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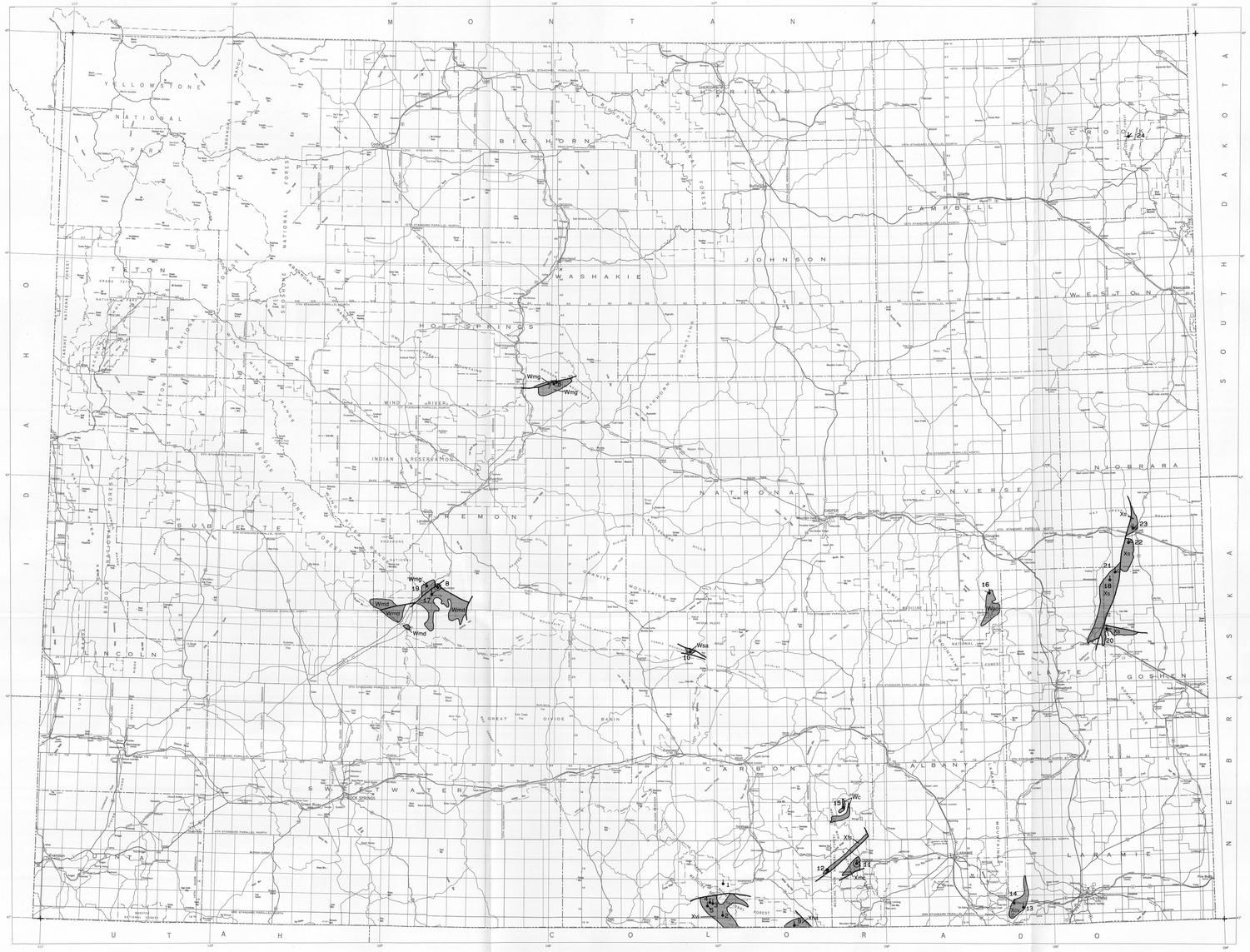
MISCELLANEOUS FIELD STUDIES
MAP MF–1853–F
VOLCANOGENIC MASSIVE SULFIDE MAP SERIES



Base from U.S. Geological Survey
1:500,000, 1967

SCALE 1:1 000 000

25 0 25 50 75 100 MILES

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Geology compiled from Bayley and others (1973), Dixs (1976), Hausel and others (1985), Houston and others (1983), Snyder and Peterman (1982), Swift (1982), and unpublished mapping by R.D. Woodfill

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METALLOGENIC MAP OF VOLCANOGENIC MASSIVE SULFIDE OCCURRENCES IN WYOMING

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VOLCANOGENIC MASSIVE SULFIDE MAP SERIES

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EXPLANATION

Location of volcanogenic massive sulfide occurrence showing the metal(s) present—Locality number keyed to table 1

- **Copper**
- **Gold**
- **Silver**
- **Zinc**
- **Other metals**
- **Cluster of prospects or mines**
- **Distribution of massive sulfide host rocks**
- **Fault or shear zone**

LIST OF MAP UNITS

HOST ROCKS OF EARLY PROTEROZOIC AND EARLY PROTEROZOIC(?) MASSIVE SULFIDE OCCURRENCES

- Xha — **Hornblende gneiss and amphibolite**
- Xmc — **Felsic volcanic rocks of the informally named Mullen Creek mafic complex**
- Xfs — **French Slate of the upper part of the Libby Creek Group**
- Xcv — **Calc-alkaline metavolcanic rocks, including rhyolite breccia**
- Xvt — **Metavolcanic rocks, metachert, and iron-formation**
- Xs — **Metasedimentary rocks, including iron-formation, ferruginous quartzite, ferruginous chert, hornblende schist, and graphite schist of the schist of Silver Springs and formation of Muskrat Canyon**

HOST ROCKS OF LATE ARCHEAN MASSIVE SULFIDE OCCURRENCES

- Wac — **Amphibolite and metachert**
- Wc — **Colberg metavolcanic rocks of the Phantom Lake Metamorphic Suite**
- Wsa — **Serpentinite and actinolite schist**
- Wmd — **Metavolcanic rocks and metasedimentary rocks of the Miners Delight Formation**
- Wmg — **Metachert, quartzofeldspathic gneiss, iron-formation, amphibolite, and biotite schist**

EDITOR'S NOTE

This map is one of several planned or published products of a study of the distribution and setting of volcanogenic massive sulfide occurrences in the Western United States. The term "volcanogenic massive sulfide" refers to occurrence types that are inferred to be associated with the development of ancient island arcs or with rift systems in a subaqueous environment. The massive sulfide occurrences shown on this map are mostly considered to be "proximal" occurrences, that is, emplaced near centers of volcanic activity. The distribution of favorable host rocks for massive sulfide occurrences and the structures that apparently control their distribution are also shown on the map. The host rocks are not necessarily formal stratigraphic units and they may contain several lithologic types. They are shown here to delineate areas that may be prospective for undiscovered massive sulfide deposits.

SUMMARY OF VOLCANOGENIC MASSIVE SULFIDE OCCURRENCES IN WYOMING

Volcanogenic massive sulfide occurrences of Late Archean age and Early Proterozoic age occur in metavolcanic and associated metasedimentary rocks in southeastern, eastern, and central Wyoming. Vein deposits in Archean volcanic terrane have accounted for a large part of the gold production in the State (Miners Delight, locality 8). Past production from all massive sulfide occurrences in the State is poorly known, but it probably did not exceed $13 million at current metal prices. The bulk of the production was from gold mines in the southern Wind River Range (localities 8 and 17). For the most part, the host rocks of the massive sulfide occurrences have been metamorphosed to amphibolite facies. As a result, the depositional environments are, in many cases, difficult to determine. For purposes of discussion, the occurrences are classified by geologic age.

LATE ARCHEAN OCCURRENCES

Massive sulfide occurrences of Late Archean age are in the Owl Creek Mountains, southern Wind River Range, eastern Ferris Mountains, Esterbrook area of the northeastern Laramie Mountains, Colberg area of the northeastern Medicine Bow Mountains, and 1 mi north of Silver lake in the Sierra Madre.

Copper silicate and carbonate minerals and anomalous amounts of gold are in metachert interlayered with amphibolite at the McGraw mine area of the Owl Creek Mountains (locality 6). Tungsten (in the form of the mineral scheelite) and pyrite are in quartzofeldspathic gneiss interlayered with amphibolite and biotite schist in the Stardust-Comet mine area of the Owl Creek Mountains (locality 7). Deposits at localities 6 and 7 are stratabound and are associated with rocks interpreted as volcanic in origin (Hausel and others, 1985).

In the southern Wind River Range, pyrite, arsenopyrite, and chalcopyrite are disseminated in metadacite of apparent volcanic origin. The metadacite, a part of the Miners Delight Formation of Late Archean age, is interlayered with basalt flows and locally with felsic breccia. The formation also contains metagraywacke, graphitic schist, andalusite-mica schist, and conglomerate. In places, the Miners Delight Formation contains crosscutting sulfide- and gold-bearing veins, such as at the Miners Delight mine (locality 8). At the Snowbird mine (locality 17), the orebody consists of stratabound bands of massive pyrite and minor chalcopyrite, calcite, and at least two generations of quartz (Prinz, 1974). Bayley and others (1973), in summarizing Cannon and others (1965), reported that galena from the Snowbird mine yielded an age of 2.85 Ga. Historically, gold has been the only metal of economic interest from these deposits in the Miners Delight Formation (Spencer, 1916; Bayley and others, 1973). At the nearby Atlantic City Iron mine (locality 19), iron-formation is host to localized stratabound concentrations of pyrite and chalcopyrite. The iron-formation and associated sulfide minerals are included in rocks of predominantly volcanic origin and represent chemical sediments deposited by exhalative processes.

At the Spanish Trail Group in the eastern Ferris Mountains, stratabound sulfides are in volcanic rocks that were altered to serpentinite and actinolite schist (locality 10). The altered volcanic rocks are near a diorite plug and they underlie a 2-mi^2 area. The principal sulfide minerals are galena, chalcopyrite, pyrite, and sphalerite, gold and silver are associated with the sulfides (Osterwald and others, 1966). Locally, sulfides and associated precious metals, which are inferred to be derived from stratabound deposits, were remobilized into crosscutting quartz veins.

Stratabound sulfide occurrences in the Esterbrook area of the northeastern Laramie Mountains are in chert associated with amphibolite. At Pheasant Draw (Trail Creek of Spencer, 1916), the occurrences are near the northern limit of the Esterbrook mining district (locality 16). The sulfides are mostly massive pyrite and associated chalcopyrite, and they also contain uraninite as well as cobalt and nickel sulfide minerals.

Near the abandoned mining town of Colberg (locality 15) in the northeastern Medicine Bow Mountains, exhalative deposits of metachert containing disseminated iron and copper sulfide minerals occur at the top of a bimodal basalt-rhyolite volcanic pile. The volcanic rocks are a part of the Colberg Metavolcanics of the Late Archean Phantom Lake Metamorphic Suite, which underlies much of the northeastern Medicine Bow Mountains (Houston and others, in press).

At the Section Eight mine (locality 1), also in the Phantom Lake Metamorphic Suite, the chert host rocks are associated with amphibolite rather than rhyolite as at the Colberg occurrence (Hausel, 1982). This mine is about 1 mi north of Silver Lake in the central Sierra Madre. Chalcopyrite is the principal sulfide mineral in this stratabound occurrence.

EARLY PROTEROZOIC OCCURRENCES

Massive sulfide occurrences of Early Proterozoic age are in the central, southwestern, and southeastern Sierra Madre, the Centennial Ridge and French Creek areas of the Medicine Bow Mountains, the Granite area of the southeastern Laramie Mountains, the McCann Pass to Duck Creek area of eastern Wyoming, and the Bear Lodge Mountain area of northeastern Wyoming.

The Green Mountain Formation (Divis, 1976) in the central and southern Sierra Madre is a volcano-sedimentary succession that crops out south of the Cheyenne belt, a possible suture that separates Archean rocks on the northwest from Proterozoic rocks on the southeast (Houston and others, 1979). The volcanic rocks of the Green Mountain Formation are well preserved in the south-central Sierra Madre near Fletcher Park (locality 5) and on Green Mountain. They consist of mafic to felsic cycles that are overlain by cherty iron-formation, carbonate rocks, graywacke, and volcaniclastic rocks. Pyrite, chalcopyrite, tenorite, and sphalerite are disseminated in siliceous and carbonate chemical sediments that overlie the volcanic rocks (Houston and others, 1983). Silver was reported in some assays.

In the southwestern Sierra Madre, many thin beds of iron-formation in the Green Mountain Formation contain disseminated sulfides (Swift, 1982). At locality 2, the Verde or Hinton mine (Spencer, 1904), mineralized chemical sediments between felsic breccia and cherty iron-formation contain disseminated chalcopyrite, pyrite, and magnetite; gold and silver have been reported in some assays. The Itmay prospect (locality 3) and prospect 9999 (locality 4) contain copper sulfide minerals in iron-formation and in metarhyolite and metachert, respectively.

In the southeastern Sierra Madre, Raymond and Sheridan (1980) reported stratabound copper and zinc sulfide occurrences in the Pearl mining district of northern Colorado and adjacent southern Wyoming (locality 9). The metamorphic host rocks are of volcanic and sedimentary origin. Gahnite, a zinc spinel, was identified in some of these occurrences.

On Centennial Ridge in the east-central part of the Medicine Bow Mountains, stratabound sulfide occurrences are in highly deformed and metamorphosed, felsic volcanic rocks and associated chemical sediments (locality 11). The sulfide minerals are primarily pyrite and chalcopyrite; gold has been reported in assays. Sulfide minerals in veins and shear zones in this area may be remobilized, in part, from stratabound occurrences. Stratabound occurrences have also been reported in metavolcanic rocks southwest of Centennial Ridge in an area west of the Golden Key mine (Keystone 7 1/2-minute quadrangle). These metavolcanic rocks are a part of the Mullen Creek mafic complex, an informally designated unit of Houston and others (1968).

Layers of massive and disseminated pyrite are in the Early Proterozoic French Slate of the upper part of the Libby Creek Group (Houston and others, 1983) at locality 12, about 1/4 mi south of the confluence of Silver Lake Creek and south French Creek in the central Medicine Bow Mountains. The pyritic zones are in graphitic French Slate near its contact with underlying metabasalt of the Towner Greenstone.

Disseminated iron sulfides and possibly copper sulfide minerals occur in rhyolite breccia on the Prince and Remount Ranches (localities 13 and 14, respectively) near Granite, Wyo., in the southeastern Laramie Mountains. The breccia crops out in an area of abundant felsic volcanic rocks that may be part of a calc-alkaline suite. The sulfide mineralogy in these occurrences is poorly known.

Massive and disseminated sulfide occurrences at localities 18 and 20-23 in eastern Wyoming are in metasedimentary rocks that we infer to be of Early Proterozoic age. The metasedimentary rocks are mostly of exhalative origin and, in places, they appear to onlap Archean gneiss. Sulfide occurrences in these rocks are interpreted to be distal deposits and consist mostly of pyrite, sphalerite, and chalcopyrite, anomalous amounts of silver, and locally anomalous amounts of gold. The host rocks are iron-formation, ferruginous chert, ferruginous quartzite, hornblende schist, and graphite schist of the schist of Silver Springs and the formation of Muskrat Canyon of Snyder and Peterman (1982).

At locality 24 in the Bear Lodge Mountains in the northeastern part of the State, approximately 40 ft of silver-rich pyrite-sphalerite massive sulfide were found by a single drill hole into a deeply buried sulfide body. The host rock is hornblende schist of inferred Early Proterozoic age. Its distribution in the subsurface is unknown.

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Table 1. *Volcanogenic massive sulfide occurrences in Wyoming*

Locality No.	Name	Location (lat N., long W.)	Age	Host rock lithology	Remarks
1	Section Eight mine.	41°11′30″, 106°58′40″.	Late Archean	Chert and amphibolite	Copper sulfide minerals in banded chert in amphibolite. No recorded production.
2	Verde or Hinton mine.	41°03′33″, 106°58′34″.	Early Proterozoic (1.9-1.7 Ga).	Fragmental meta-volcanic rocks (Xvl).	Copper sulfide minerals and trace gold in mine workings. No recorded production.
3	Itmay prospect.	41°06′06″, 107°01′17″.	Early Proterozoic (1.9-1.7 Ga).	Iron-formation (Xvi)	Copper sulfide minerals in prospect workings. No recorded production.
4	Prospect 9999.	41°06′06″, 107°03′00″.	Early Proterozoic (1.9-1.7 Ga).	Metarhyolite and metachert (Xvi).	Copper sulfide minerals in prospect workings. No production.
5	Fletcher Park outcrop.	41°05′42″, 107°03′23″.	Early Proterozoic (1.9-1.7 Ga).	Metarhyolite and metachert (Xvi).	Copper sulfide minerals in outcrops.
6	McGraw mine	43°27′, 107°55′	Late Archean	Amphibolite (Wmg)	Copper silicate and copper carbonate minerals and gold in mine workings. No recorded production.
7	Stardust-Comet mine.	43°25′30″, 107°58′30″.	Late Archean	Felsic gneiss (Wmg)	Stratabound scheelite occurrence in mine workings. No recorded production.
8	Miners Delight mine.	42°31′46″, 108°41′15″.	Late Archean	Metadacite (Wmd)	Produced $1,200,000 in gold prior to 1911.
9	Pearl mining district.	41°00′, 106°32′30″.	Early Proterozoic	Gneiss-amphibolite (Xha).	Numerous copper-zinc prospects. Copper and zinc sulfide minerals and zinc spinel (gahnite).
10	Spanish Trail Group.	42°15′10″, 107°09′20″.	Late Archean	Actinolite schist (Wsa)	Galena, chalcopyrite, and sphalerite. Associated gold-quartz veins.
11	Centennial Ridge.	41°17′, 106°10′50″.	Early Proterozoic	Felsic volcanic rocks (Xmc).	Chalcopyrite and pyrite stratabound occurrences; associated mineralized veins.
12	French Creek	41°16′28″, 106°21′09″.	Early Proterozoic	Graphitic slate (Xfs)	Pyrite zones near contact of slate and underlying metabasalt.
13	Prince Ranch	41°04′02″, 105°11′14″.	Early Proterozoic	Rhyolite breccia (Xcv)	Disseminated pyrite and copper sulfide minerals in outcrops and prospects.
14	Remount Ranch.	41°04′35″, 105°16′05″.	Early Proterozoic	Rhyolite breccia (Xcv)	Disseminated pyrite and copper sulfide minerals in outcrops and prospects.
15	Colberg	41°32′30″, 106°15′35″.	Late Archean	Cherty chemical sediments (Wc).	Mine workings at top of bimodal basalt-rhyolite sequence.
16	Pheasant Draw.	42°29′43″, 105°21′10″.	Late Archean	Cherty chemical sediments in amphibolite (Wac).	Massive sulfides exposed in mine workings. Ore mostly pyrite-chalcopyrite, also contains uraninite, and cobalt and nickel minerals.
17	Snowbird mine.	42°29′42″, 108°42′28″.	Late Archean	Amphibolite-metadacite (Wmd).	Massive pyrite-chalcopyrite exposed in mine workings, as much as 0.13 ounces per ton of gold.
18	Michigan mine	42°31′41″, 104°35′59″.	Early Proterozoic(?)	Cherty, ferruginous chemical sediments (Xs).	Stratabound copper silicate minerals.
19	Atlantic City iron mine.	42°31′50″, 108°42′40″.	Late Archean	Iron-formation (Wmg)	Major iron mine 1962-1983; locally contains layered pyrite-chalcopyrite.
20	McCann Pass prospects.	42°19′48″, 104°40′41″.	Early Proterozoic(?)	Metachert-graphite schist (Xs).	Prospects in large gossans.
21	Wildcat Canyon prospects.	42°34′48″, 104°34′12″.	Early Proterozoic(?)	Ferruginous quartzite (Xs).	Prospects in large gossan in metasedimentary rocks.
22	Silver Springs prospects.	42°43′12″, 104°29′24″.	Early Proterozoic(?)	Hornblende-graphite schist and ferruginous chert (Xs).	Prospects in gossan.
23	Duck Creek prospects.	42°46′48″, 104°28′48″.	Early Proterozoic(?)	Ferruginous, cherty iron-formation (Xs).	Prospects near Silver Cliff uranium mine.
24	Bear Lodge drill hole No. 1.	44°32′24″, 104°26′24″.	Early Proterozoic(?)	Hornblende schist	Forty feet of massive sulfides containing sphalerite and minor chalcopyrite cut by diamond drilling. Host rocks unexposed.

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