Raster Images of Geologic Maps of Middle Proterozoic Belt Strata in Parts of Benewah, Bonner, Kootenai and Shoshone Counties, Idaho and Lincoln, Mineral and Sanders Counties, Montana

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Open-File Report 01–438

2001

Approved by the Director November 28, 2001

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

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ABSTRACT

Geologic maps of the western part of the Belt Basin of western Montana and northern Idaho were converted into digital raster (*TIFF* image) format to facilitate their manipulation in geographic information systems. The 85-mile x 100-mile map area mostly contains rocks belonging to the lower and middle Belt Supergroup. The area is of interest as these Middle Proterozoic strata contain vein-type lead-zinc-silver deposits in the Coeur d'Alene Mining District in the St. Regis and Revett formations and strata-bound copper-silver deposits, such as the Troy mine, within the Revett Formation. The Prichard Formation is also prospective for strata-bound lead-zinc deposits because equivalent Belt strata in southern British Columbia, Canada host the Sullivan lead-zinc deposit.

Map data converted to digital images include 13 geological maps compiled in the 1980's at scales ranging from 1:48,000 to 1:12,000. Geologic map images produced from these maps by color scanning were registered to grid tick coverages in a Universal Transverse Mercator (North American Datum of 1927, zone 11) projection using ArcView Image Analysis. Geo-registering errors vary from 10 ft to 114 ft.

INTRODUCTION

Geologic data were collected during the period of 1979 to 1984 by ASARCO Inc. in the Idaho-Montana area extending from the Purcell Mountains on the north to the St. Joe Mountains on the south (fig. 1). Geological data were originally compiled on 11 maps at a scale of 1:48,000 and two maps (Troy West Project area, Brooks Mountain-Goat Mountain area) at a scale of 1:12,000. Geologic data were compiled on photographically constructed base maps of U.S. Geological Survey topographic maps available at the time.

The purpose of the report is to release geo-referenced geological data in digital image format that may be of use to others studying geology of the Belt Basin. Geo-referencing is valuable because these data can be presented in a Universal Transverse Mercator projection in GIS (Geographic Information System) programs for comparing with other kinds of data as well as being printed as a paper map. These maps provide insight on the interpretation of geology in parts of northwestern Montana and northern Idaho underlain by Middle Proterozoic meta-sedimentary rocks by geologists working for ASARCO Inc.

The map area includes strata of the Belt Supergroup of Middle Proterozoic age that occur within the western part of the Belt Basin. Belt strata that are of interest include the Prichard, Burke, Revett, and St. Regis formations. These strata host important lead, zinc, silver, and copper mineral deposits. Vein-type deposits of lead, zinc, and silver occur within the Prichard, Burke, Revett, and St. Regis formations in the Coeur d'Alene mining district to the south. Large strata-bound copper-silver deposits occur within the Revett Formation in the Cabinet Mountains (for example, Troy mine) and the large strata-bound Sullivan lead-zinc deposit occurs in strata equivalent to the Prichard Formation north of the study area in British Columbia.

The USGS has digitized contacts of the Revett Formation from these maps to create vector files. The vector files will be published in a related report about mineral resources of the Revett Formation (unpublished data).

Acknowledgements

Several individuals other than the authors contributed significantly in the field mapping and compilation of the geological data over five years leading to the completion of these geological maps. They include Brian White, Erick Lafco, Eileen Dye, Susan Besser, Russell Smith, Debbie Clayton, Wayne Rich, and John Balla of ASARCO Inc. Gerry Van Vorhiis, Vice President of ASARCO Inc., kindly provided permission to publish these data. Mary Carlson and Steve Munts, contract geologists for U.S.G.S. digitized the grid ticks and compiled metadata for this report.

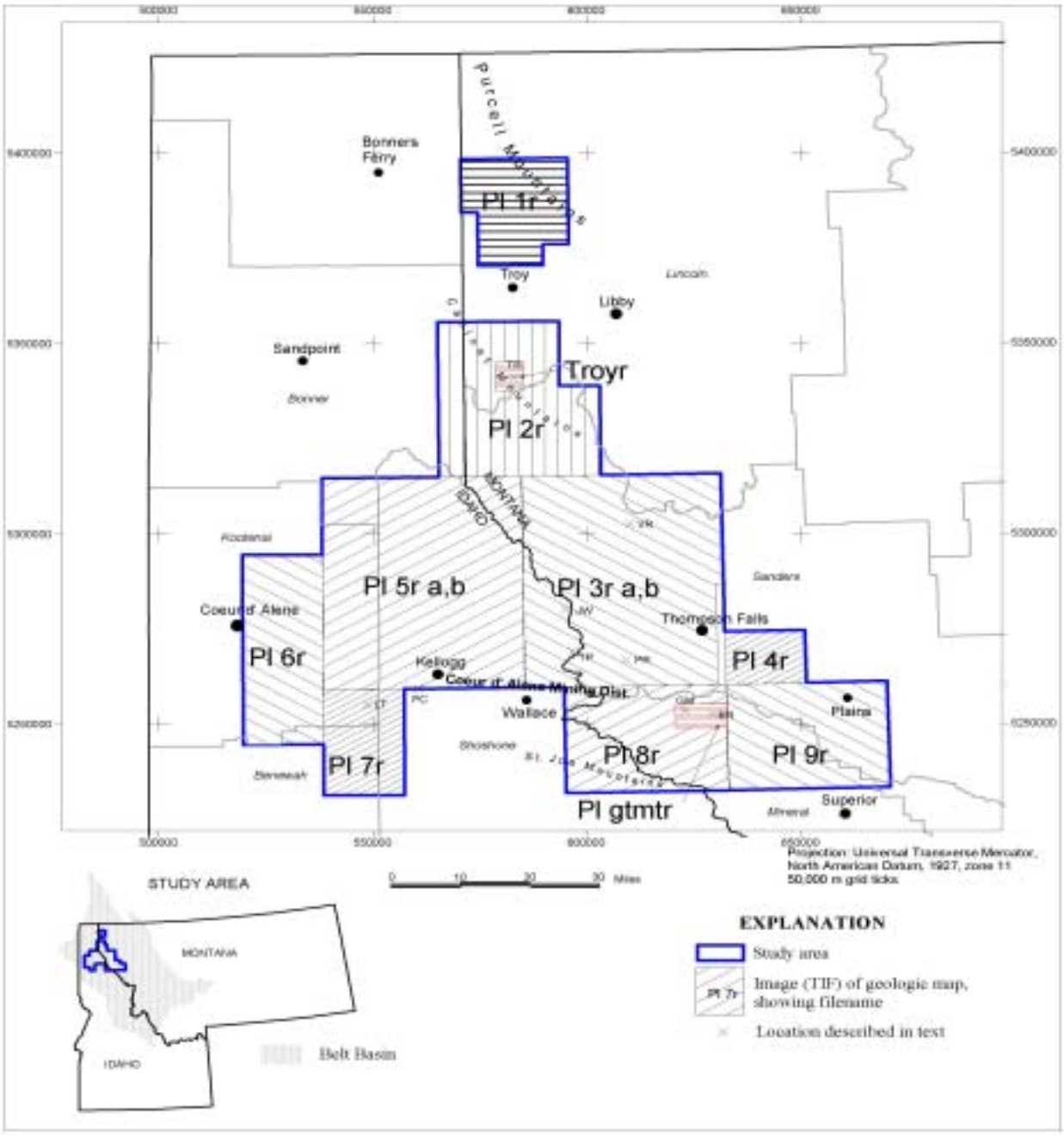

Figure 1. Location map

Hatch patterns indicate area of eleven geologic maps. Each map is identified by filename (in large letters) of image. Geologic map scale is 1:48,000 for nine larger maps and 1:12,000-scale for maps (detail images of Troyr and Plgtmtr) of smaller areas. Pl 5r and Pl 3r consist of two separate maps (a-north,b-south). BR Brooks Mountain, GM Goat Mountain, JW Jack Waite mine, LT LaTour Peak and Boise Peak, PC Pine Creek, PR Prospect Creek, TP Thompson Pass, TR Troy mine, VR Vermilion River; Italian Gulch is located ¼ mile north of Kellogg

DIGITAL CONVERSION OF MAPS

Geologic (colored paper) maps were scanned in TIFF (Tag Image File Format) raster graphic format (**.tif*). An Ideal FSC 6010 36-inch width color pass-through scanner was used at 200 pixels per inch at 8 bit indexed color level or at the 24-bit color indexed level. Images were registered and rectified to grid tick coverages in a Universal Transverse Mercator (UTM, North American Datum of 1927, zone 11) projection using ArcView Image Analysis Extension, version 1.1. The root mean square (RMS) error was recorded for each tick registration (table 1). All RMS errors are small and vary from 10 ft to 93 ft. A comparison of location of each TIFF image was made with 1:24,000-scale USGS Digital Raster Graphic (DRG) maps to determine the error between these two digital map products. Table 1 shows the difference between the locations of a recognizable point on the DRG with the identical point on the TIFF image. Features compared were quadrangle corners, surveyed section corners, benchmarks, or other readily locatable points. It shows that errors are small and vary from 10 ft to 114 ft.

Geologic map images (figs. 2 through14) are presented *as received* from ASARCO Inc. No attempt was made to modify the data on maps to meet USGS map standards. Hand pencil coloring on maps indicates where geologic data were verified in the field. Darker shading and solid outlines emphasize outcrops. Uncolored areas show geological data obtained from other published sources (not listed), but not verified in the field.

Additional information about each map image, such as description, type of file, name of metadata file, and projection information are given in Appendix I. Geologic map images listed in Appendix I are appropriate for use in a GIS.

Table 1. List of image files and errors

[*At 200 pixels per inch, an RMS error of 1.0 equates to about 20 ft for a map scale of 1:48,000 and 5 ft at 1:12,000 scale. **Number in parentheses () indicates the number of points compared between TIFF and DRG maps.]

Figure No.	Name of image	RMS error*	Mean difference between TIFF and DRG, in ft**
2	pl1r	1.85	64 (2)
3	pl2r	2.36	68 (2)
4	pl3ar	4.66	not compared
5	pl3br	3.81	108 (2)
6	pl4r	1.29	114 (2)
7	pl5ar	2.54	51 (2)
8	pl5br	2.73	not compared
9	pl6r	2.73	91 (2)
10	pl7r	3.64	65 (2)
11	pl8r	0.62	77 (2)
12	pl9r	3.76	99 (2)
13	plgtmtr	3.73	73 (3)
14	troyr	1.97	10 (4)

Digital data and files

Text and data from this report can be found on the internet at the USGS website: http://pubs.usgs.gov/of/2001/of01-438/

Text and data accompanying this report are as shown in table 2.

Table 2. List of files associated with this report.

[*.e00 - Arc export file, PDF - Adobe Acrobat Portable Document Format, TIF - Tag Image Format, TFW - world file to accompany TIF, MS – Microsoft, UTM – Universal Transverse Mercator, metadata is prepared according to FGDC standards]

Name	Folder	Type	Description	Size
README	OFR-Revett	Text	Describes report, folders and accompanying files	3 kb
gridticg, gridticu	Exportfiles	*.e00	Grid tics in geographic and UTM projection within study area	52 kb
OF01_438_fig1.pdf	Figures/ Figs_1and15	PDF	Figure 1 – Location map	122 kb
OF01_438_fig15.pdf	Figures/ Figs_1and15	PDF	Figure 15 – Stratigraphic column	16 kb
pl1r, pl2r, pl3ar, pl3br, pl4r, pl5ar, pl5br, pl6r, pl7r, pl8r, pl9r, troyr, and plgtmtr (these are shown in figures 2 through 14; see Appendix I for complete list)	Figures/ _Images	TIF, TFW	Geo-registered TIFF images of Figures 2 through 14	451 Mb
pl1r, pl2r, pl3ar, pl3br, pl4r, pl5ar, pl5br, pl6r, pl7r, pl8r, pl9r, troyr, and plgtmtr (these are shown on figures 2 through 14; see Appendix I for complete list)	Figures/ Full-size PDFs_figs2-14	PDF	Figures 2 through 14 of same size as TIFFs. These are not geo-registered but are provided for viewing purposes only; they were constructed from TIFF images.	43 Mb
OF01_438_met	Metadata	Text	Metadata for image files (TIFF)	22 kb
fig2_pl1r_pg, fig3_pl2r_pg, fig4_pl3ar_pg, fig5_pl3br_pg, fig6_pl4r_pg, fig7_pl5ar_pg, fig8_pl5br_pg, fig9_pl6r_pg, fig10_pl7r_pg, fig11_pl8r_pg, fig12_pl9r_pg, fig13_plgtmtr_pg, fig14_troyr_pg	Figures/Pagesize_ figs2-14	JPG, PDF	Figures 2 through 14 of letter (page) size constructed from TIFFS. These are not geo-registered but are provided for viewing purposes only.	
OF01_438	OFR_Revett	MS Word	Report, figures 1, 15, and metadata	1.5 Mb

Figure 2. Image of Pl1r

Figure 3. Image of Pl2r

Figure 4. Image of Pl3ar

Figure 5. Image of Pl3br

Figure 6. Image of Pl4r

Figure 7. Image of Pl5ar

Figure 8. Image of Pl5br

Figure 9. Image of Pl6r

Figure 10. Image of Pl7r

Figure 11. Image of Pl8r

Figure 12. Image of Pl9r

Figure 13. Image of Plgtmtr

Figure 14. Image of Troyr

MAP UNITS

At least 29,000 ft of Middle Proterozoic Belt Supergroup strata occur in the region (fig. 15). In addition, felsic and syenitic rocks of Cretaceous age (Kg or Ki map units) intrude the Belt strata. Porphyritic hornblende-biotite quartz monzonite and granodiorite (Kg) occur near the city of Wallace, Idaho and Vermilion River in Montana. Syenite (Ki) consists of medium-to-coarse-grained, aegerine-hornblende-mica-bearing feldspathic rock and is found northeast of Thompson Pass (Harrison, Griggs, and Wells, 1986; Harrison, Cressman, and Whipple, 1992). Descriptions of rock units that follow about the Prichard Formation mainly rely on unpublished ASARCO Inc. reports (Appelgate, 1979, written communication; Joseph, 1982, 1983, written communication) and that of the remaining units, in part, relies on work of Harrison, Griggs, and Wells (1986) and Harrison, Cressman, and Whipple (1992).

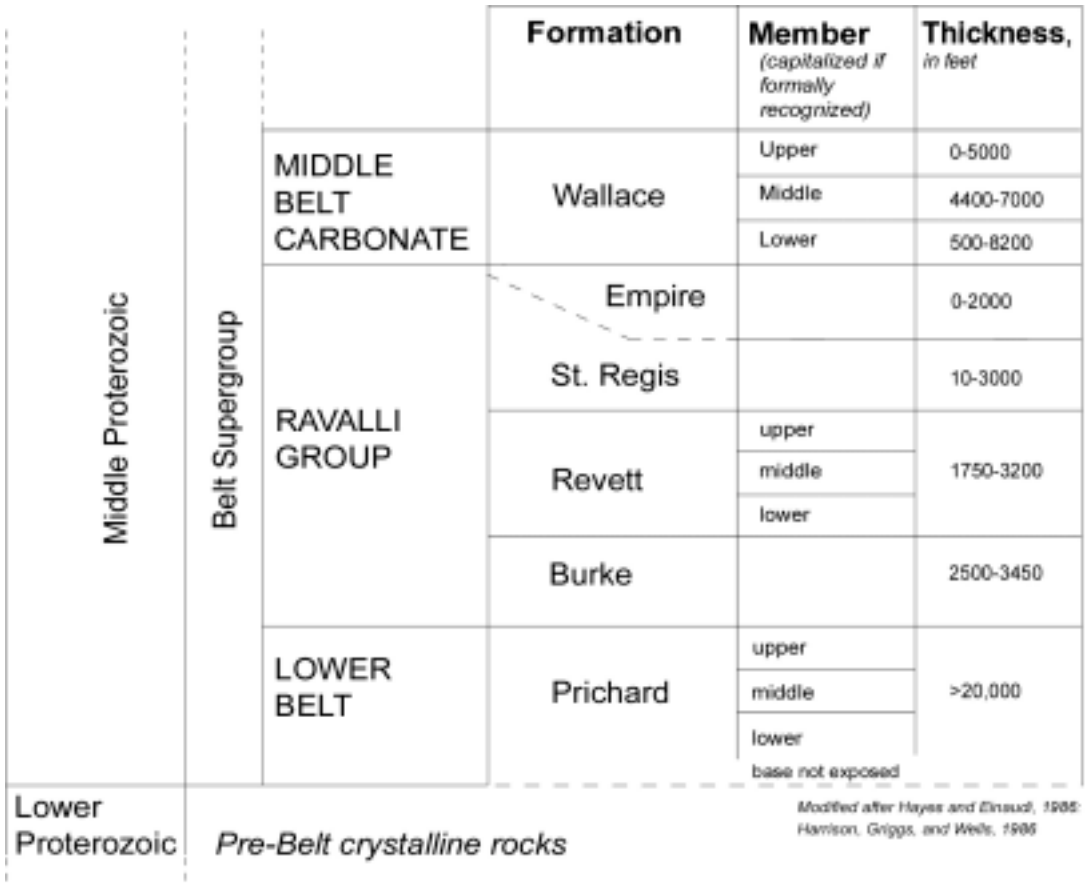

Figure 15. Stratigraphic column

Prichard Formation

Regionally, the Prichard Formation is lithologically divided into three informal members, the upper, middle, and lower members. The lower member is not exposed in the map area.

Parts of the upper and middle members can be correlated between sub-areas within the study area where detailed mapping was completed. Sub-areas referred to in the discussion about the Prichard Formation are Pine Creek, Kellogg, Italian Gulch, Prospect Creek, Jack Waite mine, and Vermilion River (fig. 1). Cumulatively, over 12,000 ft of siltite, argillite, silty quartzite, and quartzite are exposed in the upper and middle Prichard Formation strata. The upper member also includes a transition zone beneath the overlying Burke Formation. Formation terminology referred to here using upper, middle, and lower members of the Prichard Formation differs somewhat from that recognized in the Wallace 1^{o} x 2^{o} geological sheet (Harrison, Griggs, and Wells, 1986) although it has some similarities with the four-fold division (transition zone and upper, middle, and lower members) noted by Harrison and Cressman (1993). In some areas, the upper and middle members are again sub-divided into three local mapping units, from the top downward, the *A, B, and C units.* The A, B, and C units undergo rapid lateral changes that makes unit lithostratigraphic correlation difficult to impossible between sub-areas.

1. Middle member

The middle member consists of (in order of decreasing abundance) siltite, quartzite, silty quartzite, and argillite. The overall thickness of the middle member is 7300 ft at Vermilion River where it is best exposed. The middle member is divided into three local mapping units (from top downward), A, B, and C that are only recognized at Prospect Creek area east of Thompson Pass, Jack Waite mine area north of Thompson Pass, and Vermilion River area (fig. 1).

The *middle Prichard C* is at least 2300 ft thick at Vermilion River and contains light gray siltite, silty quartzite and quartzite that is often cross-bedded. The middle member is the lowest unit exposed in the study area and its base is not exposed. A lack of medium gray rusty weathering is diagnostic of the siltite laminates in the Thompson Pass area. Three mafic (hornblende diorite) Purcell sills are present in the middle Prichard C unit at Vermilion River but the sills were not seen in the section at Prospect Creek or Jack Waite mine areas. The *middle Prichard B* ranges from 2300 to 2500 ft thick at Vermilion River and Prospect Creek, respectively, where best exposed and consists of group, graded, and non-laminated medium gray to blue-gray siltite. The *middle Prichard A unit*, consists of 10 to 50 ft-thick beds of thick-bedded quartzite and siltite alternating with medium and thin-bedded interlaminated siltite-argillite (group lamina) of similar thickness. The group lamina consist of repeating flat interlaminated 1/8-in.- to 1-in.-thick (sometimes up to 2-in thick) beds of siltite and argillite. Unit thickness ranges from 1000 ft to 3000 ft (1000 ft at Pine Creek-Kellogg, 1600 ft at Prospect Creek, 3000 ft at Vermilion River). The top of the *middle member* is placed at the top of the first prominent (at least 40-ft thick) thick-bedded quartzite or silty quartzite.

2. Upper member

The upper member consists of (in order of decreasing abundance) light gray siltite, argillite, silty quartzite, and quartzite. It varies from 2700 ft to 6800 ft in thickness (thickness is 6800 ft at Pine Creek, 5100 ft near Kellogg and Italian Gulch, 4400 ft near Jack Waite mine, 4000 ft at Prospect Creek, and 2700 ft at Vermilion River). The upper member is also divided into three local mapping units (from top downward), A, B, and C units and these units are recognized only at Kellogg and Italian Gulch. An important characteristic is that many siltite-argillite beds are dominated by group lamina. Individual lamina in these beds varies in color from gray to white depending on their content of white quartz silt.

The *upper Prichard C* near the city of Kellogg, Idaho consists of 2000 ft of graded beds, group, and non-laminated (massive) green-gray siltite and silty argillite lacking quartz-rich lamina. A 50 to 100 ft thick section of thick-bedded quartzite occurs near the middle of the unit. Lateral changes are rapid and the same units are difficult to distinguish at nearby Italian Gulch. The *upper Prichard B* at Kellogg consists of 1500 ft of interbedded quartzose siltite and argillite with both graded and non-graded quartz lamina. At Kellogg, the *upper Prichard A* consists of 1000 ft of quartzite with siltite and silty quartzite interbeds.

The uppermost part of the upper member on maps includes the transition zone between the Prichard Formation and the overlying Burke Formation (Burke-Prichard transition).

3. Burke-Prichard transition

The upper member includes a 350-to-600 ft-thick (averages 400 ft thick) transition unit beneath the overlying Burke Formation. It mainly consists of laminated and unlaminated silty argillite although thick-bedded quartzite containing ½-in. pebbles are known in the Kellogg area. The thickness of this unit was not included with the upper Prichard A just described although the transition unit is included within the upper Prichard A (or upper Prichard) on maps. The Burke-Prichard contact is placed at the top of the unit where the following lithologic changes occur in the upward direction:

- Color changes from medium dark gray to light greenish (or purplish)-gray,
- Silty quartzite beds become more frequent,
- Disseminations and aggregations of pyrite and/or pyrrhotite (commonly up to 5 percent; occasionally up to 15 percent) and carbonate (trace to 5 percent, commonly**)** decrease or disappear
- Magnetite content (trace to few percent of euhedral crystals in Burke Formation) increases,
- Desiccation features substantially increase in abundance, and
- Bed character changes from beds having distinct, rhythmic alternating sets (group lamina, thickness of lamina varies from 1/8-in. to 2-in.) of very fine argillite-to-siltite lamina to beds having varying thickness of siltite lamina. The rhythmic sets are separated by one or more thick argillite lamina.

The number and appearance of these lithological characteristics may vary from location to location.

Burke Formation

The Burke Formation is informally divided into three members, upper, middle, and lower. Thickness ranges from 2500 ft at the type locality northeast of Wallace to 3450 ft on the north. The *lower member* consists of green parallel- to thinly-laminated argillite and siltite in beds 2 to 20-in. thick. The *middle member* consists of gray to purplish-gray parallel, thinly-laminated siltite with minor partings of argillite. The *upper member* consists of purplish-gray interlaminated blocky argillite and siltite with mud cracks and mud chips that alternate with white to purple-gray, fine- to medium-grained quartzite beds 3- to 6-ft thick. Quartzite beds increase in abundance upward to form a gradational contact with the overlying Revett Formation. Thick quartzite units locally occur in the upper part of the formation in the vicinity of the Troy mine.

Revett Formation

The Revett Formation is informally divided into three members, upper, middle, and lower. The upper and lower members mostly contain quartzite and a middle member mostly contains fine-grained facies consisting of siltite and argillite. *Fine facies* of the formation may be purple, green, gray-to-reddish-gray siltite, argillite, and centimeter-scale, alternating upward-graded silt and argillite beds called couplet beds. Argillitic rocks may contain mud cracks, mud chips, fluid-escape structures, and wavy parallel laminae. The *quartzite* of the Revett Formation is commonly vitreous to sub-vitreous in appearance. It often exhibits internal stratification in the form of flat laminations, trough cross bedding, and ripple-drift laminations. Other features include load casts and soft-sediment deformation structures. At the type locality of the Revett Formation near Wallace, Idaho where the formation is only partly exposed, it is characterized by white medium-grained cross-bedded quartzite interbedded with white siltite and green laminated argillite. Northeastward from the type section the formation contains less quartzite and more purple and purplish-gray siltite and argillite.

The formation makes a northward thinning clastic wedge of sediment from 6200 feet thick at LaTour Peak-Boise Peak located south of the Osburn Fault to 1750 feet thick at the Troy mine, a distance of about 60 miles. A thickness of 3200 ft is observed at the Flathead Indian Reservation (Ryan and Buckley, 1993) 50 miles east of Thompson Falls and 3100 ft thick (Harrison, 1972) near Chewelah, Wash. 50 miles west of Sandpoint, Idaho.

The lower contact of the formation is defined by the first appearance of thick-bedded quartzite above the fine-grained rocks of the Burke Formation. The upper contact with the St. Regis Formation is defined by the last occurrence of a series of thick-bedded quartzite beds below the argillite and siltite beds of the overlying St. Regis Formation.

St. Regis Formation

The St. Regis Formation consists of alternating and interlaminated dark green and dark purple argillite and siltite beds. Sedimentary structures include fluid escape, mud chip, and ripple marks and thickness varies from a few feet thick in the southwest to over 3000 ft in the north.

Empire Formation

The Empire Formation consists of thinly laminated dark green and light green dolomitic argillite or argillite and siltite. It exhibits wavy and discontinuous laminae. Fluid escape structures and ovoid or horizontal pods of calcite are particularly common. Ripple marks, syneresis cracks, and mud chips are common in places. The Empire Formation intertongues with both the Wallace and St. Regis formations. Thickness ranges from 0 ft on the south to 2000 ft to the north and west. The Empire Formation has not been recognized south of the Hope and Ninemile faults (Harrison, Griggs, and Wells, 1986).

Wallace Formation

The Wallace Formation can be subdivided into three informal members (from top downward): upper, middle, and lower. The *lower member* includes green interlaminated dolomitic argillite and siltite. It contains ribbon-like calcite veinlets 2-10 mm wide (called “molar tooth” structures). Its lower contact is sharp with the underlying purple laminated argillite of the St. Regis Formation or gradational where underlain by a green laminated argillite in the St. Regis Formation (and/or Empire Formation). Thickness ranges from 8200 ft in the south and thins to the north.

The *middle member* consists of black argillite alternating with slightly dolomitic white siltite or fine-grained quartzite. The unit varies from 7000 ft thick in the south to 4400 ft thick in the north. Molar tooth structures are present and may predominate in sections up to 1300 ft thick. Uneven or wavy bedding is a characteristic feature of the beds. The contact with the lower member is gradational and occurs where the green laminated argillites begin to dominate within the section.

The *upper member* is subdivided into three local mapping units. It consists of a characteristic black laminated argillite interbedded with green laminated argillite and minor amounts of red laminated argillite. The lower contact is gradational into the middle member. The upper contact is sharp with the overlying green and red siltites of the Snowslip Formation. Thickness varies from 0 ft in the southeast to 5000 ft in the west part of the area.

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Ryan, P.C. and Buckley, S., 1993, Sedimentation, strata-bound Cu-Ag mineralization, and syndepositional tectonics in the Revett Formation, Flathead Indian Reservation, western Montana, *in* Belt Symposium III, Berg, R. B., (Ed.): Montana Bureau of Mines and Geology, Special Publication 112, p. 278-289.

APPENDIX I. LIST OF IMAGE FILES

[Projection: Universal Transverse Mercator (UTM), North American Datum of 1927, Clarke 1866 spheroid, central meridian, –117.00, zone 11; original map scale, 1:48,000, except those having an asterisk (*) with an original scale of 1:12,000]

Fig. No.	Name	Type	Description (map title)	Size
2	pl1r.tif	image	Plate 1- Cabinet Mountains Reconnnaissance Program, Lincoln County, Montana	20.1 Mb
3	pl2r.tif	image	Plate 2 - Cabinet Mountains Reconnaissance Program, Geology and Section Location of Southwestern Lincoln County	48.1Mb
4	pl3ar.tif	image	Plate 3a (north) - Cabinet Mountains Reconnaissance Program, Geologic Map, Sanders Co. Mont. and Shoshone Co., Idaho	40.9Mb
5	pl3br.tif	image	Plate 3b (south) - Cabinet Mountains Reconnaissance Program, Geologic Map, Sanders Co. Mont. and Shoshone Co., Idaho	40.3Mb
6	pl4r.tif	image	Plate 4 - 1981 Cabinet Mtns. Reconn. Program, Troy-type Cu-Ag deposits	33.1Mb
7	pl5ar.tif	image	Plate 5a (north) - Cabinet Mountains Reconnaissance – Troy type Cu-Ag Deposits	37.0Mb
8	pl5br.tif	image	Plate 5b (south) - Cabinet Mountains Reconnaissance – Troy type Cu-Ag Deposits	41.0Mb
9	pl6r.tif	image	Plate 6 - 1981 Cabinet Mtns. Reconn. Program, Troy type Cu-Ag Deposits & Shale hosted Pb-Zn-Ag Deposits, Kootenai & Benewah Counties, Idaho	35.0Mb
10	pl7r.tif	image	Plate 7 - 1981 Cabinet Mtns. Reconn. Prog. Troy type Cu-Ag deposits, Benewah, Kootenai, and Shoshone Counties, Idaho	56.8Mb
11	pl8r.tif	image	Plate 8 - 1981 Cabinet Mountains Reconnaissance Program, Troy type Cu-Ag Deposits, Shoshone County, Idaho and Mineral County, Montana	33.3Mb
12	pl9r.tif	image	Plate 9 - 1981 Cabinet Mountains Reconnaissance Program, Troy type Cu-Ag deposits, Sanders and Mineral Counties, Montana	36.2Mb
13	plgtmtr.tif	image	Brooks Mt.-Goat Mt. mineralized zone, Mineral County, Montana (detail area) *	24.8Mb
14	troyr.tif	image	Troy West Project (detail area) *	15.6Mb
2	pl1r.tfw	world	Plate 1- Cabinet Mountains Reconnnaissance Program, Lincoln Co., Montana	1kb
3	pl2r.tfw	world	Plate 2 - Cabinet Mountains Reconnaissance Program, Geology and Section Location of Southwestern Lincoln County	1kb
4	pl3ar.tfw	world	Plate 3a (north) - Cabinet Mountains Reconnaissance Program, Geologic Map, Sanders Co. Mont. and Shoshone Co., Idaho	1kb
5	pl3br.tfw	world	Plate 3b (south) - Cabinet Mountains Reconnaissance Program, Geologic Map, Sanders Co. Mont. and Shoshone Co., Idaho	1kb
6	pl4r.tfw	world	Plate 4 - 1981 Cabinet Mtns. Reconn. Program, Troy-type Cu-Ag deposits	1kb
7	pl5ar.tfw	world	Plate 5a (north) - Cabinet Mountains Reconnaissance – Troy type Cu-Ag Deposits	1kb

Appendix I – cont.

Fig. No.	Name	Type	Description (map title)	Size
8	pl5br.tfw	world	Plate 5b (south) - Cabinet Mountains Reconnaissance – Troy type Cu-Ag Deposits	1kb
9	pl6r.tfw	world	Plate 6 - 1981 Cabinet Mtns. Reconn. Program, Troy type Cu-Ag Deposits & Shale hosted Pb-Zn-Ag Deposits, Kootenai & Benewah Counties, Idaho	1kb
10	pl7r.tfw	world	Plate 7 - 1981 Cabinet Mtns. Reconn. Prog. Troy type Cu-Ag deposits, Benewah, Kootenai, and Shoshone Counties, Idaho	1kb
11	pl8r.tfw	world	Plate 8 - 1981 Cabinet Mountains Reconnaissance Program, Troy type Cu-Ag Deposits, Shoshone County, Idaho and Mineral County, Montana	1kb
12	pl9r.tfw	world	Plate 9 - 1981 Cabinet Mountains Reconnaissance Program, Troy type Cu-Ag deposits, Sanders and Mineral Counties, Montana	1kb
13	plgtmtr.tfw	world	Brooks Mt.-Goat Mt. mineralized zone, Mineral County, Montana (detail area)	1kb
14	troyr.tfw	world	Troy West Project (detail area)	1kb

APPENDIX II. METADATA

Name of metadata file: *OF01_438_met.txt* (by Mary H. Carlson)

Identification_Information:
  Citation:
    Citation_Information:
      Originator: Boleneus, D.E., Appelgate, L.M., and Joseph, N.L., and Brandt, T.R.
      Publication_Date: 2001
      Title: Digital geological maps in the western Belt Basin, Kootenai, Bonner, Benewah and Shoshone counties, Idaho and Lincoln, Mineral, and Sanders counties, Montana
      Edition: version 1.0
      Geospatial_Data_Presentation_Form: map
      Series_Information:
        Series_Name: Open File Report
        Issue_Identification: OF01-438
      Publication_Information:
        Publication_Place: Menlo Park, CA
        Publisher: U.S. Geological Survey
  Description:
    Abstract:
      This metadata describes thirteen different geo-referenced tif images. Hand colored geological mapped data of the area in Sanders and Lincoln counties, Montana and Kootenai, Bonner, Benewah, and Shoshone counties, Idaho were converted to digital format (TIFF). These data were donated to US Geological Survey by the mineral industry. The area lies in the western part of the Belt Basin and contains metasedimentary rocks of Middle Proterozoic age. The area mainly contains rocks of the Prichard, Burke, Revett, St. Regis, Wallace, Empire and Spokane formations. The source maps were scanned on an Ideal FSC 6010 36" width color pass through scanner at 200 ppi as 8 bit indexed color or in two instances at the 24 bit color level. Images were registered and rectified to provided neatline coverages in Universal Transverse Mercator zone 11 projection using ArcView Image Analysis Extension, version 1.1. The source maps were non-published Asarco company maps representing different geographical areas. Tif image names and their corresponding descriptions belonging to the Cabinet Mountains Reconnaissance program include: Pl1R - Geologic map, Lincoln Co., MT, Pl2R - Geology and section location of southwestern Lincoln County, Pl3AR - plate 3a, Pl3BR - plate 3b -Geologic map Sanders Co., MT and Shoshone Co., Pl4R –1981 Cabinet Mountains Reconn. Program, Troy type Cu-Ag deposits, ID, Pl5AR - Plate 5a, Pl5BR - plate 5b - Geologic map Troy Type Cu-Ag deposits and shale-hosted Pb-Zn-Ag deposits, Bonner, Kootenai, and Shoshone Co.'s, ID, Pl6R - Geologic map Troy Type Cu-Ag deposits and shale-hosted Pb-Zn-Ag deposits, Kootenai and Benewah Counties, ID, Pl7R - Geologic map Troy type Cu-Ag deposits Benewah, Kootenai, and Shoshone Co.'s Idaho, Pl8R - Geologic map Troy-Type Cu-Ag deposits Shoshone, Co., Idaho and Mineral Co., MT., Pl9R - Geologic map Troy-Type Cu-Ag deposits, Sanders and Mineral Co., MT, PLGTMTR - Goat Mtn. and Brooks Mtn. mineralized zone Mineral County, Montana. The following image name belongs to the Troy West Project: TROYR - Troy Mine Area, Lincoln Co., MT.
    Purpose: This dataset was created to provide raster images of the Asarco company maps of the area located in Sanders and Lincoln counties, Montana and Kootenai, Bonner, Benewah and Shoshone counties, Idaho.
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    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: unknown
    Currentness_Reference: publication date
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    Progress: Complete
    Maintenance_and_Update_Frequency: Unknown
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    Bounding_Coordinates:

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East_Bounding_Coordinate: -115.00
North_Bounding_Coordinate: 49.00
South_Bounding_Coordinate: 47.00
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Theme_Keyword_Thesaurus: none
Theme_Keyword: geology
Theme_Keyword: geologic map
Theme_Keyword: Belt
Place:
Place_Keyword_Thesaurus: none
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Place_Keyword: Kootenai county
Place_Keyword: Idaho
Place_Keyword: Lincoln county
Place_Keyword: Mineral county
Place_Keyword: Sanders county
Place_Keyword: Montana
Place_Keyword: Belt Basin
Place_Keyword: Pacific Northwest
Place_Keyword: USA
Place_Keyword: Benewah County
Place_Keyword: Bonner County
Access_Constraints: none
Use_Constraints: 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: David E. Boleneus
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: 1-509-368-3110
Contact_Facsimile_Telephone: 1-509-368-3199
Contact_Electronic_Mail_Address: dboleneu@usgs.gov
Data_Set_Credit: Ted Brandt (USGS) scanned the thirteen maps in a color pass through scanner. The images were then registered and rectified to provide neatline coverages in UTM projection.
Native_Data_Set_Environment: Windows NT Version 4.0 (Build 1381) Service Pack 6; ESRI ArcInfo 8.0.345
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Logical_Consistency_Report: This dataset contains raster images without polygon topology.
Completeness_Report: These images were wholly derived from the Asarco company maps.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: The horizontal positional accuracy for the digital data is no better than +/- 5 meters based on the RMS error.

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Source_Citation:
Citation_Information:
Originator: Appelgate, L., and Joseph, N.
Publication_Date: Unpublished Material, 1984
Title: Geologic map of Lincoln County, Montana
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate I
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
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Source_Time_Period_of_Content:
Time_Period_Information:
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Source_Currentness_Reference: unpublished data
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Source_Contribution: This map was scanned to provide a raster image of the data.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Appelgate, L., and Lafco, E.
Publication_Date: Unpublished Material, 1981
Title: Geology and Section Location of southwestern Lincoln, County
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance program
Issue_Identification: Plate II
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
Type_of_Source_Media: paper map
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1981
Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Appelgate and Lafco, 1981
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Source_Information:
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Citation_Information:
Originator: Joseph, N. and Appelgate, L.
Publication_Date: Unpublished Material, 1981
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Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate IIIA

Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
Type_of_Source_Media: paper map
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1981
Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Joseph and Appelgate, 1981
Source_Contribution: This map was scanned to provide a raster image of the data.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Joseph, N. and Appelgate, L.
Publication_Date: Unpublished Material, 1984
Title: Geologic map of Sanders Co., MT and Shoshone Co., ID
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate IIIB
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
Type_of_Source_Media: paper map
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1984
Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Joseph and Appelgate, 1984
Source_Contribution: This map was scanned to provide a raster image of the data.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Appelgate, L., and Lafco, E.
Publication_Date: Unpublished Material, 1982
Title: Geologic map Troy Type Cu-Ag deposits Sanders Co., MT
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate IV
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
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Time_Period_Information:
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Calendar_Date: 1982
Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Appelgate and Lafco, 1982
Source_Contribution: This map was scanned to provide a raster image of the data.

Source_Information:
Source_Citation:
Citation_Information:
Originator: Appelgate, L., Joseph, N., Lafco, E., Dye, E.
Publication_Date: Unpublished Material, 1984
Title: Cabinet Mountain reconnaissance Program Troy type Cu - Ag deposits and shale - hosted Pb - Zn deposits Bonner, Kootenai, and Shoshone Counties, Idaho.
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate VA
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
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Originator: Appelgate, L., Lafco, E., Bayley, E., Joseph, N., and Dye, E.
Publication_Date: Unpublished Material, 1984
Title: Asarco Northwest Exploration Division, troy-type Cu-Ag deposits, Sanders and Mineral Counties, Montana and Shoshone County, Idaho.
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate VB
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
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Time_Period_Information:
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Source_Citation_Abbreviation: Appelgate and others, 1984
Source_Contribution: This map was scanned to provide a raster image of the data.
Source_Information:
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Originator: Dye, E
Publication_Date: Unpublished Material, 1981
Title: Geologic map Troy Type Cu-Ag deposits and shale hosted Pb-Zn-Ag deposits in Kootenai and Benewah counties, ID
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program

Issue_Identification: plate VI
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
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Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1981
Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Dye, 1981
Source_Contribution: This map was scanned to provide a raster image of the data.
Source_Information:
Source_Citation:
Citation_Information:
Originator: Appelgate, L. and Lafco, E.
Publication_Date: Unpublished Material, 1982
Title: Geologic map Troy Type Cu-Ag deposits in Benewah, Kootenai, and Shoshone Co.'s ID
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate VII
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 48,000
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Source_Time_Period_of_Content:
Time_Period_Information:
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Source_Currentness_Reference: unpublished data
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Citation_Information:
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Publication_Date: Unpublished Material, 1981
Title: Geologic map Troy Type Cu-Ag deposits in Shoshone Co., ID and Mineral Co., MT.
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate VIII
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
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Source_Citation_Abbreviation: Appelgate and Lafco, 1981

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Publication_Date: Unpublished Material, 1981
Title: Geologic map Troy Type Cu-Ag deposits in Sanders and Mineral Co., MT
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate IX
Publication_Information:
Publication_Place: unpublished
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Source_Currentness_Reference: unpublished data
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Source_Information:
Source_Citation:
Citation_Information:
Originator: Appelgate, L., Lafco, E., and Husman, J.
Publication_Date: Unpublished Material, 1981
Title: Goat Mountain and Brooks Mountain Mineralized Zone in Mineral County, Montana
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Cabinet Mountains Reconnaissance Program
Issue_Identification: Plate ?
Publication_Information:
Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
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Time_Period_Information:
Single_Date/Time:
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Source_Currentness_Reference: unpublished data
Source_Citation_Abbreviation: Appelgate and others, 1981
Source_Contribution: This map was scanned to provide a raster image of the data.
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Source_Citation:
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Originator: Appelgate, L.
Publication_Date: Unpublished Material, 1990
Title: Troy Mine Area, Lincoln County, MT
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Troy West Project
Issue_Identification: plate 1
Publication_Information:

Publication_Place: unpublished
Publisher: Asarco Northwest Exploration Division
Source_Scale_Denominator: 12,000
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Time_Period_Information:
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Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Appelgate, 1990
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Raster_Object_Type: Pixel
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Vertical_Count: 1
Distribution_Information:
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 the delivery, installation, operation, or support by the USGS.
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Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: David E. Boleneus
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: 1-509-368-3110
Contact_Facsimile_Telephone: 1-509-368-3199
Contact_Electronic_Mail_Address: dboleneu@usgs.gov
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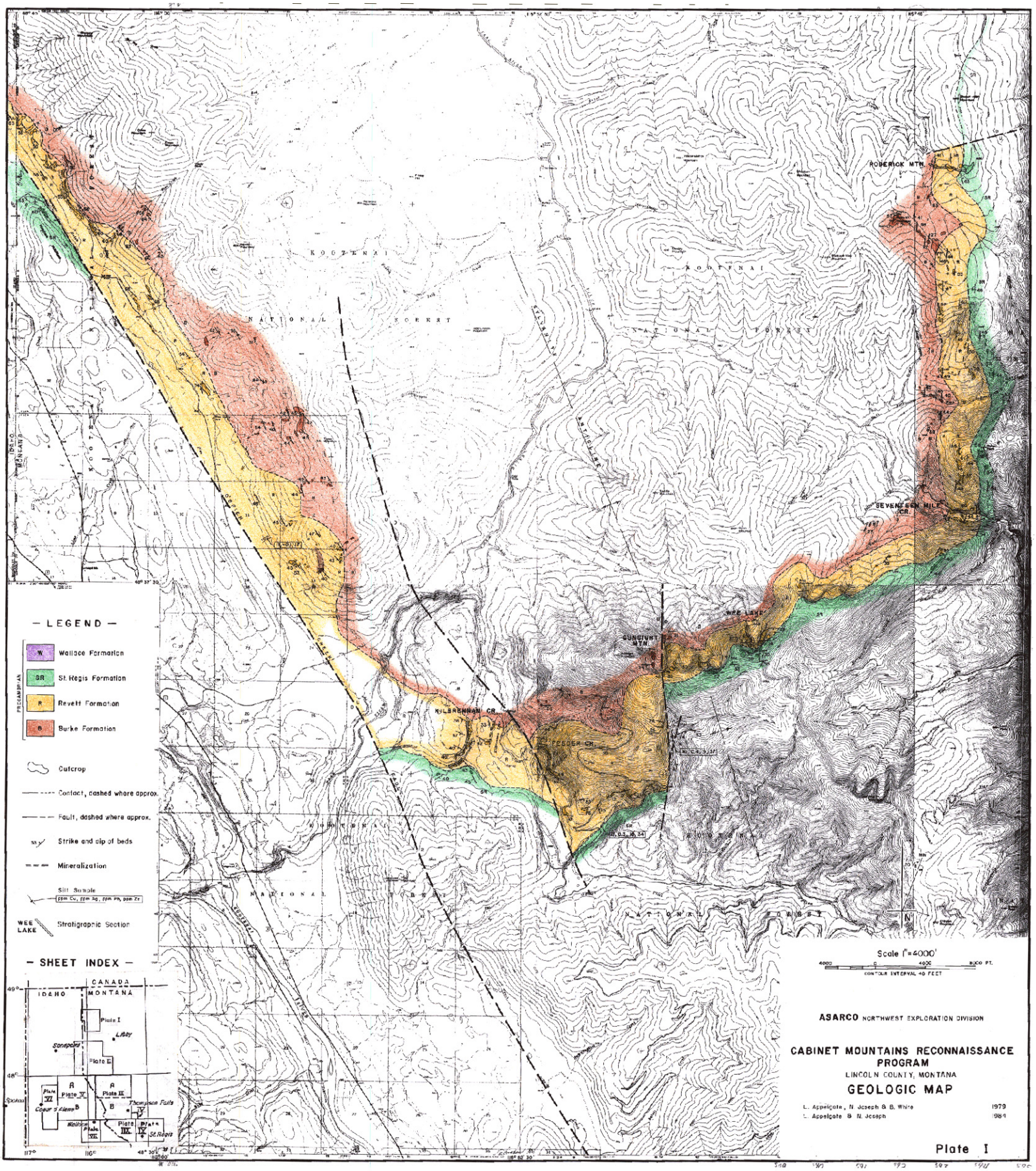
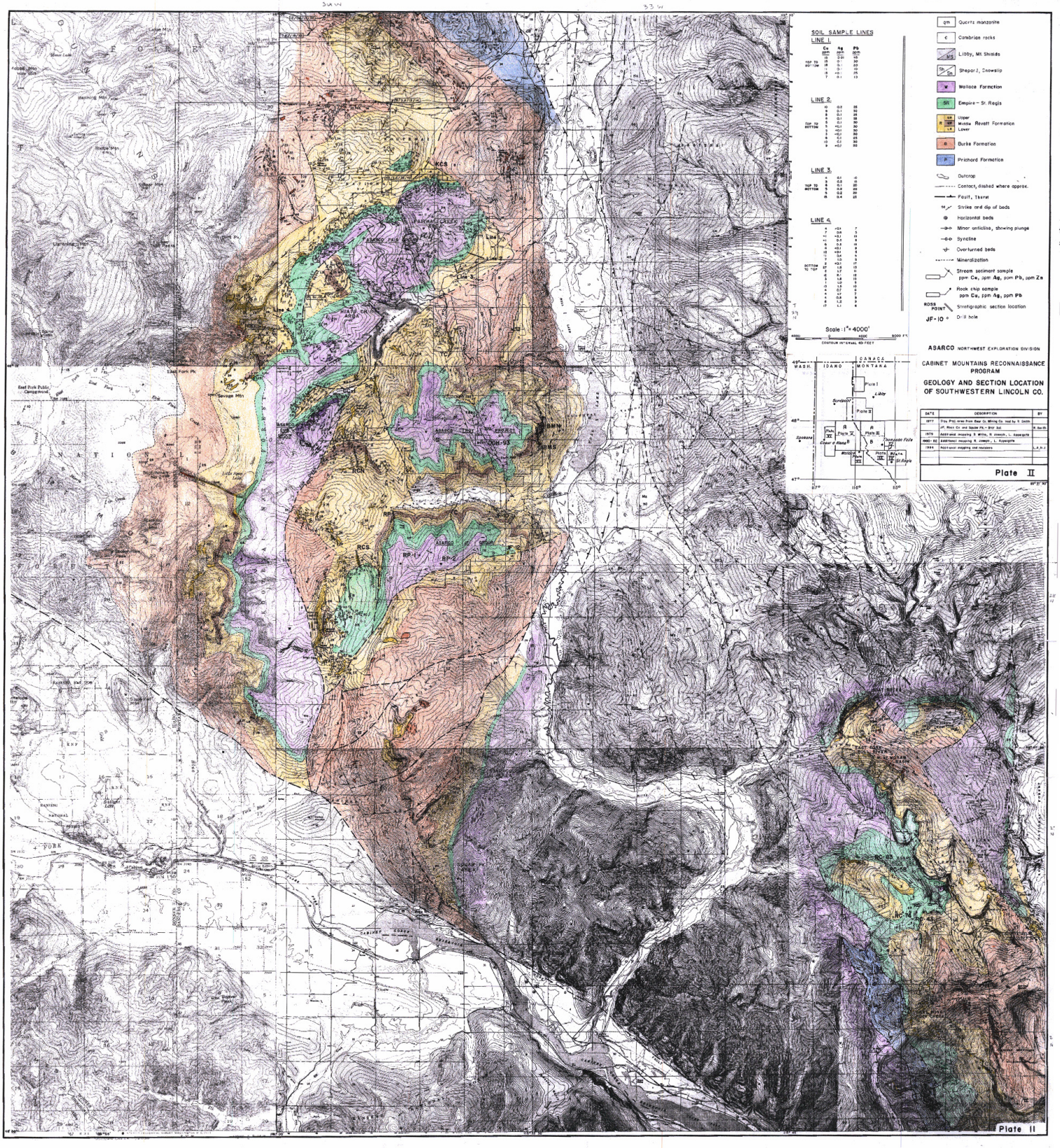
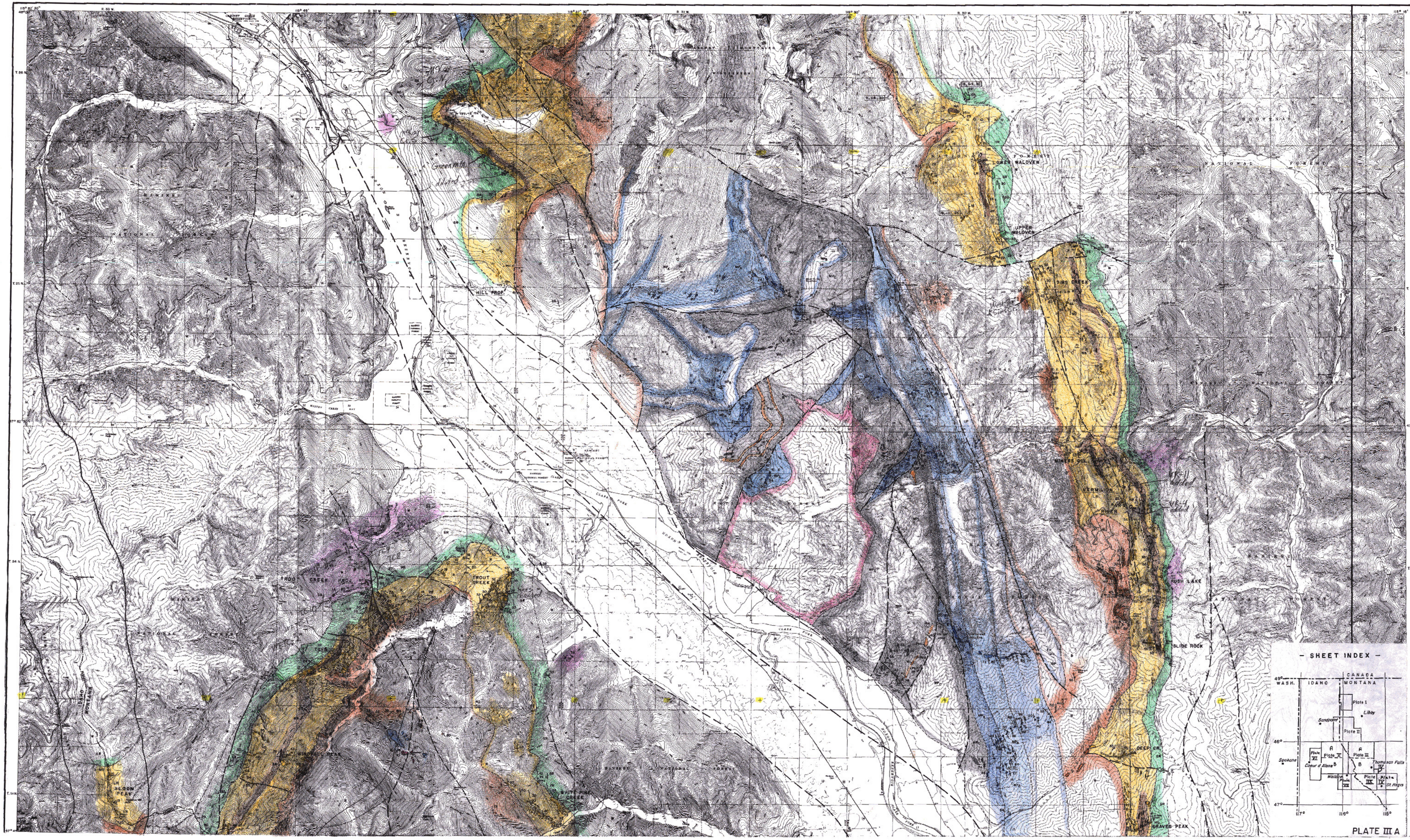
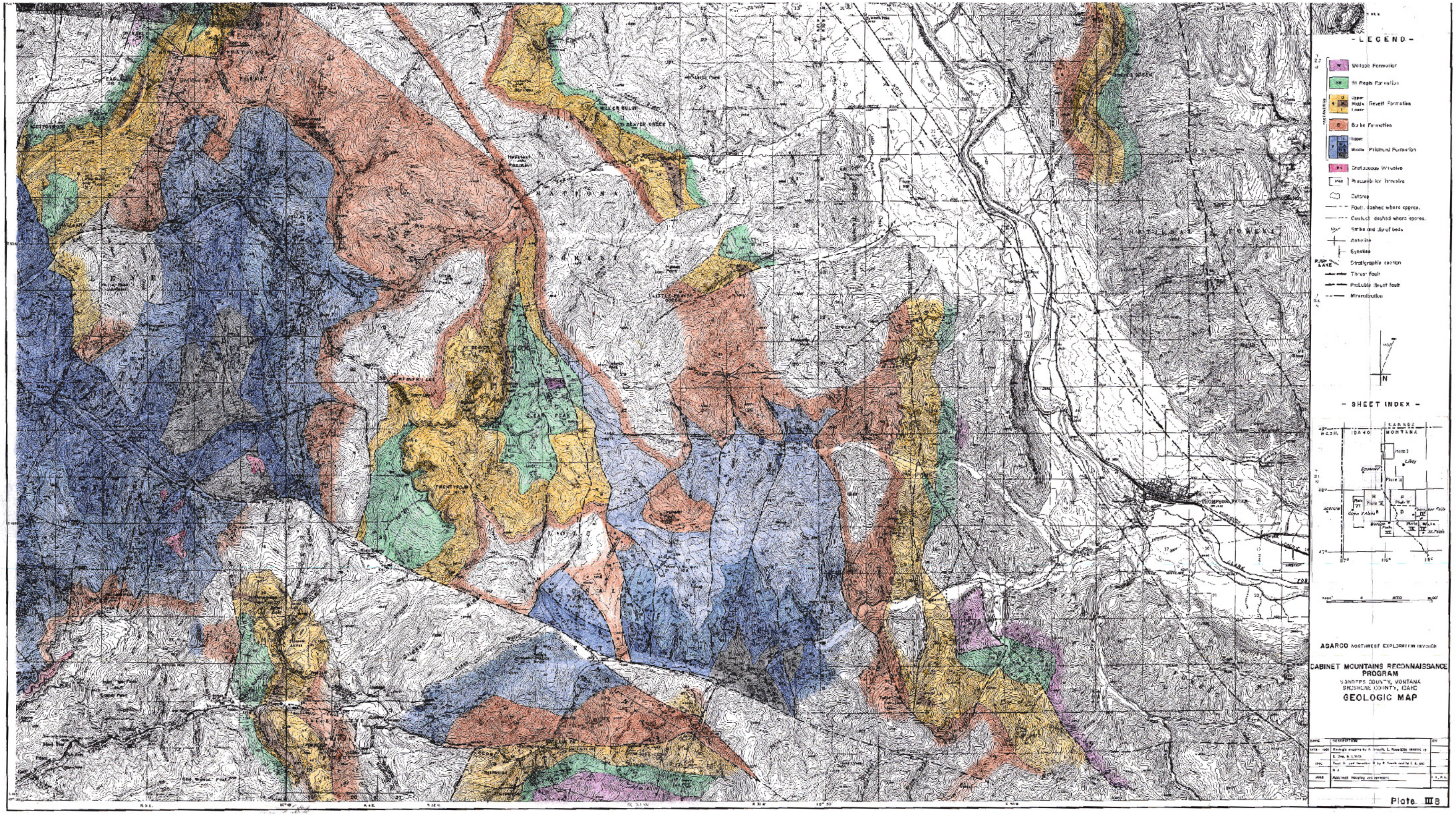

— LEGEND —
W Wallace Formation
SR St. Regis Formation
R Revett Formation
B Burke Formation
PRECAMBRIAN
Outcrop
Contact, dashed where approx.
Fault, dashed where approx.
Strike and dip of beds
Mineralization
Silt Sample
ppm Cu, ppm Ag, ppm Pb, ppm Zn
WEE LAKE
Stratigraphic Section
— SHEET INDEX —
CANADA
IDAHO
MONTANA
Plate I
Libby
Sandpoint
Plate II
Plate VI
Plate V
Plate III
Coeur d'Alene
Thompson Falls
Wallace
Plate VII
Plate IV
St. Regis
Spokane
49°
48°
117°
116°
KOOTENAI NATIONAL FOREST
ROBERTS MTN.
SUNLIGHT MTN.
SEVENTEEN MILE CR.
KILBRENNAN CR.
FEEDER CR.
WEE LAKE
Scale 1"=4000'
4000 0 4000 8000 FT.
CONTOUR INTERVAL 40 FEET
ASARCO NORTHWEST EXPLORATION DIVISION
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
LINCOLN COUNTY, MONTANA
GEOLOGIC MAP
L. Appelgate, N. Joseph & B. White 1979
L. Appelgate & N. Joseph 1984
Plate I

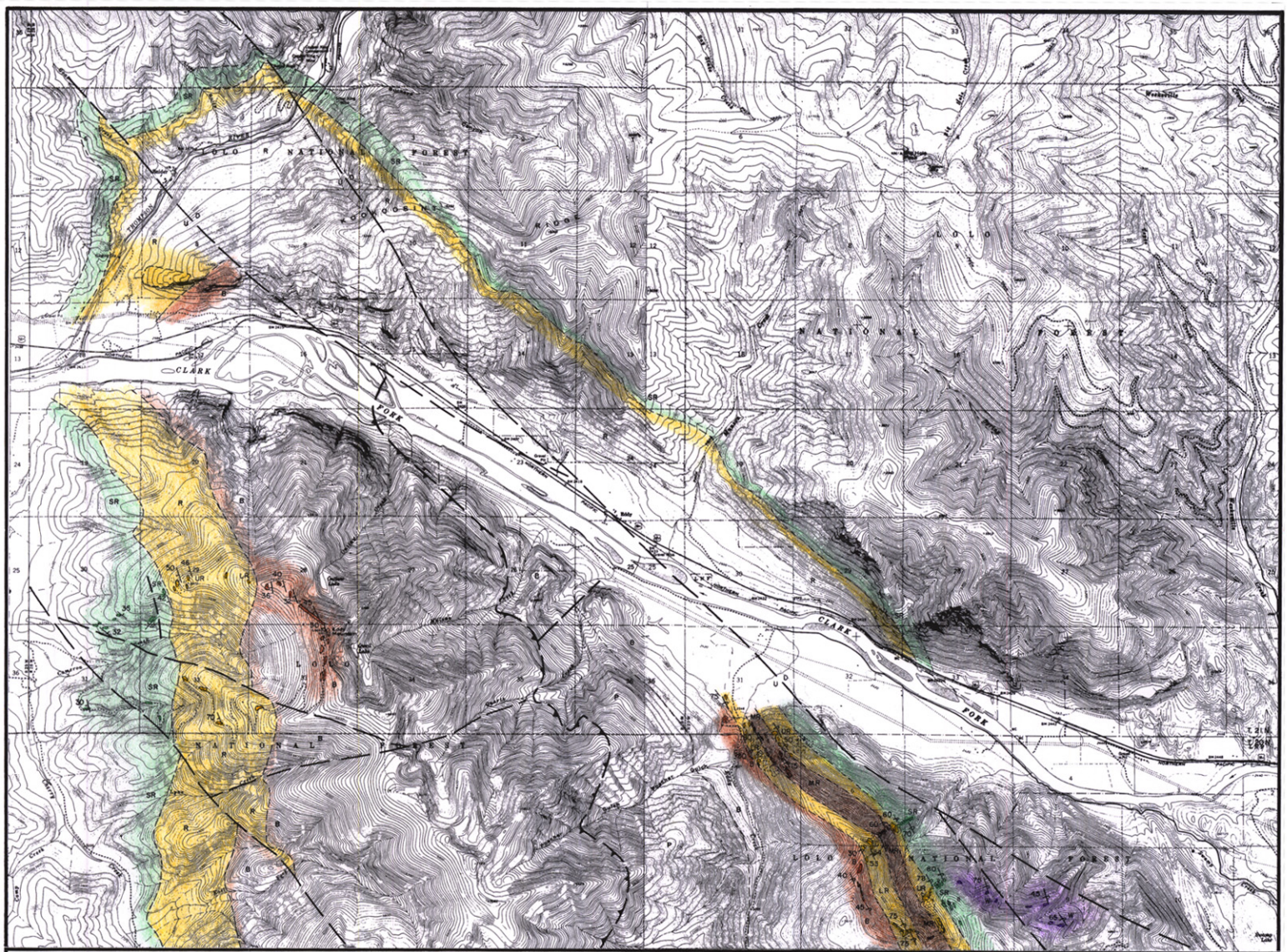

SOIL SAMPLE LINES
LINE 1
LINE 2
LINE 3
LINE 4
Scale 1" = 4000'
CONTOUR INTERVAL 40 FEET
Quartz monzonite
Cambrian rocks
Libby, Mt. Shields
Shepard, Snowslip
Wallace Formation
Empire – St. Regis
Upper
Middle Revett Formation
Lower
Burke Formation
Prichard Formation
Outcrop
Contact, dashed where approx.
Fault, Thrust
Strike and dip of beds
Horizontal beds
Minor anticline, showing plunge
Syncline
Overturned beds
Mineralization
Stream sediment sample
ppm Cu, ppm Ag, ppm Pb, ppm Zn
Rock chip sample
ppm Cu, ppm Ag, ppm Pb
Stratigraphic section location
Drill hole
JF-10
ASARCO NORTHWEST EXPLORATION DIVISION
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
GEOLOGY AND SECTION LOCATION OF SOUTHWESTERN LINCOLN CO.
Plate II
Plate II



- SHEET INDEX -
CANADA
WASH.
IDAHO
MONTANA
Plate I
Libby
Sandpoint
Plate II
Plate VI
Plate V
Plate III
Spokane
Coeur d'Alene
Thompson Falls
Wallace
Plate VII
Plate IX
St. Regis
49°
48°
47°
117°
116°
115°

PLATE III A


- LEGEND -
Wallace Formation
St Regis Formation
Upper
Middle Revett Formation
Lower
Burke Formation
Upper
Middle Prichard Formation
Cretaceous Intrusive
Precambrian Intrusive
Outcrop
Fault, dashed where approx.
Contact, dashed where approx.
Strike and dip of beds
Anticline
Syncline
Stratigraphic section
Thrust fault
Probable thrust fault
Mineralization
- SHEET INDEX -
WASH.
IDAHO
MONTANA
THOMPSON FALLS
ASARCO NORTHWEST EXPLORATION DIVISION
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
SANDERS COUNTY, MONTANA
SHOSHONE COUNTY, IDAHO
GEOLOGIC MAP
DATE
DESCRIPTION
BY
Additional mapping and revisions
Plate III B

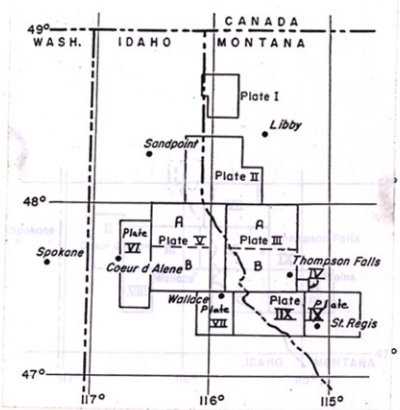


PRECAMBRIAN

- W — Wallace Formation
- SR — St Regis Formation
- RAVALLI GROUP
  - R — Revett Formation (U — Upper, M — Middle, L — Lower)
  - B — Burke Formation
  - P — Prichard Formation

- Outcrop
- Contact, dashed where approx.
- Fault
- Trust fault
- 35 — Strike and dip of beds
- Talus

— SHEET INDEX —



N

Scale : 1" = 4000'

4000 0 4000 8000 FT.

ASARCO NORTHWEST EXPLORATION DIVISION

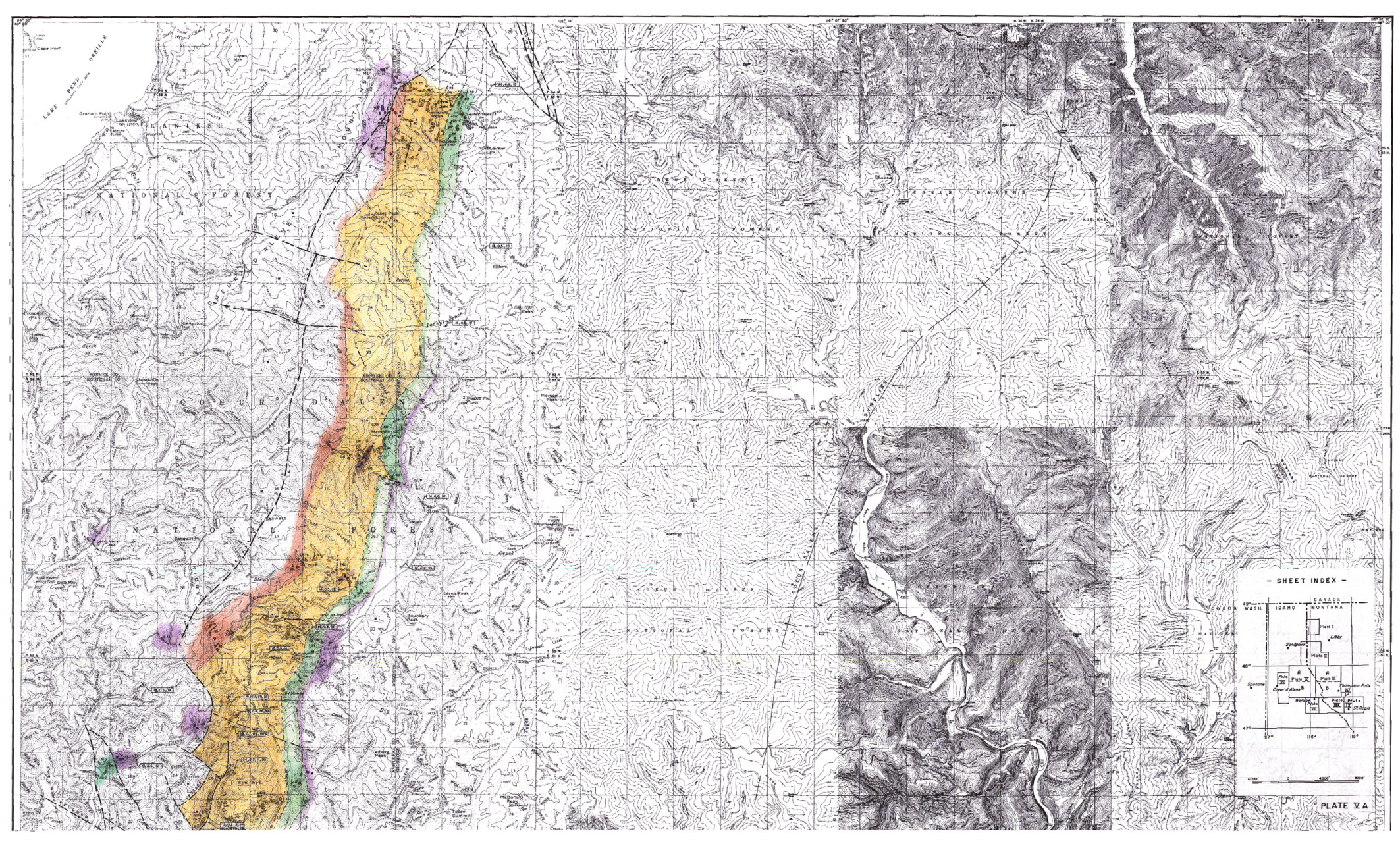
1981
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
TROY TYPE Cu-Ag DEPOSITS
SANDERS COUNTY, MONTANA

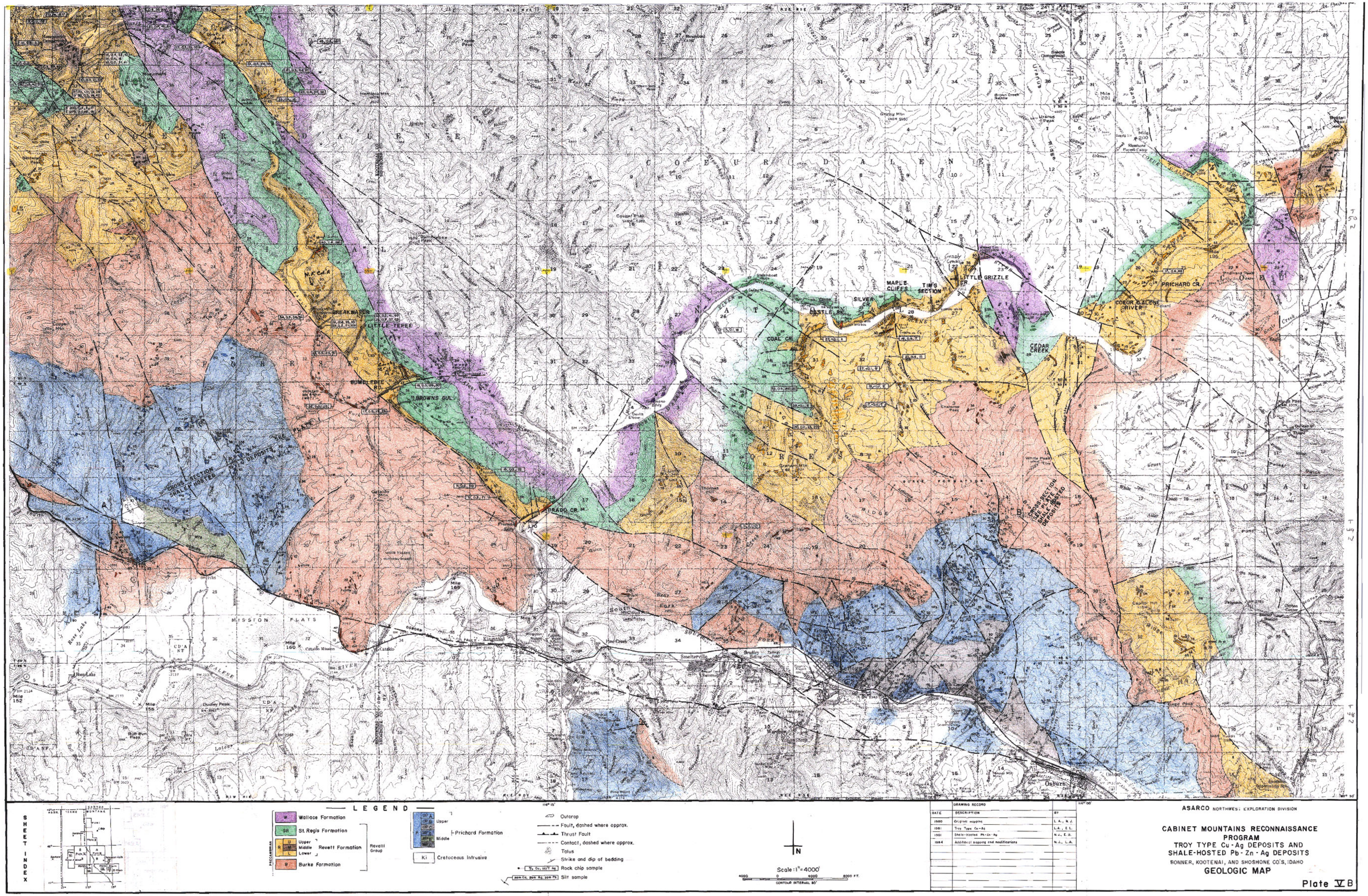
GEOLOGIC MAP

L. APPELGATE
ASSIST. E. LAFCO

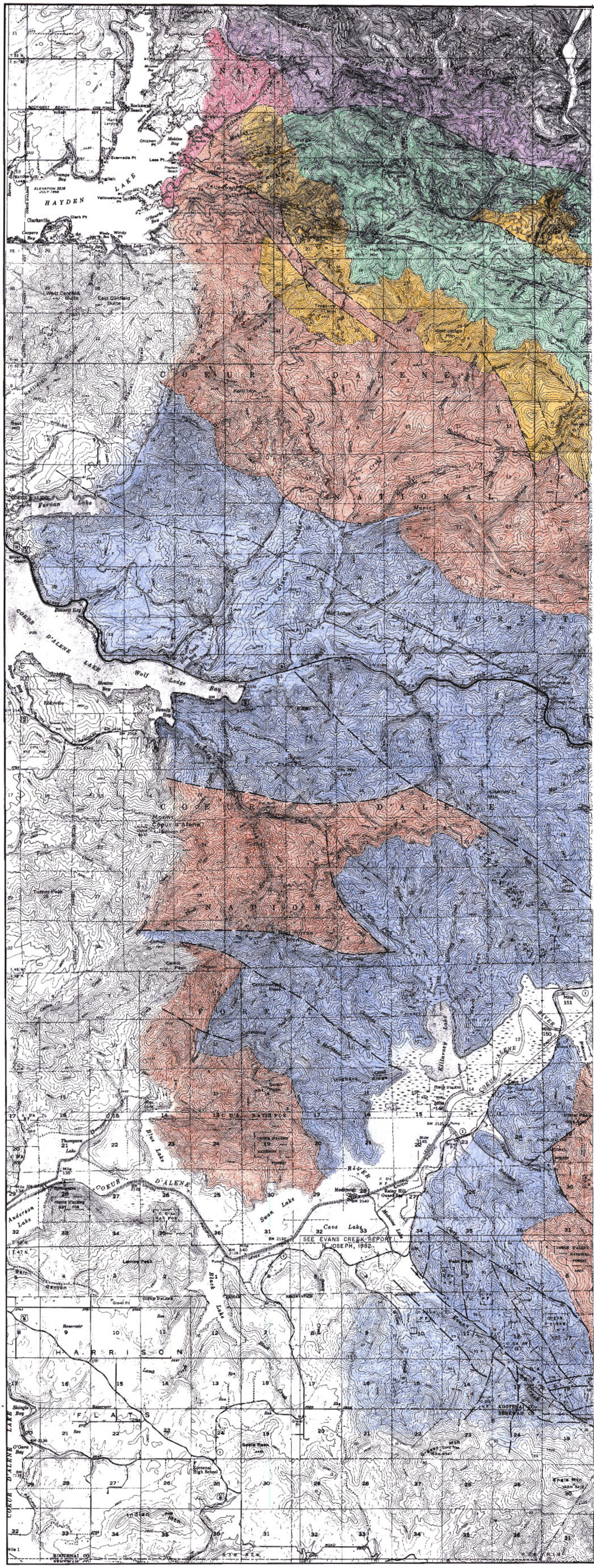
FEB. 1982

PLATE IV


– SHEET INDEX –
WASH.
IDAHO
MONTANA
CANADA
Plate I
Plate II
Plate III
Plate IV
Plate V
Plate VI
Plate VII
Plate VIII
Plate IX
Plate X
Sandpoint
Spokane
Coeur d'Alene
Thompson Falls
Wallace
St Regis
PLATE V A



COEUR D'ALENE
NATIONAL FOREST
MISSION FLATS
BREAKWATER
LITTLE TEPEE
BUMBLEBEE
BROWNS GUL.
PRADO CR.
COAL CR.
CASTLE
SILVER CR.
MAPLE CLIFFS
TIP'S SECTION
LITTLE GRIZZLE
PRICHARD CR.
COEUR D'ALENE RIVER
CEDAR CREEK
CROSS-SECTION SHALE-HOSTED DEPOSITS
Osburn
Smelterville
Kingston
Cataldo
Rose Lake
SHEET INDEX
LEGEND
W Wallace Formation
SR St. Regis Formation
R U Upper M Middle L Lower Revett Formation
B Burke Formation
Ravalli Group
PRECAMBRIAN
P UP A UP B UP C Upper MP A MP B MP C Middle Prichard Formation
Ki Cretaceous Intrusive
Outcrop
Fault, dashed where approx.
Thrust Fault
Contact, dashed where approx.
Talus
Strike and dip of bedding
% Cu, oz/T Ag Rock chip sample
ppm Cu, ppm Ag, ppm Pb Silt sample
Scale: 1" = 4000'
CONTOUR INTERVAL 80'
DRAWING RECORD
DATE DESCRIPTION BY
1980 Original mapping L.A., N.J.
1981 Troy Type Cu-Ag L.A., E.L.
1981 Shale-Hosted Pb-Zn-Ag N.J., E.D.
1984 Additional mapping and modifications N.J., L.A.
ASARCO NORTHWEST EXPLORATION DIVISION
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
TROY TYPE Cu-Ag DEPOSITS AND SHALE-HOSTED Pb-Zn-Ag DEPOSITS
BONNER, KOOTENAI, AND SHOSHONE CO.'S, IDAHO
GEOLOGIC MAP
Plate V B



— LEGEND —

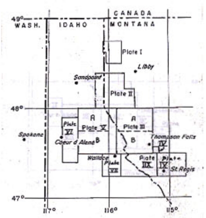
PRECAMBRIAN

Symbol	Unit
W	Wallace Formation
SR	St Regis Formation
R (U, M, L)	Upper / Middle / Lower — Revett Formation
B	Burke Formation
P	Prichard Formation
Ki	Cretaceous intrusive

RAVALLI GROUP (St Regis, Revett and Burke Formations)

- Outcrop
- Contact, dashed where approx
- Fault
- Talus
- Strike and dip of beds
- Anticline

— SHEET INDEX —



N

Scale : 1" = 4000'

4000 0 4000 8000 FT

ASARCO NORTHWEST EXPLORATION DIVISION

1981

CABINET MOUNTAINS RECONNAISANCE PROGRAM

TROY TYPE Cu-Ag DEPOSITS AND SHALE HOSTED Pb-Zn-Ag DEPOSITS

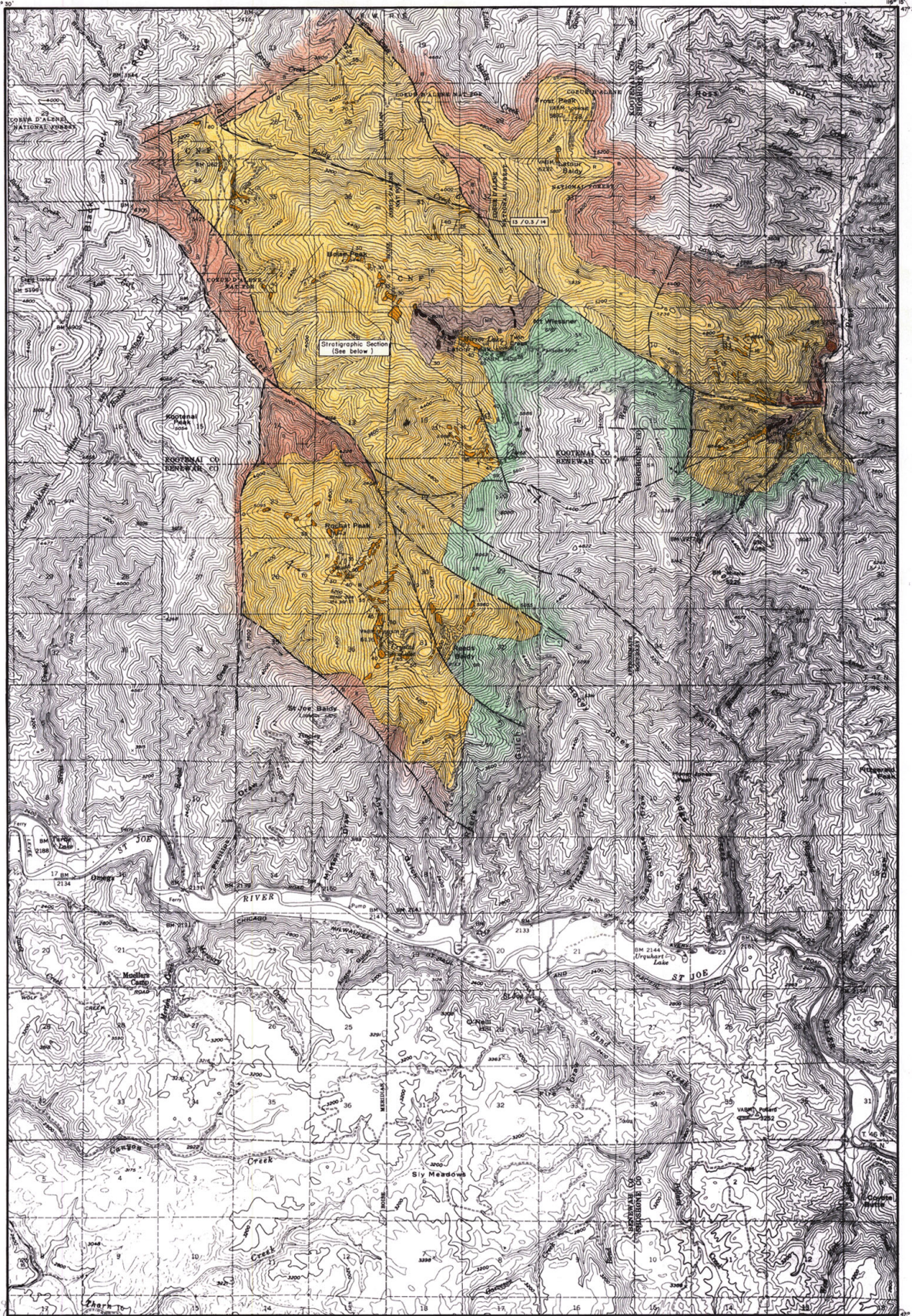
KOOTENAI AND BENEWAH COUNTIES, IDAHO

GEOLOGIC MAP

DRAWING RECORD

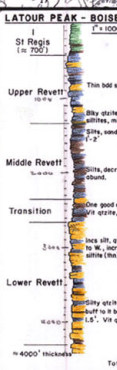
DATE	DESCRIPTION	BY
1981	Troy Type Cu-Ag L. Appelgate, E. Lofco	
1980-81	Shale Hosted Pb-Zn-Ag E. Dye, N. Joseph	

PLATE VI



LATOUR PEAK - BOISE PEAK SECTION

(1" = 1000' (Vert.))



— LEGEND —

PRECAMBRIAN — RAVALLI GROUP

- SR — St Regis Formation
- R — Upper / Middle / Lower — Revett Formation
- B — Burke Formation

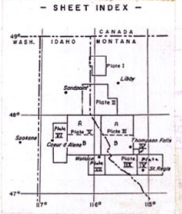
ROCK TYPE

- Quartzite
- Silty qtzite (sndy silt)
- Silts
- Argillites

Outcrop
Contact, dashed where approx.
Fault
Talus
35 — Strike and dip of beds

Stream sediment sample ppm Cu, ppm Ag, ppm Pb

— SHEET INDEX —



N

Scale : 1"= 4000'

4000 0 4000 8000 FT.

CONTOUR INTERVAL 80'

ASARCO NORTHWEST EXPLORATION DIVISION

1981 CABINET MOUNTAINS RECONNAISSANCE PROGRAM

TROY TYPE Cu-Ag DEPOSITS

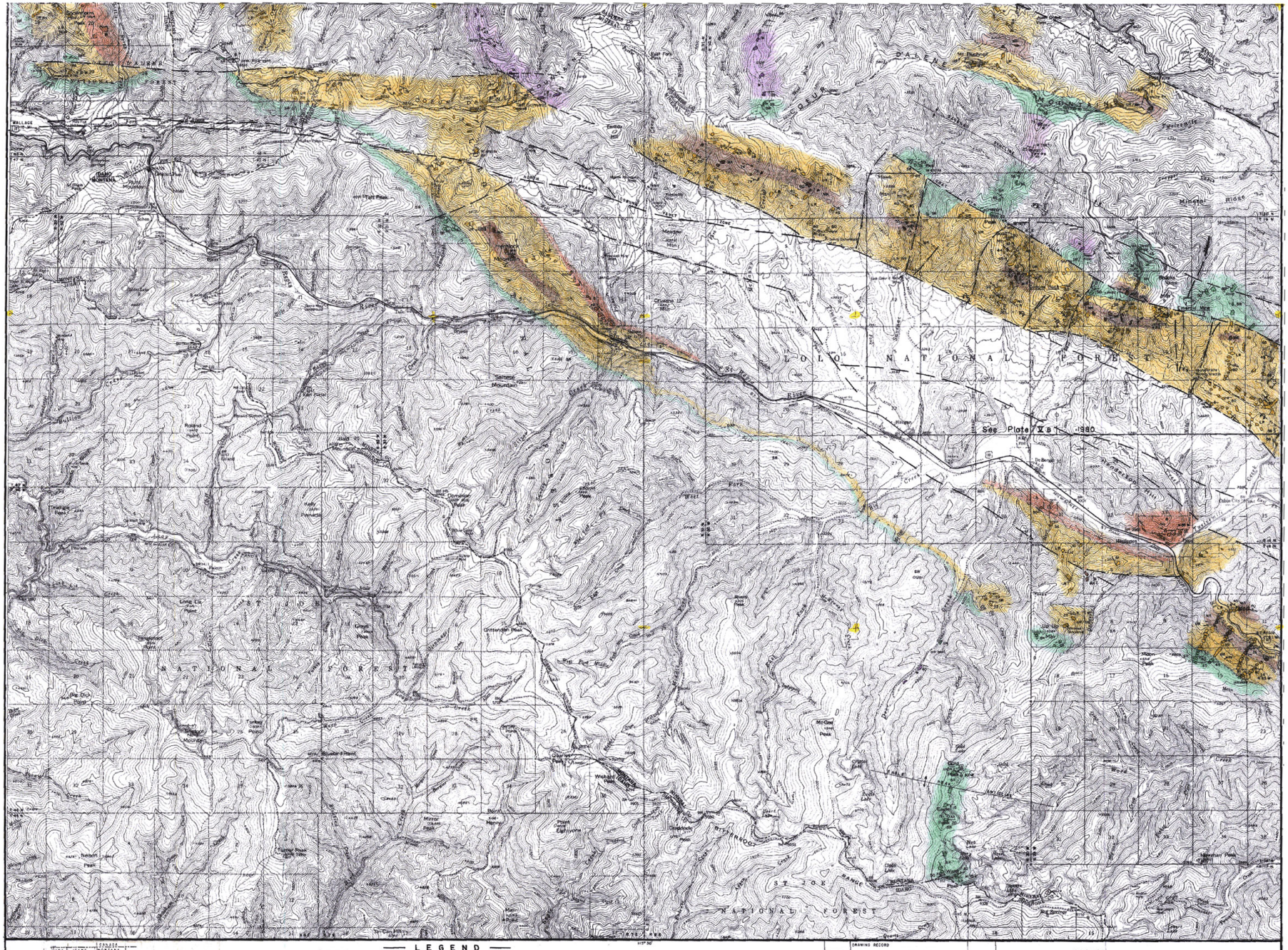
BENEWAH, KOOTENAI, AND SHOSHONE CO.'S, IDAHO

GEOLOGIC MAP

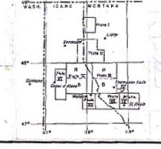
L. APPELGATE JAN. 1982

ASSIST. E. LAFCO

Plate VII



SHEET INDEX



LEGEND

PRECAMBRIAN

- W — Wallace Formation
- SR — St. Regis Formation
- R — Revett Formation (U — Upper; M — Middle; L — Lower)
- B — Burke Formation
- P — Prichard Formation

Belt Supergroup / Ravalli Group

- Outcrop
- Contact, dashed where approx.
- Fault, dashed where approx.
- Strike and dip of beds
- Minor anticline, showing plunge
- Overturned anticline
- Trench
- Mineralization

N

Scale 1" = 4000'

4000 0 4000 8000 FT.

DRAWING RECORD		
DATE	DESCRIPTION	BY
1980	Original mapping L. Appelgate, E. Lotto	
1981	Additional mapping L. Appelgate, E. Lotto	

ASARCO NORTHWEST EXPLORATION DIVISION

1981

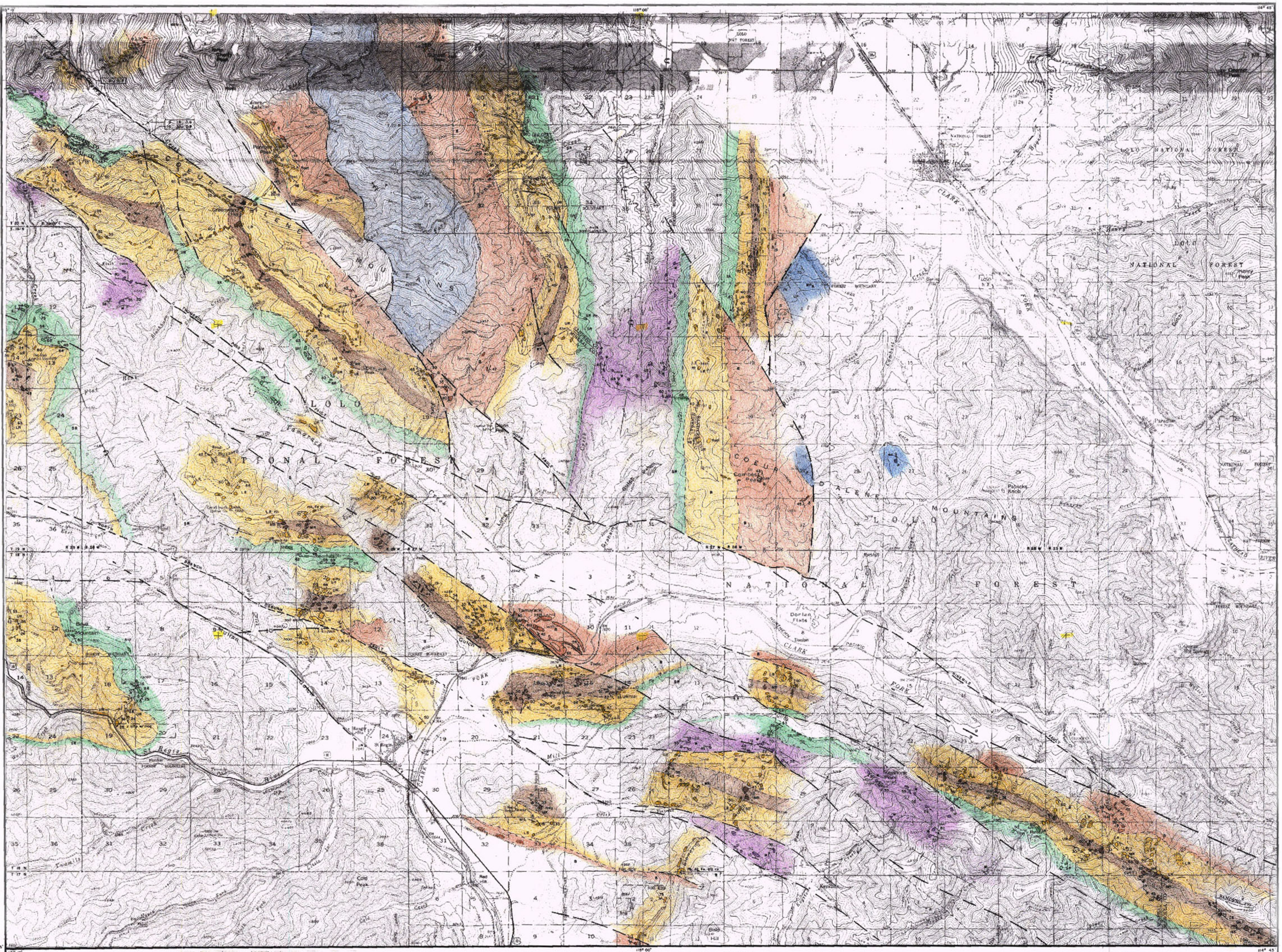
CABINET MOUNTAINS RECONNAISSANCE PROGRAM

TROY TYPE Cu-Ag DEPOSITS

SHOSHONE CO., IDAHO AND MINERAL CO., MONTANA

GEOLOGIC MAP

PLATE IIX



SHEET INDEX

N

LEGEND

PRECAMBRIAN

- W — Wallace Formation
- SR — St. Regis Formation
- R — U Upper / M Middle / L Lower — Revett Formation
- B — Burke Formation
- P — Prichard Formation

Ravalli Group (St. Regis, Revett and Burke Formations)

- Outcrop
- Contact, dashed where approx.
- Fault, dashed where approx.
- Strike and dip of beds
- Overturned anticline
- Thurst fault
- Talus
- Mineralization
- Syncline
- ppm Cu, ppm Ag, ppm Pb — Silt sample

DATE	DESCRIPTION	BY
1980	Original mapping L. Applegate, E. Lafco	
1981	Additional mapping L. Applegate, E. Lafco	

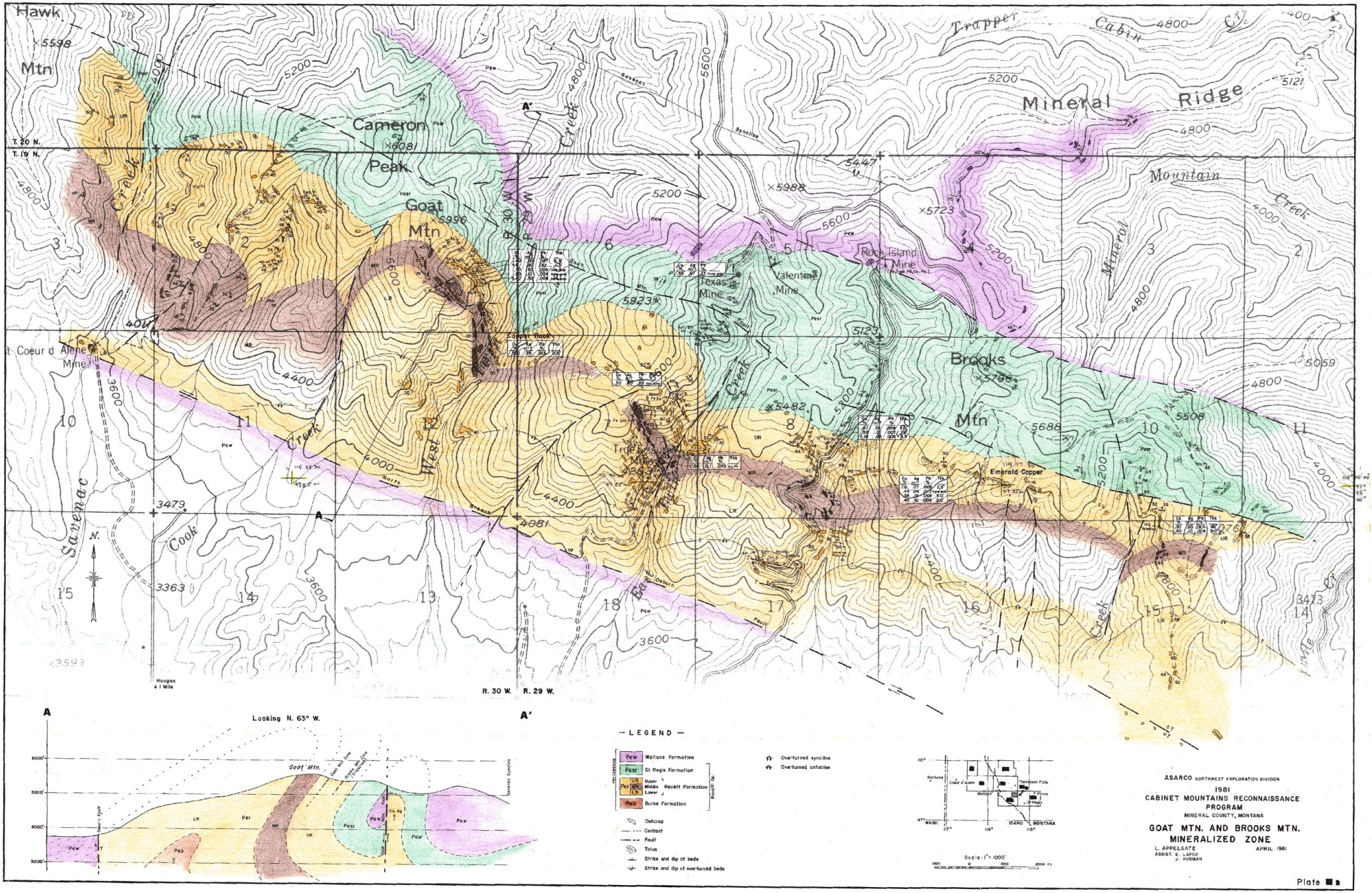
ASARCO NORTHWEST EXPLORATION DIVISION

1981
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
TROY TYPE Cu-Ag DEPOSITS
SANDERS AND MINERAL CO., MONTANA
GEOLOGIC MAP

Scale 1" = 4000'

4000 0 4000 8000 FT.

PLATE IX



— LEGEND —

- Pew Wallace Formation
- Pesr St. Regis Formation
- Per Revett Formation: Upper (UR), Middle (MR), Lower (LR)
- Peb Burke Formation
- Outcrop
- Contact
- Fault
- Talus
- Strike and dip of beds
- Strike and dip of overturned beds
- Overturned syncline
- Overturned anticline

ASARCO NORTHWEST EXPLORATION DIVISION

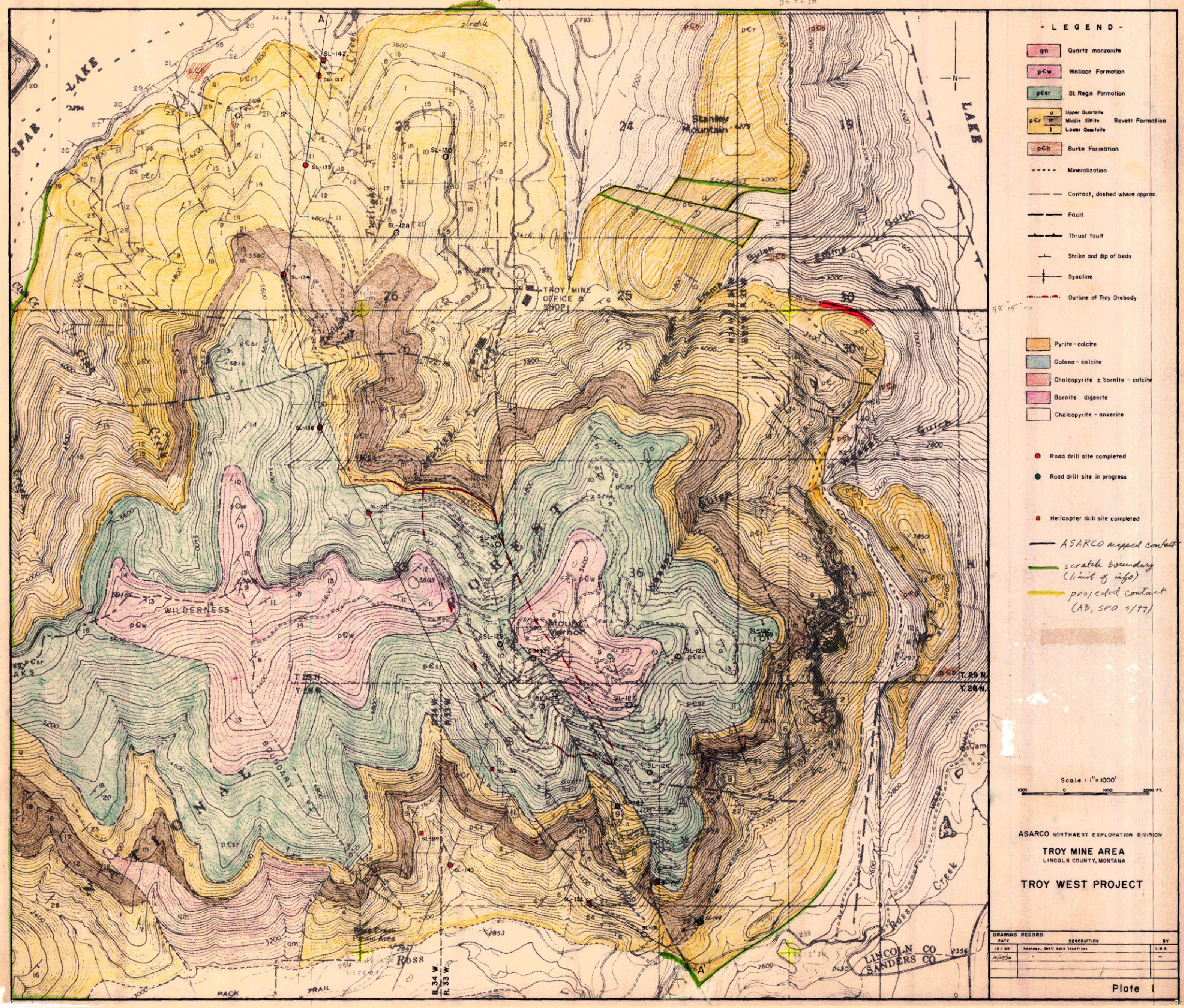
1981
CABINET MOUNTAINS RECONNAISSANCE PROGRAM
MINERAL COUNTY, MONTANA

GOAT MTN. AND BROOKS MTN. MINERALIZED ZONE

L. APPELGATE
ASSIST. E. LAFCO
C. HUSMAN

APRIL 1981

Plate ■■


- LEGEND -
qm Quartz monzonite
p€w Wallace Formation
p€sr St. Regis Formation
p€r u Upper Quartzite
m Middle Siltite
l Lower Quartzite
Revett Formation
p€b Burke Formation
Mineralization
Contact, dashed where approx.
Fault
Thrust fault
Strike and dip of beds
Syncline
Outline of Troy Orebody
Pyrite - calcite
Galena - calcite
Chalcopyrite ± bornite - calcite
Bornite digenite
Chalcopyrite - ankerite
Road drill site completed
Road drill site in progress
Helicopter drill site completed
ASARCO mapped contact
scratch boundary (limit of info)
projected contact (AD, SFO 5/99)
Scale : 1" = 1000'
1000 0 1000 2000 FT.
ASARCO NORTHWEST EXPLORATION DIVISION
TROY MINE AREA
LINCOLN COUNTY, MONTANA
TROY WEST PROJECT
DRAWING RECORD
DATE DESCRIPTION BY
10 / 90 Geology, Drill hole locations L.M.A.
Plate 1
SPAR LAKE
LAKE
Stanley Mountain
TROY MINE OFFICE & SHOP
WILDERNESS
Mount Vernon
BOUNDARY
T. 29 N.
T. 28 N.
R. 34 W.
R. 33 W.
LINCOLN CO.
SANDERS CO.
PACK TRAIL
Ross Creek
48°15'00