# Geologic and Structure Maps of the Kalispell 1° x 2° Quadrangle, Montana, and Alberta and British Columbia: A Digital Database

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Miscellaneous Investigations Series Map I-2267
Digital database, version 1.0

2000
(originally published in 1992)

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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 1:250,000 (e.g., 1:100,000 or 1:24,000).

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

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## Introduction

The geologic map of the Kalispell 1° x 2° quadrangle (Harrison and others, 1992) was originally digitized by staff at the U.S. Geological Survey's Earth Resources Observation Systems (EROS) Data Center prior to 1994 and completed by U.S. Geological Survey staff and contractors at the Spokane Field Office (WA) in 2000 for input into a geographic information system (GIS). The resulting ArcInfo digital geologic map 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 1:250,000 (e.g., 1:100,000 or 1:24,000).

The map area is located primarily in northwest Montana (fig. 1). This open-file report describes 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. Please refer to (Harrison and others, 1992) for unit descriptions and a discussion of the geology and structure.

We thank Gregory N. Green, U.S. Geological Survey, for performing a digital review of the dataset.

## Data Sources, Processing, and Accuracy

Staff at the EROS Data Center digitized Harrison and others' (1992) geologic map of the Kalispell 1° x 2° quadrangle and minimally attributed the line and polygon features prior to 1994. This initial product was acquired by the Montana Bureau of Mines and Geology (MBMG). In 1999, the Spokane field office of the U.S. Geological Survey acquired the dataset from MBMG and augmented it with an interim geologic map data model (data base), further attributed and edited the dataset, and then plotted and compared the digital geologic map to the published paper geologic map (Harrison and others, 1992) to check for digitizing and attributing errors. All processing in Spokane was done in ArcInfo versions 7.2.1 and 8 installed on a Sun Ultra workstation.

The overall accuracy (with respect to the location of lines and points) of the digital geologic map (see figs. 2 and 3 for simplified versions) is probably no better than +/-178 meters. This digital database is not meant to be used or displayed at any scale larger than 1:250,000 (e.g., 1:100,000 or 1:24,000).

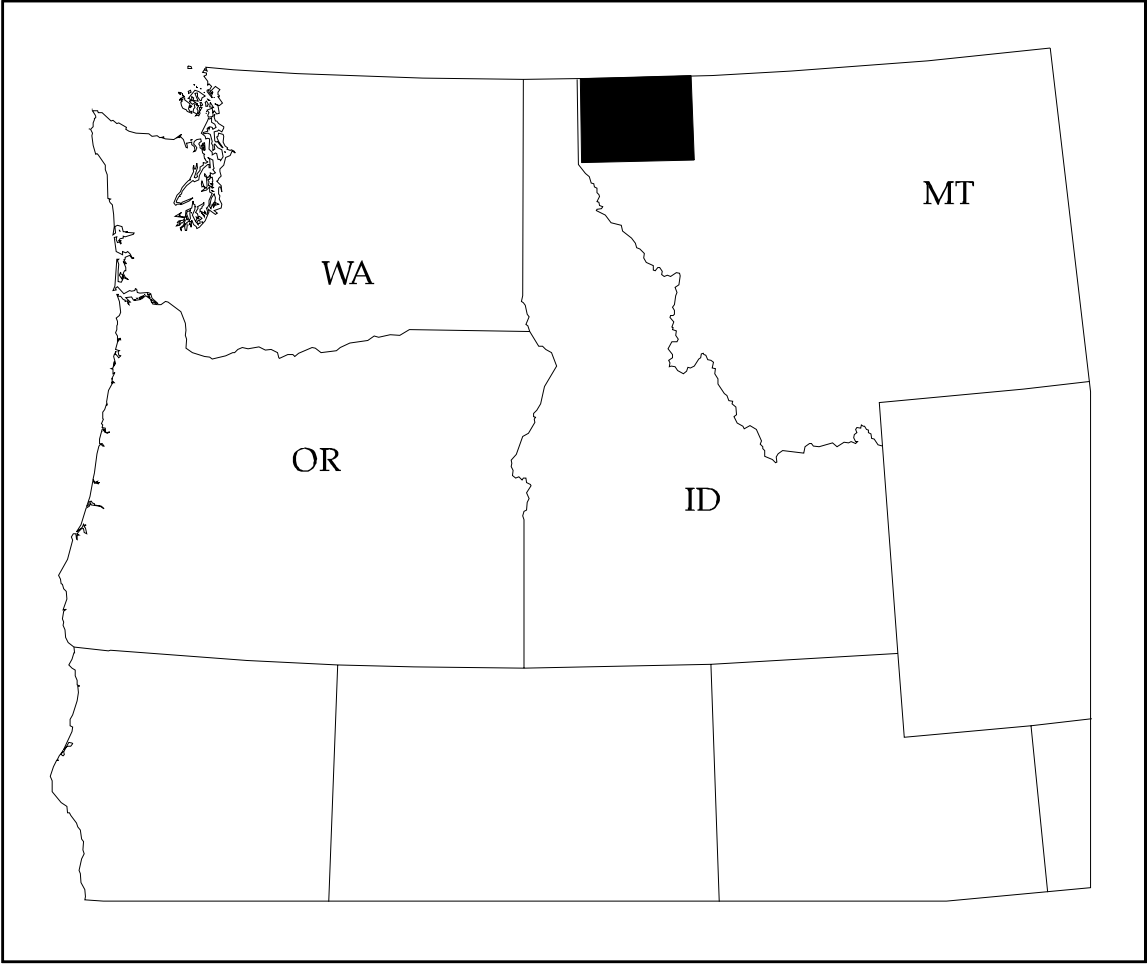


Figure 1. Index map showing the geographic extent of the Kalispell quadrangle (black fill) with respect to the Pacific Northwest.

DESCRIPTION OF MAP UNITS

Qal - Alluvial deposits (Holocene)

Qs - Landslide deposits (Holocene)

Qg - Glacial and fluvioglacial deposits (Pleistocene)

Ql - Lake sediments (Pleistocene)

Tk - Kishenehn Formation (Oligocene)

Kg - Felsic plutons (Creataceous)

Ks - Syenite (Cretaceous)

Kpy - Pyroxenite (Cretaceous)

Jf - Fernie Formation (Jurassic)

PPr - Rocky Mountain Formation (Permian and Pennsylvanian?)

Mu - Mississippian sedimentary rocks, undivided

Du - Devonian sedimentary rocks, undivided

Cu - Middle Cambrian sedimentary rocks, undivided

Dcu - Devonian and Middle Cambrian sedimentary rocks, undivided

ZYd - Mafic sills (Late and Middle Proterozoic)

Libby Formation (Middle Proterozoic)

Ylu - Upper part

Yl - Libby Formation, undivided

---

Ym - McNamara Formation (Middle Proterozoic)

Ybo - Bonner Quartzite (Middle Proterzoic)

Ybos - Siltite facies

Mount Shields Formation (Middle Proterozoic)

Ymsu - Upper part

Yms - Mount Shields Formation, undivided

---

Ysh - Shepard Formation (Middle Proterozoic)

Ypr - Purcell Lava (Middle Proterozoic)

Snowslip Formation (Middle Proterozoic)

Ysn - Red and green facies

Ysng - Green facies

Wallace Formation (Middle Proterozoic)

Ywu - Upper member

Ywm - Middle member

Ywl - Lower member

Yw - Upper, middle, and lower members, undivided

---

Ysw - Shepard, Snowslip, and Wallace Formations, undivided (Middle Proterozoic)

---

Yh - Main body of the Helena Formation (Middle Proterozoic)

Yhl - Lower member

---

Yhw - Main body of the Helena Formation and middle member of the Wallace Formation, undivided (Middle Proterozoic)

Ye - Empire Formation (Middle Proterozoic)

Ysr - St. Regis Formation (Middle Proterozoic)

Yr - Revett Formation (Middle Proterozoic)

Ys - Spokane Formation (Middle Proterozoic)

Ygl - Grinnell Formation (Middle Proterozoic)

Yb - Burke Formation (Middle Proterozoic)

Yu - Unnamed formation (Middle Proterozoic)

Yap - Appekunny Formation (Middle Proterozoic)

Yd - Mafic sills (Middle Proterozoic)

Prichard Formation (Middle Proterozoic)

Ypt - Transition member

Ypu - Upper member

Ypq - Quartzite member

Ypa - Argillite member

Ypl - Lower part

contact

fault

**Figure 2. Explanation for the Simplified Digital Geologic Map of the Kalispell 1:250,000 quadrangle.**

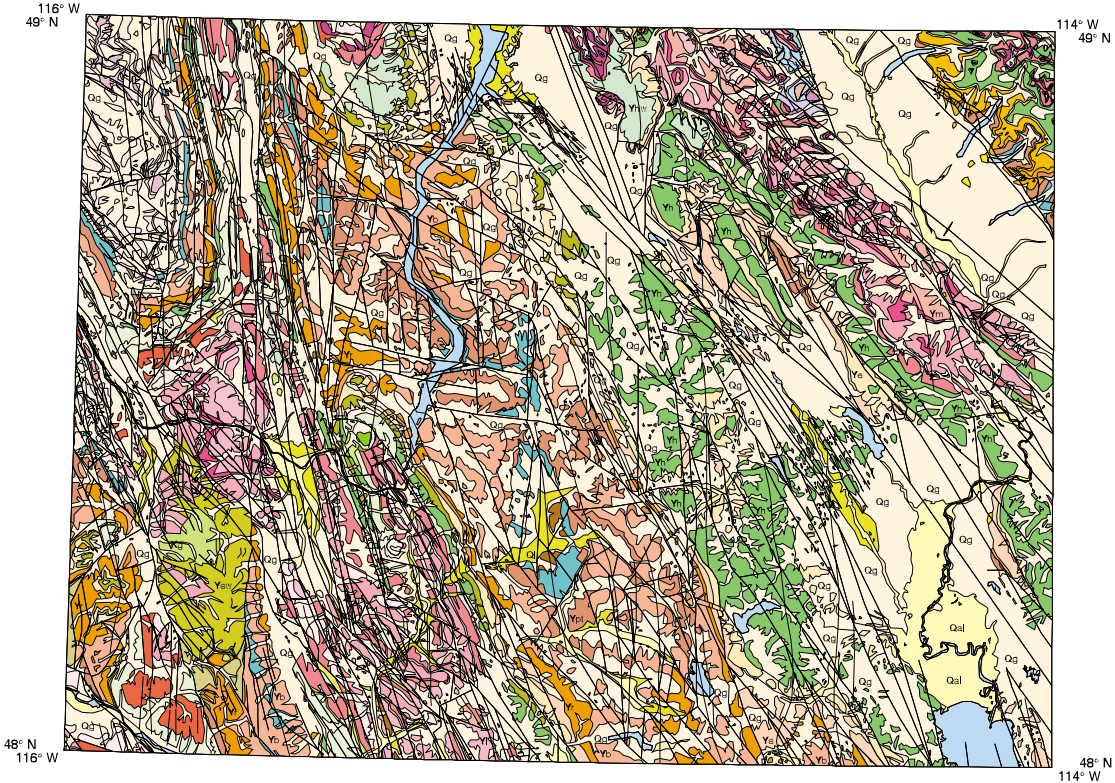


**Figure 3. Simplified Digital Geologic Map of the Kalispell 1:250,000 quadrangle.**

## GIS Documentation

The digital geologic map of the Kalispell $1^o$ x $2^o$ quadrangle includes a geologic linework arc attribute table, KAL250K.AAT, that relates to the KAL250K.CON, KAL250K.ST2, KAL250K.LGU and KAL250K.REF files and a rock unit polygon attribute table, KAL250K.PAT, that relates to the KAL250K.RU and KAL250K.REF files (see fig. 4). These data files are described below.

### *Linear Features*

Descriptions of the items identifying linear features such as contacts, boundaries (e.g., lines of latitude and longitude, state boundaries) and structures in the arc (or line) attribute table, KAL250K.AAT, are as follows:

| **KAL250K.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 KAL250K.CON file. Linecodes > 100 and < 600 represent structural features which are described in the KAL250K.ST2 file. Linecodes > 800 represent linear geologic units (e.g., dikes) which are described in the KAL250K.LGU file. |
| **name** | character | 30 | Name given to structural 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 KAL250K.REF file. |

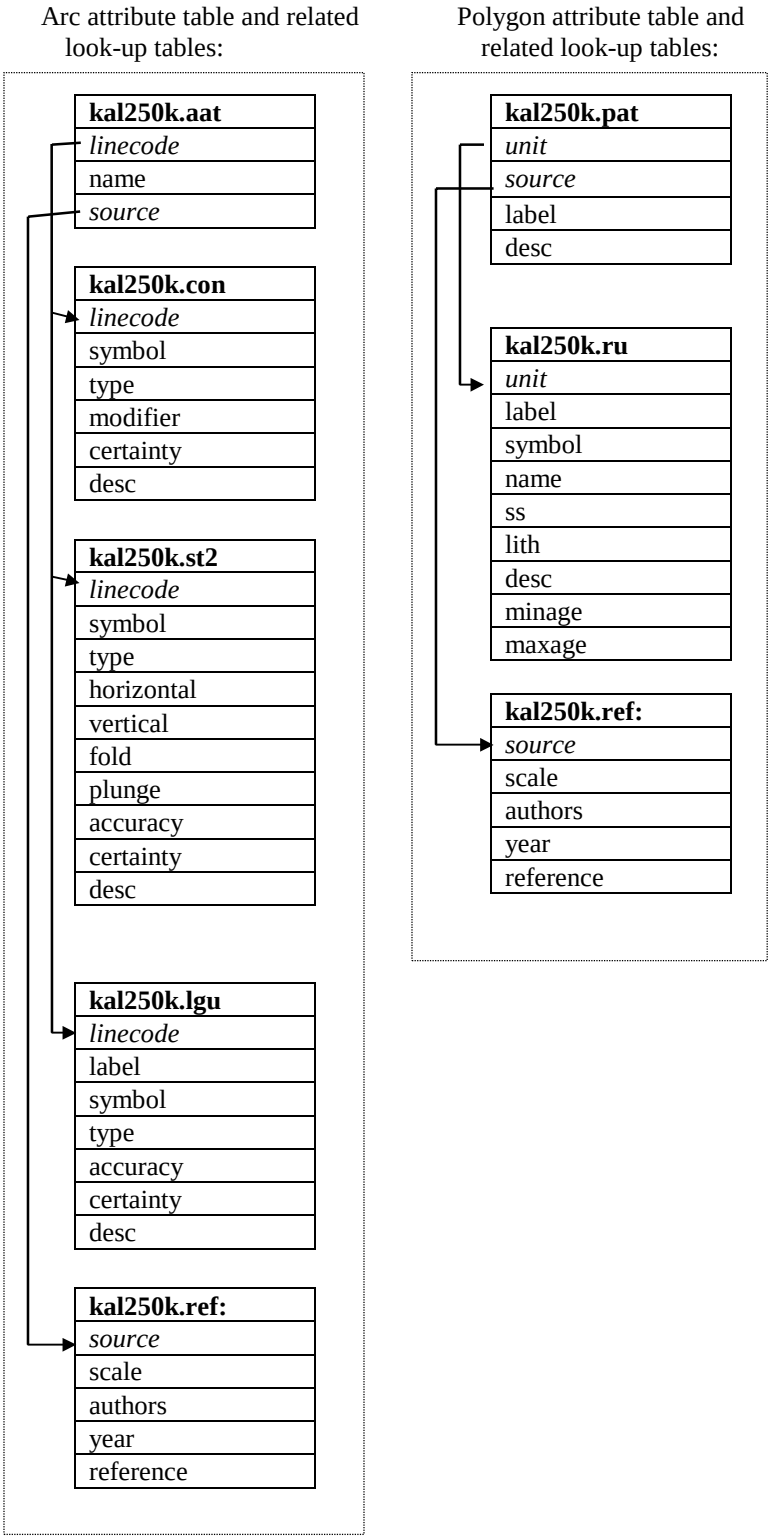


FIGURE 4: RELATIONSHIPS BETWEEN FEATURE ATTRIBUTE TABLES AND LOOK-UP TABLES.

Attribute descriptions for items in the contact (and boundary) look-table, KAL250K.CON [for use with the CARTO.LIN and GEOL_SFO.LIN linesets], are as follows:

| KAL250K.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 KAL250K.AAT.) |
| **symbol** | integer | 3 | Line symbol number used by ArcInfo to plot lines. Symbol numbers refer to the **CARTO.LIN lineset** for linecodes gt 40 and lt 100 and to the **GEOL_SFO.LIN lineset** for linecodes gt 0 and lt 40. |
| **type** | character | 10 | Major type of line, e.g., contact, state boundaries, lines of latitude and longitude used for neatlines. |
| **modifier** | character | 20 | Line type modifier, i.e., approximate, concealed, gradational. No entry implies 'known.' |
| **certainty** | character | 15 | Degree of certainty of contact or boundary, i.e., 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, KAL250K.ST2 [for use with the GEOL_SFO.LIN lineset] are as follows:

| KAL250K.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 KAL250K.AAT.) |
| **symbol** | integer | 3 | Line symbol number used by ArcInfo to plot arc (line). Symbol numbers refer to the **GEOL_SFO.LIN lineset** |
| **type** | character | 10 | Major type of structure, i.e., fault, fracture, fold, other. |
| **horizontal** | character | 20 | Type of horizontal fault movement, e.g., left-lateral, right-lateral. No entry implies 'unknown.' |
| **vertical** | character | 20 | Type of vertical fault movement, e.g., normal. No entry implies 'unknown.' |
| **fold** | character | 15 | Type of fold, e.g., anticline, syncline. |
| **plunge** | character | 15 | Type of plunge on fold, i.e., horizontal, plunging, plunging in, plunging out. |
| **accuracy** | character | 15 | Line type modifier indicating degree of accuracy, i.e., approximately located, concealed, gradational. No entry implies 'known.' |
| **certainty** | character | 15 | Degree of certainty of contact or boundary, i.e., inferred, uncertain. No entry implies 'certain.' |
| **desc** | character | 100 | Written description or explanation of structural feature. |

Attribute descriptions for items in the linear geologic units (e.g., dikes and rock units that could only be mapped as linear features at a scale of 1:250,000) look-up table, KAL250K.LGU, for use with the GEOL_SFO.LIN lineset, are as follows:

| **KAL250K.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 KAL250K.AAT.) |
| **label** | character | 10 | Map label used in the map proper to identify rock unit. |
| **symbol** | integer | 3 | Line symbol number used by ArcInfo to plot linear geologic unit.<br>Symbol numbers refer to **GEOL_SFO.LIN lineset**. |
| **type** | character | 10 | Major type of linear geologic unit, e.g., dike, formation, sill. |
| **accuracy** | character | 15 | Line type modifier indicating degree of accuracy, i.e., approximate, concealed, gradational. No entry implies 'known.' |
| **certainty** | character | 15 | Degree of line type certainty, i.e., inferred, uncertain. No entry implies 'certain.' |
| **desc** | character | 100 | Written description or explanation of linear geologic unit. |

### *Areal Features*

Descriptions of the items identifying geologic units in the polygon attribute table, KAL250K.PAT, are as follows:

| **KAL250K.PAT** | | | |
|---|---|---|---|
| ITEM NAME | ITEM TYPE | ITEM LENGTH | ATTRIBUTE DESCRIPTION |
| **unit** | integer | 4 | Numeric code used to identify the rock unit described in the KAL250K.RU look-up table. (This item also occurs in KAL250K.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 KAL250K.REF file. |
| **label** | character | 10 | Rock unit label (abbreviation) used to label unit on map. |
| **desc** | character | 100 | Written description or explanation of areal geologic unit. |

Attribute descriptions for items in the lithology (rock unit) look-table, KAL250K.RU (for use with the CALCOMP1.SHD shadeset), are as follows:

| **KAL250K.RU** | | | |
|---|---|---|---|
| ITEM NAME | ITEM TYPE | ITEM LENGTH | ATTRIBUTE DESCRIPTION |
| **unit** | integer | 4 | Numeric code used to identify rock unit. (This item also occurs in KAL250K.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 **CALCOMP1.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 lithologic unit, i.e., unconsolidated sediments, sedimentary rocks, metasedimentary rocks, intrusive rocks, extrusive rocks, metamorphic rocks, water, ice. |
| **desc** | character | 100 | Formal or informal unit name |
| **minage** | character | 7 | Minimum stratigraphic age of lithologic unit, i.e., CRET, TERT, PCY. |
| **maxage** | character | 7 | Maximum stratigraphic age of lithologic unit |

### *Source Attributes*

Descriptive source or reference information for the KAL250K ArcInfo coverage files is stored in the KAL250K.REF file. Attribute descriptions for items in the KAL250K.REF data source file is as follows:

| **KAL250K.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 KAL250K.AAT and KAL250K.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 (*.e00) with associated data files. These data and map images are maintained in a Transverse Mercator map projection:

| | |
|---|---|
| Projection: | TRANSVERSE |
| Units: | METERS |
| Spheroid: | CLARKE1866 |
| Datum: NAD27 | |
| Parameters: | |
| scale factor at central meridian: | 1.00000000 |
| longitude of central meridian | -115 0 0.00 |
| latitude of origin | 0 0 0.000 |
| false easting (meters) | 0.00000 |
| false northing (meters) | 0.00000 |

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/i-map/i-2267/**

or

2. Anonymous FTP from **geopubs.wr.usgs.gov,** in the directory
   **pub/i-map/i-2267/**

The Internet sites contain the digital geologic map of the Kalispell 1:250,000 quadrangle both as an ArcInfo interchange-format file (kal250k.e00) and as a HPGL2 plot file (kal250k.hp) of the map area, as well as the associated data files and ArcInfo macro programs which are used to plot the map at a scale of 1:250,000.

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

## Obtaining Paper Maps

Paper copies of the digital geologic map are not available from the USGS. However, with access to the Internet and access to a large-format color plotter that can interpret HPGL2 (Hewlett-Packard Graphics Language), a 1:250,000-scale paper copy of the map can be made, as follows:

1. Download the digital version of the map, **kal250k.hp,** from the USGS public access World Wide Web site on the Internet using the
   **URL = http://geopubs.wr.usgs.gov/i-map/i-2267/**

or

2. Anonymous FTP the plot file, **kal250k.hp,** from: **geopubs.wr.usgs.gov,** in the directory:
   **pub/open-file/i-map/i-2267/**

3. This file can be plotted by any large-format color plotter that can interpret HPGL2. The finished plot is about 28 inches by 40 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 ArcInfo with the provided AML.

## References Cited

Harrison, J.E., Cressman, E.R., and Whipple, J.W., 1992, Geologic and structure maps of the Kalispell $1^{o}$ x $2^{o}$ quadrangle, Montana, and Alberta and British Columbia: U.S. Geological Survey Miscellaneous Investigations Series Map I-2267, scale 1:250,000.

## Appendix A - List of digital files in the Kalispell database (packaged as mi-2267.tar.Z)

--Uncompress the **mi-2267.tar.Z** file and extract the files from the resultant **mi-2267.tar** file.
--Run '**importfile.aml**' in ArcInfo 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> kal250k.hp' command to send the kal250k.hp file to a large-format color plotter that can interpret Hewlett-Packard Graphics Language.
--To re-create the *.GRA file, open the ArcPlot module, enter 'display 1040', enter a new filename for the graphics file, enter '&run kal250k' (and enter 'quit' to exit the ArcPlot module). See the **00readme.txt** file for further file details.

**Report text in portable document format:**

- mi-2267.pdf – this report

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

- kal250k.e00
- kal250k.met

**ArcInfo graphics (*.gra) and HPGL2 map plot (*.hp) files for the geologic map:**

- kal250k.gra /.hp

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

- calcomp1.shd.e00 - shadeset
- fnt037.e00 – font 37
- fnt038.e00 – font 38
- fnt040.e00 – font 40
- geol_sfo.lin.e00
- kaltm.e00 - exterior boundary of the Kalispell quadrangle

**AML, graphics, key, and text files necessary to re-create the geologic map:**

- scale2a.aml - plots scale bar on plate
- kal250k.aml - program to create graphics file of the geologic map.
- indx_kal.gra - index map graphic
- usgslogo.gra – USGS logo
- kal_line.key - lineset symbol values and descriptive text for lines on the map sheet
- kal_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 quadrangle
- tvm.prj - a text file to identify transverse mercator map projection - for use in adding latitude and longitude notation around the margins of the map quadrangle
- cal.dat –plotter calibration text file
- kal_crd.txt - text file listing map credits on the map sheet
- kal_disc.txt – text file with disclaimer statement
- kal_ref.txt - text file listing map references on the map sheet

## Appendix B - ArcInfo Macro Language program (kal250k.aml) used to plot the geologic map of the Kalispell quadrangle

```
/*  kal250k.aml, 9/12/00,  hzk/pd
/*  to plot the digital geologic map of the
Kalispell
/*  1- by 2-degree quadrangle in color
/*  USGS Miscellaneous Investigations
Series Map I-2267 (scale 1:250,000)
/************************
/*  This Arc/Info Macro Language (AML)
program will plot the geologic map sheet
/*  for the Kalispell 1- by 2-degree
quadrangle.
/*  To run this AML:
/*  1. Type '&run kal250k' at the 'Arc:'
prompt to start the program,
/*  2. Run the Arc/Info HPGL2 command to
convert the GRA file to an HPGL2 file,
/*        i.e.,  Arc:hpgl2 kal250k kal250k.hp #
1.0 opaque # 0 # # # cal.dat
/*  3. Execute the UNIX 'lpr' command to
print the 1:250,000-scale geologic
/*        map plot on your plotter,
/*        i.e., lpr -Ppicasso kal250k.hp
/*
/***************************
ap
display 1040
kal250k.gra

clear
clearselect

pagesize 43.0 28.0
/*pagesize 35.0 28.0
pageunits inches
mapunits meters
mapscale 250000
mapposition ll 0.75 6.0
mapangle 0.2

&set cover kal250k
&set quad kaltm
&set key1 kal_line.key
&set key2 kal_pol.key
&s credits kal_crd.txt
&s refs kal_ref.txt
&s disclaimer kal_disc.txt
/* -->where 'cover' contains contacts and
structures and rock units and 'quad' is the
quadrangle boundary.

mape %cover%
maplimits 0.0 2.4 26 26

/*draw outside box
linesymbol 9
linecolor 1
box 0.5 0.5 38.0 27.5
/*
textquality proportional
textfont 94021
linedelete all

/* cut marks
markerset plotter
markersymbol 1
markersize 0.1
marker 0 0
marker 0 28
marker 38.5 0
marker 38.5 28

&label shadepolys
/* color polygons for geologic rock units
shadedelete all
shadeset calcomp1
polygonshade %cover% unit %cover%.ru

&label contacts
/* plot contacts and boundaries
linedelete all
lineset geol_sfo.lin
res %cover% arcs linecode gt 0 and
linecode lt 40
arclines %cover% linecode %cover%.con
asel %cover% arcs
linedelete all
```

```
lineset carto.lin
res %cover% arcs linecode gt 40 and
linecode lt 100
arclines %cover% linecode %cover%.con
asel %cover% arcs

&label structure
/*plot faults with line patterns
linedelete all
lineset geol_sfo.lin
res %cover% arcs linecode gt 100 and
linecode lt 400
arclines %cover% linecode %cover%.st2
asel %cover% arcs

&label morestructure
/* plot folds with line patterns
linedelete all
lineset geol_sfo.lin
res %cover% arcs linecode gt 400 and
linecode lt 600
arclines %cover% linecode %cover%.st2
asel %cover% arcs

&label lgu
/* plot linear geologic units with line pattern
linedelete all
lineset geol_sfo.lin
res %cover% arcs linecode gt 800
arclines %cover% linecode %cover%.lgu
asel %cover% arcs

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

&label geolabels
textsize 0.10
res %cover% poly area gt 3000000
labeltext %cover% unit %cover%.ru cc
asel %cover% poly

&label logotitles
textfont 93715
textquality kern
textcolor 1
textsize 0.35
plot usgslogo.gra box 2.0 25.75 5.0 26.75
move 5.5 26.35
text 'U.S. Department of the Interior'
move 5.5 25.85
text 'U.S. Geological Survey'
move 36.5 26.35
text 'Miscellaneous Investigations Series
Map I-2267' lr
move 36.5 25.85
text 'Database, version 1.0' lr
textfont 93711
textsize 0.4
move 13.75 6.0
text 'Geologic and Structure Maps of the
Kalispell 1° x 2° Quadrangle, Montana, and
Alberta and' lc
move 13.75 5.4
text 'British Columbia: A Digital Database' lc
textsize 0.3
move 13.75 4.95
text 'By' lc
move 13.75 4.5
text 'Jack E. Harrison, Earle R. Cressman,
and James W. Whipple' lc
move 13.75 4.05
text 'Digital database by' lc
move 13.75 3.6
text 'Helen Z. Kayser, Pamela D. Derkey,
and EROS Data Center' lc
move 13.75 3.15
text '2000' lc
move 13.75 2.70
text '(map originally published in 1992)' lc

&label explan-poly
/* plot explanation - geologic units
shadedelete all
shadeset calcomp1.shd
textfont 93711
textsize 0.25
/*move 25.75 25.0
move 26.55 25.0
text 'Explanation'
textsize 0.12
textquality proportional
textfont 94021
```

```
keyarea 26.55 2.8 44.30 24.5
keybox 0.6 0.35
keyseparation 0.2 0.2
keyshade %key2%

&label linekey
/*  plot explanation - line key
linedelete all
lineset geol_sfo.lin
textsize 0.12
textquality proportional
textfont 94021
keybox 1.0 0.0
keyline %key1% nobox

&label disclaimer
textfont 93713
textquality proportional
textsize 0.12
move 32.10 3.2
textfile %disclaimer%

&label credits
/*list credits
textfont 93713
textquality proportional
textsize 0.12
move 21.75 7.1
textfile %credits%

&label proj
/*plot map projection notes
textfont 93713
textquality proportional
textsize 0.12
move 2.0 7.0
text 'map projection: Transverse Mercator'

&label scale
/* plot scale bars
linedelete all
lineset plotter
textfont 94021
textsize 0.12
&r scale2a 13.75 2.25 other 250000

&label references
/* list references
textfont 93711
textsize 0.25
textcolor 1
move 32.15 6.70
text 'References'
move 32.15 6.45
textsize 0.12
textquality proportional
textfont 94021
textfile %refs%

&label index-map
plot indx_kal.gra box 32.15 3.75 35.15 5.75
textfont 93713
textquality proportional
textsize 0.12
move 32.15 3.725
text 'Index map showing Kalispell
quadrangle'

&label lat-long
/* plot neat line labels (latitude and longitude)
mape %quad%
linecolor 1
mapprojection geo.prj tvm.prj
neatline -116 48.0 -114 49.0 geo.prj
neatlinehatch 0.25 0.25 0.2 0 geo.prj
textset font.txt
textsymbol 1
textsize 8 pt
textstyle typeset
textoffset -0.35 0.15
neatlinelabels 0.25 top all geo.prj dms '
textoffset -0.75 0.0
neatlinelabels 0.25 left all geo.prj dms '

&label done
quit
display 9999 3
draw kal250k
&return
```

## Appendix C - Metadata file (kal250k.met) for the Kalispell database

Identification_Information:

  Citation:
    Citation_Information:
      Originator:
        Harrison, J.E., Cressman, E.R., Whipple, J.W., Kayser, H.K.,
        Derkey, P.D., and EROS Data Center
      Publication_Date: 2000
      Title:
        Geologic and structure maps of the Kalispell 1:250,000
        quadrangle, Montana, and Alberta and British Columbia: a
        digital database.
Description:

  Abstract:
    This dataset was digitized by the U.S. Geological Survey EROS
    Data Center and U.S. Geological Survey Spokane Field Office
    for input into an Arc/Info geographic information systsem
    (GIS). The digital geologic map database can be queried in
    many ways to produce a variety of derivative geologic maps.
  Purpose:
    This dataset was developed to provide geologic map GIS of the Kalispell
    1:250,000 quadrangle for use in the future spatial analysis by a
    variety of users.

    This database is not meant to be used or displayed at any scale larger
    than 1:250,000 (e.g., 1:100,000 or 1:24,000).
  Supplemental_Information:
    This GIS dataset consists of one major Arc/Info dataset: a line and
    polygon file (kal250k) that contains geologic contacts and structures
    (lines) and geologic map rock units (polygons).
Time_Period_of_Content:
  Time_Period_Information:
    Single_Date/Time:
      Calendar_Date: 2000
  Currentness_Reference: publication date

Status:

Progress: completed
Maintenance_and_Update_Frequency: None planned, may update with new geologic map data model.

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -116.00
East_Bounding_Coordinate: -114.00
North_Bounding_Coordinate: 49.00
South_Bounding_Coordinate: 48.00

Keywords:
Theme:
Theme_Keyword_Thesaurus: none
Theme_Keyword: geology
Theme_Keyword: geologic map
Place:
Place_Keyword_Thesaurus: none
Place_Keyword: Montana

Place_Keyword: Kalispell

Place_Keyword: Flathead County

Place_Keyword: Pacific Northwest

Place_Keyword: USA

Access_Constraints: none

Use_Constraints:
This digital database is not meant to be used or displayed at any scale larger than 1:250,000 (e.g., 1:100,000 1:24,000).

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 U.S. Geological Survey.

Point_of_Contact:

Contact_Information:
Contact_Person_Primary:
Contact_Person: Pamela D. Derkey
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: 1-509-368-3114
Contact_Facsimile_Telephone: 1-509-368-3199
Contact_Electronic_Mail_Address: pderkey@usgs.gov

Data_Set_Credit:
Jack E. Harrison, Earle R. Cressman, James W. Whipple compiled the geology and published the original geologic paper map.

EROS Data Center staff scanned/digitized geologic map and prepared the original ArcInfo data prior to 1994.

Montana Bureau Mines and Geology acquired the original data and, in 1999, provided it to the USGS in Spokane, WA.

R.J. Miller (USGS) converted the original data to a single topologically correct ArcInfo coverage.

Helen Z. Kayser (contractor) attached and attributed an interim geologic map data model.

Thomas P. Frost (USGS), Pamela D. Derkey (USGS), and William N. Kelley (contractor) visually compared the hard copy plots with the source documents;

Native_Data_Set_Environment:
SunOS, 5.7, sun4u UNIX
ARC/INFO version 7.2.1

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:

Attribute accuracy was verified by manual comparison of the source with hard copy printouts and plots.

Logical_Consistency_Report:
Polygon and chain-node topology present. Polygons intersecting the neatline are closed along the border. Segments making up the outer and inner boundaries of a polygon tie end to end to completely enclose the area. Line segments are a set of sequentially numbered coordinate pairs. No duplicate features exist nor do duplicate points in a data string. 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:
This digital geologic map is wholly derived from Harrison, and others (1992).
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: +/-178 meters
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Harrison, Jack E.; Cressman, Earle R.; and Whipple, James W.
Publication_Date: 1992
Title:
Geologic and Structure Maps of the Kalispell 1- x 2-degree Quadrangle, Montana, and Alberta and British Columbia.
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: USGS Miscellaneous Investigations Series
Issue_Identification: Map I-2267
Publication_Information:
Publication_Place: Denver, CO
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 250000
Type_of_Source_Media: published paper map
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1992

Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Harrison and others, 1992.
Source_Contribution:
These two maps were the only maps used to create the digital geologic map database.

Process_Step:
Process_Description:
The published paper geologic map was digitized by the EROS Data Center prior to 1994.
Process_Step:
Process_Description:
The digital files were attributed by Helen Z. Kayser (contractor) at the USGS Spokane Field Office using an iterim geologic map data model. The data were checked for position by comparing plots of the digital data to the source.
Process_Date: 1999-2000

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
Point_and_Vector_Object_Count: 12246
SDTS_Point_and_Vector_Object_Type: String
Point_and_Vector_Object_Count: 21022
SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Point_and_Vector_Object_Count: 9580

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Transverse Mercator
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 1.00000
Longitude_of_Central_Meridian: -115
Latitude_of_Projection_Origin: 0
False_Easting: 0.00000
False_Northing: 0,000,000.
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:

Abscissa_Resolution: not determined
Ordinate_Resolution: not determined
Planar_Distance_Units: Meters
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:
The 'Geologic map of the Kalispell 1- x 2-degree quadrangle, Montana ...' Miscellaneous Investigations Series Map I-2267 contains a detailed description of each attribute code. The database includes a geologic linework arc attribute table, kal250k.aat, that relates to the kal250k.con (contact look-up table), kal250k.st2 (structure look-up table), kal250k.lgu (linear geologic unit look-up table), and kal250k.ref (source reference look-up table) files; a rock unit polygon attribute table, kal250k.pat, that relates to the kal250k.ru (rock unit look-up table) and kal250k.ref (source reference look-up table) files.

Entity_and_Attribute_Detail_Citation:
See the kal250k.pdf file (available on the World Wide Web at http://geopubs.wr.usgs.gov/i-map/i2267/) for detailed descriptions of items in the database.

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey Information Services

Contact_Instructions:
This report is only available in an electronic format at the following URL = http://geopubs.wr.usgs.gov/i-map/i2267/ or via anonymous FTP from geopubs.wr.usgs.gov, in the directory pub/i-map/12267
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

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This digital geologic map database of the Kalispell 1:250,000 quadrangle is not meant to be used or displayed at any scale larger than 1:250,000 (e.g., 1:100,000 or 1:24,000)

Metadata_Reference_Information:
  Metadata_Date: 20001011
  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_Access_Constraints: none
  Metadata_Use_Constraints: