INVENTORY OF MINES AND MINING- RELATED FACILITIES IN IDAHO AND WESTERN MONTANA ACTIVE FROM 1997 THROUGH 2000

by

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Summary

This active mines and mine-related facility inventory provides a comprehensive tabulation of information concerning sites within Idaho and western Montana where natural resources were mined or processed during at least one continuous 30 day interval over the four year period ending December 31, 2000. Records for sites in Idaho and Montana are provided in a data file. The file contains 30 informational fields, one record number field and a comment field. Informational fields are used to identify the commodities or products produced at a site, its name, owner or operator, location, size, activity level and annual production rates, and deposit type information, where a mine is involved. In addition to the Excel spreadsheet file format the state inventory is saved in dbf and Arcview shapefile (.shp) file formats.

Sources for the information include reports and databases of Federal and state agencies that share responsibility for monitoring and regulating mining and processing activities, and publications of private sector institutions, organizations and associations that monitor the scientific, business and environmental aspects of these types of activity. The availability and accuracy of the information can be highly variable. Active sites are mainly identified from address/employment records of the Mine, Safety and Health Administration, filings with the Security and Exchange Commission, state reclamation permit records, annual activity summaries reported in industry journals, and from the owners and operators of the facilities. The minimum informational requirement for every record includes the identity of at least one commodity or processed end product, the geographic coordinates for a feature (site point-of-reference) related to the facility with its spatial relationship to the site, the name of the owner or operator, and the status of activity at the close of the year 2000. The completeness of the information entered in the remaining informational fields varies. Annual production and deposit-type data are the least complete. Production data, in particular, is considered proprietary and is rarely made public, except for publicly held corporations. Also, many of the commodities being mined currently are industrial minerals, which are derived from deposit types that have not, as yet, been descriptively modeled. Site size information, on the other hand, is more readily available, particularly for those lands that are disturbed and must be reclaimed.

The inventory contains records for 226 sites, 135 in Idaho and 91 in Montana. Thirty-two records describe processing or plant sites. Of the remaining 194 mining sites, 66 describe sites where valuable metals are recovered from the ores produced. The remaining 128 records describe sites where industrial minerals or saleable commodities are produced. The principle metallic commodities produced include gold, silver, molybdenum, lead, copper, palladium, platinum and minor by-products. Industrial and saleable commodity production includes talc, phosphate rock, garnet, pumice, perlite, limestone, a variety of rock types used for dimension and decorative purposes, several types of precious to semi-precious gemstones, industrial sand, feldspar, chlorite, zeolites and specialty clays. A few peat-producing sites have also been included. The 226 records include 45 sites that have been permanently closed or placed in a standby status as of December 31, 2000 and one additional site, the Stillwater Mining Co. East Boulder project, where production is not expected to begin until early in 2001. Through the last decade of the 20th century industrial and salable commodity mine output in the two state region has remained steady, whereas metal mining has experienced a steady decline. By the close of the year 2000 36 metal mining sites remained active, representing a 45 percent decline over the last 4 years.

Introduction

This active mines and mine-related facilities inventory contains a tabulation of information about selected sites within Idaho and western Montana where natural resources have been mined or processed at sometime during the four year interval extending from January 1, 1997 to the close of the year 2000 (Figure 1). The information serves as an adjunct to additional mineral resource related information being collected as part of a USGS effort (Headwaters Project), designed to respond to a U.S. Forest Service need for mineral resource and geologic information that can be used in their development of forest management plans. The content of this inventory complements information collected about historic mining activity and recent mineral exploration activity. One goal of the Headwaters Project is to introduce a temporal element into future mineral resource development potential assessments. An understanding of current resource development activity can provide incites on what natural resources and deposit types may be more commercially viable targets of near term development interest and be the focus of attention in land-use planning exercises.

The inventory includes mines and mining-related facilities that currently or recently produced ore or natural materials, in the case of a mine, or a processed end product, in the case of a mine-related facility. A mine or facility is included where there is clear and compelling evidence that the facility was operating productively at the end of 2000, or had operated productively at least one time during the four-year interval from 1997 through 2000, or had been productive prior to 1997 and is being maintained in a state of readiness to return to production under more favorable economic conditions. It includes facilities located on public, Native American, and private lands. The list of natural resource commodities considered in the inventory is comprehensive and includes commodities that are locatable under existing Federal law, non-energy commodities that are leasable under existing Federal law, and also most saleable commodities. Common sand and gravel and topsoil are saleable commodities that have been omitted. Listed ore processing or beneficiation facilities are limited to those where the processing of the raw material output from a mine results in the co-generation of environmentally sensitive by-products (for example, smelters, kilns, mills, etc.). Processing facilities where the processing produces little or no environmentally threatening waste products, such as packaging, drying, sorting, and cutting facilities, have been omitted.

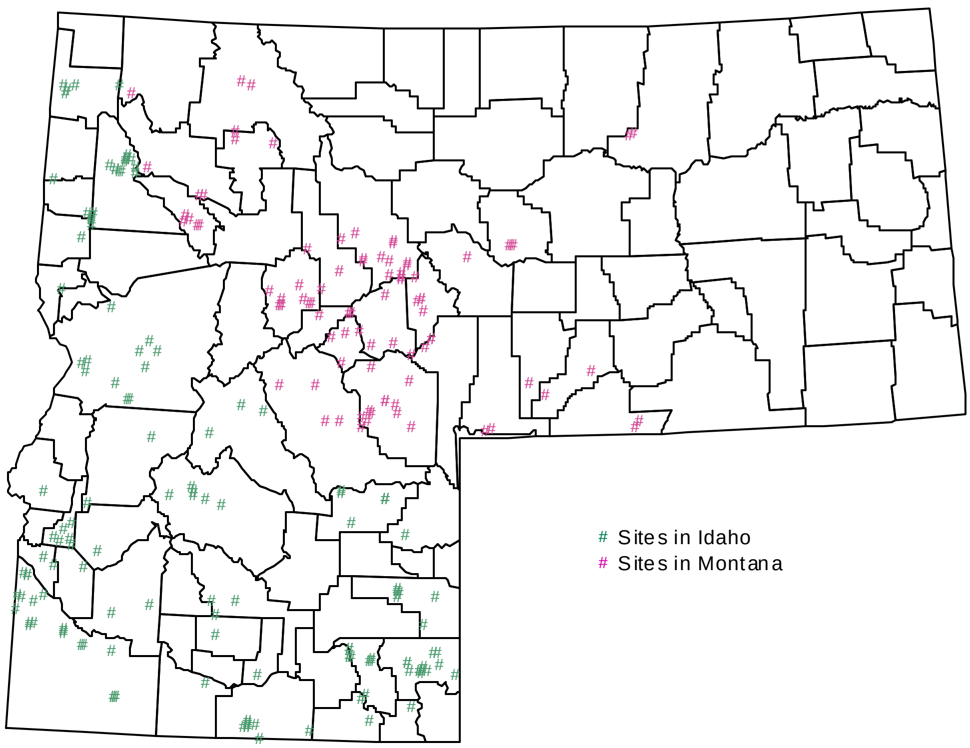

Figure 1. – Generalized map showing 226 sites in Idaho and Montana west of the 108°30' where mining or processing of natural mineral resources exclusive of common sand and gravel occurred over some significant period of time between January 1, 1997 and December 31, 2000.

Productive mining activities in the two state region range from highly productive sites covering large areas, owned and operated by commercially motivated publicly or privately held corporations, to extremely small operations that disturb less than 100 square feet of ground, operated by individuals or entrepreneurial partnerships whose economic motivations are unclear and for which production records are rarely obtainable. Properties included in this inventory are those operations that are viewed by state regulatory authorities to possess a potential to significantly damage the environment and require regulatory oversight of operations and reclamation efforts. Although the criteria used in the two states to distinguish between the two categories of operations vary, in general, activities that affect only a small area and involve no use of mechanized equipment are exempt from close oversight. There is a significant known component of activity that falls in the latter category, which is not reflected in this inventory. Most include gold and semi-precious gemstone placers on the Federal mineral estate that are monitored by the Bureau of Land Management and the U.S. Forest Service. Their absence from the inventory is not deemed to be serious in that production from these operations is believed to be trivial.

The inventory is stored in an Excel spreadsheet file format. An ArcView shape file version is included to facilitate graphic display and spatial analysis of the data. The name of the digital raster graphic image file of the 1:24,000-scale U. S. Geological Survey topographic quadrangle map that underlies each site and a Public Land

Survey System reference code (MTRS) that uniquely identifies the section in which the site lies, are also encoded for each record.

Acknowledgements

Information contained in the inventory is drawn from publicly available records of various Federal and State agencies that monitor and regulate mining and mining-related activity, from publications of associations and individuals that disseminate news and information about the mining industry and commodity sectors, and interviews of Federal, state, and company officials and commodity and industry consultants. The author is deeply indebted to the many local and regional staff members of the U. S. Bureau of Land Management and Forest Service and to the Idaho Department of Lands and the Montana Department of Environmental Quality, with whom he spoke and obtained information on the current status of mining activity. Special thanks are extended to Scott Nichols of the Idaho Department of Lands and Peter Strazdas, Pat Plantenberg, and Ryan Harris of the Montana Department of Environment Quality, who provided access to information in state permitting records. The accuracy of the information contained in the inventory is, however, solely the responsibility of the author and users are encouraged to bring any errors or corrections to his attention. He may be contacted by mail at US Geological Survey, Box 25046, MS-973, Lakewood, CO 80225, by telephone (303) 236-5705, or e-mail gspanski@usgs.gov.

Data Sources

Over the 224-year history of our Nation, the development of indigenous natural mineral resources has seen or experienced ever growing governmental scrutiny at all levels of juris diction. Mining, whether occurring on public or private lands, is subject to permitting and reporting requirements that monitor virtually every conceivable aspect of development, from the early attempts to identify and define a deposit to the final restoration of the lands disturbed, and financial conduct. Facilities that process ore or earth materials are likewise subject to permitting and oversight that is used to control and monitor interactions with the surrounding environment. The information contained in these many permits and reports is used to document current mineral resource activity and characterize the various types of deposits that are actively involved in that development.

Information about operational mines or mining-related facilities has been extracted from record systems maintained by a variety of Federal and state regulatory agencies and publications of trade, industry and professional and scientific organizations. The accuracy of the information was further verified in interviews with regulatory and operating officials. Items of information that could not be verified are shown as being estimated and, in cases where the information sought could not be collected, it is shown as being “not available”. The completeness of entries for the attribute fields is extremely variable. For example, in this initial version of the inventory the annual production and deposit type information is extremely incomplete. However, because of the invaluable contribution that this information can provide to mineral assessments, the informational categories are included as a stimulus for future data collection efforts.

Federal sources of information used in this effort include: (1) the Toxic Release Inventory System (TRIS) and Permit Compliance System (PCS) databases administered by the Environmental Protection Agency; (2) the Electronic Data Gathering, Analysis and Retrieval (EDGAR) system maintained by the Securities and Exchange Commission (SEC); (3) the Minerals Availability System (MAS) maintained by the USGS (4) the claim, permits and bonding records of the U.S. Forest Service and Bureau of Land Management; (5) the Address/Employment and Master Index files of the Mine Safety and Health Administration; and (6) technical and scientific publications of the U. S. Geological Survey and Bureau of Mines. State sources include records maintained by the Departments of Lands and Environmental Quality in Idaho and the Department of Environmental Quality in Montana and additionally publications of the Montana Bureau of Mines and Geology and the Idaho Geological Survey. Additional sources of information include the Idaho Mining Association, American Mines Handbook 1998 (Giancola, 1997), the Journal of Industrial Minerals, the Mining Engineering Magazine, Northwest Mining Association and other scientific and trade publications, and business directories.

In terms of relevance to determining the operational status of a mine or related facility, the state regulatory agency records provide the most pertinent information. In the state of Idaho surface mining activities occurring on all lands, excepting Native American lands, are regulated under authority of the Idaho Surface Mining Act (ISMA) of 1972. The Act requires that a reclamation plan is filed with the state and a bond posted before any surface mining can be initiated, where disturbance is expected to exceed one-half acre. Operations affecting less than one-half acre and mechanized equipment is not involved, and 8 inch or smaller suction dredging operations do not require a permit. The Idaho Department of Environment Quality monitors activity related to underground mining and ore processing facilities through air, water and waste permitting process. In the state of Montana, mining activities occurring on all lands, excepting Native American land, are regulated under the authority of the Montana Metal Mine Reclamation Act (MMRA). The level of regulation under this Act is determined by the size of the area that is expected to be disturbed by mining. Mining activity, that disturbs less than five acres of surface and do not involve the use of cyanide, are exempt from regulation. An operator need only notify the state annually of their intent to conduct mining activities to preserve their right to mine. Small placer operators are also required to post a minimum bond. Mining operations that disturb more than five acres or involve the use of cyanide in the processing of ore are required to obtain an operating permit and post a substantial reclamation bond. The posting of a bond is taken as an indication of an owner or operator's strong commitment to operate a mine or processing facility. Bonded sites, as a general rule, are considered active or to be in a standby mode, unless: (1) there is definitive information to the contrary, or (2) the deposit is depleted and final reclamation is underway, or (3) a facility is being dismantled.

Database

The inventory spreadsheet contains 32 attribute fields (see Table 1). The information in these fields characterizes aspects of mines and related facilities that are deemed critical to understanding the current economics of mineral development in Idaho and western Montana. A mix of text and numeric entry formats is used. Numeric formats are used in the record number, latitude, longitude, surface area, disturbed area and annual production fields; all other fields use text (character) entry format. Wherever feasible, standardized terminology or codes consistent with those approved for use in the U.S. Geological Survey's Mineral Resources Data System (MRDS) and Minerals Availability System/Minerals Industry Location System (MAS/MILS) (Kaas, 1996, and Mason and Arndt, 1996) mineral information databases are used to maximize compatibility with those

Table 1. Structure of the active mines and facilities inventory data file, *Active_mines_ID-MT.xls.*

Field Name[1]	Type	Length	Description
Record No	num	9	Unique identifier. Concatenation of state code, county code and counter value.
Commodity 1	char	18	Name of primary commodity or end product produced at the site.
Commodity 2	char	18	Name of by-product commodity or end-product produced at the site.
Commodity 3	char	18	Name of by-product commodity or end-product produced at the site.
Commodity 4	char	18	Name of by-product commodity or end-product produced at the site.
Commodity 5	char	18	Name of by-product commodity or end-product produced at the site.
Site Name	char	25	Most commonly used name applied to the site. NA=not available.
Owner	char	30	Name of owner or primary operator of site. NA=not available.
State	char	2	State in which the site location point is located. ID=Idaho, MT=Montana
County	char	18	County in which the site location point is located.
Latitude	num	8	Latitude in decimal degrees of site location point.
Longitude	num	9	Longitude in decimal degrees of site location point.
MTRS	char	16	Public Land Survey System identifier of the section in which the site location point is located.
Point Type	char	1	Identifies the spatial relationship between the site location point and a feature or aspect of the facility. E=plant entrance, Cd=centroid of disturbed area, Cs=centroid of surface area, A=main portal/shaft, B=office, shop or permanent building, O=other (see Comments).
Site Type	char	1	Identifies the character of the facility present at a site. Q=quarry, O=open pit, P=placer, S=surface mine, U= underground mine, B=processing facility.
Surface Area	num	10	Surface acreage owned or controlled in connection with a
Disturbed Area	num	10	Surface acreage disturbed in connection with activities at a
Site Size	char	1	Qualitative categorization of the size of the disturbed site area. Size code. S=0 to 5 acres, M=>5 to <100 acres, L=100 or more acres.
Activity Status 2000	char	12	Operational status of a facility on 12/31/2000 described as active, standby or closed (with or without the year of closure).
Activity Level	char	6	Characterization of operational mode during the period when the facility was active. C=continous, I=intermittent, S=seasonal, NA=not available.
Primary Deposit Type	char	18	Name of the dominant type of deposit from which the commodity(s) are extracted. ND=not determined.
Model No 1	char	6	Model number for dominant deposit type, following Cox and Singer (1986) and Stoeser and Heran (2000) nomenclature. ND=not determined.
Secondary Deposit Type	char	18	Name of subordinant type of deposit from which the commodity(s) are extracted. ND=not determined.
Model No 2	char	6	Model number for the subordinant type of deposit, following Cox and Singer (1986) and Stoeser and Heran (2000)
Annual Production Commodity 1	num	16	Average annual level of production for commodities or end products listed in Commodity 1 thru 5 fields. OZ=Troy ounces, ST=short tons, LB=pounds, CUFT=cubic feet, EST=estimated, NA=not available.
Annual Production Commodity 2	num	16	
Annual Production Commodity 3	num	16	
Annual Production Commodity 4	num	16	
Annual Productio Commodity 5	num	16	
Remaining Yrs Activity	char	6	Remaining years of productivity of a facility. S=<2 years, I=2 to 10 years, L=>10 years, D=depleted, NA=not available.
24K Quadrangle Name	char	24	Name of U.S. Geological Survey 1:24,000 scale quadrangle.
Drg Identifier	char	7	Digital raster graphic identifier for 1:24,000 quadrangle.
Comments	char	250	Comments related to values entered in any other fields.

1 Italicized field names indicate that an entry is required.

databases. Permissible entry terminology, codes and numeric values used in each data-field are described below.

A three part numeric code is used as the unique identifier for each record in a state file and is stored in the **Record No** field. The first three digits identify the state and the following three digits identify the county in which the location point for a site is located. MAS/MILS state and county codes (Ferguson, 1998) are used. The final three digits are assigned sequentially starting with 001 to sites within a county, as each is entered into the inventory. Numbers are never reissued.

Metals recovered from an ore or bulk materials extracted at a mine, quarry, pit or equivalent site or end products produced at a processing or beneficiating facility are identified in the commodity fields (**Commodity 1**, etc). Up to five commodities or end products can be associated with a site, arranged in order of their decreasing commercial importance. There must be a minimum of one commodity identified with every site. Where practical, terminology from the MAS/MILS Commodity and Commodity Modifier Tables (Ferguson, 1998) is used. Qualifiers are used with more generic commodity terms to increase specificity.

Site names in the **Site Name** field are those that are most commonly used in current references to a site. Unnamed sites and those where a name is not known are indicated as either "not available" or assigned a geographic identifier, which is followed by the word "area". The latter convention is used to represent a cluster of non-contiguous properties that are operated as a single unit and characterized in a single record.

The ownership field (**Owner**) may contain the name of the owner or operator of the facility or the owner of the land or mineral rights. It may be an individual, partnership, company or corporation. Preference is given to listing the entity that has local managerial responsibility over the operations and holds the required operating permits. Where the latter information is not available, the name of the legal owner of the facility is listed, and in the absence of that name, the name of the entity holding a lease, claim or ownership of the lands, is cited.

All location information is contained in five fields. The **State** and **County** fields identify the political subdivision at the point of reference (**Point Type**); this point is used to locate a facility for GIS purposes. Location coordinates for a point of reference are stored in the **Latitude** and **Longitude** fields, and expressed in decimal degrees to four-place precision. Latitudes are positive and longitudes are negative to indicate their position in the Northern and Western Hemispheres. Location accuracy is dependent on the type of feature selected as a location point, the quality and reliability of the source location information, and the accuracy of the control used to plot locations. A variety of permanent or semi-permanent or easily identifiable features are used as location points, which are described in the **Point Type** field and the **Comments** field. Examples of the types of locality features that are used include a road entry point to a plant site; a permanent, centrally located building at a site; a main shaft collar or adit portal; or centroid of the property's surface area or area of surface disturbance. Features identifiable on a 1:24,000-scale U.S. Geological Survey topographic map used for plotting control are inherently located to the accuracy of these maps, generally 40 feet. Where Public Land Survey System (PLSS) descriptions are used and the location of the surface area was provided only to the nearest section, then the accuracy may be no better than ±2,600 ft. The use of point locations is inherently inadequate for spatial analysis. As additional area data is acquired, the point locations will be replaced with polygon locations in future versions of the inventory. The **MTRS** field contains a sixteen-digit designator that uniquely identifies the Public Lands Survey System (PLSS) section in which the site location point is located. It is a concatenation of meridian, township, range and section information.

Six characteristics of a facility and its site are provided in the data set. These data include information about the type of facility, the land area involved in operations and the character of the activity. The type of facility located at a site is identified by code in the **Type** field. Mine facilities are distinguished as underground (U), open pit (O), quarry (Q), or placer (P). Where definitive information is lacking, a surface site is identified as surface (S). Processing or treatment facilities are coded with a (B); however, only those facilities where the processing or treatment produces environmentally sensitive by-products are included in the inventory. Examples would be mills, smelters, and kilns. Facilities where mined material is simply broken, re-shaped, dried or packaged are generally not included. Where processing and mining facilities are co-located, the mining operation is given precedence if the processing is of a minimal nature, (for example, crushing of ore at a mine or rock at a quarry). Where processing occurring at a mine site is significant in nature, then separate records are created with separate location points and attribute descriptions.

Three measures of surface area are recorded. The data stored in the **Surface Area** field are quantitative measures (in acres) of the contiguous and non-contiguous lands that are held for the purpose of conducting operations at a site. Commonly a mine property is comprised of a mix of privately owned lands and adjoining lands for which mineral rights are held by claims, leases or agreements. For some types of operations these land holdings can be many times larger than the area that is directly affected by operational activity. Where a surface area is indirectly calculated from claim records or otherwise estimated, they are so flagged as estimated (EST). A second measure of surface area is stored in the **Disturbed Area** field, which is a quantitative measure (in acres) of the lands that are permitted for disturbance and subject to reclamation. As a general rule the surface area that is actually disturbed and requires reclaiming represents between 65 and 75 percent of the permitted area. The area totals cited in the inventory reflect property holdings valid between 1997 and the end of 2000. Areas that may have been disturbed and reclaimed prior to this period are not reflected in the figures. The **Site Size** field is used to store an alternative representation of the size of the disturbed area, expressed qualitatively using a three-tier classification code. Sites involving 5 or fewer acres are coded with an (S), medium size sites covering more than 5 acres but less than 100 acres are coded with an (M) and areas of 100 or more acres are designated with an (L). This field is important where an exact acreage for a site is not known, resulting in a NA entry in the **Disturbed Area** field, but there is sufficient information to allow it to be quantitatively classified.

The **Activity Status 2000** and **Activity Level** fields identify the status of a facility at the close of the year 2000 and the frequency of activity when the facility was active. ACTIVE describes a facility that is producing ore or earth materials or processing ore or earth materials to generate a new end product for commercial gain. ACTIVE also describes facilities where activities may be temporarily or seasonally suspended but are reasonably expected to resume operations in the very near future (next 12 months). CLOSED indicates a facility that had been active at some time during the four year window of consideration, but is now inactive and operations are not expected resume in the near or foreseeable future. Reclamation may be underway or have been completed. The year in which activity ceased is indicated, if known. STANDBY indicates a facility that is being purposefully held in a care and maintenance status with the expectation that operations could be restarted given a more favorable economic or reserve outlook. The year in which that status was affected is indicated, if known. A code in the **Activity Level** field describes the temporal mode of operational activity at a facility that predominated over the four-year interval from 1997 to 2000. A (C) indicates a facility that operated continuously with only brief production interruptions for equipment repair or maintenance. A (I) indicates a facility where production is intermittently interrupted by extended periods of non-production. A (S) indicates a facility where periods of production reoccur on an annual basis and are determined by seasonal factors.

The four deposit-related fields (**Primary Deposit Type, Secondary Deposit Type, Model No 1 and Model No 2**) provide information about the type of deposit(s) being mined. The fields are only applicable for mine site records and are otherwise shaded. Two pairs of fields are available; the first pair identifies the primary or dominant deposit type being mined and the second describes a subordinate type, where applicable and the second pair lists the corresponding model numbers assigned to the respective deposit types. The deposit type terminology and model numbers used follow the naming and numbering conventions introduced by Cox and Singer (1986) and further expanded on by Stoeser and Heran (2000). A deposit type describes the empirical and genetic characteristics that are shared by a population of similar mineral deposits that have a demonstrated affinity for occurring in a specific litho-tectonic environment. (ND) indicates that either a deposit type or model number has not been defined or that a deposit could not be assigned to a specific deposit type.

The Annual Production Commodity fields are used to store production data. They are paired with the Commodity fields. For example, a value in the **Commodity 1** field reflects production for the commodity listed in the Commodity_**1** field, **Commodity 2** production for the commodity in Commodity_**2** field and so on. Annual levels of production are averages and are based on reported production for periods of activity extending back to 1993. Reporting units used are Troy ounces (OZ), short tons (ST) and cubic feet (CUFT). Most of the annual production information reported is limited to facilities operated by investor owned corporations. US corporations are required to file quarterly and annual reports of operations to the Security and Exchange Commission (SEC) and foreign corporation are likewise subject to similar forms of disclosure. A majority of the production information contained in the inventory is derived from SEC reports and their foreign equivalent. Production figures for small operations and sites operated by private corporations are not subject to these disclosure requirements and are generally not available. Production figures obtained from sources other than a operator or owner are treated as estimated (EST) values. (NA) indicates that production figures are not publicly available.

Qualitative estimates of the remaining operational life of a facility are indicated in the **Remaining Yrs Activity** field. These are estimates based on the assumptions that the facility would continue to operate at the same level of activity and that no significant change occurs in economic parameters. The estimates are based on reviews of resource/reserves, company operational projections, and market conditions. A (S) indicates a facility that is expected to close in less than 2 years. A (I) identifies a facility that is expected to remain operational for between 2 and 10 years and a site expected to operate beyond 10 years is indicated with a (L). A site at which the deposit is considered depleted or processing facility is no longer profitable under current economic conditions is coded with a (D). (NA) indicates that there is insufficient information on which to base a judgement.

The **24K Quadrangle Name** field provides a reference to the USGS-1: 24,000 scale topographic quadrangle map that contains the site location point coordinates. Digital raster graphic image control is used to plot all site location points in the inventory. A standardized seven digit alphanumeric nomenclature is used to identify the digital raster graphic image files and stored in the **Drg Identifier** field. The first five digits identify the latitude and longitude of the lower right corner of a one-degree by one-degree cell. That cell is further partitioned into an 8 by 8 grid of 64 7-1/2 by 7-1/2 minute cells. The rows of cells in this grid are labeled “a” through “h” from bottom to top and the columns 1 through 8 from right to left.

The **Comments** field is used to store information that relates to data entered in other fields, but could not be accommodated due to the restrictive entry formatting used. Commonly this field contains qualifying remarks relating to location points, facility activity, productivity, and remaining years of operation.

In addition to the Excel file, the data are also formatted in ArcView shapefiles. The *activesites_idmt.shp* shapefile allows the mine and processing facility locations to be viewed with 7-1/2 minute U.S. Geological Survey topographic digital raster graphic (drg) map coverage registered in background.

Mining Activity Summary

The Idaho and western Montana inventory contains information on 226 sites where mining or processing of natural resource commodities has occurred at some point during the four-year period ending December 31, 2000. Commodities being mined are predominantly mineral resources; however, a few sites at which peat is mined are included. One hundred thirty five sites are located in Idaho and 91 in the areas of Montana west of the 108th meridian. Twenty-eight sites in Idaho and 17 sites in Montana were either in a closed or standby status at the end of the year 2000. One site in Montana, the Stillwater Mining Co’s East Boulder project, was not yet in production by the close of the review period but is expected to begin production in early 2001 and has been included. Thirty-two of the sites are processing or treatment facilities, of which 15 are in Montana and 17 in Idaho. The somewhat lower number of sites in Montana is in part a reflection of a disparity in record keeping between the two states. Records for small sites, less than 5 acres, that in Idaho produce decorative stone, placer gold, clay, etc., are less accessible and less clear about the status of activity. Rectifying ths information shortcoming is a goal of future updates of the inventory.

A brief review of activity in Idaho shows that mine production in Idaho was dominated by industrial mineral commodities, by the end of the year 2000, even when common sand and gravel operations are excluded from consideration. Only 33 out of 135 mine sites listed produced ores valued for their metal content, leaving 102 sites producing industrial or saleable commodities. Of those 33 metal mines, 13 had closed and 6 placed on standby status by the end of the year 2000. Active mines included four significant commercial mines, three underground silver mines and one open pit molybdenum mine, 2 minor surface mines and 9 small seasonally operated gold placer operations of questionable economic viability. Major industrial mineral mines that serve markets reaching beyond the state produce phosphate rock, pumice, perlite, garnet, silica, and dimension stone. Commodities produced for local consumption include decorative stone, clay, limestone, gemstones and peat. In addition, several marginally economic zeolite deposits in southwestern Idaho have drawn sporadic interest and may become economic in the future. Of the 17 processing facilities listed for Idaho, one is closed and two are on standby. The remaining 14 facilities produce bentonitic clay products, cement, fertilizer, phosphorus-based chemicals, lime, industrial sand, and vanadium, silver and gold.

There are 91 sites in Montana in the inventory. Thirty-two sites are valued for the metal content of the ores produced and 59 sites are involved with the production of industrial or saleable commodities. Metals produced include gold, silver, molybdenum, platinum, palladium, copper, lead and zinc. Five of the active metal mines are underground operations, 4 are open pit operations and 13 are placer operations. Of the other nine operations, 6 have closed, 3 are on standby status and the East Boulder project is in the final phase of start-up as an underground operation. There are 36 active sites producing a variety of non-metallic commodities including talc, garnet, vermiculite, dimension stone, limestone, silica, chlorite, gemstones and peat. Major mines whose production serves markets outside of the state include three gold mines, one platinum mine, one copper/molybdenum mine, three talc mines and four limestone quarries. Production from the remaining mines serves local markets and operations tend to be intermittent or seasonal. The mix of major producers is expected to change in the near future with the addition of a vermiculite operation and closure of two of the gold mines within the next 24 months. Eleven of 15 processing facilities are active and produce cement, high-purity talc products, aluminum, platinum group metals, precious and base metals, lime, and limestone. The following paragraphs provide brief discussions of some of the characteristics of the mines and major commodity deposit-types that support current mineral production. This information, when combined with information on market dynamics can provide a basis for formulating short-term development scenarios to go with our resource assessments.

In a regional context, recent gold production has been derived from with two basic types of gold deposits -- placers and a group of igneous intrusion-related deposit types. In the placers, the native gold particulates are mechanically separated from a loose or semi-consolidated matrix. These deposits are attractive to individuals or limited partnerships, as opposed to large companies, because of their smaller size, more simplistic equipment requirements and limited reclamation liability. The small placer operations are for the most part seasonal, disturb less than 5 acres, are owner operated, and, although records are usually not available, annually produce at the rate of a few tens to a few hundred ounces. The intrusion-related gold deposit types are characterized by micron-size gold particles occurring distributed in a network of small veins and (or) pervasive disseminations occurring throughout a large volume of intrusive rock or adjacent host rock. Recovery entails bulk processing of large volumes of low-grade crushed ore, typically containing a few grams per short ton of gold and a few tens of grams of silver, using cyanide solutions to extract the metal. Infrastructure costs are high to very high. Large surface ownership control and moderate to large surface disturbance, depending on whether the ore is mined underground or from a surface open-pit, characterize these operations. They are attractive only to large companies or corporations. Capital costs are high, annual production is in the tens to hundreds of thousands ounce range is required and mining operations usually run year round. The types of mineral deposits that have seen recent production include hot-spring gold, disseminated gold-silver, stockwork gold, sediment-hosted gold, Homestake gold, gold skarns and, to a lesser degree, several types of polymetallic and epithermal vein types. In some cases a mine produces ore from several deposit types at a single site. Due to the passage of a referendum in Montana in 1998 banning the use of cyanide treatment to process ores and the fall of gold prices below $300 per ounce, the number of active major mines in the two state region has declined from 26 in 1997 to 9 at the close of 2000 with 6 mines on standby.

Silver production comes predominantly from polymetallic vein type deposits in the Coeur d'Alene area, where costs and depressed silver prices are partially offset by recovery of by-product base metals. Silver is also produced as a by-product from several of the vein-type gold deposits mentioned above and from two other deposit-types in which copper is the primary metal recovered. The latter include the sediment-hosted Revett-type copper deposit developed at the Troy Mine in northwestern Montana, which is on standby, and the porphyry copper-molybdenum deposit at the Continental Pit near Butte, Montana. The primary silver mines in the Coeur d'Alene area are underground operations and are characterized by large surface area ownership or control of mineral rights. However, surface disturbance usually affects only a small fraction of that surface area with a majority of that utilized for storage of mine tailings and waste rock. The operators are large companies or corporations, capital costs are high, annual production is in the hundreds of thousands to millions ounce range, and these operations run continuously. Three of five primary silver mines, the Sunshine, Lucky Friday and Coeur mines, remain active at the close of the year 2000; however, the Sunshine Mine was operating under bankruptcy court protection. The current market price for silver makes the economic viability of new deposits of equivalent type, size and grade questionable.

Other significant metal producing mining operations include the open pit Thompson Creek molybdenum mine near Clayton, Idaho, the open pit Continental copper/molybdenum mine and the Stillwater underground platinum group metal mine near Nye, Montana. The open pit molybdenum mine produces from a low-fluorine, porphyry molybdenum type deposit (Theodore, 1986) and the open pit copper/molybdenum mine produces from a porphyry copper type deposit (Cox, 1986). Platinum group metals are mined underground from a deposit in the layered ultramafic Stillwater intrusive complex, after which the Stillwater nickel-copper deposit-type (Page, 1986) is named. Large surface area control, significant surface disturbance, significant production, high capital costs, and corporate ownership characterize all three operations. The three mines have operated continuously throughout the 4-year period and are expected to continue into the foreseeable future, barring a decline in the price of molybdenum, which could jeopardize operations at the Idaho site, where ore value is solely dependent on molybdenum grade and price. Mines producing multi-metal valued ores are operationally less sensitive to fluctuations in price of a single metal. The East Boulder project, in the western end of the Stillwater Complex, is expected to come on line in early 2001 in response to a strong market for platinum group metals.

In the industrial mineral sector, phosphate rock is mined at four locations in southeastern Idaho. All produce from the same type of deposit, which is characterized as an "upwelling type phosphate deposit" and described by Mosier (1986a). Phosphate occurs in enriched organic horizons of a marine sedimentary sequence. The mines are open pit operations, involve disturbance of areas of up to several thousand acres each, and had a combined annual average production rate of 6.67 million tons for 1997 through 1999. Phosphate rock is processed at six local sites to produce fertilizer, phosphorus, phosphorus-based chemicals, and vanadium compounds. Concerns raised about high selenium levels present in these ores (Robbins and Carter, 1970; Moyle, 2000) may dampen industry growth until environmental concerns can be resolved.

Talc has been produced at the Yellowstone, Regal and Treasure State surface mines and one underground operation in southwestern Montana during the past four years. The underground mine, the Beaverhead Mine, closed in 1999. The deposits are reported to have a hydrothermal origin (Anderson and others, 1990) for which there is no formal deposit model. Annual production levels are high, reaching a reported 1.4 million short tons for the Yellowstone surface mine in 1999. Areas permitted for surface disturbance and reclamation at two of the current open-pit operations cover between 400 and 600 acres. Recent concerns over the possible cancer-causing effects of asbestiform talc and asbestiform contaminants found in some talc ores were dispelled after review by the National Institute on Enviromental Health Science. Any lingering health doubts are likely to prompt an increase in demand for high-purity Montana talc, which is virtually free of any asbestiform contamination.

A variety of gemstones are currently being produced within the two states. Industrial- and gem-grade garnet occurs in placer-type deposits at five sites in northern Idaho and two in southwestern Montana. Industrial-grade garnet, used in large part for abrasive purposes, is recovered at six sites, four in Idaho and two in Montana. The Idaho sites occur clustered in close proximity to one another on tributary drainages of the St. Maries and Potlatch Rivers and are intermittently operated by one company, Western Garnet International. From 1997 through 2000, the four permitted areas of disturbance in Idaho covered a combined 626 acres with individual sites ranging between 15 and nearly 276 acres. Annual production of abrasive grade garnet from the area averaged 23,500 tons. The two Montana sites are large placer deposits that are currently categorized as standby, due to transfers in ownership and economic uncertainties. Production has been minimal during the last four years. The supervised collection of gem quality garnet occurs at only one site in Idaho, which is operated on a seasonal basis by the U.S. Forest Service as a fee site in the St. Joe National Forest in Latah County. Informal collecting occurs at numerous sites in northern Idaho and southwestern Montana, none of which are included in the inventory.

The inventory lists 21 permitted sites at which sapphires, opal, jasper, and quartz crystals are produced from both placer and lode deposits. The operations are all characteristically small enterprises, operated by local individuals, partnerships, companies or co-operatives. Surface disturbance is less than 5 acres, costs are low, and annual production is small and usually proprietary. Two companies, American Gem and Gem River, and a co-operative association, Sapphire Village Permit Holders, recover sapphires, from four placer sites in Montana. Two companies mine sapphires at lode sites west of Lewistown, Montana. Opal and gem grade jasper are principally found in two localities in Idaho, in Clark and Owyhee Counties. At both occurrences the gemstone material fill fractures, vugs and vesicules in volcanic flows. Quartz crystals are recovered from a placer deposit at Crystal Park, Montana, which is operated by a not-for-profit gem and mineral organization.

A large number of the commercial operations listed in the inventory produce a variety of commodities that occur in stratified deposits, which are mined because they possess some unique natural property that enhances their commercial value beyond that of simple crushed stone. The processing that follows extraction is generally of a physical nature that alters the shape, size or moisture content of the mined material. Resources included in this group are limestone, quartzite, travertine, volcanic and pyroclastic rock, peat, various clays, and zeolite. Examples of the end products include dimension and building stones, decorative stones, abrasives, lightweight fillers, soil amendments, bentonite, and deodorizers. An attempt has been made in this inventory to distinguish between the crushed forms of a commodity, which are simply used to fill space, versus those that acquire added aesthetic value after processing or serve a specialized need that increases their commercial value. For example, sites producing crushed limestone used as an aggregate in concrete are excluded, whereas those producing crushed limestone valued for its decorative appearance are included. This distinction is not always easily recognized and may be the cause of errors in the inventory. These sites are predominantly small in size and annual production. There are, however, several exceptions. Pumice, from deposits associated with pyroclastic flows in southern Idaho near Malad and Idaho Falls, is used as a lightweight aggregate in building block. There are also deposits of quartzite near Oakley and Clayton, Idaho and travertine near Swan Valley, Idaho, that have unique qualities that make them marketable as a building and dimension stone. These operations are of moderate size and run intermittently in response to the fluctuating needs of the building industry.

A second group of commodities producing from stratified deposits are valued for their compositional properties. Falling in to this category are limestones used in the production of cement or lime, limestone and quartzite used as a fluxing agent in the manufacture of other end products, pumice for abrasive purposes, and perlite valued for its expansive properties. These deposits are characterized by the high purity of the raw commodity. The 17 active operations are generally moderate to large in size, run intermittently, and are owned by the end user. The larger producers serve the phosphate, cement and lime industries and have estimated annual production ranging between several hundred thousand and one million short tons. Perlite in deposits associated with pyroclastic flows in southern Idaho is valued for its unique expansive property when heat-treated and used in construction and agricultural applications. The Oneida Mine near Malad, Idaho has an estimated annual production in excess of 10,000 short tons.

In large part, deposits sourcing industrial mineral commodities have not been completely modeled in terms of their descriptive, genetic, grade and tonnage characteristics. There are few published descriptive models and fewer grade and tonnage models. The lone exception relevant to this inventory is the phosphate rock deposits in Idaho. These deposits are described in a set of "upwelling type phosphate deposits" models (Mosier, 1986a,b) that provide the descriptive and the grade and tonnage characteristics on which the potential for new deposits of this type could be quantitatively assessed. Model numbers cited in the inventory for other sedimentary-type deposits reference descriptive models published by Orris and Bliss (1991). However, the generic character of these models and preliminary nature of the comparable grade and tonnage models (Orris and Bliss, 1992) prohibit their use for assessment purposes. On the other hand, nearly all of the metallic commodity deposit-types listed in the inventory have been formally modeled by deposit-type with one glaring exception being the Coeur d'Alene type polymetallic vein deposits, which do not fit the polymetallic vein deposit-type modeled by Cox (1986). The published descriptive and grade and tonnage models in Cox and Singer (1986) and Bliss (1992) provide a basis on which the deposit potential for these deposit types can be assessed. In some cases the credibility of those assessments could be enhanced through the use of grade and tonnage models that have been modified to more closely reflect the character of the regional deposit populations. Economic filters can then be used to define what portion of that population would remain viable development targets today. The inventory supports that effort through the identification of those deposit types that are potentially viable commodity sources and provides information relating to deposit size, production rates and surficial impacts.

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