PREPARING MAPS AND OTHER ILLUSTRATIONS

THE TERM "ILLUSTRATION" is used here in a broad sense to include all geologic, geophysical, geochemical, hydrologic, and derivative maps and cross sections, mine maps, diagrams, pen-and-ink or wash sketches, columnar sections, correlation diagrams, charts, graphs, fossil plates, photographs, projection slides, engineering drawings, and computer-generated graphics. Most of the following suggestions apply directly to illustrations intended for Survey book publications or for Survey maps, charts, and atlases. Suggestions that may seem arbitrary are based on long experience and practice. Emphasis is on author preparation and author interactions with map or text editors and illustrators (graphics specialists and cartographic technicians).

Every illustration in a scientific report should either (1) give the reader a visual impression, (2) clarify something said in the text, or (3) portray facts that are discussed in the text. A visual impression made by a photograph of an outcrop, for example, supports mental images, and a geologic map provides the facts on which the words are based. Regardless of the type of report, no illustration belongs there unless it serves one of these purposes.

The author, map or text editor, and illustrator together are responsible for preparing final copy for the printer. This copy must be neat, well planned, well prepared, and uncluttered if it is to make published illustrations of professional quality. Experience shows that well-prepared copy costs no more in time and money than slipshod work. Commonly the cost is less, because expensive corrections and revisions are avoided.

Because of their obvious interdependence, authors, editors, and illustrators must work together to achieve their joint objectives. You as author should seek advice from map editors or illustrators early in the planning stage of the project; advice on such things as adequate base-map material and compilation techniques can save later grief and delay.

Authors who lack access to professional map editors and illustrators have special problems. For a given journal, read the journal's publication requirements and examine recent issues to learn what makes a good illustration and satisfactory copy. Most journals accept only finished illustrations ready for the printer. Few scientists have the technical or artistic skills to prepare finished illustrations beyond simple line drawings and photographs. Some of us acquire such skills by study and practice and by seeking advice from experts, but most of us must rely on professional illustrators, especially to prepare copy for colored maps that require perfectly registered color patterns. In any event, you are well advised to seek professional help early in the preparation process. New techniques are developing rapidly for author-prepared copy and computer-generated graphics.

PLANNING

For planning purposes maps and other illustrations for Survey reports can be broadly classified as plates or sheets and figures. A plate, as here arbitrarily defined, is any illustration larger at publication size than two facing pages. Thus, at this stage, maps that stand by themselves in the various series are considered to be plates or sheets. A figure is any illustration that can be printed within the area of two facing pages or printed as a subordinate illustration on a map sheet. Photographs of fossils or groups of fossils, however, are usually labeled as plates in Survey reports even though they are printed at page size. These distinctions are helpful to bear in mind when you fill out your "Author's Check List," Form 9-1517, shown in figure 23.

When you are planning to submit manuscripts for the Survey's various publication series, or for outside journals, you should know about limitations as to (1) image size, (2) number and size of illustrations, (3) the use of plates, (4) color, and (5) reproduction processes. Contact a map editor, illustrator, or journal editor, or study recent examples of the publication. You should also try to anticipate your needs for photographs, base maps, and other compilation materials early in the project. After your fieldwork is completed may be too late.

COST CONSIDERATIONS

Illustrations should be planned along with the research project itself or soon thereafter. By using the preliminary project description and a rough outline of your ultimate report, you can estimate the kinds and numbers of illustrations needed. For more detailed planning, you should then consult with a map editor and other advisors. This planning should explore—

1. Proposed publication series—options and constraints
2. Need and justification for multicolor plates and figures
3. Need for separate plates to be inserted in a pocket
4. Alternative of publishing some or all plates in a separate map series
5. Dimensions of figures
6. Base-map requirements (see section on "Base-Map Needs," below).

If you understand the relative costs of various printing methods, as a guide toward the most acceptable form for an illustration, you may forestall publication delays. In general, linecuts (figures that can be printed directly with the text) cost little if any more than composing and printing text; halftones of black-and-white photographs cost only a little more than text or linecuts, unless they are printed on special paper or require special screening. Duotone prints, for example, cost more than single-screen prints but provide richer tonal values. Color halftones and multicolor maps cost much more than black and white (unless the publisher has a multicolor press—then the increased cost per unit is minimal).

Any plate is more expensive and time consuming to prepare than a figure; color plates are much more expensive to print and handle than simple text and figures. These cost considerations shrink with large editions such as those of popular magazines, but they are very real for scientific reports of a few thousand copies that require precise color registration. The use of color in Survey publications is overseen by the Congressional Joint Committee on Printing, which delegates its authority to the Survey's Office of Scientific Publications.

In some Survey reports prepared for the general public, such as reports on national parks or monuments, color photographs of geologic features are encouraged as being more meaningful to the reader than black-and white photographs. In some crowded diagrams, clutter can be reduced by the substitution of a single color, such as blue or red, for some of the black lines or patterns. Other illustrations may also warrant color—photomicrographs of rock thin sections, for example—but any use of color in photographs or other illustrations must be justified in writing; prior tentative approval by the Office of Scientific Publications may avoid wasted work.

Planning Maps

A first consideration is scale—the optimum scale needed to show the details required by the aims of the project. The scale normally determines what base map will be required. Another consideration is the availability of a topographic base and its clarity at the scale of publication. In the past, planimetric bases were used when topographic maps were unavailable. Modern topographic maps are now available for most of the Nation, and interpretation of modern geologic maps is based on information supplied by the topographic base. Planimetric bases should be avoided unless intended for a simplified black-and-white illustration. How much drainage and culture are necessary? Certain maps—the Geologic Quadrangle (GQ) Map, for example—are published only on standard topographic quadrangles. You should not be parsimonious about color, because it enhances readibility, but color will not be approved unless it is necessary for clarity. Much thought must go into early planning for complex full-color maps.

Base-Map Needs

Before a mapping project is started, the project chief and supervisor determine the mapping and publication scales. The mapping and publication scales are selected on the basis of the amount of data required to solve the geologic problem. The publication scale is generally easily chosen if published topographic base maps are available, but some geologic problems may be resolvable only at larger scales. Regional relationships, on the other hand, may be depicted best on mosaicked bases of several topographic maps reduced perhaps as much as 50 percent or, if available, on one of the 1:100,000-scale topographic maps. Base maps reduced more than 50 percent are generally illegible and unusable. Rarely, for some maps, a planimetric base may suffice.

Every effort should be made to judge accurately how much detail is needed to solve the geologic problem efficiently; to plot excessive detail wastes time in mapping, in then selecting data to retain or delete, and in final drafting. For some projects, the modern 1:100,000-scale topographic base maps provide adequate detail; for others a 1:24,000-scale base is needed. Supervisors and map editors recommend that compilation and publication scales be the same.

For accurate registration, your final map compilation is plotted on scale-stable material. In planning a project, allow adequate time for preparation of the scale-stable base. Even more lead time is needed if the base is to be a mosaic of several topographic sheets, if the scale is to be different from that of the original base maps, or if the reproducible source material is stored elsewhere than at your regional headquarters. The map editor can advise you on the types of stable materials

that are available. Most mappers compile on scale-stable greenline copies of the base map.

Planning Text Figures

Text figures should be carefully planned to ensure the most effective graphic communication possible. Illustrations serve to demonstrate relations that cannot be described as clearly by written words or to relate more detail than words can effectively portray. Discuss plans for illustrations with the publication staff in advance.

Figures may be published either "bottom title" or "side title." In bottom-title figures the top of the figure is toward the top of the page, and the caption is printed beneath the figure parallel to the text. In side-title figures the figure and caption are turned sideways on the page. Small figures can be printed column width. Use side-title figures only when necessary, because they are awkward for the reader and they detract from the composition of the report; consider (1) redesigning or reproportioning such drawings or photographs, (2) using bleeds (extending the photograph to the edge of the page, to the gutter, or both) for oversized photographs, (3) placing explanations or captions on facing pages, or (4) using page-and-a-half or two-page spreads across facing pages. Such layouts can enhance composition and interest.

Image Sizes

Standard image sizes for figures and plates are given on the back side of the "Author's Check List" for illustrations, Form 9-1517 (fig. 23).

Special Requirements

Maps

Map data should be compiled directly on a stable base. Linework should be drafted in black ink or scribed. The original compilation must not be colored, because it is not easily reproduced. A paper or plastic print should be colored as a "mill" copy for reviewers, map editors, and illustrators.

Scribing is an alternative to inking. For scribing, the base map is printed on scale-stable scribe-coat material, which is ordered through a map editor. Linework is then engraved with a scribing tool. Once the technique is mastered, scribing is rapid, neat, and accurate, and if linework meets publication standards, a major step in map preparation is saved. For review copy the scribed linework is combined photographically with a screened or green base ordered by a map editor. For review purposes and as a guide for illustrators, a paper or plastic copy of the combined inked or scribed original map is then colored as a check copy. You as author cannot adequately check your own work without carefully coloring it out. Do not color the original.

Programs for microcomputers are readily available to assist earth scientists and illustrators in compiling and drafting of maps and illustrations. Lines, symbols, and codes for patterns and colors can be digitized in their proper positions on plots; screen graphics are used to assist digitizing and editing but are not primary tools in design. Electronic plotters, responding to the digital files, can plot the map or illustration at the scale or size selected. Such computer-assisted drafting saves an author much time in making corrections and copies for editing; ultimately, publication is accelerated by using the data files. Programs vary in their capabilities and complexities of use. Consult with a map editor or cartographic expert for advice on which program and equipment are best suited to needs of your map or illustration. (See also p. 224.)

Contacts, Faults, and Fold Axes

Contacts, faults, and fold axes are normally drawn or scribed as solid lines. Dashed or dotted contact lines and faults are also generally shown on maps. Standards that define the use of solid, dashed, and dotted lines are available from a map editor. A line guide for the illustrator is required, such as a colored pencil line on a black-and-white print, showing exactly what line segments are to be dashed and what are to be dotted. If most contacts on a geologic map are approximate (most are), all should be shown as solid lines and the explanation should state "Contact—Approximately located" or "Approximate contact." Individual contact relations can also be explained in the descriptions of the formations.

Faults may be drafted as solid, dashed, or dotted lines, based on established standards, and mappers must exercise discriminating care in using the correct line to depict actual field conditions. A solid line designates a known fault accurately located within the scale limitations of the map. A dashed line may designate a known fault approximately located or an inferred fault. Queries can be added to express doubt beyond what is implied by mere inference. A dotted line is used only for a concealed fault; for example, if a surficial deposit such as alluvium or talus laps against bedrock along a fault line but is not involved in the faulting, the line should be dotted; a solid or dashed line would imply that the alluvium or talus had been faulted. Similarly, if a fault is shown by a

dotted line through any unit, the fault must pass beneath the unit.

Lithologic Patterns

Authors who plan to use lithologic patterns on an illustration should consult the map editor and illustrator. Lithologic patterns rarely are overprinted on full-color geologic maps. They appear more commonly on cross sections. If so, authors should supply exact copy on a registered, scale-stable overlay. Because such patterns follow structure and must be drafted by hand, author copy is used if possible. Lithologic patterns generally should be avoided because they are time consuming to draft, they clutter the map, and they obscure the base. Lithologic patterns are commonly used in columnar sections, however, and are available for that purpose in ready-made, adhesive-backed form. Computer programs are available, also, that will plot lithologic patterns in log form.

Map Explanations

Authors should scan recently published maps for guidance in preparing map explanations. Check with your map editor. The explanation must include all information needed to understand the illustration, which in turn must stand alone without reference to the text or to another illustration.

Two types of explanations are used with geologic maps published by the Survey—short and expanded. The two types differ only in the amount of stratigraphic and lithologic detail. Both types usually consist of a "Correlation of Map Units," a "Description [or a "List] of Map Units," and a list of line and point symbols used on the map. In either event, the "Description of Map Units" must include the names of the rock-stratigraphic units and their assigned systems.

The short "Description of Map Units" includes the names of the mapped groups, formations, or members but either no lithologic description or a brief description limited to the major lithology. Short explanations commonly depend on an accompanying book, pamphlet, or graphic columnar section for lithologic details.

Where space is available, an expanded "Description of Map Units" giving stratigraphic detail is desirable. Detail may include information such as lithologic content, color, grain size, bedding characteristics, porosity, permeability, fracture characteristics, mineral or fossil content, remanent magnetization, and thickness. Correlation with other units, nature of contacts, radiometric or other age determinations, and sources of specific information (citations) may be provided. The length and detail are limited only by the size of the map and the number of map units. If the explanation will not fit, a second map sheet or a pamphlet may be added.

Explanations having many map units cause special problems in form and layout. Look to recently published maps for guidance, such as State maps and 1:250,000-scale maps, and consult with map editors and representatives of your Geologic Names Unit.

Suggestions for the treatment of stratigraphic symbols and the arrangement and format of map-unit boxes in map explanations are given in the section on stratigraphic descriptions (p. 49).

Stratigraphic details in the explanation should be limited to data from within the map area, although brief correlations with rock units in adjacent areas may be appropriate. References may be included. Descriptions should use telegraphic style; nonessential articles ("a," "an," "the") may be deleted; complete sentences are unnecessary. To separate ideas, periods or semicolons may be better than conjunctions. Let brevity and good judgment decide. The description may be paragraphed. Periods are omitted at the end of each entry or paragraph.

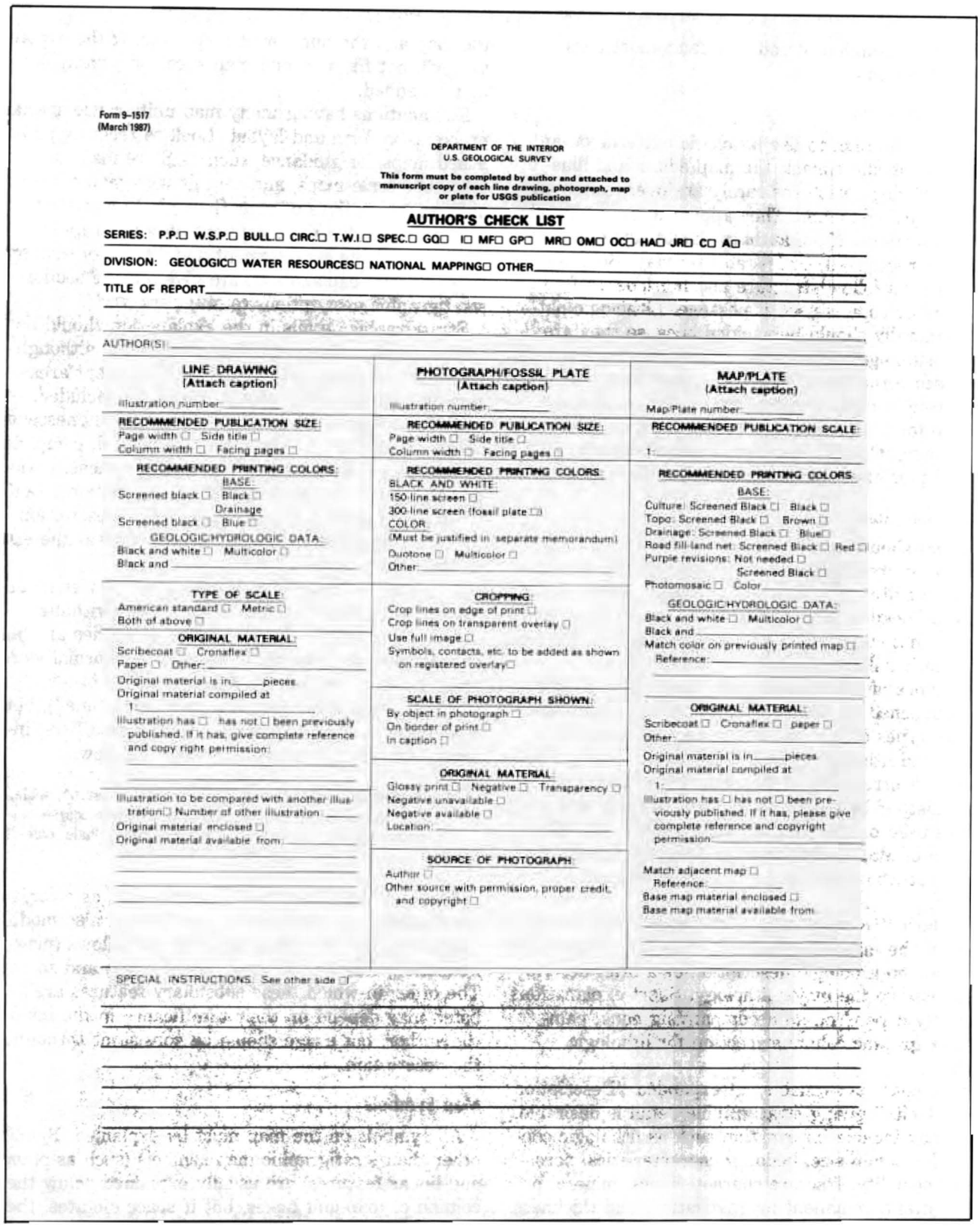
The order of describing lithology may differ from map to map, but it should be consistent within a given "Description of Map Units." If entries are fairly short and no lithology predominates, normal word order reads more smoothly than inverted order ("Sandy green shale and silty gray sandstone"), but if an entry is long and has a string of modifiers, inverted sentence structure is easier to follow:

> **Curtis Formation (Jurassic)**—Interbedded sandstone, shale, and limestone. Sandstone, light-gray, fine- to coarse-grained, poorly sorted, and thickly bedded. Shale, pale-green, * * *. Limestone, * * *.

Features that characterize a unit, such as color, permeability, or gradations in grain size, also modify the lithologic term; other information follows (magnetization, fossil or mineral content, age, and so on). The order in which these subsidiary features are listed may depend on their significance in the mind of the author, but usage should be consistent throughout the description.

Map Symbols

All symbols on the map must be explained. Symbols other than stratigraphic map symbols (such as planar and linear features) are usually explained below the column of map-unit boxes, but if space dictates, they can be grouped elsewhere on the map sheet. Conventional symbols for outcrops, contacts, faults, folds, linear features, bedding attitudes, foliation, cleavage, joints, isopleths, ore and rock alterations, mine devel-



Form 9-1517
(March 1987)

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

This form must be completed by author and attached to manuscript copy of each line drawing, photograph, map or plate for USGS publication

AUTHOR'S CHECK LIST

SERIES: P.P.☐ W.S.P.☐ BULL.☐ CIRC.☐ T.W.I.☐ SPEC.☐ GQ☐ I☐ MF☐ GP☐ MR☐ OM☐ OC☐ HA☐ JR☐ C☐ A☐

DIVISION: GEOLOGIC☐ WATER RESOURCES☐ NATIONAL MAPPING☐ OTHER

TITLE OF REPORT

AUTHOR(S)

LINE DRAWING
(Attach caption)

Illustration number:

RECOMMENDED PUBLICATION SIZE:
Page width ☐ Side title ☐
Column width ☐ Facing pages ☐

RECOMMENDED PRINTING COLORS:
BASE:
Screened black ☐ Black ☐
Drainage
Screened black ☐ Blue ☐
GEOLOGIC/HYDROLOGIC DATA:
Black and white ☐ Multicolor ☐
Black and

TYPE OF SCALE:
American standard ☐ Metric ☐
Both of above ☐

ORIGINAL MATERIAL:
Scribecoat ☐ Cronaflex ☐
Paper ☐ Other:
Original material is in pieces
Original material compiled at
1:
Illustration has ☐ has not ☐ been previously published. If it has, give complete reference and copy right permission:

Illustration to be compared with another illustration ☐ Number of other illustration:
Original material enclosed ☐
Original material available from:

PHOTOGRAPH/FOSSIL PLATE
(Attach caption)

Illustration number:

RECOMMENDED PUBLICATION SIZE:
Page width ☐ Side title ☐
Column width ☐ Facing pages ☐

RECOMMENDED PRINTING COLORS:
BLACK AND WHITE:
150-line screen ☐
300-line screen (fossil plate ☐)
COLOR:
(Must be justified in separate memorandum)
Duotone ☐ Multicolor ☐
Other:

CROPPING:
Crop lines on edge of print ☐
Crop lines on transparent overlay ☐
Use full image ☐
Symbols, contacts, etc. to be added as shown on registered overlay ☐

SCALE OF PHOTOGRAPH SHOWN:
By object in photograph ☐
On border of print ☐
In caption ☐

ORIGINAL MATERIAL:
Glossy print ☐ Negative ☐ Transparency ☐
Negative unavailable ☐
Negative available ☐
Location:

SOURCE OF PHOTOGRAPH:
Author ☐
Other source with permission, proper credit, and copyright ☐

MAP/PLATE
(Attach caption)

Map/Plate number:

RECOMMENDED PUBLICATION SCALE:
1:

RECOMMENDED PRINTING COLORS:
BASE:
Culture: Screened Black ☐ Black ☐
Topo: Screened Black ☐ Brown ☐
Drainage: Screened Black ☐ Blue ☐
Road fill-land net: Screened Black ☐ Red ☐
Purple revisions: Not needed ☐
Screened Black ☐
Photomosaic ☐ Color
GEOLOGIC/HYDROLOGIC DATA:
Black and white ☐ Multicolor ☐
Black and
Match color on previously printed map ☐
Reference:

ORIGINAL MATERIAL:
Scribecoat ☐ Cronaflex ☐ paper ☐
Other:
Original material is in pieces
Original material compiled at
1:
Illustration has ☐ has not ☐ been previously published. If it has, please give complete reference and copyright permission:

Match adjacent map ☐
Reference:
Base map material enclosed ☐
Base map material available from:

SPECIAL INSTRUCTIONS: See other side ☐

Front

Figure 23.—"Author's Check List," front and back (Form 9-1517, revised March 1987). The original sheet (8½ × 11 inches on yellow paper) must be completed for each illustration to be published in a Survey report.

THE FOLLOWING IS GENERAL INFORMATION MADE AVAILABLE TO AUTHORS TO HELP EXPEDITE REPORTS DURING CARTOGRAPHIC PREPARATION

MAXIMUM PUBLICATION ILLUSTRATION SIZES IN INCHES (PICAS) FOR BOOK REPORTS

PROFESSIONAL PAPER

Bottom title
7⅛" x 8½" (43 x 51)
Side title
9" x 6⅝" (54 x 40)
Column width bottom title
3½" x 8½" (21 x 51)

CIRCULAR, BULLETIN, WATER-SUPPLY PAPER, AND TWI

Bottom title
6¾" x 8⅛" (41½ x 52)
Side title
9¼" x 6⅛" (55 x 38½)
Column width bottom title
3¼" x 8⅛" (20 x 52)

STANDARD FILM AND IMAGE SIZES AND ALLDIS PUNCH NUMBERS FOR PLATES

Film size	Image size **	1*	2*	3	4
42" x 58"	40" x 56"	55	39	59	43
34" x 44"	32" x 42"	45	31	41	35
30" x 42"	28" x 40"	39	29	43	27
24" x 30"	22" x 28"	31	17	27	29

* Top of plate

**Maximum image press size for the USGS printing plant is 41½" x 57". Plates exceeding these dimensions must have OSP approval for printing by a private contractor.

RECOMMENDED PUBLICATION SCALES FOR PLATES

1:20,000 (Puerto Rico)	1:125,000	1:25,000
1:24,000	1:250,000	1:31,680
1:62,500	1:500,000	1:50,000
1:63,360 (Alaska)	1:100,000	

PHOTOGRAPHS

1. Submit glossy print at publication scale or indicate by crop lines to bring to publication scale.
2. 300-line screen to be used for fossil plates and where fine detail is essential.
3. Do not write on the front or back of photographs; avoid using paper clips, especially on the image area. Scale should be drawn outside of image area.
4. Use registered overlay to show line and symbol placement. Never draw on photographic prints.
5. Do not mount with glue, tape, or permanent attaching materials.
6. Do not place any kind of tape over image area.
7. Register all overlays by corner ticks or other marks; indicate top if not obvious.
8. NOTE: Original negatives of all photographs published in USGS reports are sent to the Photo Library, Denver, Colorado, by the Branch of Technical Reports.

SPECIAL INSTRUCTIONS:

Reverse

opment, and oil, gas, and water wells are shown in "Cartographic and Digital Standards for Earth Science Publications—Principles, Symbols, Colors, Patterns, Codes, and Formats" (Reynolds and others, in press).

One way to organize an explanation of symbols is to list them in this order: patterns (other than those for map-unit symbols), line symbols (contacts, faults, folds, isograds, structure contours), planar symbols (strike and dip of bedding or other features), linear symbols (bearing and plunge of lineations or other features), and point symbols (such as quarries, mines, and sample localities), but the order may be altered for emphasis.

If linework is dashed, dotted, or both, be sure it is explained. If planar and linear features are shown in inclined, vertical, or horizontal positions, be sure each case is shown separately. The point here is to do everything possible to keep the reader from having to guess what the symbols are showing. Special map symbols may be devised as needed, with the concurrence of the editor or illustrator. Such a unique symbol must be identified in the explanation.

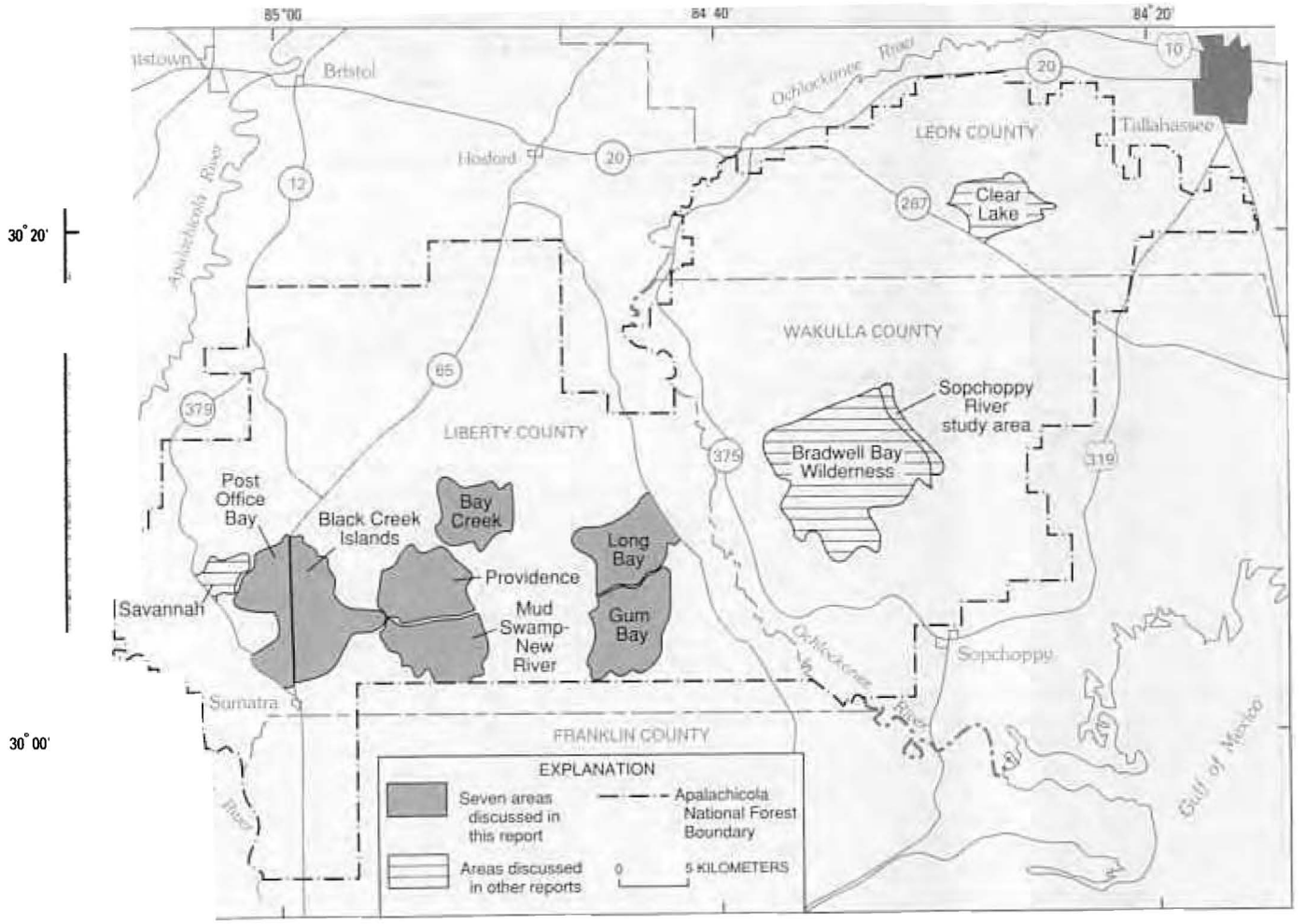


Figure 24 (above). Special-purpose index map showing location of the roadless and wilderness areas in the Apalachicola National Forest, Liberty, Leon, Franklin, and Wakulla Counties, Florida. Map shows latitude and longtitude, rake scale, towns, roads, and county lines.

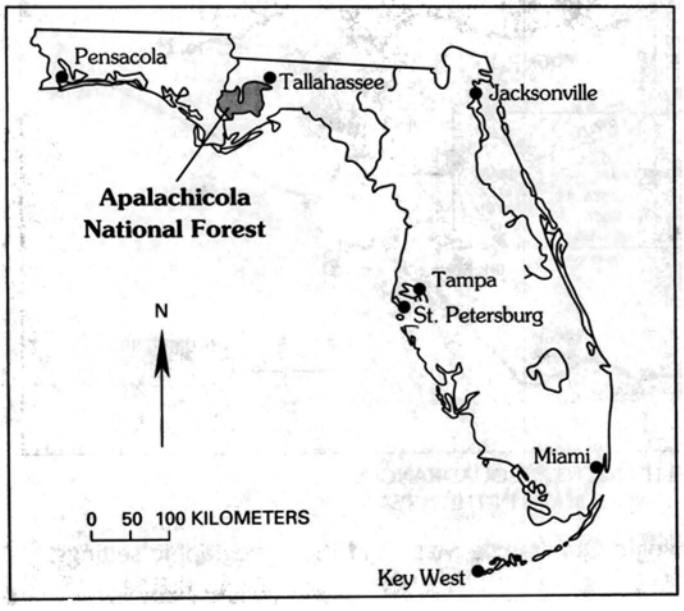
Figure 25 (opposite page). Location map accompanies map above. Shows location of the Apalachicola National Forest, scale, and north arrow.

Index Maps

Most book reports, journal articles, and plate-size maps include an index map to locate the area of the report geographically. A second index map may be needed to locate geographic and structural features mentioned in the text. Index maps range widely in complexity. A complex one should show latitude and longitude or townships and ranges, a rake scale, and perhaps a north arrow. It may show minimal drainage, cultural features such as major towns, county lines, roads, and minimal topography. A township grid alone is rarely adequate, because readers relate better geographically to towns, streams, and roads, although for some reports—those on oil fields, for example—townships and ranges are more useful to the map user than latitude and longitude. If the map includes all or parts of several counties or States, their names should be on the index map. The report area should be identified by pattern, color, or outline.

Most plate-size maps include a small outline map of the State or States enclosing the map area, showing the area in color, pattern, or black silhouette. Additional index maps may be used to show such things as sources of information, sample localities, credits for areas of mapping, published maps of adjacent areas, and regional structural trends. If the map is in color, the index map may be printed in some or all of the same colors, as needed. Examples of index maps shown in figures 24–28 illustrate their range of diversity.

If a figure shows latitude and longitude coordinates on an outline of an area, but no other geographic or cultural data, the figure is simply termed an index, rather than an index map.



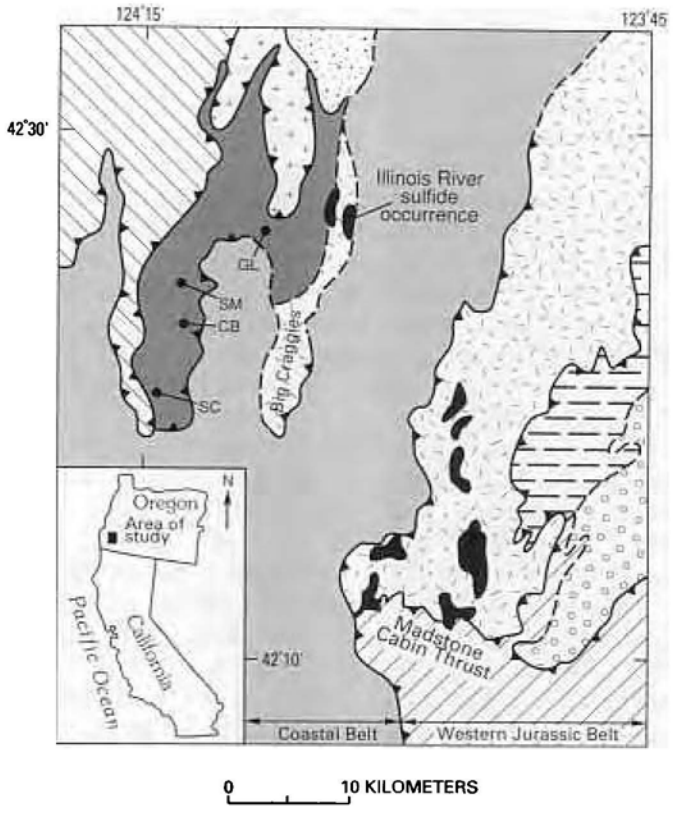


Figure 26 (above). Special-purpose index map showing geologic setting of the Illinois River sulfide occurrence. SC, Snow Camp Mountain; CB, Collier Butte; SM, Saddle Mountain; and GL, Game Lake. Shows use of two maps to locate study area, latitude and longitude, north arrow, and generalized geology.

Mine Maps

Detailed geologic mine maps (not plans or plan maps) are expensive to prepare. Regardless of form of publication, a geologic mine map should have a complete explanation and all the other requisites of a geologic map: north arrow, scale, location in terms of latitude and longitude ticks or of section, township, and range, or some other geographic coordinate system. Notes leadered to points of pertinent observa-

tions may take the place of a lengthy explanation; such notes should be in telegraphic style but without abbreviations except for units of measure.

If a series of maps of various levels of a mine is to be published, all the maps should be at the same scale. If some of the maps are too large to be printed on a single page or facing pages, they all can perhaps be grouped in a logical and easily understandable fashion on an oversize plate. Color may be used to depict ore, other mineralized areas, or geologic features if such things cannot be shown clearly by black-and-white patterns.

Mine levels are sometimes designated in either of two ways: (1) A numeric designation such as "100 level" is appropriate if a designation is merely a numbering system for mine levels not separated by precise intervals or elevations below a datum; (2) "100-foot level" is appropriate if a company designation also is a surveyed or precise elevation. If a mining company itself uses both systems, either is acceptable, but only one should be used in a given report. If needed to be shown, names for levels or other workings, such as "main haulage level," should be used as applied by the mine operator.

Cross Sections

Cross sections should depict scientifically or economically important relationships where structural data are sufficient to allow for reasonable subsurface extrapolations. No more sections should be submitted for publication than are needed to show the inferred relationships. Cross sections should show significant facts and inferences that are better visualized graphically than verbally.

Structural data show best and with least distortion in sections drawn perpendicular to prevailing structural trends. Oblique sections distort dips and thicknesses. Sections need extend only far enough to show relevant structural details; they need not extend across the entire map. They should be oriented to read from either west to east or south to north and should be at the same scale as the map. If several sections are drawn to illustrate through-going structural features common to all, however, all sections should be oriented alike to maintain structural continuity, regardless of the viewer's orientation.

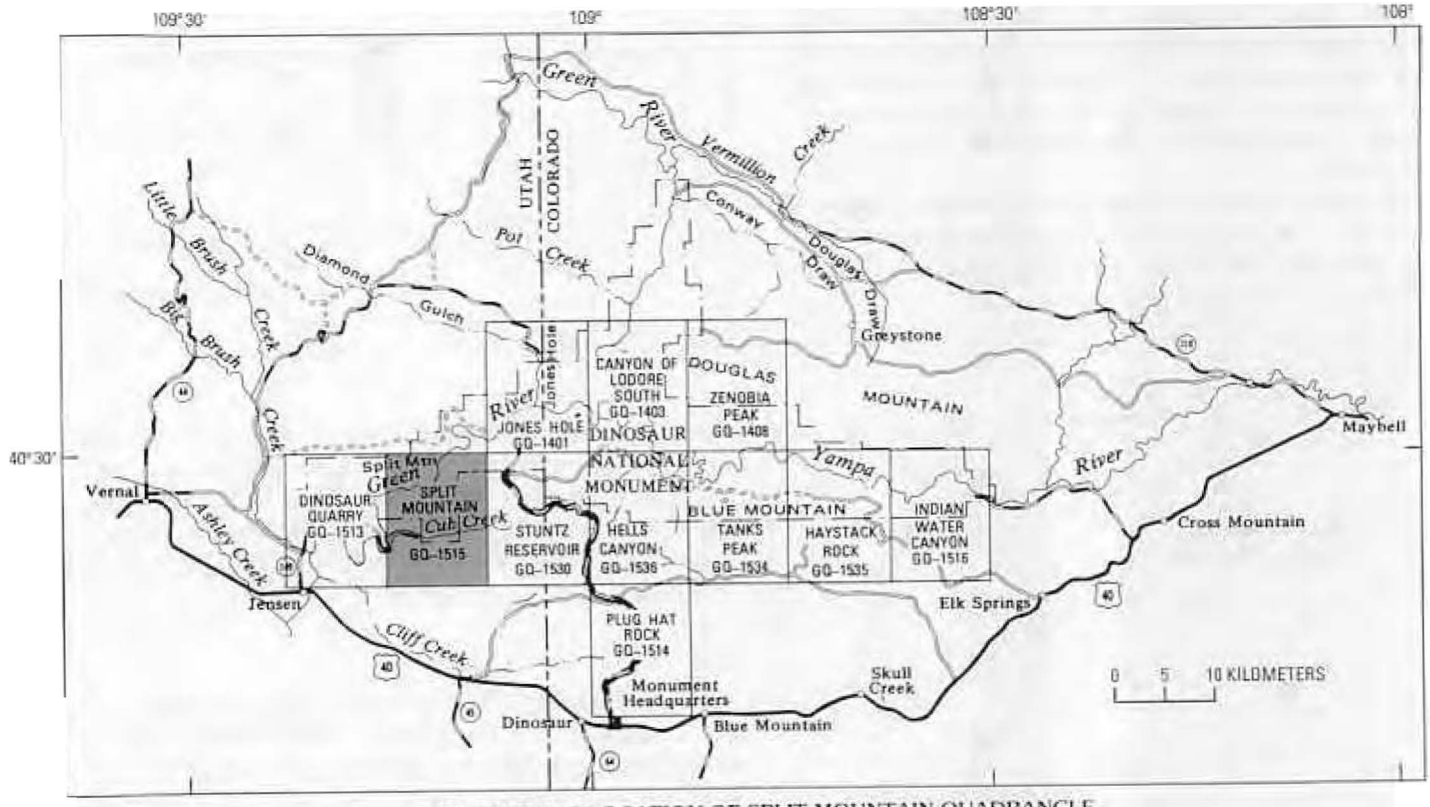


Figure 27. An index map identifying several published Geologic Quadrangle Maps and their geographic settings including drainage and major highways and roads.

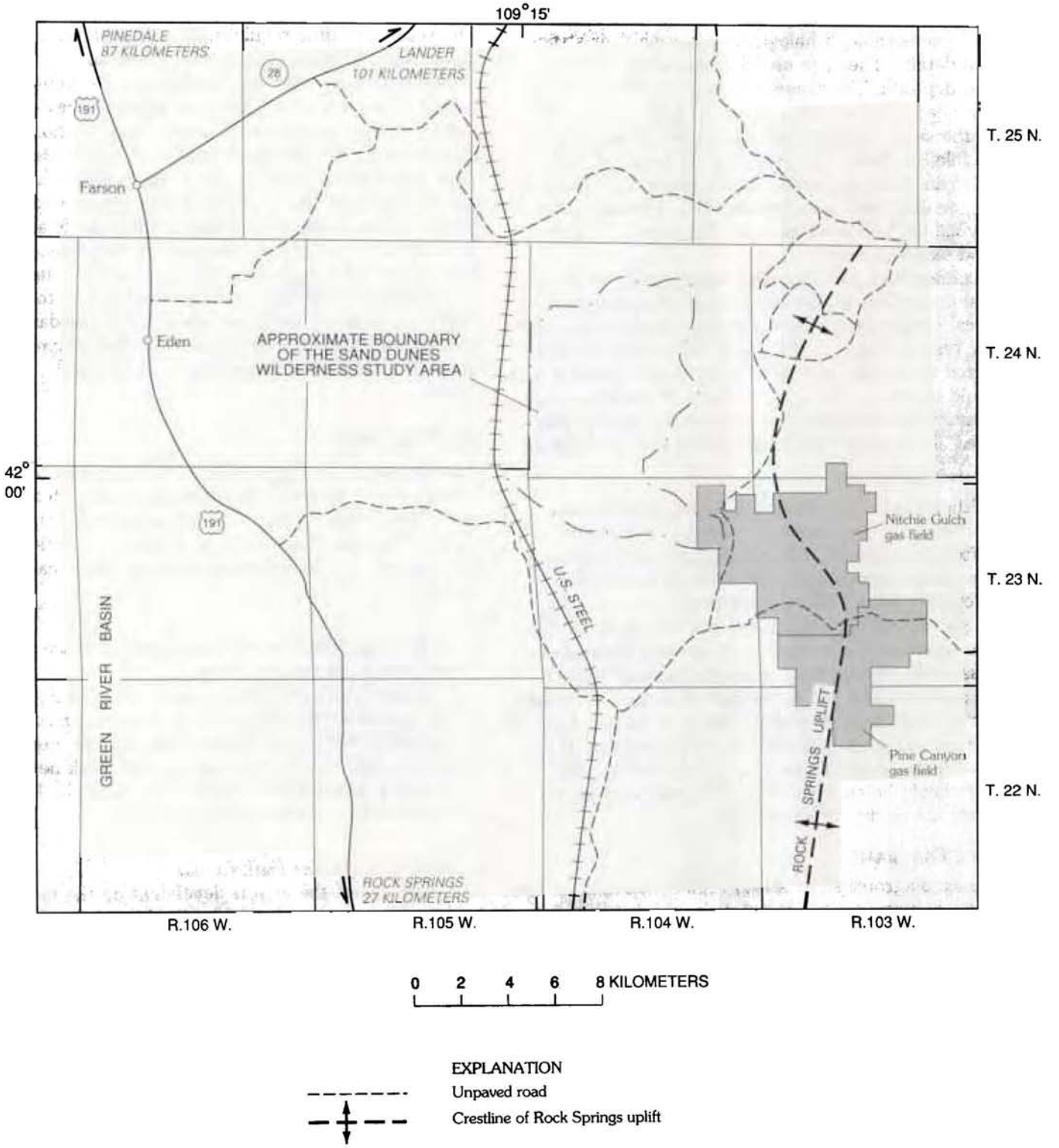


Figure 28. Index map of the Sand Dunes Wilderness Study Area, Sweetwater County, Wyo. Shows latitude and longitude, townships and ranges, roads and highways, and other features of interest.

Exaggerated Sections

Exaggerated vertical scales are sometimes used to show geomorphic, lithologic, stratigraphic, or structural details. They are useful in depicting thin surficial deposits. The exaggeration should be no more than needed to show the detail, and all sections having the same exaggeration should be grouped, where possible, on the same plate. The thickness of thin units can be exaggerated for the purpose of illustration, or thin units may be lumped in a cross section if they cannot be shown at scale. In general, however, avoid exaggeration.

Exaggerated vertical scale causes apparent structural distortions if dips exceed a few degrees, and illogical or impossible apparent structural relationships may result. Exaggerated scales, therefore, should be limited to sections through flat-lying rocks, and a note should be added (below the lower left margin) to call attention to the distortion. A true-scale profile published above an exaggerated section may be helpful.

Patterns and Lines

Lithologic patterns should be used sparingly on cross sections, because they must be individually drafted or scribed to follow structure, and because they are expensive and often difficult for the illustrator to prepare. All contacts in the cross section, though inherently interpretive, are shown as solid lines. Queries can be inserted in contact lines to express doubt. Faults may be shown as solid, dashed, and queried lines, but not dotted. If a fault or contact is projected above ground profile to show structure, it is dashed. If color is needed to clarify restored (projected above ground) parts of a cross section, that color should be omitted from a narrow band immediately above the ground profile.

Fence Diagrams

Fence diagrams show stratigraphic interrelation and structure by means of intersecting crossing sections drafted in true geographic projection. Properly constructed, they can present geologic interpretations very clearly, but care is needed to avoid projection errors in apparent dip, thickness, and slope. The height and orientation of the sections, moreover, affect the chosen direction of view and the optimal distance apart of the sections. Fence diagrams are difficult to prepare correctly, are expensive to draft for publication, and have few advantages over well-planned conventional sections.

Page-Size Maps

For many reports, page-size maps contain scientific and geographic information needed by the reader to understand the text. In preparing page-size maps, your first focus should be on (1) initial decisions about size, scale, and time requirements; (2) materials; and (3) overview of the components of the map.

Page-size maps often are troublesome for you as author to prepare, for critics and editors to review, and for the graphic artist to draft. Consideration must be given to the final "look" of the map, especially if you wish timely drafting and publication. Careful planning can forestall vexing bottlenecks in preparing the artwork by enabling the graphic artist to use most or all of your author-prepared copy, or at least to correctly interpret your copy. Many sources of help exist for authors who don't know how to get started or even where to ask about time, standards, and quality. Consult with map editors and graphics specialists for advice on materials, design, and format.

Initial Decisions

At the outset, a rough draft of the map may be helpful, at the desired publication size and with all intended geographic detail. This visual aid will help you choose the scale, base needs, and other elements of the illustration. The following questions then may be asked.

1. *Is the map based on previously published work or is it based on new mapping?*

   A previously published source map probably will be of a different scale, may be in color, and may be too detailed or too generalized for the intended illustration, or the map may be new work never before published. The distinctions should be kept in mind before drafting begins.

2. *What are the size limitations?*

   The size of the map is dependent on the maximum image size allowed by the intended publication. Consult a map editor about in-house reports, or the journal editor outside. Most likely, you will have a choice between bottom-title, side-title, and column-title orientations on the page; the choice may depend on the widest dimension of the map. Some layouts can be spread over two pages, or a map can be on one page and its explanation on a facing page. Look at prior publications for examples. See the reverse side of Form 9-1517 ("Author's Check List") for specific dimensions. Authors may try to save publication time and cost by avoiding oversized (larger than page-size) illustrations, but be sure that what you are attempting is feasible.

3. *What is the ideal scale?*

   You need to know the scale (and implications) of the available base maps. The Survey has many standard base-map products at scales of 1:24,000, 1:100,000, 1:250,000, and 1:500,000 and some smaller scales for maps of larger parts of the United States. Some maps are available at 1:50,000. Scale choice depends on the problem to be solved or character of the data to be presented. For best results, compile at or close to publication scale.

4. *What are the time constraints?*

   Time may be short on the cutting edge of science, where the results of your research are in immediate demand, but try to allow adequate time to prepare your illustrations. Be familiar with the production cycle so that time is available to properly draft your map. To judge production time, talk to a map editor or graphics specialist or to the editor of the outside journal and work out a production schedule that meets all deadlines.

Materials

A map editor or graphics specialist can help you decide what is needed for compilation. All the items described in this section, except basic drafting tools and supplies, are available through the Branches of Technical Reports (BTRs). Instructions on preparing artwork are outside the scope of this section, but a few words about basic materials should be remembered.

Base maps. Once you have decided on the size and scale of the illustration, ask a map editor about base-map materials. Map editors keep them on hand, or they can order appropriate base negatives or mosaics. The map editor will order a sheet of scale-stable frosted plastic with the base map printed in non-photographic green (a "greenline"). An order for base materials can take several weeks to fill, so allow for the extra time. The greenline will have registration holes punched near its margins; these holes are needed to register any overlays to the greenline.

If no suitable base map exists, you may have to prepare one yourself, perhaps by finding an available map at the next closest scale and transferring the desired features onto a clean sheet of scale-stable material. Include the geographic coordinates. Towns, drainages, roads, and physiographic depictions are helpful but are optional. An enlarging-reducing photocopier or projector will make this job easier.

Overlays. In preparing a figure, you can use overlays to separate information plotted on the original artwork. For example, consider figure 29, which shows the location of Wilderness Lands in the State of Arizona in relation to the geology and shows the State outline, geographic coordinates, counties, and major population centers. One overlay would have the Wilderness Lands, shown here in gray. Another overlay would show the lithologic units and still another would show drill holes, outcrops, and lines of geologic cross sections. Compiling all these layers of information on one sheet of material would present difficulties for both reviewers and the drafter who must interpret your copy. Take care to avoid duplicating information. Overlays should always be compiled on scale-stable material (the same material as a greenline) registered to the greenline or skeletal base map. Decide in advance what information can be grouped together.

Pens and inks. For the cleanest linework, use a technical pen filled with carbon-base black ink specially developed for inking on plastic and less than a year old. Avoid india ink, pencil, ballpoint pen, fountain pen, or felt-tip pen—these will yield less satisfactory results and may not photograph well. Scribing is a good alternative to pen and ink.

Lettering, symbols, and patterns. Lettering and symbols can be hand drafted with pen and ink or can be applied with adhesive-backed drafting products. Choose the latter method if your illustration is to be camera ready. Scan a variety of USGS publications to decide what styles and sizes of type to use and what symbols are standard for the map features you will show.

Choice of patterns is somewhat subjective; what looks best to you may violate the sensibilities of a graphic specialist. A map editor or graphics specialist can help you decide which patterns are best and which to use, if any. Remember that patterns are substitutes for color on a page-size map and must be selected just as carefully. Avoid patterns that may cause unwanted moire effects or that inhibit legibility. Try to choose tints of gray or small, densely spaced pattern elements rather than stripes or large, widely spaced elements.

Components of Page-Size Geologic Maps

Geographic coordinates and neatline. Unless the map scale is very large, geographic coordinates should be plotted. Once these are plotted, a neatline (or boundary) of the map area can be added. The coordinate ticks should be projected to the neatline and their values placed beside them, outside the neatline, to the left and top of the map. Coordinate intersection crosshairs can be plotted inside the map area if desired, but drawing the entire grid inside the map area detracts from the legibility. Other applicable

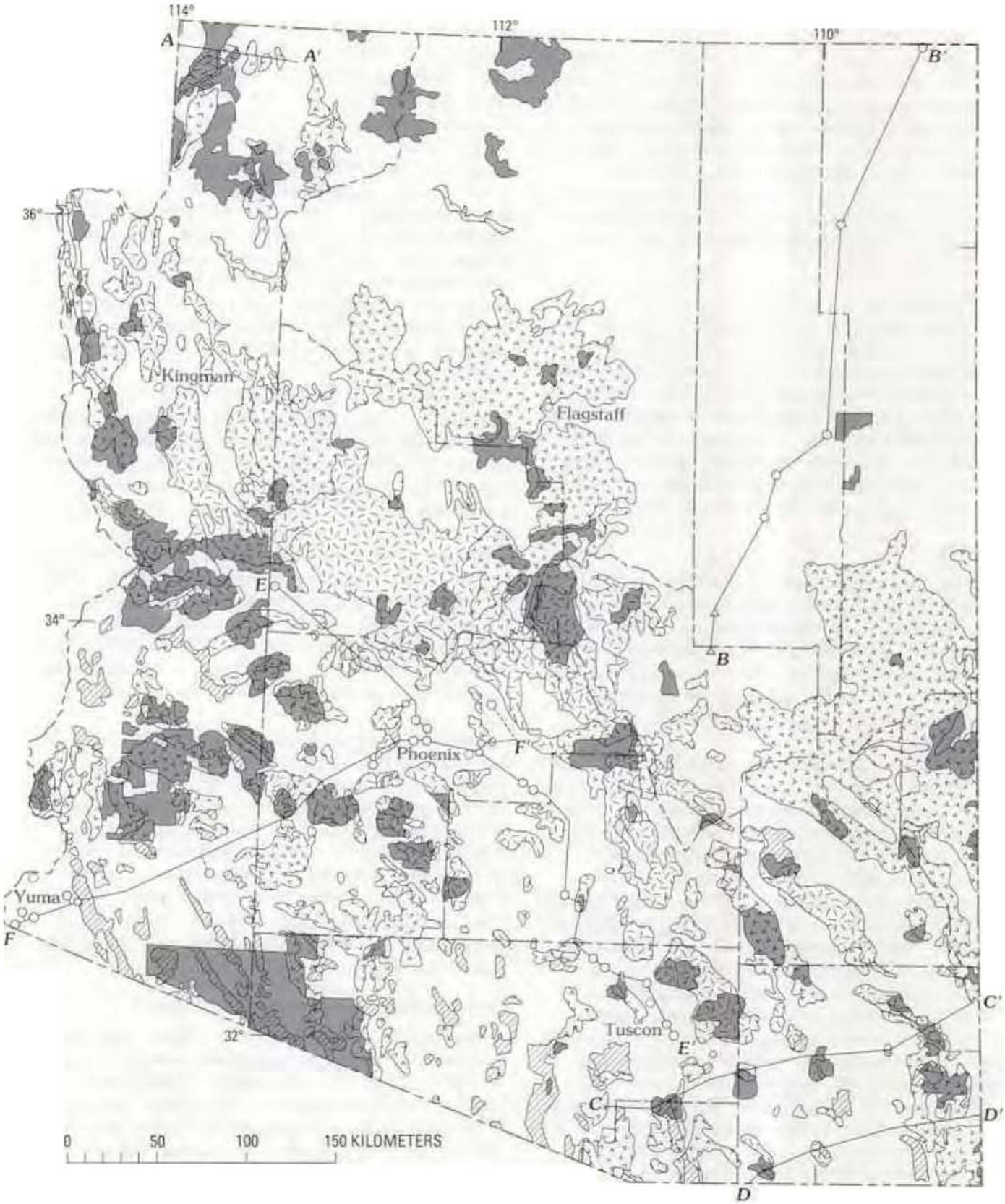
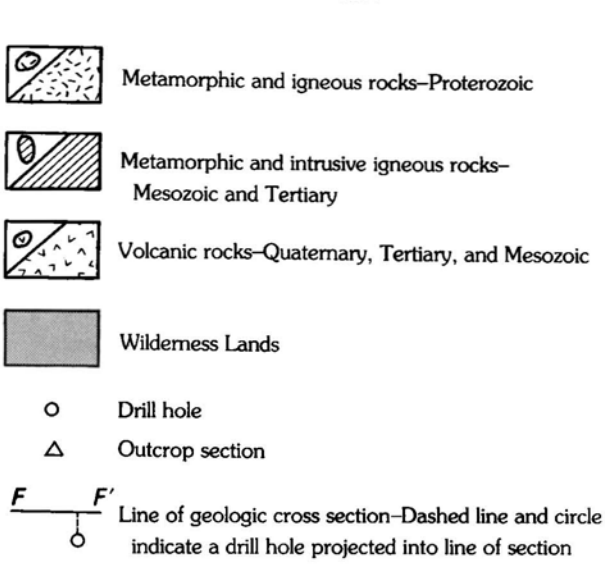


Figure 29. Major outcrops of igneous and metamorphic rocks and lines of cross sections.



coordinate system ticks can be added around the neatline, such as UTM coordinates, State grid values, and public land surveys (township and range).

Scale. Every map must have a scale. If the scale is a standard Survey scale, and no enlargement or reduction is planned in the printing, use the standard bar scale. If an odd scale will result from enlargement or reduction, use a rake scale. If your report uses both English and metric units, the map should have both English and metric scales.

Base-map credit note. Always acknowledge the source for the base map, the publication (and photorevision) date, and the original scale if it differs from your illustration. Wording such as "Base from U.S. Geological Survey, 1:250,000, 1966" is a common way to phrase a credit note, but check with a map editor if you are unsure. The credit note should identify the projection of the base map. Knowledge of the base-map projection is essential for map users who incorporate the map data in a digital information base.

Mapping credit note. Always acknowledge the mappers. If the mapping was done by you, the author, the credit note should state when the mapping was done. If the mapping was modified from someone else's work, the note should read "modified from * * *" If the mapping exactly duplicates another person's work, a proper reference citation should be given in the credit note (be sure to get copyright permission from private sources). Field assistance should be acknowledged here also.

Index or location map. If space on the page permits, an appropriate index or location map should accompany the page-size map.

Explanation. The explanation of a page-size map should include a list of map units (giving the map-unit symbols, names, and ages) and an explanation of map symbols. If space allows, a brief description of the units may spare the readers from having to hunt through the text to find the basics of each. Every illustration in a report should stand on its own. Each symbol in the explanation, whether a line, point, or pattern, should be explained.

Flexibility. Keep in mind that these guidelines are flexible. The space requirements of a particular illustration often dictate the amount of flexibility. Figures 30, 31, and 32 are examples of page-size geologic maps that show a good balance between the scale and detail and a thoughtful selection of patterns.

Stratigraphic Sections, Lithologic Columnar Sections, and Well Logs

Authors preparing stratigraphic sections, columnar sections, and well logs should be mindful of publication scale. Copy should be drafted at publication scale or only slightly larger (not more than 20 percent) so that original, carefully done linework can be used without redrafting; then the illustrator needs only to add type for column headings, explanations, and titles. Illustrators may have difficulty redrafting poorly done, fine detail. Authors should check the technical standards and consult with a map editor or illustrator on line weights and special symbols. Lithologic symbols used in a graphic column must be explained separately unless the description of each unit is printed clearly beside the column. The vertical scale as published should equal some even unit of an engineer's or metric scale. Published widths of columns should be not less than 1 cm nor more than 2. (See also p. 55 and 58, fig. 14.)

Special logs, such as electric, radioactivity, resistivity, and many others, are normally prepared by the author personally or under the author's immediate supervision, with the expectation that they will be photographed and used for final publication copy. Only the author can judge what degree of generalization is acceptable.

Color printing is unnecessary for most graphic logs and sections. Carefully selected black-and-white patterns and distinctive contrasting line weights will adequately portray most data.

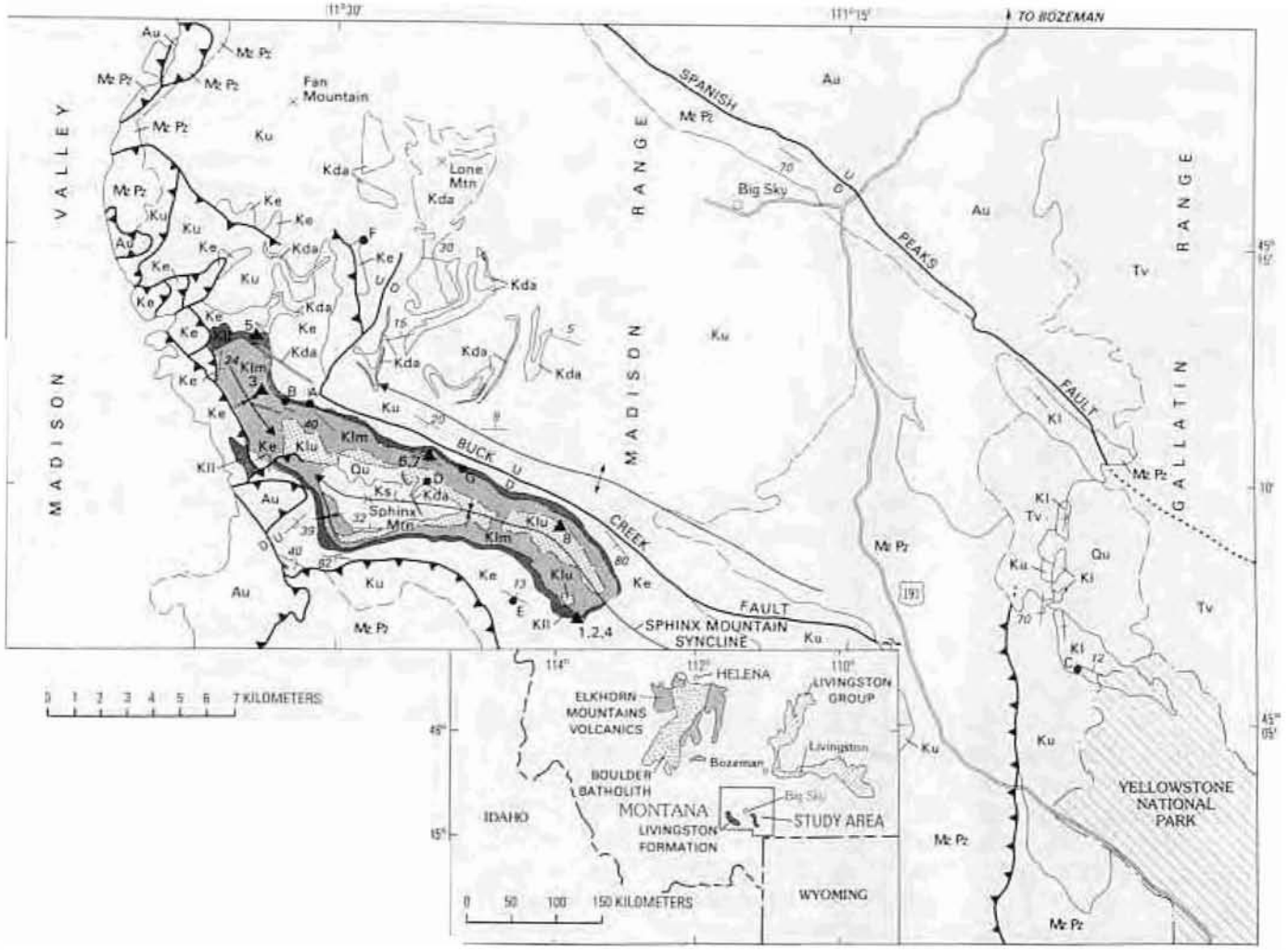


Figure 30. Geologic map showing outcrop areas of Livingston Formation in the Madison and Gallatin Ranges, locations of paleontological collections (A–G), and sample sites of igneous rocks (1–8).

Computer Graphics

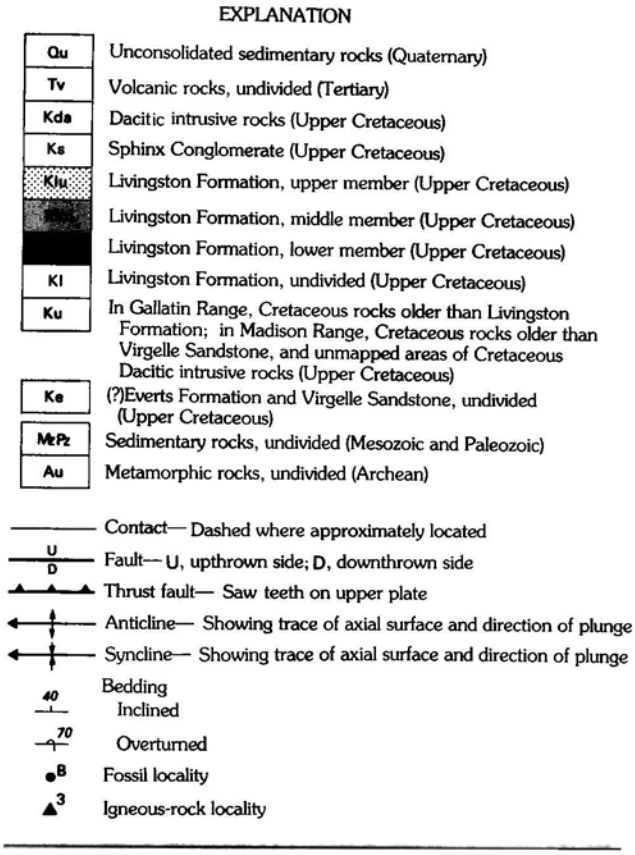
Computer graphics offer a rapidly growing field of illustration. Techniques are constantly being updated, so you may wish to ask the advice of an expert in planning and preparing computer-generated maps and other graphics at an early stage of the project. Some computer plots may require extensive touchup or redrafting. The most successful package presently used by USGS authors is the GSMAP/GSDRAW package developed by Selner and others (1986). Computer graphics suitable for lecture slides can be photographed directly from the video screen or can be produced from a program designed for that purpose.

Photographs

Photographs submitted as figures should be essential to the clarity of the text. Effective photography requires sharp focus and good contrast. Well-chosen and adequately captioned photographs are among the best and least expensive illustrations to prepare and print. If you submit more photographs than necessary, in the mistaken belief that a certain proportion will be arbitrarily rejected by the editors, you will waste everyone's time.

Black-and-White Prints

The mill copy of the photograph should be printed at about publication scale and at about the correct tonal value for printing. Review prints should be close to publication size so that the reviewers and editors can verify that the photographs show what they intend to show. Prints from copiers may be unacceptable for review. You should retain all negatives with your other original illustrations until they are requested by the publication staff.



If you wish to publish a photograph but do not have a negative, a high-quality copy negative should be made, especially if only one print of the picture is available. If you wish to publish a black-and-white photograph from a color slide or color print, a black-and-white negative and a print at publication size should be prepared for review and publication. Color originals, however, seldom make black-and-white prints of quality equal to black-and-white originals.

Color Prints

The mill copy for a photograph to be printed in color should be a color print of about publication size and of the desired color balance. The printer will use the mill copy as a guide to cropping and color reproduction. The original—preferably a first-generation color transparency, a high-quality original print, or color negative, in that order—furnished to the printer should be marked "To be returned to USGS Photographic Library." Note that a color negative requires the printer to make a suitable print from which the color separations are made. These extra steps do not ensure quality printing.

Special Requirements

If a long, narrow picture is intended for a book report, such as a panoramic view made from three or four photographs, it is better printed as a bottom-title figure across two pages and as a center spread than as a side-title figure. An oversize photograph might fit best on a page as a bleed. If as much as 4 millimeters can be cropped from each side without loss to the picture, the printer can easily bleed the photograph to the edges of the page. A bled photograph on a single page of a professional paper can be as much as 60 percent larger in total area than the conventional-size, page-width photograph of the same image. Bled photographs have high pictorial impact, but if overused they lose much of their effect.

Mounting photographs for the printer should generally be left to a graphics expert. Instructions follow for preparing photographs for review:

1. Submit photographic prints at publication scale. Use crop lines on translucent overlays to bring to publication scale or to delete extraneous parts of the image; composition is almost always improved by cropping, but do not trim along crop lines; submit a print of the complete negative.
2. Request 300-line screen only for fossil plates or other prints that require fine detail. Stereopairs, for example, require fine screening because the viewing stereoscope enlarges and emphasizes the dot pattern of the halftone print. Consult with a graphics specialist. Photomicrographs are usually printed in a fine (200-line) screen to preserve fine detail. In any event, justify the need for fine screening.
3. Do not write or draw on photographic prints, front or back, and do not use paper clips. A scale, if any, should be drawn in rough draft outside the image area or on an overlay; the illustrator can decide its final placement with your concurrence.
4. Use a registered overlay to show line and symbol placement. To register overlays, use corner ticks; indicate top.
5. Do not mount with staples, tape, or adhesive material.
6. Do not place tape of any kind over the image area.

Instructions to the photographer concerning cropping, dodging to bring out detail, or other custom treatment for photographs may be placed on the mill copy, on a translucent overlay of the mill copy, or on the back of the "Author's Check List" (Form 9-1517).

Captions for Photographs

To be meaningful, captions must adequately describe what is shown. "View of Heart Mountain," for example, is insufficient. The location, the direction in which the photograph was taken, a reference to the

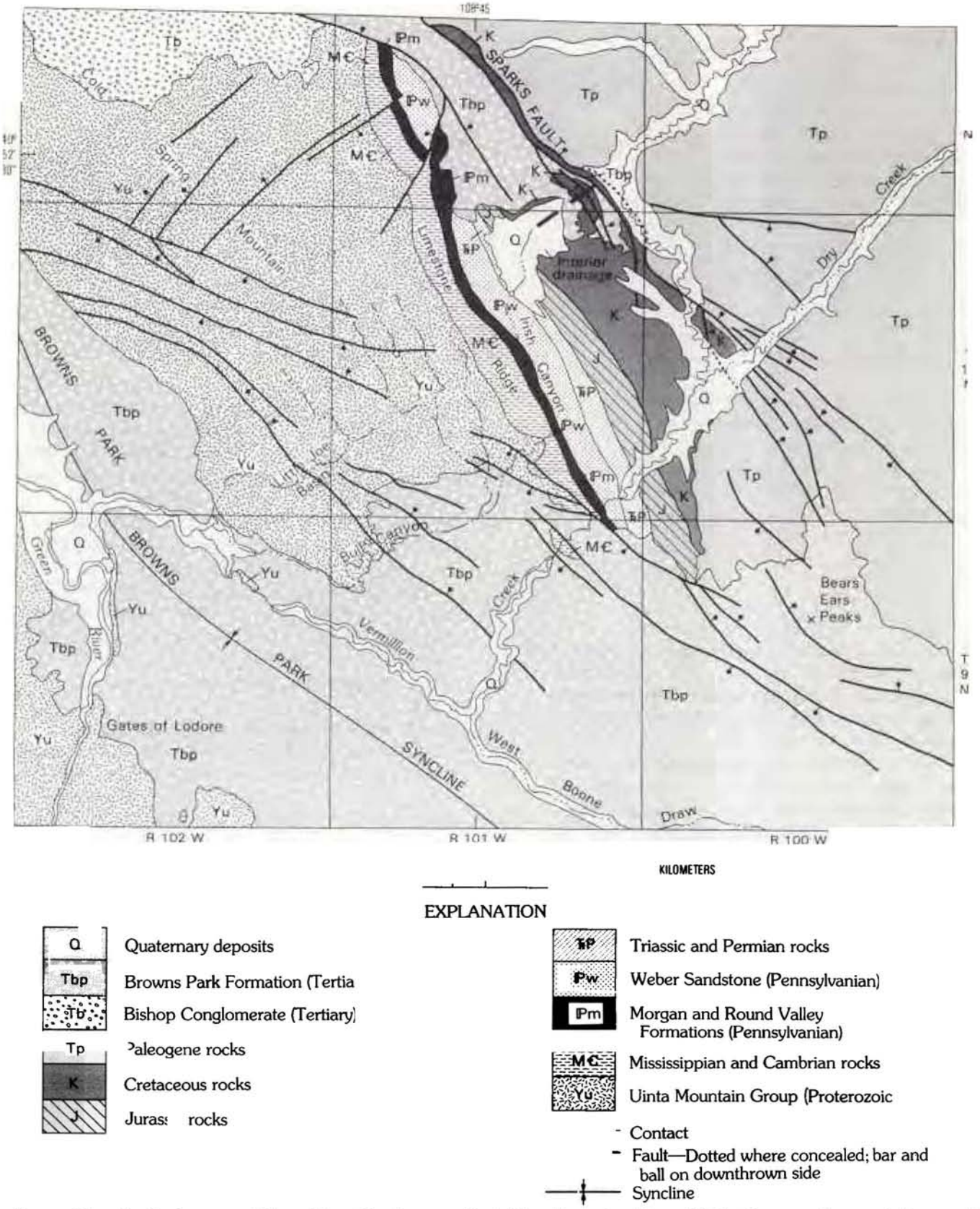


Figure 31. Geologic map of Vermillion Creek area affected by the beheading of Irish Canyon. Heavy dashes mark wind gap at head of Irish Canyon.

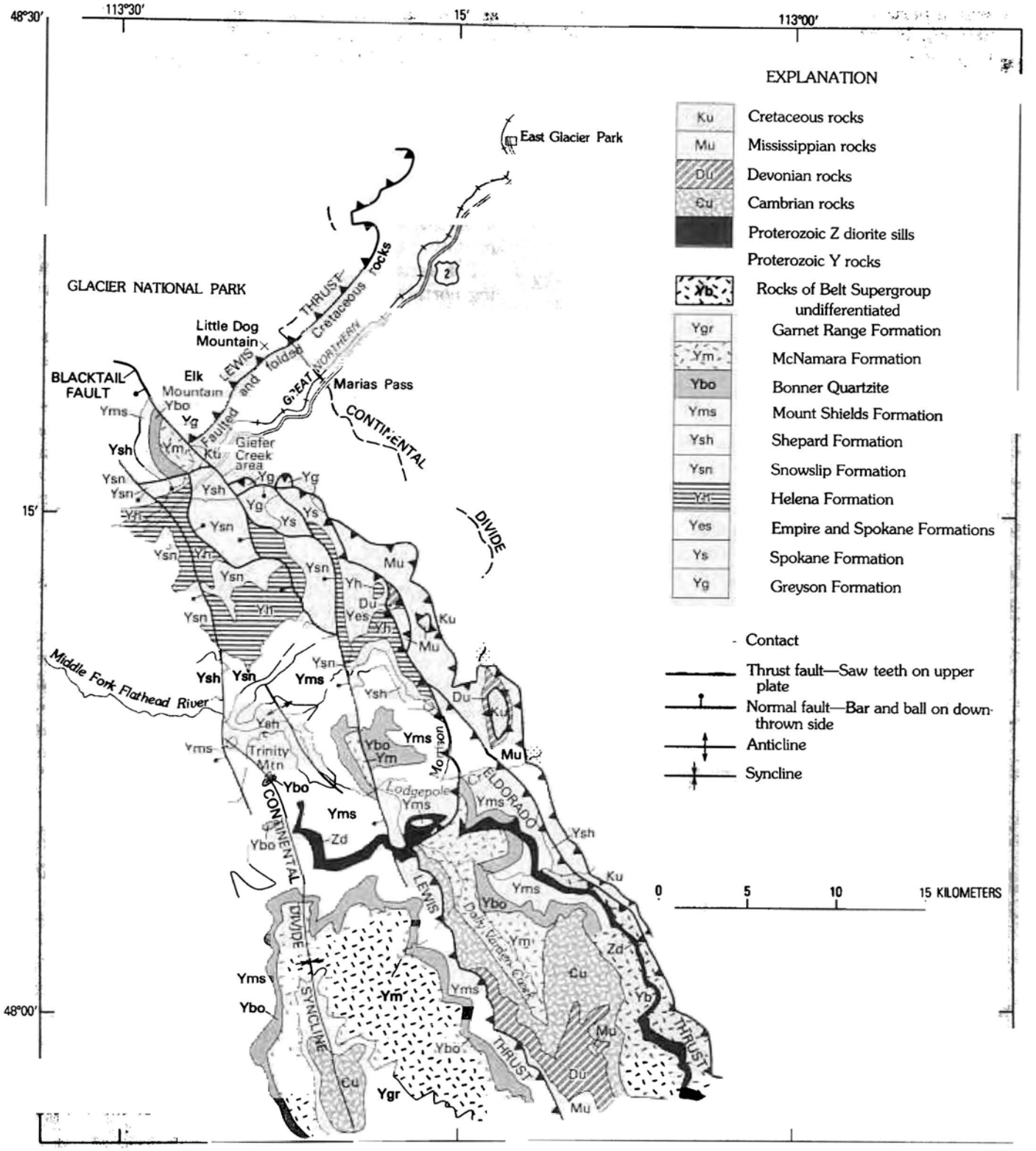


Figure 32. Part of a geologic map of the Lewis and Eldorado thrust plates from the southern part of Glacier National Park (shown) to Steamboat Mountain (not shown).

scale of the photograph, if not obvious, and an explanation of any symbols shown on the overlay are essential parts of the caption. The date of photography may be included if relevant. Credit the source, if it is not you.

Irrelevancies

Manmade structures such as head frames, drill rigs, or machinery are not normally acceptable as illustrations unless they relate specifically to the subject matter of the report. A photograph of a discovery well, for example, has little relevance.

Photographs on Oversize Plates and Maps

Black-and-white and color photographs occasionally are published on oversize plates and on map-series reports. These must be justified, because the quality of reproduction on map sheets may not preserve fine detail. If several photographs are to appear on the same sheet, they will reproduce best if they all have about the same tonal intensity and contrast; if not, some may be washed out, others may be crisp and clear, and still others may be too dark.

Drawings from Photographs

Geologic relationships may not be obvious on photographs, and printed overlays showing those relationships may obscure what geology is shown. A sketch prepared from a photograph can often better portray the information. A simple line drawing beneath the photograph, or instead of the photograph, can show the significant features better than words. Submit the original photograph and a rough sketch on a translucent overlay to guide the illustrator. High-contrast photographs can be shot as unscreened linecuts in place of line drawings for special effect, but this technique does not ordinarily lend itself to geologic subjects.

Fossil Plates

Authors who prepare tentative layouts for proposed fossil plates should check recent publications for style and should work closely with the illustrator in their preparation. Some authors may prefer to do the plates themselves; if so, an illustrator can give technical advice for preparing, arranging, and mounting the parts.

Aerial Photographs

If aerial photographs or prints from remote sensors such as Landsat multispectral images are to be used as illustrations, their source, identification number, and date should be a part of the caption. Single aerial photographs present no special problems. Aerial photographs that are to appear as stereopairs do present problems and must be precisely mounted for stereoviewing. Many readers, moreover, cannot see stereoscopically without special equipment. Stereopairs should be submitted at publication size, and you as author should work closely with your illustrator in mounting them.

For aerial photographs, the general rule of orienting north toward the top of the page may be waived. Aerial photographs filmed in the Northern Hemisphere have a natural light source in the southern quadrant, whereas the source of light at ground level commonly is from above—that is, from apparent north. Relief features, therefore, may appear inverted on aerial photographs; ridges appear as valleys and craters appear as domes. This troublesome illusion may be averted by orienting the photograph so that south is toward the top or side of the page. A north arrow and scale should always be added.

Shaded-Relief Maps from Photographs

Inexpensive shaded-relief maps for use as index maps can be made by photographing the back of plastic raised-relief maps with a light source in the lower right quadrant (southeast). When the negative is printed, the light source appears to be in the upper left (Stacy, 1962, p. D165). The front of the plastic map should be photographed with flat overhead light at the same scale and at the same time to provide a guide for the illustrator to add geographic or geologic overlays to the final illustration.

Frontispieces

A Survey book publication may rarely contain a frontispiece to illustrate the general subject of a report and set the general tone. It may be a panorama of the area or a sketch. If you have an outstanding picture of a more specific nature, it too may be suitable. Color may be approved, but it requires specific justification.

Cover Art and Other Special Artwork

Many but not most Survey book publications feature cover art, particularly reports aimed at the general

public or at a nontechnical readership. Simple, tastefully drawn linework that relates clearly to the subject matter of the report is especially fitting; the range of possibilities is wide. If you are a talented artist, your own work may be used, but the cover more likely will be designed and executed by a professional artist after you have made the necessary arrangements through your publication people. Similarly, unobtrusive artwork may be used for special effect in the body of the report. Such artwork is used most commonly in popularly oriented reports to help project an appropriate mood or to serve as attractive space fillers at the ends of paragraphs or chapters.

Graphs and Diagrams

Graph scales commonly used in Survey publications include arithmetic, logarithmic, semilogarithmic, and probability scales, shown by a grid of lines across the diagram or merely by ticks along the vertical and horizontal axes. If extension of the grid across the graph is important to the reader, the graph or diagram should be outlined and ticked on all four sides. The grid should be extended to include all data shown on the graph.

Scales are generally labeled only along the left and bottom axes. Scale numbers normally should increase from bottom to top and from left to right. Captions for axes are all in capital letters; they should be complete and should include the unit of measure, as "XX, IN PERCENT." All symbols used on a graph must appear in an explanation or figure caption or be labeled on the graph.

Graphs and diagrams enhance reader comprehension by using points, lines, shadings, patterns, colors, numbers, and symbols to summarize and analyze data that otherwise might be buried in lengthy narratives or tabulations. Variety is limited only by your imagination and ingenuity.

Preparing Graphs and Diagrams for Review

Time spent in preparing neat, legible review (mill) copy will be made up in the review and production processes. Nonphotographic blue grid lines on base material will make for better review copy than other colors such as orange, which tend to overpower the data in xerographic prints. Bear in mind that you should retain your original copy until it is requested by your publication staff.

Required elements of a graph that are most commonly overlooked are identified on figure 33.

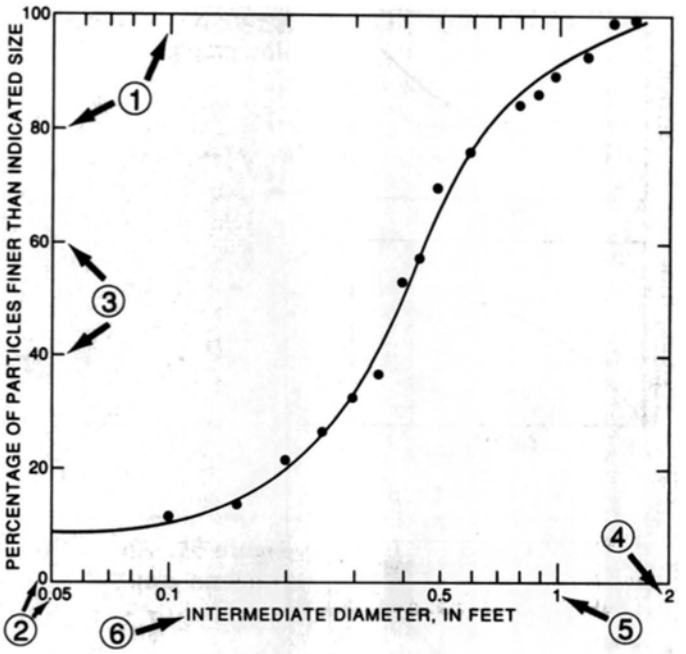


Figure 33. Elements of a graph.

Grid ticks should appear on all four sides of graph, inside the graph boundaries.

2. Tick values should be labeled across bottom and left side of graph, unless graph is multiscale.
3 Scale increments should be uniform (except on log and probability scales) and, ideally, should extend from one labeled increment to the next. Labeled increments should cover the full range of the data.
4. When, because of space limitations, it is impractical to extend the graph to the next labeled tick of the scale increment being used, the scale can be switched to accommodate the data; the switch in scale must be labeled at the corners of the graphs.
5. Ticks for log scales should be labeled at each cycle (for example, 0.1, 1, 10, 100, and so forth). Intermediate ticks must be added for clarity and may be labeled if necessary.
6. *X* and *Y* axis labels should be in uppercase, including what the axis represents and the unit of measure.

Unit of measure is spelled out in all Survey publications. For example:

DISCHARGE, IN CUBIC METERS PER SECOND

However, if you are submitting an article to a journal that insists on using accepted abbreviations (for example, ft^3/s, mg/L), use these on axis labels and throughout your text consistently.

Figures 34–54 show some types of graphs and diagrams that commonly appear in Survey reports.

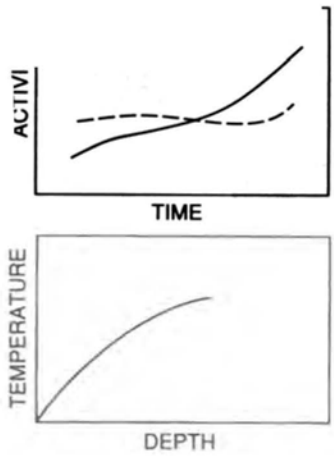


Figure 34. Curve or line graph.

Emphasizes trend or rate of relatively continuous data by connecting plotted data points. Differing line symbols distinguishing various properties may become cluttered if more than three line symbols are to be compared, and multiple graphs may then be necessary, or color or screening might be needed to enhance readability. This curve is commonly used to show variation trends of two or more properties, as in isochron plots and equilibrium diagrams.

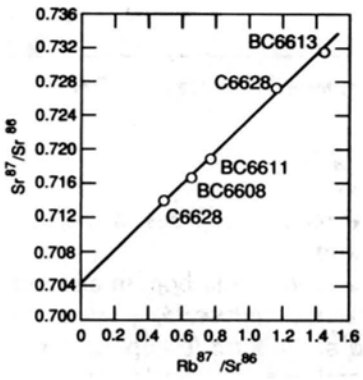


Figure 35. An isochron plot.

Plotted on a line graph. Example shows Rb/Sr ratios and positions of samples on plotted line.

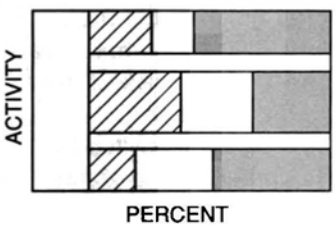


Figure 36. Horizontal bar graph.

Emphasizes volume of data and best shows percentages. When used to compare different items simultaneously, it has only one numerical scale, because no time scale is needed. Bars representing plotted data should be arranged in order of magnitude.

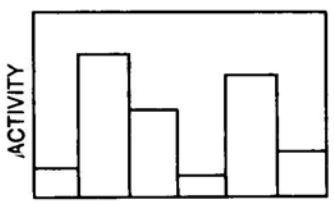


Figure 37. Column or vertical bar graph.

Emphasizes fluctuating magnitudes of data for one item at different times. Bars may be subdivided by patterns, tones, or colors to represent component parts of the total by the heights of those parts of the columns.

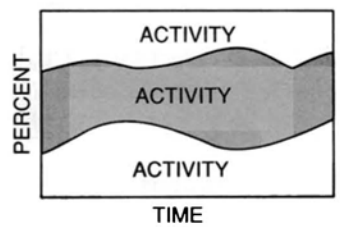


Figure 38. Surface or band graph.

Emphasizes amount of data. Various values placed in layers one above another form a cumulative total. The graph is especially effective for showing components but should not be used if sharply fluctuating data distort other components.

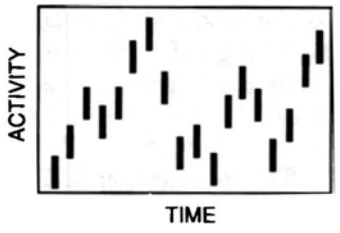


Figure 39. Symbol graph. Emphasizes general trends of data. Symbols unconnected by lines represent data. Possible applications could be (1) symbols plotted as data points, where a trend line is not possible or desired, or (2) a series of vertical bars, each bar showing the maximum and minimum values of some data such as monthly mean water levels for a period of time.

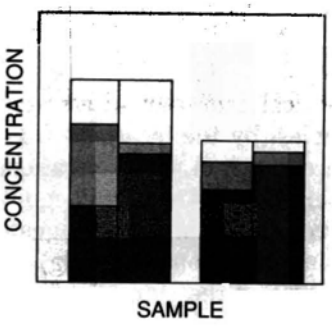


Figure 40. Collins diagram.

Used in water analysis to show total solute concentration and the proportions assigned to each principal ionic species. Each analysis is represented by a vertical bar graph whose total height is proportional to the total concentration of anions or cations. The bar is divided into a left half representing cations and a right half representing anions. Each half is then divided by horizontal lines to show concentrations of the major ions, which are identified by distinctive patterns, tones, or colors. The lengths of the cation and anion halves should be equal.

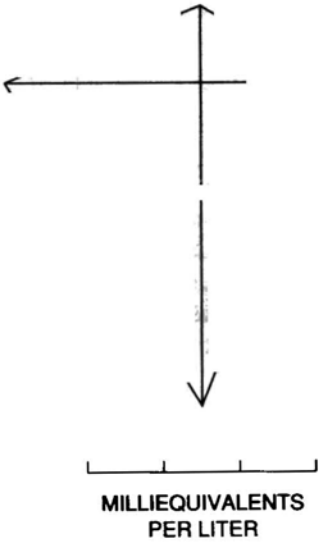


Figure 41. Kite diagram.

Concentrations of cations and anions, or other properties, are represented on rectangular coordinates. The length of each coordinate line from center corresponds to the concentration of constituents, in milliequivalents per liter. Once the ends of the four coordinate lines are connected, thereby forming a distinctive shape, the patterns for different water types can be easily and quickly compared visually.

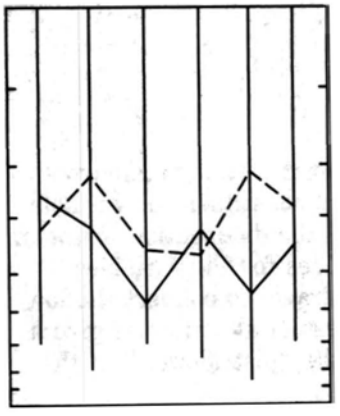


Figure 42. Nomograph.

Depicts one or a group of analyses. Lines on the interior scales of the nomograph represent concentrations of ions in milligrams per liter. Scales for milliequivalents per liter at the left and right sides of the nomograph have the advantage of showing the relationship to scales for milligrams per liter. Waters of similar composition plot as near-parallel lines.

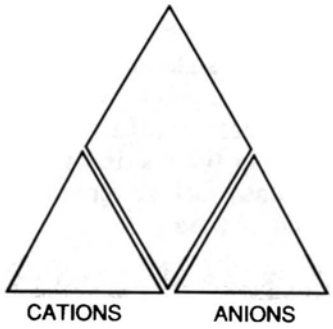


Figure 43. Piper diagram. In water analyses, indicates the essential chemical character by single-point plottings of cations and anions on trilinear coordinates. The proportions of cations and anions are plotted in each of the lower triangles; then the points are extended into the central diamond-shaped field. The intersection of the projections represents the composition of water with respect to the combination of ions shown.

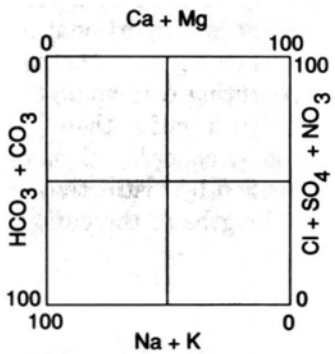


Figure 44. Modified Piper diagram.

Indicates the essential chemical character of a water sample, or group of samples, by the location of plotted points within a square diagram. Concentrations of the ions for each water sample are in milliequivalents per liter; points are plotted in percentages of total anions. Thus, the sum of cations (Ca+Mg)+(Na+K) equals 100 percent and the sum of anions equals 100 percent.

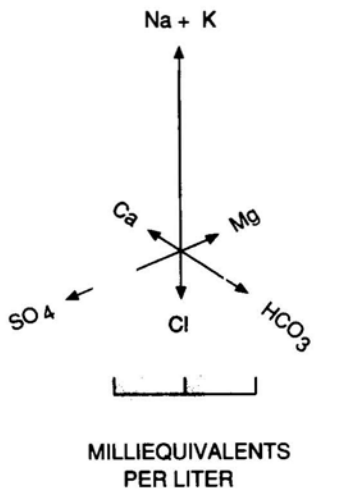


Figure 45. Radiating-vectors diagram.

Uses a system of plotting analyses by radiating vectors. The length of each of the six vectors from the center represents the concentration of principal ionic species, in milliequivalents per liter. A scale of units must be included with each diagram. A summation of the lengths of the arrows for cations should equal the lengths for the anions.

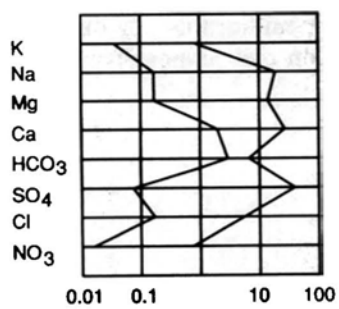


Figure 46. Semilog concentration graph (Ropes diagram).

Each of a set of parallel horizontal log-scale axes corresponds to a selected constituent or variable. On each axis are plotted the distribution, minimum, mean, and maximum values for the variables selected. Straight lines drawn to connect the low values and the high values of all variables give a characteristic shape to the "distribution" of the selected group of data.

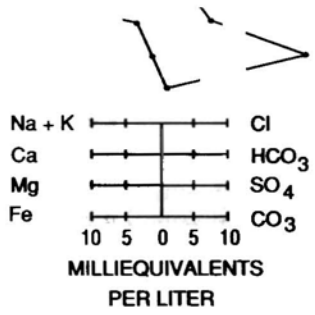


Figure 47. Stiff diagram.

Forms a distinctive pattern that can be used to show water composition differences or similarities. Four horizontal lines extending on each side of a vertical line form a grid on which cations are plotted to the left and anions plotted to the right. The plotted points are connected by lines to form a closed pattern that characterizes the analyzed water. The width of the pattern is an approximate indication of total ionic content.

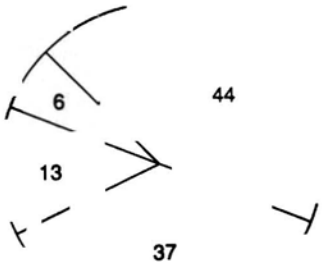


Figure 48. Circular (pie) diagram.

Emphasizes subdivisions of a whole. This diagram is commonly used to show percentages, but it can also be drawn with a scale for the radii. Values are easily perceived, but graphs are easier to interpret quantitatively than pie diagrams because the eye can judge linear distances easier than radial ones. Important subdivisions can be screened or patterned in black and white or set off in color.

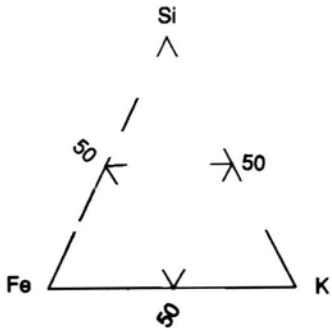


Figure 49. Triangular diagram.

Shows a percentage composition in terms of relative amounts of three components.

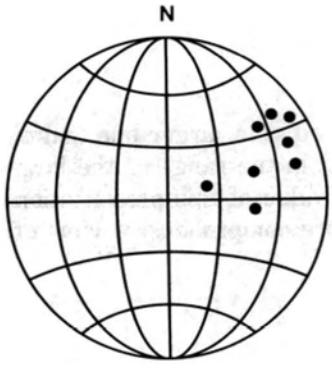


Figure 50. Schmidt equal-area projection.

Shows azimuths measured clockwise from north and about a point directly beneath the observer (if grid is deleted, center point is shown by a "+" and north is ticked).

Combination graphs. Two or more of the preceding graph forms can be combined to compare additional components, as shown by figures 51–54.

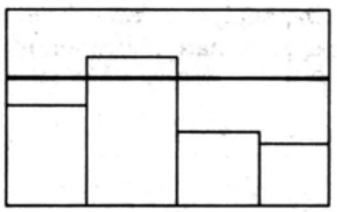


Figure 51. A vertical bar and straight horizontal line combination.

Useful for measuring performance against a goal or standard, such as annual precipitation by bars and average annual precipitation by a horizontal line.

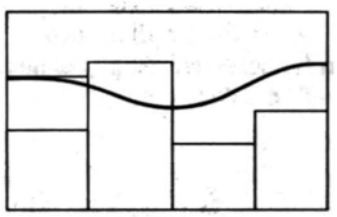


Figure 52. A combination of vertical bars and a curved line.

Useful for showing variables such as water use and population, or precipitation and water levels in wells.

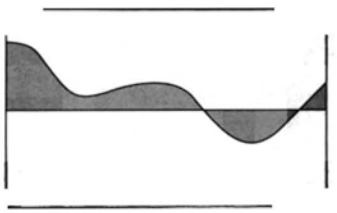


Figure 53. A curved line and straight horizontal line.

Can be combined to compare monthly or annual precipitation with an average or cumulative departure from average.

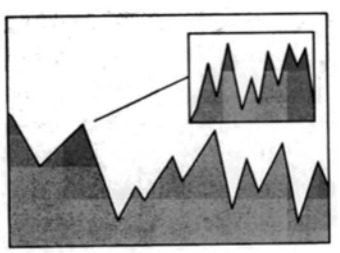


Figure 54. An inset

Smaller graph superimposed on a larger one magnifies part of the data lost in the range of the larger graph. The informative value of this presentation lies in a different or more comprehensive view of the data.

Engineering Drawings

Circuit diagrams, working drawings for laboratory apparatus, patent drawings (which are usually exploded drawings of a working model), and so on may be required in some scientific reports. Before attempting such a drawing, you should consult a professional engineering draftsman or a knowledgeable illustrator.

Slides and Viewgraphs

Although color transparencies and viewgraphs are not ordinarily used as illustrations, they are important visual aids for oral presentation, and many organizations have prepared manuals for their preparation. Among the best are those by the American Association of Petroleum Geologists (1970) and Allen (1977).

Preparation of Author Copy

Author's original copy for every illustration should be neat, clear, and accurate. Few authors are able to prepare finished copy ready for printing, so most illustrations are redrafted. Author-prepared copy is used, however, in the MF series (p. 3) and in many Bulletins and Circulars. Stratigraphic sections generally are printed directly from author copy also. Final preparation follows Director's approval for publication, but you should consult your map editor or illustrator early enough to ensure that your copy (mill copy) is adequate for technical reviewers, editors, and illustrators. Illustrations are generally prepared in final form at publication scale.

Your original copy should be in black ink, or it should be scribed. Colored inks or photographically reproducible pencil should be used only with the concurrence of your map editor. Make lines no heavier than necessary; an author's overly heavy lines leave the exact placement of final fine lines up to the illustrator, who should not have to make such judgments. If your lines are too light, however, they may not be picked up on scribe coats or proof prints. Legible hand-lettering is preferred for your author's copy; the illustrator will place final lettering.

Stick-on ("zip") patterns are used on some maps and cross sections. Choice of patterns is usually left to the map editor and illustrator, though you may suggest styles and preferences. Review and mill copies of illustrations should include both uncolored and hand-colored copy prints of the original drawings, whether they are to be printed in color or in black and white. Distinctive and contrasting colors work best. Never color the originals. A note may be attached to the "Author's Check List" for plates, figures, and photographs (fig. 23) to suggest which units should be emphasized, what colors are preferred, and what published maps should be matched in final reproduction.

Illustrations must be complete when they leave your hands. Show all lines, symbols, numerals, letters, words, and limits of areas to be patterned or colored, and explain all symbols on the illustration. Each illustration should be able to stand alone without reference to the text or to any other illustration for explanations of its symbols. Illustrators will put your material into publishable form, but they cannot be expected to supply missing lines or interpret ill-prepared work.

Titles and Captions of Illustrations

Titles and captions of illustrations should be both informative and concise. For a separately published illustration such as a map, the title should be short, but it also should express content and location. Explanatory material belongs on the illustration itself, not in the title. Captions for text figures are set in type by the typesetter; they may be longer than those for plates and may include explanatory material, but they should not take the place of text.

For each illustration a figure number and complete caption are typed double spaced on a separate page at the end of the manuscript; a duplicate caption is attached to the mill copy of the illustration. To guide the editor and the typesetter, the phrase "**FIGURE x.--NEAR HERE**" is inserted in the text at the end of the paragraph that contains the chief reference to the figure. Leave a blank line above and below. (See also p. 254.) The figure or plate number is also placed on the mill copy of the illustration to identify the illustration if title and mill copy should become separated.

The following factors control the content and form of titles:

1. Kind of illustration. In book reports the kind of illustration (map, photograph, diagram) is indicated in the list of illustrations in the contents of the report but is generally omitted in the figure caption itself. In separately published illustrations, the kind of illustration must appear in the title: "Geologic Map of the * * *." Although a map may contain secondary illustrative items such as cross sections, columnar sections, or diagrams, the map title ordinarily does not mention them. Essential subordinate or specialized data, however, can be mentioned by such additions as "* * * and structure," "* * * and cross sections," "* * * showing sample localities."

2. Geographic location. Titles of separately published maps must include quadrangle name, if applicable, county or region, and State(s). Complete geographic location (county, State) is not needed in titles of figures bound within a publication unless the figures portray only part of or more than the entire area studied.

3. Qualifications. If special conditions affect the character of a map, qualifying adjectives may be used, such as "preliminary," "sketch," "generalized," "reconnaissance," "surficial," or "bedrock."

4. Multisheet maps and separately printed texts. If a map is to be printed as more than one sheet (for example, if it includes special data to be printed separately—not simply an oversize map that requires more than one sheet to go through the press) or if it includes a pamphlet text, a common title that applies to all parts must appear on each part. The individual parts should be identified also by subtitles.

5. Reference locations. The illustration itself should not be confused either in caption or in text with the physical actualities it represents. Thus:

Incorrect	Correct
The west side of figure 2 is within 56 kilometers of the easternmost sedimentary rocks of the western Nevada Mesozoic province * * *.	The area shown in the left side of figure 2 is within 56 kilometers * * *.
A trace of the fault is exposed 8 kilometers north of figure 5.	A trace of the fault is exposed 8 kilometers north of the area shown in figure 5.

6. Verbal scale, ratio scale, and magnification. These should not be given in a caption, because the scale may be changed in or after cartographic preparation. (Draw a rake scale on the figure or on a translucent overlay and register it to the photograph or photomicrograph for drafting by an illustrator.) Fossil plates are exceptions; the scale of each specimen is given in the caption, which commonly is on the page facing the plate. If a photograph contains no easily recognized object, such as a hammer or a person, the size of some other recognizable object should be noted in the caption. On oblique aerial photographs such an object might be a segment of a road, the face of a cliff, or even the distance across the front of the picture.

7. Map-unit and other symbols. These must be described in an explanation or in the caption. Symbols should not be used in the text, except in parentheses to clarify a unit name; for example, "Tertiary intrusive rocks (Ti)."

Use of Abbreviations

All words should be spelled out in the body of a map or figure, with the following exceptions:

1. Geographic names. The generic noun (as mountain, mount, river, canyon, creek) may be abbreviated on the map if clutter is reduced by using the abbreviation.
2. Geologic names. Nouns such as sandstone, conglomerate, and group may be abbreviated to fit into available space. See page 55.
3. No period is used in the body of an illustration after an abbreviated word.
4. Well names. Words such as "Company," "Corporation," and "Brothers" may be abbreviated.

Abbreviations are discussed at greater length in the section on abbreviations, signs, and symbols beginning on page 104.

Final Check of Maps and Other Illustrations Before Review

Draft copies of most illustrations are likely to contain small discrepancies and omissions, regardless of your careful preparations. The following checklist should help obviate most problems. It should also be helpful to you as a reviewer, as well as an author.

Authors, technical reviewers, and map editors should carefully check each illustration for possible errors of omission or commission. The checklist applies particularly to geologic maps and cross sections, but many of the items apply to other illustrations as well. All items do not apply to all illustrations.

1. **Completeness**
   - —— All units are labeled on the map and cross sections and are noted in the explanation.
   - —— All geologic symbols on the map appear in the explanation.
   - —— All geologic units in the explanation are shown on the map. Subsurface units that appear only in cross sections need not appear in the explanation if the names of the units can be spelled out on the sections themselves.

—— Positions of cross sections are shown by ruled lines on map.
—— All formal geographic names within the map area that are referred to in the text are shown on the map. Newly approved geographic names may be added to the base map only if the date of the domestic names decision is supplied. Unapproved or informal names are not shown on the map.

2. **Correctness**
—— Plotting is accurate. Linework is compatible with topographic or planimetric base.
—— Geographic and geologic names are spelled correctly in the text and agree with spellings on the map and explanation.
—— Locations, directions, and dimensions agree between text, maps, and cross sections.
—— Geologic names and ages on the map explanation agree with the text.
—— Dips as projected in cross sections agree with those on the map.
—— All features on the map are legible at the publication scale.

3. **Scale**
—— Shown graphically in International System (SI) units; some maps may require both SI and inch-pound units (see p. 122 for policy).
—— Ratio scale (such as 1:24,000) is not shown on illustrations that may be enlarged or reduced for printing.

4. **Topographic contour interval and datum**
—— Shown beneath scale.

5. **Caption**
—— Title is succinct but definitive. For a series map or a plate, the term "map," "cross section," or other suitably descriptive term is included. "Geology of the Blank Quadrangle" is not acceptable, but "Geologic Map of the Blank Quadrangle" is.

6. **Authorship**
—— Shown beneath the title of a series map; shown in the geologic credit note in a book publication, text figure, or plate. Affiliation is shown for non-Survey coauthors.

7. **Geologic credit**
—— Authors, compilers, and contributors are named; dates of mapping are given. A source index may be substituted. If a published geologic map is used as a base, its author(s) must be credited and a full citation listed. Place at bottom right.

8. **Base credit**
—— Source, date, and map projection at bottom left.

9. **Cooperative note**
—— Sponsor or cooperating organizations are shown at the top center of the map sheet (on series maps) and on map plates of areas in foreign countries. If the cooperating organization expresses no preference, the wording to be used is "Prepared in cooperation with * * *."

10. **Marginal data**
—— True and magnetic north and numerical declination are shown (will be added by illustrator if a standard base map is used). Magnetic north and declination are unnecessary on page-size maps, and they are omitted from maps that show aeromagnetic contours, because of possible confusion as to whether the declination is that of the date of the base, the date of the data collection, or the date of publication of the map. On page-size maps the true north arrow is unnecessary if latitude and longitude ticks and values are shown and north is to the top of the map.
- Latitude, longitude, townships, ranges, and geographic reference points or grids are shown by labeled tick marks.
- Vertical scale and exaggeration, if any, appear on sections.

11. **"Author's Check List" for plates, figures, and photographs** (Form 9-1517)
—— List is complete. Doublecheck notes for illustrators regarding colors and important map units.

TECHNICAL REVIEW OF AUTHOR COPY

When your report and its illustrations are ready to go forward, the next step is their technical (peer) review. Routing procedures vary somewhat from one organizational unit of the Survey to another, and the actual mechanics of review vary with every report and each reviewer, but certain steps and actions are common to all. Guidelines are given in the section on reviewing maps and cross sections, and you as author may profit from a careful scan of the suggestions offered therein (p. 230).

The original drawing or compilation should not be submitted for review. Rather, a legible mill copy

produced by an office copier will be reviewed and approved for publication; the editors and illustrators will rely on this copy for guidance in ordering and placing type for the final version. The illustrator, however, will trace the original—not the mill copy—for placement and position of all linework and symbols. Any discrepancies in linework between the original and the mill copy, therefore, will delay preparation until those matters are resolved. You must make all corrections on both the original and the mill copy or note on the mill copy that the original is to be followed. Blurred, reduced, or otherwise illegible prints of illustrations may cause your reviewers to react negatively to the entire report. The time and expense of preparing final copy of illustrations for publication are affected by the quality of the mill copy.

AUTHOR RESPONSE TO TECHNICAL REVIEW

The sole purpose of review is to ferret out weaknesses and upgrade the quality of the report. You as author must respond to all questions and comments on the mill copy and make changes as necessary. As with edited text, every query by technical reviewers or map editors should be answered adequately, either by appropriate changes in the illustrations or by replying in writing and striking the query mark. If the reviewed copy is heavily marked, you should supply a new mill copy and transmit it to the next person or office listed on the routing sheet, with the already reviewed copy, the reviewer's comments, and your replies. The new mill copy need not be colored out again if few changes have been made, but any changes involving color must be indicated on the colored copy, which must accompany the new mill copy.

TRANSMITTAL FOR APPROVAL AND PREPARATION

Mill copies of illustrations must be transmitted with manuscript text but in a separate package at the back of the text; they should not be inserted in text. You should gather together in one place all original material for the report. Hold original line drawings and photographic negatives until they are requested by publication staff for use in final preparation. This step normally follows Director's approval.

A list of illustrations must also be included, even though it may remain unpublished. The list should show, for each illustration, the type (map, diagram, photograph, or other), a unique short title (caption) that is easily related to the illustration, and the manuscript page number of the principal reference to the illustration. The list should be typed in the same order as the principal references in the text, which need not necessarily be their first mention. The original list goes in the manuscript after the table of contents; a copy goes with the illustrations package.

Descriptive captions for each illustration are typed on separate pages (one caption per page) assembled at the end of the manuscript, after the list of references. A duplicate caption is attached to the mill copy of each illustration in the illustrations package, along with a completed "Author's Check List" (Form 9-1517) for plates, figures, and photographs. All this seems complicated, but it in fact is very simple and important; Form 9-1517 contains instructions for the illustrator. (Do not cut the caption out or paste it to the mill copy.) Mill copies of figures and captions are then placed at the end of the text (not interleaved) for forwarding to technical reviewers. To alert the editor and the typesetter, each illustration should have a locating reference in the manuscript at the end of the paragraph containing the principal reference, such as:

"FIGURE X.--NEAR HERE"

If you revise and retype a caption after review, attach the new version to the edited caption and return both with the mill copy.

Except for photographic plates of fossils and for illustrations larger than double-page size, you should designate all illustrations as figures, numbered consecutively as the manuscript is prepared. Once a number is assigned in a long, complex report, you would be wise not to change it except to correct an obvious error, such as a duplication. Numbering changes during the evolution of the manuscript are apt to cause errors. Don't renumber figures just because you change their order of appearance in the text; that order may be changed again before you finish the manuscript, or a figure may be added or deleted. The best time to renumber figures is just before the manuscript is transmitted for Director's approval. Special instructions as to placement of figures in the text should be noted on the caption sheet in the text, as "Text Editor: Please print on page facing figure X" or "To be printed on same page as figure X."

Figure numbers should appear on the illustrations themselves, not on attached slips. If copy for the illustration consists of more than one piece, such as a base map and an overlay sheet for geologic contacts or as three sections in three pieces, that fact should be shown on each piece, as "Figure 15, part 2 of 3

parts." Preferably, the base should be the first numbered, to show the order of layering.

Review of Map Preparation Plans After Director's Approval

If your report contains colored plates or figures, you will receive a memorandum containing color and pattern choices and color chips for units on the map. Review the color choices carefully and discuss any questions or objections with your illustrator or map editor. Color changes are very expensive after map preparation begins and should be avoided.

Review of Check Prints After Preparation for Publication

Routing procedures for prepared illustrations vary from office to office, but before your report goes to the printer, you will receive the original illustrations, mill copies, and check prints of the art. This material usually accompanies the edited text if the illustrations are part of a book report. Check prints, often called proofs, for your review are washcoat color prints or black-and-white copies of figures and photographs. (Technically, proofs are prints from the printing press and are rarely seen by the author.) Inasmuch as the check prints ordinarily provide your last chance to make corrections, you must check them carefully for placement of lines and type, symbols, explanation, spelling, color or patterns, and titles. Any changes or corrections should be clearly marked on the print: Draw a line from the item to be corrected to the margin, and note the correction in the margin so the illustrator will unmistakably understand it. Any corrections or queries placed on the check prints by the illustrator or editor should also be marked by you to show agreement, disagreement, or clarification. A small check mark or "OK" will indicate agreement.

At check-print stage, significant changes not on the approved mill copy must be justified. The mill copy and originals cannot be updated or otherwise altered at this time without editor approval. Some changes may be refused. The editor will accept essential and desirable changes that can be made quickly, easily, and inexpensively.

Date and Initial

You must date and initial each check print in the box indicated so that all persons concerned will know you have seen it. If the final-drafted illustration is unacceptable, however, and a new, corrected check print is desired, you should so state on the unaccepted print. You must return all check prints, originals, and mill copies.

After approved changes are made in text and illustrations, the manuscript and illustrations are ready for the printer.

Disposition of Original Illustrations, Photographs, and Reproducibles After Publication

After a book or map has been published, the original illustrations and mill copy, except photographs, are returned to you as author. Printer's negatives for books and MF maps are stored by the Branches of Technical Reports in Reston, Va., Denver, Colo., and Menlo Park, Calif. Printer's negatives for other map series are sent to the Washington National Records Center in Suitland, Md. Drafted material for all maps is returned to you as author after publication, but drafted material for books is returned only if requested.

All photographs used in Survey publications, both prints and negatives, are sent to the Survey's Photographic Library in Denver soon after a report is printed. (See following section.) They are not returned to the author.