U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MAS/MILS Arc/Info point coverage for the Western U. S. (excluding Hawaii)

by

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Introduction

The U.S. Geological Survey has two international and one regional digital database that contains information on mineral properties. This report describes the conversion of selected data from one of the international databases - MAS/MILS (Mineral Availability System/Mineral Industry Location System) - into a spatial data product.

The MAS/MILS database, obtained from the U.S. Bureau of Mines (USBM) upon its closure, contains over 221,000 records of mineral properties and processing facilities throughout the world. However, the majority of the records in the database are of sites located in the western U.S. This is due to the extensive mineral activity that has occurred in the West, and the work done by mineral professionals in the Western, Alaska, and Intermountain Field Operations Centers of the USBM.

The purpose of this project was to create a spatial coverage of the western U.S. containing mineral resource information. This coverage includes information for the states of Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. For this report, locations from MAS/MILS were converted to a point coverage using a geographic information system (GIS). All work was done using Arc/Info v. 7.0.4. There are 128,441 points in the coverage.

This open-file report discusses the database used to create the coverage, information contained in the digital files, methods used to convert the database into a GIS format, documentation of the file structure, limitations of the data, and explanation of how to download the digital files from the U.S. Geological Survey public access World Wide Web site on the Internet.

Acknowledgments

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MAS/MILS Database

The MAS/MILS database is an amalgam of location, ownership, geologic descriptions, mining and processing procedures, mine economics, and costing information developed by the Bureau of Mines over a period of about 30 years.

Developmental History

The Bureau of Mines created a system to predict availability of minerals as a component of its mineral's intelligence function in the 1960's and developed it over about a 10 year period (Gary Kingston, written communication, 9/22/91). One of the major components of this system was a digital database. The Minerals Availability System (MAS) database existed a number of years before it was formally established as a program in 1975 (Babitzke and others, 1982; Staff, Bureau of Mines-Minerals Supply, 1974). The objective of the program was a "systematic measurement and classification of domestic and foreign mineral deposits according to their respective extraction technologies, economics, and commercial availability" (Berg and Carillo, 1980, p. 1). It's focus was on minerals important to the nation, those designated "strategic and critical". Simultaneously with the development of the MAS database, the Mineral Industry Location System (MILS) was developed to describe the location and some basic information about mineral properties. These two projects were combined to produce the MAS/MILS database.

The system was designed and developed on a Burroughs 7900 computer. All input was by punch cards. The information was transferred to a Prime computer using the relational database Oracle in 1989. The final transfer was to a Hewlett Packard 9000 minicomputer. This last hardware upgrade allowed direct access to the database by Bureau personnel and most updating was done directly from remote terminals by the evaluators.

As the data was upgraded to newer computer systems and converted to an Oracle database some improvements were made in the database. However, the modifications also caused some problems. One problem occurred during the conversion to Oracle at which time the bibliography field was truncated from 67 to 65 characters. Another problem

occurred because codes were widely used for data input. At one point, the codes used for commodities were changed. Many evaluators had memorized the codes used to input data and would sometimes use the old code, which resulted in the wrong commodity being entered. These errors were not always corrected.

Another Bureau of Mines database, ADIT (Advanced Deposit Information Tracking), was developed in 1978 to "support MAS in budget planning and overall evaluation monitoring for significant MAS mine/mill/plants" (U.S. Bureau of Mines, written communication, 1994). ADIT is a global database comprised of site specific engineering, economic, and other operational information on mineral occurrences, mines, and mineral processing operations. The database covers 34 commodities, which represented the most significant in terms of value, tonnage, and import reliance. It contains over 4,000 mines and processing plants around the world, which are used in mineral supply/availability studies. This information was combined with the MAS/MILS database in 1991. In 1993, work was begun to incorporate into MAS/MILS the Supply Analysis Model (SAM), used to support mineral analyses; and Mine Simulation (MINSIM), used to obtain cost and economic data. MINSIM combined financial and tax conditions with engineering costs to simulate Discounted Cash Flow/Rates of Return that could be obtained by a mining operation (Coppa, 1988). SAM incorporated data from MINSIM with recoverable tonnages from deposits to produce supply curves showing total recoverable tonnages of a specific mineral commodity from deposits at various prices (Davidoff, 1980). The process of integrating the various analysis programs was completed shortly before closure of the Bureau of Mines. Most of the information in the MAS/MILS database that is critical to developing supply/availability analyses is confidential.

In 1995, the Bureau of Mines (U.S. Bureau of Mines, 1995) published some of the information in the MAS/MILS database on a CD-ROM. This limited publication quickly sold out and the information contained therein was re-released as part of another CD-ROM in 1996 (Kaas, 1996). The CD-ROMs contain GSSEARCH, a program developed by the USGS to query data. There is also a rudimentary spatial data display capability in another USGS program called Mapper, which is included on the CD-ROM. However, the GSSEARCH program is unable to query by latitude-longitude blocks. Also, the programs only run in a DOS environment.

In 1996 when the U.S. Bureau of Mines was closed, the MAS/MILS database was transferred to the U.S. Geological Survey. However, although some of the mineral intelligence functions were transferred to the Survey with funding, no funding was appropriated to support the database.

Database Organization and Information

The MAS portion of the database is part of a decision-oriented program that allows analyses of "the Nation's existing and potential availability to produce or acquire commercially useable mineral supplies" (Ridenour, 1991). The MILS portion of the database "was designed for the rapid retrieval of mines by location…, commodity, type of operation," etc. (Ridenour, 1991).

The MAS program collected detailed information from a representative sampling of mineral properties and production facilities around the world to keep track of mining activity, to help predict supply and demand, and to rapidly forecast the effects of various political actions on the mineral material needs of the U.S. At the same time an attempt was made to populate the database with certain basic information about all mineral occurrences (including industrial minerals), mines, geothermal wells, and mineral processing plants in the U.S. This information came from published literature, other databases, and Bureau of Mines projects such as the Mineral Land Assessment program.

The MAS/MILS database also contains proprietary information, which makes up a small percent of the database. Because the proprietary part of the database was used to make supply/demand and economic forecasts, the information contained therein is different than the non-proprietary portion. The information in the proprietary area can pertain to either an actual or a proposed operation; however, this distinction is not made in the database. In cases where no mining had occurred, a proposed mining operation was developed by Bureau of Mines geologists and engineers so that they could create models necessary for economic analyses and material flow projections.

The MAS/MILS relational database resides in Oracle and includes 14 tables containing public information. These tables are: MILS, COMMODITY, BIBLIOGRAPHY, COMMENTS, GEOMETRY, HISTORY OF EXPLORATION, HISTORY OF PRODUCTION, LITHOLOGY, MINERALS, NAME (alternate), OWNERSHIP, RESOURCES, RESOURCE-ASSAY, and ROCK. With the exception of the BIBLIOGRAPHY,

COMMODITY, NAME, and MILS tables, most of these tables only have information for a small percentage of the records.

To establish a record; a sequence number (unique identification code), current status, type of operation, and latitude - longitude (or UTM) location are required. This information resides in the MILS table. All other fields in the various tables are optional, although operating procedures in the 1980's to 1990's requested commodity and bibliographic references to be included with any new property. In 1996, two numeric fields, a decimal latitude and decimal longitude, were added to the database and populated by conversion of information in the character based LAT and LON fields. The information in those fields was used to generate the point coverage for the Western Region.

A few predefined reports can be generated from data in the database. Each of these reports contains headers and information from selected fields. The output is an ASCII text file. In addition, SQL (Structured Query Language) queries can be written to select different data outputs. A specialized query was employed to obtain the data for this project.

MAS/MILS Database Limitations

The quality of the data in the MILS portion of the database is highly variable for two reasons. During creation of the database, quality was dependent on the source of the data, most of which was from publications and maps. The second problem is that different offices were responsible for selected parts of the database. After the database was initially constructed and populated, little funding was appropriated for maintenance/upgrading of the MILS data. Management decisions at the different field centers dictated whether improvements to the database were a priority for their projects. While updating the database was considered in personnel performance evaluations at the Western Field Operations Center WFOC, it was not at Intermountain Field Operations Center (IFOC). However, most of the corrections and additions were limited to fields describing location, commodity, and bibliographic data. Very little geologic, historical, or resource data was added to the database at any field center.

The database is designed to be dynamic, with the potential to modify records and add new fields or tables at any time. A major objective of the database design was to be able to determine the economics of mineral deposits. This meant that although there are many fields that can be populated to describe all factors about a mineral property, information is sparse for most records. In a database of over 221,000 records, only about 5,000 contain detailed information. Presently, the database is not currently being supported, and use is generally limited to retrieving data for ongoing projects, not updating.

The responsibility for maintaining the database was distributed among the various Field Centers of the Bureau of Mines. Initially, the states east of the Mississippi River were the responsibility of the Eastern Field Operations Center. When it was closed, responsibility was transferred to IFOC (Denver, Colorado), which previously had only been responsible for the central states. The western U.S. (California, Hawaii, Idaho, Montana, Nevada, Oregon, and Washington) was maintained by WFOC (Spokane, Washington). Alaska was the responsibility of the Alaska Field Operations Center (Anchorage and Juneau, Alaska). The Minerals Availability Field Office (Denver, Colorado) and some personnel in Washington, DC, handled data for foreign countries.

Records in the database were obtained mainly from published sources, such as state, private, U.S. Geological Survey, and U.S. Bureau of Mines publications. Additional information was obtained from the U.S. Geological Survey's MRDS database (mostly from its predecessor CRIB), the Mine Health and Safety Administration (MHSA) [as well as its predecessor, the Mine Enforcement Safety Administration (MESA)], and the U.S. Forest Service and Bureau of Land Management. Because most locations in the database were not field checked, this is a reference-specific database, which also contains some site-specific records.

To compensate for the widely varied quality of locational descriptions among the various source documents, the database contains a precision of point (POP) field that estimates the probable error in location. (No judgment is made as to the true accuracy of the location.) This field can be used to filter the data. For example, the latitude-longitude coordinate given to a property, if the reference only reported the location as a township and range, would be the center of the township with a POP of 5000 meters; similarly, a precision of 1000 meters was assigned to locations reported to the nearest section. Generally, properties visited by U.S. Bureau of Mines personnel or shown on a U.S. Geological Survey topographic map were given a POP of 10 or 100 meters (precision based on scale of available topographic map or use of GPS (global position system)).

Since its inception in the 1970's, no systematic verification of the records was made. One problem was typographical errors in entering data (including latitude and longitude). Typographical errors most commonly occurred in coded fields where the data entry person entered a code rather than the name. Among other problems are duplicate records for the same property, properties with several workings or claims, multiple claim names, and outdated information (such as producers that have subsequently stopped production). Consequently, judgments had to be made by the evaluator in how to enter data and there was little consistency. A recent problem is that most U.S. Bureau of Mines files have been archived or lost. For example, files maintained by WFOC were commonly split up with the proprietary information being sent to the National Archives and the non-proprietary information sent to the National Records Center. Since these files were sometimes the only reference used, verification of information is currently difficult or impossible.

Several factors affect the applicability of the data to analyses. These factors include the quality, reason for collection, and completeness of the data. Use of any data for purposes different than that for which it was collected can produce erroneous results. When the data is digital, it is extremely easy to create scenarios that improperly depict the facts. For example, someone looking for titanium properties for exploration sites could mistakenly do a query on the commodity (COM) item. However, inspection of either the modifier item (MOC) or the type of operation (TYP) would show that some of the properties that list titanium as a commodity are processing plants.

GIS Project Description

The MAS/MILS database contains over 221,000 records. Of this number, 128,441 are in the region included in this Arc/Info coverage. The data used to create this coverage was extracted from the database April 17, 1998.

The area included in the point coverage for the Western U.S. includes states managed by the Western Region (except Hawaii), USGS (hatched) and adjoining states managed by the Central Region, USGS (Figure 1). The Arc/Info coverage can either be used by itself or combined with other GIS coverages to perform analyses that require mineral deposit information. The coverage is not intended to replace or duplicate the database, but to provide an easy means to analyze data from the database in a geographic information system. Several criteria were used to determine what information in the database should be included as items in the coverage. First, a database field should have a significant percentage of the records populated. For a majority of the fields in the database, less than 10 percent of the records have an entry. A second criterion is that analyses can be performed on the information. For example, the bibliography information was excluded because it cannot be spatially analyzed. The third criterion is that the information should be generally useful for mineral resource analyses. Such fields as FOD (foreign or domestic), FOC (field operations center responsible for deposit information), and EVA (name of evaluator) were eliminated for this reason. This last is somewhat subjective, but the first two criteria eliminated over 90 percent of the fields from consideration. Many of the remaining fields were specific to Bureau of Mines statistics or projects and not of general usefulness.

Fifteen fields were selected from the MILS table and three fields from the COMMODITY table in the MAS/MILS database. The MILS table fields include: sequence number (SEQ), name (NAM), type of operation (TYP), current status (CUR), point of reference (POR), precision of point (POP), domain (DOM), land holdings (HOL), MRDS number (GSC), mining district name (MDN), mineral land assessment (MLA), latitude (LAT), longitude (LON), state (STA), and county (COU). The state and county fields are codes in the MAS/MILS database and were converted to names in this project. The COMMODITY table fields include: commodity (COM), modifier of commodity (MOC), and industry reporting code (IRC).

Most of the fields selected for this project are list-limited fields (i.e. only certain words are allowed in the field). This factor, while having some limitations, ensures consistency in the data and makes searching the fields easier. Besides the restriction of possible values in the fields, consistent spelling was enforced. The fields from the MILS table that are list-limited include: TYP, CUR, POR, POP, DOM, HOL, and MLA. The fields extracted from the COMMODITY table are also list-limited. In addition, the IRC field is not independent from the COM field (i.e. each commodity has a defined Industry Reporting Code).

GIS Documentation

The MAS/MILS database was the source of all the data to make the point coverage. An initial query of the database was made for all properties located within the 12 states. Point data (decimal latitude and longitude) was extracted from the database. The fields used were the DLAT and DLON, which were created from the LAT and LON fields.

The SEQ field was used for the unique id number by eliminating leading zeros. Data from these three fields was used to create (Arc/Info GENERATE command) a point coverage in Arc/Info version 7.1.1. Some properties in the initial query plotted outside of the 12-state area of interest for this project (usually because of typos in the property location that had not been corrected). These were corrected in the MAS/MILS database. A second query of the database was then made April 17, 1998. This is the data included in this Arc/Info coverage. Points that plotted within the Western U.S., but are in the wrong state or county, have not been corrected. Modifications to the MAS/MILS database after April 17, 1998 are not reflected in this coverage.

The MAS/MILS sequence number and additional fields from the MILS table were then joined (JOINITEM command) to the point attribute table (.pat) created by Arc/Info. The accuracy of the point locations is a function of the accuracy of the point in the original database. Accuracies vary from as good as ± 10 meters to very poor.

There is one related table associated with MAS/MILS point coverage (MILS.COM). This table contains information from the COMMODITY table in the MAS/MILS database. The information contained in the MILS.COM table was obtained using a select query of the MAS/MILS database. The ASCII file generated by Oracle was converted to dBASE format on a personal computer. The dBASE file was converted in Arc using the DBASEINFO command to create the MILS.COM table.

Lookup tables were created to provide symbols and descriptions of the values for some of the items in the MILS.PAT and MILS.COM tables. This was done only for the items that are list-limited fields in the MAS database. The relationship between Info tables is shown in figure 2. In addition, a relate table was made to facilitate linking the MILS.PAT table to the MILS.COM table for use in developing queries based on commodity.

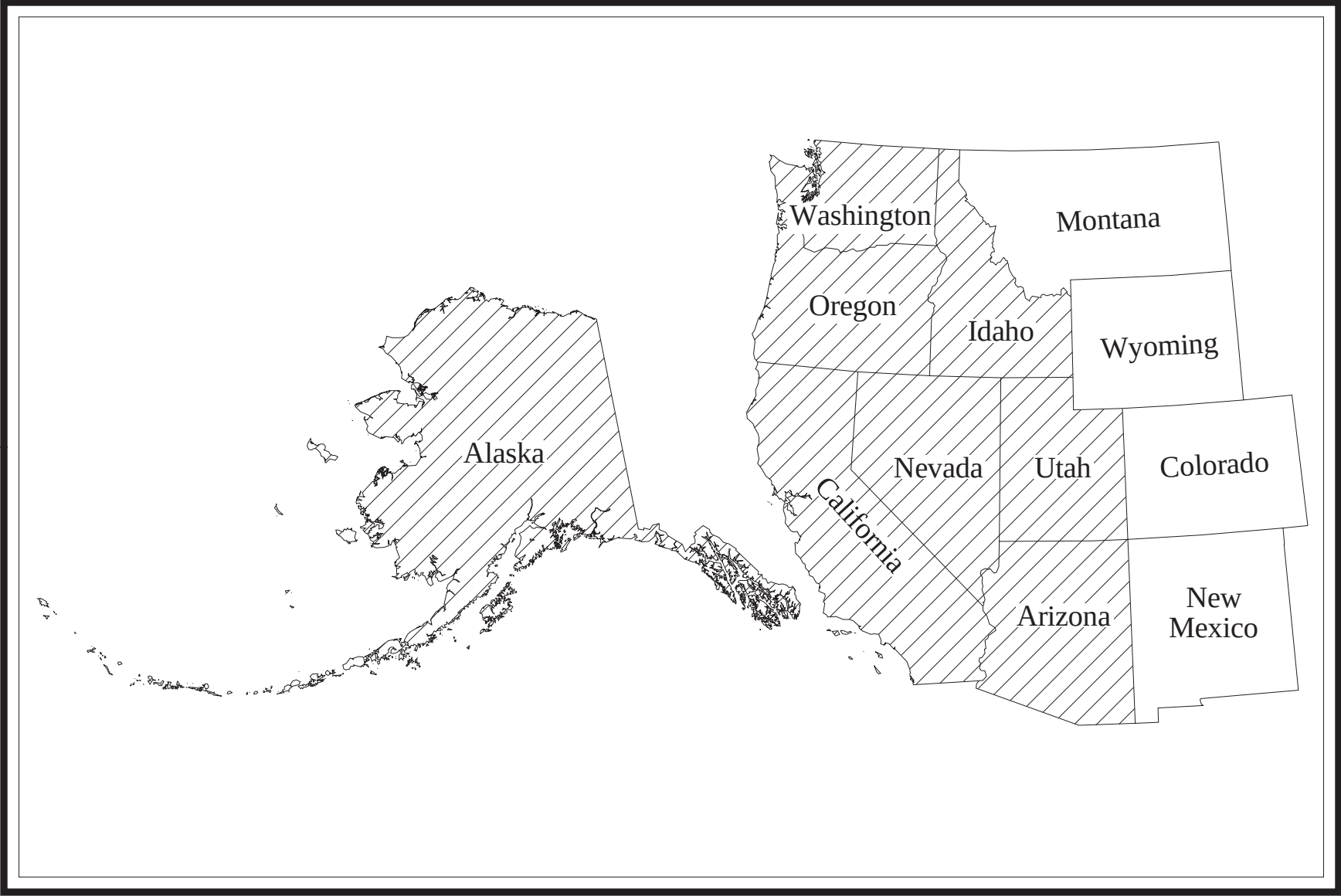
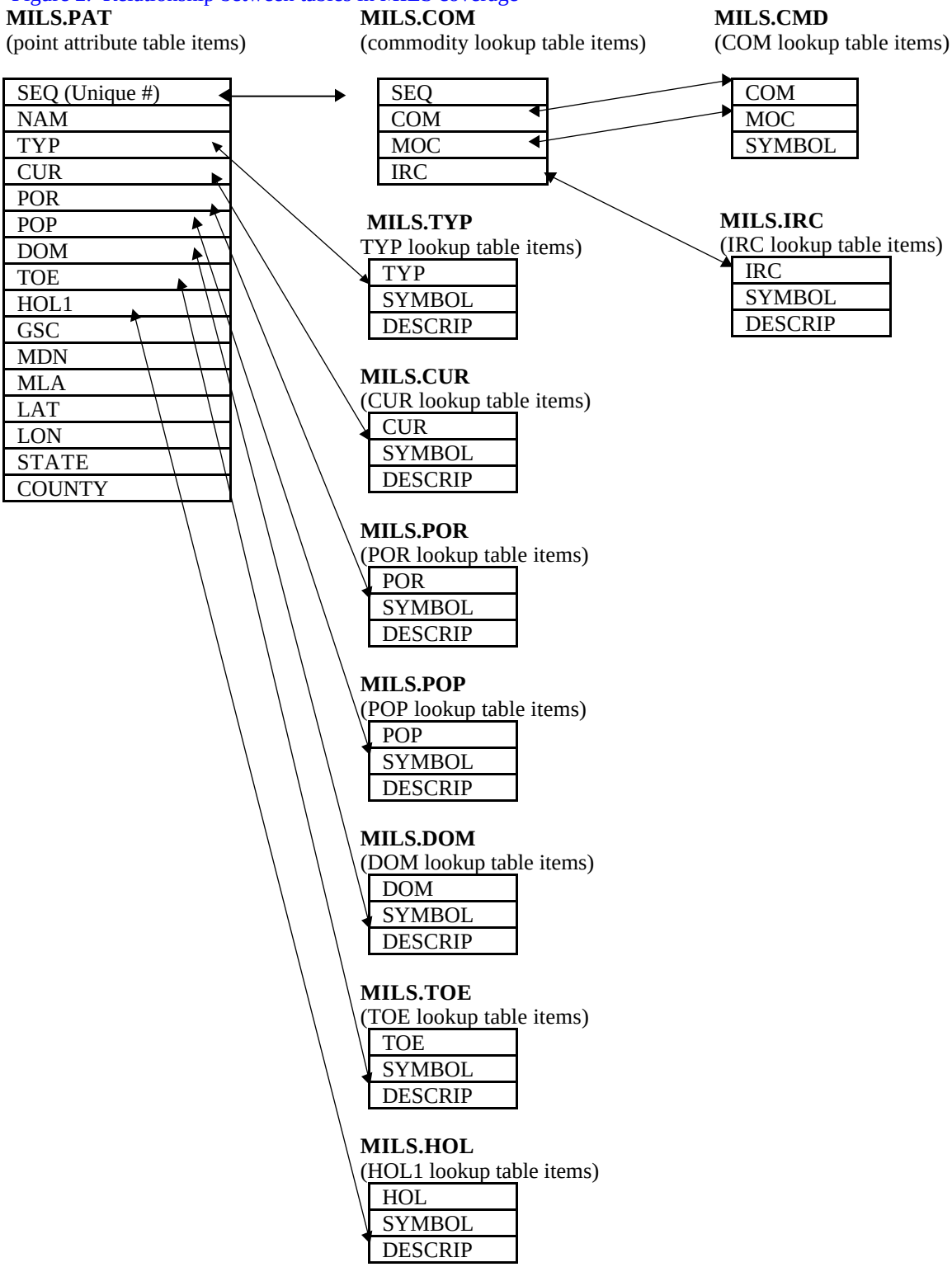

Washington
Montana
Oregon
Idaho
Wyoming
Alaska
Nevada
Utah
Colorado
California
Arizona
New
Mexico

Figure 2. Relationship between tables in MILS coverage



MAS/MILS Point Features

Table 1. Descriptions of the items in the point attribute table, MILS.PAT.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
seq	character	10	Unique identification number used to identify a property in the MAS/MILS database.
nam	character	35	Primary name given to mineral property.
cur	character	21	Current status of mineral property. Current often refers to date of information source used, rather than present date. (This item also occurs in MILS.CUR.)
typ	character	12	Type of operation occurring at the mineral property. Generally this was coded to be what was present at the time the "current status" was reported. (This item also occurs in MILS.TYP.)
por	character	8	Point of reference indicates where the latitude-longitude point was determined. (This item also occurs in MILS.POR.)
pop	integer	5	Precision of point gives the estimated maximum deviation from the exact point of reference in meters. (This item also occurs in MILS.POP.)
dom	character	14	Describes the land ownership of the property. (This item also occurs in MILS.DOM.)
toe	character	1	Type of evaluation that best describes the source of the information for the corresponding record. The possible choices vary from information that came from some literature to properties that had intensive study by a Bureau of Mines evaluator. (This item also occurs in MILS.TOE.)
hol1	character	13	Describes mineral and access rights (holdings) for the property. (This item also occurs in MILS.HOL.)
gsc	character	7	Unique identification used by MRDS database for this property. (This item is the same as Record no. in the MRDS database.)
mdn	character	15	Mining district name.
mla	character	1	Yes/no field - Is there a U.S. Bureau of Mines Mineral Land Assessment report on this property.
lat	character	7	Latitude in direction, degrees, minutes, seconds (e.g. N453021).
lon	character	8	Longitude in direction, degrees, minutes, seconds (e.g. W1173021).
state	character	20	State name.
county	character	20	County name.

The reader is referred to Staff (1974) for detailed descriptions of the database fields.

In addition to the digital GIS layer which contains the locations of points and associated attributes from the MAS/MILS database; one relate table was created, MILS.COM. This table is described below. All item names used are the same as the field names used in the MAS/MILS database.

Table 2. Attribute descriptions for items in the relate table, MILS.COM.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
seq	character	10	Unique identification number used to identify a property in the MAS/MILS database.
com	character	14	Commodity name. (This item also occurs in MILS.CMD.)
moc	character	22	Modifier of commodity. In the MAS/MILS database this is an integral part of the commodity field and cannot be added, modified, or deleted as an independent field. (This item also occurs in MILS.CMD.)
irc	character	1	Industry report code is the group into which industry normally categorizes this commodity. (This item also occurs in MILS.IRC.)

There are nine lookup tables that contain the values allowable for items in the mils.pat and mils.com tables.

Table 3. Attribute descriptions for items in the look-up table, MILS.TYP.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
typ	character	12	Abbreviated description of the type of operation occurring at the mineral property. Generally this was coded to be what was present at the time the "current status" was reported. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the names and abbreviations used in the typ item.

Table 4. Allowable entries in the MILS.TYP lookup table.

type of operation	**symbol**	**descrip**tion
UNKNOWN	1	Unknown or undetermined by evaluator.
SURFACE	2	Surface operation.
UNDERGROUND	3	Underground operation.
SURF-UNDERG	4	Surface-underground operation.
OFFSHORE	5	Underwater operations.
WELL	6	Geothermal well.
PROC PLANT	7	Processing plant.
LEACH	8	Leach operation.
BRINE OP	29	Brine recovery operation.
GEOTHERMAL	41	Natural hot springs.
PLACER	25	Placer operation.

Table 5. Attribute descriptions for items in the look-up table, MILS.CUR.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
cur	character	21	Abbreviated description of the current status of mineral property. Current often refers to date of information source used, rather than present date. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	60	Description of the meaning of the names and abbreviations used in the cur item.

Table 6. Allowable entries in the MILS.CUR look-up table.

current status	**symbol**	**descrip**tion
UNKNOWN	5	Unknown or undetermined.
PRODUCER	85	Property in production at time of information.
PAST PRODUCER	86	Previously operating mineral property, now abandoned.
DEVEL DEPOSIT	3	Resource defined, development initiated.
EXP PROSPECT	2	Explored prospect, resource defined.
RAW PROSPECT	1	No resource defined.
INTERMITTENT PRODUCER	87	Operates only part of year.
TEMP SHUTDOWN	88	Temporary halt in mineral production.
MINERAL LOCATION	4	Mineral prospect or claim without workings.
RECLAIMED	45	Mine closed and property reclaimed.
OTHER	13	Status other than one of the above.

Table 7. Attribute descriptions for items in the look-up table, MILS.POR.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
por	character	8	Abbreviated description of the point of reference indicates where the latitude-longitude point was determined. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the names and abbreviations used in the por item.

Table 8. Allowable entries in the MILS.POR look-up table.

por (point of reference)	**symbol**	**descrip**tion
MAIN ENT	1	Main entrance to a mine, usually the main portal.
TRENCH	5	Trench, usually a bulldozer cut.
ORE BODY	13	Center of ore body.
CLAIM	21	Center of claim.
PLANT	25	Location of processing plant.
TOWN	29	Nearest town used if mine location not known.
PIT	41	Center of open pit or prospect pit.
APPROX	53	Used when other categories aren't correct.

Table 9. Attribute descriptions for items in the look-up table, MILS.POP.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
pop	binary	5	Precision of point gives the estimated maximum deviation from the exact point of reference in meters. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the numeric values used in the pop item.

Table 10. Allowable entries in the MILS.POP look-up table.

pop (precision of point)	**symbol**	**descrip**tion
10	1	10 meters precision for location.
100	5	100 meters precision for location.
250	13	250 meters precision for location.
500	21	500 meters precision for location.
1000	25	1,000 meters precision for location.
5000	29	5,000 meters precision for location.
10000	41	10,000 meters precision for location.
99999	53	Over 10,000 meters precision for location.

Table 11. Attribute descriptions for items in the look-up table, MILS.TOE.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
toe	character	1	Type of evaluation that best describes the source of the information for the corresponding record. The possible choices vary from information that came from some literature to properties that had intensive study by a Bureau of Mines evaluator. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the symbols used in the toe item.

Table 12. Allowable entries in the MILS.TOE look-up table.

toe (type of evaluation)	**symbol**	**descrip**tion
A	1	Information from ADIT database.
M	5	Location information from general sources.
L	13	Location confirmed by USBM evaluator.
R	21	Resource information and MILS information.
C	53	Complete deposit description.

Table 13. Attribute descriptions for items in the look-up table, MILS.DOM.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
dom	character	14	Abbreviated description of the land ownership of the property. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the names and abbreviations used in the dom item.

Table 14. Allowable entries in the MILS.DOM look-up table.

domain	**symbol**	**descrip**tion
UNKNOWN	1	Land ownership unknown.
MIXED	2	Property contains more than one surface estate.
PRIVATE	3	Land in private ownership.
MUNICIPALITY	5	Land owned by local government.
COUNTY	4	County land.
STATE	6	State land.
STATE FOREST	7	State forest land.
STATE PARK	8	State park land.
STATE OFFSHORE	13	Ocean and lake bottom claimed by state
FEDERAL	14	Federal land, un-designated administration.
NAT FOREST	15	National Forest land.
NAT RECREATION	16	National Recreation Area land.
NAT WILDERNESS	21	National Wilderness land.
NAT PRIMITIVE	22	National Primitive Area land.
NAT PARK	23	National Park land.
NAT MONUMENT	24	National Monument land.
INDIAN RES	41	Indian Reservation.
NAT OFFSHORE	42	Ocean bottom claimed by United States.
BLM ADMIN	43	Public land under Bureau of Land Management.
MILITARY RES	44	Military Reservation.
FORGN OFFSHORE	53	Foreign land under an ocean.
INTERNAT WAT	54	Ocean bottom not claimed by a government.
UN ADMIN	55	Land under United Nations administration.

Table 15. Attribute descriptions for items in the look-up table, MILS.HOL.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
hol1	character	13	Abbreviated description of the mineral and access rights (holdings) for the property. (This item also occurs in MILS.PAT.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	50	Description of the meaning of the names and abbreviations used in the hol1 item.

Table 16. Allowable entries in the MILS.HOL1 look-up table.

hol1 (mineral holding)	**symbol**	**descrip**tion
UNKNOWN	1	Mineral estate ownership unknown.
LOCATED CLAIM	2	Located claim on Federal land.
PATENTED	3	Patented mining claim.
FEDERAL LEASE	4	Mineral rights leased from the Federal Government.
STATE LEASE	5	Mineral rights leased from State Government.
PRIVATE LEASE	13	Mineral rights leased from private owner.
FEE OWNERSHIP	21	Mineral rights owned by operator.
MINERALS ONLY	41	Mineral rights owned, but not surface.
OTHER	53	Ownership not one of other categories.

Table 17. Attribute descriptions for items in the look-up table, MILS.IRC.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
irc	character	1	Industry report code is the group into which industry normally categorizes this commodity. (This item also occurs in MILS.COM.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbol numbers refer to plotter.mrk markerset.)
descrip	character	15	Description of the meaning of the symbols used in the irq item.

Table 18. Allowable entries in the MILS.IRC look-up table.

irc (industry reporting code)	**symbol**	**descrip**tion
F	5	Ferrous
M	13	Metallic
N	21	Non-metallic
E	1	Energy
$	53	Precious metal
C	46	Contaminant

Table 19. Attribute descriptions for items in the look-up table, MILS.CMD.

ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
com	character	14	Commodity name. (This item also occurs in MILS.COM.)
moc	character	22	Modifier of commodity. In the MAS/MILS database this is an integral part of the commodity field and cannot be added, modified, or deleted as an independent field. (This item also occurs in MILS.COM.)
symbol	binary	3	Markerset symbol number used by Arc/Info to plot point. (Symbols less than 100 are from the plotter.mrk markerset; all others from the mineral.mrk markerset.)

Table 20. Allowable entries in the MILS.CMD look-up table.

COM (Commodity)	MOC (Modifier of commodity)	SYMBOL
ABRASIVE		15
ABRASIVE	BLASTING SAND	15
ABRASIVE	CORUNDUM	15
ABRASIVE	CRUSHING BORT	15
ABRASIVE	DIAMOND	15
ABRASIVE	EMERY	15
ABRASIVE	GARNET	15
ABRASIVE	INDUSTRIAL DIAMOND	15
ALKALI		53
ALKALI	OXIDE	53
ALUMINUM		21
ALUMINUM	ALUMINA	21
ALUMINUM	ALUMINOUS SHALE	21
ALUMINUM	ALUNITE	21
ALUMINUM	ANORTHOSITE	21
ALUMINUM	BAUXITE	21
ALUMINUM	BAUXITE ABR	21
ALUMINUM	BAUXITE CHEM	21
ALUMINUM	BAUXITE REF	21
ALUMINUM	CONTAINED OR METAL	21
ALUMINUM	DAWSONITE	21
ALUMINUM	HI-ALUMINA CLAY	21
ALUMINUM	PHOSPHATE ROCK	21
ALUMINUM	SAPROLITE	21
ANTIMONY		54
ANTIMONY	OXIDE	54
ARSENIC		55
ASBESTOS		43
ASBESTOS	LONG FIBER	43
ASBESTOS	SHORT FIBER	43
ASH		53
ASH	AS RECEIVED	53
ASH	DRY BASIS	53
BARITE	SULFATE	44
BARITE	CARBONATE	44
BARITE	BARIUM	44
BERYLLIUM		56
BERYLLIUM	OXIDE	56
BISMUTH		3
BORAX		29
BORON		29
BROMINE		30
BROMINE	LAKE & WELL BRINE	30

BROMINE	OCEAN BRINE	30
CADMIUM		4
CALCIUM		16
CALCIUM	CALCAREOUS MARL	16
CALCIUM	CALCITE	16
CALCIUM	CALCIUM CHLORIDE BRINE	16
CALCIUM	CHLORIDE BRINE	16
CALCIUM	DOLOMITE	16
CALCIUM	LIMESTONE	16
CALCIUM	OXIDE	16
CALCIUM	SHELL OR OYSTER SHELL	16
CESIUM		25
CHLORINE		30
CHLORINE	OCEAN BRINE	30
CHLORINE	CHLORIDE-CONTAMINANT	30
CHLORINE	SALINE LAKE	30
CHLORINE	SALT	30
CHROMIUM		22
CHROMIUM	CHROMITE	22
CHROMIUM	CHROMITE CHEM	22
CHROMIUM	CHROMITE MC	22
CHROMIUM	CHROMITE MET	22
CHROMIUM	CHROMITE MR	22
CHROMIUM	CHROMITE REF	22
CHROMIUM	FERROCHROME	22
CHROMIUM	HFERROCHROME	22
CHROMIUM	LFERROCHROME	22
CLAY		41
CLAY	BALL CLAY	41
CLAY	BENTONITE	41
CLAY	COMMON CLAY	41
CLAY	FIRE CLAY	41
CLAY	FULLERS EARTH	41
CLAY	HECTORITE	41
CLAY	ILLITE	41
CLAY	KAOLIN (CHINA CLAY)	41
CLAY	MONTMORILLONITE	41
CLAY	REFRACTORY	41
COAL		42
COAL	ANTHRACITE	42
COAL	BITUMINOUS	42
COAL	LIGNITE	42
COAL	PEAT	42
COAL	SUBBITUMINOUS	42
COAL	SULFUR (REC)	42
COAL	SULFUR (DRY)	42

COBALT		28
COLUMBIUM		32
COLUMBIUM	COLUMBITE	32
COLUMBIUM	PYROCHLORE	32
COLUMBIUM	COLUMBITE/TANTALITE	32
COPPER		1
COPPER	NATIVE	1
COPPER	OXIDE	1
COPPER	SULFIDE	1
CYANIDE	CONTAMINANT	53
DIATOMITE		45
FELDSPAR		52
FIXED CARBON	AS RECEIVED	53
FIXED CARBON	DRY BASIS	53
FLUORINE		30
FLUORINE	FLUORSPAR	30
FLUORINE	FLUORSPAR A	30
FLUORINE	FLUORSPAR C	30
FLUORINE	FLUORSPAR M	30
FLUORINE	HYDROGEN FLUORIDE	30
GALLIUM		407
GEMSTONE	DIAMOND	46
GEMSTONE	EMERALD	46
GEMSTONE	NON-PRECIOUS	46
GEMSTONE	RUBY	46
GEMSTONE	SAPPHIRE	46
GEMSTONE	SEMIPRECIOUS OTHER	46
GEMSTONE	SEMIPRECIOUS SILICATE	46
GEOTHERMAL		47
GERMANIUM		407
GERMANIUM	OXIDE	407
GOLD		2
GOLD	LODE	2
GOLD	PLACER	2
GOLD	REFINERY	2
GRAPHITE		110
GRAPHITE	AMORPHOUS-CRYSTALLINE	110
GRAPHITE	FLAKE	110
GYPSUM		48
GYPSUM	ANHYDRITE	48
GYPSUM	GYPSITE	48
GYPSUM	ROCK GYPSUM	48
HAFNIUM		210
HEAT VALUE	AS RECEIVED	53
HEAT VALUE	DRY BASIS	53
HEAVY METALS	CONTAMINANT	53

HELIUM		31
HYDROGEN	CONTAMINANT	53
INDIUM		4
IODINE		30
IODINE	BRINES	30
IODINE	CALCHE NITRATES	30
IRON		22
IRON	FERRIC OXIDE	22
IRON	FERROUS OXIDE	22
IRON	GOETHITE	22
IRON	HEMATITE	22
IRON	PYRRHOTITE	22
IRON	MAGNETITE	22
IRON	PIG IRON	22
IRON	SIDERITE	22
IRON	SULFIDE	22
IRON	TACONITE	22
IRON	TACONITE BOTTOM LEAN	22
IRON	TACONITE LEAN	22
IRON	TACONITE OXIDIZED	22
IRON	TACONITE OXIDIZE LEAN	22
IRON	TACONITE SILICEOUS	22
IRON	TACONITE SILICEO LEAN	22
IRON	TITANIFEROUS MAGNETITE	22
KYANITE GROUP		301
LEAD		3
LEAD	CARBONATE	3
LEAD	OXIDE	3
LEAD	SULFIDE	3
LEAD	SMELTER	3
LEAD	REFINER	3
LITHIUM		401
LITHIUM	BRINES	401
LITHIUM	CARBONATE	401
LITHIUM	PEGMATITE	401
MAGNESIUM		23
MAGNESIUM	BRINES	23
MAGNESIUM	BRUCITE	23
MAGNESIUM	CONTAINED OR METAL	23
MAGNESIUM	DOLOMITE	23
MAGNESIUM	EVAPORITES	23
MAGNESIUM	MAGNESITE	23
MAGNESIUM	MAGNESIUM CHLORIDE	23
MAGNESIUM	MG - CAUSTIC	23
MAGNESIUM	MG - DEADBURNED	23
MAGNESIUM	MG - HYDROXIDE	23

MAGNESIUM	MG - OXIDE	23
MAGNESIUM	SEA WATER	23
MAGNESIUM	OLIVINE-CHRYSOLITE	23
MAGNESIUM	OXIDE	23
MANGANESE		24
MANGANESE	DIOXIDE	24
MANGANESE	NODULES	24
MANGANESE	OXIDE	24
MANGANESE	FERROMANGANESE	24
MERCURY		6
MICA		105
MICA	BOOK	105
MICA	FLAKE	105
MICA	SERICITE	105
MOLYBDENUM		7
MOLYBDENUM	FERROMOLY	7
MOLYBDENUM	MOLY IN CONCENTRATE	7
MOLYBDENUM	MOLY OXIDE	7
MOLYBDENUM	SULFIDE	7
NATURAL GAS		31
NEPHELINE SYEN		52
NICKEL		28
NICKEL	OXIDE	28
NICKEL	SILICATE	28
NICKEL	SULFIDE	28
NICKEL	SMELTER	28
NICKEL	REFINER	28
NITRATE	CONTAMINANT	53
NITROGEN		31
PERLITE		205
PETROLEUM		31
PETROLEUM	CRUDE	31
PETROLEUM	GILSONITE	31
PETROLEUM	OIL SHALE	31
PETROLEUM	ROCK ASPHALT	31
PETROLEUM	TAR SANDS	31
PHOSPHATE		49
PHOSPHATE	PHOSPHOROUS	49
PHOSPHATE	PRODUCT	49
PHOSPHATE	WASTE	49
PHOSPHATE	ACID	49
PLATINUM GROUP		8
PLATINUM GROUP	IRIDIUM	8
PLATINUM GROUP	OSMIUM	8
PLATINUM GROUP	PALLADIUM	8
PLATINUM GROUP	PLATINUM	8

PLATINUM GROUP	RHODIUM	8
PLATINUM GROUP	RUTHENIUM	8
POTASH		51
POTASH	BEDDED DEPOSITS	51
POTASH	BRINES	51
POTASH	SULFATE	51
PUMICE		205
PUMICE	PUMICITE	205
PUMICE	SCORIA	205
PUMICE	VOLCANIC ASH	205
PUMICE	VOLCANIC CINDER	205
PUMICE	VOLCANIC DUST	205
QUARTZ CRYSTAL		310
QUARTZ CRYSTAL	ELECTRONIC GRADE	310
QUARTZ CRYSTAL	OPTICAL GRADE	310
RADIUM		27
RARE EARTH		305
RARE EARTH	BASTNASITE	305
RARE EARTH	CERIUM GROUP	305
RARE EARTH	YTTRIUM GROUP	305
RHENIUM		1
RUBIDIUM		410
RUBIDIUM	SAND	410
SAND & GRAVEL		13
SCANDIUM		103
SELENIUM		1
SILICON		310
SILICON	DIOXIDE	310
SILICON	FERROSILICON	310
SILICON	FOUNDRY SAND	310
SILICON	GLASS SAND	310
SILICON	QUARTZ	310
SILICON	QUARTZITE	310
SILICON	SANDSTONE	310
SILVER		5
SILVER	CARBONATE	5
SILVER	NATIVE	5
SILVER	OXIDE	5
SILVER	SULFIDE	5
SILVER	REFINERY	5
SODIUM		405
SODIUM	BICARBONATE-NAHCOLITE	405
SODIUM	BRINE	405
SODIUM	CARBONATE (TRONA)	405
SODIUM	OXIDE	405
SODIUM	SALT	405

SODIUM	SULFATE	405
STONE		14
STONE	AGGREGATE CB*	14
STONE	BALLAST CB	14
STONE	BASALT CB	14
STONE	BASALT DM	14
STONE	BASALT DR	14
STONE	CALCAREOUS MARL	14
STONE	DECOMPOSED GRANITE CB	14
STONE	CINDERS DR	14
STONE	DECOMPOSED GRANITE	14
STONE	DIMENSION	14
STONE	FILL CB	14
STONE	GRANITE CB	14
STONE	GRANITE DM	14
STONE	GRANITE DR	14
STONE	GRANITIC DR	14
STONE	LIMESTONE CB	14
STONE	LIMESTONE DM	14
STONE	LIMESTONE DR	14
STONE	MARBLE CB	14
STONE	MARBLE DM	14
STONE	METAMORPHIC DR	14
STONE	MICA SCHIST CB	14
STONE	MICA SCHIST DM	14
STONE	MISCELLANEOUS CB	14
STONE	MISCELLANEOUS DM	14
STONE	MISCELLANEOUS DR	14
STONE	QUARTZITE CB	14
STONE	QUARTZITE DM	14
STONE	RIP RAP	14
STONE	SANDSTONE CB	14
STONE	SANDSTONE DM	14
STONE	SANDSTONE DR	14
STONE	SEDIMENTARY DR	14
STONE	SHALE CB	14
STONE	SHELL CB	14
STONE	SLATE CB	14
STONE	SLATE DM	14
STONE	SLATE DR	14
STONE	SUBBASE CB	14
STONE	TRAVERTINE DM	14
STONE	TRAVERTINE DR	14
STONE	VOLCANIC DR	14
STRONTIUM		410
SULFUR		107

SULFUR	NATIVE	107
SULFUR	PYRITE	107
SULFUR	PYRITE-CONTAMINANT	107
SULFUR	SULFURIC ACID	107
SULFUR	SULFATE-CONTAMINANT	107
SULFUR	SULFIDE-CONTAMINANT	107
TALC		50
TALC	BLOCK STEATITE	50
TALC	GROUP	50
TALC	PYROPHYLLITE	50
TALC	SOAPSTONE	50
TANTALUM		32
TANTALUM	TANTALITE	32
TANTALUM	TIN SLAG	32
TELLURIUM		1
THALLIUM		4
THORIUM		27
THORIUM	OXIDE	27
TIN		207
TIN	LODE	207
TIN	PLACER	207
TIN	TAILINGS	207
TITANIUM		25
TITANIUM	ANATASE	25
TITANIUM	HI TI 70	25
TITANIUM	HI TI 90	25
TITANIUM	ILMENTITE	25
TITANIUM	ILMENTITE STOCK	25
TITANIUM	ILMENTITE TO SR	25
TITANIUM	LEUCOXENE	25
TITANIUM	RICHBAY SLAG	25
TITANIUM	RUTILE	25
TITANIUM	RUTILE-SYNTHETIC	25
TITANIUM	SOREL SLAG	25
TITANIUM	TITANIFEROUS MAGNETITE	25
TITANIUM	METAL	25
TUNGSTEN		26
TUNGSTEN	BRINES	26
TUNGSTEN	LODE	26
TUNGSTEN	TAILINGS	26
TUNGSTEN	PLACER	26
TUNGSTEN	WO3 CONTENT	26
TUNGSTEN	REFINERY	26
URANIUM		27
URANIUM	U3O8 CONTENT	27
VANADIUM		307

VANADIUM	PHOSPHATIC SHALE	307
VANADIUM	TITANIFEROUS MAGNETITE	307
VANADIUM	V2O5 CONTENT	307
VERMICULITE		205
VOLATILE CONT		53
VOLATILE CONT	AS RECEIVED	53
VOLATILE CONT	DRY BASIS	53
WATER CONTENT		53
WATER CONTENT	FREE WATER	53
WATER CONTENT	HYDRATED WATER	53
WATER CONTENT	TOTAL WATER	53
WOLLASTONITE		201
XANTHATE	CONTAMINANT	53
ZEOLITES		101
ZINC		4
ZINC	CARBONATE	4
ZINC	OXIDE	4
ZINC	SILICATE	4
ZINC	SULFIDE	4
ZINC	SMELTER	4
ZINC	REFINER	4
ZIRCONIUM		210
ZIRCONIUM	BADDELEYITE	210
ZIRCONIUM	ZIRCON	210

CB = Crushed and broken STONE
DM = Dimension STONE
DR = Decorative rock or decorative STONE

Obtaining Digital Data

The complete digital files are available in Arc/Info export format with associated data files at the USGS web site. Also available at this site is a file describing the data structure of the non-proprietary part of the MAS/MILS database (masnp.pdf). These data and map images are maintained in a geographic map projection:

To obtain copies of the digital data, do one of the following:

1. Download the digital files from the USGS public access World Wide Web site on the Internet: **URL = http://wrgis.wr.usgs.gov/open-file/of98-512.html**

or

2. Anonymous FTP from **wrgis.wr.usgs.gov**, in the directory **pub/open-file/of98-512**

The Internet sites contains a text file (mils_readme.txt), an Arc/Info EXPORT-format file (mils.e00.Z), and a HPGL2 plot file (mils.hp.Z), as well as the associated data files and Arc/Info macro program and coverages that are used to plot the map at a scale of 1:5,000,000. The files have been compressed using UNIX compression. Multiple files have been tared.

To manipulate this data in a geographic information system (GIS), requires a GIS that is capable of reading Arc/Info Export formatted files and a computer capable of reading UNIX ASCII files. To use these files on a DOS computer,

they must be put through a UNIX-to-DOS filter. However, pc-Arc/Info v.3.5 does not need a UNIX-to-DOS conversion. To use the .e00 files in ArcView v. 3, use the Import71 program that comes with ArcView. Because of ArcView design features, this data will process much slower in the Mac version of ArcView 3.0 than on the Windows or Unix versions.

Obtaining Paper Maps

Paper copies of the digital maps are not available from the USGS. However, with access to the Internet and access to a large-format color plotter that can interpret HPGL2 (Hewlett-Packard Graphics Language), 1:5,000,000-scale paper copies of the MAS/MILS map (figure 3) can be made, as follows:

1. Download the digital version of the complete map, **mils.hp**, from the USGS public access World Wide Web site on the Internet using the

URL = http://wrgis.wr.usgs.gov/open-file/of98-512.html

or
Anonymous FTP the plot file, **mils.hp,** from: **wrgis.wr.usgs.gov**, in the directory:

pub/open-file/of98-512

2. This file can be plotted by any large-format graphics plotter that can interpret HPGL2. The finished mils plot is about 36 by 30 inches.

Paper copies of the map can also be created by obtaining the digital file as described above, and then creating a plot file in a GIS.

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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 98-512
PLATE 1 OF 1

PROJECTION FOR LOWER 11 STATES

Scale 1:5,000,000

Projection: Albers
Datum: NAD27
Units: Meters
Spheroid: Clarke 1866
1st Standard Parallel: 29 30 00
2nd Standard Parallel: 45 30 00
Central Meridian: -113 00 00
Latitude of Projections Origin: 23 00 00
False Easting: 700,000 Meters
False Northing: 0 Meters

PROJECTION FOR ALASKA

Scale 1:7,000,000

Projection: Albers
Datum: NAD27
Units: Meters
Spheroid: Clarke 1866
1st Standard Parallel: 55 00 00
2nd Standard Parallel: 65 00 00
Central Meridian: -154 00 00
Latitude of Projections Origin: 50 00 00
False Easting: 0.0 Meters
False Northing: 0.0 Meters

Map showing MAS/MILS sites in the Western United States

by J. Douglas Causey

1998