



Chromite Deposits in Central Part Stillwater Complex, Sweet Grass County, Montana: A Digital Database for the Geologic Map of the East Slope of Iron Mountain

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Open-File Report 01-321
Digital database, version 1.0

2001

Manuscript approved for publication September 7, 2001

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government. The digital database is not meant to be used or displayed at any scale larger than 1:3077 (such as, 1:2000 or 1:1500).

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

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Introduction

In 1940, A.L. Howland and J. W. Peoples, assisted by W.R. Jones and M.G. Bennett, mapped the geology of the east slope of Iron Mountain, Montana. The map was revised and extended by Howland in 1942 and published in 1955 as plate 10 of the U.S. Geological Survey Bulletin 1015-D (Howland, 1955). In 2000, the USGS contracted Optronics Specialty Co., Inc. of Northridge, CA to prepare a scanned digital version of plate 10. Geospatial editing and attributing of the scanned map of the east slope of Iron Mountain was performed by the USGS in order to produce an interim digital product. This digital geospatial database is one of many being created by the U.S. Geological Survey as an ongoing effort to provide geologic information in a geographic information system (GIS) for use in spatial analysis.

The map was compiled from the preliminary digital files prepared by Optronics Specialty Co., Inc. which were prepared and transformed by Helen Z. Kayser, Information Systems Support, Inc., Spokane, WA. The resulting digital geologic map (GIS) database can be queried in many ways to produce a variety of geologic maps. Digital base map data files (topography, roads, towns, rivers and lakes, etc.) are not included: they may be obtained from a variety of commercial and government sources. This database is not meant to be used or displayed at any scale larger than the original map scale 1:3077 (such as, 1:2000 or 1:1500). The digital geologic map graphics and plot files ([ironmtn.gra/eps](#) and [ironmtn-map.pdf](#)) that are provided in the digital package are representations of the digital database.

The map area is located in the central part of the Stillwater complex of south central Montana ([fig. 1](#)). This report lists the geologic map units, the methods used to convert the geologic map data into a digital format, the ArcInfo GIS file structures and relationships, and explains how to download the digital files from the U.S. Geological Survey public access World Wide Web site on the Internet.

Manuscript reviews by Helen Z. Kayser and Pamela D. Derkey are greatly appreciated. We also wish to thank Michael L. Zientek for the review of the map units and the digital files.

List of Map Units

The rock units listed below are from the published geologic map of the east slope of Iron Mountain, Sweet Grass County, Montana, plate 10 of Howland (1955).

STILLWATER COMPLEX

	Ultramafic Zone
pg	Basic pegmatite
br	Bronzitite
hz	Harzburgite
shz	Serpentinized harzburgite

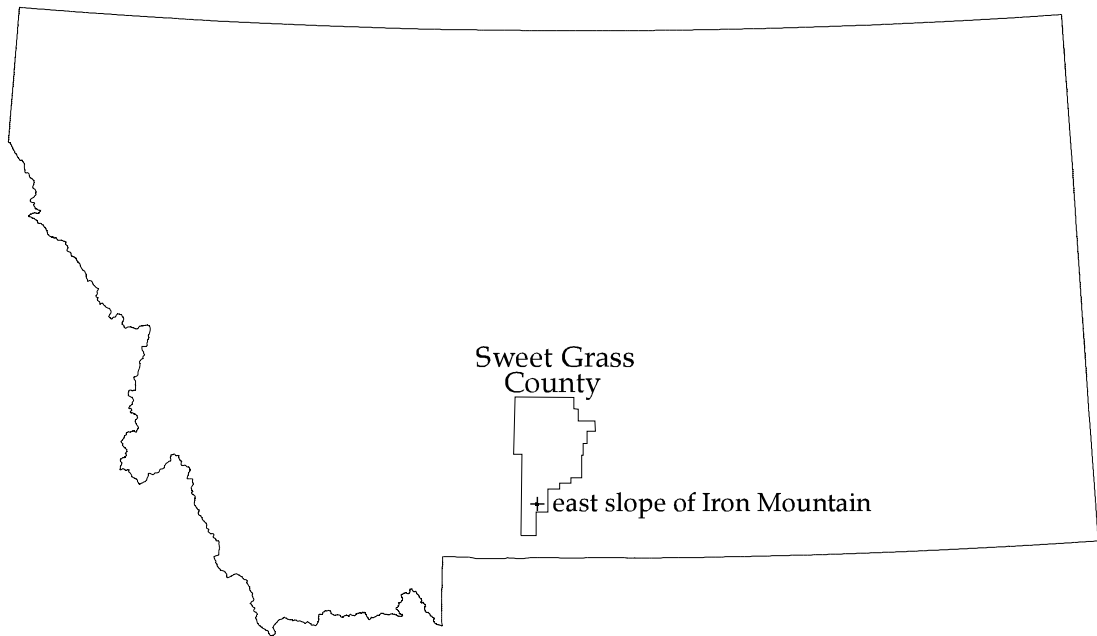


Figure 1. Index map showing the geographic extent of the mapped area.

gh	Granular harzburgite
sgh	Serpentinized granular harzburgite
ph	Poikilitic harzburgite
ph/cr	Poikilitic harzburgite with disseminated chromite
sph	Serpentinized granular harzburgite
sph/cr	Serpentinized poikilitic harzburgite with disseminated chromite
	Basal Zone
dn	Diabasic norite

BASEMENT COMPLEX

bc	Metasedimentary rock
----	----------------------

Data Sources, Processing, and Accuracy

The geologic map of the east slope of Iron Mountain, Sweet Grass County, Montana (Howland, 1955) was originally a paper document, converted to digital files by Optronics Specialty Co., Inc. The preliminary digital files were given to the U.S. Geological Survey (USGS) in an ArcInfo interchange format in scanner units. The files were then prepared and transformed, using tic points, to Montana State Plane projection (zone 4526, NAD 27) by Helen Z. Kayser, Information Systems Support, Inc. The digital files were augmented with an interim geologic map data model (data base), further attributed and edited by Lorre A. Moyer (USGS), and then plotted and compared to the original field geologic maps to check for digitizing and attributing errors. Processing by the U.S. Geological Survey was done in ArcInfo version 8.0 installed on a Sun Ultra workstation and Arc8 installed on an NT desktop computer.

The overall accuracy (with respect to the location of lines and points) of the digital geologic map ([see figs. 2 and 3 for page-size versions](#)) is probably no better than +/- 15 feet. This digital database is not meant to be used or displayed at any scale larger than 1:3077 (for example, 1:2000 or 1:1500).

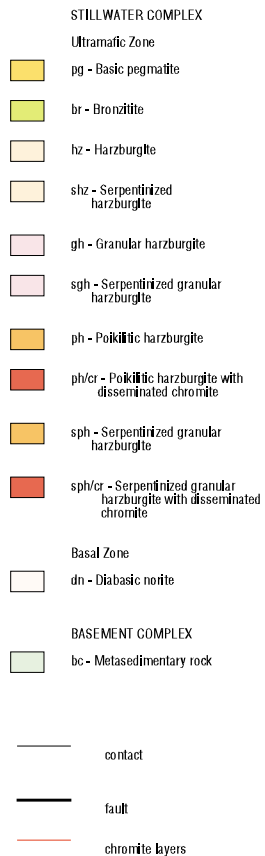


Figure 2. Explanation for the Simplified Digital Geologic Map of the East Slope of Iron Mountain

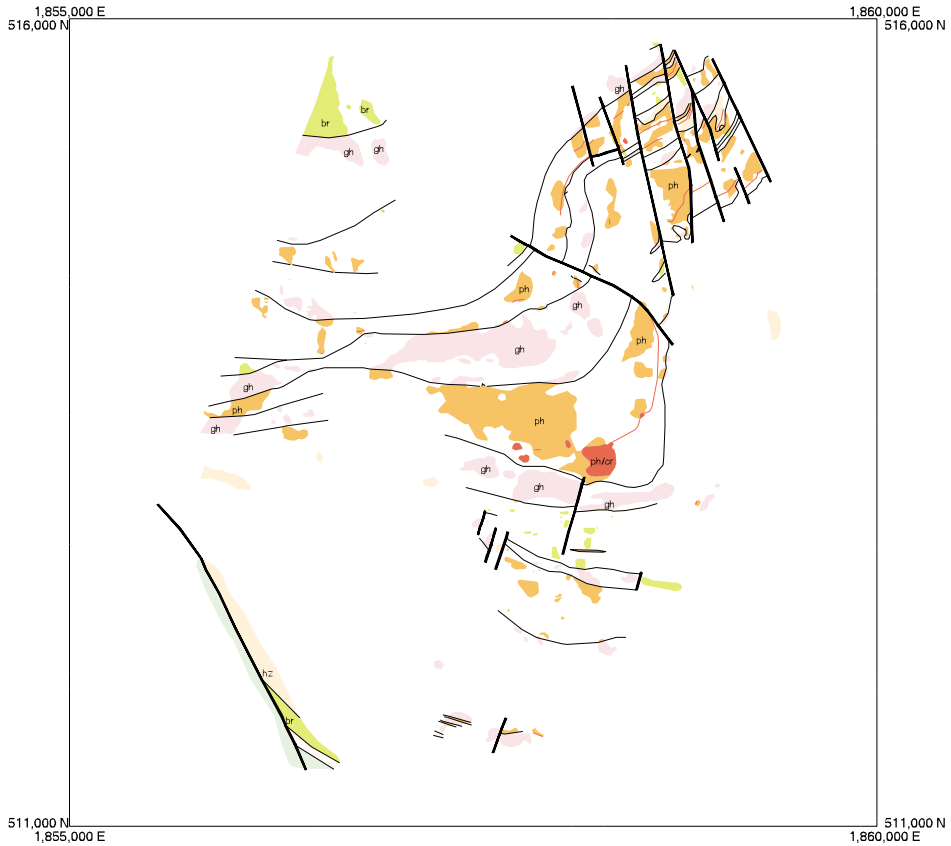


Figure 3. Simplified Digital Geologic Map of the East Slope of Iron Mountain

GIS Documentation

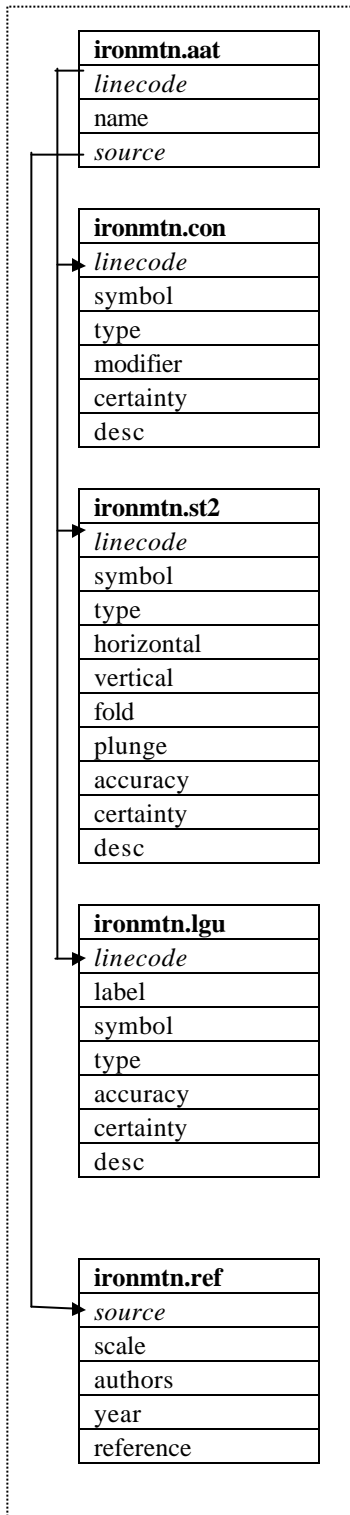
The digital geologic map of the east slope of Iron Mountain (scale 1:3077) includes a geologic linework arc attribute table, **IRONMTN.AAT**, that relates to the **IRONMTN.CON**, **IRONMTN.ST2**, **IRONMTN.LGU** and **IRONMTN.REF** files; a rock unit polygon attribute table, **IRONMTN.PAT**, that relates to the **IRONMTN.RU** and **IRONMTN.REF** files; and a geologic map symbol point attribute table, **IRONMTNP.PAT**, that relates to the **IRONMTNP.SYM** and **IRONMTNP.REF** files (see fig. 4). These data files are described below.

Linear Features

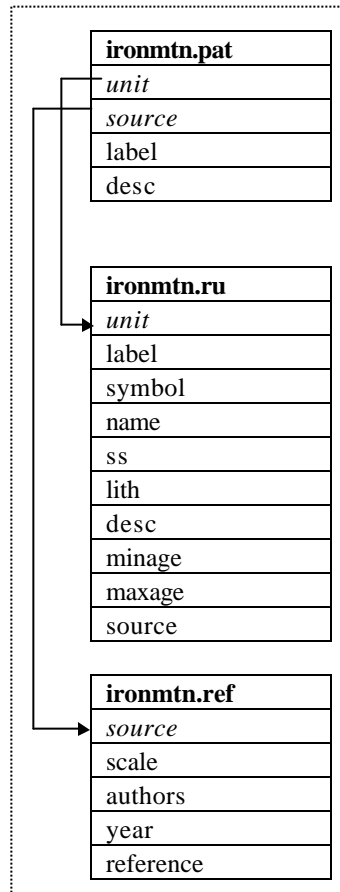
Descriptions of the items identifying linear features such as contacts, boundaries (for example, lines of latitude and longitude, state boundaries) and structures in the arc (or line) attribute table, **IRONMTN.AAT**, are as follows:

IRONMTN.AAT			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code used to identify type of linear feature. Linecodes < 100 are used for contacts and boundaries which are described in the IRONMTN.CON file. Linecodes > 100 and < 600 represent structural features which are described in the IRONMTN.ST2 file. Linecodes > 800 represent linear geologic units that are described in the IRONMTN.LGU file.
name	character	30	Name given to mineralized feature.
source	integer	4	Numeric code used to identify the data source for the linear feature. Complete references for the sources are listed in the IRONMTN.REF file.

Arc attribute table and related look-up tables:



Polygon attribute table and related look-up tables:



Point attribute table and related look-up tables:

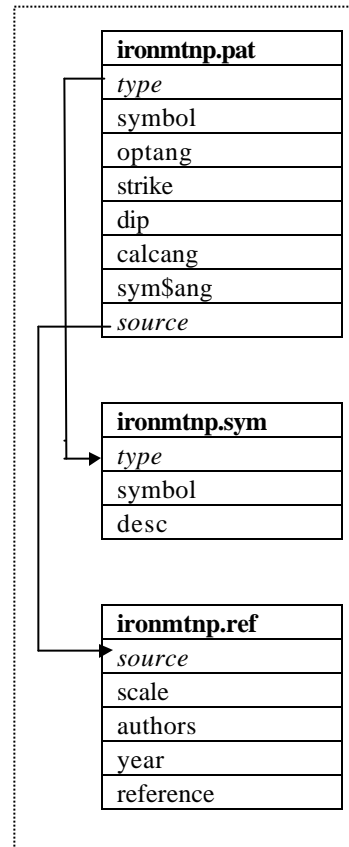


Figure 4: Relationships between feature attribute tables and look-up tables

Attribute descriptions for items in the contact (and boundary) look-table, IRONMTN.CON [GEOL_DIA.LIN linesets], are as follows:

IRONMTN.CON			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value < 100) used to identify type of contact or boundary. (This item also occurs in IRONMTN.AAT .)
symbol	integer	3	Line symbol number used by Arc/Info to plot lines. Symbol numbers refer to the GEOL_DIA.LIN lineset for linecodes < 100.
type	character	10	Major type of line, for example, contact, state boundaries, lines of latitude and longitude used for neatlines.
modifier	character	20	Line type modifier, that is, approximate, concealed, gradational. No entry implies 'known.'
certainty	character	15	Degree of certainty of contact or boundary, that is, inferred, uncertain. No entry implies 'certain.'
desc	character	100	Written description or explanation of contact or boundary.

Attribute descriptions for items in the structure look-up table, IRONMTN.ST2 [for use with the GEOL_DIA.LIN lineset], are as follows:

IRONMTN.ST2			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value > 100 and < 600) used to identify type of structural feature. (This item also occurs in IRONMTN.AAT .)
symbol	integer	3	Line symbol number used by Arc/Info to plot arc (line). Symbol numbers refer to the GEOL_DIA.LIN lineset.
type	character	10	Major type of structure, that is, fault, fracture, fold, other.
horizontal	character	20	Type of horizontal fault movement, for example, left-lateral, right-lateral. No entry implies 'unknown.'
vertical	character	20	Type of vertical fault movement, for example, normal. No entry implies 'unknown.'
fold	character	15	Type of fold, for example, anticline, syncline.
plunge	character	15	Type of plunge on fold, that is, horizontal, plunging, plunging in, plunging out.
accuracy	character	15	Line type modifier indicating degree of accuracy, that is, approximately located, concealed, gradational. No entry implies 'known.'
certainty	character	15	Degree of certainty of contact or boundary, that is, inferred, uncertain. No entry implies 'certain.'
desc	character	100	Written description or explanation of structural feature.

Attribute descriptions for items in the structure look-up table, IRONMTN.LGU [for use with the GEOL_DIA.LIN lineset], are as follows:

IRONMTN.LGU			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value > 800) used to identify type of linear geologic unit. (This item also occurs in IRONMTN.AAT .)
label	character	10	Linear geologic unit label used to label unit on map.
symbol	integer	3	Line symbol number used by ArcInfo to plot arc (line). Symbol numbers refer to the GEOL_DIA.LIN lineset.
type	character	10	Major type of linear geologic unit, that is, basic dike, chromite layers, other.
accuracy	character	15	Line type modifier indicating degree of accuracy, that is, approximately located, concealed, gradational. No entry implies 'known.'
certainty	character	15	Degree of certainty of contact or boundary, that is, inferred, uncertain. No entry implies 'certain.'
desc	character	100	Written description or explanation of structural feature.

Areal Features

Descriptions of the items identifying geologic units in the polygon attribute table, IRONMTN.PAT, are as follows:

IRONMTN.PAT			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
unit	integer	4	Numeric code used to identify the rock unit which is described in the IRONMTN.RU look-up table. (This item also occurs in IRONMTN.RU .)
source	integer	4	Numeric code used to identify the data source for the rock unit. Complete references for the sources are listed in the IRONMTN.REF file.
label	character	10	Rock unit label (abbreviation) used to label unit on map. (This item was joined from the IRONMTN.RU look-up table.)
desc	character	250	Formal or informal unit name. (This item was joined from the IRONMTN.RU look-up table.)

Attribute descriptions for items in the lithology (rock unit) look-table, IRONMTN.RU (for use with the WPGCMYK.SHD shadeset), are as follows:

IRONMTN.RU			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
unit	integer	4	Numeric code used to identify rock unit. (This item also occurs in IRONMTN.PAT.)
label	character	10	Rock unit label (abbreviation) used to label unit on map.
symbol	integer	3	Shadeset symbol number used by ArcInfo to plot a filled/shaded polygon. The symbol numbers used in this file refer to the WPGCMYK.SHD shadeset.
name	character	7	The prefix portion of the rock unit label that does not include subscripts. (If subscripting is not used in the original unit label, then the 'name' entry is the same as the 'label' entry.)
ss	character	3	The suffix portion of the geologic unit label that includes subscripts.
lith	character	20	Major type of lithostratigraphic unit, that is, unconsolidated sediments, sedimentary rocks, metasedimentary rocks, intrusive rocks, extrusive rocks, metamorphic rocks, water, ice.
desc	character	250	Formal or informal unit name
minage	character	7	Minimum stratigraphic age of lithologic unit, that is, CRET, TERT, PCY.
maxage	character	7	Maximum stratigraphic age of lithologic unit
source	character	4	Numeric code used to identify the data source for the rock unit. Complete reference for the sources are listed in the IRONMTN.REF.

Point Features

Descriptions of the items identifying geologic map symbols are given in the point attribute table, IRONMTNP.PAT, which is defined as follows:

IRONMTNP.PAT			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
type	character	32	Type of point symbol, for example, strike and dip of inclined bedding, strike and dip of inclined cleavage, geochemical sample location. (This item also occurs in the IRONMTNP.SYM file.)
symbol	integer	3	Marker symbol number used by ArcInfo to identify type of geologic map symbol. Symbol numbers refer to the GEOSCAMP2.MRK markerset (Matti and others, 1997). (This item also occurs in the IRONMTNP.SYM file.)
optang	integer	3	The angle value assigned to the strike symbol when digitized by Optronics Specialty Co., Inc
strike	integer	3	Strike of bedding, foliation or cleavage. Strike is an azimuthal angle (measured in degrees from 0 to 360 in a clockwise direction from North).
dip	integer	3	Dip of bedding, foliation or cleavage. This value is an angle measured (in degrees from 0 to 90) down from the horizontal; thus a horizontal dip is 0 degrees and a vertical dip is 90 degrees.
calcang	integer	4	An interim value used to calculate sym\$angle. The various structural map symbols in the GEOSCAMP2.MRK markerset (Matti and others, 1997) had to be rotated by different amounts to achieve their proper map orientation. For the strike and dip symbols, calcang = strike – 90.
sym\$ang	integer	4	The angle used to complete the mathematical rotation of the structural map symbol to its proper orientation on the map. This value is the \$angle pseudoitem value for the point.
source	integer	4	Numeric code used to identify the data source for the structural map symbol. Complete references for the sources are listed in the IRONMTNP.REF file.

Attribute descriptions for items in the geologic map symbols look-up table, IRONMTNP.SYM, [for use with the GEOSCAMP2.MRK markerset (Matti and others, 1997)], are as follows:

IRONMTNP.SYM			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
type	character	32	Type of point symbol, for example, strike and dip of inclined bedding, strike and dip of inclined cleavage. (This item also occurs in the IRONMTNP.PAT file.)
symbol	integer	3	Marker symbol number used by ArcInfo to identify type of structural map symbol. Symbol numbers refer to the GEOSCAMP2.MRK markerset (Matti and others, 1997).
desc	character	250	Written description or explanation of map symbol.

Source Attributes

Descriptive source or reference information for the IRONMTN and IRONMTNP ArcInfo datasets is stored in the IRONMTN.REF and IRONMTNP.REF files, respectively. Attribute descriptions for items in the IRONMTN.REF and IRONMTNP.REF data source files are as follows:

IRONMTN.REF / IRONMTNP.REF			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
source	integer	4	Numeric code used to identify the data source. (This item also occurs in the IRONMTN.AAT , IRONMTN.PAT , and IRONMTNP.PAT files.)
scale	integer	8	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.)
authors	character	200	Author(s) or compiler(s) of source map entered as last name, first name or initial, and middle initial.
year	integer	4	Source (map) publication date
reference	character	250	Remainder of reference in USGS reference format.

Obtaining Digital Data

The complete digital version of the geologic map is available in ArcInfo interchange format with associated data files. These data and map images are maintained in a state plane coordinate system:

Projection: stateplane
Zone: 4526
Datum: NAD27
Units: feet

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

1. Download the digital files from the USGS public access World Wide Web site on the Internet: **URL = <http://geopubs.wr.usgs.gov/open-file/of01-321/>**
2. Anonymous FTP from **geopubs.wr.usgs.gov**, in the directory **pub/open-file/of01-321**

The Internet sites contain the spatial digital database for the geologic map of the Iron Mountain area as ArcInfo interchange-format files (ironmtn.e00 and ironmtnp.e00); a geologic map as Encapsulated PostScript and Adobe Acrobat portable document files (ironmtn.eps/.pdf), as well as the associated data files and ArcInfo macro programs which are used to plot the map at a scale of 1:3077 (see Appendix A and B); and formatted metadata (see Appendix C).

To manipulate this data in a geographic information system (GIS), you must have a GIS that is capable of reading ArcInfo interchange-format files.

Obtaining Paper Maps

Paper copies of the digital geologic map are not available from the U.S. Geological Survey. However, with access to the Internet and access to a large-format color plotter that can interpret either Encapsulated PostScript files, or PDF (portable document format) files, a 1:3077-scale paper copy of the map can be made, as follows:

1. Download the digital version of the map, **ironmtn.eps** or **ironmtn-map.pdf**, from the USGS public access World Wide Web site on the Internet using the **URL = <http://geopubs.wr.usgs.gov/open-file/of01-321/>**
or
2. Anonymous FTP the plot file, **ironmtn.eps** or **ironmtn-map.pdf**, from: **geopubs.wr.usgs.gov**, in the directory:
pub/open-file/of01-321
3. This file can be plotted by any large-format color plotter that can interpret EPS or PDF files. The finished plot is about 18 inches by 20 inches.

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

References Cited

Howland, A.L., 1955, Chromite deposits in central part Stillwater Complex, Sweet Grass County, Montana: U.S. Geological Survey Bulletin 1015-D, 121 p., 4 plates.

Matti, J.C., Miller, F.K., Powell, R.E., Kennedy, S.A., Bunyapanasarn, T. P., Koukladas, C., Hauser, R.M., and Cossette, P.M., 1997, Geologic-point attributes for digital geologic-map data bases produced by the Southern California Areal Mapping Project (SCAMP): U.S. Geological Survey Open-File Report 97-859, 7 p.

Appendix A - List of digital files in the Iron Mountain GIS

- Use the 'importfile.aml' to IMPORT all of the *.E00 files for use in ArcInfo.
- Use the ArcInfo 'DRAW' command to plot the *.GRA file to your screen. (Make sure the display is set with the ArcInfo 'DISPLAY' command.)
- Use the ArcInfo 'HPGL2' command to create a HPGL2 file from the *.GRA file.
- Use the UNIX 'lpr -P<plotter_name> ironmntn.hp' command to send the ironmntn.hp file to a large-format color plotter that can interpret Hewlett-Packard Graphics Language.
- To re-create the *.GRA file, enter the ArcInfo command '&run ironmntn' at the Arc: prompt.

Primary ArcInfo exchange-format (*.e00) and metadata files for the digital geology:

- ironmntn.e00 – line and poly GIS
- ironmntnp.e00 – point GIS
- ironmntn.met – metadata

ArcInfo graphics (*.gra), Encapsulated PostScript map plot (*.eps), and portable document format (*.pdf) files for the geologic map sheet:

- ironmntn.gra/.eps
- ironmntn-map.pdf

Additional ArcInfo exchange -format files (*.e00) necessary to re-create the geologic map sheet:

- fnt026.e00 – font 26
- fnt027.e00 – font 27
- fnt035.e00 – font 35
- fnt037.e00 – font 37
- fnt038.e00 – font 38
- fnt039.e00 – font 39
- fnt040.e00 – font 40
- geol_dia.lin.e00 - lineset
- geoscamp2.mrk.e00 - markerset
- imquad.e00 - exterior boundary of the map area
- wpgcmyk.shd.e00 - shadeset

ArcInfo Macro Language (*.aml), graphics (*.gra), key (*.key), projection (*.prj), and text (*.dat and *.txt) files necessary to re-create the geologic map sheet:

- ironmntn.aml - program that creates a graphics file of the geologic map
- linebar.aml – program that creates a scalebar
- indx_irmt.gra - index map graphic file
- usgslogo.gra – USGS visual identity
- irmt-lin.key - lineset symbol values and descriptive text for lines on the map sheet.
- irmt-pnt.key - markerset symbol values and descriptive text for map symbols (markers) on the map sheet.
- irmt-pol.key - shadeset symbol values and descriptive text for geologic map units on the map sheet
- geo.prj - a text file used to identify real-world (geographic) coordinates - for use in adding latitude and longitude notation around the margins of the map
- msp.prj - a text file to identify Montana State Plane South (zone 4526) coordinate system - for use in adding spatial reference notation around the margins of the map
- irmt-crd.txt - text file listing map credits.
- irmt-dis.txt – text file giving USGS disclaimer statement
- irmt-ref.txt - text file listing map references
- cal.dat – plotter calibration data file

Appendix B - ArcInfo Macro Language program (ironmtn.aml) used to plot the geologic map of the East Slope of Iron Mountain

```

/* ironmtn.aml, 5/15/01 lam; 12/6/01, pd
/* U.S. Geological Survey Open-File Report 01-
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/* This ArcInfo Macro Language (AML)
program will plot a digital geologic map for
/* the east slope of Iron Mountain at 1:3077
scale.

/* To run this AML:
/* 1. Type '&run ironmtn' at the 'Arc:' prompt to
start the program,
/* 2. Run the ArcInfo HPGL2 command to
convert the GRA file to an HPGL2 file,
/*i.e., hpgl2 ironmtn ironmtn.hp # 1.0 opaque # 0
# # # cal.dat
/* 3. Execute the UNIX 'lpr' command to print
the 1:3077-scale geologic map
/*on your plotter, i.e., lpr -Ppicasso ironmtn.hp
/*****
ap
display 1040
ironmtn.gra

clear
clearselect

pagesize 34 31.5
pageunits inches
mapunits feet
mapscale 3077
mapposition ll 2.75 6.0

&set cover ironmtn
&set quad imquad
&set logo = usgslogo.gra
&set pntcover ironmtnp
/* where 'cover' contains contacts and structures
and rock units;
/* where 'quad' is an outer boundary;
/* where 'pntcover' contains structural symbols
for layers and joints
/* and uses symbols from geoscamp2.mrk

&s key1 irmt-pol.key

&s key2 irmt-lin.key
&s key3 irmt-ref.txt
&s key4 irmt-pnt.key
&s credits irmt-crd.txt
&s disclaimer irmt-dis.txt

mape %quad%
maplimits 0.0 2.4 28.5 28.5

/*draw outside box
linesymbol 9
linecolor 1
box 0.5 0.5 33.0 30.0

textquality proportional
textfont 94021
linedelete all

/* cut marks
markerset plotter
markersymbol 1
markersize 0.1
marker 0 0
marker 0 30.5
marker 33.5 0
marker 33.5 30.5

&label shadepolys
/* color polygons for geologic rock units
shadedelete all
shadeset wpgcmyk.shd
polygonshade %cover% unit %cover%.ru

&label contacts
/* plot contacts and boundaries
linedelete all
lineset geol_dia.lin
res %cover% arcs linecode gt 0 and linecode lt
100
arclines %cover% linecode %cover%.con
asel %cover% arcs

&label lgu
linedelete all
lineset geol_dia.lin

```

```

res %cover% arcs linecode gt 800 and linecode lt
807
arclines %cover% linecode %cover%.lgu
asel %cover% arcs

&label structures
/* plot faults with line patterns
linedelete all
lineset geol_dia.lin
res %cover% arcs linecode gt 100 and linecode lt
600
arclines %cover% linecode %cover%.st2
asel %cover% arcs

/* scalebar
&r linebar.aml 11.5 2 1000 10 feet feet .02 .1

&label mapquad
/* plot quadrangle boundary
linedelete all
lineset plotter
linesymbol 5
arcs %quad%

&label geolabels
textsize 0.10
res %cover% poly area gt 3500
labeltext %cover% unit %cover%.ru cc
asel %cover% poly

&label points
/* plot points for map symbols
markerdelete all
markerset geoscamp2.mrk
pointmarkers %pntcover% symbol

&label anno
/*plot annotation for all points and names
textset font.txt
textquality proportional
annotext %pntcover% dip
annotext %cover% name

&label titles
textfont 93715
textquality kern
textsize 0.35
plot %logo% box 2.0 27.75 5.0 28.75
move 5.5 28.5
text 'U.S. Department of the Interior'
move 5.5 27.9
text 'U.S. Geological Survey'
move 30.0 28.5
text 'Open-File Report 01-321' lr

move 30.0 27.9
text 'Database, Version 1.0' lr
textfont 93711
textsize 0.5
move 13.75 5.5
text 'Chromite Deposits in Central Part Stillwater
Complex,' lc
move 13.75 4.9
text 'Sweet Grass County, Montana:' lc
textsize 0.5
move 13.75 4.3
text 'A Digital Database for the Geologic Map of
the East Slope of Iron Mountain' lc
textsize 0.3
move 13.75 3.7
text 'by' lc
move 13.75 3.2
text 'A. L. Howland and Lorre A. Moyer' lc
move 13.75 2.7
text '2001' lc
textfont 93711
textsize 0.12
move 13.75 2.3
text 'Scale 1:3077' lc

&label explan
/* plot explanation - geologic units
shadedelete all
shadeset wpgcmyk.shd
textfont 93711
textsize 0.25
move 25.75 25.0
text 'Explanation'
textsize 0.12
textquality proportional
textfont 94021
keyarea 25.75 2.8 43.5 24.5
keybox 0.6 0.35
keyseparation 0.2 0.2
keyshade %key1%

&label linekey
/*plot explanation - line key
linedelete all
lineset geol_dia.lin
keybox 0.6 0.0
keyline %key2% nobox

&label strikedip
/*plot explanation - point key
textsize 0.12
textquality proportional textfont 94021
markerdelete all
markerset geoscamp2.mrk

```

```

keymarker %key4% nobox
markerdelete all
textsize 0.10
textquality proportional move 33.6 14.0

&label disclaimer
textfont 94021
textquality proportional
textsize 0.12
move 25.75 2.2
textfile %disclaimer%

&label credits
/*list credits
textfont 94021
textquality proportional
textsize 0.12
move 19.45 6.75
textfile %credits%

&label proj
/*plot map projection notes
textfont 94021
textquality proportional
textsize 0.12
move 3.9 6.75
text 'State Plane Coordinate System, zone 4526'
move 3.9 6.65
text 'Units: feet'
move 3.9 6.47
text 'North American Datum 1927'

&label references
/* list references
textfont 93711
textsize 0.25
textcolor 1
move 25.75 6.75
text 'References'
move 25.75 6.5
textsize 0.12
textquality proportional
textfont 94021
textfile irmt-ref.txt

&label index-map
plot indx_irmt.gra box 25.75 3.25 31.9 5.25
textfont 94021
textquality proportional
textsize 0.12
move 25.75 3.05
text 'Index map showing Iron Mountain area'
move 25.75 2.945
text 'in Sweet Grass County, Montana'

&label lat-long
/*plot neat line labels (latitude and longitude)
mape %quad%
linecolor 1
mapprojection geo.prj msp.prj
neatline 1855000 511000 1860000 516000 msp.prj
neatlinehatch 1000 1000 .25 0 msp.prj
textset font.txt
textsymbol 1
textsize 8 pt
textstyle typeset
textoffset -0.35 0.15
neatlinelabels 1000 top all msp.prj
textoffset -0.75 0.0
neatlinelabels 1000 left all msp.prj

&label done
quit
display 9999 3
draw ironmtn
&return

```

Appendix C - Metadata file (ironmtn.met) for the Iron Mountain GIS

Identification_Information:

Citation:

Citation_Information:

Originator: A.L. Howland and L. A. Moyer

Publication_Date: 2001

Title:

Chromite deposits in central part Stillwater Complex, Sweet Grass County, Montana: A digital database for the geologic map of the east slope of Iron Mountain

Edition: Version 1.0

Geospatial_Data_Presentation_Form: map

Series_Information:

Series_Name: U.S. Geological Survey Open-File Report

Issue_Identification: Open-File Report 01-321

Publication_Information:

Publication_Place: Menlo Park, CA

Publisher: U. S. Geological Survey

Online_Linkage:

URL =

<http://geopubs.wr.usgs.gov/open-file/of01-321/>

Description:

Abstract:

The digital geologic map of the east slope of Iron Mountain, Sweet Grass County, Montana was prepared from preliminary digital datasets digitized by Optronics Specialty Co., Inc. from a paper copy of plate 10 from UGSG Bulletin 1015-D (Howland, 1955). The files were prepared and transformed to the Montana State Plane South projection by Helen Z. Kayser (Information Systems Support, Inc.). Further editing and attributing was performed by Lorre A. Moyer in 2001. The resulting spatial digital database can be queried in many ways to produce a variety of derivative geologic maps.

Purpose:

This dataset was developed to provide a geologic map GIS of the east slope of Iron Mountain, Sweet Grass County, Montana for use in future spatial analysis by a variety of users. These data can be printed in a variety of ways to display various geologic features or used for digital analysis and modeling. This database is not meant to be used or displayed at any scale larger than 1:3077 (for example, 1:2000 or 1:1500).

Supplemental_Information:

This GIS consists of two major ArcInfo datasets: one line and polygon file

(ironmtn) containing geologic contacts and structures (lines) and geologic map rock units (polygons), and one point file (ironmtnp) containing structural data.

Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 1955

Currentness_Reference: Publication date of paper map.

Status:

Progress: complete

Maintenance_and_Update_Frequency: No updates are planned.

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -110.06

East_Bounding_Coordinate: -110.05

North_Bounding_Coordinate: 45.41

South_Bounding_Coordinate: 45.40

Keywords:

Theme:

Theme_Keyword_Thesaurus: none

Theme_Keyword: geology

Theme_Keyword: geologic map

Place:

Place_Keyword_Thesaurus: none

Place_Keyword: Montana

Place_Keyword: Sweet Grass County

Place_Keyword: Iron Mountain

Place_Keyword: USA

Access_Constraints: none

Use_Constraints:

This digital database is not meant to be used or displayed at any scale larger than 1:3077 (such as 1:2000).

Any hardcopies utilizing these data sets shall clearly indicate their source.

If the user has modified the data in any way they are obligated to describe the types of modifications they have performed on the hardcopy map. User specifically agrees not to misrepresent these data sets, nor to imply that changes they made were approved by the US Geological Survey.

Point_of_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Michael L. Zientek

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

Country: USA

Contact_Voice_Telephone: 1-509-368-3105

Contact_Facsimile_Telephone: 1-509-368-3199

Contact_Electronic_Mail_Address: mziertek@usgs.gov

Data_Set_Credit:

In 2000, the U.S. Geological Survey contracted Optronics Specialty Co., Inc. (Northridge, CA) to scan and vectorize the geologic map of the east slope of Iron Mountain (Howland, 1955, plate 10). Helen Z. Kayser (contractor) transformed the GIS provided by Optronics from scanner inches to a state plane coordinate system (Montana South). Lorre A. Moyer then edited and attributed the spatial digital data files with an interim geologic data model in 2001.

Native_Data_Set_Environment:

SunOS, 5.7, sun4u UNIX, and Windows NT 4.0 PC Workstation

ARC/INFO version 8.0

Data_Quality_Information:**Attribute_Accuracy:****Attribute_Accuracy_Report:**

Attribute accuracy was verified by manual comparison of the source with hard copy printouts, plots, and on-screen evaluation.

Logical_Consistency_Report:

Polygon and chain-node topology present. Segments making up the outer and inner boundaries of a polygon tie end-to-end to completely enclose the area.

Line segments area set of sequentially numbered coordinate pairs. No duplicate features exist nor duplicate points in a data string.

Intersecting lines are separated into individual line segments at the point of intersection. Point data are represented by two sets of coordinate pairs, each with the same coordinate values. All nodes are represented by a single coordinate pair which indicates the beginning or end of a line segment. The neatline was generated by mathematically generating the four sides of the quadrangle, densifying the lines of latitude and projecting the file to Montana State Plane zone 4526.

Completeness_Report:

All geologic units from Howland (1955, plate 10) are included in this GIS.

Positional_Accuracy:**Horizontal_Positional_Accuracy:****Horizontal_Positional_Accuracy_Report:**

The horizontal position accuracy for the digital data is no better than 15 feet based on the digitizing RMS error.

Lineage:

Source_Information:

Source_Citation:

Citation_Information:

Originator: Howland, A.L.

Publication_Date: 1955

Title: Geologic map of the east slope of Iron Mountain, Sweet Grass County, Montana

Geospatial_Data_Presentation_Form: map

Series_Information:

Series_Name: U.S. Geological Survey Bulletin

Issue_Identification: Bulletin 1015-D

Publication_Information:

Publication_Place: Washington, D.C.

Publisher: U.S. Geological Survey

Source_Scale_Denominator: 3077

Type_of_Source_Media: paper map

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 1955

Source_Currentness_Reference: publication date

Source_Citation_Abbreviation: Howland (1955)

Source_Contribution:

Howland (1955, plate 10) was the sole source of geologic information in this GIS.

Process_Step:

Process_Description:

Optronics Specialty Co., Inc. (Northridge, CA) scanned and vectorized the geologic map of the east slope of Iron Mountain (Howland, 1955, plate 10). Helen Z. Kayser (contractor) transformed the GIS provided by Optronics from scanner inches to a state plane coordinate system (Montana South). Lorre A. Moyer then edited and attributed the spatial digital data files with an interim geologic data model.

Process_Date: 2000-2001

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:

Grid_Coordinate_System_Name: State Plane Coordinate System

State_Plane_Coordinate_System:

SPCS_Zone_Identifier: 4526

Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: coordinate pair

Coordinate_Representation:

Abscissa_Resolution: 0.000004

Ordinate_Resolution: 0.000004

Planar_Distance_Units: Survey feet

Geodetic_Model:

Horizontal_Datum_Name: North American Datum of 1927

Ellipsoid_Name: Clarke 1866

Semi-major_Axis: 6378206.4

Denominator_of_Flattening_Ratio: 294.98

Entity_and_Attribute_Information:**Overview_Description:****Entity_and_Attribute_Overview:**

U.S. Geological Survey Open-File Report 01-321 contains a detailed description of each attribute code and a reference to the associated map symbols on the map source materials. The GIS includes a geologic linework arc attribute table, ironmtn.aat, that relates to the ironmtn.con (contact look-up table), ironmtn.st2 (structure look-up table), and the ironmtn.ref (source reference look-up table) files; a rock unit polygon attribute table, ironmtn.pat, that relates to the ironmtn.ru (rock unit look-up table) and ironmtn.ref (source reference look-up table) files; and a geologic map symbol point attribute table, ironmtnp.pat, that relates to the ironmtnp.sym (structural point data look-up tables) and ironmtnp.ref (source reference look-up table) files.

Entity_and_Attribute_Detail_Citation:

A detailed description of the items in the Iron Mountain GIS are given in the text of Open-File Report 01-321 available in Adobe Acrobat PDF format on the World Wide Web at <http://geopubs.wr.usgs.gov/open-file/01-321/>

Distribution_Information:**Distributor:****Contact_Information:****Contact_Organization_Primary:**

Contact_Organization: U.S. Geological Survey

Contact_Voice_Telephone: 1-888-ASK-USGS

Contact_Instructions:

This report is only available in electronic format at URL = <http://geopubs.wr.usgs.gov/open-file/of01-321/> or via anonymous FTP from [geopubs.wr.usgs.gov](http://geopubs.wr.usgs.gov/pub/open-file/of01-321) in the directory [pub/open-file/of01-321](http://geopubs.wr.usgs.gov/pub/open-file/of01-321)

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This digital geologic map GIS of the east slope of Iron Mountain, Sweet Grass County, Montana is not meant to be used or displayed at any scale larger than 1:3077 (for example, 1:2000).

Metadata_Reference_Information:

Metadata_Date: 20011205

Metadata_Contact:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: U.S. Geological Survey

Contact_Person: Pamela D. Derkey

Contact_Position: geologist

Contact_Address:

Address_Type: mailing and physical address

Address: 904 West Riverside Avenue, Rm 202

City: Spokane

State_or_Province: WA

Postal_Code: 99201

Country: USA

Contact_Voice_Telephone: 1-509-368-3114

Contact_Facsimile_Telephone: 1-509-368-3199

Contact_Electronic_Mail_Address: pderkey@usgs.gov

Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata

Metadata_Standard_Version: FGDC-STD-001-1998

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