Digital database of mining-related features at selected historic and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho

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U.S. Geological Survey Open-File Report 01-142
Digital Database, Online version 1.0

2001

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

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CONTENTS

CONTENTS ................................................................................................................................. 2
ABSTRACT ...................................................................................................................................... 4
INTRODUCTION .......................................................................................................................... 5
  Location, Background, and Purpose ......................................................................................... 5
  Previous Studies ...................................................................................................................... 5
METHODOLOGY ........................................................................................................................... 6
  Spatial Database ..................................................................................................................... 6
  Data Problems ......................................................................................................................... 7
  Reclamation ............................................................................................................................ 7
MINE SPECIFIC DESCRIPTIONS .................................................................................................. 8
  Ballard Mine ............................................................................................................................ 8
  Champ Mine/Champ Mine Extension ...................................................................................... 9
  Conda/Woodall Mountain/Trail Canyon Mines ..................................................................... 9
  Diamond Gulch Mine ............................................................................................................ 9
  Dry Valley Mine .................................................................................................................... 9
  Enoch Valley Mine ................................................................................................................. 9
  Gay Mine ............................................................................................................................... 10
  Georgetown Canyon Mine .................................................................................................... 10
  Henry Mine ........................................................................................................................... 10
  Home Canyon Mine ............................................................................................................. 10
  Lanes Creek Mine .................................................................................................................. 10
  Maybe Canyon Mine (North Maybe Canyon, South Maybe Canyon, North Maybe Canyon Extension) .................................................................................. 11
  Mountain Fuel Mine ............................................................................................................ 11
  Rasmussen Ridge Mine ........................................................................................................... 11
  Rattlesnake Mine .................................................................................................................. 11
  Smoky Canyon Mine ............................................................................................................ 11
  Waterloo Mine ....................................................................................................................... 11
  Wooley Valley Mine [Mill Canyon (Unit # 4), Little Long Valley (Unit # 3), and Blackfoot Narrows (Unit #1)] ........................................................................ 12
SUMMARY OF SPATIAL COVERAGE ......................................................................................... 12
ACKNOWLEDGEMENTS ............................................................................................................. 22
REFERENCES CITED .................................................................................................................. 22
APPENDIX A – DIGITAL DOCUMENTATION ............................................................................. 25
  Introduction ............................................................................................................................ 25
  GIS Documentation ............................................................................................................... 26
  Areal Features ....................................................................................................................... 26
  Polygon Feature Attribute Table Definitions ......................................................................... 27
  Descriptions of Revised Mine Features ................................................................................ 30
  Linear Features ...................................................................................................................... 33
  Source Attributes .................................................................................................................. 34
  Obtaining Digital Data .......................................................................................................... 34
APPENDIX B – LIST OF DIGITAL FILES .................................................................................... 36
APPENDIX C - METADATA .......................................................................................................... 37
FIGURES

Figure 1. Generalized map of the southeast Idaho phosphate resource area showing the 19 mine sites included in the spatial database................................................................. 14
Figure 2. Chart of phosphate mining-related disturbed lands, ranked by total area of surface disturbance, in southeastern Idaho................................................................. 16
Figure 3. Map of phosphate mining-related surface disturbance at the Gay mine, Bingham, Bannock, and Caribou Counties, Idaho........................................................................ 17
Figure 4. Map of phosphate mining-related surface disturbance at the Conda and Trail Canyon mines, Caribou County, Idaho........................................................................ 18
Figure 5. Map of phosphate mining-related surface disturbance at the Smoky Canyon mine, Caribou County, Idaho.............................................................................. 19
Figure 6. Map of phosphate mining-related surface disturbance at selected mines in the Blackfoot River watershed, Idaho........................................................................ 20
Figure 7. Map of phosphate mining-related surface disturbance at the Wooley Valley mine and Angus Creek watershed, Caribou County, Idaho................................. 21

TABLES

Table 1. Mine feature acreage for 19 mines and total for southeastern Idaho phosphate resource area.......................................................................................................................... 15
Table A-1. Relationship between feature attribute table and lookup table for references........ 26
Table A-2. Index of original mine features from all data sources and revised mine features... 28
Table A-3. List of revised mine features............................................................................. 30
Table A-4. Descriptions of linetype used in the phosmine.aat........................................... 33
ABSTRACT

This report provides a description of data and processes used to produce a spatial database that delineates mining-related features in areas of historic and active phosphate mining in the core of the southeastern Idaho phosphate resource area. The data have varying degrees of accuracy and attribution detail. Classification of areas by type of mining-related activity at active mines is generally detailed; however, the spatial coverage does not differentiate mining-related surface disturbance features at many of the closed or inactive mines.

Nineteen phosphate mine sites are included in the study. A total of 5,728 hc (14,154 ac), or more than 57 km$^2$ (22 mi$^2$), of phosphate mining-related surface disturbance are documented in the spatial coverage of the core of the southeast Idaho phosphate resource area. The study includes 4 active phosphate mines - Dry Valley, Enoch Valley, Rasmussen Ridge, and Smoky Canyon - and 15 historic phosphate mines - Ballard, Champ, Conda, Diamond Gulch, Gay, Georgetown Canyon, Henry, Home Canyon, Lanes Creek, Maybe Canyon, Mountain Fuel, Trail Canyon, Rattlesnake Canyon, Waterloo, and Wooley Valley. Spatial data on the inactive historic mines is relatively up-to-date; however, spatially described areas for active mines are based on digital maps prepared in early 1999. The inactive Gay mine has the largest total area of disturbance, 1,917 hc (4,736 ac) or about 19 km$^2$ (7.4 mi$^2$). It encompasses over three times the disturbance area of the next largest mine, the Conda mine with 607 hc (1,504 ac), and it is nearly four times the area of the Smoky Canyon mine, the largest of the active mines with 497 hc (1,228 ac).

The wide range of phosphate mining-related surface disturbance features (approximately 80) were reduced to 13 types or features used in this study—adit and pit, backfilled mine pit, facilities, mine pit, ore stockpile, railroad, road, sediment catchment, tailings or tailings pond, topsoil stockpile, water reservoir, and disturbed land (undifferentiated). In summary, the spatial coverage includes polygons totaling 1,114 hc (2,753 ac) of mine pits, 272 hc (671 ac) of backfilled mine pits, 1,570 hc (3,880 ac) of waste dumps, 26 hc (64 ac) of ore stockpiles, and 44 hc (110 ac) of tailings or tailings ponds. Areas of undifferentiated phosphate mining-related land disturbances, called “disturbed land,” total 2,176 (5,377 ac) or nearly 21.8 km$^2$ (8.4 mi$^2$). No determination has been made as to status of reclamation on these lands. Subsequent site-specific studies to delineate distinct mine features will allow modification of this preliminary spatial database.
INTRODUCTION

Location, Background, and Purpose

The U.S. Geological Survey (USGS) has been studying the Permian Phosphoria Formation and related rock units in southeastern Idaho and the Western Phosphate Field throughout much of the twentieth century. In response to a request by the Bureau of Land Management (BLM), a new series of resource, geological, and geoenvironmental studies was undertaken by the USGS in 1998. Present studies, conducted under the Western U.S. Phosphate Project, consist of integrated, multidisciplinary research directed toward (1) resource and reserve estimation of phosphate in selected 7.5-minute quadrangles; (2) element residence, mineralogical, and petrochemical characteristics; (3) mobilization and reaction pathways, transport, and fate of potentially toxic elements associated with the occurrence, development, and societal use of phosphate; (4) geophysical signatures; and (5) improving understanding of depositional environment. To carry out these studies, the USGS has formed collaborative research with the BLM and the U.S. Forest Service (FS), which are responsible for land management and resource conservation on public lands, and with five companies currently leasing or developing phosphate resources in southeast Idaho: Agrium U.S. Inc. (Rasmussen Ridge mine), Astaris LLC (formerly FMC Corporation) (Dry Valley mine), J.R. Simplot Company (Smoky Canyon mine), Rhodia Inc. (Wooley Valley mine – inactive), and Monsanto (formerly Solutia Inc.) (Enoch Valley mine). Because raw data acquired during the project require time to interpret, the data are released in open-file reports for prompt availability to other scientists. Open-file reports associated with this series of resource and geoenvironmental studies are submitted to the Federal and industry collaborators for comment; however, the USGS is solely responsible for the contents of the reports.

One of the purposes of the Western U.S. Phosphate Project is to identify lands in southeastern Idaho affected by phosphate mining-related activities, and delineate mining-related features at the mines utilizing a geographic information system (GIS). A geospatial database of phosphate-mining related features provides a digital foundation for resource studies and monitoring the progress of regional geoenvironmental studies as well as analysis and interpretation of the results. Although the digital data are dated, particularly in areas of active mining and reclamation, the database can be periodically updated as needed.

Previous Studies

A spatially registered description of the phosphate mines in southeastern Idaho has not been published or released previous to this work. Several Mineral Investigation Resource Maps published in the early 1980s show mine pit boundaries (Derkey and others, 1983-1985; Palmer and others, 1985); however, these maps only show the boundaries as of the time the maps were created. Considerable mining has occurred since that time, some within the area covered by previously published maps.

Although none of the historic literature applies directly to work reported here, mention of selected references is essential. Pioneering workers such as Mansfield (1918, 1920, 1927, 1933), McKelvey and others (1953a, 1953b, 1959, 1967), Sheldon (1963, 1989), Service and Popoff
(1964), Service (1966, 1967), and Gulbrandsen and Krier (1980), concentrated predominantly on
delineation and evaluation of phosphate resources and on deposit origin. Research in recent
decades has produced significant literature by Gulbrandsen (1966), Piper (1974), Desborough
(1977), Altschuler (1980) and others on the unusual chemistry of the Meade Peak Phosphatic
Shale Member, the primary source of phosphate ore. Phosphate deposit origin, demand, and
commodity studies are reported in Herring (1995), Herring and Fantel (1993), and Herring and

**METHODOLOGY**

Spatial Database

Three primary types of spatial data were collected and utilized to verify the location of selected
mine boundaries and features: Computer-Aided Drawing (CAD) files provided by phosphate
mining companies; hard copy maps provided by a variety of agencies and companies; and USGS
Digital Orthophoto Quarter Quadrangles (DOQQs). Other types of information used include
color aerial photographs and the locations of control points identified using a field-portable
Rockwell PLGR (Precision Lightweight GPS Receiver) Geographic Positioning System (GPS)
unit during field visits. Spatial data were compiled using ArcView and ArcInfo software.

J.R. Simplot, Monsanto, Astaris LLC, and Agrium provided CAD files showing the status of
mining at the end of 1998 for the four active mines in southeast Idaho, respectively, the Smoky
Canyon, Enoch Valley, Dry Valley, and Rasmussen Ridge mines. In addition, J.R. Simplot
provided a CAD drawing of the Conda/Woodall Mountain mine, Agrium provided hard copy
mine maps for the Mountain Fuel, Champ, and Maybe Canyon mines, and Monsanto staff at the
Enoch Valley mine provided hard copy maps of the Ballard mine. In order to identify and
delineate older mined lands, DOQQ coverage was obtained for southeast Idaho. The DOQQs
were created from black and white aerial photography flown in 1992 and 1993. Since DOQQs
are georegistered, they were used to map mined areas for which no other digital data were
available. Additionally, color and color infrared aerial photographs flown in the 1970s, 1980s
and 1990s were used to identify and delineate mining-related features. Mapping of mine
boundaries and features was accomplished with a mouse employing on-screen digitizing in
ArcView 3.2 and ArcInfo. Where available, color stereo photo pairs were used to interpret
information that could not be clearly distinguished on the DOQQs.

Despite the fact that DOQQs are spatially registered, additional processing was necessary to
transform other data into spatially registered digital format. CAD files were obtained both in
Drawing Interchange Format (DXF) and as AutoCad drawing (.dwg) files. Company surveying
for the CAD files was based on local mine grids. Idaho Stateplane East projection was used for
most of the drawings. ArcInfo was used to convert the CAD files to Arc format using DXFARC
command. Control points used to transform the files varied with the data supplied. For CAD
files that had latitude/longitude locations, those points were used to transform the CAD drawings
to ArcInfo spatial databases. Most of the files and hard copy maps had only a Public Land
Survey (PLS) grid for spatial control. The PLS grid was used to transform the data to a spatially
registered coverage. For this process, a PLS ArcInfo coverage of Idaho, obtained from Idaho
Department of Water Resources, was used to create a tic file. Section corners were converted to tics and used for the transforms. Coverages were then attributed with information supplied by the mining companies. The resolution of the PLS coverage is 1:100,000.

Mine features on paper copies of maps obtained from Agrium and the Bureau of Indian Affairs (BIA) were digitized using ArcInfo. Latitude-longitude control points were not present on the maps, so section corners were used to transform the data, similar to the method used for the CAD drawings.

Individual mine coverages were combined into a single coverage for the region. Since the mining companies used a variety of names for similar mine features, revised feature names were assigned to groups or classes of mine features in order to apply a simple common terminology to all disturbed land. Thus, in addition to area (m$^2$) and perimeter (m), seven items have been added to the polygon feature attribute table: source, mine name, original feature, date, feature (assigned classification), hectares (hc), and acres (ac). Items reported in the feature attribute table, as well as a list of original mine features shown on the phosphate company maps, are described in Appendix A.

Data Problems

Several data problems were encountered. Most of the CAD files did not have a perfect correspondence to the disturbed area visible on the DOQQs. Minor changes were made in some areas to correct specific deficiencies, but no major revisions of the polygons were made. A problem encountered in digitizing from black and white DOQQs was the difficulty of distinguishing areas of re-vegetated mine waste from undisturbed land. This was overcome for many of the mine sites by using stereo pairs of color aerial photographs, since recent reclamation commonly applied standard vegetative mixes that exhibit a color response that contrasts with the surrounding natural vegetation. In areas that predate modern reclamation efforts, waste disposal areas may not be obvious, even on color photographs, due to sloughing and natural re-vegetation. In this and similar cases, the overall mining disturbed area, or polygon, is undifferentiated and is assigned as “disturbed land” (see Appendix A). The authors attempted to develop a data set of “reclaimed lands” in the database of mine features; however, several problems preclude inclusion of such data at this time (see “Reclamation” below).

Reclamation

Reclamation of mined lands has been a standard practice for companies operating phosphate mines in Idaho since the 1970’s. In fact, phosphate mining and processing companies operating in southeastern Idaho have received numerous awards for their reclamation efforts over the last 25 years.

Reclamation standards developed by the land managing agencies and the companies have changed over time in response both to regulatory development and as knowledge and experience have been gained. Consequently, reclamation procedures are in a constant state of flux. Because our understanding of the ecosystem is evolving, even the application of state-of-the-art mining and reclamation standards have resulted in unexpected impacts. Much of this is due to an incomplete understanding of the geologic characteristics of the rock and how rocks are affected
by ground and surface waters as well as plant nutrition needs. In response to the lack of understanding of the interaction of phosphatic rock and shale with water and biota, other scientists involved in the Western U.S. Phosphate project are studying these relationships in order to provide better guidance for disposal of waste rock from phosphate production.

Several difficulties culminated in the decision not to include a reclamation data set in this first-generation GIS coverage. First, there is the question of “what constitutes reclamation?” As noted above, standards changed over time. Companies operating before 1970 were commonly released from lease liability with little or no requirements for re-grading, reseeding, or backfilling pits; however, these lands may be considered as reclaimed. As various laws and regulations developed, mining and reclamation practices were modified to address such conditions resulting in much higher standards for today’s operators. The issue of land ownership also affects reclamation. Phosphate resources occur on Federal, State, and private lands, and reclamation standards of the various land administrators and owners may not be consistent. There is also a problem with reliability and consistency of available data. Digital and hard-copy maps acquired from different sources varied considerably in reclamation classifications. Furthermore, active mining post-dated aerial photo coverage. Even at older mines (e.g. Lanes Creek), some reclamation activity has occurred in the nine years since regional aerial photo coverage was taken.

Reclamation also crosscuts mining features. To capture reclamation status would entail delineation of features that do not necessarily coincide with mining features and are best captured in a different GIS product.

**MINE SPECIFIC DESCRIPTIONS**

Specific mines included in the ArcInfo coverage provided with this report are discussed below in alphabetical order. Data attribute quality varies considerably, as only limited time was available for field checking. Information on time intervals of mine operations was obtained from Lee (2000). A detailed description of the mining history of the phosphate mines listed below can be found in Lee’s report.

**Ballard Mine**

The Ballard mine opened in 1952 and ceased operation in 1969 (Lee, 2000). Two mylar copies of mine maps were obtained from Enoch Valley mine staff, Monsanto Company. The maps contained an outline of the mine area disturbed by mining; however, the boundaries on the two maps did not agree. For this reason, it was decided to digitize the disturbance from DOQQs created using 1992 photography. Digitizing was conducted on screen in ArcView 3.2. Color aerial photographs and information collected during a 1999 site visit were used to adjust the boundaries and to delineate specific mine features.
Champ Mine/Champ Mine Extension

Mining at the Champ mine and Champ mine extension began in 1982 and was completed in 1985 (Lee, 2000). Mine boundaries and features were digitized from a 1994 reclamation map for the Champ/Champ mine extension provided by Agrium U.S. Inc. Adjustments to boundaries and features were accomplished using color aerial photographs and information collected during a 1999 site visit.

Conda/Woodall Mountain/Trail Canyon Mines

Mining at the Conda mine, including Woodall Mountain, occurred between 1920 and 1984 (Lee, 2000). Underground methods were used until 1956, and surface stripping was phased in beginning in 1952 (Lee, 2000). J.R. Simplot Company provided a DXF file that detailed most activity in this area through 1998. Not included in the file was the make-up water pond at the Conda mine and the Trail Canyon mine. These features were digitized in ArcView 3.2 from DOQQs. Delineation of some mine features was supplemented by using color aerial photography.

Kerr McGee’s adjoining limestone mine was also digitized and included in the current coverage; however, the open pit disturbance area is not included in the summary statistics. The mine was included because limestone from this mine was used in vanadium recovery from ferrophosphorous slag (highly reduced iron-phosphorous waste).

Diamond Gulch Mine

Diamond Gulch was mined in 1960 (Lee, 2000). The outline of the mined area was digitized from DOQQs using ArcView 3.2 supplemented by a site visit in 1999. Due to the complex nature of strip mining, waste disposal, and reclamation at this site, no attempt was made to delineate individual features.

Dry Valley Mine

Minor production from the Dry Valley Mine reportedly occurred in 1971 for testing purposes. Full production began in 1992, and the mine is presently in operation (Lee, 2000). Astaris LLC provided a DXF file and a hard copy map outlining mining areas and specific features as of the end of 1998.

Enoch Valley Mine

The Enoch Valley mine began production in 1989, and it remains in operation (Lee, 2000). Monsanto provided a DXF file and a hard copy map outlining mining areas and specific features as of the end of 1998. Map boundaries between the Enoch Valley mine DXF map and the adjacent Rasmussen Ridge mine DXF map did not match. Modifications were made to the road that connects the two mines.
Gay Mine

The Gay mine, located on the Fort Hall Reservation of the Shoshone-Bannock Tribes, operated from 1946 to 1993 (Lee, 2000). The BIA provided hard copy maps; a mine panel map as of December 1990 and a reclamation map as of 1989. The mine panel map was digitized, and additional land affected by the mining operation was digitized from DOQQs created from aerial photographs taken in July 1992. The hard copy map of mining panels did not correspond well to mined areas visible on the DOQQs; therefore, most of the mine pits and backfilled mine pits are included in the category of disturbed lands. Also included in the disturbed lands category are more than 50 mill shale piles stockpiled by the mine operators. Mill shales are composed of subgrade phosphatic shales that generally range in grade from 14 to 18 percent $P_2O_5$. These materials were stockpiled in anticipation of their potential use in direct fertilizer applications. Since mining was not completed until 1993, it is possible that some of the areas impacted by mining are not delineated in this coverage.

Georgetown Canyon Mine

Georgetown Canyon was mined between 1958 and 1964 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 supplemented by color and color infrared aerial photography, and information collected during site visits in 1999 and 2000. In addition to alluvium, disturbed lands in the valley bottom may also be underlain by both mine and processing wastes, including slag.

Henry Mine

The Henry mine operated between 1969 and 1989 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 with supplemental information from color aerial photography and a site visit in 1999. Much of the historic mine area has been reclaimed; therefore, in some areas, disturbed lands are difficult to delineate on the DOQQs.

Home Canyon Mine

Mining at the Home Canyon mine, entirely by underground methods, occurred from 1920 to 1924 (Lee, 2000). The area encompassed by the main adit and dump was digitized from a DOQQ using ArcView v. 3.2 supplemented by information gathered during site visits in 1999 and 2000.

Lanes Creek Mine

Mining began at the Lanes Creek mine in 1978 and continued until at least 1988 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 with modifications based on a site visit in 1999. The mine is presently (2000) undergoing reclamation.
Maybe Canyon Mine (North Maybe Canyon, South Maybe Canyon, North Maybe Canyon Extension)

Maybe Canyon mine operated between 1965 and 1993 (Lee, 2000). Features in the mined area were digitized from two 1995 reclamation maps of the North Maybe and South Maybe mines provided by Agrium U.S. Inc. Adjustments to the delineated features were accomplished by using DOQQs in ArcView 3.2 with supplemental information collected during a site visit in 1999. An adit and dump located between the North and South Maybe Canyon mines, along with a settling pond at the mouth of Maybe Canyon, were digitized from DOQQs.

Mountain Fuel Mine

Mountain Fuel mine operated briefly in 1966-1967; however no ore was produced at that time. Operations began again in 1985, and phosphate was produced until 1993 when the mine closed (Lee, 2000). Features in the mined area were digitized from a 1995 reclamation map of the Mountain Fuel mine created by Nu-West Mining, Inc. and provided by Agrium U.S. Inc. Adjustments to the delineated features were accomplished by using DOQQs in ArcView 3.2 with supplemental information collected during a site visit in 1999.

Rasmussen Ridge Mine

Mining at the Rasmussen Ridge mine began in 1991, and it remains in operation (Lee, 2000). Agrium U.S. Inc. provided a DXF file that detailed mining-related features in this area through 1998. Map boundaries between the DXF maps of the Rasmussen Ridge mine and the adjacent Enoch Valley mine did not match and were modified. Some polygons were modified to match the disturbed area visible on the DOQQs made from 1992 aerial photography.

Rattlesnake Mine

Limited mining was conducted at the Rattlesnake mine, entirely by underground methods, in early 1920 (Lee, 2000). The area encompassed by the main adit and dump was digitized from a DOQQ using ArcView v. 3.2 supplemented by information gathered during brief site visits in 2000. The workings were mostly hidden under a canopy of trees, and GPS measurements were used to help define the polygon made for this property.

Smoky Canyon Mine

The Smoky Canyon mine began production in 1984, and it is still in operation (Lee, 2000). The J.R. Simplot Company provided a DXF file that detailed mining-related features in this area through 1998. The polygon shapes were modified only slightly.

Waterloo Mine

Phosphate was mined by underground methods at the Waterloo mine between 1907 and the late 1920’s and by open-pit methods between 1945 and 1960 (Lee, 2000). The disturbed area was mapped from DOQQs using ArcView 3.2 with supplemental information collected during a site visit in 1999. Due to the size and complexity of the site and the lack of a mine map, no attempt
was made to delineate individual mine features. The mined area is now a landfill operated and owned by Bear Lake County and is undergoing additional changes.

**Wooley Valley Mine [Mill Canyon (Unit # 4), Little Long Valley (Unit # 3), and Blackfoot Narrows (Unit #1)]**

The Wooley Valley mine operated between 1955 and 1989 (Lee, 2000). Disturbed areas were mapped and delineated from DOQQs using ArcView 3.2 with supplemental input from color aerial photographs and information collected during site visits in 1999 and 2000. Due to reclamation efforts on selected parts of the historic mine, disturbed lands features are difficult to delineate on the DOQQs.

**SUMMARY OF SPATIAL COVERAGE**

Seventeen of the nineteen sites included in this spatial database of phosphate mines in the core of the southeastern Idaho phosphate resource area were mined predominantly by open pit methods, the standard phosphate mining practice since the 1940s. Open pit phosphate mines that operated over the last 50 years in southeastern Idaho are typically characterized by large open pits, up to 90 to 120 m (300 to 400 ft) deep, voluminous waste dumps that may contain as much as 23 million m³ (30 million yd³) or more, and major support facilities and transportation systems (see Appendix A). Such a mine complex may occupy an area ranging from a few hectares to several square kilometers. Land disturbances associated with underground mines typically cover a few hectares or less. Three small underground mine sites are included in the spatial database. One of these is part of the Maybe Canyon mine complex, lying in Maybe Canyon between the North and South Maybe pits. The Rattlesnake and Home Canyon mines were underground operations. A major part of the Waterloo mine, and the Conda mine prior to 1956, was underground as well (Lee, 2000).

Figure 1 is a generalized map of the southeast Idaho phosphate resource area showing the 19 mine sites included in the spatial database, and Table 1 summarizes the acreage of the various mine features at each of the sites. The spatial coverage of phosphate mining-related surface disturbance in southeastern Idaho covers an area from the Gay mine northeast of Pocatello to the Waterloo mine near Montpelier and from the Conda mine near Soda Springs east to the Smoky Canyon mine. Several predominantly underground mine sites located to the south, between Montpelier and the Utah border, and north to the Montana border, are not included in this coverage. The 19 mines in the area studied include a total of 5,728 hc (14,154 ac) or more than 57 km² (22 mi²). Figure 2 charts the relative size of land disturbance of the 19 mine sites. The Gay mine (figure 3) has by far the largest total area of disturbance, 1,917 hc (4,736 ac) or about 19 km² (7.4 mi²). It encompasses over three times the disturbance area of the next largest mine, the Conda mine (figure 4) with 607 hc (1,504 ac), and it is nearly four times the area of the Smoky Canyon mine (figure 5), the largest of the active mines with 497 hc (1228 ac). Figure 6 shows a cluster of mines in the core of the Blackfoot River watershed, and Figure 7 is a map of the Wooley Valley mine and Angus Creek drainage, the location of on-going site-specific studies by USGS scientists also participating in the Western U.S. Phosphate project.
The spatial coverage includes mine feature polygons totaling 1,114 ha (2,753 acres) of mine pits, 272 ha (671 acres) of backfilled mine pits, 1,570 ha (3,880 acres) of waste dumps, 26 ha (64 acres) of ore stockpiles, and 44 ha (110 acres) of tailings or tailings ponds (Table 1). The cumulative area of lands classed as “disturbed land” (undifferentiated), 2,176 ha (5,377 acres), may include any or all of the full range of mine features, especially mine pits, backfilled mine pits, waste dumps, and facilities. “Disturbed land” accounts for the largest area of phosphate mining-related disturbance, followed by waste dumps and mine pits. Subsequent site-specific studies to delineate distinct mine features will allow modification of this preliminary spatial database.
Figure 1. Generalized map of the southeast Idaho phosphate resource area showing the 19 mine sites included in the spatial database.
Table 1. Mine feature acreage for 19 mines and total for southeastern Idaho phosphate resource area.

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<td>0.002</td>
<td>0.4</td>
<td>0.0007</td>
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</tr>
</tbody>
</table>

= active mine

723 | 0.6 | 1114 | 272 | 1570 | 26 | 44 | 2176 | 65 | 455 | 5 | 5728 | 57.3 | 14154 | 22.1


Figure 2. Chart of phosphate mining-related disturbed lands, ranked by total area of surface disturbance, in southeastern Idaho.
Figure 3. Map of phosphate mining-related surface disturbance at the Gay mine, Bingham, Bannock, and Caribou Counties, Idaho.
Figure 4. Map of phosphate mining-related surface disturbance at the Conda and Trail Canyon mines, Caribou County, Idaho.
Figure 5. Map of phosphate mining-related surface disturbance at the Smoky Canyon mine, Caribou County, Idaho.
Figure 6. Map of phosphate mining-related surface disturbance at selected mines in the Blackfoot River watershed, Idaho.
Figure 7. Map of phosphate mining-related surface disturbance at the Wooley Valley mine and Angus Creek watershed, Caribou County, Idaho.
ACKNOWLEDGEMENTS

The authors appreciate the assistance of the numerous phosphate mining industry and land management agency staff that provided input to this product. Susan Nash and Larry Raymond, J.R. Simplot Company, Steve Smith and Mike Vice, Monsanto, Monty Johnson, Alan Haslam, Dan Kline, and Randy Lowe, Agrium U.S. Inc., and Scott Lusty and Jim Williams, Astaris LLC, contributed time or supplied digital and hard copy maps that were used to create the ArcInfo coverage included in this report. Sam Hernandez, BIA, Fort Hall, ID, provided copies of mine maps, aerial photographs and a tour of the Gay mine. Bill Lee, Peter Oberlindacher, and Jeff Cundick, BLM, and Jeff Jones, USFS, provided information and maps of phosphate mining activity in southeastern Idaho. Eastern Washington University students Mary Carlson and Zack McInelly digitized several of the mined land maps.

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Derkey, P.D., Paul, Ken, Johnston, Bea, Palmer, Pamela, Zemanek, Alexandra, Pakourbayat, Mahasti, and Hovland, R.D., 1985, Maps showing selected geology and phosphate resources of the Snowdrift Mountain Quadrangle, Bear Lake and Caribou Counties,


---, 1967, The Phosphoria, Park City, and Shedhorn Formations in western phosphate field, in Anatomy of the western phosphate field, a guide to the geologic occurrence, exploration


APPENDIX A – DIGITAL DOCUMENTATION

Introduction

As discussed in the ‘methodology’ section of this report, the digital map of the core of the southeastern Idaho phosphate resource area includes input on many different mines from a variety of sources: digital maps, hard copy maps, and reports from mining companies and land management agencies; DOQQs; color and infrared aerial photos; and others. Sources of data varied not only by type, but also date. For instance, digital data provided by the companies was current as of late 1998 or early 1999, whereas, DOQQs were made from aerial photographs taken in 1992 and 1993. Data input included many different terms for similar mine-related disturbances, or features, shown on the map as polygons. Some data delineated land by reclamation status while others described mine status. In order to reduce the number of polygon or feature types, the authors developed a simplified terminology scheme based on mining related features. For instance, the terms ore stockpile, ore stockpile residue, and stockpile area, used variably by different companies, are combined into one term, ore stockpile. The original list of 80 polygons, or mine features, are presented in table A-1, and the 13 revised polygon classes, or mine features, are presented in table A-2. Both the original and revised lists include a polygon labeled as “undisturbed” to represent polygons enclosed or surrounded by mine disturbance features.
GIS Documentation
The digital map of mining-related features includes both a polygon attribute table (*phosmine.pat*) and an arc attribute table (*phosmine.aat*) that are related to a table of source information (*phosmine.ref*) by the SOURCE item (Table A-1).

Table A-1. Relationships between feature attribute tables and lookup table, for the PHOSMINE dataset.

Areal Features

Descriptions of user defined items added in the polygon attribute table, *PHOSMINE.PAT*, are:

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<tr>
<th>ITEM NAME</th>
<th>ITEM TYPE</th>
<th>ITEM LENGTH</th>
<th>ATTRIBUTE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>source</td>
<td>integer</td>
<td>4</td>
<td>Numeric code or abbreviation of the source information. (This item and related information occur in the PHOSMINE.REF file.)</td>
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<tr>
<td>mine_name</td>
<td>character</td>
<td>50</td>
<td>Name of mines</td>
</tr>
<tr>
<td>orig_feat</td>
<td>character</td>
<td>50</td>
<td>Original name given to polygon feature</td>
</tr>
<tr>
<td>date</td>
<td>character</td>
<td>50</td>
<td>Date of information</td>
</tr>
<tr>
<td>feature</td>
<td>character</td>
<td>50</td>
<td>Name assigned to feature for this report</td>
</tr>
<tr>
<td>acres</td>
<td>number</td>
<td>16.2</td>
<td>Acreage determined by multiplying the area item by 0.0002471</td>
</tr>
<tr>
<td>hectares</td>
<td>number</td>
<td>16.2</td>
<td>Hectares determined by multiplying the area item by 0.0001</td>
</tr>
</tbody>
</table>
Polygon Feature Attribute Table Definitions

The feature attribute table includes seven user defined items: source, mine_name, orig_feat, date, feature, acres, and hectares. Attributes are described below:

♦ **Source**: The attribute in the source item is a code number that relates to a record in the `phosmine.ref` look up table. Many of the sources are mining company files and maps that are not published and were loaned to the authors for this compilation.

♦ **Mine_Name**: Names of operating mines are assigned based on that used by the phosphate company; names of historic mines are taken primarily from Lee (2000).

♦ **Orig_feat**: Original name of feature. This is either the name supplied by the mining company or the name used during digitization of the feature.

♦ **Date**: Generally the most recent date of the information source is assigned. In some cases, linework supplied by the mining companies was modified to match features visible on DOQQ’s, but the earlier date was not used.

♦ **Feature**: Revised feature names are assigned to areas, or polygons, that reflect major groups or classes of mine disturbance. The authors exercised some latitude in the interpretation of particular terms used on mining company maps after selected mine visits and careful examination of color aerial photographs. In general, mine pits indicate where phosphate resources have been removed, whereas waste dumps, ore stockpiles, tailings and tailings ponds, and backfilled pits constitute impoundments of mining or processing wastes. Original and revised mine feature terms are listed in tables A-2 and A-3, and definitions and examples of revised mine features are presented below.

♦ **Acres**: The area of the polygons in acres calculated by multiplying the area item (square meters) by 0.0002471.

♦ **Hectares**: The area of the polygons in hectares calculated by multiplying the area item (square meters) by 0.0001.
Table A-2. Index of original mine features from all data sources and revised mine features.

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<td>Adit and Dump</td>
</tr>
<tr>
<td>2</td>
<td>1998 Reclamation</td>
<td>Disturbed Land</td>
</tr>
<tr>
<td>3</td>
<td>Miscellaneous</td>
<td>Disturbed Land</td>
</tr>
<tr>
<td>4</td>
<td>Pit and Dump</td>
<td>Disturbed Land</td>
</tr>
<tr>
<td>5</td>
<td>Proposed N.M.M.E. Pit</td>
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<tr>
<td>6</td>
<td>Unnamed Disturbance</td>
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<tr>
<td>7</td>
<td>Agrium Shop and Offices</td>
<td>Facilities</td>
</tr>
<tr>
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<td>Bone Yard</td>
<td>Facilities</td>
</tr>
<tr>
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<td>Maintenance Shop</td>
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Table A-3. List of revised mine features.

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<tr>
<th>NO.</th>
<th>REVISED MINE FEATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mine Pit</td>
</tr>
<tr>
<td>2</td>
<td>Backfilled Mine Pit</td>
</tr>
<tr>
<td>3</td>
<td>Waste Dump</td>
</tr>
<tr>
<td>4</td>
<td>Adit and Dump</td>
</tr>
<tr>
<td>5</td>
<td>Ore Stockpile</td>
</tr>
<tr>
<td>6</td>
<td>Topsoil Stockpile</td>
</tr>
<tr>
<td>7</td>
<td>Tailings or Tailings Pond</td>
</tr>
<tr>
<td>8</td>
<td>Sediment Catchment</td>
</tr>
<tr>
<td>9</td>
<td>Facilities</td>
</tr>
<tr>
<td>10</td>
<td>Road</td>
</tr>
<tr>
<td>11</td>
<td>Railroad</td>
</tr>
<tr>
<td>12</td>
<td>Water Reservoir</td>
</tr>
<tr>
<td>13</td>
<td>Disturbed Land</td>
</tr>
<tr>
<td>14</td>
<td>Undisturbed</td>
</tr>
</tbody>
</table>

Descriptions of Revised Mine Features

♦ **Mine Pit**: Open pit or strip mine is an excavation that may include overburden, phosphate ore, and low-grade waste. The typical modern phosphate mine pit is a hundred meters or more wide, hundreds to thousands of meters long, and up to 120 m deep. Some of the thirteen original feature terms used on digital or hard copy mine maps include pit, pit # 1, pit # 2, north pit, south pit, and BHA-pit. Mine operators often assign site-specific names to mine pits for management purposes. Note that the “disturbed land” classification may include additional mine pits that were not evident to the authors.

♦ **Backfilled Mine Pit**: An open pit or strip mine that is partially or completely back filled with waste rock. Typically, this waste material consists of overburden, such as Rex Chert, or low-grade material from the Meade Peak member, such as center shale waste. Some of the eight original feature terms used on digital or hard copy mine maps include backfill, backfill dump, and north pit backfill. Note that the “disturbed land” classification may include additional backfilled pits that were not evident to the authors.

♦ **Waste Dump**: Pile or body of mine waste or spoil materials. Typically, this material consists of a range of materials including overburden, such as Rex Chert, low-grade material from the Meade Peak member, such as center waste shale, or any other materials removed in order to expose, excavate, and ship ore. Some of the twenty-four original feature terms used on digital or hard copy mine maps include: A dumps, active dump, center dump, east dump, and valley dump. Mine operators also commonly assign site-specific names to waste dumps for management purposes. Note that the “disturbed land” classification may include additional waste dumps that were not evident to the authors.
♦ **Adit and Dump**: An adit is a horizontal or nearly horizontal passage driven (excavated) from the surface for the working of an underground mine. An accompanying dump contains the excavated waste material (see Waste Dump above). An adit may be driven for exploration or for production.

♦ **Ore Stockpile**: Phosphatic ore stored on the surface before shipping. This feature is also referred to as ore stockpile residue or stockpile area. Note that the “disturbed land” classification may include additional ore stockpiles that were not evident to the authors.

♦ **Topsoil Stockpile**: A pile of topsoil typically reserved for mine reclamation. This feature is also referred to as a growth media storage area.

♦ **Tailings or Tailings Pond**: Waste material or slurry from processing of phosphate ore usually stored in an impoundment; typically fine grained. Note that the “disturbed land” classification may include additional tailings features that were not evident to the authors.

♦ **Sediment Catchment**: A surface structure, such as a reservoir, constructed to hold runoff or discharge waters. This feature is also referred to as a sediment basin, settling pond, or silt retention pond.

♦ **Facilities**: Any buildings, related structures, or areas constructed and maintained to support the phosphate mining and processing operation. Examples of original feature terms include buildings, building foundation, maintenance shop, office, parking area, plant, prill silo, and spare equipment storage area. Note that the “disturbed land” classification may include additional facilities that were not evident to the authors.

♦ **Road**: A roadway or pathway for wheeled vehicles in support of mining. Examples of original feature terms include haul road, backside haulage road, and road and surface area. Roads may have been constructed by cut, cut and fill, or fill methods. Cut or cut and fill methods will generally result in a road composed of rock through which the road is cut. However, roads constructed using fill materials may be composed of any rock wasted from the mining operation or surrounding area including overburden or waste rock bounding the ore zones.

♦ **Railroad**: Rail transport system used to haul phosphate ore from the mine loading facility, typically referred to as a tipple, to the storage area at a processing plant.

♦ **Water Reservoir**: A fresh water reservoir at Conda provides make-up water for a phosphate slurry pipeline, operated by J.R. Simplot Company, that transports phosphate produced at the Smoky Canyon mine to the processing plant in Pocatello.

♦ **Disturbed Land**: An undifferentiated disturbance, including any of the above described features, related to phosphate mining, transport, or processing. This classification was assigned to many areas, or polygons, that could not otherwise be identified due to lack of hard copy or digital maps of mine features, inadequate resolution on DOQQs or aerial photos, or insufficient time for field reconnaissance. For instance, lacking both maps of mine...
features and a thorough field reconnaissance, the entire area affected by the Waterloo mine is classified as disturbed land. Certainly, subsequent studies to delineate distinct mine features will allow modification of the spatial database.

- **Undisturbed**: Areas of undisturbed land that are included with or are enclosed by polygons of phosphate mining-related surface disturbance.
Linear Features

Descriptions of user defined items added to the arc attribute table, PHOSMINE.AAT, are:

<table>
<thead>
<tr>
<th>ITEM NAME</th>
<th>ITEM TYPE</th>
<th>ITEM LENGTH</th>
<th>ATTRIBUTE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>source</td>
<td>integer</td>
<td>4</td>
<td>Numeric code or abbreviation of the source information. (This item and related information occur in the PHOSMINE.REF file.)</td>
</tr>
<tr>
<td>linetype</td>
<td>character</td>
<td>50</td>
<td>Description of the line type</td>
</tr>
</tbody>
</table>

Linetype has two sources. Data converted from CAD or DXF files and lines that were digitized from DOQQ’s or paper maps. Most of the lines that were digitized or converted from CAD were coded line type 1. These are generally contacts of features specifically related to extraction and deposition of rock material. Lines digitized from DOQQ’s mostly fall in that category also. The remaining line types are infrastructure, geographic features, and potential mining areas. Table A-4 lists the line types used and their description.

Table A-4. Descriptions of linetype used in the phosmine.aat.

<table>
<thead>
<tr>
<th>Linetype</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lines delineating mining features from CAD files or digitized from paper maps.</td>
</tr>
<tr>
<td>Building</td>
<td>Building outline, digitized from DOQQ’s</td>
</tr>
<tr>
<td>Creek</td>
<td>CAD lines of unnamed creek cutting through Smoky Canyon Mine</td>
</tr>
<tr>
<td>Digitized from DOQQ</td>
<td>Interpreted mine features digitized from Digital Orthophoto Quarter Quarter quadrangle maps</td>
</tr>
<tr>
<td>Mine Extension</td>
<td>Lines digitized from paper map that delineate lands not disturbed in 2000, but may be mined at a future date.</td>
</tr>
<tr>
<td>Ore Tram</td>
<td>Digitized lines of location of an ore tram at Wooley Valley Mine that is no longer in existence</td>
</tr>
<tr>
<td>Power line</td>
<td>Power lines</td>
</tr>
<tr>
<td>Railroad</td>
<td>Railroad tracks digitized from paper maps</td>
</tr>
<tr>
<td>Road</td>
<td>Roads</td>
</tr>
<tr>
<td>Sage Creek</td>
<td>CAD lines of Sage Creek, Idaho cutting through Smoky Canyon Mine</td>
</tr>
<tr>
<td>Stream</td>
<td>CAD lines of unnamed stream cutting through Smoky Canyon Mine</td>
</tr>
<tr>
<td>U of I Selenium Test Site</td>
<td>CAD lines of University of Idaho selenium test site at Smoky Canyon Mine</td>
</tr>
</tbody>
</table>
Source Attributes

Descriptive source or reference information for the PHOSMINE ArcInfo coverage files is stored in the PHOSMINE.REF file. Attribute descriptions for items in the PHOSMINE.REF data source file is as follows:

<table>
<thead>
<tr>
<th>ITEM NAME</th>
<th>ITEM TYPE</th>
<th>ITEM LENGTH</th>
<th>ATTRIBUTE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>source</td>
<td>integer</td>
<td>4</td>
<td>Numeric code used to identify the data source. (This item also occurs in the PHOSMINE.PAT AND PHOSMINE.AAT files.)</td>
</tr>
<tr>
<td>scale</td>
<td>integer</td>
<td>8</td>
<td>Scale of source map. (This value is the denominator of the proportional fraction that identifies the scale of the map that was digitized or scanned to produce the digital map.)</td>
</tr>
<tr>
<td>authors</td>
<td>character</td>
<td>200</td>
<td>Author(s) or compiler(s) of source map entered as last name, first name or initial, and middle initial.</td>
</tr>
<tr>
<td>year</td>
<td>integer</td>
<td>4</td>
<td>Source (map) publication date</td>
</tr>
<tr>
<td>reference</td>
<td>character</td>
<td>250</td>
<td>Remainder of reference in USGS reference format.</td>
</tr>
</tbody>
</table>

Obtaining Digital Data

The digital version of this coverage is available in ArcInfo interchange-format with associated data files. These data and map images are maintained in a Universal Transverse Mercator (UTM) map projection:

- Projection: UTM
- Zone: 12
- Units: meters
- Datum: NAD83

Note that this projection can also be described in the following manner:

- Transverse Mercator:
  - Scale Factor at Central Meridian: 0.999600
  - Longitude of Central Meridian: -111.000000
  - False Easting: 500000.000000
  - False Northing: 0.000000
  - Units: meters
- HorizontalDatumName: North American Datum of 1983
- Ellipsoid Name: Geodetic Reference System 80
To obtain copies of the digital data, do one of the following:

or

2. Anonymous FTP from geopubs.wr.usgs.gov, in the directory pub/open-file/of01-142/

The Internet sites contain the digital coverage of disturbed areas at selected phosphate mines in southeastern Idaho in ArcInfo interchange-format files (phosmine.e00).

To manipulate these data in a geographic information system (GIS), you must have a GIS that is capable of reading ArcInfo interchange-format files and can perform relational linking.
APPENDIX B – LIST OF DIGITAL FILES

There are three files associated with this report. They are:

Phosmine.e00 – Arc Export format spatial database of mining-related features
Phosmine.met – Metadata for phosmine spatial data
OF_01142.pdf – This report in Adobe Portable Document Format (PDF)
APPENDIX C - METADATA

Identification_Information:
Citation:
Citation_Information:
Originator: J. Douglas Causey and Phillip R. Moyle
Publication_Date: 2001
Title: Digital database of mining-related features at selected historic
and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou
Counties, Idaho
Edition: 1
Geospatial_Data_Presentation_Form: vector digital data
Series_Information:
Series_Name: Open File Report
Issue_Identification: OF 01-142
Publication_Information:
Publication_Place: Menlo Park, CA
Publisher: U.S. Geological Survey
Description:
Abstract: This is a spatial database that delineates mining-related
features in areas of historic and active phosphate mining in the core of the
southeastern Idaho phosphate resource area. The data has varying degrees of
accuracy and attribution detail. The breakdown of areas by type of activity at
active mines is detailed; however, the disturbed areas at many of the closed
or inactive mines are not subdivided into specific categories detailing the
type of activity that occurred.
Purpose: It is used to identify lands in southeastern Idaho affected by
phosphate mining, and delineate mining-related features at the mines.
Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1998
Currentness_Reference: ground condition
Status:
Progress: Complete
Maintenance_and_Update_Frequency: None planned
Spatial_Domain:
Bounding_Coordinates:
West_BoundingCoordinate: -112.178715
East_BoundingCoordinate: -111.114629
North_BoundingCoordinate: 43.107205
South_BoundingCoordinate: 42.305389
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: phosphate
Theme_Keyword: mining
Theme_Keyword: mine land
Theme_Keyword: disturbed land
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Idaho
Place_Keyword: Soda Springs
Place_Keyword: Caribou County
Place_Keyword: Bear Lake County
Place_Keyword: Blackfoot Reservoir
Polygon and chain-node topology present. Segments making up the boundaries of a polygon tie end-to-end to completely enclose the area. No duplicate features exist. Intersecting lines are separated into individual line segments at the point of intersection. All nodes are represented by a single coordinate pair which indicates the beginning or end of a line segment.

Completeness_Report: All polygons were derived from company or government maps, or digitized using aerial photo interpretation.

Positional_Accuracy:
  Horizontal_Positional_Accuracy:
  Horizontal_Positional_Accuracy_Report: Accuracy is variable. Most lines are probably within 10 meters.

Lineage:
  Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: J. Douglas Causey and Phillip R. Moyle
      Publication_Date: 2001
      Title: Digital database of mining-related features at selected historic and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho
      Edition: 1
      Geospatial_Data_Presentation_Form: map
    Series_Information:
      Series_Name: Open file report
      Issue_Identification: OF 01-142
    Publication_Information:
      Publication_Place: Menlo Park, California
      Publisher: U.S. Geological Survey
      Online_Linkage: http://geopubs.wr.usgs.gov/open-file/of01-142
    Source_Scale_Denominator: 24000
    Type_of_Source_Media: online
    Source_Time_Period_of_Content:
      Time_Period_Information:
        Single_Date/Time:
          Calendar_Date: 1998
          Source_Currentness_Reference: ground condition
      Source_Citation_Abbreviation: Causey and Moyle, 2001
      Source_Contribution: Combined, attributed, and defined all digital work into one report
    Process_Step:
      Process_Description: Hard copy maps were digitized, see report
      Source_Used_Citation_Abbreviation: See phosmine.ref table
      Process_Date: January, 2001
      Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001
    Process_Contact:
      Contact_Information:
        Contact_Person_Primary:
          Contact_Person: J. Douglas Causey
          Contact_Organization: U.S. Geological Survey
          Contact_Position: Geologist
        Contact_Address:
          Address_Type: mailing and physical address
          Address: 904 W. Riverside Ave., Rm 202
          City: Spokane
State or Province: WA
Postal Code: 99201-1087
Country: USA
Contact_Voice_Telephone: 509.368.3116
Contact_Facsimile_Telephone: 509.368.3199
Contact_Electronic_Mail_Address: dcausey@usgs.gov
Hours of Service: 8 AM - 4 PM PST

Process Step:
Process Description: CAD files were converted to Arc files
Source Used Citation Abbreviation: CAD files
Process Date: January, 2001
Source Produced Citation Abbreviation: Causey and Moyle, 2001

Process Contact:
Contact Information:
Contact Person Primary:
Contact Person: J. Douglas Causey
Contact Organization: U.S. Geological Survey
Contact Position: Geologist
Contact Address:
Address Type: mailing and physical address
Address: 904 W. Riverside Ave., Rm 202
City: Spokane
State or Province: WA
Postal Code: 99201-1087
Country: USA
Contact Voice Telephone: 509.368.3116
Contact Facsimile Telephone: 509.368.3199
Contact Electronic Mail Address: dcausey@usgs.gov
Hours of Service: 8 AM - 4 PM PST

Process Step:
Process Description: Data digitized from DOQQ's
Source Used Citation Abbreviation: DOQQ
Process Date: February, 2001
Source Produced Citation Abbreviation: Causey and Moyle, 2001

Process Contact:
Contact Information:
Contact Person Primary:
Contact Person: J. Douglas Causey
Contact Organization: U.S. Geological Survey
Contact Position: Geologist
Contact Address:
Address Type: mailing and physical address
Address: 904 W. Riverside Ave., Rm 202
City: Spokane
State or Province: WA
Postal Code: 99201-1087
Country: USA
Contact Voice Telephone: 509.368.3116
Contact Facsimile Telephone: 509.368.3199
Contact Electronic Mail Address: dcausey@usgs.gov
Hours of Service: 8 AM - 4 PM PST

Process Step:
Process Description: Data from previous 3 process steps were projected
to common projection (UTM Zone 12, NAD 83, units meters) and combined.
Mismatches were corrected based on DOQQ's. Attributes were defined.
Source Used Citation Abbreviation: DOQQ
Process Date: March, 2001

40
Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001

Process_Contact:
Contact_Information:
  Contact_Person_Primary:
    Contact_Person: J. Douglas Causey
    Contact_Organization: U.S. Geological Survey
    Contact_Position: Geologist
  Contact_Address:
    Address_Type: mailing and physical address
    Address: 904 W. Riverside Ave., Rm 202
    City: Spokane
    State_or_Province: WA
    Postal_Code: 99201-1087
    Country: USA
  Contact_Voice_Telephone: 509.368.3116
  Contact_Facsimile_Telephone: 509.368.3199
  Contact_Electronic_Mail_Address: dcausey@usgs.gov
  Hours_of_Service: 8 AM - 4PM PST

Cloud_Cover: 0

Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Vector
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Complete chain
      Point_and_Vector_Object_Count: 3833
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Entity point
      Point_and_Vector_Object_Count: 724
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
      Point_and_Vector_Object_Count: 724
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Point
      Point_and_Vector_Object_Count: 242

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  Horizontal_Coordinate_System_Definition:
    Planar:
      Map_Projection:
        Map_Projection_Name: Transverse Mercator
        Transverse_Mercator:
          Scale_Factor_at_Central_Meridian: 0.999600
          Longitude_of_Central_Meridian: -111.000000
          False_Easting: 500000.000000
          False_Northing: 0.000000
    Planar_Coordinate_Information:
      Planar_Coordinate_Encoding_Method: coordinate pair
      Coordinate_Representation:
        Abscissa_Resolution: 0.000128
        Ordinate_Resolution: 0.000128
      Planar_Distance_Units: meters

Geodetic_Model:
  Horizontal_Datum_Name: North American Datum of 1983
  Ellipsoid_Name: Geodetic Reference System 80
  Semi-major_Axis: 6378137.000000
  Denominator_of_Flattening_Ratio: 298.257222

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  Detailed_Description:
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   Entity_Type_Label: phosmine.aat
   Entity_Type_Definition: Boundary lines on disturbed land polygons
   Entity_Type_Definition_Source: This report
Attribute:
   Attribute_Label: FID
   Attribute_Definition: Software coding
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: SHAPE
   Attribute_Definition: Software coding
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: FNODE#
   Attribute_Definition: From node
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: TNODE#
   Attribute_Definition: To node
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: LPOLY#
   Attribute_Definition: Left polygon
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: RPOLY#
   Attribute_Definition: Right polygon
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: LENGTH
   Attribute_Definition: Length of line
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: PHOSMINE#
   Attribute_Definition: Internal number
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: PHOSMINE-ID
   Attribute_Definition: User identification number
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: LINETYPE
   Attribute_Definition: Line type
   Attribute_Definition_Source: This report
Attribute:
   Attribute_Label: $ID
   Attribute_Definition: Software coding
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: $FROMNODE
   Attribute_Definition: Software coding
   Attribute_Definition_Source: ESRI
Attribute:
   Attribute_Label: $TONODE
   Attribute_Definition: Software coding
   Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: $LEFTPOLYGON
Attribute_Definition: Software coding
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: $RIGHTPOLYGON
Attribute_Definition: Software coding
Attribute_Definition_Source: ESRI
Detailed_Description:
Entity_Type:
Entity_Type_Label: phosmine.pat
Entity_Type_Definition: Polygons delineating features at mines sites
Entity_Type_Definition_Source: This report
Attribute:
Attribute_Label: FID
Attribute_Definition: Software coding
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: SHAPE
Attribute_Definition: Software coding
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: AREA
Attribute_Definition: Area of polygon in square meters
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: PERIMETER
Attribute_Definition: Perimeter of polygon in meters
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: PHOSMINE#
Attribute_Definition: Internal number
Attribute_Definition_Source: ESRI
Attribute:
Attribute_Label: PHOSMINE-ID
Attribute_Definition: User defined id number = phosmine# - 1
Attribute_Definition_Source: ESRI
Beginning_Date_of_Attribute_Values: 2001
Ending_Date_of_Attribute_Values: 2001
Attribute:
Attribute_Label: SOURCE
Attribute_Definition: Code for source reference of these polygons
Attribute_Definition_Source: phosmine.ref
Attribute:
Attribute_Label: MINE_NAME
Attribute_Definition: Name of mine
Attribute_Definition_Source: This report
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value_Definition: Names of Mines that were included in this coverage
Enumerated_Domain_Value_Definition_Source: This report
Attribute:
Attribute_Label: ORIG_FEAT
Attribute_Definition: Name originally ascribed to feature when it was
digitally captured
Attribute_Definition_Source: This report
Attribute_Domain_Values:
  Enumerated_Domain:
    Enumerated_Domain_Value: Any description of type of disturbance
    Enumerated_Domain_Value_Definition: Term describing disturbance of
    land surface by mining and related activities
    Enumerated_Domain_Value_Definition_Source: Original sources and this
    report
Attribute:
  Attribute_Label: DATE
  Attribute_Definition: Date of information related to this polygon
  Attribute_Definition_Source: This report
  Attribute_Domain_Values:
    Enumerated_Domain:
      Enumerated_Domain_Value: Any 4 digit date
      Enumerated_Domain_Value_Definition: Date of information about
disturbance of land surface
      Enumerated_Domain_Value_Definition_Source: This report
Attribute:
  Attribute_Label: FEATURE
  Attribute_Definition: Standardized name given to feature
  Attribute_Definition_Source: This report
  Attribute_Domain_Values:
    Enumerated_Domain:
      Enumerated_Domain_Value: Adit and Dump, backfilled mine pit,
disturbed land, facilities, mine pit, ore stockpile, railroad, road, sediment
      catchment, tailings, tailings pond, topsoil stockpile, undisturbed, waste
dump, water reservoir
      Enumerated_Domain_Value_Definition: Terms that describe the type of
      land disturbance
      Enumerated_Domain_Value_Definition_Source: This report
Attribute:
  Attribute_Label: ACRES
  Attribute_Definition: Area of polygon in acres
  Attribute_Definition_Source: Derived by multiplying Area item by
  0.0002471
  Attribute_Domain_Values:
    Enumerated_Domain:
      Enumerated_Domain_Value: Any numeric
      Enumerated_Domain_Value_Definition: Number of acres in polygon
      Enumerated_Domain_Value_Definition_Source: This report
Attribute:
  Attribute_Label: HECTARES
  Attribute_Definition: Area of polygon in hectares
  Attribute_Definition_Source: Derived by multiplying Area item by 0.0001
  Attribute_Domain_Values:
    Enumerated_Domain:
      Enumerated_Domain_Value: Any numeric
      Enumerated_Domain_Value_Definition: Number of hectares in the
      polygon
      Enumerated_Domain_Value_Definition_Source: This report
Distribution_Information:
  Distributor:
  Contact_Information:
Contact_Organization_Primary:
  Contact_Organization: U.S. Geological Survey
Contact_Address:
  Address_Type: mailing address
  Address: Open-File Reports, Box 25286
  City: Denver
  State_orProvince: CO
  Postal_Code: 80225
  Country: USA
  Contact_Voice_Telephone: 1-303-202-4200

Distribution_Liability:
The U.S. Geological Survey (USGS) provides these geographic data "as is". The USGS makes no guarantee or warranty concerning the accuracy of information contained in the geographic data. The USGS further makes no warranties, either expressed or implied as to any other matter whatsoever, including, without limitation, the condition of the product, or its fitness for any particular purpose. The burden for determining fitness for use lies entirely with the user. Although these data have been processed successfully on computers at the USGS, no warranty, expressed or implied, is made by the USGS regarding the use of these data on any other system, nor does the fact of distribution constitute or imply any such warranty. In no event shall the USGS have any liability whatsoever for payment of any consequential, incidental, indirect, special, or tort damages of any kind, including, but not limited to, any loss of profits arising out of use of or reliance on the geographic data or arising out of the delivery, installation, operation, or support by USGS.

This data is not to be used at any scale greater than 1:24,000 (e.g. 1:12,500)

Standard_Order_Process:
Digital_Form:
  Digital_Transfer_Information:
    Format_Name: ARC
    Format_Version_Number: 8.0.2
    File_Decompression_Technique: No compression applied
    Transfer_Size: 1.941
  Digital_Transfer_Option:
    Online_Option:
      Computer_Contact_Information:
        Network_Address:
        Network_Resource_Name: http://geopubs.wr.usgs.gov/open-file/of01-142
    Access_Instructions: World Wide Web (WWW)

Metadata_Reference_Information:
Metadata_Date: 20010313
Metadata_Future_Review_Date: None planned
Metadata_Contact:
  Contact_Information:
    Contact_Organization_Primary:
      Contact_Organization: U.S. Geological Survey
      Contact_Person: J. Douglas Causey
      Contact_Position: Geologist
    Contact_Address:
      Address_Type: mailing and physical address
      Address: 904 W. Riverside Ave., Rm 202
      City: Spokane
State or Province: WA
Postal Code: 99201-1087
Country: USA
Contact_VoiceTelephone: 509.368.3116.
Contact_FacsimileTelephone: 509.368.3199
Contact_ElectronicMailAddress: dcausey@usgs.gov
Hours_of_Service: 8 AM - 4 PM PST
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_Use_Constraints: None
Metadata_Extensions:
  Online_Linkage: http://www.esri.com/metadata/esriprof80.html
  Profile_Name: ESRI Metadata Profile