial surface		*color 100% magenta; crossbar lineweight .25 mm; circle diameter 3.0 mm; lineweight .2 mm*	Use when beds are too tightly folded to show traces of individual folds or when small, minor folds are observed in outcrop but cannot be traced away from that outcrop. Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.11.2	Small, minor dome		*color 100% magenta; 5.5 mm; 40°; lineweight .2 mm; 1.475 mm*	
5.11.3	Small, minor basin		*color 100% magenta; 5.5 mm; 40°; lineweight .2 mm; 1.475 mm; .5 mm*	
5.11.4	Small, minor anticline, vertical or near-vertical axial surface (1st option)—Showing strike		*color 100% magenta; 2.75 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm*	
5.11.5	Small, minor anticline, inclined axial surface (1st option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.6	Small, minor anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		*color 100% magenta; 2.75 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm*	
5.11.7	Small, minor anticline, inclined axial surface (2nd option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.8	Small, minor antiform, vertical or near-vertical axial surface (1st option)—Showing strike		*color 100% magenta; 2.75 mm; 60°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm*	
5.11.9	Small, minor antiform, inclined axial surface (1st option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.10	Small, minor antiform, vertical or near-vertical axial surface (2nd option)—Showing strike		*color 100% magenta; 2.75 mm; 60°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm*	
5.11.11	Small, minor antiform, inclined axial surface (2nd option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.12	Small, minor asymmetric anticline, vertical or near-vertical axial surface (1st option)—Showing strike		*color 100% magenta; 2.25 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 3.5 mm; lineweight .25 mm*	
5.11.13	Small, minor asymmetric anticline, inclined axial surface (1st option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.14	Small, minor asymmetric anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		*color 100% magenta; 2.25 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 3.5 mm; lineweight .25 mm*	
5.11.15	Small, minor asymmetric anticline, inclined axial surface (2nd option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.16	Small, minor overturned anticline, vertical or near-vertical axial surface (1st option)—Showing strike		*color 100% magenta; 2.275 mm; 40°; arrow lineweight .2 mm; 1.0 mm radius; 1.475 mm; 6.0 mm; lineweight .25 mm*	
5.11.17	Small, minor overturned anticline, inclined axial surface (1st option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.18	Small, minor overturned anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		*color 100% magenta; 2.275 mm; 40°; arrow lineweight .2 mm; 1.0 mm radius; 1.475 mm; 6.0 mm; lineweight .25 mm*	
5.11.19	Small, minor overturned anticline, inclined axial surface (2nd option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.20	Small, minor inverted anticline, vertical or near-vertical axial surface (1st option)—Showing strike		*color 100% magenta; .875 mm radius; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.25 mm; lineweight .25 mm*	
5.11.21	Small, minor inverted anticline, inclined axial surface (1st option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	
5.11.22	Small, minor inverted anticline, vertical or near-vertical axial surface (2nd option)—Showing strike		*color 100% magenta; .875 mm radius; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.25 mm; lineweight .25 mm*	
5.11.23	Small, minor inverted anticline, inclined axial surface (2nd option)—Showing strike and dip		*HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

5—FOLDS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	5.11—Small, minor folds (continued)			
5.11.24	Small, minor syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta; 2.75 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm	Use when beds are too tightly folded to show traces of individual folds or when small, minor folds are observed in outcrop but cannot be traced away from that outcrop. Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular fold type. May also be shown in black or other colors.
5.11.25	Small, minor syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.26	Small, minor syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta; 2.75 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm	
5.11.27	Small, minor syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.28	Small, minor synform, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta; 2.75 mm; 60°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm	
5.11.29	Small, minor synform, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.30	Small, minor synform, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta; 2.75 mm; 60°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.75 mm; lineweight .25 mm	
5.11.31	Small, minor synform, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.32	Small, minor asymmetric syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta; 2.25 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 3.5 mm; lineweight .25 mm	
5.11.33	Small, minor asymmetric syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.34	Small, minor asymmetric syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta; 2.25 mm; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 3.5 mm; lineweight .25 mm	
5.11.35	Small, minor asymmetric syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.36	Small, minor overturned syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta; 2.275 mm; 40°; arrow lineweight .2 mm; 1.0 mm radius; 1.475 mm; 6.0 mm; lineweight .25 mm	
5.11.37	Small, minor overturned syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.38	Small, minor overturned syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta; 2.275 mm; 40°; arrow lineweight .2 mm; 1.0 mm radius; 1.475 mm; 6.0 mm; lineweight .25 mm	
5.11.39	Small, minor overturned syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.40	Small, minor inverted syncline, vertical or near-vertical axial surface (1st option)—Showing strike		color 100% magenta; .875 mm radius; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.25 mm; lineweight .25 mm	
5.11.41	Small, minor inverted syncline, inclined axial surface (1st option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	
5.11.42	Small, minor inverted syncline, vertical or near-vertical axial surface (2nd option)—Showing strike		color 100% magenta; .875 mm radius; 40°; arrow lineweight .2 mm; 6.0 mm; 1.475 mm; 2.25 mm; lineweight .25 mm	
5.11.43	Small, minor inverted syncline, inclined axial surface (2nd option)—Showing strike and dip		HI-6 (100% black); 35; tick length 1.75 mm; lineweight .2 mm; color 100% magenta; 9.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

6—BEDDING

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
6.1	Horizontal bedding	⊕	*all lineweights .2 mm* ⊕ *circle diameter 2.5 mm*	Inclined (upright) and overturned bedding symbols are used when the top direction of beds is known to a reasonable degree of certainty. On maps where determination of top direction is "known" at some places and "unknown" at others, such symbols also may be used to indicate where top direction is "unknown" (compare with ref. nos. 6.13-24). Symbols may be used without a dip value to indicate the generalized strike and direction of dip of beds. For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
6.2	Inclined bedding—Showing strike and dip	*40*	*1.0 mm* *40* *HI-6* *5.0 mm* *all lineweights .2 mm*	
6.3	Vertical bedding—Showing strike		*2.0 mm*	
6.4	Overturned bedding—Showing strike and dip	*65*	*1.0 mm* *65* *HI-6* *.625 mm radius*	
6.5	Bedding overturned more than 180 degrees—Showing strike and dip	*20*	*.7 mm* *20* *.375 mm radius*	
6.6	Inclined (dip direction to right) bedding, for multiple observations at one locality—Showing strike and dip	*40*	*5.5 mm* *40* *HI-6* *1.0 mm* *1.325 mm*	
6.7	Inclined (dip direction to left) bedding, for multiple observations at one locality—Showing strike and dip	*40*	*40*	
6.8	Vertical bedding, for multiple observations at one locality—Showing strike		*2.0 mm*	
6.9	Overturned (dip direction to right) bedding, for multiple observations at one locality—Showing strike and dip	*65*	*.625 mm radius* *65* *HI-6* *1.0 mm*	
6.10	Overturned (dip direction to left) bedding, for multiple observations at one locality—Showing strike and dip	*65*	*65*	
6.11	Bedding overturned more than 180 degrees (dip direction to right), for multiple observations at one locality—Showing strike and dip	*20*	*20* *HI-6* *.7 mm* *.375 mm radius*	
6.12	Bedding overturned more than 180 degrees (dip direction to left), for multiple observations at one locality—Showing strike and dip	*20*	*20*	
6.13	Inclined bedding, where top direction of beds is known from local features—Showing strike and dip	*30*	*1.0 mm* *30* *HI-6* *all lineweights .2 mm* *5.0 mm* *dot diameter .75 mm*	Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction. On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known" (compare with ref. nos. 6.1-12). For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
6.14	Vertical bedding, where top direction of beds is known from local features—Showing strike. Ball shows top direction		*2.0 mm*	
6.15	Overturned bedding, where top direction of beds is known from local features—Showing strike and dip	*85*	*1.0 mm* *85* *HI-6* *.625 mm radius*	
6.16	Bedding overturned more than 180 degrees, where top direction of beds is known from local features—Showing strike and dip	*10*	*.7 mm* *10* *HI-6* *.375 mm radius*	
6.17	Inclined (dip direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*30*	*5.5 mm* *30* *HI-6* *1.0 mm* *1.325 mm*	
6.18	Inclined (dip direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*30*	*30*	
6.19	Vertical (top direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike. Ball shows top direction		*2.0 mm*	
6.20	Vertical (top direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike. Ball shows top direction			
6.21	Overturned (dip direction to right) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*85*	*.625 mm radius* *85* *HI-6* *1.0 mm* *1.7 mm*	
6.22	Overturned (dip direction to left) bedding, where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*85*	*85*	
6.23	Bedding overturned more than 180 degrees (dip direction to right), where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*10*	*HI-6* *10* *.375 mm radius* *.7 mm* *1.325 mm*	
6.24	Bedding overturned more than 180 degrees (dip direction to left), where top direction of beds is known from local features, for multiple observations at one locality—Showing strike and dip	*10*	*10*	

**For more information, see general guidelines on pages A-i to A-v.*

6—BEDDING (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
6.25	Inclined crenulated, warped, undulatory, or contorted bedding—Showing approximate strike and dip	25	1.0 mm; 25; HI-6; .375 mm; all lineweights .2 mm; 5.0 mm; .75 mm radius	Symbols may be used without a dip value to indicate the generalized strike and direction of dip of beds.
6.26	Vertical or near-vertical crenulated, warped, undulatory, or contorted bedding—Showing approximate strike		2.1875 mm; 5.0 mm	
6.27	Inclined graded bedding—Showing strike and dip	25	all lineweights .2 mm; 25; HI-6; 1.0 mm; .5 mm; dash length .875 mm; spacing .5 mm	
6.28	Vertical or near-vertical graded bedding—Showing strike		2.25 mm	
6.29	Overturned graded bedding—Showing strike and dip	70	1.0 mm; 70; HI-6; .625 mm radius	
6.30	Inclined bedding in crossbedded rocks—Showing approximate strike and dip	35	1.0 mm; 35; HI-6; all lineweights .2 mm; .5 mm; 5.0 mm; .625 mm radius	
6.31	Vertical or near-vertical bedding in crossbedded rocks—Showing approximate strike		2.25 mm	
6.32	Overturned bedding in crossbedded rocks—Showing approximate strike and dip	75	1.0 mm; 75; HI-6; .625 mm radius	
6.33	Approximate orientation of inclined bedding—Showing approximate strike and dip	15	HI-6; 15; 2.0 mm; 1.0 mm; .7 mm; all lineweights .2 mm; 5.0 mm	Use when the measurement of strike and (or) dip value is approximate but the location of observation is accurate. Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction. On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known."
6.34	Approximate orientation of vertical or near-vertical bedding—Showing approximate strike		2.0 mm; .7 mm	
6.35	Approximate orientation of overturned bedding—Showing approximate strike and dip	85	.7 mm; 85; HI-6; .625 mm radius	
6.36	Approximate orientation of inclined bedding, where top direction of beds is known from local features—Showing approximate strike and dip	25	HI-6; 25; 2.0 mm; 1.0 mm; .7 mm; dot diameter .75 mm; 5.0 mm; all lineweights .2 mm	
6.37	Approximate orientation of vertical or near-vertical bedding, where top direction of beds is known from local features—Showing approximate strike. Ball shows top direction		2.0 mm; .7 mm	
6.38	Approximate orientation of overturned bedding, where top direction of beds is known from local features—Showing approximate strike and dip	75	HI-6; 75; 2.0 mm; 1.0 mm; .7 mm; .625 mm radius	
6.39	Horizontal bedding, as determined remotely or from aerial photographs		.75 mm; 2.0 mm; all lineweights .2 mm	Usually reserved for use in reconnaissance geologic mapping.
6.40	Gently inclined (between 0° and 30°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		1.375 mm; .4375 mm; 1.0 mm; 5.0 mm	
6.41	Moderately inclined (between 30° and 60°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		.5 mm	
6.42	Steeply inclined (between 60° and 90°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		.5 mm	
6.43	Vertical or near-vertical bedding, as determined remotely or from aerial photographs—Showing approximate strike		2.0 mm	
6.44	Gently overturned (between 0° and 30°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		.625 mm radius	
6.45	Moderately overturned (between 30° and 60°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		.5 mm	
6.46	Steeply overturned (between 60° and 90°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip		.5 mm	

**For more information, see general guidelines on pages A-i to A-v.*

7—CLEAVAGE

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
7.1	Horizontal cleavage (generic or type unspecified)			For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
7.2	Inclined cleavage (generic or type unspecified)—Showing strike and dip			
7.3	Vertical cleavage (generic or type unspecified)—Showing strike			
7.4	Inclined (dip direction to right) cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike and dip			
7.5	Inclined (dip direction to left) cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike and dip			
7.6	Vertical cleavage (generic or type unspecified), for multiple observations at one locality—Showing strike			
7.7	Horizontal continuous, slaty cleavage			
7.8	Inclined continuous, slaty cleavage—Showing strike and dip			
7.9	Vertical continuous, slaty cleavage—Showing strike			
7.10	Inclined (dip direction to right) continuous, slaty cleavage, for multiple observations at one locality—Showing strike and dip			
7.11	Inclined (dip direction to left) continuous, slaty cleavage, for multiple observations at one locality—Showing strike and dip			
7.12	Vertical continuous slaty, cleavage, for multiple observations at one locality—Showing strike			
7.13	Horizontal disjunctive, spaced cleavage			
7.14	Inclined disjunctive, spaced cleavage—Showing strike and dip			
7.15	Vertical disjunctive, spaced cleavage—Showing strike			
7.16	Inclined (dip direction to right) disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike and dip			
7.17	Inclined (dip direction to left) disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike and dip			
7.18	Vertical disjunctive, spaced cleavage, for multiple observations at one locality—Showing strike			
7.19	Horizontal disjunctive, symmetric crenulation cleavage			
7.20	Inclined disjunctive, symmetric crenulation cleavage—Showing strike and dip			
7.21	Vertical or near-vertical disjunctive, symmetric crenulation cleavage—Showing strike			
7.22	Inclined (dip direction to right) disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike and dip			
7.23	Inclined (dip direction to left) disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike and dip			
7.24	Vertical or near-vertical disjunctive, symmetric crenulation cleavage, for multiple observations at one locality—Showing strike			

*For more information, see general guidelines on pages A-i to A-v.

7—CLEAVAGE (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
7.25	Horizontal disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage	S	all lineweights .2 mm; 4.0 mm; 4.0 mm; draft as shown; long dash length 1.0 mm; short dash, .5 mm; spacing .5 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
7.26	Inclined disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage—Showing strike and dip	40 S	HI-6; 40; draft as shown; 1.0 mm; S; 5.0 mm	
7.27	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage—Showing strike	S	S; 1.5 mm	
7.28	Inclined (dip direction to right) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip	40	5.5 mm; 40; HI-6; draft as shown; 1.0 mm	
7.29	Inclined (dip direction to left) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip	40	40	
7.30	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike		1.5 mm	
7.31	Horizontal disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage	Z	all lineweights .2 mm; 4.0 mm; 4.0 mm; draft as shown; long dash length 1.0 mm; short dash, .5 mm; spacing .5 mm	
7.32	Inclined disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage—Showing strike and dip	45 Z	HI-6; 45; draft as shown; 1.0 mm; Z; 5.0 mm	
7.33	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage—Showing strike	Z	Z; 1.5 mm	
7.34	Inclined (dip direction to right) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip	45	5.5 mm; 45; HI-6; draft as shown; 1.0 mm	
7.35	Inclined (dip direction to left) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike and dip	45	45	
7.36	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation cleavage, for multiple observations at one locality—Showing strike		1.5 mm	

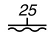
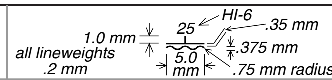
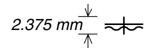
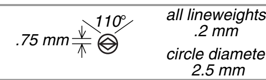
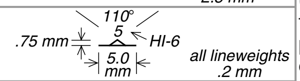
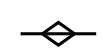
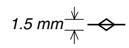
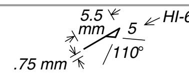
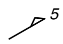
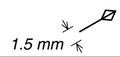
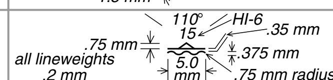
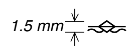
*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	8.1—Generic foliation (origin not known or not specified)			
8.1.1	Horizontal generic (origin not known or not specified) foliation		all lineweights .2 mm; 90°; 1.5 mm; circle diameter 2.5 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.1.2	Inclined generic (origin not known or not specified) foliation—Showing strike and dip	55	90°; 55; HI-6; 1.0 mm; 5.0 mm; all lineweights .2 mm	
8.1.3	Vertical generic (origin not known or not specified) foliation—Showing strike		2.0 mm	
8.1.4	Inclined (dip direction to right) generic (origin not known or not specified) foliation, for multiple observations at one locality—Showing strike and dip	55	5.5 mm; HI-6; 55; 1.0 mm; 90°	
8.1.5	Inclined (dip direction to left) generic (origin not known or not specified) foliation, for multiple observations at one locality—Showing strike and dip	55	55	
8.1.6	Vertical generic (origin not known or not specified) foliation or foliation, for multiple observations at one locality—Showing strike		2.0 mm	
	8.2—Primary foliation or layering (in igneous rocks)			
8.2.1	Massive igneous rock		dot diameter .35 mm; 2.0 mm; 90°	May be used at locality where foliation and lineation are absent.
8.2.2	Horizontal flow banding, lamination, layering, or foliation in igneous rock		all lineweights .2 mm; 60°; circle diameter 2.5 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.3	Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip	10	60°; 10; HI-6; 1.0 mm; 5.0 mm; all lineweights .2 mm	
8.2.4	Vertical flow banding, lamination, layering, or foliation in igneous rock—Showing strike		2.0 mm	
8.2.5	Inclined (dip direction to right) flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike and dip	10	5.5 mm; 10; HI-6; 1.0 mm; 60°	
8.2.6	Inclined (dip direction to left) flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike and dip	10	10	
8.2.7	Vertical flow banding, lamination, layering, or foliation in igneous rock, for multiple observations at one locality—Showing strike		2.0 mm	
8.2.8	Inclined crinkled or deformed flow banding, lamination, layering, or foliation in igneous rock—Showing approximate strike and dip	20	60°; 20; HI-6; 1.0 mm; .375 mm; all lineweights .2 mm; 5.0 mm; .75 mm radius	
8.2.9	Vertical or near-vertical crinkled or deformed flow banding, lamination, layering, or foliation in igneous rock—Showing approximate strike		2.0 mm	
8.2.10	Horizontal cumulate foliation		all lineweights .2 mm; circle diameter 2.5 mm; .5 mm	Inclined (upright) and overturned cumulate foliation symbols are used when the top direction of layers is known to a reasonable degree of certainty. Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction. On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
8.2.11	Inclined cumulate foliation—Showing strike and dip	45	all lineweights .2 mm; 1.0 mm; 45; HI-6; .5 mm	
8.2.12	Vertical cumulate foliation—Showing strike		2.5 mm	
8.2.13	Overturned cumulate foliation—Showing strike and dip	70	1.0 mm; 70; HI-6; .625 mm radius	
8.2.14	Inclined cumulate foliation, where top direction of layers is known from local features—Showing strike and dip	30	all lineweights .2 mm; .5 mm; 30; HI-6; 1.0 mm; 5.0 mm; dot diameter .75 mm	
8.2.15	Vertical cumulate foliation, where top direction of layers is known from local features—Showing strike. Ball shows top direction		2.5 mm	
8.2.16	Overturned cumulate foliation, where top direction of layers is known from local features—Showing strike and dip	80	1.0 mm; 80; HI-6; .625 mm radius	

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	8.2—Primary foliation or layering (in igneous rocks) (continued)			
8.2.17	Inclined crinkled or deformed cumulate foliation—Showing approximate strike and dip			For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.2.18	Vertical or near-vertical crinkled or deformed cumulate foliation—Showing approximate strike			
8.2.19	Horizontal eutaxitic foliation			
8.2.20	Inclined eutaxitic foliation—Showing strike and dip			
8.2.21	Vertical or near-vertical eutaxitic foliation—Showing strike			
8.2.22	Inclined (dip direction to right) eutaxitic foliation, for multiple observations at one locality—Showing strike and dip			
8.2.23	Inclined (dip direction to left) eutaxitic foliation, for multiple observations at one locality—Showing strike and dip			
8.2.24	Vertical or near-vertical eutaxitic foliation, for multiple observations at one locality—Showing strike			
8.2.25	Inclined crinkled or deformed eutaxitic foliation—Showing approximate strike and dip			
8.2.26	Vertical or near-vertical crinkled or deformed eutaxitic foliation—Showing approximate strike			

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	8.3—Secondary foliation (caused by metamorphism or tectonism)			
8.3.1	Horizontal metamorphic or tectonic foliation		60° circle diameter 2.5 mm lineweight .2 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.2	Inclined metamorphic or tectonic foliation—Showing strike and dip	35	60° 35 HI-6 1.0 mm 5.0 mm lineweight .2 mm	
8.3.3	Vertical metamorphic or tectonic foliation—Showing strike		2.0 mm	
8.3.4	Inclined (dip direction to right) metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike and dip	35	5.5 mm 35 HI-6 1.0 mm 60°	
8.3.5	Inclined (dip direction to left) metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike and dip	35	35	
8.3.6	Vertical metamorphic or tectonic foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.7	Horizontal metamorphic or tectonic foliation parallel to bedding		circle diameter 2.5 mm all lineweights .2 mm	Inclined (upright) and overturned foliation symbols are used when the top direction of bedding is known to a reasonable degree of certainty. Symbols that have a ball may be used to indicate a greater level of certainty in the determination of top direction. On maps where determination of top direction is "known" at some places and "unknown" at others, symbols that have a ball also may be used to indicate where top direction is "known".
8.3.8	Inclined metamorphic or tectonic foliation parallel to bedding—Showing strike and dip	10	1.0 mm 10 60° 1.0 mm HI-6 5.0 mm all lineweights .2 mm	
8.3.9	Vertical metamorphic or tectonic foliation parallel to bedding—Showing strike		4.0 mm 2.0 mm	
8.3.10	Inclined metamorphic or tectonic foliation parallel to overturned bedding—Showing strike and dip	75	75 HI-6 .625 mm radius	
8.3.11	Inclined metamorphic or tectonic foliation parallel to upright bedding, where top direction of beds is known from local features—Showing strike and dip	15	1.0 mm 15 60° dot diameter .75 mm 1.0 mm HI-6 5.0 mm all lineweights .2 mm	
8.3.12	Vertical metamorphic or tectonic foliation parallel to bedding, where top direction of beds is known from local features—Showing strike. Ball shows top direction		4.0 mm 2.0 mm	
8.3.13	Inclined metamorphic or tectonic foliation parallel to overturned bedding, where top direction of beds is known from local features—Showing strike and dip	85	85 HI-6 .625 mm radius	
8.3.14	Inclined crinkled or deformed metamorphic or tectonic foliation—Showing approximate strike and dip	30	60° HI-6 30 1.0 mm .375 mm lineweight .2 mm 5.0 mm .75 mm radius	
8.3.15	Vertical or near-vertical crinkled or deformed metamorphic or tectonic foliation—Showing approximate strike		2.0 mm	
8.3.16	Horizontal continuous, penetrative foliation		60° .5 mm 1.0 mm all lineweights .2 mm circle diameter 2.5 mm 4.25 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.17	Inclined continuous, penetrative foliation—Showing strike and dip	25	1.0 mm 60° 25 HI-6 1.0 mm .5 mm 5.0 mm all lineweights .2 mm	
8.3.18	Vertical continuous, penetrative foliation—Showing strike		2.0 mm	
8.3.19	Inclined (dip direction to right) continuous, penetrative foliation, for multiple observations at one locality—Showing strike and dip	25	5.5 mm 25 HI-6 1.0 mm .5 mm 1.0 mm 60°	
8.3.20	Inclined (dip direction to left) continuous, penetrative foliation, for multiple observations at one locality—Showing strike and dip	25	25	
8.3.21	Vertical continuous, penetrative foliation, for multiple observations at one locality—Showing strike		2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.3—Secondary foliation (caused by metamorphism or tectonism) (continued)				
8.3.22	Horizontal disjunctive, spaced foliation		circle diameter 2.5 mm; all lineweights .2 mm; 60°; 1.0 mm; 1.0 mm; 3.6 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.23	Inclined disjunctive, spaced foliation—Showing strike and dip	30	HI-6; 60°; 30; 1.0 mm; 1.0 mm; 1.0 mm; 5.0 mm	
8.3.24	Vertical disjunctive, spaced foliation—Showing strike		2.0 mm	
8.3.25	Inclined (dip direction to right) disjunctive, spaced foliation, for multiple observations at one locality—Showing strike and dip	30	5.5 mm; 30; HI-6; 1.0 mm; 1.0 mm; 1.0 mm; 60°	
8.3.26	Inclined (dip direction to left) disjunctive, spaced foliation, for multiple observations at one locality—Showing strike and dip	30	30	
8.3.27	Vertical disjunctive, spaced foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.28	Horizontal disjunctive, symmetric crenulation foliation		circle diameter 2.5 mm; 60°; all lineweights .2 mm; draft as shown	
8.3.29	Inclined disjunctive, symmetric crenulation foliation—Showing strike and dip	35	draft as shown; 60°; 35; HI-6; 1.0 mm; 1.0 mm; 5.0 mm	
8.3.30	Vertical or near-vertical disjunctive, symmetric crenulation foliation—Showing strike		2.0 mm	
8.3.31	Inclined (dip direction to right) disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike and dip	35	5.5 mm; 35; HI-6; 1.0 mm; 1.0 mm; draft as shown; 60°	
8.3.32	Inclined (dip direction to left) disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike and dip	35	35	
8.3.33	Vertical or near-vertical disjunctive, symmetric crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.34	Horizontal disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation		circle diameter 2.5 mm; 60°; all lineweights .2 mm; draft as shown	
8.3.35	Inclined disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation—Showing strike and dip	40	60°; 40; HI-6; 1.0 mm; 1.0 mm; draft as shown; 5.0 mm	
8.3.36	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation—Showing strike		2.0 mm	
8.3.37	Inclined (dip direction to right) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip	40	5.5 mm; 40; HI-6; 1.0 mm; 1.0 mm; draft as shown; 60°	
8.3.38	Inclined (dip direction to left) disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip	40	40	
8.3.39	Vertical or near-vertical disjunctive, asymmetric (S-shaped, counterclockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.40	Horizontal disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation		circle diameter 2.5 mm; 60°; all lineweights .2 mm; draft as shown	
8.3.41	Inclined disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation—Showing strike and dip	45	60°; 45; HI-6; 1.0 mm; 1.0 mm; 5.0 mm; draft as shown	
8.3.42	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation—Showing strike		2.0 mm	
8.3.43	Inclined (dip direction to right) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip	45	5.5 mm; 45; HI-6; 1.0 mm; 1.0 mm; draft as shown; 60°	
8.3.44	Inclined (dip direction to left) disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike and dip	45	45	
8.3.45	Vertical or near-vertical disjunctive, asymmetric (Z-shaped, clockwise sense of shear) crenulation foliation, for multiple observations at one locality—Showing strike		2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

8—FOLIATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
8.3—Secondary foliation (caused by metamorphism or tectonism) (continued)				
8.3.46	Horizontal gneissic layering		circle diameter 2.5 mm; 60°; 1.0 mm; all lineweights .2 mm; 4.0 mm	For symbols representing a single observation at one locality, point of observation is the midpoint of the strike line. For multiple observations at one locality, join symbols at the "tail" ends of the strike lines (opposite the ornamentation); the junction point is at point of observation. To obey the right-hand rule, use the "dip direction to right" symbols (use "dip direction to left" symbols only when necessary to prevent overcrowding).
8.3.47	Inclined gneissic layering—Showing strike and dip	50	HI-6; 60°; 50; 1.0 mm; 1.0 mm; 5.0 mm	
8.3.48	Vertical or near-vertical gneissic layering—Showing strike		2.0 mm	
8.3.49	Inclined (dip direction to right) gneissic layering, for multiple observations at one locality—Showing strike and dip	50	5.5 mm; 50; HI-6; 1.0 mm; 1.0 mm; 60°	
8.3.50	Inclined (dip direction to left) gneissic layering, for multiple observations at one locality—Showing strike and dip	50	50	
8.3.51	Vertical or near-vertical gneissic layering, for multiple observations at one locality—Showing strike		2.0 mm	
8.3.52	Horizontal undulatory gneissic layering		circle diameter 2.5 mm; 60°; 1.5 mm radius; 1.0 mm; .375 mm; all lineweights .2 mm; 5.0 mm	
8.3.53	Inclined undulatory gneissic layering—Showing strike and dip	55	HI-6; 60°; 55; 1.5 mm radius; 1.0 mm; .375 mm; all lineweights .2 mm; 1.0 mm; 5.0 mm	
8.3.54	Vertical or near-vertical undulatory gneissic layering—Showing strike		2.0 mm	
8.3.55	Horizontal mylonitic foliation		circle diameter 2.5 mm; 60°; 1.5 mm; all lineweights .2 mm; 1.475 mm	
8.3.56	Inclined mylonitic foliation—Showing strike and dip	60	HI-6; 60°; 60; 1.5 mm; 1.0 mm; 1.475 mm; 5.0 mm	
8.3.57	Vertical or near-vertical mylonitic foliation—Showing strike		2.0 mm	
8.3.58	Inclined (dip direction to right) mylonitic foliation, for multiple observations at one locality—Showing strike and dip	60	5.5 mm; 60; HI-6; 1.5 mm; 1.0 mm; 60°	
8.3.59	Inclined (dip direction to left) mylonitic foliation, for multiple observations at one locality—Showing strike and dip	60	60	
8.3.60	Vertical or near-vertical mylonitic foliation, for multiple observations at one locality—Showing strike		2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.1	Approximate plunge direction of inclined generic (origin or type not known or not specified) lineation or linear structure (1st option)		lineweight .2 mm; 6.0 mm; 25°; 1.25 mm	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.2	Approximate plunge direction of inclined generic (origin or type not known or not specified) lineation or linear structure (2nd option)		all lineweights .2 mm	
9.3	Inclined generic (origin or type not known or not specified) lineation or linear structure (1st option)—Showing bearing and plunge	20	HI-6; 20	
9.4	Inclined generic (origin or type not known or not specified) lineation or linear structure (2nd option)—Showing bearing and plunge	30	30	
9.5	Horizontal generic (origin or type not known or not specified) lineation or linear structure (1st option)—Showing bearing		lineweight .2 mm; 6.0 mm; 25°; 25°; 1.25 mm; 1.25 mm	
9.6	Horizontal generic (origin or type not known or not specified) lineation or linear structure (2nd option)—Showing bearing		all lineweights .2 mm	
9.7	Vertical or near-vertical generic (origin or type not known or not specified) lineation or linear structure (1st option)		all lineweights .2 mm; 4.5 mm; .975 mm; .975 mm	
9.8	Vertical or near-vertical generic (origin or type not known or not specified) lineation or linear structure (2nd option)			
9.9	Inclined parting lineation in sedimentary materials (1st option)—Showing bearing and plunge	20	all lineweights .2 mm; 1.25 mm; 20; 2.5 mm; 1.0 mm	
9.10	Inclined parting lineation in sedimentary materials (2nd option)—Showing bearing and plunge	30	30	
9.11	Horizontal parting lineation in sedimentary materials (1st option)—Showing bearing		all lineweights .2 mm; 1.25 mm; 2.5 mm; 1.0 mm	
9.12	Horizontal parting lineation in sedimentary materials (2nd option)—Showing bearing			
9.13	Inclined sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (1st option)—Showing bearing and plunge	20	2.0 mm; lineweight .2 mm; 20; draft as shown	
9.14	Inclined sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (2nd option)—Showing bearing and plunge	30	all lineweights .2 mm; 30	
9.15	Horizontal sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (1st option)—Showing bearing		2.0 mm; lineweight .2 mm; draft as shown	
9.16	Horizontal sole mark, tool mark, scour mark, flute mark, groove, or channel in sedimentary materials (2nd option)—Showing bearing		all lineweights .2 mm	
9.17	Inclined slickenline, groove, or striation on fault surface (1st option)—Showing bearing and plunge	20	lineweight .2 mm; 6.0 mm; 30°; 20; 1.5 mm; 60°	
9.18	Inclined slickenline, groove, or striation on fault surface (2nd option)—Showing bearing and plunge	30	all lineweights .2 mm; 30	
9.19	Horizontal slickenline, groove, or striation on fault surface (1st option)—Showing bearing		lineweight .2 mm; 6.0 mm; 30°; 30°; 1.5 mm; 1.5 mm; 60°; 60°	
9.20	Horizontal slickenline, groove, or striation on fault surface (2nd option)—Showing bearing		all lineweights .2 mm	
9.21	Inclined surface groove or striation (origin not known or not specified) (1st option)—Showing bearing and plunge	20	all lineweights .2 mm; 1.25 mm; 20; 3.0 mm	
9.22	Inclined surface groove or striation (origin not known or not specified) (2nd option)—Showing bearing and plunge	30	30	
9.23	Horizontal surface groove or striation (origin not known or not specified) (1st option)—Showing bearing		all lineweights .2 mm; 1.25 mm; 3.0 mm	
9.24	Horizontal surface groove or striation (origin not known or not specified) (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.25	Inclined aligned-object lineation (1st option)—Showing bearing and plunge	20	*dot diameter 1.0 mm; 6.0 mm; HI-6; 25°; 20; lineweight .2 mm; 2.5 mm; 1.25 mm*	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.26	Inclined aligned-object lineation (2nd option)—Showing bearing and plunge	30	*30; all lineweights .2 mm*	
9.27	Horizontal aligned-object lineation (1st option)—Showing bearing		*dot diameter 1.0 mm; 6.0 mm; 25°; 25°; lineweight .2 mm; 2.5 mm; 1.25 mm; 1.25 mm*	
9.28	Horizontal aligned-object lineation (2nd option)—Showing bearing		*all lineweights .2 mm*	
9.29	Inclined aligned-clast or aligned-grain lineation (in sedimentary materials) (1st option)—Showing bearing and plunge	20	*2.425 mm; 30°; 20; lineweight .2 mm; .675 mm; 2.0 mm*	
9.30	Inclined aligned-clast or aligned-grain lineation (in sedimentary materials) (2nd option)—Showing bearing and plunge	30	*30; all lineweights .2 mm*	
9.31	Horizontal aligned-clast or aligned-grain lineation (in sedimentary materials) (1st option)—Showing bearing		*2.425 mm; 30°; lineweight .2 mm; .675 mm; 2.0 mm*	
9.32	Horizontal aligned-clast or aligned-grain lineation (in sedimentary materials) (2nd option)—Showing bearing		*all lineweights .2 mm*	
9.33	Inclined aligned-inclusion lineation (in igneous rocks) (1st option)—Showing bearing and plunge	20	*circle diameter 1.0 mm; 20; all lineweights .2 mm; 2.5 mm*	
9.34	Inclined aligned-inclusion lineation (in igneous rocks) (2nd option)—Showing bearing and plunge	30	*30*	
9.35	Horizontal aligned-inclusion lineation (in igneous rocks) (1st option)—Showing bearing		*circle diameter 1.0 mm; all lineweights .2 mm; 2.5 mm*	
9.36	Horizontal aligned-inclusion lineation (in igneous rocks) (2nd option)—Showing bearing			
9.37	Inclined aligned-mineral lineation (1st option)—Showing bearing and plunge	20	*1.0 mm; 1.0 mm; 20; lineweight .2 mm; 2.5 mm*	
9.38	Inclined aligned-mineral lineation (2nd option)—Showing bearing and plunge	30	*30; all lineweights .2 mm*	
9.39	Horizontal aligned-mineral lineation (1st option)—Showing bearing		*1.0 mm; 1.0 mm; lineweight .2 mm; 2.5 mm*	
9.40	Horizontal aligned-mineral lineation (2nd option)—Showing bearing		*all lineweights .2 mm*	
9.41	Inclined aligned mineral-aggregate lineation (1st option)—Showing bearing and plunge	20	*.75 mm; .5 mm; .75 mm; 20; lineweight .2 mm; 2.0 mm; .75 mm*	
9.42	Inclined aligned mineral-aggregate lineation (2nd option)—Showing bearing and plunge	30	*30; all lineweights .2 mm*	
9.43	Horizontal aligned mineral-aggregate lineation (1st option)—Showing bearing		*.75 mm; .5 mm; .75 mm; lineweight .2 mm; 2.0 mm; .75 mm*	
9.44	Horizontal aligned mineral-aggregate lineation (2nd option)—Showing bearing		*all lineweights .2 mm*	
9.45	Inclined aligned deformed-mineral lineation (1st option)—Showing bearing and plunge	20	*2.75 mm; .5 mm; 1.0 mm; 20; lineweight .2 mm; 30°*	
9.46	Inclined aligned deformed-mineral lineation (2nd option)—Showing bearing and plunge	30	*30; all lineweights .2 mm*	
9.47	Horizontal aligned deformed-mineral lineation (1st option)—Showing bearing		*2.75 mm; .5 mm; 1.0 mm; lineweight .2 mm; 30°*	
9.48	Horizontal aligned deformed-mineral lineation (2nd option)—Showing bearing		*all lineweights .2 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.49	Inclined aligned stretched-object lineation (1st option)—Showing bearing and plunge	20	6.0 mm; HI-6; 25°; .875 mm; 20; 1.75 mm; 2.125 mm; 1.25 mm; lineweight .2 mm	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.50	Inclined aligned stretched-object lineation (2nd option)—Showing bearing and plunge	30	30; all lineweights .2 mm	
9.51	Horizontal aligned stretched-object lineation (1st option)—Showing bearing		lineweight .2 mm; 6.0 mm; .875 mm; 25°; 25°; 2.125 mm; 1.25 mm; 1.25 mm; 1.75 mm	
9.52	Horizontal aligned stretched-object lineation (2nd option)—Showing bearing		all lineweights .2 mm	
9.53	Inclined aligned stretched-pebble lineation (1st option)—Showing bearing and plunge	20	2.125 mm; .875 mm; 20; 1.75 mm; all lineweights .2 mm	
9.54	Inclined aligned stretched-pebble lineation (2nd option)—Showing bearing and plunge	30	30	
9.55	Horizontal aligned stretched-pebble lineation (1st option)—Showing bearing		2.125 mm; .875 mm; 1.75 mm; all lineweights .2 mm	
9.56	Horizontal aligned stretched-pebble lineation (2nd option)—Showing bearing			
9.57	Inclined aligned stretched-ooid lineation (1st option)—Showing bearing and plunge	20	2.4 mm; 30°; 20; .75 mm; 1.5 mm; all lineweights .2 mm	
9.58	Inclined aligned stretched-ooid lineation (2nd option)—Showing bearing and plunge	30	30	
9.59	Horizontal aligned stretched-ooid lineation (1st option)—Showing bearing		2.4 mm; 30°; .75 mm; 1.5 mm; all lineweights .2 mm	
9.60	Horizontal aligned stretched-ooid lineation (2nd option)—Showing bearing			
9.61	Inclined rodding (1st option)—Showing bearing and plunge	20	1.75 mm; .75 mm; 20; 2.5 mm; 30°; lineweight .2 mm	
9.62	Inclined rodding (2nd option)—Showing bearing and plunge	30	30; all lineweights .2 mm	
9.63	Horizontal rodding (1st option)—Showing bearing		1.75 mm; .75 mm; 2.5 mm; 30°; lineweight .2 mm	
9.64	Horizontal rodding (2nd option)—Showing bearing		all lineweights .2 mm	
9.65	Inclined mullions (1st option)—Showing bearing and plunge	20	2.0 mm; 20; circle diameters 1.0 mm; all lineweights .2 mm	
9.66	Inclined mullions (2nd option)—Showing bearing and plunge	30	30	
9.67	Horizontal mullions (1st option)—Showing bearing		2.0 mm; circle diameters 1.0 mm; all lineweights .2 mm	
9.68	Horizontal mullions (2nd option)—Showing bearing			
9.69	Inclined boudins (1st option)—Showing bearing and plunge	20	2.8 mm; .4 mm; 20; .625 mm radius; all lineweights .2 mm	
9.70	Inclined boudins (2nd option)—Showing bearing and plunge	30	30	
9.71	Horizontal boudins (1st option)—Showing bearing		2.8 mm; .4 mm; .625 mm radius; all lineweights .2 mm	
9.72	Horizontal boudins (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.73	Inclined pencil structure (1st option)—Showing bearing and plunge	20	all lineweights .2 mm; 6.0 mm; HI-6; 25°; .75 mm; 20; 1.75 mm; 1.25 mm; 2.5 mm; 30°	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation.
9.74	Inclined pencil structure (2nd option)—Showing bearing and plunge	30	30	
9.75	Horizontal pencil structure (1st option)—Showing bearing		all lineweights .2 mm; 6.0 mm; .75 mm; 25°; 25°; 1.75 mm; 1.25 mm; 1.25 mm; 2.5 mm; 30°	
9.76	Horizontal pencil structure (2nd option)—Showing bearing			
9.77	Inclined lineation at intersection of bedding and cleavage (1st option)—Showing bearing and plunge	20	2.5 mm; 1.25 mm; 20; 45°; .75 mm; all lineweights .2 mm	
9.78	Inclined lineation at intersection of bedding and cleavage (2nd option)—Showing bearing and plunge	30	30	
9.79	Horizontal lineation at intersection of bedding and cleavage (1st option)—Showing bearing		2.5 mm; 1.25 mm; 45°; .75 mm; all lineweights .2 mm	
9.80	Horizontal lineation at intersection of bedding and cleavage (2nd option)—Showing bearing			
9.81	Inclined lineation at intersection of two cleavages (1st option)—Showing bearing and plunge	20	2.5 mm; 1.25 mm; 20; 45°; .825 mm; all lineweights .2 mm	
9.82	Inclined lineation at intersection of two cleavages (2nd option)—Showing bearing and plunge	30	30	
9.83	Horizontal lineation at intersection of two cleavages (1st option)—Showing bearing		2.5 mm; 1.25 mm; 45°; .825 mm; all lineweights .2 mm	
9.84	Horizontal lineation at intersection of two cleavages (2nd option)—Showing bearing			
9.85	Inclined lineation at intersection of two fractures or joints (1st option)—Showing bearing and plunge	20	2.4375 mm; 1.125 mm; 20; 1.125 mm; all lineweights .2 mm	
9.86	Inclined lineation at intersection of two fractures or joints (2nd option)—Showing bearing and plunge	30	30	
9.87	Horizontal lineation at intersection of two fractures or joints (1st option)—Showing bearing		2.4375 mm; 1.125 mm; 1.125 mm; all lineweights .2 mm	
9.88	Horizontal lineation at intersection of two fractures or joints (2nd option)—Showing bearing			
9.89	Inclined lineation at intersection of two foliations (1st option)—Showing bearing and plunge	20	2.25 mm; 1.5 mm; 20; 45°; 1.5 mm; all lineweights .2 mm	
9.90	Inclined lineation at intersection of two foliations (2nd option)—Showing bearing and plunge	30	30	
9.91	Horizontal lineation at intersection of two foliations (1st option)—Showing bearing		2.25 mm; 1.5 mm; 45°; 1.5 mm; all lineweights .2 mm	
9.92	Horizontal lineation at intersection of two foliations (2nd option)—Showing bearing			
9.93	Inclined lineation at intersection of two surfaces (origin or type unspecified) (1st option)—Showing bearing and plunge	20	3.0 mm; 1.25 mm; 20; 90°; 1.25 mm; all lineweights .2 mm	
9.94	Inclined lineation at intersection of two surfaces (origin or type unspecified) (2nd option)—Showing bearing and plunge	30	30	
9.95	Horizontal lineation at intersection of two surfaces (origin or type unspecified) (1st option)—Showing bearing		3.0 mm; 1.25 mm; 90°; 1.25 mm; all lineweights .2 mm	
9.96	Horizontal lineation at intersection of two surfaces (origin or type unspecified) (2nd option)—Showing bearing			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.97	Inclined fold hinge of generic (type or orientation unspecified) small, minor fold (1st option)—Showing bearing and plunge	20	dot diameter .5 mm; 6.0 mm; HI-6 (100% black); 25°; 20; color 100% magenta; 2.75 mm; 1.25 mm; lineweight .2 mm	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation. May also be shown in black or other colors.
9.98	Inclined fold hinge of generic (type or orientation unspecified) small, minor fold (2nd option)—Showing bearing and plunge	30	all lineweights .2 mm; 30	
9.99	Horizontal fold hinge of generic (type or orientation unspecified) small, minor fold (1st option)—Showing bearing		dot diameter .5 mm; 6.0 mm; lineweight .2 mm; 25°; 25°; 2.75 mm; 1.25 mm; 1.25 mm; color 100% magenta	
9.100	Horizontal fold hinge of generic (type or orientation unspecified) small, minor fold (2nd option)—Showing bearing		all lineweights .2 mm	
9.101	Inclined fold hinge of small, minor penecontemporaneous soft-sediment fold (1st option)—Showing bearing and plunge	20	3.0 mm; all lineweights .2 mm; color 100% magenta; 20; draft as shown	
9.102	Inclined fold hinge of small, minor penecontemporaneous soft-sediment fold (2nd option)—Showing bearing and plunge	30	30	
9.103	Horizontal fold hinge of small, minor penecontemporaneous soft-sediment fold (1st option)—Showing bearing		3.0 mm; all lineweights .2 mm; color 100% magenta; draft as shown	
9.104	Horizontal fold hinge of small, minor penecontemporaneous soft-sediment fold (2nd option)—Showing bearing			
9.105	Inclined fold hinge of small, minor anticline (1st option)—Showing bearing and plunge	20	color 100% magenta; 3.5 mm; all lineweights .2 mm; 20; draft as shown	
9.106	Inclined fold hinge of small, minor anticline (2nd option)—Showing bearing and plunge	30	30	
9.107	Horizontal fold hinge of small, minor anticline (1st option)—Showing bearing. Ball on topographically higher side of fold		dot diameter .5 mm; 3.5 mm; all lineweights .2 mm; color 100% magenta; draft as shown; .4 mm	
9.108	Horizontal fold hinge of small, minor anticline (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.109	Inclined fold hinge of small, minor antiform (1st option)—Showing bearing and plunge	20	color 100% magenta; 3.3 mm; all lineweights .2 mm; 20; draft as shown	
9.110	Inclined fold hinge of small, minor antiform (2nd option)—Showing bearing and plunge	30	30	
9.111	Horizontal fold hinge of small, minor antiform (1st option)—Showing bearing. Ball on topographically higher side of fold		dot diameter .5 mm; 3.5 mm; all lineweights .2 mm; color 100% magenta; draft as shown; .4 mm	
9.112	Horizontal fold hinge of small, minor antiform (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.113	Inclined fold hinge of small, minor syncline (1st option)—Showing bearing and plunge	20	color 100% magenta; 2.45 mm; all lineweights .2 mm; 20; draft as shown	
9.114	Inclined fold hinge of small, minor syncline (2nd option)—Showing bearing and plunge	30	30	
9.115	Horizontal fold hinge of small, minor syncline (1st option)—Showing bearing. Ball on topographically higher side of fold		dot diameter .5 mm; 2.45 mm; all lineweights .2 mm; color 100% magenta; draft as shown; 1.3 mm	
9.116	Horizontal fold hinge of small, minor syncline (2nd option)—Showing bearing. Ball on topographically higher side of fold			
9.117	Inclined fold hinge of small, minor synform (1st option)—Showing bearing and plunge	20	color 100% magenta; 3.3 mm; all lineweights .2 mm; 20; draft as shown	
9.118	Inclined fold hinge of small, minor synform (2nd option)—Showing bearing and plunge	30	30	
9.119	Horizontal fold hinge of small, minor synform (1st option)—Showing bearing. Ball on topographically higher side of fold		dot diameter .5 mm; 3.3 mm; all lineweights .2 mm; color 100% magenta; draft as shown; .8 mm	
9.120	Horizontal fold hinge of small, minor synform (2nd option)—Showing bearing. Ball on topographically higher side of fold			

*For more information, see general guidelines on pages A-i to A-v.

9—LINEATION (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
9.121	Inclined symmetric minor fold hinge (1st option)—Showing bearing and plunge	20	*color 100% magenta; 6.0 mm; HI-6 (100% black); 25°; 20; draft as shown; all lineweights .2 mm; 2.75 mm; 1.25 mm*	Open-arrowed ("2nd option") symbols may be used to show a second generation or another instance of a particular lineation. Lineation symbols may be used separately or combined with other symbols. For lineation symbols representing a single observation at one locality, the point of observation is at one of the following two places: for inclined lineations, at the "tail" end (opposite the arrowhead); for horizontal lineations, at the midpoint of the bearing line. For a single lineation symbol combined with a single planar-feature (for example, bedding or foliation) symbol, join the "tail" end of the lineation arrow to the midpoint of the strike line of the planar-feature symbol; the junction point is at the point of observation. For multiple observations at one locality, join all symbols at their "tail" ends (opposite the arrowheads or other ornamentations); the junction point is at the point of observation. May also be shown in black or other colors.
9.122	Inclined symmetric minor fold hinge (2nd option)—Showing bearing and plunge	30	*30*	
9.123	Horizontal symmetric minor fold hinge (1st option)—Showing bearing		*color 100% magenta; 6.0 mm; all lineweights .2 mm; 25°; 25°; 1.25 mm; 1.25 mm; 2.5 mm; draft as shown*	
9.124	Horizontal symmetric minor fold hinge (2nd option)—Showing bearing			
9.125	Inclined asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (1st option)—Showing bearing and plunge	20	*color 100% magenta; 3.0 mm; all lineweights .2 mm; 20; draft as shown*	
9.126	Inclined asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (2nd option)—Showing bearing and plunge	30	*30*	
9.127	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (1st option)—Showing bearing		*color 100% magenta; 3.0 mm; all lineweights .2 mm; draft as shown*	
9.128	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) minor fold hinge (2nd option)—Showing bearing			
9.129	Inclined asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (1st option)—Showing bearing and plunge	20	*color 100% magenta; 3.0 mm; all lineweights .2 mm; 20; draft as shown*	
9.130	Inclined asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (2nd option)—Showing bearing and plunge	30	*30*	
9.131	Horizontal asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (1st option)—Showing bearing		*color 100% magenta; 3.0 mm; all lineweights .2 mm; draft as shown*	
9.132	Horizontal asymmetric (Z-shaped, clockwise sense of shear) minor fold hinge (2nd option)—Showing bearing			
9.133	Inclined crenulation lineation (1st option)—Showing bearing and plunge	20	*color 100% magenta; 3.0 mm; all lineweights .2 mm; 20; draft as shown*	
9.134	Inclined crenulation lineation (2nd option)—Showing bearing and plunge	30	*30*	
9.135	Horizontal crenulation lineation (1st option)—Showing bearing		*color 100% magenta; 3.0 mm; all lineweights .2 mm; draft as shown*	
9.136	Horizontal crenulation lineation (2nd option)—Showing bearing			
9.137	Inclined asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (1st option)—Showing bearing and plunge	20	*color 100% magenta; 3.0 mm; all lineweights .2 mm; 20; draft as shown*	
9.138	Inclined asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (2nd option)—Showing bearing and plunge	30	*30*	
9.139	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (1st option)—Showing bearing		*color 100% magenta; 3.0 mm; all lineweights .2 mm; draft as shown*	
9.140	Horizontal asymmetric (S-shaped, counterclockwise sense of shear) kink-band crenulation lineation (2nd option)—Showing bearing			
9.141	Inclined asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (1st option)—Showing bearing and plunge	20	*color 100% magenta; 3.0 mm; all lineweights .2 mm; 20; draft as shown*	
9.142	Inclined asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (2nd option)—Showing bearing and plunge	30	*30*	
9.143	Horizontal asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (1st option)—Showing bearing		*color 100% magenta; 3.0 mm; all lineweights .2 mm; draft as shown*	
9.144	Horizontal asymmetric (Z-shaped, clockwise sense of shear) kink-band crenulation lineation (2nd option)—Showing bearing			

**For more information, see general guidelines on pages A-i to A-v.*

10—PALEONTOLOGICAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	10.1—Fossil locality			
10.1.1	Fossil locality—Showing collection number	D4426	*90°* *2.5 mm* D4426 *H-8* *lineweight .2 mm* *dot diameter .5 mm*	May be shown in red or other colors.

REF NO	DESCRIPTION	SYMBOL
	10.2—Fossil symbols	
10.2.1	Macrofossils	
10.2.2	Invertebrates	
10.2.3	Annelids	
10.2.4	Arthropods	
10.2.5	Arachnids	
10.2.6	Crustaceans	
10.2.7	Insects	
10.2.8	Trilobites	
10.2.9	Brachiopods	
10.2.10	Bryozoans	
10.2.11	Cnidarians	
10.2.12	Corals	
10.2.13	Stromatoporoids	
10.2.14	Echinoderms	
10.2.15	Crinoids	
10.2.16	Echinoids	
10.2.17	Graptolites	
10.2.18	Mollusks	
10.2.19	Cephalopods	
10.2.20	Ammonoids	
10.2.21	Belemnoids	
10.2.22	Nautiloids	

REF NO	DESCRIPTION	SYMBOL
	10.2—Fossil symbols (continued)	
10.2.23	Gastropods	
10.2.24	Pelecypods	
10.2.25	Sponges	
10.2.26	Vertebrates	
10.2.27	Amphibians	
10.2.28	Fish	
10.2.29	Mammals	
10.2.30	Reptiles	
10.2.31	Plants	
10.2.32	Leaves	
10.2.33	Roots	
10.2.34	Wood	
10.2.35	Algae	
10.2.36	Conifers	
10.2.37	Ferns	
10.2.38	Flowering plants and (or) trees	
10.2.39	Stromatolites	
10.2.40	Fungi	
10.2.41	Trace fossils	
10.2.42	Burrows	
10.2.43	Coprolites	
10.2.44	Tracks	

REF NO	DESCRIPTION	SYMBOL
	10.2—Fossil symbols (continued)	
10.2.45	Microfossils	
10.2.46	Conodonts	
10.2.47	Diatoms	
10.2.48	Foraminifera	
10.2.49	Larger foraminifera, or fusulinids	
10.2.50	Smaller, benthonic foraminifera	
10.2.51	Smaller, planktonic foraminifera	
10.2.52	Nannofossils	
10.2.53	Ostracodes	
10.2.54	Palynomorphs	
10.2.55	Acritarchs	
10.2.56	Chitinozoans	
10.2.57	Dinoflagellates	
10.2.58	Pollen and (or) spores	
10.2.59	Radiolarians	
10.2.60	Silicoflagellates	
10.2.61	Spicules	

CARTOGRAPHIC SPECIFICATIONS*

all lineweights .125 mm *draft as shown; size may vary (see below)*	*fill color 100% white*	*fill color 100% black*

NOTES ON USAGE*

Fossil symbols usually are reserved for use on stratigraphic columns, sections, or charts.

Cartographic specifications, although shown for only two examples, pertain to all fossil symbols.

Fossil symbols may be reduced in size, and lineweights reduced accordingly. Note, however, that lineweights below .125 mm may not plot correctly if output at higher resolutions (1800 dpi or higher).

May also be shown in other colors.

For more information, see general guidelines on pages A-i to A-v.

11—GEOPHYSICAL AND STRUCTURE CONTOURS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
11.1	Geophysical contour (index)—Accurately located	200	lineweight .325 mm; HI-8; 200; line and text color 100% red	On most maps, every fourth or fifth contour should be an index contour. Only index contours are labeled. Negative values must be preceded by a minus (–) sign. Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value). May be shown in black or other colors.
11.2	Geophysical contour (index)—Showing datum (in parentheses): SL, sea level	200(SL)	200(SL)	
11.3	Geophysical contour (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.0 mm; 1.0 mm	
11.4	Geophysical contour (index)—Approximately located where data are incomplete		.5 mm; 4.5 mm	
11.5	Geophysical contour (index)—Approximately located where data are incomplete. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.0 mm; 1.0 mm	
11.6	Geophysical contour (intermediate)—Accurately located		lineweight .2 mm; line color 100% red	
11.7	Geophysical contour (intermediate)—Accurately located. Hachures point into closed areas of lower values		all lineweights .2 mm; 5.0 mm; 1.0 mm	
11.8	Geophysical contour (intermediate)—Approximately located where data are incomplete		.5 mm; 4.5 mm	
11.9	Geophysical contour (intermediate)—Approximately located where data are incomplete. Hachures point into closed areas of lower values		5.0 mm; 1.0 mm	
11.10	Geophysical data collection locality		2.0 mm; 2.0 mm; line color 100% red; 90°; lineweight .25 mm	May be shown in black or other colors.
11.11	Geophysical data collection locality—Showing value where known	752	752; HI-7; line and text color 100% red	
11.12	Maximum or minimum intensity value within closed high or closed low	2864	lineweights .15 mm; 30°; HI-7; 2864; line and text color 100% red; 2.0 mm; 2.0 mm	
11.13	Structure contour, 1st surface (index)—Accurately located	600	lineweight .4 mm; HI-9; 600; line and text color 100% red	On most maps, every fourth or fifth contour should be an index contour. Only index contours are labeled. Negative values must be preceded by a minus (–) sign. Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value). May be shown in black or other colors.
11.14	Structure contour, 1st surface (index)—Showing datum (in parentheses): SL, sea level	600(SL)	600(SL)	
11.15	Structure contour, 1st surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.16	Structure contour, 1st surface (index)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.17	Structure contour, 1st surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.18	Structure contour, 1st surface (intermediate)—Accurately located		lineweight .275 mm	
11.19	Structure contour, 1st surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.20	Structure contour, 1st surface (intermediate)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.21	Structure contour, 1st surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.22	Outcrop point as structural control point (1st surface)	1520	line and text color 100% red; 90°; 1520; HI-7; lineweight .275 mm; 2.0 mm; 2.0 mm	May be shown in black or other colors.

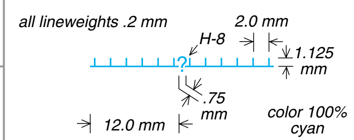
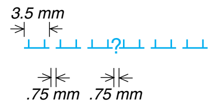
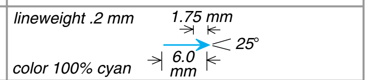
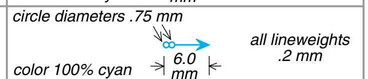
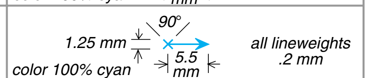
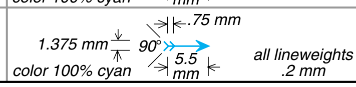
*For more information, see general guidelines on pages A-i to A-v.

11—GEOPHYSICAL AND STRUCTURE CONTOURS (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
11.23	Structure contour, 2nd surface (index)—Accurately located	600	lineweight .4 mm; HI-9; 600; line and text color 100% violet	On most maps, every fourth or fifth contour should be an index contour. Only index contours are labeled. Negative values must be preceded by a minus (–) sign. Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value). May be shown in black or other colors.
11.24	Structure contour, 2nd surface (index)—Showing datum (in parentheses): SL, sea level	600(SL)	600(SL)	
11.25	Structure contour, 2nd surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.26	Structure contour, 2nd surface (index)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.27	Structure contour, 2nd surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.28	Structure contour, 2nd surface (intermediate)—Accurately located		lineweight .275 mm	
11.29	Structure contour, 2nd surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.30	Structure contour, 2nd surface (intermediate)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.31	Structure contour, 2nd surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.32	Outcrop point as structural control point (2nd surface)	×1520	line and text color 100% violet; 90°; 1520; HI-7; lineweight .275 mm; 2.0 mm; 2.0 mm	May be shown in black or other colors.
11.33	Structure contour, 3rd surface (index)—Accurately located	600	lineweight .4 mm; HI-9; 600; line and text color 100% green	On most maps, every fourth or fifth contour should be an index contour. Only index contours are labeled. Negative values must be preceded by a minus (–) sign. Add hachures to indicate closed areas of low values or if it is unclear that contour values are decreasing (hachures point into areas of low value). May be shown in black or other colors.
11.34	Structure contour, 3rd surface (index)—Showing datum (in parentheses): SL, sea level	600(SL)	600(SL)	
11.35	Structure contour, 3rd surface (index)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.36	Structure contour, 3rd surface (index)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.37	Structure contour, 3rd surface (index)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.38	Structure contour, 3rd surface (intermediate)—Accurately located		lineweight .275 mm	
11.39	Structure contour, 3rd surface (intermediate)—Accurately located. Hachures point into closed areas of lower values		hachure lineweight .2 mm; 5.5 mm; 1.0 mm	
11.40	Structure contour, 3rd surface (intermediate)—Approximately located where control is poor		.5 mm; 5.0 mm	
11.41	Structure contour, 3rd surface (intermediate)—Approximately located where control is poor. Hachures point into closed areas of lower values		5.5 mm; 1.0 mm	
11.42	Outcrop point as structural control point (3rd surface)	×1520	line and text color 100% green; 90°; 1520; HI-7; lineweight .275 mm; 2.0 mm; 2.0 mm	May be shown in black or other colors.

*For more information, see general guidelines on pages A-i to A-v.

12—FLUVIAL AND ALLUVIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
12.1	Fluvial terrace scarp—Identity and existence certain, location accurate. Hachures point downscarp			May also be shown in black or other colors.
12.2	Fluvial terrace scarp—Identity or existence questionable, location accurate. Hachures point downscarp			
12.3	Fluvial terrace scarp—Identity and existence certain, location approximate. Hachures point downscarp			
12.4	Fluvial terrace scarp—Identity or existence questionable, location approximate. Hachures point downscarp			
12.5	Fluvial transport direction			
12.6	Sediment transport direction determined from imbrication			
12.7	Sediment transport direction determined from crossbeds			
12.8	Sediment transport direction determined from flute casts			

*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.1	Crevasse on glacier		lineweights .2 mm; color 100% cyan; lengths may vary	
13.2	Ice-flow direction		lineweight .25 mm; color 100% cyan; 60°; length may vary; 1.5 mm	
13.3	Glacial-lake spillway—Arrow shows direction of flow		color 100% cyan; 1.25 mm; 25°; length may vary; lineweight .2 mm; 60°; 2.0 mm	
13.4	Glacial-lake spillway—Showing elevation. Arrow shows direction of flow	785'	785'; HI-6 (100% black)	
13.5	Inferred glacial-lake spillway—Arrow shows direction of flow		all lineweights .2 mm	
13.6	Inferred glacial-lake spillway—Showing estimated elevation. Arrow shows direction of flow	785'	785'	
13.7	Glacial meltwater stream—Barbs show direction of flow		all lineweights .2 mm; 7.5 mm; 20°; spacing may vary; color 100% cyan; 3.0 mm; 2.25 mm	
13.8	Cutbanks of glacial meltwater stream channel (mapped to scale)—Hachures point into channel		spacing may vary; all lineweights .25 mm; color 100% cyan; 1.125 mm; 3.0 mm	
13.9	Flow direction of glacial meltwater in stream channel		color 100% cyan; stem lengths may vary; all lineweights .2 mm; 25°; 2.0 mm	
13.10	Crest line of moraine, sense of symmetry unspecified (1st option)		color 100% cyan; lineweight .2 mm; circle diameter .75 mm; spacing .625 mm	
13.11	Crest line of moraine, sense of symmetry unspecified (2nd option)		color 100% cyan; dot diameter .825 mm; spacing .625 mm	
13.12	Crest line of symmetrical moraine		3.0 mm; .5 mm; color 100% cyan; all lineweights .2 mm; circle diameter .675 mm; hachure height 1.5 mm	
13.13	Crest line of asymmetrical moraine—Ticks point down steeper slope		hachure height .75 mm	
13.14	Ridges on moraine		color 100% cyan; lineweight .25 mm; lengths and spacing may vary	
13.15	Scarp at top of ice-contact slope—Hachures point downscarp		.5 mm; 1.375 mm; 12°; color 100% cyan	
13.16	Ice-contact slope		pattern 521-C in 50% cyan	
13.17	Esker or ice-channel deposit, transport direction unknown		1.25 mm; .375 mm; .625 mm; 70°; color 100% cyan; lineweight .2 mm	
13.18	Esker or ice-channel deposit, transport direction known (1st option)—Chevrons point in direction of transport		color 100% cyan; 70°; 1.25 mm; lineweight .2 mm; 1.0 mm	
13.19	Esker or ice-channel deposit, transport direction known (2nd option)—Chevrons point in direction of transport		color 100% cyan; 70°; 5.0 mm; 1.25 mm; lineweight .375 mm; lineweight .2 mm	
13.20	Drumlin—Showing bearing and direction of flow		2.25 mm; 1.25 mm; all lineweights .2 mm; 1.25 mm; 25°; color 100% cyan; 1.875 mm; 6.0 mm	Point of observation is at the midpoint of the bearing line. May also be shown in black or other colors.
13.21	Drumlin, flow direction unknown (1st option)—Showing bearing		1.875 mm; 6.0 mm	
13.22	Drumlin, flow direction unknown (2nd option)—Showing bearing		1.75 mm; lineweight .2 mm; 1.0 mm; 3.5 mm; color 100% cyan	
13.23	Drumlin (length mapped to scale)—Showing bearing and direction of flow		color 100% cyan; 1.25 mm; 1.25 mm; 25°; draw length to scale; all lineweights .2 mm	Use when map scale is large enough to show actual length of drumlin. May also be shown in black or other colors.
13.24	Drumlin (length mapped to scale), flow direction unknown—Showing bearing		draw length to scale	

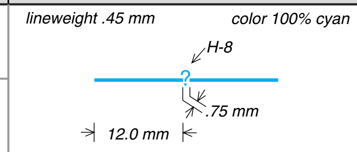
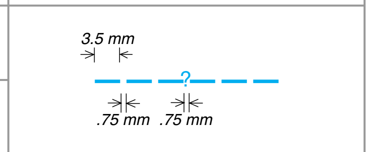
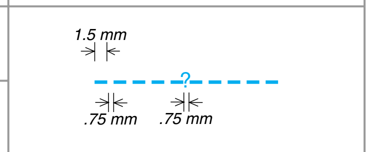
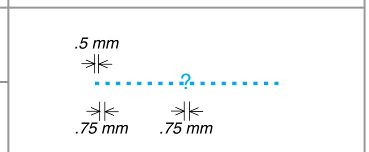
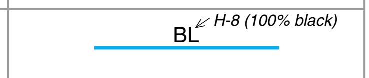
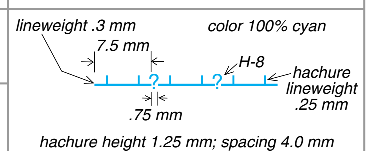
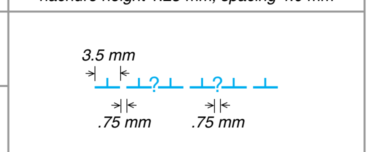
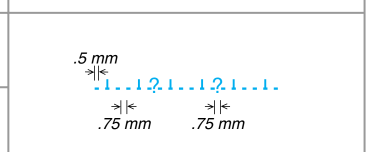
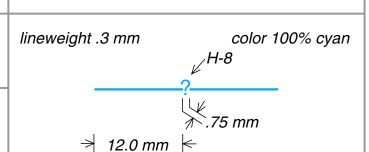
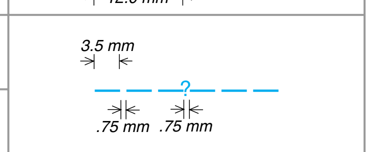
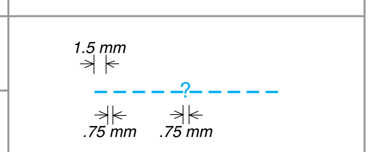
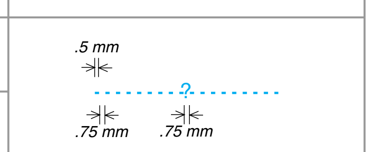
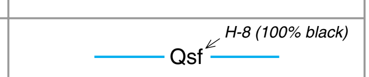
*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.25	Kettle		color 100% cyan; all lineweights .2 mm; 45°; 3.0 mm; 1.75 mm	May also be shown in black or other colors.
13.26	Hummocky topography (1st option)		pattern 523-K in 50% black	
13.27	Hummocky topography (2nd option)		pattern 523-DO in 50% black	
13.28	Hummocky topography (3rd option)		pattern 524-K in 50% black	
13.29	Younger glacial striation or groove—Showing general bearing and direction of flow		lineweight .2 mm; 6.0 mm; 25°; color 100% cyan; 1.25 mm	Point of observation is at the midpoint of the bearing line. May also be shown in black or other colors.
13.30	Younger glacial striation or groove—Showing measured bearing and direction of flow. Dot indicates location of observation point		2.625 mm; dot diameter .75 mm	
13.31	Older glacial striation or groove—Showing general bearing and direction of flow		2.625 mm; all lineweights .2 mm; .75 mm	
13.32	Older glacial striation or groove—Showing measured bearing and direction of flow. Open circle indicates location of observation point		2.625 mm; all lineweights .2 mm; circle diameter .75 mm	
13.33	Younger glacial striation or groove, flow direction unknown—Showing general bearing		lineweight .2 mm; color 100% cyan; 6.0 mm	
13.34	Younger glacial striation or groove, flow direction unknown—Showing measured bearing. Dot indicates location of observation point		2.625 mm; dot diameter .75 mm	
13.35	Older glacial striation or groove, flow direction unknown—Showing general bearing		2.625 mm; all lineweights .2 mm; .75 mm	
13.36	Older glacial striation or groove, flow direction unknown—Showing measured bearing. Open circle indicates location of observation point		2.625 mm; all lineweights .2 mm; circle diameter .75 mm	
13.37	Younger glacial striation or groove (length mapped to scale)—Arrow shows direction of flow		lineweight .2 mm; length may vary; 25°; color 100% cyan; 1.5 mm	Use when map scale is large enough to show actual length of striation or groove. May also be shown in black or other colors.
13.38	Younger glacial striation or groove (length mapped to scale), flow direction unknown		length may vary	
13.39	Older glacial striation or groove (length mapped to scale)—Arrow shows direction of flow		lineweight .2 mm; 2.125 mm; color 100% cyan; length may vary; .75 mm	
13.40	Older glacial striation or groove (length mapped to scale), flow direction unknown		length may vary	
13.41	Cirque headwall—Hachures point into cirque		color 100% cyan; lineweight .2 mm; lineweight .3 mm; hachure height 1.0 mm; spacing 1.0 mm	May also be shown in black or other colors.
13.42	Arête or headwall of adjoining cirques		color 100% cyan; lineweight .2 mm; lineweight .3 mm; hachure height 2.0 mm; spacing 1.0 mm	
13.43	Margin of glacially scoured basin—Identity and existence certain, location accurate. Hachures point into basin		all lineweights .225 mm; color 100% cyan; H-8; ?; 1.0 mm; .75 mm; 12.0 mm; 2.0 mm	
13.44	Margin of glacially scoured basin—Identity or existence questionable, location accurate. Hachures point into basin	?		
13.45	Margin of glacially scoured basin—Identity and existence certain, location approximate. Hachures point into basin		3.5 mm; 2.0 mm; ?; .75 mm; .75 mm	
13.46	Margin of glacially scoured basin—Identity or existence questionable, location approximate. Hachures point into basin	?		
13.47	Margin of glacially scoured basin—Identity and existence certain, location concealed. Hachures point into basin		1.25 mm; ?; .75 mm; .75 mm	
13.48	Margin of glacially scoured basin—Identity or existence questionable, location concealed. Hachures point into basin	?		

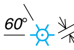
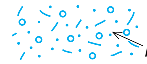
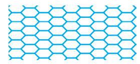
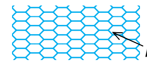
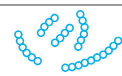
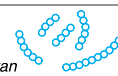
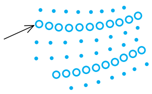
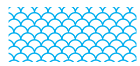
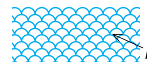
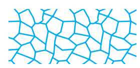
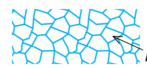
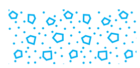
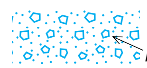
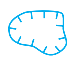
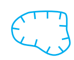
*For more information, see general guidelines on pages A-i to A-v.

13—GLACIAL AND GLACIOFLUVIAL FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
13.49	Glacial limit or terminus—Identity and existence certain, location accurate			May also be shown in black or other colors.
13.50	Glacial limit or terminus—Identity or existence questionable, location accurate	?		
13.51	Glacial limit or terminus—Identity and existence certain, location approximate			
13.52	Glacial limit or terminus—Identity or existence questionable, location approximate	?		
13.53	Glacial limit or terminus—Identity and existence certain, location inferred			
13.54	Glacial limit or terminus—Identity or existence questionable, location inferred	?		
13.55	Glacial limit or terminus—Identity and existence certain, location concealed			
13.56	Glacial limit or terminus—Identity or existence questionable, location concealed	?		
13.57	Glacial limit or terminus—Showing name of glaciation (BL, Bull Lake)	BL		
13.58	Limit of significant glacial advance—Identity and existence certain, location accurate. Hachures on side of advancing ice			
13.59	Limit of significant glacial advance—Identity or existence questionable, location accurate. Hachures on side of advancing ice	? ?		
13.60	Limit of significant glacial advance—Identity and existence certain, location approximate. Hachures on side of advancing ice			
13.61	Limit of significant glacial advance—Identity or existence questionable, location approximate. Hachures on side of advancing ice	? ?		
13.62	Limit of significant glacial advance—Identity and existence certain, location concealed. Hachures on side of advancing ice			
13.63	Limit of significant glacial advance—Identity or existence questionable, location concealed. Hachures on side of advancing ice	? ?		
13.64	Retreatal position of stagnant ice margin—Identity and existence certain, location accurate			
13.65	Retreatal position of stagnant ice margin—Identity or existence questionable, location accurate	?		
13.66	Retreatal position of stagnant ice margin—Identity and existence certain, location approximate			
13.67	Retreatal position of stagnant ice margin—Identity or existence questionable, location approximate	?		
13.68	Retreatal position of stagnant ice margin—Identity and existence certain, location inferred			
13.69	Retreatal position of stagnant ice margin—Identity or existence questionable, location inferred	?		
13.70	Retreatal position of stagnant ice margin—Identity and existence certain, location concealed			
13.71	Retreatal position of stagnant ice margin—Identity or existence questionable, location concealed	?		
13.72	Retreatal position of stagnant ice margin—Showing name of depositional unit	Qsf		

*For more information, see general guidelines on pages A-i to A-v.

14—PERIGLACIAL FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
14.1	Pingo		all lineweights .2 mm; 60°; .875 mm;  color 100% cyan; dot diameter .325 mm; circle diameter 1.5 mm	May also be shown in black or other colors.
14.2	Periglacial patterned ground		 pattern 591-C	
14.3	Polygonal patterned ground		 pattern 592-C	
14.4	Sorted circles		 diameter .9 mm; color 100% cyan; lineweight .2 mm	
14.5	Stone stripe, fine debris		circle diameter .9 mm; spacing .45 mm; circle lineweight .2 mm;  color 100% cyan; dot diameter .5 mm; spacing 1.25 mm	
14.6	Stone stripe, coarse debris			
14.7	Solifluction lobes		 pattern 593-C	
14.8	Ice-wedge polygon		2.25 mm;  color 100% cyan	
14.9	Ice-wedge polygons		 pattern 594-C	
14.10	Felsenmeer		 pattern 595-C	
14.11	Thermokarst depression		color 100% cyan; all lineweights .2 mm;  hachure height 1.0 mm; spacing 1.75 mm	

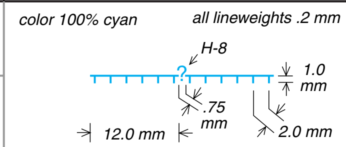
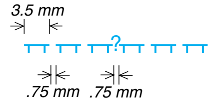
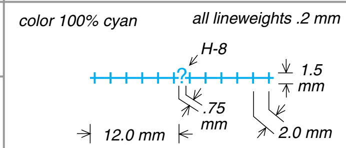
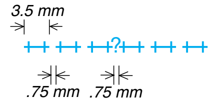
*For more information, see general guidelines on pages A-i to A-v.

15—LACUSTRINE AND MARINE FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
15.1	Beach		*color 100% cyan; dot diameter .75 mm; spacing .75 mm*	May also be shown in black or other colors.
15.2	Beach ridges		*color 100% cyan; lineweight .2 mm; length and spacing may vary*	
15.3	Marine-abrasion platform (1st option)		*pattern 201-C (at 45°)*	
15.4	Marine-abrasion platform (2nd option)		*pattern 522-C*	
15.5	Aggradational shoreline—Identity and existence certain, location accurate. Triangles point offshore		*color 100% cyan; lineweight .2 mm; H-8; 1.5 mm; .4 mm; .75 mm; 22°; 12.0 mm; 2.0 mm*	
15.6	Aggradational shoreline—Identity or existence questionable, location accurate. Triangles point offshore	?		
15.7	Aggradational shoreline—Identity and existence certain, location approximate. Triangles point offshore		*3.5 mm; .75 mm; .75 mm*	
15.8	Aggradational shoreline—Identity or existence questionable, location approximate. Triangles point offshore	?		
15.9	Erosional shoreline—Identity and existence certain, location accurate. Triangles point onshore		*color 100% cyan; lineweight .2 mm; H-8; 1.5 mm; .4 mm; .75 mm; 22°; 12.0 mm; 2.0 mm*	
15.10	Erosional shoreline—Identity or existence questionable, location accurate. Triangles point onshore	?		
15.11	Erosional shoreline—Identity and existence certain, location approximate. Triangles point onshore		*3.5 mm; .75 mm; .75 mm*	
15.12	Erosional shoreline—Identity or existence questionable, location approximate. Triangles point onshore	?		
15.13	Former shoreline or marine limit—Identity and existence certain, location accurate		*lineweight .25 mm; color 100% cyan; H-8; .75 mm; 12.0 mm*	
15.14	Former shoreline or marine limit—Identity or existence questionable, location accurate	?		
15.15	Former shoreline or marine limit—Identity and existence certain, location approximate		*3.5 mm; .75 mm; .75 mm*	
15.16	Former shoreline or marine limit—Identity or existence questionable, location approximate	?		
15.17	Former shoreline or marine limit—Identity and existence certain, location inferred		*1.5 mm; .75 mm; .75 mm*	
15.18	Former shoreline or marine limit—Identity or existence questionable, location inferred	?		
15.19	Former shoreline or marine limit—Identity and existence certain, location concealed		*.5 mm; .75 mm; .75 mm*	
15.20	Former shoreline or marine limit—Identity or existence questionable, location concealed	?		
15.21	Former shoreline or marine limit—Showing name (B, Bonneville)	B	*H-8 (100% black)*; B	

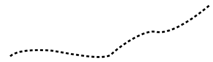
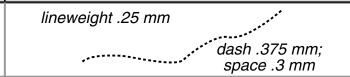
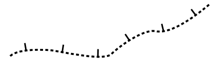
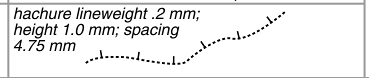
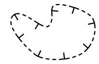
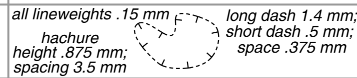
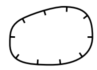
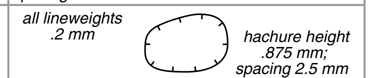
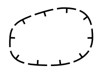
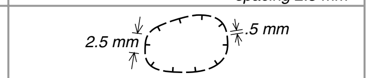
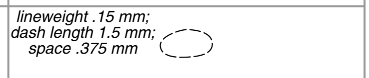
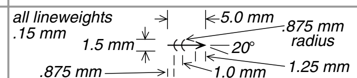
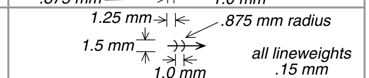
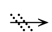
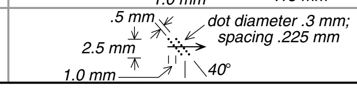
For more information, see general guidelines on pages A-i to A-v.

15—LACUSTRINE AND MARINE FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
15.22	Shoreline cliff—Identity and existence certain, location accurate. Hachures point down cliff			May also be shown in black or other colors.
15.23	Shoreline cliff—Identity or existence questionable, location accurate. Hachures point down cliff			
15.24	Shoreline cliff—Identity and existence certain, location approximate. Hachures point down cliff			
15.25	Shoreline cliff—Identity or existence questionable, location approximate. Hachures point down cliff			
15.26	Spit or bar—Identity and existence certain, location accurate			
15.27	Spit or bar—Identity or existence questionable, location accurate			
15.28	Spit or bar—Identity and existence certain, location approximate			
15.29	Spit or bar—Identity or existence questionable, location approximate			

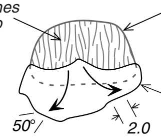
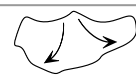
*For more information, see general guidelines on pages A-i to A-v.

16—EOLIAN FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
16.1	Dune crest			Dune forms shown by traces of dune crests.
16.2	Scarp on dune crest, caused by slip—Hachures point down slip face of dune			
16.3	Blowout rim around closed depression of eolian origin in dune field—Hachures point into closed depression			
16.4	Blowout rim around closed depression of eolian origin in bedrock—Accurately located. Hachures point into closed depression			
16.5	Blowout rim around closed depression of eolian origin in bedrock—Approximately located. Hachures point into closed depression			
16.6	Edge of dry lakebed within closed depression of eolian origin in bedrock			
16.7	Sediment transport direction determined from dune forms			Point of observation is at the midpoint of the bearing line.
16.8	Sediment transport direction determined from dune bedding in horizontal section			
16.9	Sediment transport direction determined from eolian crossbedding in vertical or near-vertical section			

*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.1	Outline of slip surface of landslide—Identity and existence certain, location accurate		linecolor 60% black; lineweight .2 mm; H-8 (60% black); ?; .75 mm; 12.0 mm	May be used to outline area of slip surface of landslide if desired. Do not use to outline landslide deposits (use a map-unit boundary contact instead).
17.2	Outline of slip surface of landslide—Identity or existence questionable, location accurate	?		
17.3	Outline of slip surface of landslide—Identity and existence certain, location approximate		3.5 mm; ?; .75 mm; .75 mm	
17.4	Outline of slip surface of landslide—Identity or existence questionable, location approximate	?		
17.5	Outline of slip surface of landslide—Identity and existence certain, location inferred		1.5 mm; ?; .75 mm; .75 mm	
17.6	Outline of slip surface of landslide—Identity or existence questionable, location inferred	?		
17.7	Outline of slip surface of landslide—Identity and existence certain, location concealed		.5 mm; ?; .75 mm; .75 mm	
17.8	Outline of slip surface of landslide—Identity or existence questionable, location concealed	?		
17.9	Area of slip surface of landslide		pattern 431-K in 50% black (rotated so lines parallel slip direction); outline of slip surface [lineweight .2 mm, in 60% black]  contact [lineweight .15 mm]; 50°; 2.0 mm; arrow lineweight .175 mm; length and curve of arrow may vary	Downslope edge of slip surface is usually concealed by landslide deposits or debris materials. Landslide arrows may be shown singly or in pairs.
17.10	Direction of downslope movement of landslide			
17.11	Landslide deposits—Arrows show direction of downslope movement			
17.12	Head or main scarp of landslide—Active, sharp, distinct, and accurately located. Hachures point down scarp		all lineweights .25 mm; hachure height 1.0 mm; spacing 1.75 mm	Place line along crown of scarp. May be shown in red or other colors.
17.13	Head or main scarp of landslide—Inactive, subdued, indistinct, and (or) approximately located. Hachures point down scarp		.5 mm; 3.0 mm	
17.14	Head or main scarp of landslide—Showing height (in meters). Hachures point down scarp	0.8	0.8; HI-7	
17.15	Head or main scarp of rotated block in landslide—Arrow shows direction of oblique slip. Hachures point down scarp		5.0 mm; arrow lineweight .175 mm; 2.5 mm; 15°	
17.16	Internal or minor scarp in landslide—Active, sharp, distinct, and accurately located. Hachures point down scarp		all lineweights .25 mm; hachure height .75 mm; spacing 1.25 mm	
17.17	Internal or minor scarp in landslide—Inactive, subdued, indistinct, and (or) approximately located. Hachures point down scarp		.5 mm; 2.0 mm	
17.18	Internal or minor scarp in landslide—Showing height (in meters). Hachures point down scarp	0.3	0.3; HI-6	
17.19	Internal or minor scarp of rotated block in landslide—Arrow shows direction of oblique slip. Hachures point down scarp		4.5 mm; arrow lineweight .175 mm; 15°; 2.0 mm	

*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.20	Main toe of landslide—Active, sharp, distinct, and accurately located		3.0 mm; 60°; 1.0 mm; lineweight .25 mm	Place line along base of toe; sawteeth on over-riding block. May be shown in red or other colors.
17.21	Main toe of landslide—Inactive, subdued, indistinct, and (or) approximately located		.5 mm; 3.0 mm	
17.22	Minor toe, internal thrust fault, or pressure ridge in landslide—Active, sharp, distinct, and accurately located		2.5 mm; 60°; .85 mm; lineweight .25 mm	
17.23	Minor toe, internal thrust fault, or pressure ridge in landslide—Inactive, subdued, indistinct, and (or) approximately located		.5 mm; 2.0 mm	
17.24	Minor toe, internal thrust fault, or pressure ridge in landslide, showing transport reversal—Active, sharp, distinct, and accurately located		lineweight .25 mm; 60°; .85 mm; .85 mm; 5.0 mm; 60°	
17.25	Minor toe, internal thrust fault, or pressure ridge in landslide, showing transport reversal—Inactive, subdued, indistinct, and (or) approximately located		.5 mm; 2.0 mm	
17.26	Right flank of landslide or right-lateral shear feature—Active, sharp, distinct, and accurately located		15°; 2.5 mm; arrow lineweight .175 mm; lineweight .25 mm; 5.0 mm	Arrow shows sense of lateral movement. Place arrow on side of moving ground or on displaced earth materials. In cross section, can also be used to show plane of slope failure. May be shown in red or other colors.
17.27	Right flank of landslide or right-lateral shear feature—Inactive, subdued, indistinct, and (or) approximately located		.5 mm; 3.0 mm	
17.28	Right flank of landslide or right-lateral shear feature—Concealed by landslide deposits or debris materials		.5 mm; .5 mm	
17.29	Right flank of landslide or right-lateral shear feature—Showing amount of offset (in meters)	2.3	2.3; HI-7	
17.30	Left flank of landslide or left-lateral shear feature—Active, sharp, distinct, and accurately located		2.5 mm; 15°; arrow lineweight .175 mm; lineweight .25 mm; 5.0 mm	
17.31	Left flank of landslide or left-lateral shear feature—Inactive, subdued, indistinct, and (or) approximately located		.5 mm; 3.0 mm	
17.32	Left flank of landslide or left-lateral shear feature—Concealed by landslide deposits or debris materials		.5 mm; .5 mm	
17.33	Left flank of landslide or left-lateral shear feature—Showing amount of offset (in meters)	2.3	2.3; HI-7	
17.34	Open tension crack or fracture on landslide		hachure height .5 mm; all lineweights .2 mm; 1.5 mm	Hachures point into crack.
17.35	Tension crack or fracture on landslide (1st option)		all lineweights .2 mm; 1.0 mm	May be shown in red or other colors.
17.36	Tension crack or fracture on landslide (2nd option)		all lineweights .2 mm; 1.2 mm; dash .375 mm; space .325 mm	
17.37	Tension crack or fracture on landslide (3rd option)		lineweight .2 mm	
17.38	En echelon cracks or fractures on landslide, indicating right-lateral shear		15°; 2.5 mm; crack lineweights .2 mm; arrow lineweight .175 mm; 5.0 mm	Arrow shows sense of lateral movement. May be shown in red or other colors.
17.39	En echelon cracks or fractures on landslide, indicating left-lateral shear		2.5 mm; 15°; crack lineweights .2 mm; arrow lineweight .175 mm; 5.0 mm	
17.40	Anticlinal soft-sediment fold, buckle fold, bulge, or linear ridge on landslide		line length can vary; 60°; 1.0 mm; 2.0 mm; arrow lineweight .175 mm; lineweight .25 mm	May be shown in red or other colors.
17.41	Dome structure or bulge on landslide		line length can vary; 60°; 1.0 mm	
17.42	Synclinal soft-sediment fold or linear depression on landslide		lineweight .25 mm; 60°; 1.0 mm; 1.0 mm; arrow lineweight .175 mm; line length can vary	
17.43	Basin structure or depression on landslide		1.0 mm; line lengths can vary; 60°; .75 mm	

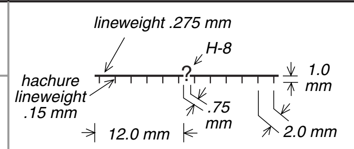
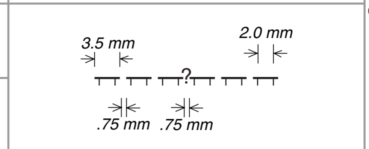
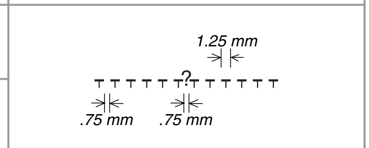
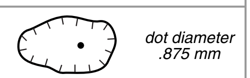
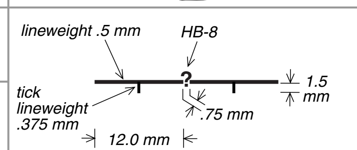
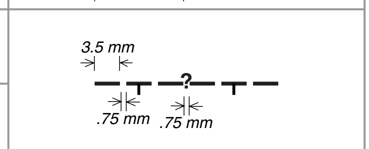
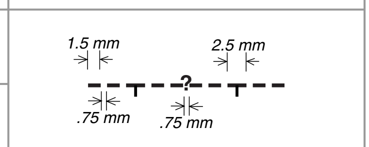
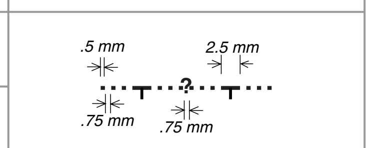
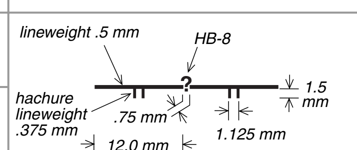
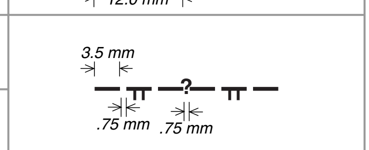
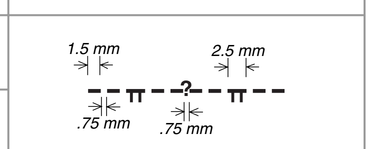
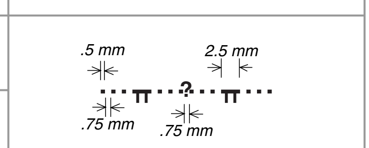
*For more information, see general guidelines on pages A-i to A-v.

17—LANDSLIDE AND MASS-WASTING FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
17.44	Crest line of lateral levee on landslide (1st option)		lineweights .175 mm; .65 mm; 1.0 mm; 60°; 1.5 mm	
17.45	Crest line of lateral levee on landslide (2nd option)		.65 mm; 1.0 mm; 60°; 1.5 mm	
17.46	Path of gully on landslide		all lineweights .2 mm; 1.375 mm; 25°; 4.5 mm; 1.575 mm	
17.47	Soil creep or incipient sliding on landslide		lineweight .2 mm; 1.0 mm; 20°; 6.75 mm; 1.5 mm	Arrow points downhill. May be shown in red or other colors.
17.48	Spring, seep, or drainage (runoff) on landslide		lineweight .2 mm; circle diameter 1.5 mm; tail length 3.0 mm	Tail points downhill. May be shown in red or other colors.
17.49	Sag pond or closed depression on landslide (mapped to scale)		all lineweights .175 mm; hachure height .875 mm; spacing 1.25 mm	Hachures point into depression.
17.50	Hummock on landslide (mapped to scale)		all lineweights .175 mm; hachure height .875 mm; spacing 1.25 mm	Hachures point away from hummock.
17.51	Hummock on landslide (shown as point symbol when too small to outline at map scale)		all lineweights .175 mm; 60°; .875 mm; circle diameter 1.5 mm	
17.52	Tilt direction of surface of landslide		4.0 mm; 30°; lineweight .2 mm; 1.125 mm; 2.0 mm; 2.0 mm	Usually shown on special-purpose landslide activity maps. May also be shown in red or other colors.
17.53	Tilt direction of surface of landslide—Showing angle of tilt	14	14 ← HI-6	
17.54	Displacement vector—Showing bearing		lineweight .2 mm; 1.75 mm; 6.75 mm; 25°	
17.55	Displacement vector—Showing bearing and distance	1.3	1.3 ← HI-7	
17.56	Active, reactivated, or historically active debris flow, showing a sharply defined morphology		1.5 mm; 4.0 mm; 20°; color 100% magenta	Usually shown on special-purpose landslide activity maps. If necessary, alphanumeric characters may be added to help distinguish landslide areas. May also be shown in red or other colors.
17.57	Dormant-young debris flow, showing a fresh and uneroded morphology but having no evidence of historic activity		color 50% magenta	
17.58	Active, reactivated, or historically active landslide (mapped to scale), showing a sharply defined morphology		fill color 60% magenta	
17.59	Dormant-young landslide (mapped to scale), showing a fresh and uneroded morphology but having no evidence of historic activity		fill color 40% magenta	
17.60	Dormant-mature landslide (mapped to scale), showing a smoothed and eroded morphology		fill color 20% magenta	
17.61	Dormant-old or relict landslide (mapped to scale), showing a weak morphology		fill color 8% magenta	
17.62	Rock slide, slump, block-glide landslide, rotational landslide, or Toreva block, consisting of a relatively intact mass of displaced materials		draft as shown; .5 mm; all lineweights .3 mm; 90°	Usually shown on special-purpose landslide activity maps. May also be shown in red or other colors. If necessary, symbols may be enlarged or reduced.
17.63	Earth flow, consisting of a relatively thick and jumbled mixture of displaced materials		1.0 mm; 4.5 mm; all lineweights .3 mm; 90°	
17.64	Debris slide, consisting of a loose and relatively shallow veneer of displaced materials		draft as shown; all lineweights .3 mm; 90°	
17.65	Debris-slide slope (mapped to scale), consisting of coalesced scars of landslides and debris flows that are too small or numerous to be shown at map scale		fill color 20% black	Usually shown on special-purpose landslide activity maps.

*For more information, see general guidelines on pages A-i to A-v.

18—VOLCANIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.1	Rim of volcanic crater—Identity and existence certain, location accurate. Hachures point into crater			Use to show outline of topographic wall. Rim may not outline crater completely. May also be shown in red, magenta, or other colors.
18.2	Rim of volcanic crater—Identity or existence questionable, location accurate. Hachures point into crater			
18.3	Rim of volcanic crater—Identity or existence certain, location approximate. Hachures point into crater			
18.4	Rim of volcanic crater—Identity or existence questionable, location approximate. Hachures point into crater			
18.5	Rim of volcanic crater—Identity and existence certain, location concealed. Hachures point into crater			
18.6	Rim of volcanic crater—Identity or existence questionable, location concealed. Hachures point into crater			
18.7	Rim of volcanic crater—Dot shows low point of crater			
18.8	Caldera margin (1st option)—Identity and existence certain, location accurate. Ticks point into caldera			May also be shown in red, magenta, or other colors.
18.9	Caldera margin (1st option)—Identity or existence questionable, location accurate. Ticks point into caldera			
18.10	Caldera margin (1st option)—Identity and existence certain, location approximate. Ticks point into caldera			
18.11	Caldera margin (1st option)—Identity or existence questionable, location approximate. Ticks point into caldera			
18.12	Caldera margin (1st option)—Identity and existence certain, location inferred. Ticks point into caldera			
18.13	Caldera margin (1st option)—Identity or existence questionable, location inferred. Ticks point into caldera			
18.14	Caldera margin (1st option)—Identity and existence certain, location concealed. Ticks point into caldera			
18.15	Caldera margin (1st option)—Identity or existence questionable, location concealed. Ticks point into caldera			
18.16	Caldera margin (2nd option)—Identity and existence certain, location accurate. Ticks point into caldera			May also be shown in red, magenta, or other colors.
18.17	Caldera margin (2nd option)—Identity or existence questionable, location accurate. Ticks point into caldera			
18.18	Caldera margin (2nd option)—Identity and existence certain, location approximate. Ticks point into caldera			
18.19	Caldera margin (2nd option)—Identity or existence questionable, location approximate. Ticks point into caldera			
18.20	Caldera margin (2nd option)—Identity and existence certain, location inferred. Ticks point into caldera			
18.21	Caldera margin (2nd option)—Identity or existence questionable, location inferred. Ticks point into caldera			
18.22	Caldera margin (2nd option)—Identity and existence certain, location concealed. Ticks point into caldera			
18.23	Caldera margin (2nd option)—Identity or existence questionable, location concealed. Ticks point into caldera			

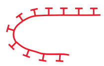
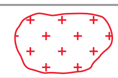
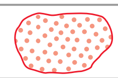
*For more information, see general guidelines on pages A-i to A-v.

18—VOLCANIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.24	Contact separating individual lava flows within same map unit—Identity and existence certain, location accurate		lineweight .2 mm color 100% red H-8 ? .75 mm 12.0 mm	May also be shown in magenta, black, or other colors.
18.25	Contact separating individual lava flows within same map unit—Identity or existence questionable, location accurate	?		
18.26	Contact separating individual lava flows within same map unit—Identity and existence certain, location approximate		3.5 mm ? .75 mm .75 mm	
18.27	Contact separating individual lava flows within same map unit—Identity or existence questionable, location approximate	?		
18.28	Contact separating individual lava flows within same map unit—Identity and existence certain, location inferred		1.5 mm ? .75 mm .75 mm	
18.29	Contact separating individual lava flows within same map unit—Identity or existence questionable, location inferred	?		
18.30	Contact separating individual lava flows within same map unit—Identity and existence certain, location concealed		.5 mm ? .75 mm .75 mm	
18.31	Contact separating individual lava flows within same map unit—Identity or existence questionable, location concealed	?		
18.32	Flow lobe or lava-flow front—Identity and existence certain, location accurate. Hachures on side of overlying younger flow		all lineweights .2 mm color 100% red 7.5 mm ? ? H-8 .75 mm hachure height 1.25 mm; spacing 4.0 mm	
18.33	Flow lobe or lava-flow front—Identity or existence questionable, location accurate. Hachures on side of overlying younger flow	? ?		
18.34	Flow lobe or lava-flow front—Identity and existence certain, location approximate. Hachures on side of overlying younger flow		3.5 mm ? ? .75 mm .75 mm	
18.35	Flow lobe or lava-flow front—Identity or existence questionable, location approximate. Hachures on side of overlying younger flow	? ?		
18.36	Flow lobe or lava-flow front—Identity and existence certain, location concealed. Hachures on side of overlying younger flow		.5 mm ? ? .75 mm .75 mm	
18.37	Flow lobe or lava-flow front—Identity or existence questionable, location concealed. Hachures on side of overlying younger flow	? ?		
18.38	Form line on lava flow		lineweight .2 mm color 100% red length and spacing may vary	
18.39	Flow lines on lava flow		color 100% red stem lineweight .175 mm 25° 2.0 mm stem length and spacing may vary	
18.40	Cracks on surface of lava flow		lineweight .25 mm color 100% red length and spacing may vary	
18.41	Volcanic fissure		lineweight .25 mm .375 mm 1.25 mm .5 mm .375 mm hachure lineweight .15 mm color 100% red	
18.42	Buried volcanic fissure			
18.43	Volcanic fissure where lava has been emitted			
18.44	Lava tube—Red circles indicate presence of skylights (not mapped to scale) along lava tube		circle lineweight .2 mm; diameter .75 mm; color 100% red 1.375 mm 25° lineweight .15 mm	
18.45	Lava tube—Red circles outline collapses (mapped to scale) along lava tube		lineweight .2 mm; color 100% red	
18.46	Crest line of pressure ridge or tumulus on lava flow		lineweight .2 mm color 100% red 60° 60° 1.0 mm 5.5 mm	
18.47	Pressure ridge on lava flow		lineweight .2 mm color 100% red 60° 1.0 mm 5.5 mm	

*For more information, see general guidelines on pages A-i to A-v.

18—VOLCANIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
18.48	Ice-contact lava-flow margin—Identity and existence certain, location accurate. Rectangles on side of overlying younger flow		lineweight .2 mm; color 100% red; H-8; ? ; .5 mm; .75 mm; 2.0 mm; 12.0 mm	May also be shown in magenta, black, or other colors.
18.49	Ice-contact lava-flow margin—Identity or existence questionable, location accurate. Rectangles on side of overlying younger flow			
18.50	Ice-contact lava-flow margin—Identity and existence certain, location approximate. Rectangles on side of overlying younger flow		3.5 mm; ? ; .75 mm; .75 mm	
18.51	Ice-contact lava-flow margin—Identity or existence questionable, location approximate. Rectangles on side of overlying younger flow			
18.52	Ice-contact lava-flow margin—Identity and existence certain, location concealed. Rectangles on side of overlying younger flow		.5 mm; 2.5 mm; ? ; .75 mm; .75 mm	
18.53	Ice-contact lava-flow margin—Identity or existence questionable, location concealed. Rectangles on side of overlying younger flow			
18.54	Outline of basalt-filled lava pond		all lineweights .2 mm; .875 mm; 1.0 mm; tick spacing 2.0 mm (at base); color 100% red	May also be shown in magenta, black, or other colors.
18.55	Small cone, vent, cinder cone, or spatter cone		lineweight .2 mm; 60°; 2.0 mm; color 100% red; 2.0 mm	May also be shown in magenta, black, or other colors.
18.56	Large cone, vent, cinder cone, or spatter cone		lineweight .2 mm; 2.625 mm; 2.625 mm; 60°; color 100% red	
18.57	Small hornito		lineweight .2 mm; 2.0 mm; 45°; 2.0 mm; color 100% red; 2.0 mm	
18.58	Large hornito		lineweight .2 mm; 2.625 mm; 45°; 2.625 mm; color 100% red; 2.625 mm	
18.59	Spatter rampart		lineweight .2 mm; .5 mm; 90°; color 100% red; 1.5 mm	
18.60	Rootless vent area on lava flow		lineweight .2 mm; line color 100% red; pattern 327-R	
18.61	Thermal area		lineweight .2 mm; line color 100% red; pattern 121-R in 50% red	
18.62	Thermal spring		color 100% red; H-7; lineweight .15 mm; radius .5 mm; dot diameter 1.5 mm; 2.0 mm	Rotate tail to downhill. May also be shown in magenta or other colors.
18.63	Geyser		lineweight .2 mm; lineweight .375 mm; lineweight .2 mm; color 100% red; radius .5 mm; 2.75 mm; ellipse height 1.25 mm; width 2.5 mm	May also be shown in magenta, black, or other colors.
18.64	Fumarole or steam vent		draft as shown; 2.5 mm; all lineweights .2 mm; color 100% red; ellipse height 1.25 mm; width 2.5 mm	
18.65	Recent volcano on small-scale maps		color 100% red; 22.5°; all lineweights .2 mm; outer diameter 3.0 mm; inner diameter 1.375 mm	
18.66	Active volcano on small-scale maps		2.625 mm; 60°; lineweight .3 mm; color 100% red	Usually reserved for maps at scales of 1:250,000 or smaller. May also be shown in magenta, black, or other colors.
18.67	Inactive volcano on small-scale maps		90°; 2.5 mm; color 100% red; lineweight .3 mm	
18.68	Cinder cone on small-scale maps		circle diameter 1.375 mm; lineweight .2 mm; color 100% red	
18.69	Diatreme		D; H-7; dot diameter 1.375 mm; color 100% red	
18.70	Breccia pipe		B; H-7; dot diameter 1.375 mm; color 100% red	
18.71	Collapse structure—Indicating breccia pipe at depth		lineweight .2 mm; C; H-7; circle diameter 1.375 mm; color 100% red	

*For more information, see general guidelines on pages A-i to A-v.

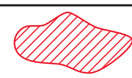
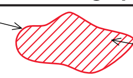
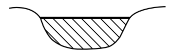
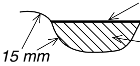
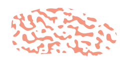
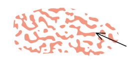
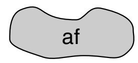
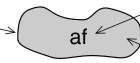
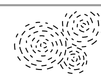
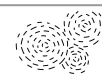
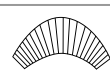
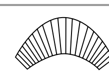
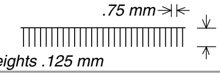
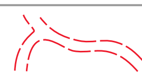
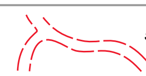
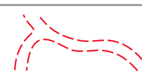
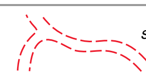
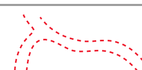
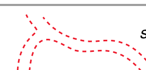
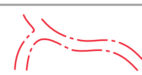
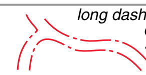
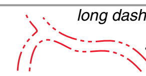
19—NATURAL RESOURCES

19.1—Veins and mineralized areas; mineral resource areas; metamorphic facies boundary

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.1.1	Vein, veinlet, or mineralized stringer—Identity and existence certain, location accurate		*lineweight .25 mm; color 100% red; 8.0 mm; H-8; .75 mm; dot diameter .75 mm; spacing 4.5 mm*	May also be shown in black or other colors.
19.1.2	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location accurate	? ?		
19.1.3	Vein, veinlet, or mineralized stringer—Identity and existence certain, location approximate		*3.625 mm; .75 mm; .75 mm*	
19.1.4	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location approximate	? ?		
19.1.5	Vein, veinlet, or mineralized stringer—Identity and existence certain, location concealed		*.5 mm; .75 mm; .75 mm; .75 mm*	
19.1.6	Vein, veinlet, or mineralized stringer—Identity or existence questionable, location concealed	? ?		
19.1.7	Vein, veinlet, or mineralized stringer—Showing type of mineral occurrence	Cu	Cu *H-8 (100% black)*	
19.1.8	Inclined vein, veinlet, or mineralized stringer (1st option)—Showing dip value and direction	35	*tick length 1.75 mm; lineweight .2 mm; 35; HI-6 (100% black); tick color 100% black*	Place tick, arrow, or other line-symbol decoration where observation was made. Add arrowhead or '90' to ticks showing dip if necessary for clarity.
19.1.9	Inclined vein, veinlet, or mineralized stringer (2nd option)—Showing dip value and direction	15	*tick length 1.375 mm; lineweight .2 mm; 15; .875 mm; 30°*	
19.1.10	Vertical or near-vertical vein, veinlet, or mineralized stringer (1st option)		*tick length 2.5 mm; lineweight .2 mm*	
19.1.11	Vertical or near-vertical vein, veinlet, or mineralized stringer (2nd option)	90	*90; HI-6 (100% black)*	
19.1.12	Small, minor inclined vein, veinlet, or mineralized stringer—Showing strike and dip	70	*HI-6 (100% black); 70; lineweight .25 mm; line color 100% red; 1.25 mm; 5.5 mm*	May also be shown in black or other colors.
19.1.13	Small, minor vertical or near-vertical vein, veinlet, or mineralized stringer—Showing strike		*2.5 mm*	
19.1.14	Zone of mineralized or altered rock (1st option)		*pattern 405-R (at 45°)*	Add labels to show specific types of alteration. May be used alone or may overprint other mapped units. May also be shown in black or other colors.
19.1.15	Zone of mineralized or altered rock (2nd option)		*pattern 405-R in 50% red (at 45°)*	
19.1.16	Zone of mineralized or altered rock, showing high level of mineralization		*pattern 119-R*	
19.1.17	Zone of mineralized or altered rock, showing low level of mineralization		*pattern 117-R*	
19.1.18	Area of identified resources		*lineweight .5 mm; color 100% red*	Usually reserved for use on special-purpose maps, not on general-purpose geologic maps. Generally shown in red, but may also be shown in black or other colors.
19.1.19	Area of high mineral resource potential	H	*lineweight .3 mm; line and text color 100% red; H; H-12; pattern 427-R in 50% red*	
19.1.20	Area of moderate mineral resource potential	M	*lineweight .3 mm; M; H-12; pattern 229-R (at 45°) in 50% red*	
19.1.21	Area of low mineral resource potential	L	*lineweight .2 mm; L; H-10*	
19.1.22	Area considered to have mineral resource potential but not evaluated, mostly because of inadequate data	N	*lineweight .2 mm; N; H-10; dash 1.75 mm; space .5 mm*	
19.1.23	Metamorphic facies boundary—Showing approximate boundary between diagnostic mineral assemblages	Greenschist Amphibolite	*H-8; Greenschist; Amphibolite; line and text color 100% red; dot diameter .5 mm; spacing .5 mm*	May also be shown in black or other colors.

For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.2—Areas of extensively disturbed ground; surface workings; subsurface workings projected to surface				
19.2.1	Graded area—Extensive amount of mapped geologic unit has been removed		 lineweight .2 mm; line color 100% red; pattern 226-R (at 45°)	Patterns should overlay other mapped units. Generally shown in black or red, but may also be shown in brown or other colors.
19.2.2	Strip mine (1st option)		 lineweight .3 mm; lineweight .15 mm; pattern 226-K (at 45°)	
19.2.3	Strip mine (2nd option)		 pattern 419-R in 50% red	
19.2.4	Artificial fill—Earth materials		 lineweight .15 mm; af; H-8; 20% black	Show as separately mapped units. Generally shown in black or red, but may also be shown in other colors.
19.2.5	Artificial fill—Human-generated refuse (landfill)		 lineweight .15 mm; afr; H-8; pattern 226-R (at 45°)	
19.2.6	Tailings		 lineweights .125 mm; draft as shown	Symbols should overlay other mapped units. Generally shown in red or black, but may also be shown in brown or other colors.
19.2.7	Mine dump (1st option)		 all lineweights .125 mm; dash length and spacing may vary; draft as shown	
19.2.8	Mine dump (2nd option)		 all lineweights .125 mm; dash length and spacing may vary; draft as shown	
19.2.9	Mine dump bench		 .75 mm; 2.5 mm; all lineweights .125 mm	
19.2.10	Subsurface workings, projected to surface (1st option)		 color 100% red; lineweights .2 mm; spacing may vary	Different symbols may be used to show different levels of workings. Symbols should overlay other mapped units. Generally shown in red, but may also be shown in black or other colors.
19.2.11	Subsurface workings, projected to surface (2nd option)		 dash 3.0 mm; spacing .5 mm	
19.2.12	Subsurface workings, projected to surface (3rd option)		 dash 1.5 mm; spacing .5 mm	
19.2.13	Subsurface workings, projected to surface (4th option)		 dash .5 mm; spacing .5 mm	
19.2.14	Subsurface workings, projected to surface (5th option)		 long dash 2.5 mm; short dashes .5 mm; spacing .5 mm	
19.2.15	Subsurface workings, projected to surface (6th option)		 long dash 4.0 mm; short dash .5 mm; spacing .5 mm	

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.3—Mining and mineral exploration (at surface)				
19.3.1	Prospect (pit or small open cut)		*lineweight .2 mm; 1.75 mm; 60°*	
19.3.2	Sand, gravel, clay, or placer pit		*3.125 mm; all lineweights .15 mm; 60°; .7 mm*	
19.3.3	Abandoned sand, gravel, clay, or placer pit		*1.5 mm; all lineweights .15 mm*	
19.3.4	Open pit, quarry, or glory hole		*pick thickness .25 mm; radius 1.625 mm; 1.5 mm; 1.5 mm; lineweight .15 mm; 3.125 mm; hammerhead thickness .3 mm; radius 1.625 mm*	
19.3.5	Abandoned open pit, quarry, or glory hole		*all lineweights .15 mm; 1.5 mm*	
19.3.6	Open pit or quarry (mapped to scale)		*all lineweights .25 mm; hachure height .6 mm; spacing 1.5 mm*	
19.3.7	Trench (generalized trace)		*1.5 mm; length may vary; 90°; all lineweights .25 mm*	
19.3.8	Trench (drawn to scale)		*all lineweights .25 mm; hachure height .6 mm; spacing 1.5 mm*	
19.3.9	Adit or tunnel entrance (1st option)		*all lineweights .175 mm; 3.5 mm; 90°; 1.5 mm; 2.75 mm*	Long line points in direction of adit or tunnel entrance at surface. Map position of adit or tunnel entrance is at intersection of long line and two short lines.
19.3.10	Approximately located adit or tunnel entrance (1st option)		*1.0 mm; .25 mm*	
19.3.11	Destroyed adit or tunnel entrance (1st option)		*.25 mm; .25 mm*	
19.3.12	Abandoned or inaccessible adit or tunnel entrance (1st option)		*all lineweights .175 mm; 1.25 mm; 1.75 mm*	
19.3.13	Adit or tunnel entrance (1st option)—Showing angle of inclination (negative value indicates downward slope)	*-40*	*HI-6; -40*	Angle of inclination may be added to any adit or tunnel entrance symbol.
19.3.14	Adit or tunnel entrance (2nd option)		*all lineweights .175 mm; 90°; 3.5 mm; 1.5 mm; 1.0 mm; 2.75 mm*	Long line points in direction of adit or tunnel entrance at surface. Map position of adit or tunnel entrance is at intersection of long line and two short lines.
19.3.15	Approximately located adit or tunnel entrance (2nd option)		*1.0 mm; .25 mm*	
19.3.16	Destroyed adit or tunnel entrance (2nd option)		*.25 mm; .25 mm*	
19.3.17	Abandoned or inaccessible adit or tunnel entrance (2nd option)		*all lineweights .175 mm; 1.25 mm; 1.75 mm*	
19.3.18	Adit or tunnel entrance (2nd option)—Showing angle of inclination (negative value indicates downward slope)	*-50*	*HI-6; -50*	Angle of inclination may be added to any adit or tunnel entrance symbol.
19.3.19	Portal		*all lineweights .175 mm; radius .75 mm; 1.5 mm; 3.5 mm*	Long lines point in direction of portal entry at surface. Map position of portal entry is between the two lines, at the position where the short curved lines intersect the long lines.
19.3.20	Approximately located portal		*1.0 mm; .25 mm*	
19.3.21	Destroyed portal		*.25 mm; .25 mm*	
19.3.22	Abandoned or inaccessible portal		*all lineweights .175 mm; 1.75 mm*	
19.3.23	Portal and open cut		*all lineweights .175 mm; radius .75 mm; tick length .5 mm*	Open cut may be added to any portal symbol.
19.3.24	Portal—Showing angle of inclination (negative value indicates downward slope)	*-30*	*HI-6; -30*	Angle of inclination may be added to any portal symbol.

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.3—Mining and mineral exploration (at surface) (continued)				
19.3.25	Drill hole for mineral exploration		*lineweight .175 mm* *diameter 1.5 mm*	
19.3.26	Drill hole for mineral exploration—No geologic data available	ND	ND *H-6*	
19.3.27	Drill hole for mineral exploration—Showing name and number	PAHUTE 2	PAHUTE 2 *H-7*	
19.3.28	Drill hole for mineral exploration—Showing type (DDH, diamond drill hole)	*DDH*	*HI-6* *DDH*	
19.3.29	Drill hole for exploration of low-grade ore		*all lineweights .175 mm* *4.0 mm*	
19.3.30	Drill hole for exploration of high-grade ore		*4.0 mm*	
19.3.31	Inclined drill hole for mineral exploration—Showing location of collar (circle) and projected trace (dashed line) and bottom (T) of drill hole		*all lineweights .175 mm* *1.0 mm* *1.5 mm* *.5 mm* *length may vary*	Projected trace of drill hole, angle of inclination, surface altitude, and total depth may be added to any drill hole symbol.
19.3.32	Inclined drill hole for mineral exploration—Showing angle of inclination (negative value indicates downward slope)	*-65*	*-65* *HI-6*	
19.3.33	Inclined drill hole for mineral exploration—Showing surface altitude of collar (in meters)	*2500*	*HI-6* *2500*	
19.3.34	Inclined drill hole for mineral exploration—Showing total depth of drill hole (in meters)	*TD 1000*	*TD 1000* *HI-6*	
19.3.35	Vertical mine shaft, as shown on smaller scale or general-purpose maps		*lineweight .175 mm* *1.5 mm*	
19.3.36	Multiple vertical mine shafts, as shown on smaller scale or general-purpose maps			
19.3.37	Abandoned or inaccessible vertical mine shaft, as shown on smaller scale or general-purpose maps	A	A *H-7*	
19.3.38	Inclined mine shaft, as shown on smaller scale or general-purpose maps—Showing direction of inclination		*all lineweights .175 mm* *1.0 mm*	
19.3.39	Inclined mine shaft, as shown on smaller scale or general-purpose maps—Showing angle of inclination (negative value indicates downward slope)	*-25*	*-25* *HI-6*	

**For more information, see general guidelines on pages A-i to A-v.*

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	19.4—Mines and subsurface workings			
19.4.1	Vertical mine shaft at surface (drawn to scale), as shown on subsurface exploration maps		size may vary; lineweight .175 mm	
19.4.2	Inclined mine shaft at surface (drawn to scale), as shown on subsurface exploration maps—Showing direction of inclination		all lineweights .175 mm; lengths may vary	
19.4.3	Inclined mine shaft at surface (drawn to scale), as shown on subsurface exploration maps—Showing angle of inclination (negative value indicates downward slope)	-30	-30; HI-6	
19.4.4	Mine shaft, above and below level (drawn to scale), as shown on subsurface exploration maps		size may vary; all lineweights .175 mm	
19.4.5	Bottom of mine shaft (drawn to scale), as shown on subsurface exploration maps		size may vary; all lineweights .175 mm	
19.4.6	Winze or head of raise (drawn to scale), as shown on subsurface exploration maps		size may vary; all lineweights .175 mm	
19.4.7	Raise or winze extending through level (drawn to scale), as shown on subsurface exploration maps		size may vary; all lineweights .175 mm	
19.4.8	Raise or foot of winze (drawn to scale), as shown on subsurface exploration maps		size may vary; all lineweights .175 mm	
19.4.9	Crosscut tunnel or intersection of workings (drawn to scale), as shown on subsurface exploration maps		radius 1.25 mm; size may vary; lineweight .175 mm	
19.4.10	Workings (drawn to scale), as shown on subsurface exploration maps		spacing may vary; lineweights .175 mm	
19.4.11	Caved or otherwise inaccessible workings (drawn to scale), as shown on subsurface exploration maps		all lineweights .175 mm; spacing may vary; length of crossbar may vary; dash 1.5 mm; spacing .5 mm	
19.4.12	Inclined workings, as shown on subsurface exploration maps (drawn to scale)—Chevrons point downslope (multiple chevrons indicate steeper slope)		all lineweights .175 mm; spacing may vary; 90°	
19.4.13	Ore chute (drawn to scale), as shown on subsurface exploration maps		1.5 mm; 1.5 mm; spacing may vary; all lineweights .15 mm	
19.4.14	Lagging or cribbing along drift (drawn to scale), as shown on subsurface exploration maps		all lineweights .15 mm; spacing may vary; .55 mm; circle diameter .75 mm; spacing .75 mm	
19.4.15	Elevation of roof or back, as shown on subsurface exploration maps	2801'	60°; all lineweights .15 mm; 1.0 mm; 2801'; HI-6	
19.4.16	Elevation of floor or sill, as shown on subsurface exploration maps	2809'	HI-6; 2809'; 1.0 mm; 60°	
19.4.17	Stoped area (drawn to scale), as shown on subsurface exploration maps (section view)		all lineweights .15 mm; dash 1.5 mm; spacing .5 mm; pattern 226-K (at 45°); dash .3 mm; spacing .3 mm	
19.4.18	Inferred stoped area (drawn to scale), as shown on subsurface exploration maps (section view)			

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation				
19.5.1	Oil field—Extent defined		lineweight .2 mm; fill color 50% green; line color 100% green	Patterned areas (extent defined) should be shown as separately mapped units. Outlined areas (extent not yet defined) should overlay other mapped units. Generally shown in red and (or) green, but may also be shown in other colors or patterns.
19.5.2	Oil field—Extent not yet defined		lineweight .2 mm; dash .5 mm; spacing .5 mm; line color 50% green	
19.5.3	Gas field—Extent defined		lineweight .2 mm; fill color 50% red; line color 100% red	
19.5.4	Gas field—Extent not yet defined		lineweight .2 mm; dash 2.0 mm; spacing .5 mm; line color 100% red	
19.5.5	Oil and gas field—Extent defined		lineweight .2 mm; pattern 426 (at 45°)	
19.5.6	Oil and gas field—Extent not yet defined		lineweight .2 mm; long dash 2.0 mm; short dash .5 mm; space .5 mm	
19.5.7	Core (nonspecific depth)		lineweight .2 mm; dot diameter .5 mm; 1.75 mm	May also be shown in other colors.
19.5.8	Shallow core			Use if both shallow and deep cores are shown on map. May also be shown in other colors.
19.5.9	Deep core		all lineweights .2 mm; circle diameter 2.75 mm	
19.5.10	Drilling well or well location for hydrocarbon exploration or exploitation		lineweight .2 mm; diameter 1.5 mm	Name, number, and total depth may be added to any type of well symbol. May also be shown in green (oil), red (gas), or other colors.
19.5.11	Drill hole for hydrocarbon exploration or exploitation—No data available	ND	ND; H-6	
19.5.12	Drill hole for hydrocarbon exploration or exploitation—Showing name and number	SHELL 1-55	SHELL 1-55; H-7	
19.5.13	Drill hole for hydrocarbon exploration or exploitation—Showing total depth (in meters)	1000	HI-6; 1000	
19.5.14	Inclined drill hole for hydrocarbon exploration or exploitation—Showing location of collar (circle) and projected trace (dashed line) and bottom (T) of drill hole		all lineweights .2 mm; length of trace may vary; 1.0 mm; 1.5 mm; .5 mm	Projected trace of drill hole, angle of inclination, surface altitude, and total depth may be added to any type of well symbol. May also be shown in green (oil), red (gas), or other colors.
19.5.15	Inclined drill hole for hydrocarbon exploration or exploitation—Showing angle of inclination	-70	-70; HI-6	
19.5.16	Inclined drill hole for hydrocarbon exploration or exploitation—Showing surface altitude of collar (in meters)	75	HI-6; 75	
19.5.17	Inclined drill hole for hydrocarbon exploration or exploitation—Showing total depth of drill hole (in meters)	TD 650	TD 650; HI-6	
19.5.18	Multiple wells drilled from single platform—Showing location of collar (open circle) on platform. Types of wells indicated at drill hole bottoms			Any type of well symbol may be shown at bottoms of drill holes.

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.19	Dry hole (nonspecific depth)		*all lineweights .2 mm* *.625 mm* *diameter 1.5 mm*	May also be shown in other colors.
19.5.20	Dry hole—Showing map unit at surface (Km) and at bottom of hole (Kd). Also showing altitude at surface and total depth of hole (in meters)	Km 2809 Kd 4996	*H-7* Km 2809 Kd 4996 *all lineweights .2 mm*	
19.5.21	Shallow dry hole			Use if both shallow and deep dry holes are shown on map. May also be shown in other colors.
19.5.22	Deep dry hole		*all lineweights .2 mm* *outer circle diameter 2.75 mm*	
19.5.23	Junked hole (nonspecific depth)		*all lineweights .2 mm* *diameter 1.5 mm* *.625 mm*	May also be shown in other colors.
19.5.24	Shallow junked hole			Use if both shallow and deep junked holes are shown on map. May also be shown in other colors.
19.5.25	Deep junked hole		*all lineweights .2 mm* *outer circle diameter 2.75 mm*	
19.5.26	Disposal well (nonspecific depth)		*60°* *2.0 mm* *lineweight .2 mm*	May also be shown in other colors.
19.5.27	Plugged and abandoned disposal well (nonspecific depth)		*all lineweights .2 mm* *4.0 mm*	
19.5.28	Shallow disposal well			Use if both shallow and deep disposal wells are shown on map. May also be shown in other colors.
19.5.29	Plugged and abandoned shallow disposal well			
19.5.30	Deep disposal well		*all lineweights .2 mm* *circle diameter 2.75 mm*	
19.5.31	Plugged and abandoned deep disposal well		*all lineweights .2 mm* *4.0 mm*	
19.5.32	Salt-water disposal well (nonspecific depth)		*60°* *2.0 mm* *all lineweights .2 mm* *circle diameter 1.0 mm*	May also be shown in other colors.
19.5.33	Plugged and abandoned salt-water disposal well (nonspecific depth)		*all lineweights .2 mm* *4.0 mm*	
19.5.34	Shallow salt-water disposal well			Use if both shallow and deep salt-water disposal wells are shown on map. May also be shown in other colors.
19.5.35	Plugged and abandoned shallow salt-water disposal well			
19.5.36	Deep salt-water disposal well		*all lineweights .2 mm* *outer circle diameter 2.75 mm*	
19.5.37	Plugged and abandoned deep salt-water disposal well		*all lineweights .2 mm* *4.0 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.38	Oil seep		lineweight .2 mm; 90°; 90°; 1.2 mm; diameter 1.5 mm	May also be shown in green or other colors.
19.5.39	Oil show		lineweight .2 mm; diameter 1.5 mm	
19.5.40	Oil well (nonspecific depth)		diameter 1.5 mm	
19.5.41	Suspended oil well (nonspecific depth)		lineweight.2 mm; 4.0 mm	
19.5.42	Plugged and abandoned oil well (nonspecific depth)		lineweight .2 mm; 4.0 mm	
19.5.43	Shallow oil well			Use if both shallow and deep oil wells are shown on map.
19.5.44	Suspended shallow oil well			May also be shown in green or other colors.
19.5.45	Plugged and abandoned shallow oil well			
19.5.46	Deep oil well		lineweight .2 mm; inner dot diameter 1.5 mm; outer circle diameter 2.75 mm	
19.5.47	Suspended deep oil well		all lineweights .2 mm; 4.0 mm	
19.5.48	Plugged and abandoned deep oil well		all lineweights .2 mm; 4.0 mm	
19.5.49	Gas seep		all lineweights .2 mm; 90°; 90°; 1.2 mm; .625 mm; diameter 1.5 mm	May also be shown in red or other colors.
19.5.50	Gas show		all lineweights .2 mm; .625 mm; diameter 1.5 mm	
19.5.51	Gas well (nonspecific depth)		all lineweights .2 mm; diameter 1.5 mm; .625 mm	
19.5.52	Suspended gas well (nonspecific depth)		all lineweights .2 mm; 4.0 mm	
19.5.53	Plugged and abandoned gas well (nonspecific depth)		all lineweights .2 mm; 4.0 mm	
19.5.54	Shallow gas well			Use if both shallow and deep gas wells are shown on map.
19.5.55	Suspended shallow gas well			May also be shown in red or other colors.
19.5.56	Plugged and abandoned shallow gas well			
19.5.57	Deep gas well		inner circle diameter 1.5 mm; outer circle diameter 2.75 mm; all lineweights .2 mm; .625 mm	
19.5.58	Suspended deep gas well		all lineweights .2 mm; 4.0 mm	
19.5.59	Plugged and abandoned deep gas well		all lineweights .2 mm; 4.0 mm	
19.5.60	Deep gas well, plugged back and producing shallow gas		all lineweights .2 mm; 1.25 mm	May also be shown in red or other colors.

*For more information, see general guidelines on pages A-i to A-v.

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.61	Oil and gas seep		*all lineweights .2 mm; 90° 90° 1.2 mm; .625 mm; diameter 1.5 mm*	May also be shown in other colors.
19.5.62	Oil and gas show		*all lineweights .2 mm; .625 mm; diameter 1.5 mm*	
19.5.63	Oil and gas well (nonspecific depth)		*all lineweights .2 mm; diameter 1.5 mm; .625 mm*	
19.5.64	Suspended oil and gas well (nonspecific depth)		*all lineweights .2 mm; 4.0 mm*	
19.5.65	Plugged and abandoned oil and gas well (nonspecific depth)		*all lineweights .2 mm; 4.0 mm*	
19.5.66	Shallow oil and gas well			Use if both shallow and deep oil and gas wells are shown on map. May also be shown in other colors.
19.5.67	Suspended shallow oil and gas well			
19.5.68	Plugged and abandoned shallow oil and gas well			
19.5.69	Deep oil and gas well		*inner dot diameter 1.5 mm; outer circle diameter 2.75 mm; all lineweights .2 mm; .625 mm*	
19.5.70	Suspended deep oil and gas well		*all lineweights .2 mm; 4.0 mm*	
19.5.71	Plugged and abandoned deep oil and gas well		*all lineweights .2 mm; 4.0 mm*	
19.5.72	Condensate show		*lineweight .2 mm; diameter 1.5 mm*	May also be shown in other colors.
19.5.73	Condensate well (nonspecific depth)		*lineweight .2 mm; diameter 1.5 mm*	
19.5.74	Suspended condensate well (nonspecific depth)		*lineweight .2 mm; 4.0 mm*	
19.5.75	Plugged and abandoned condensate well (nonspecific depth)		*lineweight .2 mm; 4.0 mm*	
19.5.76	Shallow condensate well			Use if both shallow and deep condensate wells are shown on map. May also be shown in other colors.
19.5.77	Suspended shallow condensate well			
19.5.78	Plugged and abandoned shallow condensate well			
19.5.79	Deep condensate well		*all lineweights .2 mm; inner dot diameter 1.5 mm; outer circle diameter 2.75 mm*	
19.5.80	Suspended deep condensate well		*all lineweights .2 mm; 4.0 mm*	
19.5.81	Plugged and abandoned deep condensate well		*all lineweights .2 mm; 4.0 mm*	

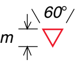
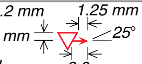
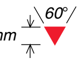
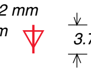
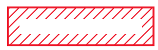
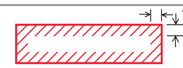
**For more information, see general guidelines on pages A-i to A-v.*

19—NATURAL RESOURCES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
19.5—Oil and gas fields; wells drilled for hydrocarbon exploration or exploitation (continued)				
19.5.82	Gas and condensate show		*all lineweights .2 mm; diameter 1.5 mm; .625 mm*	May also be shown in other colors.
19.5.83	Gas and condensate well (nonspecific depth)		*all lineweights .2 mm; diameter 1.5 mm; .625 mm*	
19.5.84	Suspended gas and condensate well (nonspecific depth)		*all lineweights .2 mm; 4.0 mm*	
19.5.85	Plugged and abandoned gas and condensate well (nonspecific depth)		*all lineweights .2 mm; 4.0 mm*	
19.5.86	Shallow gas and condensate well			Use if both shallow and deep gas and condensate wells are shown on map. May also be shown in other colors.
19.5.87	Suspended shallow gas and condensate well			
19.5.88	Plugged and abandoned shallow gas and condensate well			
19.5.89	Deep gas and condensate well		*inner circle diameter 1.5 mm; outer circle diameter 2.75 mm; all lineweights .2 mm; .625 mm*	
19.5.90	Suspended deep gas and condensate well		*all lineweights .2 mm; 4.0 mm*	
19.5.91	Plugged and abandoned deep gas and condensate well		*all lineweights .2 mm; 4.0 mm*	
19.5.92	Gas storage well (nonspecific depth)		*1.75 mm*	May also be shown in other colors.
19.5.93	Plugged and abandoned gas storage well (nonspecific depth)		*lineweight .2 mm; 4.0 mm*	
19.5.94	Shallow gas storage well			Use if both shallow and deep gas storage wells are shown on map. May also be shown in other colors.
19.5.95	Plugged and abandoned shallow gas storage well			
19.5.96	Deep gas storage well		*lineweight .2 mm; outer circle diameter 2.75 mm*	
19.5.97	Plugged and abandoned deep gas storage well		*all lineweights .2 mm; 4.0 mm*	
19.5.98	Observation well for gas-storage field (nonspecific depth)		*diameter 1.5 mm; .725 mm; all lineweights .2 mm*	May also be shown in other colors.
19.5.99	Plugged and abandoned observation well for gas-storage field [nonspecific depth]		*all lineweights .2 mm; 4.0 mm*	
19.5.100	Shallow observation well for gas-storage field			Use if both shallow and deep observation wells are shown on map. May also be shown in other colors.
19.5.101	Plugged and abandoned shallow observation well for gas-storage field			
19.5.102	Deep observation well for gas-storage field		*all lineweights .2 mm; outer circle diameter 2.75 mm*	
19.5.103	Plugged and abandoned deep observation well for gas-storage field		*all lineweights .2 mm; 4.0 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

20—HAZARDOUS WASTE SITES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
20.1	Hazardous waste site		 60° 2.375 mm color 100% red lineweight .2 mm	Generally shown in red, but may also be shown in black or other colors.
20.2	Hazardous waste site—Showing direction of surface-leachate flow from site		 all lineweights .2 mm 1.25 mm 1.125 mm 25° color 100% red 2.0 mm	
20.3	Active (operating) hazardous waste site		 60° 2.375 mm color 100% red	
20.4	Inactive (closed) hazardous waste site		 triangle lineweight .2 mm bar lineweight .3 mm 3.75 mm color 100% red	
20.5	Hazardous waste site—Clean-up activities are in progress		 color 100% red lineweight .25 mm	
20.6	Hazardous waste site—Clean-up activities have been completed		 color 100% red lineweight .25 mm	
20.7	Hazardous waste site, showing smaller restricted area (mapped to scale)		 lineweight .25 mm pattern 226-R (at 45°) color 100% red	
20.8	Hazardous waste site, showing larger restricted area (mapped to scale)		 1.5 mm	

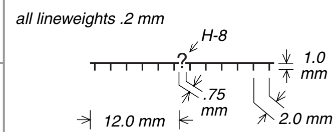
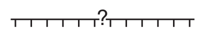
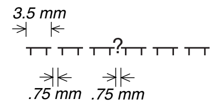
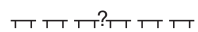
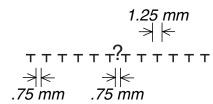
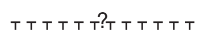
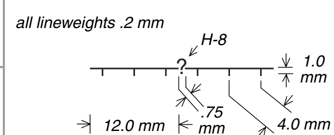
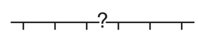
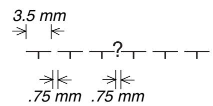
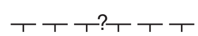
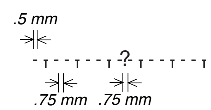
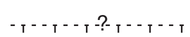
*For more information, see general guidelines on pages A-i to A-v.

21—NEOTECTONIC AND EARTHQUAKE-HAZARD FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
21.1	Earthquake epicenter, magnitude 7.5 or larger		*color 100% violet; inner dot diameter 4.5 mm; outer circle diameter 7.0 mm; inner circle diameter 5.75 mm; lineweight .25 mm*	The type of scale used for measuring earthquakes should be noted. May also be shown in black or other colors.
21.2	Earthquake epicenter, magnitude 7–7.49		*color 100% violet; dot diameter 4.25 mm*	
21.3	Earthquake epicenter, magnitude 6.5–6.99		*color 100% violet; inner dot diameter 2.375 mm; circle diameter 4.0 mm; lineweight .25 mm*	
21.4	Earthquake epicenter, magnitude 6–6.49		*color 100% violet; dot diameter 2.25 mm*	
21.5	Earthquake epicenter, magnitude 5.5–5.99		*color 100% violet; circle diameter 2.25 mm; lineweight .25 mm*	
21.6	Earthquake epicenter, magnitude 4–5.49		*color 100% violet; circle diameter 1.4 mm; lineweight .225 mm*	
21.7	Earthquake epicenter, magnitude less than 4		*color 100% violet; circle diameter .875 mm; lineweight .2 mm*	
21.8	Fault-plane or focal-mechanism diagram for vertical, down-to-the-left offset along north-striking, vertical fault—Black quadrant indicates region of compression		*size may vary; lineweight .175 mm*	Note that two types of fault motion and (or) two different fault-plane orientations could be represented by the same focal-mechanism diagram. For example, the focal-mechanism diagram that shows right-lateral strike-slip offset along a north-striking, vertical fault (ref. no. 21.9) could also show left-lateral strike-slip offset along an east-west-striking, vertical fault.
21.9	Fault-plane or focal-mechanism diagram for right-lateral strike-slip offset along north-striking, vertical fault—Black quadrants indicate regions of compression			
21.10	Fault-plane or focal-mechanism diagram for left-lateral strike-slip offset along north-striking, vertical fault—Black quadrants indicate regions of compression			
21.11	Fault-plane or focal-mechanism diagram for normal, down-to-the-left offset along north-striking, west-dipping (at 45°) fault—Black quadrants indicate regions of compression			
21.12	Fault-plane or focal-mechanism diagram for normal, down-to-the-left offset along northwest-striking, southwest-dipping (at 30°) fault—Black quadrants indicate regions of compression			
21.13	Fault-plane or focal-mechanism diagram for reverse, left-side-up offset along north-striking, west-dipping (at 45°) fault—Black quadrant indicates region of compression			
21.14	Fault-plane or focal-mechanism diagram for reverse, left-side-up offset along northwest-striking, southwest-dipping (at 60°) fault—Black quadrant indicates region of compression			
21.15	Fault-plane or focal-mechanism diagram for oblique reverse, left-side-up offset along northwest-striking, southwest-dipping (at 60°) fault—Black quadrants indicate regions of compression			
21.16	Outer limit of subsidence caused by shock—Identity and existence certain, location accurate. Hachures point into subsided area		*all lineweights .275 mm; H-8; ?; 1.25 mm; .75 mm; 12.0 mm*	May also be shown in purple or other colors.
21.17	Outer limit of subsidence caused by shock—Identity or existence questionable, location accurate. Hachures point into subsided area	?		
21.18	Outer limit of subsidence caused by shock—Identity or existence certain, location approximate. Hachures point into subsided area		*3.5 mm; ?; .75 mm; .75 mm*	
21.19	Outer limit of subsidence caused by shock—Identity or existence questionable, location approximate. Hachures point into subsided area	?		
21.20	Outer limit of subsidence caused by shock—Identity or existence certain, location inferred. Hachures point into subsided area		*1.5 mm; ?; .75 mm; .75 mm*	
21.21	Outer limit of subsidence caused by shock—Identity or existence questionable, location inferred. Hachures point into subsided area	?		
21.22	Outer limit of subsidence caused by shock—Identity and existence certain, location concealed. Hachures point into subsided area		*.75 mm; ?; .75 mm; .75 mm*	
21.23	Outer limit of subsidence caused by shock—Identity or existence questionable, location concealed. Hachures point into subsided area	?		

For more information, see general guidelines on pages A-i to A-v.

21—NEOTECTONIC AND EARTHQUAKE-HAZARD FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
21.24	Rim crest or crater with rim, formed by shock or sand blowouts—Identity and existence certain, location accurate. Hachures point into crater			May also be shown in purple or other colors.
21.25	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location accurate. Hachures point into crater			
21.26	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence certain, location approximate. Hachures point into crater			
21.27	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location approximate. Hachures point into crater			
21.28	Rim crest or crater with rim, formed by shock or sand blowouts—Identity and existence certain, location concealed. Hachures point into crater			
21.29	Rim crest or crater with rim, formed by shock or sand blowouts—Identity or existence questionable, location concealed. Hachures point into crater			
21.30	Sinkhole or crater without rim, formed by shock—Identity and existence certain, location accurate. Hachures point into sinkhole			
21.31	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location accurate. Hachures point into sinkhole			
21.32	Sinkhole or crater without rim, formed by shock—Identity or existence certain, location approximate. Hachures point into sinkhole			
21.33	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location approximate. Hachures point into sinkhole			
21.34	Sinkhole or crater without rim, formed by shock—Identity or existence certain, location concealed. Hachures point into sinkhole			
21.35	Sinkhole or crater without rim, formed by shock—Identity or existence questionable, location concealed. Hachures point into sinkhole			
21.36	Fissures or cracks, formed in ground by earthquake			
21.37	Fissures and sand and (or) other material ejected during earthquake			

*For more information, see general guidelines on pages A-i to A-v.

22—PLATE-TECTONIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
22.1	Active spreading axis or mid-oceanic ridge, with rift—Accurately located. Sawteeth point in direction of spreading		color 100% red; 60°; lineweight .375 mm; 1.25 mm; spacing may vary; sawtooth lineweight .25 mm; spacing 12.5 mm	May also be shown in black or other colors.
22.2	Active spreading axis or mid-oceanic ridge, with rift—Approximately located. Sawteeth point in direction of spreading		10.0 mm; 2.5 mm	
22.3	Active spreading axis or mid-oceanic ridge, without rift—Accurately located. Sawteeth point in direction of spreading		color 100% red; 60°; lineweight .625 mm; 1.25 mm; sawtooth lineweight .25 mm; spacing 12.5 mm	
22.4	Active spreading axis or mid-oceanic ridge, without rift—Approximately located. Sawteeth point in direction of spreading		10.0 mm; 2.5 mm	
22.5	Ancient spreading axis or mid-oceanic ridge—Accurately located. Sawteeth point in direction of spreading		1.25 mm; 60°; all lineweights .25 mm; .75 mm; sawtooth spacing 12.5 mm	May also be shown in other colors.
22.6	Ancient spreading axis or mid-oceanic ridge—Approximately located. Sawteeth point in direction of spreading		10.0 mm; 2.5 mm	
22.7	Surface trace of active deep-seismofocal or subduction zone—Accurately located. Sawteeth on upper plate		lineweight .375 mm; color 100% red; 1.25 mm; 6.25 mm; sawtooth radius 3.0 mm	May also be shown in black or other colors.
22.8	Surface trace of active deep-seismofocal or subduction zone—Approximately located. Sawteeth on upper plate		5.25 mm; 1.0 mm	
22.9	Surface trace of active deep-seismofocal or subduction zone—Showing fore-arc sediments. Sawteeth on upper plate		pattern 427-R	
22.10	Active convergent plate boundary—Accurately located. Sawteeth on upper plate		lineweight .375 mm; color 100% red; 6.25 mm; 60°; 2.0 mm	
22.11	Active convergent plate boundary—Approximately located. Sawteeth on upper plate		5.25 mm; 1.0 mm	
22.12	Active convergent plate boundary—Showing accretionary prism. Sawteeth on upper plate		pattern 429-R	
22.13	Ancient convergent plate boundary—Accurately located. Sawteeth on upper plate		lineweight .25 mm; 6.25 mm; 60°; 1.75 mm	May also be shown in other colors.
22.14	Ancient convergent plate boundary—Approximately located. Sawteeth on upper plate		5.25 mm; 1.0 mm	
22.15	Active transform fault, sense of offset unspecified—Accurately located		color 100% red; lineweight .375 mm	May also be shown in black or other colors.
22.16	Active transform fault, sense of offset unspecified—Approximately located		3.5 mm; 1.0 mm	
22.17	Active transform fault, right-lateral offset—Accurately located. Arrows show relative motion		arrow lineweight .3 mm; 25°; 1.75 mm; color 100% red; 5.0 mm; lineweight .375 mm	
22.18	Active transform fault, right-lateral offset—Approximately located. Arrows show relative motion		3.5 mm; 1.0 mm	
22.19	Active transform fault, left-lateral offset—Accurately located. Arrows show relative motion		arrow lineweight .3 mm; 1.75 mm; 25°; color 100% red; 5.0 mm; lineweight .375 mm	
22.20	Active transform fault, left-lateral offset—Approximately located. Arrows show relative motion		3.5 mm; 1.0 mm	
22.21	Active transform fault, normal offset—Accurately located. Hachures on downthrown side		color 100% red; lineweight .375 mm; 1.0 mm; hachure lineweight .175 mm; spacing .375 mm	
22.22	Active transform fault, normal offset—Approximately located. Hachures on downthrown side		3.5 mm; 1.0 mm	
22.23	Ancient transform fault, sense of offset unspecified—Accurately located		lineweight .25 mm	May also be shown in black or other colors.
22.24	Ancient transform fault, sense of offset unspecified—Approximately located		3.5 mm; 1.0 mm	

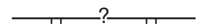
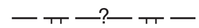
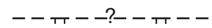
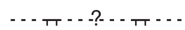
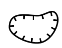
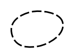
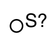
*For more information, see general guidelines on pages A-i to A-v.

22—PLATE-TECTONIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
22.25	Continental slope—Accurately located. Rectangles point downslope		*lineweight 25 mm; 6.25 mm; tooth height .875 mm; width 1.5 mm*	May also be shown in other colors.
22.26	Continental slope—Approximately located. Rectangles point downslope		*5.25 mm; 1.0 mm*	
22.27	Continental slope—Showing margin filled by sedimentation. Rectangles point downslope		*pattern 119-K*	
22.28	Outline of basin—Accurately located. Sawteeth point into basin		*all lineweights .2 mm; 6.25 mm; 90°; .75 mm*	
22.29	Outline of basin—Approximately located. Sawteeth point into basin		*5.25 mm; 1.0 mm*	
22.30	Deep-sea trench—Patterned where filled by sedimentation		*all lineweights .2 mm; pattern 119-K*	
22.31	Margin of oceanic rise—Accurately located. Hachures point downslope		*all lineweights .2 mm; .625 mm; 6.25 mm; 1.0 mm*	
22.32	Margin of oceanic rise—Approximately located. Hachures point downslope		*5.25 mm; 1.0 mm*	
22.33	Volcanic ridge or edifice—Accurately located. Hachures point downslope		*all lineweights .2 mm; .625 mm; 3.125 mm*	
22.34	Volcanic ridge or edifice—Approximately located. Hachures point downslope		*5.25 mm; 1.0 mm*	
22.35	Guyot—Hachures point downslope		*all lineweights .2 mm; hachure height .625 mm; spacing .5 mm*	
22.36	Seamount, nonvolcanic origin—Sawteeth point downslope		*sawtooth spacing 5.0 mm; 60°; 1.0 mm; all lineweights .2 mm*	
22.37	Seamount, volcanic origin—Sawteeth point downslope			
22.38	Seamount, nonvolcanic origin (shown as point symbol when too small to outline at map scale)		*all lineweights .2 mm; .625 mm; circle diameter 1.375 mm*	
22.39	Seamount, volcanic origin (shown as point symbol when too small to outline at map scale)		*lineweights .2 mm; dot diameter 1.375 mm*	

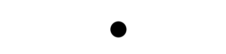
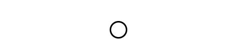
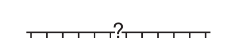
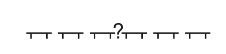
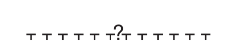
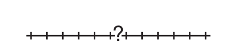
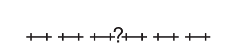
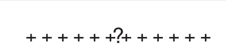
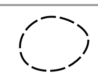
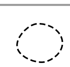
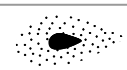
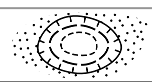
**For more information, see general guidelines on pages A-i to A-v.*

23—MISCELLANEOUS UPLIFT AND COLLAPSE FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
23.1	Outline of metamorphic core complex—Identity and existence certain, location accurate. Hachures on upper plate		lineweight .25 mm; H-8; hachure lineweight .2 mm; .75 mm; 12.0 mm; 1.25 mm; .75 mm	
23.2	Outline of metamorphic core complex—Identity or existence questionable, location accurate. Hachures on upper plate			
23.3	Outline of metamorphic core complex—Identity and existence certain, location approximate. Hachures on upper plate		3.5 mm; .75 mm; .75 mm	
23.4	Outline of metamorphic core complex—Identity or existence questionable, location approximate. Hachures on upper plate			
23.5	Outline of metamorphic core complex—Identity and existence certain, location inferred. Hachures on upper plate		1.5 mm; 2.5 mm; .75 mm; .75 mm	
23.6	Outline of metamorphic core complex—Identity or existence questionable, location inferred. Hachures on upper plate			
23.7	Outline of metamorphic core complex—Identity and existence certain, location concealed. Hachures on upper plate		.5 mm; 2.5 mm; .75 mm; .75 mm	
23.8	Outline of metamorphic core complex—Identity or existence questionable, location concealed. Hachures on upper plate			
23.9	Collapse structure or sinkhole (too small to draw to scale)		lineweight .2 mm; circle diameter 2.0 mm; dot diameter .5 mm	
23.10	Collapse structure or sinkhole (drawn to scale)		all lineweights .2 mm; hachure height .55 mm; spacing 1.25 mm	
23.11	Crater outline, unspecified origin		dash length 1.25 mm; spacing .375 mm; lineweight .2 mm	
23.12	Uplift—Local, intensely disturbed		circle diameter 2.5 mm; lineweight .25 mm; crossbar lineweight .175 mm	
23.13	Salt dome		H-7; dot diameter 1.625 mm	
23.14	Possible salt dome		lineweight .2 mm; H-7; circle diameter 1.625 mm	
23.15	Salt and (or) shale diapirs		100% black	

*For more information, see general guidelines on pages A-i to A-v.

24—TERRESTRIAL IMPACT FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
24.1	Primary terrestrial impact crater (too small to draw to scale) (1st option)		*dot diameter 2.125 mm*	
24.2	Secondary terrestrial impact crater (too small to draw to scale) (1st option)—Formed by debris thrown from primary crater		*lineweight .2 mm*; *circle diameter 2.125 mm*	
24.3	Primary terrestrial impact crater (too small to draw to scale) (2nd option)		*dot diameter 1.625 mm*	
24.4	Secondary terrestrial impact crater (too small to draw to scale) (2nd option)—Formed by debris thrown from primary crater		*lineweight .2 mm*; *circle diameter 1.625 mm*	
24.5	Terrestrial impact crater without raised rim—Identity and existence certain, location accurate. Hachures point into crater		*all lineweights .2 mm*; *H-8*; *1.0 mm*; *.75 mm*; *12.0 mm*; *2.0 mm*	
24.6	Terrestrial impact crater without raised rim—Identity or existence questionable, location accurate. Hachures point into crater			
24.7	Terrestrial impact crater without raised rim—Identity or existence certain, location approximate. Hachures point into crater		*3.5 mm*; *.75 mm*; *.75 mm*	
24.8	Terrestrial impact crater without raised rim—Identity or existence questionable, location approximate. Hachures point into crater			
24.9	Terrestrial impact crater without raised rim—Identity and existence certain, location concealed. Hachures point into crater		*1.25 mm*; *.75 mm*; *.75 mm*	
24.10	Terrestrial impact crater without raised rim—Identity or existence questionable, location concealed. Hachures point into crater			
24.11	Terrestrial impact crater with raised rim—Identity and existence certain, location accurate		*all lineweights .2 mm*; *H-8*; *1.0 mm*; *.75 mm*; *12.0 mm*; *2.0 mm*	
24.12	Terrestrial impact crater with raised rim—Identity or existence questionable, location accurate			
24.13	Terrestrial impact crater with raised rim—Identity or existence certain, location approximate		*3.5 mm*; *.75 mm*; *.75 mm*	
24.14	Terrestrial impact crater with raised rim—Identity or existence questionable, location approximate			
24.15	Terrestrial impact crater with raised rim—Identity or existence certain, location concealed		*1.25 mm*; *.75 mm*; *.75 mm*	
24.16	Terrestrial impact crater with raised rim—Identity or existence questionable, location concealed			
24.17	Outer boundary of floor of terrestrial impact crater		*dash length 2.0 mm; spacing .5 mm*; *lineweight .25 mm*	
24.18	Outer boundary of central mound of complex terrestrial impact crater		*dash length .75 mm; spacing .375 mm*; *lineweight .2 mm*	
24.19	Terrestrial palimpsest area		*100% black*; *pattern 119-K*	
24.20	Palimpsest area around complex terrestrial impact crater—Ejecta obscures morphology of area surrounding crater			

*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.1	Contact, planetary—Location accurate		lineweight .15 mm	
25.2	Contact, planetary—Location approximate		3.5 mm; .75 mm	
25.3	Contact, planetary—Location inferred		1.5 mm; .75 mm	
25.4	Contact, planetary—Location concealed		.5 mm; .75 mm	
25.5	Fault, planetary, sense of offset unspecified—Location accurate		lineweight .375 mm	
25.6	Fault, planetary, sense of offset unspecified—Location approximate		3.5 mm; .75 mm	
25.7	Fault, planetary, sense of offset unspecified—Location inferred		1.5 mm; .75 mm	
25.8	Fault, planetary, sense of offset unspecified—Location concealed		.5 mm; .75 mm	
25.9	Normal fault, planetary—Location accurate. Ball and bar on downthrown block		lineweight .375 mm; .875 mm diameter; tick length 1.0 mm; lineweight .175 mm	
25.10	Normal fault, planetary—Location approximate. Ball and bar on downthrown block		3.5 mm; .75 mm	
25.11	Normal fault, planetary—Location inferred. Ball and bar on downthrown block		1.5 mm; .75 mm	
25.12	Normal fault, planetary—Location concealed. Ball and bar on downthrown block		.5 mm; .75 mm	
25.13	Strike-slip fault, planetary, right-lateral offset—Location accurate. Arrows show relative motion		lineweight .375 mm; 25°; 1.75 mm; 5.0 mm; arrow lineweight .2 mm	
25.14	Strike-slip fault, planetary, right-lateral offset—Location approximate. Arrows show relative motion		3.5 mm; .75 mm	
25.15	Strike-slip fault, planetary, right-lateral offset—Location inferred. Arrows show relative motion		1.5 mm; .75 mm	
25.16	Strike-slip fault, planetary, right-lateral offset—Location concealed. Arrows show relative motion		.5 mm; .75 mm	
25.17	Strike-slip fault, planetary, left-lateral offset—Location accurate. Arrows show relative motion		lineweight .375 mm; 1.75 mm; 25°; 5.0 mm; arrow lineweight .2 mm	
25.18	Strike-slip fault, planetary, left-lateral offset—Location approximate. Arrows show relative motion		3.5 mm; .75 mm	
25.19	Strike-slip fault, planetary, left-lateral offset—Location inferred. Arrows show relative motion		1.5 mm; .75 mm	
25.20	Strike-slip fault, planetary, left-lateral offset—Location concealed. Arrows show relative motion		.5 mm; .75 mm	
25.21	Thrust fault, planetary—Location accurate. Sawteeth on upper plate		sawtooth height 1.5 mm; lineweight .375 mm; 60°	
25.22	Thrust fault, planetary—Location approximate. Sawteeth on upper plate		3.5 mm; .75 mm	
25.23	Thrust fault, planetary—Location inferred. Sawteeth on upper plate		1.5 mm; 2.5 mm; .75 mm	
25.24	Thrust fault, planetary—Location concealed. Sawteeth on upper plate		.5 mm; 2.5 mm; .75 mm	

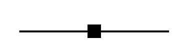
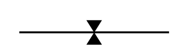
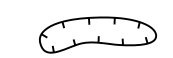
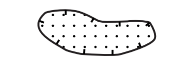
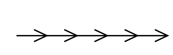
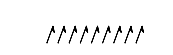
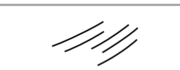
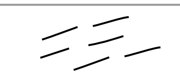
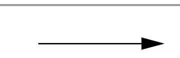
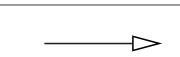
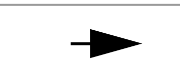
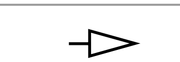
*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.25	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location accurate		lineweight .375 mm; dot diameter 1.375 mm	
25.26	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location approximate		3.5 mm; .75 mm	
25.27	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location inferred		1.5 mm; .75 mm	
25.28	Graben trace, planetary (shown as single line where bounding normal faults cannot be mapped separately)—Location concealed		.5 mm; .75 mm	
25.29	Regional fracture, planetary		lineweight .3 mm; color 100% cyan	
25.30	Partly buried regional fracture, planetary		1.5 mm; .75 mm	
25.31	Arcuate fracture, planetary		lineweight .2 mm; color 100% purple	
25.32	Partly buried arcuate fracture, planetary		1.5 mm; .75 mm	
25.33	Radial fracture, planetary (associated with coronae)		lineweight .325 mm; color 100% purple	
25.34	Concentric fracture, planetary (associated with coronae)		lineweight .25 mm; color 100% violet	
25.35	Fold crest, planetary		lineweight .3 mm; color 100% red	
25.36	Broad warp, planetary		lineweight .635 mm; .75 mm; color 100% red; .75 mm	
25.37	Wrinkle ridge, planetary		lineweight .25 mm; color 100% magenta	
25.38	Ribbon trends, planetary		lineweight .25 mm; color 100% green	
25.39	Ridge belt, planetary		all lineweights .25 mm; 1.75 mm; color 100% red	
25.40	Broad ridge crest, planetary (generally associated with coronae)		lineweight .635 mm; color 100% red	
25.41	Ridge crest, planetary (1st option)		65°; lineweight .25 mm; 3.0 mm; 65°	
25.42	Ridge crest, planetary (2nd option)		all lineweights .25 mm	
25.43	Ridge crest, planetary (1st option)—Arrowhead shows abrupt termination of ridge		65°; 1.375 mm	
25.44	Ridge crest, planetary (2nd option)—Arrowhead shows abrupt termination of ridge			
25.45	Ridge crest (possible dike), planetary		70°; all lineweights .25 mm; 3.5 mm	
25.46	Corona annulus ridge, planetary—Showing axial trace and plunge. Short arrow indicates steeper limb or scarp bounding corona trough		3.75 mm; all lineweights .25 mm; 2.0 mm; 75°	

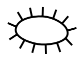
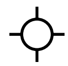
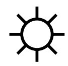
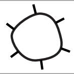
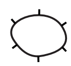
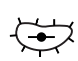
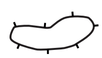
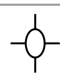
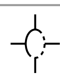
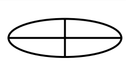
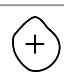
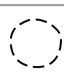
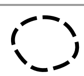
*For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.47	Groove (generic), planetary		*lineweight .25 mm*	
25.48	Sharp groove, planetary		*all lineweights .25 mm; 1.5 mm; .825 mm*	
25.49	Subdued groove, planetary		*all lineweights .25 mm; 1.5 mm*	
25.50	Radially grooved ejecta (schematic), planetary		*.75 mm; .75 mm; .25 mm; .75 mm; .75 mm; .75 mm*	
25.51	Furrow, planetary		*lineweight .25 mm; 1.75 mm; 1.75 mm*	
25.52	Trough or narrow depression, planetary		*lineweight .25 mm; 65°; 3.0 mm; 65°*	
25.53	Depression (mapped to scale), planetary		*all lineweights .25 mm; hachure height .875 mm; spacing 3.5 mm*	
25.54	Large depression (mapped to scale), planetary		*all lineweights .25 mm; pattern 118-K; hachure height .625 mm; spacing 3.5 mm*	
25.55	Shallow, linear depression or valley, or narrow channel, planetary		*lineweight .25 mm; color 100% cyan*	
25.56	Channel (canali), planetary		*lineweight .25 mm; long dash 2.5 mm; short dash .5 mm; spacing .5 mm*	
25.57	Channel (canali), planetary—Two short dashes where structureless or indefinite		*lineweight .25 mm; long dash 2.5 mm; short dashes .5 mm; spacing .5 mm*	
25.58	Narrow channel (possible lava channel), planetary—Arrows point in direction of flow		*all lineweights .175 mm; 4.0 mm; 45°; 1.875 mm*	
25.59	Erosional boundary, planetary—Erosion increases in direction of arrows		*2.5 mm; 30°; 1.0 mm; lineweight .175 mm; 20°; 1.5 mm*	
25.60	Angular unconformity, planetary—Hachures indicate truncated beds		*lineweight .3 mm; lineweight .2 mm; hachure height 1.75 mm; spacing 2.5 mm*	
25.61	Angular unconformity, planetary—Uncertain. Hachures indicate truncated beds		*2.25 mm; .5 mm*	
25.62	Layer, planetary		*1.125 mm; lineweight .2 mm; .75 mm*	
25.63	Lineament, planetary		*lineweight .3 mm; 1.5 mm; .5 mm*	
25.64	Layering in canyon wall, planetary		*all lineweights .2 mm; lengths and spacing will vary*	
25.65	Fabric of short radar-bright lineaments (schematic), planetary		*all lineweights .25 mm; lengths and spacing will vary*	
25.66	Penetrative lineations, within tessera terrain, planetary		*all lineweights .125 mm; lengths and spacing will vary*	
25.67	Flow direction, planetary		*lineweight .175 mm; 30°; 1.5 mm; length may vary; 3.0 mm*	
25.68	Wind streaks, planetary—Arrow points in inferred wind direction		*all lineweights .2 mm; 3.5 mm; 1.875 mm; 30°; length may vary*	
25.69	Area of channelized erosion and scouring, planetary—Arrow points in direction of interpreted flow		*lineweight .375 mm; 6.0 mm; 30°; 2.75 mm*	
25.70	Area of eolian transport, planetary—Arrow points in direction of air flow		*all lineweights .375 mm*	

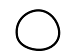
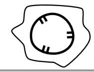
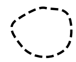
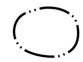
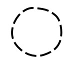
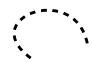
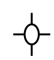
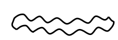
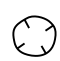
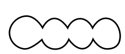
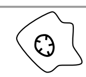
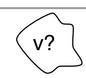
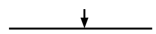
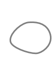
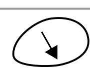
**For more information, see general guidelines on pages A-i to A-v.*

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.71	Scarp, planetary—Hachures point downscarp		*all lineweights .25 mm; 5.0 mm; 1.0 mm*	
25.72	Lobate scarp, planetary—Hachures point downscarp		*all lineweights .25 mm; 2.0 mm; 1.0 mm*	
25.73	Basal scarp, planetary—Hachures point downscarp		*all lineweights .25 mm; 3.0 mm; 1.25 mm*	
25.74	Base of scarp, planetary—Barb points downscarp		*lineweight .25 mm; 65°; 1.5 mm*	
25.75	Dome, edifice, or circular scarp, planetary (mapped to scale)—Hachures point downscarp		*all lineweights .25 mm; hachure height 1.25 mm; spacing 1.25 mm*	
25.76	Very small shield, dome, or volcanic construct, planetary (not mapped to scale)		*all lineweights .4 mm; 1.5 mm*	
25.77	Small shield, dome, or volcanic construct, planetary (not mapped to scale)		*all lineweights .6 mm; 2.5 mm*	
25.78	Large, steep-sided shield, dome, or volcanic construct, planetary (not mapped to scale)		*all lineweights .375 mm; circle diameter 4.0 mm; 1.625 mm; 1.625 mm*	
25.79	Mesa, planetary (not mapped to scale)		*all lineweights .375 mm; circle diameter 4.0 mm; all barb lengths 1.625 mm*	
25.80	Large shield, dome, or volcanic construct, planetary (mapped to scale)—Hachures point downscarp		*all lineweights .3 mm; hachure height 1.25 mm; spacing 3.75 mm*	
25.81	Large cone, planetary (mapped to scale)—Hachures point downscarp		*all lineweights .25 mm; hachure height .75 mm; spacing 3.5 mm*	
25.82	Knob or central peak, planetary (not mapped to scale)		*all lineweights .25 mm; circle diameter 2.0 mm; 1.65 mm; 1.65 mm*	
25.83	Knob, planetary (mapped to scale)—Bar and ball indicate apical fissure. Hachures point downscarp		*dot diameter 1.25 mm; all lineweights .25 mm; 3.5 mm; hachure height .9 mm; spacing 2.0 mm*	
25.84	Elevated plateau, planetary (mapped to scale)—Hachures point downscarp		*all lineweights .25 mm; hachure height .625 mm; spacing 3.75 mm*	
25.85	Steep-sided edifice, planetary (not mapped to scale)		*2.0 mm; all lineweights .25 mm; 2.5 mm; 3.75 mm*	
25.86	Steep-sided edifice, planetary (not mapped to scale)—Dotted where concealed or buried		*short dashes .5 mm; spacing .5 mm*	
25.87	Large edifice, planetary (not mapped to scale)		*all lineweights .25 mm; 15.0 mm; 5.0 mm*	
25.88	Very small tholi, planetary (not mapped to scale)		*lineweight .25 mm; 2.5 mm*	
25.89	Small tholi, planetary (not mapped to scale)		*all lineweights .25 mm; circle diameter 3.0 mm*	
25.90	Small tholi, planetary (mapped to scale)		*all lineweights .25 mm*	
25.91	Corona, planetary		*lineweight .25 mm; dash length 1.5 mm; spacing .75 mm*	
25.92	Nova, planetary		*lineweight .5 mm; dash length 2.25 mm; spacing .75 mm*	
25.93	Palimpsest ring, planetary		*dot diameter .875 mm; spacing .375 mm*	

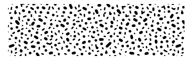
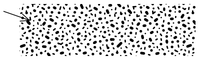
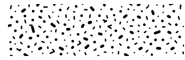
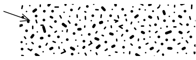
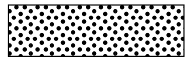
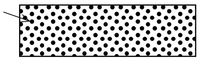
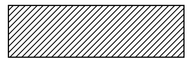
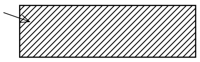
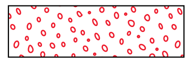
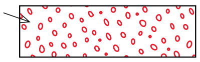
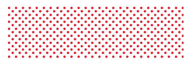
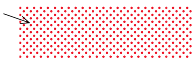
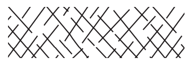
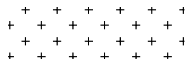
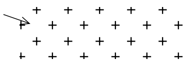
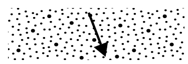
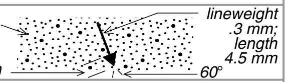
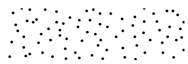
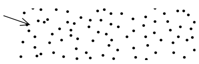
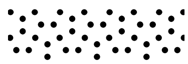
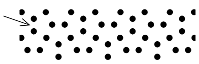
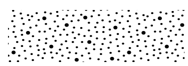
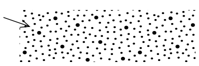
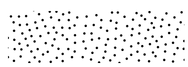
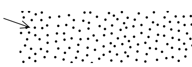
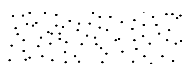
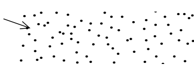
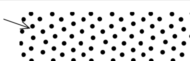
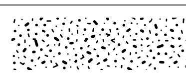
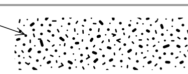
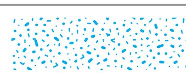
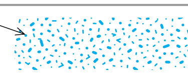
For more information, see general guidelines on pages A-i to A-v.

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.94	Raised rim of larger impact crater, planetary—Hachures point into crater		*all lineweights .3 mm; hachure height .75 mm; spacing of hachure pairs .5 mm; .375 mm*	
25.95	Raised rim of smaller impact crater, planetary		*lineweight .3 mm*	
25.96	Raised rim of impact crater, planetary—Showing visible ejecta blanket		*lineweight .15 mm*	
25.97	Degraded impact crater rim, planetary (1st option)		*lineweight .3 mm; dash length 1.0 mm; spacing .5 mm*	
25.98	Rimless impact crater, subdued impact crater rim, degraded impact crater rim (2nd option), or buried impact crater rim, planetary		*lineweight .3 mm; long dash 4.0 mm; short dashes .2 mm; spacing .5 mm*	
25.99	Secondary impact crater chain and cluster, planetary		*lineweight .25 mm; dash length 1.5 mm; spacing .5 mm*	
25.100	Basin ring, planetary		*lineweight .375 mm; dash length .75 mm; spacing .75 mm*	
25.101	Central peak of impact crater, planetary (1st option)		*ellipse width 1.875 mm; height 2.625 mm; 1.5 mm; all lineweights .2 mm*	
25.102	Central peak of impact crater, planetary (2nd option)		*2.375 mm; all lineweights .2 mm*	
25.103	Pit of impact crater floor, planetary (1st option)		*lineweight .2 mm*	
25.104	Pit of impact crater floor, planetary (2nd option)		*dot diameter .875 mm*	
25.105	Pit-crater chain (mapped to scale), planetary		*lineweight .2 mm*	
25.106	Small endogenic crater, planetary		*dot diameter 1.0 mm*	
25.107	Small endogenic crater (mapped to scale), planetary		*lineweight .25 mm*	
25.108	Medium-sized endogenic crater (mapped to scale), planetary		*lineweight .25 mm; dot diameter 1.0 mm*	
25.109	Large endogenic crater (mapped to scale), planetary		*all lineweights .25 mm; hachure height 1.25 mm; spacing 3.175 mm*	
25.110	Chain craters or collapsed lava tube (mapped to scale), planetary		*lineweight .2 mm*	
25.111	Caldera, planetary		*all lineweights .25 mm; hachure height .625 mm; spacing .875 mm*	
25.112	Volcano, planetary, having summit crater		*lineweight .15 mm*	
25.113	Volcano, planetary, without summit crater—Queried if origin is conjectural		v? *H-8*	
25.114	Flow front, planetary—Arrow indicates flow direction		*1.375 mm; 1.125 mm; lineweight .25 mm; 40°; arrow lineweight .25 mm*	
25.115	Mountain (rugged), planetary—Origin uncertain		*lineweight .2 mm; line color 50% black*	
25.116	Channel bars, planetary—May be erosional or depositional		*lineweight .2 mm; line color 30% black*	
25.117	Slide or slump material, planetary—Arrow indicates direction of movement		*lineweight .25 mm; 1.75 mm; 2.5 mm; 60°; arrow lineweight .2 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

25—PLANETARY GEOLOGY FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
25.118	Dark-colored ejecta, planetary		pattern 428-K 	May also be shown in red or other colors.
25.119	Light-colored ejecta, planetary		pattern 429-K 	
25.120	Terrace deposits, planetary		pattern 427-K 	
25.121	Dark-colored mantling material, planetary		pattern 214-K (at 45°) 	
25.122	Secondary crater field, planetary		pattern 102-R 	May also be shown in black or other colors.
25.123	Diffuse highland-lowland boundary scarp, planetary		pattern 134-R 	
25.124	Joint or fracture pattern, planetary		pattern 430-K 	May also be shown in red or other colors.
25.125	Area of reticulate grooves, planetary—Showing trend		pattern 327-K 	
25.126	Detached lobe, planetary—Arrow points in direction of interpreted landslide or debris flow		pattern 116-K; 1.75 mm 	
25.127	Low albedo smooth material, planetary—Interpreted as eolian material		pattern 136-K 	
25.128	Airburst spot		pattern 434-K 	
25.129	Mantling material, planetary—Light-colored		pattern 435-K in 50% black 	
25.130	Splotch, planetary—Circular, radar-bright halo on surface		pattern 116-K 	
25.131	Reticulate pattern on plains, planetary		pattern 119-K 	
25.132	Fracture zone, planetary		pattern 137-K 	
25.133	Superficial crater material having weak radar back-scatter coefficient, planetary		pattern 436-K 	
25.134	Crater-associated ejecta halo, planetary		pattern 429-K 	
25.135	Halo without associated crater, planetary		pattern 429-C 	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.1—Water wells			
26.1.1	Water well, type unspecified		*lineweight .15 mm* *diameter 1.75 mm*	May also be shown in cyan or other colors.
26.1.2	Unused water well		*bar lineweight .3 mm* *3.725 mm* *circle lineweight .2 mm*	
26.1.3	Capped water well		*1.235 mm* *1.125 mm* *all lineweights .2 mm*	
26.1.4	Shut-in water well		*1.125 mm* *1.235 mm* *all lineweights .2 mm*	
26.1.5	Dry hole used for water exploration		*1.0 mm* *1.0 mm* *all lineweights .2 mm*	
26.1.6	Well used for collection of water data		*1.0 mm* *all lineweights .2 mm*	
26.1.7	Well used for domestic-water supply		*diameter 1.75 mm*	
26.1.8	Flowing artesian well used for domestic-water supply		*2.0 mm* *20°* *1.25 mm* *arrow lineweight .15 mm*	
26.1.9	Nonflowing artesian well used for domestic-water supply		*1.375 mm* *radius .3125 mm* *lineweight .175 mm*	
26.1.10	Recharge or waste-injection well, once used for domestic-water supply		*2.0 mm* *20°* *1.25 mm* *arrow lineweight .15 mm*	
26.1.11	Observation well used for domestic-water supply		*bar lineweight .3 mm* *3.725 mm* *45°*	
26.1.12	Observation well used for domestic-water supply—Equipped with a recorder	R	R *H-6*	
26.1.13	Dry well, once used for domestic-water supply		*bar lineweight .2 mm* *45°* *3.725 mm*	
26.1.14	Destroyed well, once used for domestic-water supply		*bar lineweights .2 mm* *90°* *3.725 mm* *3.725 mm*	
26.1.15	Test hole for well used for domestic-water supply		*.6 mm* *bar lineweights .15 mm* *2.75 mm*	
26.1.16	Well used for stock-water supply		*lineweight .25 mm* *diameter 1.75 mm*	
26.1.17	Flowing artesian well used for stock-water supply		*2.0 mm* *20°* *1.25 mm* *arrow lineweight .15 mm*	
26.1.18	Nonflowing artesian well used for stock-water supply		*1.375 mm* *radius .3125 mm* *lineweight .175 mm*	
26.1.19	Recharge or waste-injection well, once used for stock-water supply		*2.0 mm* *20°* *1.25 mm* *arrow lineweight .15 mm*	
26.1.20	Observation well used for stock-water supply		*bar lineweight .3 mm* *3.725 mm* *45°*	
26.1.21	Observation well used for stock-water supply—Equipped with a recorder	R	R *H-6*	
26.1.22	Dry well, once used for stock-water supply		*bar lineweight .2 mm* *45°* *3.725 mm*	
26.1.23	Destroyed well, once used for stock-water supply		*bar lineweights .2 mm* *90°* *3.725 mm* *3.725 mm*	
26.1.24	Test hole for well used for stock-water supply		*.6 mm* *bar lineweights .15 mm* *2.75 mm*	

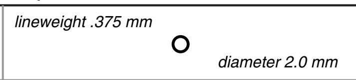
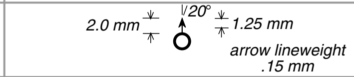
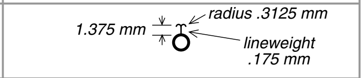
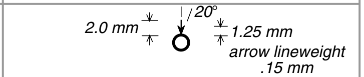
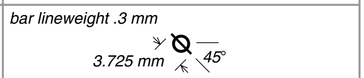
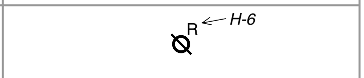
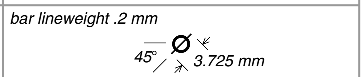
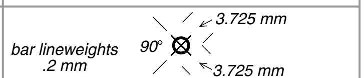
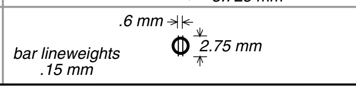
*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.1—Water wells (continued)				
26.1.25	Well used for irrigation-water supply		*outer circle diameter 2.0 mm; lineweight .2 mm* *inner circle diameter 1.125 mm; lineweight .15 mm*	May also be shown in cyan or other colors.
26.1.26	Flowing artesian well used for irrigation-water supply		*2.0 mm 20° 1.25 mm arrow lineweight .15 mm*	
26.1.27	Nonflowing artesian well used for irrigation-water supply		*1.375 mm radius .3125 mm lineweight .175 mm*	
26.1.28	Recharge or waste-injection well, once used for irrigation-water supply		*2.0 mm 20° 1.25 mm arrow lineweight .15 mm*	
26.1.29	Observation well used for irrigation-water supply		*bar lineweight .3 mm 3.725 mm 45°*	
26.1.30	Observation well used for irrigation-water supply—Equipped with a recorder	R	R *H-6*	
26.1.31	Dry well, once used for irrigation-water supply		*bar lineweight .2 mm 45° 3.725 mm*	
26.1.32	Destroyed well, once used for irrigation-water supply		*3.725 mm bar lineweights .2 mm 90° 3.725 mm*	
26.1.33	Test hole for well used for irrigation-water supply		*.6 mm bar lineweights .15 mm 2.75 mm*	
26.1.34	Well used for industrial-water supply		*outer circle diameter 2.0 mm; lineweight .2 mm* *inner dot diameter 1.125 mm*	
26.1.35	Flowing artesian well used for industrial-water supply		*2.0 mm 20° 1.25 mm arrow lineweight .15 mm*	
26.1.36	Nonflowing artesian well used for industrial-water supply		*1.375 mm radius .3125 mm lineweight .175 mm*	
26.1.37	Recharge or waste-injection well, once used for industrial-water supply		*2.0 mm 20° 1.25 mm arrow lineweight .15 mm*	
26.1.38	Observation well used for industrial-water supply		*bar lineweight .3 mm 3.725 mm 45°*	
26.1.39	Observation well used for industrial-water supply—Equipped with a recorder	R	R *H-6*	
26.1.40	Dry well, once used for industrial-water supply		*bar lineweight .2 mm 45° 3.725 mm*	
26.1.41	Destroyed well, once used for industrial-water supply		*3.725 mm bar lineweights .2 mm 90° 3.725 mm*	
26.1.42	Test hole for well used for industrial-water supply		*.6 mm bar lineweights .15 mm 2.75 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.1—Water wells (continued)			
26.1.43	Well used for public-water supply			May also be shown in cyan or other colors.
26.1.44	Flowing artesian well used for public-water supply			
26.1.45	Nonflowing artesian well used for public-water supply			
26.1.46	Recharge or waste-injection well, once used for public-water supply			
26.1.47	Observation well used for public-water supply			
26.1.48	Observation well used for public-water supply—Equipped with a recorder			
26.1.49	Dry well, once used for public-water supply			
26.1.50	Destroyed well, once used for public-water supply			
26.1.51	Test hole for well used for public-water supply			

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.2—Springs			
26.2.1	Spring, type of use unspecified		all lineweights .15 mm; draft "tail" as shown; circle diameter 1.75 mm	Rotate "tail" to point in direction of flow. May also be shown in cyan, red, or other colors.
26.2.2	Unused spring		bar lineweight .3 mm; circle and "tail" lineweight .2 mm; 3.725 mm	
26.2.3	Spring used for collection of water-quality data		circle and "tail" lineweight .2 mm; dot diameter .375 mm	
26.2.4	Spring used for domestic-water supply		"tail" lineweight .2 mm; draft "tail" as shown; dot diameter 1.75 mm	
26.2.5	Thermal spring used for domestic-water supply		H-6 → T	
26.2.6	Mineral spring used for domestic-water supply		H-6 → M	
26.2.7	Extinct spring, once used for domestic-water supply		3.725 mm; bar lineweight .2 mm	
26.2.8	Spring used for stock-water supply		"tail" lineweight .2 mm; draft "tail" as shown; circle diameter 1.75 mm; lineweight .25 mm	
26.2.9	Thermal spring used for stock-water supply		H-6 → T	
26.2.10	Mineral spring used for stock-water supply		H-6 → M	
26.2.11	Extinct spring, once used for stock-water supply		3.725 mm; bar lineweight .2 mm	
26.2.12	Spring used for irrigation-water supply		inner circle diameter 1.125 mm; lineweight .15 mm; draft "tail" as shown; "tail" lineweight .2 mm; outer circle diameter 1.75 mm; lineweight .2 mm	
26.2.13	Thermal spring used for irrigation-water supply		H-6 → T	
26.2.14	Mineral spring used for irrigation-water supply		H-6 → M	
26.2.15	Extinct spring, once used for irrigation-water supply		3.725 mm; bar lineweight .2 mm	
26.2.16	Spring used for industrial-water supply		inner dot diameter 1.125 mm; draft "tail" as shown; "tail" lineweight .2 mm; outer circle diameter 1.75 mm; lineweight .2 mm	
26.2.17	Thermal spring used for industrial-water supply		H-6 → T	
26.2.18	Mineral spring used for industrial-water supply		H-6 → M	
26.2.19	Extinct spring, once used for industrial-water supply		3.725 mm; bar lineweight .2 mm	
26.2.20	Spring used for public-water supply		"tail" lineweight .2 mm; draft "tail" as shown; circle diameter 2.0 mm; lineweight .375 mm	
26.2.21	Thermal spring used for public-water supply		H-6 → T	
26.2.22	Mineral spring used for public-water supply		H-6 → M	
26.2.23	Extinct spring, once used for public-water supply		3.725 mm; bar lineweight .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.3—Water gaging stations			
26.3.1	Water gaging station, type of measurement unspecified		2.25 mm; 60°; lineweight .15 mm	May also be shown in cyan or other colors.
26.3.2	Discontinued water gaging station		bar lineweight .3 mm; 3.75 mm; triangle lineweight .2 mm	
26.3.3	Continuous-record water gaging station		2.25 mm; 60°	
26.3.4	Continuous-record water gaging station—Equipped with a telephone or radio		1.25 mm; 60°; 1.5 mm; 60°; .875 mm; "antenna" lineweight .175 mm	
26.3.5	Continuous-record peak-flow measurement water gaging station		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.6	Continuous-record low-flow measurement water gaging station		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.7	Continuous-record stage-measurement water gaging station		3.0 mm; 1.125 mm; bar lineweight .2 mm	
26.3.8	Partial-record water gaging station (floods)		2.25 mm; 60° [same angle for both triangles]; 1.25 mm; outer triangle lineweight .175 mm	
26.3.9	Partial-record water gaging station (floods)—Equipped with a telephone or radio		1.25 mm; 60°; 1.5 mm; 60°; .875 mm; "antenna" lineweight .175 mm	
26.3.10	Partial-record peak-flow measurement water gaging station (floods)		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.11	Partial-record low-flow measurement water gaging station (floods)		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.12	Partial-record stage-measurement water gaging station (floods)		3.0 mm; 1.125 mm; bar lineweight .2 mm	
26.3.13	Measurement site without a gage		2.25 mm; 60°; lineweight .25 mm	
26.3.14	Measurement site without a gage—Equipped with a telephone or radio		1.25 mm; 60°; 1.5 mm; 60°; .875 mm; "antenna" lineweight .175 mm	
26.3.15	Peak-flow measurement site without a gage		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.16	Low-flow measurement site without a gage		25°; 2.0 mm; 1.25 mm; arrow lineweight .15 mm	
26.3.17	Stage-measurement site without a gage		3.0 mm; 1.125 mm; bar lineweight .2 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.4—Quality-of-water sites			
26.4.1	Quality-of-water site, type of measurement unspecified		lineweight .15 mm; 2.25 mm; 60°	May also be shown in cyan or other colors.
26.4.2	Inactive quality-of-water site		triangle lineweight .2 mm; 3.75 mm; bar lineweight .3 mm	
26.4.3	Active quality-of-water site		2.25 mm; 60°	
26.4.4	Active quality-of-water site, chemical measurement		1.25 mm; bar lineweight .25 mm	
26.4.5	Active quality-of-water site, temperature measurement		1.25 mm; bar lineweight .25 mm	
26.4.6	Active quality-of-water site, biological measurement		1.25 mm; bar lineweight .25 mm	
26.4.7	Active quality-of-water site, sediment measurement		1.25 mm; bar lineweight .25 mm	
26.4.8	Active quality-of-water site—Equipped with a monitor		lineweight .375 mm; 2.25 mm; 60°	
26.4.9	Active quality-of-water site, chemical measurement—Equipped with a monitor		1.25 mm; bar lineweight .25 mm	
26.4.10	Active quality-of-water site, temperature measurement—Equipped with a monitor		1.25 mm; bar lineweight .25 mm	
26.4.11	Active quality-of-water site, biological measurement—Equipped with a monitor		1.25 mm; bar lineweight .25 mm	
26.4.12	Active quality-of-water site, sediment measurement—Equipped with a monitor		1.25 mm; bar lineweight .25 mm	

*For more information, see general guidelines on pages A-i to A-v.

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.5—Geohydrologic contours			
26.5.1	Structure contour (index), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Accurately located	600	*lineweight .375 mm* *HI-9* *600* *line and text color 100% red*	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.2	Structure contour (index), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Approximately located		*.5 mm* *5.0 mm*	
26.5.3	Structure contour (intermediate), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Accurately located		*lineweight .275 mm* *line color 100% red*	
26.5.4	Structure contour (intermediate), as shown on hydrologic maps, showing altitude of top or base of, or horizon within, stratigraphic unit, aquifer, or confining bed—Approximately located		*.5 mm* *5.0 mm*	
26.5.5	Bedrock contour (index), as shown on hydrologic maps, showing altitude of bedrock surface—Accurately located	600	*lineweight .375 mm* *HI-9* *600* *line and text color 100% violet*	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.6	Bedrock contour (index), as shown on hydrologic maps, showing altitude of bedrock surface—Approximately located		*.5 mm* *5.0 mm*	
26.5.7	Bedrock contour (intermediate), as shown on hydrologic maps, showing altitude of bedrock surface—Accurately located		*lineweight .275 mm* *line color 100% violet*	
26.5.8	Bedrock contour (intermediate), as shown on hydrologic maps, showing altitude of bedrock surface—Approximately located		*.5 mm* *5.0 mm*	
26.5.9	Water-table contour (index), showing altitude of unconfined water table [date]—Accurately located	600	*lineweight .375 mm* *HI-9* *600* *line and text color 100% cyan*	Use only in reference to unconfined (water-table) conditions. On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.10	Water-table contour (index), showing altitude of unconfined water table [date]—Approximately located		*.5 mm* *5.0 mm*	
26.5.11	Water-table contour (intermediate), showing altitude of unconfined water table [date]—Accurately located		*lineweight .275 mm* *line color 100% cyan*	
26.5.12	Water-table contour (intermediate), showing altitude of unconfined water table [date]—Approximately located		*.5 mm* *5.0 mm*	
26.5.13	Potentiometric or water-level contour (index), showing altitude at which water level would have stood in tightly cased wells [date]—Accurately located	600	*lineweight .375 mm* *HI-9* *600* *line and text color 100% cyan*	Use in reference to either confined (artesian) or unconfined conditions, when they are not differentiated on map. On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.14	Potentiometric or water-level contour (index), showing altitude at which water level would have stood in tightly cased wells [date]—Approximately located		*.5 mm* *5.0 mm*	
26.5.15	Potentiometric or water-level contour (intermediate), showing altitude at which water level would have stood in tightly cased wells [date]—Accurately located		*lineweight .275 mm* *line color 100% cyan*	
26.5.16	Potentiometric or water-level contour (intermediate), showing altitude at which water level would have stood in tightly cased wells [date]—Approximately located		*.5 mm* *5.0 mm*	
26.5.17	Water-quality-zone contour (index), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Accurately located	600	*lineweight .375 mm* *HI-9* *600* *line and text color 100% green*	On most maps, every fourth or fifth contour is an index contour, and usually only index contours are labeled. May be shown in black or other colors.
26.5.18	Water-quality-zone contour (index), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Approximately located		*.5 mm* *5.0 mm*	
26.5.19	Water-quality-zone contour (intermediate), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Accurately located		*lineweight .275 mm* *line color 100% green*	
26.5.20	Water-quality-zone contour (intermediate), showing altitude of top or base of, or horizon within, [type of] water-quality zone or water in aquifer [date]—Approximately located		*.5 mm* *5.0 mm*	

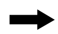
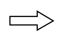
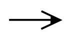
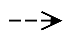
**For more information, see general guidelines on pages A-i to A-v.*

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	26.6—Geohydrologic lines			
26.6.1	Line of equal, average, mean, or median (etc.) annual, monthly, or daily (etc.) precipitation [date]—Accurately located	24	*lineweight .375 mm* *HI-9* 24 *line and text color 100% cyan*	Negative values must be preceded by a minus (–) sign. Date needed only for parameters that vary with time. May be shown in black or other colors.
26.6.2	Line of equal, average, mean, or median (etc.) annual, monthly, or daily (etc.) precipitation [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.3	Line of equal depth to geologic formation, bedrock, aquifer, or water (etc.) [date]—Accurately located	100	*lineweight .375 mm* *HI-9* 100 *line and text color 100% cyan*	
26.6.4	Line of equal depth to geologic formation, bedrock, aquifer, or water (etc.) [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.5	Line of equal thickness of geologic formation, aquifer, confining bed, or saturated material (etc.) [date]—Accurately located	50	*lineweight .375 mm* *HI-9* 50 *line and text color 100% cyan*	
26.6.6	Line of equal thickness of geologic formation, aquifer, confining bed, or saturated material (etc.) [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.7	Line of equal water temperature [date]—Accurately located	10	*lineweight .375 mm* *HI-9* 10 *line and text color 100% cyan*	
26.6.8	Line of equal water temperature [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.9	Line of equal specific conductance [date]—Accurately located	2000	*lineweight .375 mm* *HI-9* 2000 *line and text color 100% cyan*	
26.6.10	Line of equal specific conductance [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.11	Line of equal dissolved-solids concentration, hardness, or chemical-constituent concentration [date]—Accurately located	500	*lineweight .375 mm* *HI-9* 500 *line and text color 100% cyan*	
26.6.12	Line of equal dissolved-solids concentration, hardness, or chemical-constituent concentration [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.13	Line of equal water-level change, rise, or decline [date]—Accurately located	20	*lineweight .375 mm* *HI-9* 20 *line and text color 100% cyan*	
26.6.14	Line of equal water-level change, rise, or decline [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.15	Line of equal runoff [date]—Accurately located	6	*lineweight .375 mm* *HI-9* 6 *line and text color 100% cyan*	
26.6.16	Line of equal runoff [date]—Approximately located		*.5 mm* *5.0 mm*	
26.6.17	Line of equal transmissivity, hydraulic conductivity, or porosity (etc.)—Accurately located	10,000	*lineweight .375 mm* *HI-9* 10,000 *line and text color 100% cyan*	
26.6.18	Line of equal transmissivity, hydraulic conductivity, or porosity (etc.)—Approximately located		*.5 mm* *5.0 mm*	

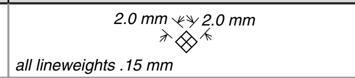
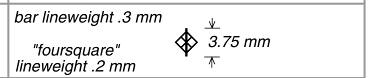
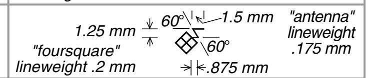
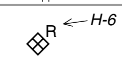
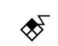
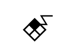
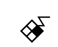
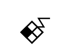
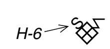
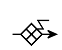
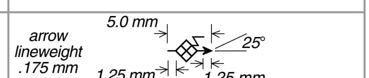
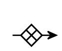
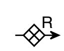
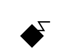
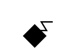
**For more information, see general guidelines on pages A-i to A-v.*

26—GEOHYDROLOGIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
26.7—Miscellaneous geohydrologic features				
26.7.1	Watershed basin boundary, drainage divide, or surface-water basin boundary		*lineweight .6 mm; dash length 7.5 mm; dot diameter .625 mm; spacing .5 mm*	May also be shown in cyan or other colors.
26.7.2	Watershed subbasin boundary, drainage subdivide, or surface-water subbasin boundary		*lineweight .425 mm; dash length 5.0 mm; dot diameter .45 mm; spacing .5 mm*	
26.7.3	Ground-water divide—Accurately located		*dot diameter .675 mm; spacing .575 mm*	
26.7.4	Ground-water divide—Approximately located		*lineweight .15 mm; circle diameter .675 mm; spacing .575 mm*	
26.7.5	Ground-water barrier (geologic)—Accurately loca-ted		*lineweight .175 mm; dot diameter .675 mm; spacing .575 mm*	
26.7.6	Ground-water barrier (geologic)—Approximately located		*lineweight .175 mm; circle lineweight .15 mm; diameter .675 mm; spacing .575 mm*	
26.7.7	Infiltration gallery		*all lineweights .15 mm; 1.75 mm; 1.125 mm; .625 mm*	
26.7.8	Direction of ground-water flow (1st option)—Accurately located		*5.75 mm; 1.125 mm; 30°; 2.125 mm*	
26.7.9	Direction of ground-water flow (2nd option)—Accurately located		*lineweight .15 mm*	
26.7.10	Direction of ground-water flow (1st option)—Approximately located		*6.75 mm; 25°; all lineweights .25 mm; 2.75 mm; 1.5 mm*	
26.7.11	Direction of ground-water flow (2nd option)—Approximately located		*dash 1.5 mm; space .5 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

27—WEATHER STATIONS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
27.1	Weather station, type of measurement unspecified		 2.0 mm 2.0 mm all lineweights .15 mm	
27.2	Discontinued weather station		 bar lineweight .3 mm 3.75 mm "foursquare" lineweight .2 mm	
27.3	Snow-survey course—Equipped with a telephone or radio		 1.25 mm 60° 1.5 mm "antenna" lineweight .175 mm "foursquare" lineweight .2 mm 60° .875 mm	
27.4	Snow-survey course—Equipped with a recorder		 R H-6	
27.5	Weather station measuring precipitation—Equipped with a telephone or radio			
27.6	Weather station measuring precipitation—Equipped with a recorder			
27.7	Weather station measuring evaporation—Equipped with a telephone or radio			
27.8	Weather station measuring evaporation—Equipped with a recorder			
27.9	Weather station measuring temperature—Equipped with a telephone or radio			
27.10	Weather station measuring temperature—Equipped with a recorder			
27.11	Weather station measuring humidity—Equipped with a telephone or radio			
27.12	Weather station measuring humidity—Equipped with a recorder			
27.13	Weather station measuring solar radiation—Equipped with a telephone or radio		 H-6	
27.14	Weather station measuring solar radiation—Equipped with a recorder			
27.15	Weather station measuring wind velocity—Equipped with a telephone or radio		 arrow lineweight .175 mm 5.0 mm 25° 1.25 mm 1.25 mm	
27.16	Weather station measuring wind velocity—Equipped with a recorder			
27.17	Complete weather station—Equipped with a telephone or radio			
27.18	Complete weather station—Equipped with a recorder			

*For more information, see general guidelines on pages A-i to A-v.

28—TRANSPORTATION FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
28.1	Highway (generic)		*lineweight .325 mm; line color 70% black*	May be used on non-topographic maps to show highways and streets.
28.2	Road or street (generic)		*lineweight .25 mm; line color 50% black*	
28.3	Primary highway, undivided (Class 1)		*outlines: lineweight .125 mm in 100% black* *.5 mm* *fill: lineweight .5 mm; line color 100% red*	
28.4	Primary highway, divided by centerline (Class 1)		*.5 mm* *.5 mm*	
28.5	Primary highway, divided by median strip (Class 1)		*.5 mm* *spacing may vary*	
28.6	Secondary highway, undivided (Class 2)		*fill: dash length 3.0 mm; space 3.0 mm*	
28.7	Secondary highway, divided by centerline (Class 2)		*.5 mm* *.5 mm*	
28.8	Secondary highway, divided by median strip (Class 2)		*.5 mm* *spacing may vary*	
28.9	Light-duty road, paved (Class 3)		*outlines: lineweight .125 mm in 100% black* *.5 mm* *fill: lineweight .5 mm; line color 50% black*	
28.10	Light-duty road, gravel (Class 3)		*.5 mm* *fill: dash length 3.0 mm; space 1.5 mm*	
28.11	Light-duty road, dirt (Class 3)		*.5 mm* *fill: dash length 1.5 mm; space 3.0 mm*	
28.12	Street in urban area; light-duty road, composition unspecified (Class 3)		*lineweights .125 mm* *.5 mm*	
28.13	Unimproved road (Class 4)		*lineweights .125 mm* *.5 mm* *dash length 1.25 mm; space .5 mm*	
28.14	Four-wheel-drive road (Class 5)	4WD	*lineweights .125 mm* *4WD* *HI-5* *.5 mm* *dash length 1.25 mm; space .5 mm*	
28.15	Trail		*lineweight .15 mm* *dash length 1.25 mm; space .5 mm*	
28.16	Interstate route marker	70	*H-6 (100% red)* *draft as shown* 70 *lineweight .2 mm; line color 100% red*	
28.17	U.S. route marker	25	*H-6 (100% red)* *draft as shown* 25 *lineweight .2 mm; line color 100% red*	
28.18	State route marker	36	*H-6 (100% red)* *circle diameter 4.375 mm* 36 *lineweight .2 mm; line color 100% red*	
28.19	Railroad (single track)		*all lineweights .125 mm* *1.0 mm* *5.0 mm*	
28.20	Railroad (more than one track)—Showing number of tracks	4 TRACKS	*all lineweights .125 mm* *5.0 mm* *1.325 mm* *4 TRACKS* *HI-5* *.5 mm*	

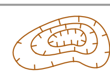
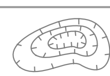
**For more information, see general guidelines on pages A-i to A-v.*

29—BOUNDARIES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
29.1	Boundary—National	UNITED STATES MEXICO	*long dash 6.35 mm;* UNITED STATES *lineweight .4 mm* *short dashes 1.75 mm; space .835 mm* MEXICO *T-9*	
29.2	Boundary—State, territory	NEBRASKA KANSAS	*long dash 6.35 mm;* NEBRASKA *lineweight .3 mm* *short dashes 1.75 mm; space .835 mm* KANSAS *T-8*	
29.3	Boundary—County, parish, Alaska borough, municipio, judicial division	HUMBOLDT MENDOCINO	*long dash 6.35 mm;* HUMBOLDT *lineweight .25 mm* *short dash 1.75 mm; space .835 mm* MENDOCINO *T-7*	
29.4	Boundary—Civil township, town, district, precinct, barrio		*lineweight .175 mm* *dash length 4.325 mm; space .835 mm*	
29.5	Boundary—Incorporated city, village, town, borough, or hamlet		*lineweight .175 mm* *long dash 2.0 mm; short dash 1.0 mm; space .5 mm*	
29.6	Boundary—National or state park, monument, reservation, forest, grassland, wilderness area, or wildlife refuge; Hawaii Homestead, Forest Reserve		*lineweight .175 mm* *dot diameter .25 mm* *dash length 6.35 mm; space 2.5 mm*	
29.7	Boundary—Small park		*lineweight .125 mm* *dash length 1.0 mm; space .5 mm*	
29.8	Continental Divide	CONTINENTAL DIVIDE	*lineweight .3 mm* CONTINENTAL *HI-5* DIVIDE *dash 10.0 mm; space 2.5 mm*	

**For more information, see general guidelines on pages A-i to A-v.*

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.1—Topographic, bathymetric, and glacier contours				
30.1.1	Index topographic contour (1st option)	300	lineweight .25 mm; 300; HI-6; line and text color 100% brown	On most maps, every fourth or fifth contour is an index contour. Usually only index and supplementary contours are labeled. Negative values must be preceded by a minus (–) sign.
30.1.2	Index topographic contour (1st option)—Approximate or indefinite	200	1.75 mm; .5 mm; 200; HI-6	
30.1.3	Intermediate topographic contour (1st option)		lineweight .15 mm; line color 100% brown	
30.1.4	Intermediate topographic contour (1st option)—Approximate or indefinite		1.75 mm; .5 mm	
30.1.5	Supplementary topographic contour (1st option)	185	lineweight .2 mm; 185; HI-6; line and text color 100% brown	
30.1.6	Supplementary topographic contour (1st option)—Approximate or indefinite	145	1.75 mm; .5 mm; 145; HI-6	
30.1.7	Index topographic depression contour (1st option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm; contour lineweight .25 mm; line color 100% brown	Hachures are added to indicate closed areas of low values.
30.1.8	Intermediate topographic depression contour (1st option)		tick length .5 mm; spacing 3.0 mm; all lineweights .15 mm; line color 100% brown	
30.1.9	Supplementary topographic depression contour (1st option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm; contour lineweight .2 mm; line color 100% brown	
30.1.10	Topographic depression contours (1st option)—Showing tick spacing of adjacent contours		tick spacing 1.0 mm on lowest contour; on next contour, 2.0 mm; on all others, 3.0 mm; (lineweights, etc., are given above)	
30.1.11	Index topographic contour (2nd option)	300	lineweight .25 mm; 300; HI-6; line and text color 50% black	On most maps, every fourth or fifth contour is an index contour. Usually only index and supplementary contours are labeled. Negative values must be preceded by a minus (–) sign.
30.1.12	Index topographic contour (2nd option)—Approximate or indefinite	200	1.75 mm; .5 mm; 200; HI-6	
30.1.13	Intermediate topographic contour (2nd option)		lineweight .15 mm; line color 50% black	
30.1.14	Intermediate topographic contour (2nd option)—Approximate or indefinite		1.75 mm; .5 mm	
30.1.15	Supplementary topographic contour (2nd option)	185	lineweight .2 mm; 185; HI-6; line and text color 50% black	
30.1.16	Supplementary topographic contour (2nd option)—Approximate or indefinite	145	1.75 mm; .5 mm; 145; HI-6	
30.1.17	Index topographic depression contour (2nd option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm; contour lineweight .25 mm; line color 50% black	Hachures are added to indicate closed areas of low values.
30.1.18	Intermediate topographic depression contour (2nd option)		tick length .5 mm; spacing 3.0 mm; all lineweights .15 mm; line color 50% black	
30.1.19	Supplementary topographic depression contour (2nd option)		tick lineweight .15 mm; length .5 mm; spacing 3.0 mm; contour lineweight .2 mm; line color 50% black	
30.1.20	Topographic depression contours (2nd option)—Showing tick spacing of adjacent contours		tick spacing 1.0 mm on lowest contour; on next contour, 2.0 mm; on all others, 3.0 mm; (lineweights, etc., are given above)	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
30.1—Topographic, bathymetric, and glacier contours (continued)				
30.1.21	Index primary bathymetric contour	250	lineweight .275 mm; 250; HI-6	On most maps, every fourth or fifth contour is an index contour.
30.1.22	Index primary bathymetric contour—Approximate	150	5.0 mm; 1.5 mm; 150; HI-6	Do not break contours for contour values.
30.1.23	Primary bathymetric contour	50	lineweight .175 mm; 50; HI-6	Bathymetric contour values are always given in "below sea-level" units, so they are not preceded by a minus (–) sign.
30.1.24	Primary bathymetric contour—Approximate	25	5.0 mm; 1.5 mm; 25; HI-6	
30.1.25	Supplementary bathymetric contour	12	lineweight .2 mm; 12; HI-6 (100% black); line color 40% black	
30.1.26	Supplementary bathymetric contour—Approximate	8	5.0 mm; 1.5 mm; 8; HI-6 (100% black)	
30.1.27	Index bathymetric contour	20	lineweight .25 mm; 20; HI-6 (100% black); line color 100% cyan	
30.1.28	Index bathymetric contour—Approximate	10	5.0 mm; 1.5 mm; 10; HI-6 (100% black)	
30.1.29	Intermediate bathymetric contour	2	lineweight .15 mm; 2; HI-6 (100% black); line color 100% cyan	
30.1.30	Intermediate bathymetric contour—Approximate	1	5.0 mm; 1.5 mm; 1; HI-6 (100% black)	
30.1.31	Index primary bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies); contour lineweight .275 mm	Hachures are added to the lowest contour(s) to indicate a closed area of low values (depression) and also an area of higher value (rise) inside a depression.
30.1.32	Index primary bathymetric rise contour (inside depression)			
30.1.33	Primary bathymetric depression contour		tick length .375 mm (spacing varies); all lineweights .175 mm	
30.1.34	Primary bathymetric rise contour (inside depression)			
30.1.35	Supplementary bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies); contour lineweight .2 mm; line color 40% black	
30.1.36	Supplementary bathymetric rise contour (inside depression)			
30.1.37	Index bathymetric depression contour		tick lineweight .175 mm; length .375 mm (spacing varies); contour lineweight .25 mm; line color 100% cyan	
30.1.38	Index bathymetric rise contour (inside depression)			
30.1.39	Intermediate bathymetric depression contour		tick length .375 mm (spacing varies); all lineweights .15 mm; line color 100% cyan	
30.1.40	Intermediate bathymetric rise contour (inside depression)			
30.1.41	Bathymetric rise contour (inside depression)—Showing hachure spacing for closed contours less than 12.7 mm in circumference		tick spacing 1.0 mm; show ticks on lowest two contours only	
30.1.42	Bathymetric depression contours—Showing hachure spacing for closed contours less than 12.7 mm in circumference		tick spacing 1.0 mm; show ticks on lowest contour only	
30.1.43	Bathymetric depression or rise contours—Showing hachure spacing for closed contours between 12.7 mm and 76.2 mm in circumference		tick spacing 2.0 mm	
30.1.44	Bathymetric depression or rise contours—Showing hachure spacing for closed contours more than 76.2 mm in circumference		tick spacing 2.5 mm	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE
30.1—Topographic, bathymetric, and glacier contours (continued)				
30.1.45	Index contour on glacier or permanent snowfield		*lineweight .225 mm* *line color 100% cyan*	On most maps, every fourth or fifth contour is an index contour.
30.1.46	Index contour on glacier or permanent snowfield—Approximate or indefinite		*2.5 mm* *.5 mm*	
30.1.47	Intermediate contour on glacier or permanent snowfield		*lineweight .125 mm* *line color 100% cyan*	
30.1.48	Intermediate contour on glacier or permanent snowfield—Approximate or indefinite		*2.5 mm* *.5 mm*	
30.1.49	Index depression contour on glacier or permanent snowfield		*tick lineweight .15 mm; length .5 mm; spacing 3.0 mm* *contour lineweight .225 mm* *line color 100% cyan*	Hachures are added to indicate closed areas of low values.
30.1.50	Intermediate depression contour on glacier or permanent snowfield—Approximate or indefinite		*tick length .5 mm; spacing 3.0 mm* *all lineweights .125 mm* *line color 100% cyan*	

**For more information, see general guidelines on pages A-i to A-v.*

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	30.2—Drainage features			
30.2.1	Perennial river, stream, or creek (single-line drainage)	Colma Creek	Colma Creek; TI-8 (100% black); lineweight .2 mm; line color 100% cyan	Letter size and spacing may be increased along longer features.
30.2.2	Intermittent river, stream, creek, or wash (single-line drainage)		lineweight .2 mm; long dash length 4.3 mm; very short dash, .2 mm; spacing .6 mm; color 100% cyan	
30.2.3	Perennial river, stream, or creek (double-line drainage)	Yuba River	TI-8 (100% black); Yuba River; color fill 20% cyan; spacing may vary; all lineweights .2 mm	Letter size and spacing may be increased along wider features.
30.2.4	River mileage marker	Mile 49	Mile 49; H-6; lineweight .2 mm	
30.2.5	Intermittent river, stream, creek, or wash (double-line drainage)		pattern 132-C	
30.2.6	Braided river, stream, or creek		all lineweights .2 mm; color 100% cyan	
30.2.7	Canal or ditch (single-line drainage)	HIGHLINE CANAL	HIGHLINE CANAL; HI-6 (100% cyan); lineweight .2 mm	
30.2.8	Canal or ditch (double-line drainage)	ERIE CANAL	ERIE CANAL; color fill 20% cyan; spacing may vary; all lineweights .2 mm	
30.2.9	Canal lock (single-line drainage) (1st option)	Lock	1.25 mm; Lock; H-6 (100% black); lineweight .35 mm	
30.2.10	Canal lock (single-line drainage) (2nd option)	Lock	Lock	
30.2.11	Canal lock (double-line drainage)	Lock	Lock; lineweight .35 mm; width may vary	
30.2.12	Floodgate	Floodgate	Floodgate; H-6 (100% black); lineweight .35 mm	
30.2.13	Tidegate	Tidegate	Tidegate; H-6 (100% black); lineweight .35 mm	
30.2.14	Sluice gate	Sluice Gate	Sluice Gate; H-6 (100% black); lineweight .35 mm	
30.2.15	Fish ladder	Fish Ladder	Fish Ladder; H-6 (100% black); lineweight .5 mm; length may vary	
30.2.16	Aqueduct (single-line drainage)	AQUEDUCT	AQUEDUCT; HI-6 (100% cyan); lineweight .2 mm	
30.2.17	Aqueduct (double-line drainage)	AQUEDUCT	AQUEDUCT; color fill 20% cyan; spacing may vary; all lineweights .2 mm	
30.2.18	Underground or underwater aqueduct	AQUEDUCT	AQUEDUCT; dash length 1.25 mm; spacing .5 mm	
30.2.19	Aboveground water pipeline	ABOVEGROUND PIPELINE	ABOVEGROUND PIPELINE; HI-6 (100% cyan)	
30.2.20	Underground or submerged water pipeline	PIPELINE	PIPELINE; HI-6 (100% cyan); dash length 1.25 mm; spacing .5 mm	
30.2.21	Elevated water pipeline	ELEVATED	wing length .575 mm; angle 45°; ELEVATED; HI-6 (100% cyan); all lineweights .2 mm	
30.2.22	Flume	FLUME	FLUME; HI-6 (100% cyan)	
30.2.23	Siphon	SIPHON	SIPHON; HI-6 (100% cyan); dash length 1.25 mm; spacing .5 mm	
30.2.24	Penstock	PENSTOCK	PENSTOCK; HI-6 (100% cyan)	

*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	30.2—Drainage features (continued)			
30.2.25	Falls (single-line drainage)	*Falls*	TBI-7 (100% black); all lineweights .2 mm; line color 100% cyan; *Falls*; 1.25 mm	
30.2.26	Falls (double-line drainage)	*Falls*	*Falls*; lineweights .125 mm	
30.2.27	Rapids (single-line drainage)	*Rapids*	.6 mm; *Rapids*; 1.25 mm	
30.2.28	Rapids (double-line drainage)	*Rapids*	*Rapids*; lineweights .125 mm	
30.2.29	Shoreline—Showing open water		line color 100% cyan; color fill 20% cyan; lineweight .2 mm	
30.2.30	Indefinite or unsurveyed shoreline		dash length 1.75 mm; spacing .5 mm	
30.2.31	Approximate mean low water line		lineweight .15 mm	
30.2.32	Perennial lake or pond—Showing name	*Bass Lake*	TI-8 (100% black); *Bass Lake*; color fill 20% cyan; line color 100% cyan; lineweight .2 mm	Letter size and spacing may be increased within larger features.
30.2.33	Intermittent lake or pond		lineweight .2 mm; dash length 1.75 mm; spacing .5 mm; pattern 132-C; line color 100% cyan	
30.2.34	Dry lake or pond		pattern 132-B	
30.2.35	Land subject to inundation		pattern 231-C (@90%)	
30.2.36	Reservoir with natural shoreline		line color 100% cyan; color fill 20% cyan	
30.2.37	Dammed reservoir		color fill 20% cyan; lineweight .3 mm	
30.2.38	Area to be submerged behind dam		pattern 132-C	
30.2.39	Reservoir (uncovered) with man-made shoreline		color fill 20% cyan; lineweight .15 mm	
30.2.40	Covered water storage reservoir		pattern 214-K (@45°) [pattern overprints 20% cyan color fill]; lineweight .15 mm	
30.2.41	Salt flat	Salt Flat	H-7; Salt Flat; line color 100% cyan; lineweight .2 mm	
30.2.42	Carolina bay		dash length 1.75 mm; spacing .5 mm; line color 100% cyan; lineweight .2 mm	
30.2.43	Tailings pond	Tailings Pond	H-7; Tailings Pond; pattern 232-B; line color 100% brown; dash length 1.75 mm; spacing .5 mm; lineweight .2 mm	
30.2.44	Outline of glacier or permanent snowfield		color 100% cyan; lineweight .2 mm; dash length 1.75 mm; spacing .5 mm	
30.2.45	Outline of glacier or permanent snowfield—Form lines show glacial trend		pattern 522-C (rotated perpendicular to glacial trend)	
30.2.46	Marsh, wetland, swamp, or bog		pattern 420-C	
30.2.47	Mangrove area		pattern 424-C	
30.2.48	Rice field		pattern 423-C	

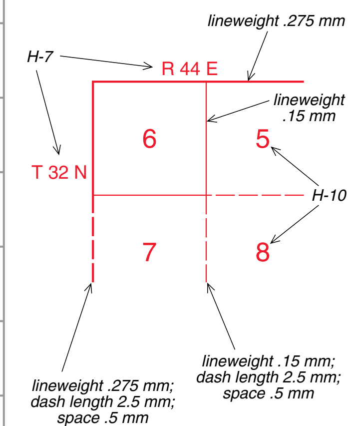
*For more information, see general guidelines on pages A-i to A-v.

30—TOPOGRAPHIC AND HYDROGRAPHIC FEATURES (continued)

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
	30.3—Miscellaneous topographic and hydrographic features			
30.3.1	Open pit mine or quarry, as shown on topographic maps or on general-purpose or smaller scale maps	Quarry	H-7 Quarry; draft as shown	
30.3.2	Gravel, sand, clay, or borrow pit, as shown on topographic maps or on general-purpose or smaller scale maps	Gravel Pit	H-7 Gravel Pit; 2.235 mm; .75 mm; lineweight .15 mm	
30.3.3	Adit or mine tunnel entrance, as shown on topographic maps or on general-purpose or smaller scale maps	Mine	H-7 Mine; 2.225 mm; all lineweights .15 mm; 55°; 1.175 mm; 1.75 mm	Rotate symbol so that long line points in direction of cave or mine entrance.
30.3.4	Cave entrance, as shown on topographic maps or on general-purpose or smaller scale maps	Cave	H-7 Cave	
30.3.5	Prospect, as shown on topographic maps or on general-purpose or smaller scale maps	Prospect	H-7 Prospect; lineweight .15 mm; 1.75 mm; 45°	
30.3.6	Mine shaft, as shown on topographic maps or on general-purpose or smaller scale maps—Showing name	Garnet Mine	lineweight .15 mm; Garnet Mine H-7; 1.0 mm	
30.3.7	Landmark object, as shown on topographic maps or on general-purpose or smaller scale maps	Lookout	H-7 Lookout; dot diameter .225 mm; lineweight .15 mm; circle diameter 1.0 mm	Add label for type of object (as is shown for example of "lookout").
30.3.8	Windmill, as shown on topographic maps or on general-purpose or smaller scale maps	Windmill	H-7 Windmill; 1.125 mm; 1.25 mm; windmill arm angles 110°, 70°; .675 mm; lineweight .15 mm	
30.3.9	Oil or gas well, as shown on topographic maps or on general-purpose or smaller scale maps	Well	H-7 Well; circle diameter 1.0 mm; lineweight .15 mm	
30.3.10	Water well, as shown on topographic maps or on general-purpose or smaller scale maps	Well	H-7 Well; circle diameter 1.0 mm; line color 100% cyan; lineweight .2 mm	
30.3.11	Geothermal well, as shown on topographic maps or on general-purpose or smaller scale maps	Geothermal	H-7 Geothermal; circle diameter 1.0 mm; line color 100% cyan; lineweight .2 mm	
30.3.12	Spring, as shown on topographic maps or on general-purpose or smaller scale maps	Spring	circle diameter 1.0 mm; draft "tail" as shown; H-7 Spring; line color 100% cyan; lineweight .2 mm	
30.3.13	Geyser, fumarole, mud pot, or thermal spring, as shown on topographic maps or on general-purpose or smaller scale maps	Geyser	H-7 Geyser; circle diameter 1.0 mm; line color 100% cyan; lineweight .2 mm	
30.3.14	Gaging station, as shown on topographic maps or on general-purpose or smaller scale maps	Gaging Station	H-7 Gaging Station; circle diameter 1.25 mm; lineweight .15 mm	
30.3.15	Pumping station, as shown on topographic maps or on general-purpose or smaller scale maps	Pumping Station	H-7 Pumping Station; .875 mm	
30.3.16	Rock	Rock	H-7 Rock; 60°; lineweight .2 mm; 1.25 mm	
30.3.17	Exposed wreck		lineweight .15 mm; draft as shown	
30.3.18	Coral reef	Coral	H-7 Coral; lineweight .15 mm	
30.3.19	Shoal	Shoal	dash length .2 mm; spacing .425 mm; Shoal H-7; lineweight .2 mm	
30.3.20	Ruins	Ruins	dash length 1.0 mm; spacing .5 mm; Ruins H-7; lineweight .15 mm	
30.3.21	Power transmission line		lineweight .125 mm; dot diameter .425 mm; .825 mm; .425 mm	
30.3.22	Telephone line	TELEPHONE	lineweight .125 mm; TELEPHONE HI-5; dash length 2.5 mm; space .5 mm	
30.3.23	Underground gas or oil pipeline	PIPELINE	PIPELINE HI-5; lineweight .125 mm	
30.3.24	Aboveground gas or oil pipeline	ABOVEGROUND PIPELINE	ABOVEGROUND PIPELINE HI-5; lineweight .125 mm	

*For more information, see general guidelines on pages A-i to A-v.

31—MISCELLANEOUS MAP ELEMENTS

REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
31.1	Township and range line—Definite		*line and text color 100% red* 	On larger scale maps (for example, 1:24,000 scale), usually every section (nos. 1–36) is numbered. On smaller scale maps (for example, 1:100,000 scale), usually only corner sections (nos. 1, 6, 31, 36) are numbered (type size may be decreased if necessary). Every township and range, regardless of scale, should be numbered. May also be shown in 50% black, especially if contours or other base-map information is shown in 50% black (see Section 30.1).
31.2	Township and range line—Location approximate			
31.3	Township label	T 32 N		
31.4	Range label	R 44 E		
31.5	Section line—Definite			
31.6	Section line—Location approximate			
31.7	Section number	5		
31.8	Map neatline		*lineweight .25 mm*	
31.9	Map neatline—Showing latitude or longitude tick and value	40°37'30"	40°37'30" *H-8* *2.0 mm* *lineweight .25 mm*	
31.10	Cross section line and label	A A'	*lineweight .2 mm* A A' *TBI-12*	
31.11	Leader		*lineweight .175 mm*	
31.12	Map-unit label (add leader where necessary)	Qal Qof	*[contact lineweight .15 mm]* *H-8* Qal Qof *H-8* *[leader lineweight .175 mm]*	
31.13	Map-unit label containing geologic age character (add leader where necessary)	₸g Mzv	*FG-8 (or H-8)* *FG-8* ₸g Mzv *FG-8 (or H-8)* *FG-8*	
31.14	Area of outcrop (1st option)		*100% black*	Patterns should overprint other map units. Do not outline with contact (use scratch boundary instead). May be shown in other colors.
31.15	Area of outcrop (2nd option)		*scratch boundary [lineweight 0.0 mm]* *50% black*	
31.16	Area of outcrop (3rd option)		*100% red*	
31.17	Area of outcrop (4th option)		*50% red*	
31.18	Area of outcrop in surficial deposits (1st option)		*pattern 134-K*	
31.19	Area of outcrop in surficial deposits (2nd option)		*pattern 134-K in 50% black*	
31.20	Area of outcrop in surficial deposits (3rd option)		*pattern 134-R*	
31.21	Sample locality—Showing sample number	• 98-103	• 98-103 *H-7* *dot diameter 1.25 mm*	May be shown in red or other colors.
31.22	Field station locality, as shown on small-scale maps or on page-size illustrations	•	• *dot diameter .5 mm*	
31.23	Chronostratigraphic zone, chronozone, or stage boundary	....	*dot diameter .5 mm; spacing .5 mm* .... *color 100% red*	May be shown in black or other colors. Names may either be placed along zone boundary or within zones.
31.24	Chronostratigraphic-zone, chronozone, or stage boundary—Showing names of stratigraphic ages	Aptian .... Albian	Aptian *H-8* .... Albian *color 100% red*	

*For more information, see general guidelines on pages A-i to A-v.

32—GEOLOGIC AGE SYMBOL FONT ("FGDCGeoAge")

REF NO	STRATIGRAPHIC AGE	SUBDIVISION TYPE	AGE SYMBOL*	KEYBOARD POSITION FOR "FGDCGeoAge" FONT*
32.1	Cenozoic	Era	Cz	{ (left curly bracket = shift–left square bracket)
32.2	Quaternary	Period	Q	No keyboard substitution needed (or, use Helvetica)
32.3	Tertiary	Period	T	No keyboard substitution needed (or, use Helvetica)
32.4	Neogene	Subperiod	N	No keyboard substitution needed (or, use Helvetica)
32.5	Paleogene	Subperiod	Pe	: (colon = shift–semi-colon)
32.6	Mesozoic	Era	Mz	} (right curly bracket = shift–right square bracket)
32.7	Cretaceous	Period	K	No keyboard substitution needed (or, use Helvetica)
32.8	Jurassic	Period	J	No keyboard substitution needed (or, use Helvetica)
32.9	Triassic	Period	TR	^ (caret = shift-6)
32.10	Paleozoic	Era	Pz	| (vertical line = shift-backslash)
32.11	Permian	Period	P	No keyboard substitution needed (or, use Helvetica)
32.12	Carboniferous	Period	C	No keyboard substitution needed (or, use Helvetica)
32.13	Pennsylvanian	Period	IP	* (asterisk = shift-8)
32.14	Mississippian	Period	M	No keyboard substitution needed (or, use Helvetica)
32.15	Devonian	Period	D	No keyboard substitution needed (or, use Helvetica)
32.16	Silurian	Period	S	No keyboard substitution needed (or, use Helvetica)
32.17	Ordovician	Period	O	No keyboard substitution needed (or, use Helvetica)
32.18	Cambrian	Period	Є	_ (underscore = shift-hyphen)
32.19	Precambrian	Era	pЄ	= (equal sign)
32.20	Proterozoic	Eon	Ᵽ	< ("less than" sign = shift-comma)
32.21	Late Proterozoic	Era	Z	No keyboard substitution needed (or, use Helvetica)
32.22	Middle Proterozoic	Era	Y	No keyboard substitution needed (or, use Helvetica)
32.23	Late Middle Proterozoic	Era	Y^3	` (accent grave)
32.24	Middle Middle Proterozoic	Era	Y^2	~ (shift–accent grave)

**For more information, see general guidelines on pages A-i to A-v.*

32—GEOLOGIC AGE SYMBOL FONT ("FGDCGeoAge") (continued)

REF NO	STRATIGRAPHIC AGE	SUBDIVISION TYPE	AGE SYMBOL*	KEYBOARD POSITION FOR "FGDCGeoAge" FONT*
32.25	Early Middle Proterozoic	Era	Y^1	! (exclamation point = shift-1[one])
32.26	Early Proterozoic	Era	X	No keyboard substitution needed (or, use Helvetica)
32.27	Late Early Proterozoic	Era	X^3	@ ("at" sign = shift-2)
32.28	Middle Early Proterozoic	Era	X^2	# (pound sign = shift-3)
32.29	Early Early Proterozoic	Era	X^1	$ (dollar sign = shift-4)
32.30	Archean	Eon	A	No keyboard substitution needed (or, use Helvetica)
32.31	Late Archean	Era	W	No keyboard substitution needed (or, use Helvetica)
32.32	Middle Archean	Era	V	No keyboard substitution needed (or, use Helvetica)
32.33	Early Archean	Era	U	No keyboard substitution needed (or, use Helvetica)
32.34	pre-Archean	Eon	pA	> ("greater than" sign = shift-period)

**For more information, see general guidelines on pages A-i to A-v.*

33—SUGGESTED RANGES OF MAP-UNIT COLORS FOR VOLCANIC AND PLUTONIC ROCKS AND FOR STRATIGRAPHIC AGES OF SEDIMENTARY AND METAMORPHIC ROCKS

CMYK* values (K = 0): A = 8%; 1 = 13%; 2 = 20%; 3 = 30%; 4 = 40%; 5 = 50%; 6 = 60%; 7 = 70%; X = 100%

33.1—Suggested range of map-unit colors for volcanic and plutonic rocks*

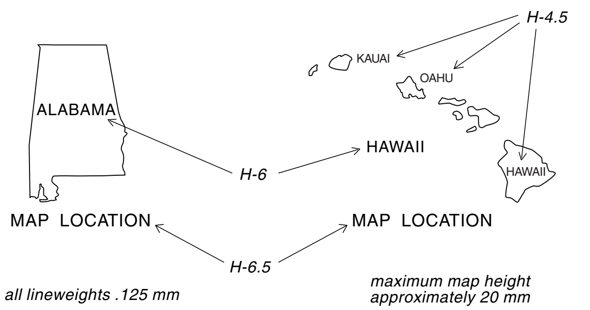
010	030	050	070	0X0	057	07X	036	047	05X
A60	270	3X0	150	370	5X0	033	055	077	0XX

33.2—Suggested range of map-unit colors for stratigraphic ages of sedimentary and metamorphic rocks*

Q 007	001	0A6	005	003			
T 037	0A3	A4X	A37	026	014	A25	024
K 507	104	517	415	406	305		
J 604	202	705	504	303			
TR 602	20A	6A3	402	301			
P 600	300	701	501	40A			
IP 620	4A0	72A	61A	510			
M 431	21A	531	42A	32A			
D 540	220	650	440	330			
S 350	A20	460	34A	230			
O 051	02A	A51	041	031			
Є 054	022	A54	043	A33			
pЄ 446	A11	455	344	233	122	121	
	A12	457	346	235	124	A13	
	1A3	537	436	326	324	214	
	1AA	533	433	422	322	211	

For more information, see general guidelines on pages A-i to A-v.

34—STATE LOCATION MAPS

CARTOGRAPHIC SPECIFICATIONS	NOTES ON USAGE
	State location maps are at various scales; projection is Albers Equal-Area, based on parallels 29 1/2° and 45 1/2°. Maps are modified from the United States Base Map (U.S. Geological Survey, 1965, scale 1:3,168,000) and the Digital Shaded-Relief Image of Alaska (J.R. Riehle and others, 1997, U.S. Geological Survey Miscellaneous Investigations Map I-2585, scale 1:2,500,000; see fig. 2, approximate scale 1:8,000,000). To show a quadrangle or map-area location, place a small black-filled rectangle (■) or polygon (■) that shows the approximate location within state (adjust size and shape accordingly). Reposition state name if necessary. If a quadrangle or map-area location is within two or more adjoining states, create one new location map that contains each state by extracting states from location map of 48 conterminous states (see Section 34.2). Rotate new location map so that it is approximately horizontal, and resize it so that it is about 2–2.5 cm high. Add rectangle or polygon showing location of mapped area, then add names to each state. Center "MAP LOCATION" below new location map.

34.1—Individual states; District of Columbia; Guam; Puerto Rico; U.S. Virgin Islands

34—STATE LOCATION MAPS (continued)

34.1—Individual states; District of Columbia; Guam; Puerto Rico; U.S. Virgin Islands (continued)

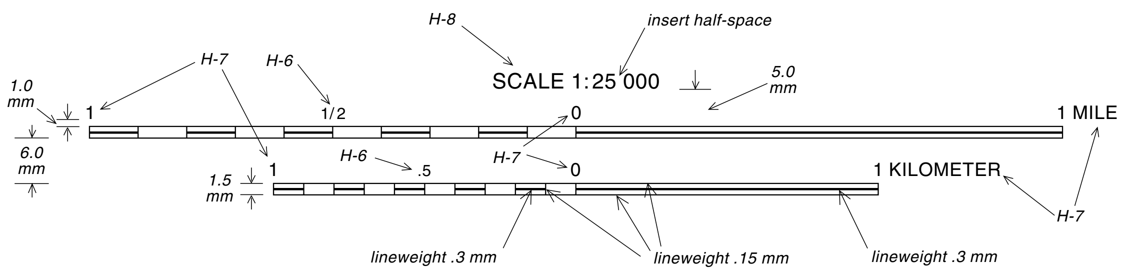
34—STATE LOCATION MAPS (continued)

34.2—Conterminous states

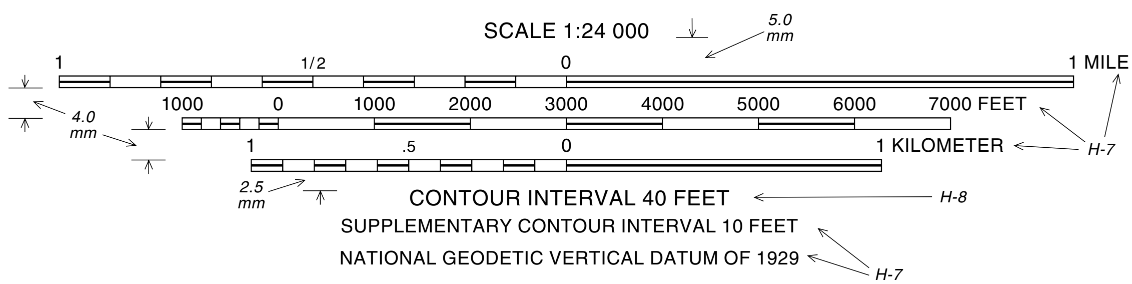
35—BAR SCALES

CARTOGRAPHIC SPECIFICATIONS

2 UNITS OF MEASUREMENT:



3 UNITS OF MEASUREMENT:



DISTANCE MEASURES

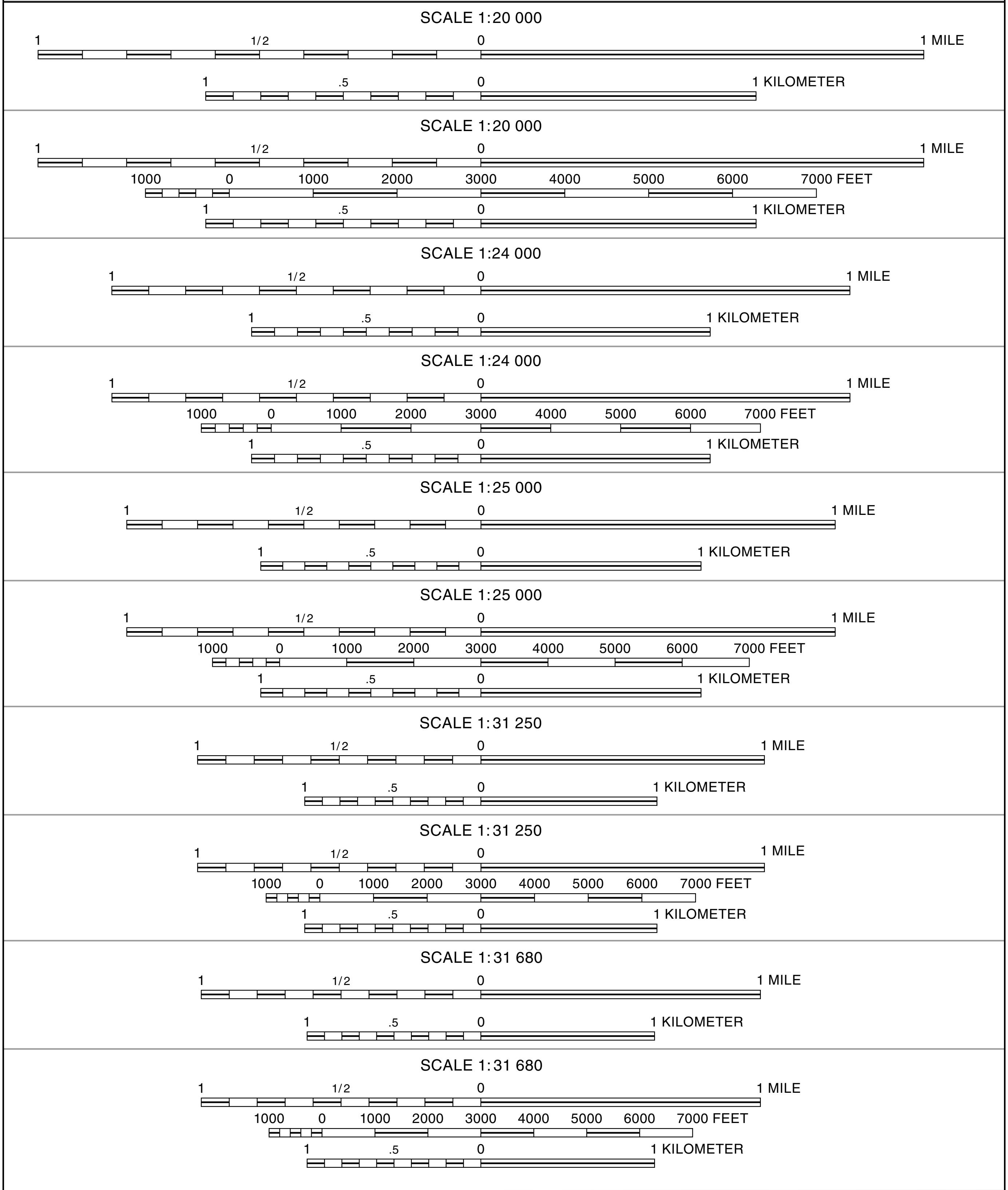
1 mile (mi)	= 63,360 inches (in)
	= 5,280 feet (ft)
1 kilometer (km)	= 3,280.833 ft
	= 0.62137 mi

MEASUREMENT EQUIVALENTS

	Metric	English
1 millimeter (mm)	= 1/10 cm	= 0.039 in
	= 1/1000 m	
1 centimeter (cm)	= 10 mm	= 0.393 in
	= 1/100 m	
1 meter (m)	= 100 cm	= 39.37 in
	= 1,000 mm	or 3.28 ft
	= 1/1,000 km	or 0.00062 mi
1 kilometer (km)	= 1,000 m	= 3,280.833 ft
	= 100,000 cm	or 0.62137 mi
	= 1,000,000 mm	

35—BAR SCALES (continued)

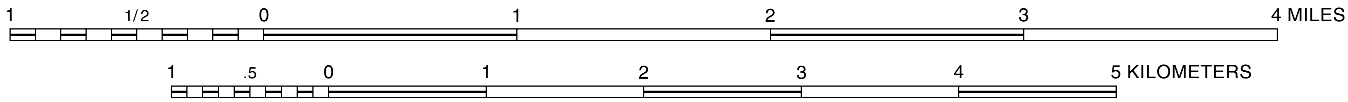
1:20 000, 1:24 000, 1:25 000, 1:31 250, 1:31 680



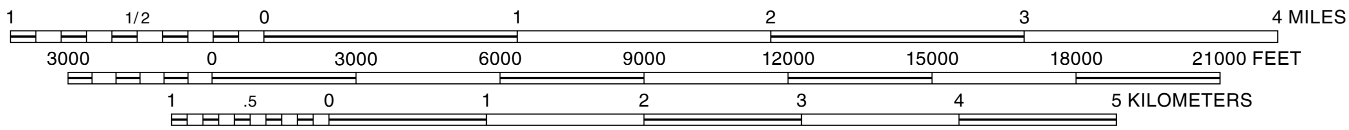
35—BAR SCALES (continued)

1:48 000, 1:50 000, 1:62 500, 1:63 360, 1:72 000

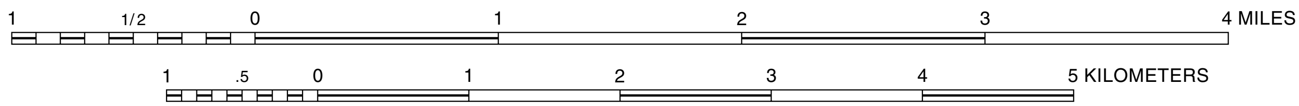
SCALE 1:48 000



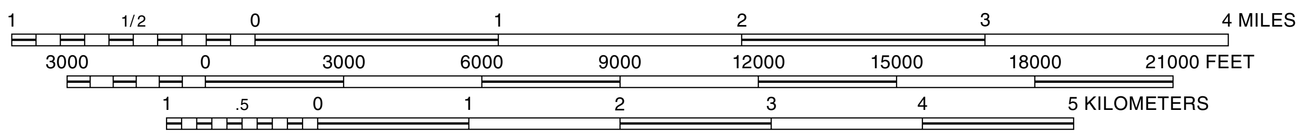
SCALE 1:48 000



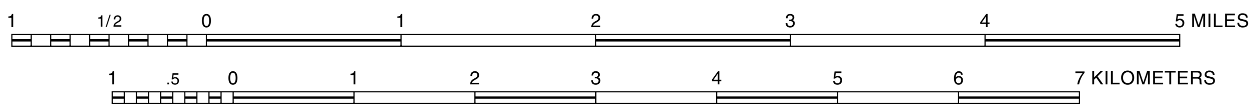
SCALE 1:50 000



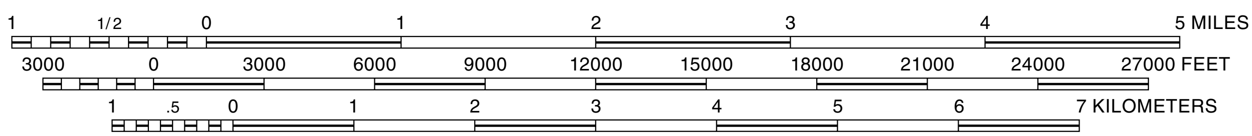
SCALE 1:50 000



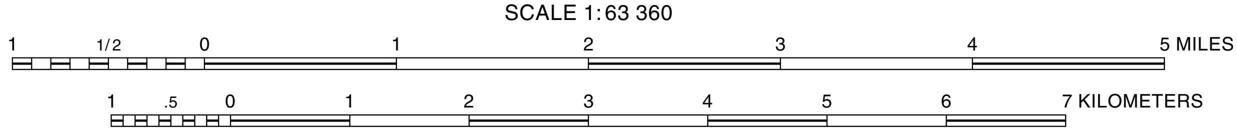
SCALE 1:62 500



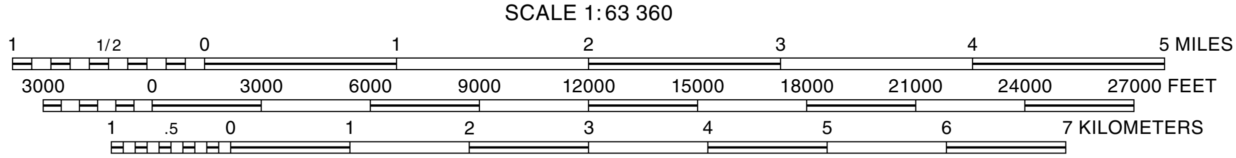
SCALE 1:62 500



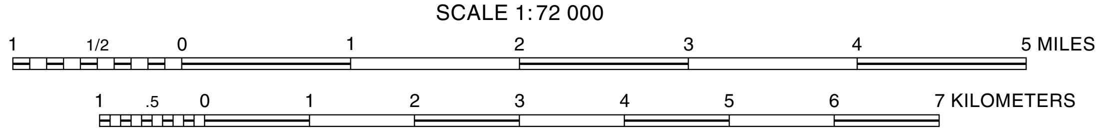
SCALE 1:63 360



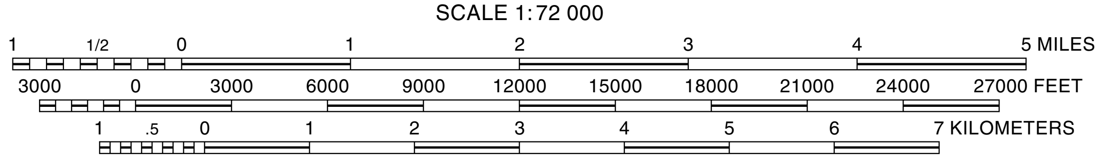
SCALE 1:63 360



SCALE 1:72 000

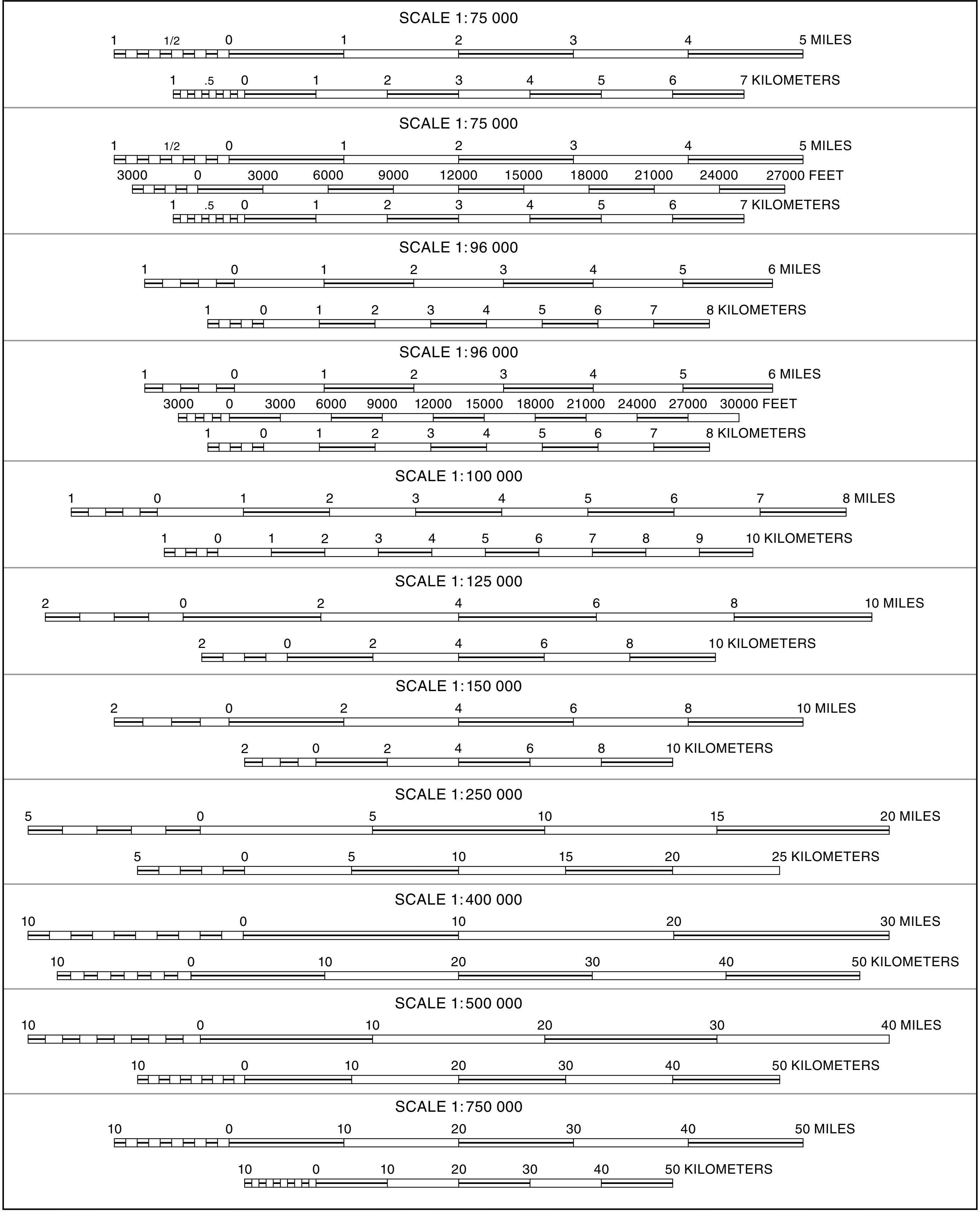


SCALE 1:72 000



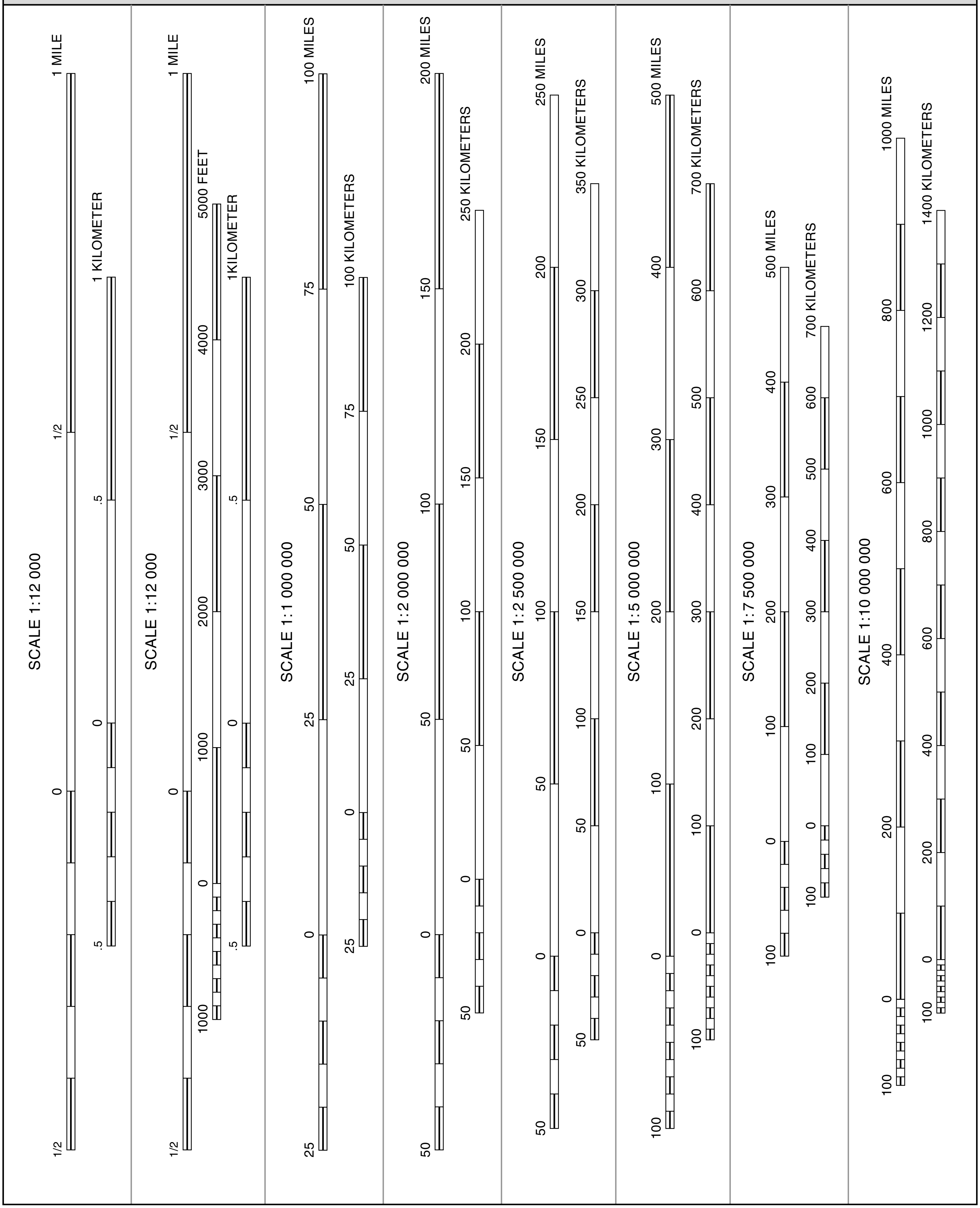
35—BAR SCALES (continued)

1:75 000, 1:96 000, 1:100 000, 1:125 000, 1:150 000, 1:250 000, 1:400 000, 1:500 000, 1:750 000



35—BAR SCALES (continued)

1:12 000, 1:1 000 000, 1:2 000 000, 1:2 500 000, 1:5 000 000, 1:7 500 000, 1:10 000 000



35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — MILES (1 mile = 63,360 inches)

FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION: Scale Unit :	represents Map Unit	TO FIND MILES PER INCH (x in ratio) Use ratio below or $\frac{\text{SCALE}}{63\,360}$	MILES PER INCH	TOTAL MILES ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (y in ratio) Use ratio below or $\frac{\text{Miles on scale}}{\text{Miles per inch}}$	TOTAL SCALE LENGTH (INCHES)
1:12 000	1 inch	12 000 in	$\frac{63\,360}{1} = \frac{12\,000}{\mathbf{x}}$	0.1893939	1.5	$\frac{0.1893939}{1} = \frac{1.5}{\mathbf{y}}$	7.920
1:20 000	1 inch	20 000 in	$\frac{63\,360}{1} = \frac{20\,000}{\mathbf{x}}$	0.3156565	2	$\frac{0.3156565}{1} = \frac{2}{\mathbf{y}}$	6.336
1:24 000	1 inch	24 000 in	$\frac{63\,360}{1} = \frac{24\,000}{\mathbf{x}}$	0.3787878	2	$\frac{0.3787878}{1} = \frac{2}{\mathbf{y}}$	5.280
1:25 000	1 inch	25 000 in	$\frac{63\,360}{1} = \frac{25\,000}{\mathbf{x}}$	0.3945707	2	$\frac{0.3945707}{1} = \frac{2}{\mathbf{y}}$	5.068
1:31 250	1 inch	31 250 in	$\frac{63\,360}{1} = \frac{31\,250}{\mathbf{x}}$	0.4932133	2	$\frac{0.4932133}{1} = \frac{2}{\mathbf{y}}$	4.055
1:31 680	1 inch	31 680 in	$\frac{63\,360}{1} = \frac{31\,680}{\mathbf{x}}$	0.500	2	$\frac{0.500}{1} = \frac{2}{\mathbf{y}}$	4.000
1:48 000	1 inch	48 000 in	$\frac{63\,360}{1} = \frac{48\,000}{\mathbf{x}}$	0.7575757	5	$\frac{0.7575757}{1} = \frac{5}{\mathbf{y}}$	6.600
1:50 000	1 inch	50 000 in	$\frac{63\,360}{1} = \frac{50\,000}{\mathbf{x}}$	0.7891414	5	$\frac{0.7891414}{1} = \frac{5}{\mathbf{y}}$	6.336
1:62 500	1 inch	62 500 in	$\frac{63\,360}{1} = \frac{62\,500}{\mathbf{x}}$	0.9864267	6	$\frac{0.9864267}{1} = \frac{6}{\mathbf{y}}$	6.082
1:63 360	1 inch	63 360 in	$\frac{63\,360}{1} = \frac{63\,360}{\mathbf{x}}$	1.000	6	$\frac{1.000}{1} = \frac{6}{\mathbf{y}}$	6.000
1:72 000	1 inch	72 000 in	$\frac{63\,360}{1} = \frac{72\,000}{\mathbf{x}}$	1.1363636	6	$\frac{1.1363636}{1} = \frac{6}{\mathbf{y}}$	5.280
1:75 000	1 inch	75 000 in	$\frac{63\,360}{1} = \frac{75\,000}{\mathbf{x}}$	1.1837121	6	$\frac{1.1837121}{1} = \frac{6}{\mathbf{y}}$	5.068
1:96 000	1 inch	96 000 in	$\frac{63\,360}{1} = \frac{96\,000}{\mathbf{x}}$	1.5151515	7	$\frac{1.5151515}{1} = \frac{7}{\mathbf{y}}$	4.620
1:100 000	1 inch	100 000 in	$\frac{63\,360}{1} = \frac{100\,000}{\mathbf{x}}$	1.5782828	9	$\frac{1.5782828}{1} = \frac{9}{\mathbf{y}}$	5.702
1:125 000	1 inch	125 000 in	$\frac{63\,360}{1} = \frac{125\,000}{\mathbf{x}}$	1.9728535	12	$\frac{1.9728535}{1} = \frac{12}{\mathbf{y}}$	6.082
1:150 000	1 inch	150 000 in	$\frac{63\,360}{1} = \frac{150\,000}{\mathbf{x}}$	2.3674242	12	$\frac{2.3674242}{1} = \frac{12}{\mathbf{y}}$	5.068

To find miles per inch on 1: 12 000 map . . .

63,360 inches = 1 mile
Show in ratio as ...

$$\frac{63\,360}{1}\ \frac{\textit{inches}}{\textit{miles}}$$

Let SCALE (12 000) be in inches
Fractional scale says 1 inch represents 12,000 in
Let **x** be miles that 1 inch represents on map
Show in ratio as ...

$$\frac{12\,000}{\mathbf{x}}\ \frac{\textit{inches}}{\textit{miles}}$$

Solution . . .

$$\frac{63\,360}{1} = \frac{12\,000}{\mathbf{x}}$$

$$63\,360 \cdot \mathbf{x} = 12\,000 \cdot 1$$

$$\frac{63\,360\,\mathbf{x}}{63\,360} = \frac{12\,000}{63\,360}$$

$$\mathbf{x} = \frac{12\,000\ (\text{SCALE})}{63\,360}$$

$$\mathbf{x} = 0.1893939$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — MILES (1 mile = 63,360 inches)—continued

FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION Scale Unit :	represents Map Unit	TO FIND MILES PER INCH (**x** in ratio) Use ratio below or SCALE / 63 360	MILES PER INCH	TOTAL MILES ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (**y** in ratio) Use ratio below or Miles on scale / Miles per inch	TOTAL SCALE LENGTH (INCHES)
1:250 000	1 inch	250 000 in	$\frac{63\,360}{1} = \frac{250\,000}{\mathbf{x}}$	3.945707	25	$\frac{3.945707}{1} = \frac{25}{\mathbf{y}}$	6.336
1:400 000	1 inch	400 000 in	$\frac{63\,360}{1} = \frac{400\,000}{\mathbf{x}}$	6.3131313	40	$\frac{6.3131313}{1} = \frac{40}{\mathbf{y}}$	6.336
1:500 000	1 inch	500 000 in	$\frac{63\,360}{1} = \frac{500\,000}{\mathbf{x}}$	7.8914141	50	$\frac{7.8914141}{1} = \frac{50}{\mathbf{y}}$	6.336
1:750 000	1 inch	750 000 in	$\frac{63\,360}{1} = \frac{750\,000}{\mathbf{x}}$	11.837121	60	$\frac{11.837121}{1} = \frac{60}{\mathbf{y}}$	5.068
1:1 000 000	1 inch	1 000 000 in	$\frac{63\,360}{1} = \frac{1\,000\,000}{\mathbf{x}}$	15.782828	125	$\frac{15.782828}{1} = \frac{125}{\mathbf{y}}$	7.920
1:2 000 000	1 inch	2 000 000 in	$\frac{63\,360}{1} = \frac{2\,000\,000}{\mathbf{x}}$	31.565656	250	$\frac{31.565656}{1} = \frac{250}{\mathbf{y}}$	7.920
1:2 500 000	1 inch	2 500 000 in	$\frac{63\,360}{1} = \frac{2\,500\,000}{\mathbf{x}}$	39.45707	300	$\frac{39.45707}{1} = \frac{300}{\mathbf{y}}$	7.603
1:5 000 000	1 inch	5 000 000 in	$\frac{63\,360}{1} = \frac{5\,000\,000}{\mathbf{x}}$	78.914141	600	$\frac{78.914141}{1} = \frac{600}{\mathbf{y}}$	7.603
1:7 500 000	1 inch	7 500 000 in	$\frac{63\,360}{1} = \frac{7\,500\,000}{\mathbf{x}}$	118.37121	600	$\frac{118.37121}{1} = \frac{600}{\mathbf{y}}$	5.068
1:10 000 000	1 inch	10 000 000 in	$\frac{63\,360}{1} = \frac{10\,000\,000}{\mathbf{x}}$	157.82828	1100	$\frac{157.82828}{1} = \frac{1100}{\mathbf{y}}$	6.969

To find miles per inch on 1: 250 000 map . . .

63,360 inches = 1 mile
Show in ratio as ...

$$\frac{63\,360}{1}\ \frac{\textit{inches}}{\textit{miles}}$$

Let SCALE (250 000) be in inches
Fractional scale says 1 inch represents 250,000 in
Let **x** be miles that 1 inch represents on map
Show in ratio as ...

$$\frac{250\,000}{\mathbf{x}}\ \frac{\textit{inches}}{\textit{miles}}$$

Solution . . .

$$\frac{63\,360}{1} = \frac{250\,000}{\mathbf{x}}$$

$$63\,360 \cdot \mathbf{x} = 250\,000 \cdot 1$$

$$\frac{63\,360\,\mathbf{x}}{63\,360} = \frac{250\,000}{63\,360}$$

$$\mathbf{x} = \frac{250\,000\ (\text{SCALE})}{63\,360}$$

$$\mathbf{x} = 3.945707$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — FEET (1 foot = 12 inches)

FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION: Scale Unit :	represents Map Unit	TO FIND FEET PER INCH (**x** in ratio) Use ratio below or $\frac{\text{SCALE}}{12}$	FEET PER INCH	TOTAL FEET ON SCALE	TO FIND TOTAL SCALE LENGTH IN INCHES (**y** in ratio) Use ratio below or $\frac{\text{Feet on scale}}{\text{Feet per inch}}$	TOTAL SCALE LENGTH (INCHES)
1:12 000	1 inch	12 000 in	$\frac{12}{1} = \frac{12\,000}{\mathbf{x}}$	1000.000	6000	$\frac{1000.000}{1} = \frac{6000}{\mathbf{y}}$	6.000
1:20 000	1 inch	20 000 in	$\frac{12}{1} = \frac{20\,000}{\mathbf{x}}$	1666.6666	8000	$\frac{1666.6666}{1} = \frac{8000}{\mathbf{y}}$	4.800
1:24 000	1 inch	24 000 in	$\frac{12}{1} = \frac{24\,000}{\mathbf{x}}$	2000.000	8000	$\frac{2000.000}{1} = \frac{8000}{\mathbf{y}}$	4.000
1:25 000	1 inch	25 000 in	$\frac{12}{1} = \frac{25\,000}{\mathbf{x}}$	2083.3333	8000	$\frac{2083.3333}{1} = \frac{8000}{\mathbf{y}}$	3.840
1:31 250	1 inch	31 250 in	$\frac{12}{1} = \frac{31\,250}{\mathbf{x}}$	2604.1666	8000	$\frac{2604.1666}{1} = \frac{8000}{\mathbf{y}}$	3.072
1:31 680	1 inch	31 680 in	$\frac{12}{1} = \frac{31\,680}{\mathbf{x}}$	2640.000	8000	$\frac{2640.000}{1} = \frac{8000}{\mathbf{y}}$	3.030
1:48 000	1 inch	48 000 in	$\frac{12}{1} = \frac{48\,000}{\mathbf{x}}$	4000.000	24 000	$\frac{4000.000}{1} = \frac{24\,000}{\mathbf{y}}$	6.000
1:50 000	1 inch	50 000 in	$\frac{12}{1} = \frac{50\,000}{\mathbf{x}}$	4166.6666	24 000	$\frac{4166.6666}{1} = \frac{24\,000}{\mathbf{y}}$	5.760
1:62 500	1 inch	62 500 in	$\frac{12}{1} = \frac{62\,500}{\mathbf{x}}$	5208.3333	30 000	$\frac{5208.3333}{1} = \frac{30\,000}{\mathbf{y}}$	5.760
1:63 360	1 inch	63 360 in	$\frac{12}{1} = \frac{63\,360}{\mathbf{x}}$	5280.000	30 000	$\frac{5280.000}{1} = \frac{30\,000}{\mathbf{y}}$	5.681
1:72 000	1 inch	72 000 in	$\frac{12}{1} = \frac{72\,000}{\mathbf{x}}$	6000.000	30 000	$\frac{6000.000}{1} = \frac{30\,000}{\mathbf{y}}$	5.000
1:75 000	1 inch	75 000 in	$\frac{12}{1} = \frac{75\,000}{\mathbf{x}}$	6250.000	30 000	$\frac{6250.000}{1} = \frac{30\,000}{\mathbf{y}}$	4.800
1:96 000	1 inch	96 000 in	$\frac{12}{1} = \frac{96\,000}{\mathbf{x}}$	8000.000	33 000	$\frac{8000.000}{1} = \frac{33\,000}{\mathbf{y}}$	4.125

To find feet per inch on 1: 12 000 map . . .

12 inches = 1 foot
Show in ratio as ...

$$\frac{12 \text{ } \textit{inches}}{1 \text{ } \textit{feet}}$$

Let SCALE (12 000) be in inches
Fractional scale says 1 inch represents 12,000 in
Let **x** be feet that 1 inch represents on map
Show in ratio as ...

$$\frac{12\,000 \text{ } \textit{inches}}{\mathbf{x} \text{ } \textit{feet}}$$

Solution . . .

$$\frac{12}{1} = \frac{12\,000}{\mathbf{x}}$$

$$12 \cdot \mathbf{x} = 12\,000 \cdot 1$$

$$\frac{12\,\mathbf{x}}{12} = \frac{12\,000}{12}$$

$$\mathbf{x} = \frac{12\,000}{12} \text{ (SCALE)}$$

$$\mathbf{x} = 1000.00$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — KILOMETERS (1 kilometer = 100,000 centimeters)

FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION: Scale Unit :	represents Map Unit	TO FIND KILOMETERS PER CENTIMETER (CM) (**x** in ratio) Use ratio below or SCALE / 100 000	KILO-METERS PER CM	TOTAL KILOMETERS ON SCALE	TO FIND TOTAL SCALE LENGTH IN CENTIMETERS (**y** in ratio) Use ratio below or Kilometers on scale / Kilometers per cm	TOTAL SCALE LENGTH IN CENTI-METERS	TOTAL SCALE LENGTH IN MILLI-METERS
1:12 000	1 cm	12 000 cm	$\frac{100\,000}{1} = \frac{12\,000}{\mathbf{x}}$	0.120	1.5	$\frac{0.120}{1} = \frac{1.5}{\mathbf{y}}$	12.500	125.00
1:20 000	1 cm	20 000 cm	$\frac{100\,000}{1} = \frac{20\,000}{\mathbf{x}}$	0.200	2	$\frac{0.200}{1} = \frac{2}{\mathbf{y}}$	10.000	100.00
1:24 000	1 cm	24 000 cm	$\frac{100\,000}{1} = \frac{24\,000}{\mathbf{x}}$	0.240	2	$\frac{0.240}{1} = \frac{2}{\mathbf{y}}$	8.333	83.33
1:25 000	1 cm	25 000 cm	$\frac{100\,000}{1} = \frac{25\,000}{\mathbf{x}}$	0.250	2	$\frac{0.250}{1} = \frac{2}{\mathbf{y}}$	8.000	80.00
1:31 250	1 cm	31 250 cm	$\frac{100\,000}{1} = \frac{31\,250}{\mathbf{x}}$	0.3125	2	$\frac{0.3125}{1} = \frac{2}{\mathbf{y}}$	6.400	64.00
1:31 680	1 cm	31 680 cm	$\frac{100\,000}{1} = \frac{31\,680}{\mathbf{x}}$	0.3168	2	$\frac{0.3168}{1} = \frac{2}{\mathbf{y}}$	6.313	63.13
1:48 000	1 cm	48 000 cm	$\frac{100\,000}{1} = \frac{48\,000}{\mathbf{x}}$	0.480	6	$\frac{0.480}{1} = \frac{6}{\mathbf{y}}$	12.500	125.00
1:50 000	1 cm	50 000 cm	$\frac{100\,000}{1} = \frac{50\,000}{\mathbf{x}}$	0.500	6	$\frac{0.500}{1} = \frac{6}{\mathbf{y}}$	12.000	120.00
1:62 500	1 cm	62 500 cm	$\frac{100\,000}{1} = \frac{62\,500}{\mathbf{x}}$	0.625	8	$\frac{0.625}{1} = \frac{8}{\mathbf{y}}$	12.800	128.00
1:63 360	1 cm	63 360 cm	$\frac{100\,000}{1} = \frac{63\,360}{\mathbf{x}}$	0.6336	8	$\frac{0.6336}{1} = \frac{8}{\mathbf{y}}$	12.626	126.26
1:72 000	1 cm	72 000 cm	$\frac{100\,000}{1} = \frac{72\,000}{\mathbf{x}}$	0.720	8	$\frac{0.720}{1} = \frac{8}{\mathbf{y}}$	11.111	111.11
1:75 000	1 cm	75 000 cm	$\frac{100\,000}{1} = \frac{75\,000}{\mathbf{x}}$	0.750	8	$\frac{0.750}{1} = \frac{8}{\mathbf{y}}$	10.666	106.66
1:96 000	1 cm	96 000 cm	$\frac{100\,000}{1} = \frac{96\,000}{\mathbf{x}}$	0.960	9	$\frac{0.960}{1} = \frac{9}{\mathbf{y}}$	9.375	93.75
1:100 000	1 cm	100 000 cm	$\frac{100\,000}{1} = \frac{100\,000}{\mathbf{x}}$	1.000	11	$\frac{1.000}{1} = \frac{11}{\mathbf{y}}$	11.000	110.00
1:125 000	1 cm	125 000 cm	$\frac{100\,000}{1} = \frac{125\,000}{\mathbf{x}}$	1.250	12	$\frac{1.250}{1} = \frac{12}{\mathbf{y}}$	9.600	96.00
1:150 000	1 cm	150 000 cm	$\frac{100\,000}{1} = \frac{150\,000}{\mathbf{x}}$	1.500	12	$\frac{1.500}{1} = \frac{12}{\mathbf{y}}$	8.000	80.00

To find kilometers per centimeter on 1: 12 000 map . . .

100 000 centimeters = 1 kilometer
Show in ratio as ...

$$\frac{100\,000}{1}\quad \frac{\textit{centimeters}}{\textit{kilometers}}$$

Let SCALE (12 000) be in centimeters
Fractional scale says 1 centimeter represents 12,000 centimeters
Let **x** be kilometers that 1 cm represents on map
Show in ratio as ...

$$\frac{12\,000}{\mathbf{x}}\quad \frac{\textit{centimeters}}{\textit{kilometers}}$$

Solution . . .

$$100\,000 \cdot \mathbf{x} = 12\,000 \cdot 1$$

$$\frac{100\,000}{1} = \frac{12\,000}{\mathbf{x}} \qquad \frac{100\,000\,\mathbf{x}}{100\,000} = \frac{12\,000}{100\,000}$$

$$\mathbf{x} = \frac{12\,000}{100\,000}\ \text{(SCALE)}$$

$$\mathbf{x} = 0.120$$

35—BAR SCALES (continued)

BAR SCALE CALCULATIONS — KILOMETERS (1 kilometer = 100,000 centimeters)—continued

FRACTIONAL SCALE	SCALE TO MAP REPRESENTATION: Scale Unit :	represents Map Unit	TO FIND KILOMETERS PER CENTIMETER (CM) (**x** in ratio) Use ratio below or SCALE / 100 000	KILO-METERS PER CM	TOTAL KILOMETERS ON SCALE	TO FIND TOTAL SCALE LENGTH IN CENTIMETERS (**y** in ratio) Use ratio below or Kilometers on scale / Kilometers per cm	TOTAL SCALE LENGTH IN CENTI-METERS	TOTAL SCALE LENGTH IN MILLI-METERS
1:250 000	1 cm	250 000 cm	$\frac{100\,000}{1} = \frac{250\,000}{\mathbf{x}}$	2.500	30	$\frac{2.500}{1} = \frac{30}{\mathbf{y}}$	12.000	120.00
1:400 000	1 cm	400 000 cm	$\frac{100\,000}{1} = \frac{400\,000}{\mathbf{x}}$	4.000	60	$\frac{4.000}{1} = \frac{60}{\mathbf{y}}$	15.000	150.00
1:500 000	1 cm	500 000 cm	$\frac{100\,000}{1} = \frac{500\,000}{\mathbf{x}}$	5.000	60	$\frac{5.000}{1} = \frac{60}{\mathbf{y}}$	12.000	120.00
1:750 000	1 cm	750 000 cm	$\frac{100\,000}{1} = \frac{750\,000}{\mathbf{x}}$	7.500	60	$\frac{7.500}{1} = \frac{60}{\mathbf{y}}$	8.000	80.00
1:1 000 000	1 cm	1 000 000 cm	$\frac{100\,000}{1} = \frac{1\,000\,000}{\mathbf{x}}$	10.000	125	$\frac{10.000}{1} = \frac{125}{\mathbf{y}}$	12.500	125.00
1:2 000 000	1 cm	2 000 000 cm	$\frac{100\,000}{1} = \frac{2\,000\,000}{\mathbf{x}}$	20.000	300	$\frac{20.000}{1} = \frac{300}{\mathbf{y}}$	15.000	150.00
1:2 500 000	1 cm	2 500 000 cm	$\frac{100\,000}{1} = \frac{2\,500\,000}{\mathbf{x}}$	25.000	400	$\frac{25.000}{1} = \frac{400}{\mathbf{y}}$	16.000	160.00
1:5 000 000	1 cm	5 000 000 cm	$\frac{100\,000}{1} = \frac{5\,000\,000}{\mathbf{x}}$	50.000	800	$\frac{50.000}{1} = \frac{800}{\mathbf{y}}$	16.000	160.00
1:7 500 000	1 cm	7 500 000 cm	$\frac{100\,000}{1} = \frac{7\,500\,000}{\mathbf{x}}$	75.000	800	$\frac{75.000}{1} = \frac{800}{\mathbf{y}}$	10.666	106.66
1:10 000 000	1 cm	10 000 000 cm	$\frac{100\,000}{1} = \frac{10\,000\,000}{\mathbf{x}}$	100.000	1500	$\frac{100.000}{1} = \frac{1500}{\mathbf{y}}$	15.000	150.00

To find kilometers per centimeter on 1: 250 000 map . . .

100 000 centimeters = 1 kilometer
Show in ratio as ...

$$\frac{100\,000 \text{ centimeters}}{1 \text{ kilometers}}$$

Let SCALE (250 000) be in centimeters
Fractional scale says 1 centimeter represents 250,000 centimeters
Let **x** be kilometers that 1 cm represents on map
Show in ratio as ...

$$\frac{250\,000 \text{ centimeters}}{\mathbf{x} \text{ kilometers}}$$

Solution . . .

$$\frac{100\,000}{1} = \frac{250\,000}{\mathbf{x}}$$

$$100\,000 \cdot \mathbf{x} = 250\,000 \cdot 1$$

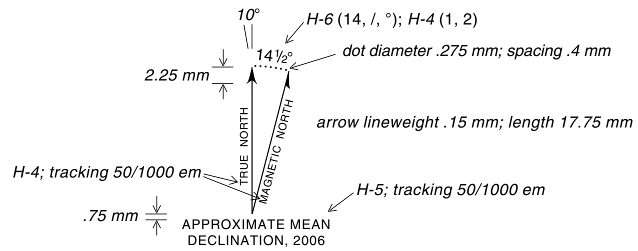
$$\frac{100\,000\,\mathbf{x}}{100\,000} = \frac{250\,000}{100\,000}$$

$$\mathbf{x} = \frac{250\,000 \text{ (SCALE)}}{100\,000}$$

$$\mathbf{x} = 2.5$$

36—MEAN DECLINATION ARROWS

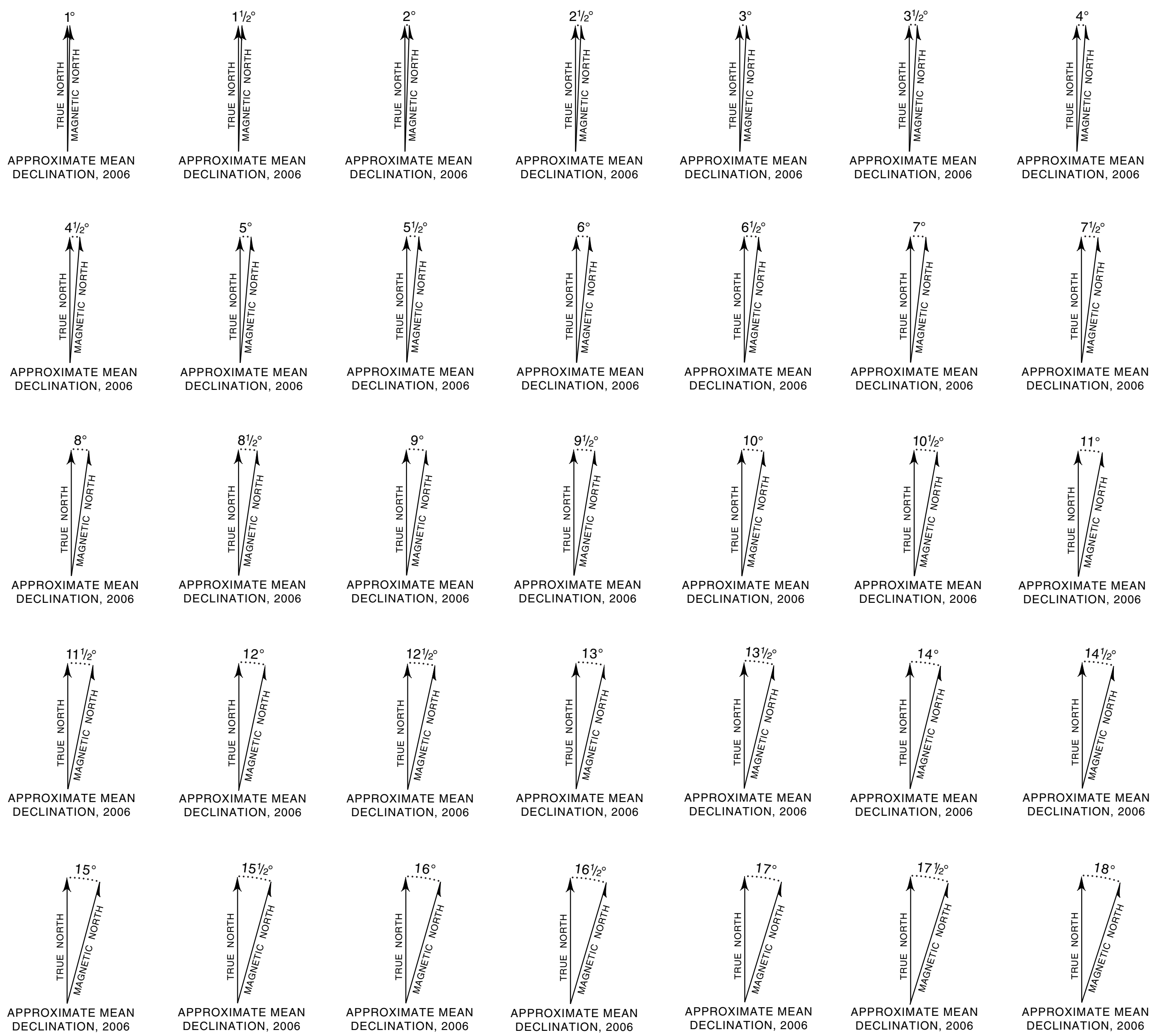
CARTOGRAPHIC SPECIFICATIONS



NOTES ON USAGE

Because magnetic declination changes over time, the degree of declination should be determined at the time of publication, and the year of the declination measurement should be changed to the year of publication. In northern latitudes where the change in declination can be significant, it may be helpful to also note what the degree of declination was at the time of mapping, especially if the geologic information was gathered several years before the date of publication.

36.1—Magnetic north, east of true north

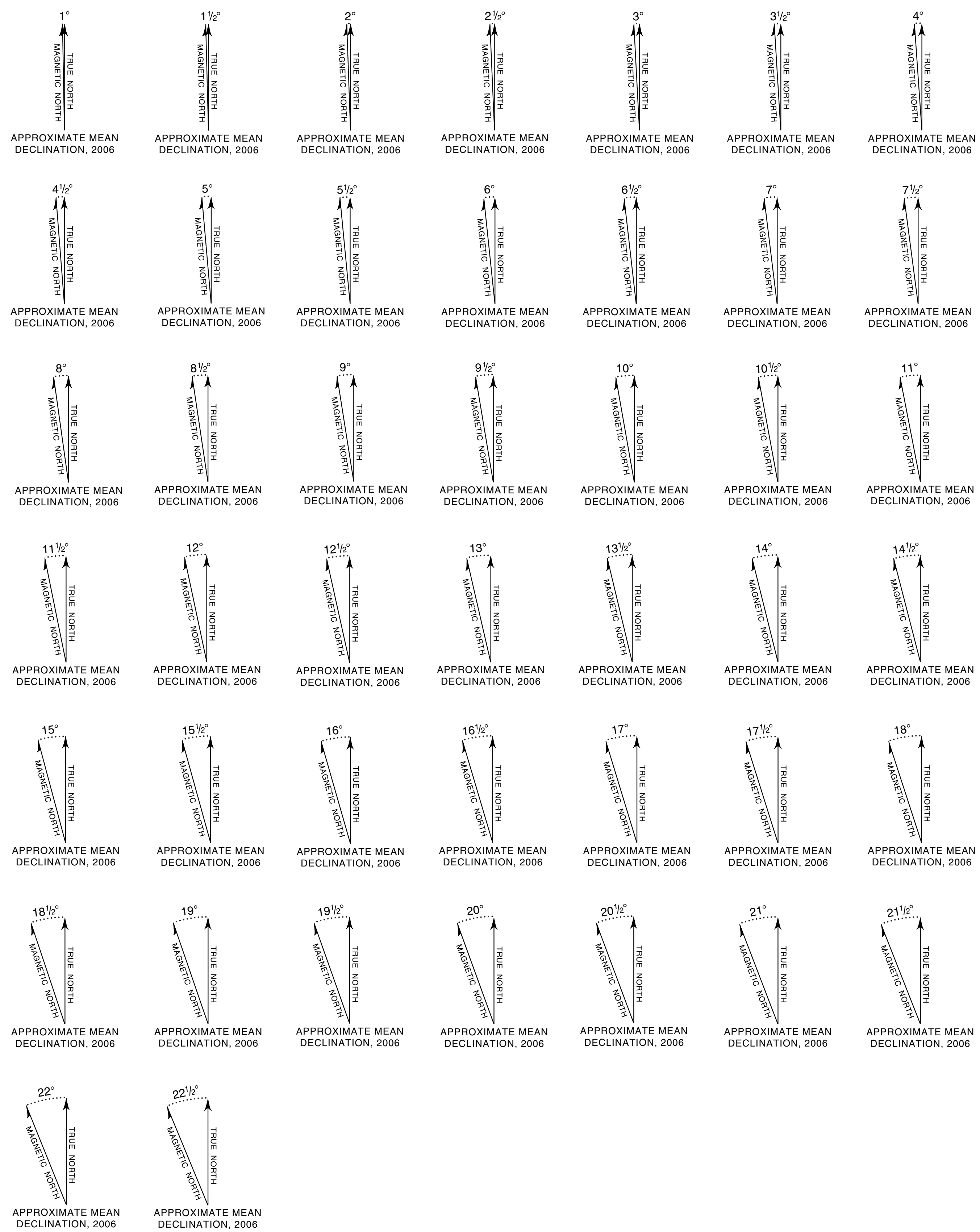


36—MEAN DECLINATION ARROWS (continued)

36.1—Magnetic north, east of true north (continued)

36—MEAN DECLINATION ARROWS (continued)

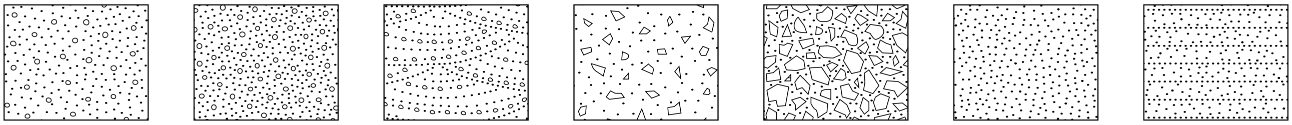
36.2—Magnetic north, west of true north



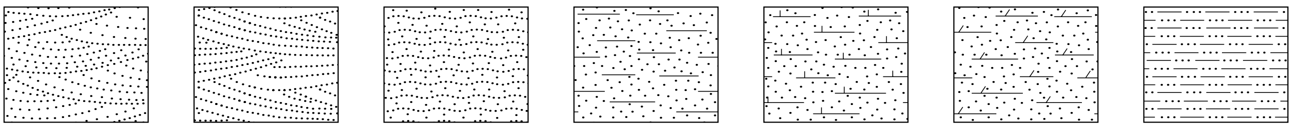
37—LITHOLOGIC PATTERNS

[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

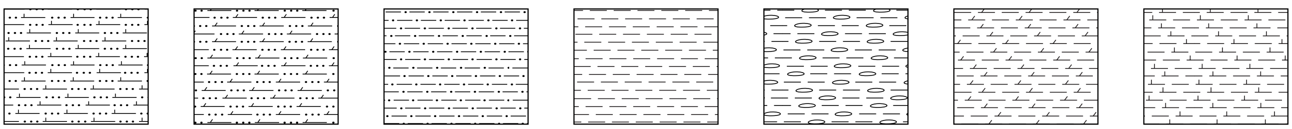
37.1—Sedimentary-rock lithologic patterns



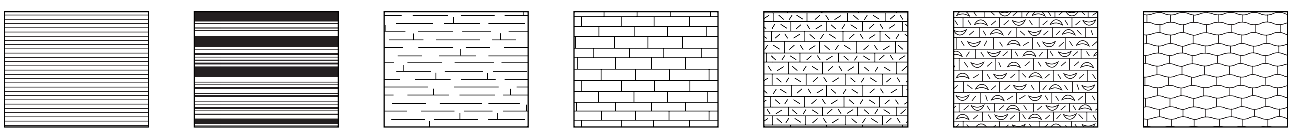
601	602	603	605	606	607	608
Gravel or conglomerate (1st option)	Gravel or conglomerate (2nd option)	Crossbedded gravel or conglomerate	Breccia (1st option)	Breccia (2nd option)	Massive sand or sandstone	Bedded sand or sandstone



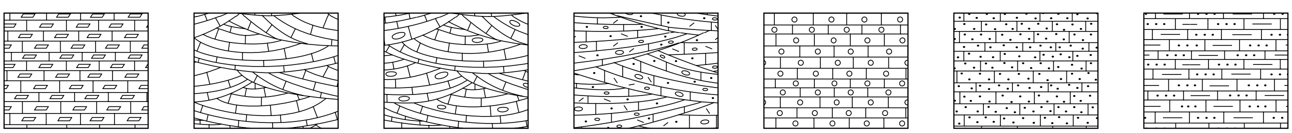
609	610	611	612	613	614	616
Crossbedded sand or sandstone (1st option)	Crossbedded sand or sandstone (2nd option)	Ripple-bedded sand or sandstone	Argillaceous or shaly sandstone	Calcareous sandstone	Dolomitic sandstone	Silt, siltstone, or shaly silt



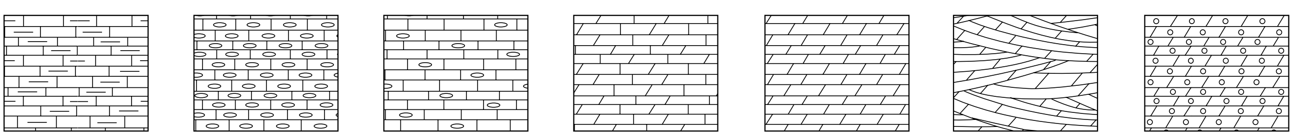
617	618	619	620	621	622	623
Calcareous siltstone	Dolomitic siltstone	Sandy or silty shale	Clay or clay shale	Cherty shale	Dolomitic shale	Calcareous shale or marl



624	625	626	627	628	629	630
Carbonaceous shale	Oil shale	Chalk	Limestone	Clastic limestone	Fossiliferous clastic limestone	Nodular or irregularly bedded limestone



631	632	633	634	635	636	637
Limestone, irregular (burrow?) fillings of saccharoidal dolomite	Crossbedded limestone	Cherty crossbedded limestone	Cherty and sandy crossbedded clastic limestone	Oolitic limestone	Sandy limestone	Silty limestone



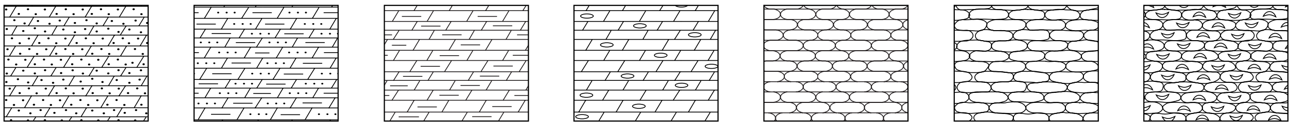
638	639	640	641	642	643	644
Argillaceous or shaly limestone	Cherty limestone (1st option)	Cherty limestone (2nd option)	Dolomitic limestone, limy dolostone, or limy dolomite	Dolostone or dolomite	Crossbedded dolostone or dolomite	Oolitic dolostone or dolomite

*For more information, see general guidelines on pages A-i to A-v.

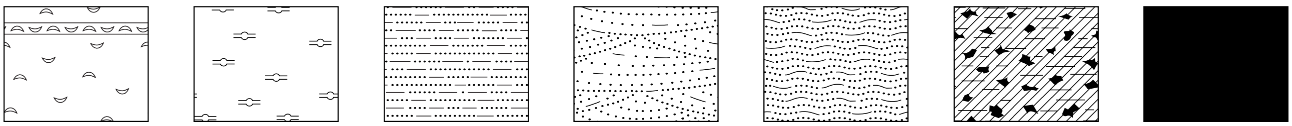
37—LITHOLOGIC PATTERNS (continued)

[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

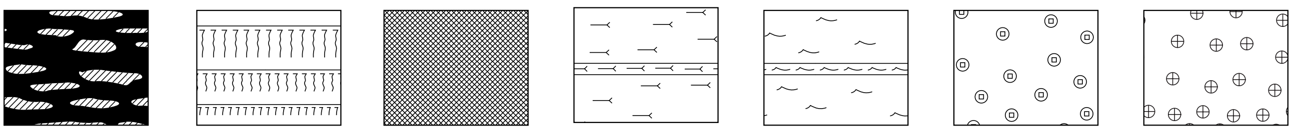
37.1—Sedimentary-rock lithologic patterns (continued)



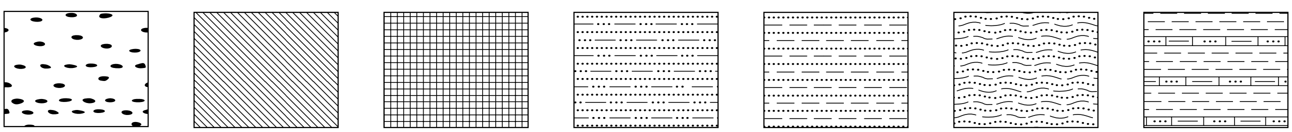
645 Sandy dolostone or dolomite
646 Silty dolostone or dolomite
647 Argillaceous or shaly dolostone or dolomite
648 Cherty dolostone or dolomite
649 Bedded chert (1st option)
650 Bedded chert (2nd option)
651 Fossiliferous bedded chert



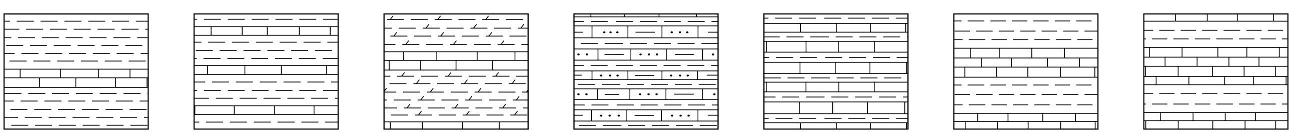
652 Fossiliferous rock
653 Diatomaceous rock
654 Subgraywacke
655 Crossbedded subgraywacke
656 Ripple-bedded subgraywacke
657 Peat
658 Coal



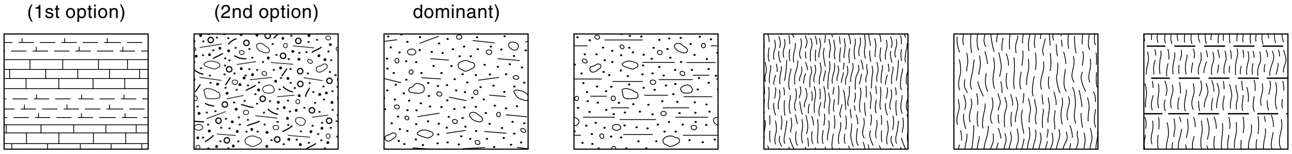
659 Bony coal or impure coal
660 Underclay
661 Flint clay
662 Bentonite
663 Glauconite
664 Limonite
665 Siderite



666 Phosphatic-nodular rock
667 Gypsum
668 Salt
669 Interbedded sandstone and siltstone
670 Interbedded sandstone and shale
671 Interbedded ripple-bedded sandstone and shale
672 Interbedded shale and silty limestone (shale dominant)



673 Interbedded shale and limestone (shale dominant) (1st option)
674 Interbedded shale and limestone (shale dominant) (2nd option)
675 Interbedded calcareous shale and limestone (shale dominant)
676 Interbedded silty limestone and shale
677 Interbedded limestone and shale (1st option)
678 Interbedded limestone and shale (2nd option)
679 Interbedded limestone and shale (limestone dominant)



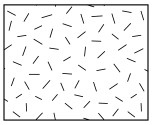
680 Interbedded limestone and calcareous shale
681 Till or diamicton (1st option)
682 Till or diamicton (2nd option)
683 Till or diamicton (3rd option)
684 Loess (1st option)
685 Loess (2nd option)
686 Loess (3rd option)

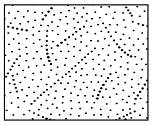
*For more information, see general guidelines on pages A-i to A-v.

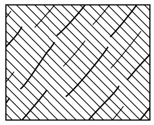
37—LITHOLOGIC PATTERNS (continued)

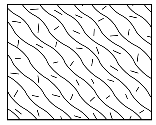
[Lithologic patterns are usually reserved for use on stratigraphic columns, sections, or charts]

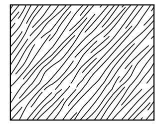
37.2—Metamorphic-rock, igneous-rock, and vein-matter lithologic patterns

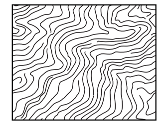

701
Metamorphism

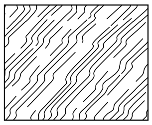

702
Quartzite

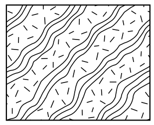

703
Slate

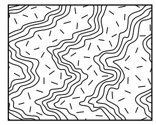

704
Schistose or gneissoid granite

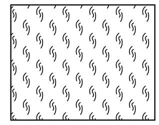

705
Schist

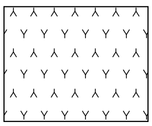

706
Contorted schist

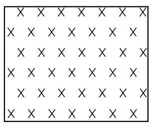

707
Schist and gneiss

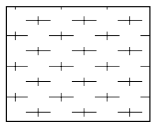

708
Gneiss

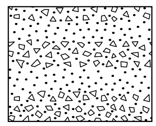

709
Contorted gneiss

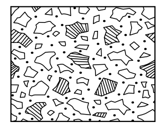

710
Soapstone, talc, or serpentinite

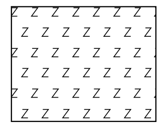

711
Tuffaceous rock

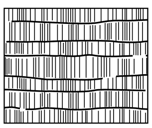

712
Crystal tuff

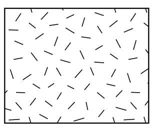

713
Devitrified tuff

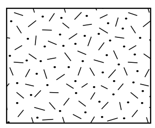

714
Volcanic breccia and tuff

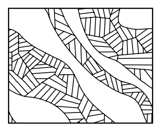

715
Volcanic breccia or agglomerate

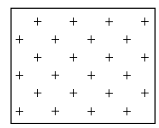

716
Zeolitic rock

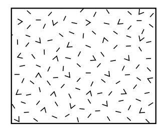

717
Basaltic flows

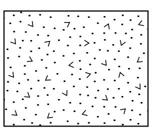

718
Granite (1st option)

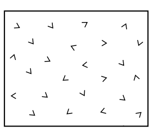

719
Granite (2nd option)

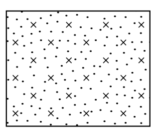

720
Banded igneous rock

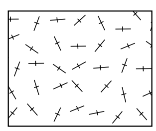

721
Igneous rock (1st option)

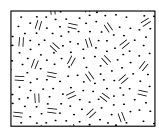

722
Igneous rock (2nd option)

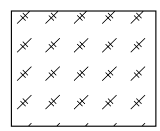

723
Igneous rock (3rd option)

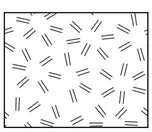

724
Igneous rock (4th option)

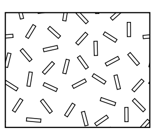

725
Igneous rock (5th option)

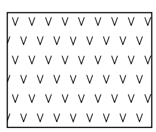

726
Igneous rock (6th option)

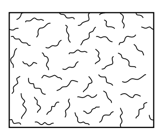

727
Igneous rock (7th option)

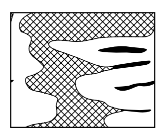

728
Igneous rock (8th option)


729
Porphyritic rock (1st option)


730
Porphyritic rock (2nd option)


731
Vitrophyre


732
Quartz


733
Ore

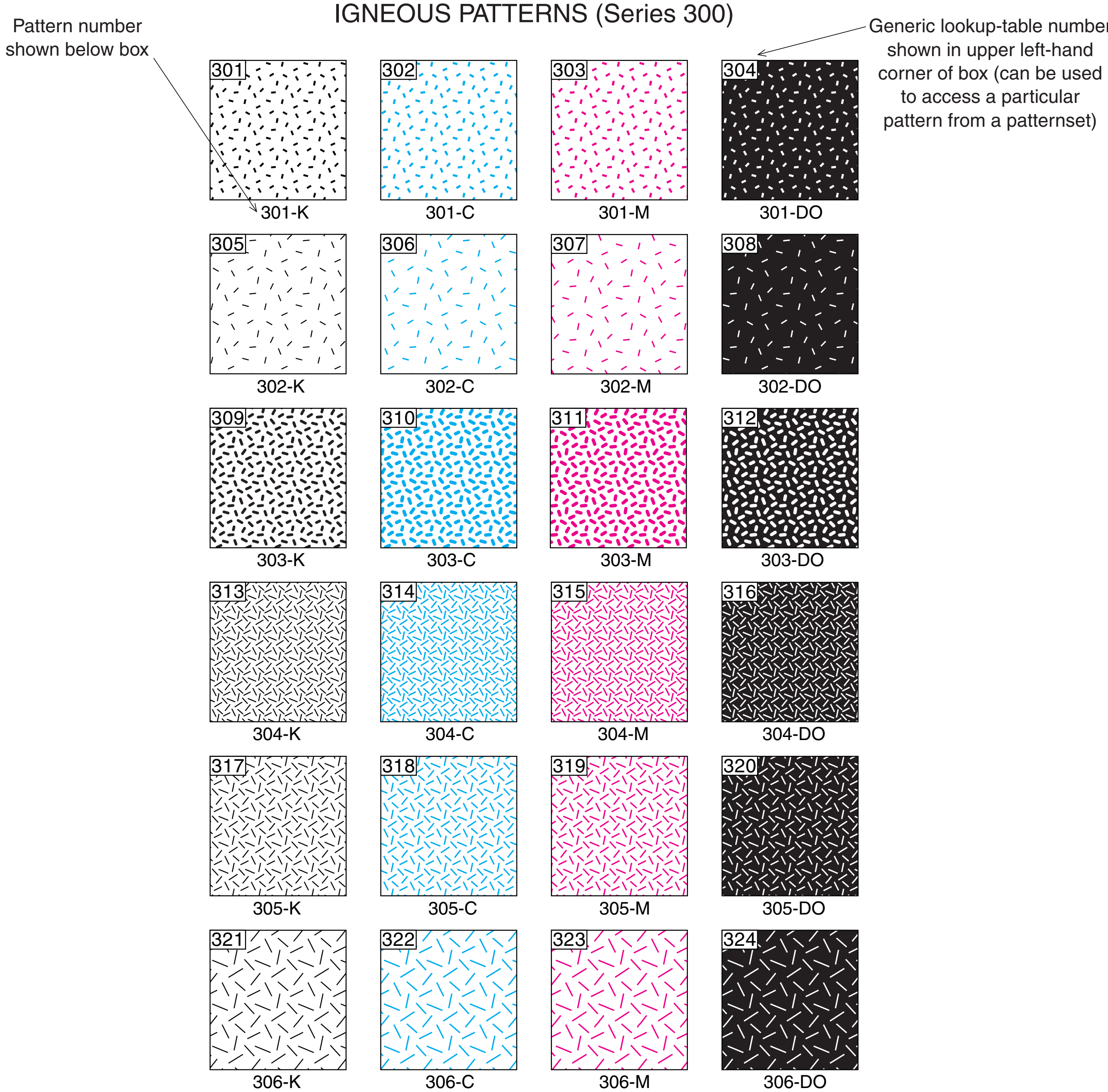
For more information, see general guidelines on pages A-i to A-v.

38—EXPLANATION FOR PATTERN CHART

DISCUSSION*
This diagram provides some basic information on how to use the new Pattern Chart, which is enclosed in the sleeve on the inside back cover of this standard volume. For more specific information on the use of patterns (and color) on geologic maps, see Section 5, entitled "Guidelines for Map Color and Pattern Selection," in the accompanying introductory text. Most patterns on this new chart were designed (in Adobe Illustrator 8.0.1) to closely replicate patterns in the informal "Technical Cartographic Standards" volume (U.S. Geological Survey, ca. 1975). In some cases, however, lineweights of pattern elements had to be increased to facilitate higher resolution (1800 dpi) digital output; therefore, some patterns may not plot or print correctly if output at lower resolutions. Each pattern has been assigned a new pattern number (see below each box). In addition, each pattern now has associated with it a generic look-up table number that can be used to access a pattern if it has been incorporated into a patternset.

DESCRIPTION	
Abbreviations used in pattern numbers:	• K, black; C, cyan; M, magenta; DO, dropout; R, red; B, brown
Overprint patterns have white background	• Pattern is in front. One bounding box (having Fill and Stroke set to 'None') is in back • White background is transparent (underlying map-unit color will be visible)
Dropout patterns have black background	• Pattern is in front. Two bounding boxes are in back: box directly beneath pattern has Fill set to 100% black and Stroke set to 'None'; box to rear has both Fill and Stroke set to 'None' • Black background represents underlying map-unit color. If white pattern is used "as is," it will knock out the underlying map-unit color; if pattern is changed to one of the CMYK values in the underlying map-unit color, it will knock out the other CMYK value(s) in map-unit color

IGNEOUS PATTERNS (Series 300)



*For more information, see general guidelines on pages A-i to A-v.

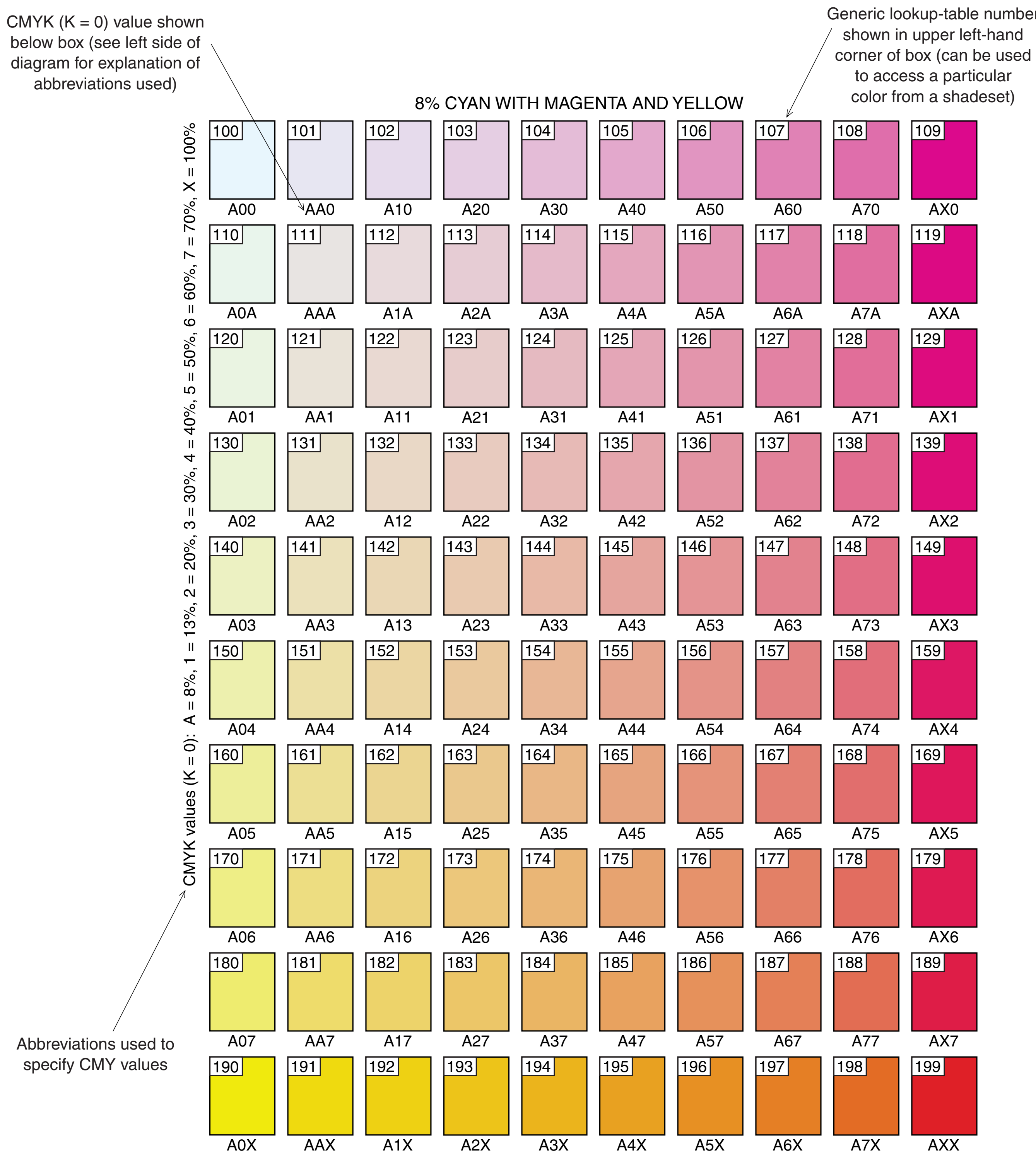
39—EXPLANATION FOR CMYK COLOR CHART

DISCUSSION*

This diagram explains how to use the new CMYK Color Chart, which is enclosed in the sleeve on the inside back cover of this standard volume. For more specific information on the use of color (and patterns) on geologic maps, see Section 5, entitled "Guidelines for Map Color and Pattern Selection," in the accompanying introductory text.

This new CMYK Color Chart was designed in Adobe Illustrator 8.0.1 (Macintosh) to closely replicate the colors on the U.S. Geological Survey's original offset-printed process-ink color chart, entitled "Printing Colors and Screens in Use by the U.S. Geological Survey for Geologic and Hydrologic Maps" [yellow/magenta/cyan version], which has long been used at the USGS for choosing colors on geologic maps. The new color chart contains the same colors that were in the original offset-printed USGS color chart; however, the old color codes indicating the YMC (yellow/magenta/cyan) values have been updated to show CMYK (cyan/magenta/yellow, with K = 0) values, to conform to industry standards.

In addition, each color now has associated with it a generic look-up table number that can be used to access a particular color if it has been incorporated into a shadeset.



*For more information, see general guidelines on pages A-i to A-v.

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INTRODUCTORY TEXT

AND APPENDIX A

INDEX TO INTRODUCTORY TEXT AND APPENDIX A