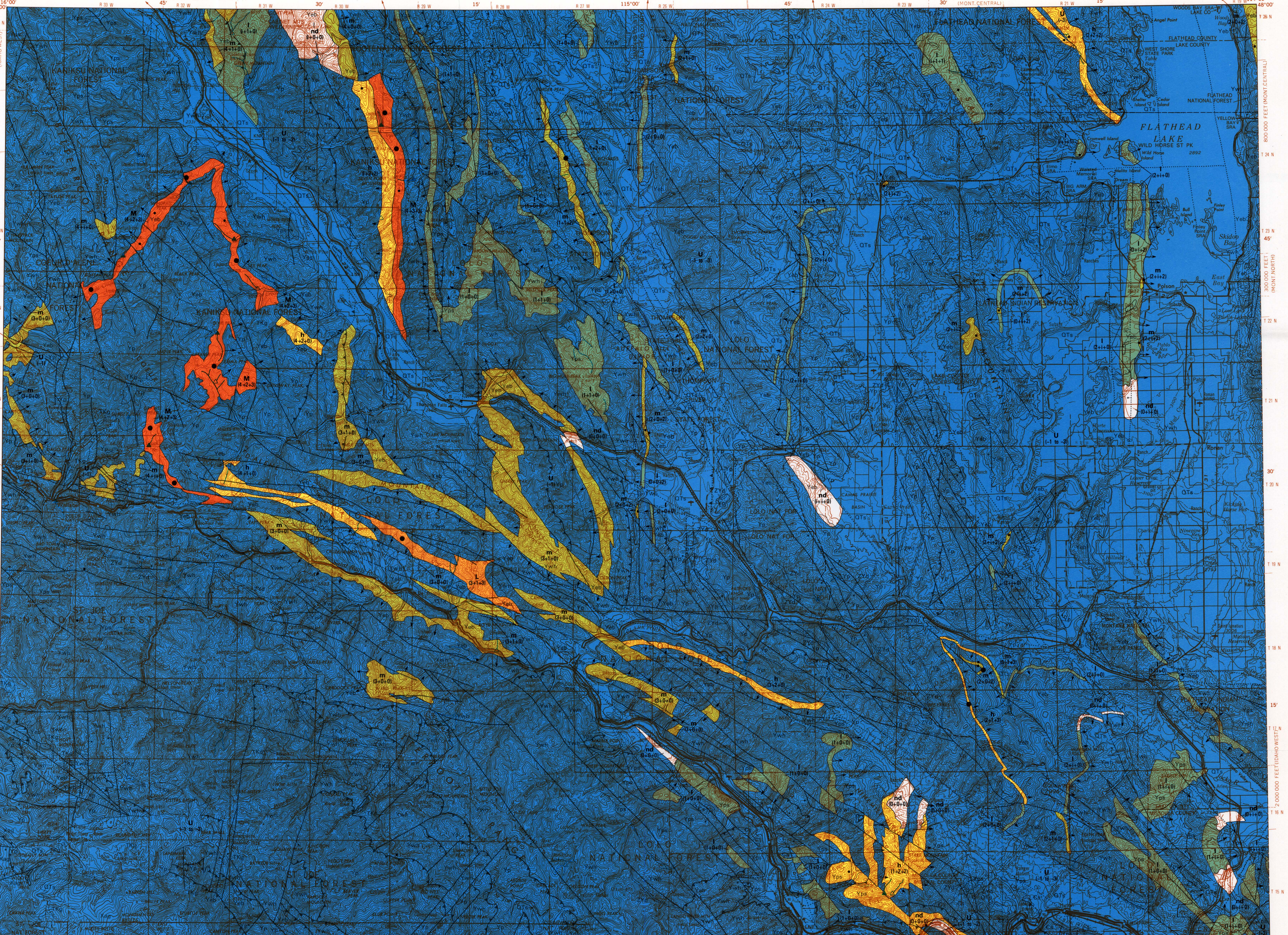
PREPARED IN COOPERATION WITH THE
MONTANA BUREAU OF MINES AND GEOLOGY



Base from U.S. Geological Survey, 1956, revised 1981

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MONTANA
IDAHO
QUADRANGLE LOCATION

Geology by J.E. Harrison, A.B. Griggs, and J.D. Wells, 1970–80; assisted by H.R. Covington, 1972; Joseph Boggs, 1973; and J.P. Harrison, 1970–80. Resource appraisal data compiled by J.E. Harrison, 1981

CORRELATION OF MAP UNITS

- QTs — QUATERNARY AND TERTIARY
- Tv — TERTIARY
- TKg, TKd — TERTIARY AND CRETACEOUS
- Unconformity
- Ꞓs — CAMBRIAN
- Unconformity
- ZYd — LATE AND MIDDLE PROTEROZOIC
- Yps (Missoula Group), Ywh, Yeb and Yp (Ravalli Group) — Belt Supergroup — MIDDLE PROTEROZOIC
- Unconformity
- Xag — EARLY PROTEROZOIC

DESCRIPTION OF GEOLOGIC MAP UNITS

QTs VALLEY FILL DEPOSITS (QUATERNARY AND TERTIARY)—Alluvium, glacial deposits, and semiconsolidated to consolidated conglomerate interlayered in places with shale, coal, and volcanic ash; shown only in major valleys and basins or along main stream courses

Tv VOLCANIC ROCKS (TERTIARY)—Largely andesitic to dacitic welded tuff

TKg GRANITIC INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)

TKd DIORITIC INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)

Ꞓs SEDIMENTARY ROCKS (CAMBRIAN)—Includes Red Lion Formation, Hasmark Dolomite, Silver Hill Formation, Flathead Quartzite, and equivalent rocks

ZYd DIORITIC TO GABBROIC SILLS AND DIKES (LATE AND MIDDLE PROTEROZOIC)

Yps MISSOULA GROUP (MIDDLE PROTEROZOIC)—Includes Pilcher, Libby, Garnet Range, and McNamara Formations, Bonner Quartzite, and Striped Peak, Mount Shields, Shepard, and Snowslip Formations

Ywh WALLACE AND HELENA FORMATIONS (MIDDLE PROTEROZOIC)

Yeb RAVALLI GROUP (MIDDLE PROTEROZOIC)—Includes Empire, St. Regis, Spokane, Revett, and Burke Formations

Yp PRICHARD FORMATION (MIDDLE PROTEROZOIC)

Xag ANORTHOSITE, SCHIST, AND GNEISS (EARLY PROTEROZOIC)

CONTACT

FAULT—Dotted where concealed. Bar and ball on downthrown side; arrows show relative direction of apparent horizontal movement

THRUST FAULT—Dotted where concealed. Sawteeth on upper plate

Note: The generalized and simplified geologic map was prepared as an underlay for various geophysical and geochemical data collected in the Wallace 1° x 2° quadrangle. A fuller treatment of geologic units and structure can be found on map I–1509–A in the Wallace CUSMAP folio.

This map is part of a folio of maps of the Wallace 1° x 2° quadrangle, Montana-Idaho, prepared under the Conterminous United States Mineral Assessment Program (CUSMAP). Background information about this folio is published in U.S. Geological Survey Circular 920.

OCCURRENCE MODEL FOR STRATABOUND COPPER-SILVER DEPOSITS

REGIONAL SETTING

Stratabound copper-silver ores and occurrences are found in white, buff, or pale-green quartzites, in green beds in red-bed sequences, and in minor amounts associated with stromatolites in carbonate rocks. Quartzites of the Revett Formation in the western part of Belt terrane contain the ore occurrences known presently, and these are in deltaic, channel, and perhaps bar facies; the principal mine in these rocks is near Spar Lake, about 25 km north of the northwest corner of the Wallace quadrangle. Green-bed occurrences are marginal to submarginal in resource potential to date, but are widespread throughout Belt terrane in tidal-flat and shallow-shelf facies of the Ravalli and Missoula Groups. White quartzite channels, lenses, and thin (less than 3 ft) layers in green argillitic beds commonly contain sulfides in areas where green beds also contain anomalous sulfides.

A north-trending area about 25 km wide contains several ore deposits and marginal resources in the Revett Formation. This zone extends from the Coeur d' Alene mining district near Wallace, Idaho, northward almost to Canada and has been called a "mineral belt."

DEPOSIT CHARACTERISTICS

Sulfides occur in lense-shaped bodies that generally are found in certain formations or strata (stratabound) but that grossly transect the strata (not stratiform). Sulfides are found predominantly in white, gray, or green strata rather than in red, purple, dark-gray, or black rocks.

The dominant sulfides are bornite, chalcocite, and digenite, and lesser amounts of chalcopyrite, tetrahedrite, and covellite are present. Minor amounts of galena, molybdenite, wittichenite, native silver, magnetite, pyrite, and barite have been reported from some occurrences. Chalcopyrite is dominant in a few occurrences. Spar Lake ore is clearly zoned from an inner core of bornite-chalcocite through successive shells of chalcopyrite, galena, and pyrite.

In detail, the sulfides tend to be concentrated along sedimentary features, such as in cross-strata, at the base of graded beds, in silty laminations in argillitic rocks, in mud cracks, and in fluid-escape structures. Disseminated sulfides occur between grains in the rock or fill voids, but larger clots formed later in the rocks and replaced silicate or carbonate grains or cements and rock clasts. Sulfides also occur along small diagenetic fractures, as well as along major faults that cut the strata. One part of the major known ore deposit (Spar Lake) has sulfide mineralization along bedding-plane shears that are probably related to thrusts of Cretaceous-Tertiary age.

GEOCHEMICAL CHARACTERISTICS

Rock samples of occurrences and ore contain anomalous amounts of copper, silver, and mercury, and they may also contain anomalous amounts of lead, molybdenum, bismuth, and barium. Ratios of copper to silver in fresh rock samples are 200:1 or larger for the better grade ores, range from about 300:1 to 500:1 for marginal to submarginal resources, and are 700:1 or smaller for submarginal resources. Surface samples tend to show variable secondary enrichment in silver and are not reliable indicators of probable grade at depth. Because most analyzed rock samples are from outcrops, we have not used the copper to silver ratio in our rating scale for resource potential.

Stream-sediment samples in drainages near known stratabound copper-silver occurrences show anomalous amounts of copper with or without silver or lead. However, none contain anomalous zinc, antimony, molybdenum, or bismuth. It should be noted that the simple geochemical suite of copper or silver with or without lead is also characteristic of stream sediments in drainages that contain certain mafic sills or dikes or that contain one of the few mineralogically simple veins. We have shown the locations of all the stream-sediment samples that contain the simple copper-silver-lead anomaly, even though several of them, particularly in the southwestern part of the quadrangle, show an anomaly that seems attributable to copper-bearing dikes and sills.

RESOURCE POTENTIAL

The one ore body being mined at Spar Lake is reported (Balla, 1983) to have 64 million short tons of ore containing about 0.7 percent copper and 1.6 ounces of silver per ton. Smaller ore bodies of slightly lower grade are also known.

In terms of submarginal to marginal resources, both the quartzite and green-bed occurrences have several billion tons of metal in scattered small- to moderate-sized bodies of rock that contain about 0.3 percent copper and perhaps 0.3–0.5 ounces of silver per ton.

RATING SCALE

Geologic characteristics

+4 Revett Formation having abundant white quartzite beds that show intense crossbedding and channeling; dominantly associated with white or green siltites within "mineral belt." Carbonate cement common

+3 Revett Formation having white to buff quartzite beds located at edges of "mineral belt." Minor carbonate cement

+2 Middle part of the Burke Formation where it contains alternating beds of purple and green argillites and siltites; also, upper part of the Spokane Formation

+1 Snowslip, upper part of Mount Shields, and McNamara Formations where they contain alternating red and green argillites and siltites; upper part of the St. Regis and basal part of the Empire Formations where in conformable contact

0 Areas of extensive valley fill that covers favorable host-rock zones

−1 Black, dark-gray, or gray strata of any lithology; stromatolite zones in carbonate rocks; St. Regis Formation in most of the area

−2 Carbonate rocks

−3 Red or purple strata of any lithology; thick and extensive valley-fill deposits; intrusive rocks

Geochemical anomalies

Samples from each locality have been analyzed for total metals in 80-mesh stream sediments, partially extractable metals in those samples, and metals in the nonmagnetic fraction of panned concentrates.

+3 Copper and silver with or without lead in total metals; copper with or without silver or lead in either partially extractable metals or panned concentrates

+2 Copper or silver with or without lead in total metals; copper with or without silver or lead in either partially extractable metals or panned concentrates

+1 Copper or silver in a single type of sample

0 No copper or silver in any type of sample

−1 Copper with or without silver or lead plus zinc or antimony or molybdenum or bismuth (the last four elements are part of the trace-element suite associated with mesothermal veins, not stratabound copper-silver occurrences)

Known mineral occurrences

+4 One or more copper-silver mines in favorable stratigraphic zone

+3 One or more copper-silver prospects in favorable stratigraphic zone

+2 Sulfide minerals visible in outcrop of favorable stratigraphic zone, and sample 4 in. thick contains at least 100 parts per million copper and at least a trace of silver

+1 Sulfide minerals visible in outcrop, and sample 4 in. thick contains at least 100 parts per million of copper

0 Sulfide minerals not observed in outcrops visited in favorable stratigraphic zone

Other characteristics

Copper to silver ratio (average of multiple fresh-rock samples showing copper sulfides).

+1 Copper to silver is 200:1 or larger

0 Copper to silver is 300:1 to 500:1

−1 Copper to silver is 700:1 or smaller

SCALE VALUES

The confidence-favorability diagram for stratabound copper-silver deposits is given in figure 1.

EXPLANATION FOR RESOURCE APPRAISAL

● PRINCIPAL PROSPECT FOR STRATABOUND COPPER-SILVER DEPOSIT

• OUTCROP CONTAINING VISIBLE AND ANOMALOUS COPPER SULFIDES

STREAM-SEDIMENT SAMPLE AND TRACE OF DRAINAGE SAMPLED—Sample contains anomalous copper and silver in one type of sample or copper or silver in two types of samples

STREAM-SEDIMENT SAMPLE AND TRACE OF DRAINAGE SAMPLED—Sample contains anomalous copper or silver in one type of sample

AREA OF INCOMPLETE GEOCHEMICAL DATA

LITHOLOGIC CONTACT SHOWING DIRECTION OF DIP OF MORE FAVORABLE UNIT INTO SUBSURFACE BELOW LESS FAVORABLE UNIT AND OUTLINE OF GROUND FAVORABLE OR UNFAVORABLE FOR STRATABOUND COPPER-SILVER DEPOSITS—Short arrow, dip greater than 30°; long arrow, dip less than 30°; no arrow, nearly horizontal units or units bounded by faults having major displacement

m (4+i+0) RESOURCE APPRAISAL BASED ON RATING SCALE GIVEN IN TEXT—Values in parentheses are maximum for outlined area and are listed in order of geology, geochemistry, and known resources

nd (i+i+0) AVAILABLE DATA ARE NOT DIAGNOSTIC FOR EITHER FAVORABLE OR UNFAVORABLE GROUND—Used when all parts of formula are either 0 or i

U (−1) UNFAVORABLE AREA BASED ON GEOLOGIC CHARACTERISTICS—See rating scale for explanation of negative number

i INCOMPLETE DATA

PROBABILITY FOR OCCURRENCE OF STRATABOUND COPPER-SILVER DEPOSITS

- **M** Moderately diagnostic
- **L** Slightly diagnostic
- **h** Highly suggestive
- **m** Moderately suggestive
- **l** Slightly suggestive
- **nd** No diagnostic data
- **U** Unfavorable

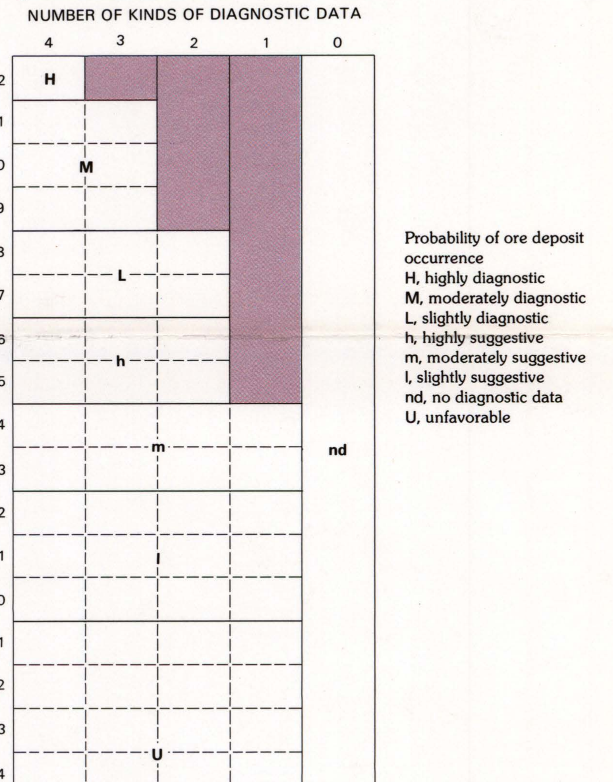


Figure 1.—CONFIDENCE-FAVORABILITY DIAGRAM FOR STRATABOUND COPPER-SILVER DEPOSITS.

GENERAL REFERENCES

Balla, J. C., 1983, Stop 7, Outcrop of the Troy mine mineralization *in* Belt Symposium II, Guide to field trips: Missoula, Mont., University of Montana, p. 50.

Bowden, T. D., 1977, Depositional processes and environments within the Revett Formation, Precambrian Belt Supergroup, northwestern Montana and northern Idaho: Riverside, Calif., University of California at Riverside, unpublished M.S. thesis, 161 p.

Clark, A. L., 1971, Strata-bound copper sulfides in the Precambrian Belt Supergroup, northern Idaho and northwestern Montana: Society of Mining Geologists of Japan Special Issue 3, p. 261–267.

Collins, J. A., and Smith, Leigh, 1977, Genesis of cupriferous quartz arenite cycles in the Grinnell Formation (Spokane equivalent), middle Proterozoic Belt-Purcell Supergroup, eastern Rocky Mountains: Bulletin of the Canadian Petroleum Geologists, v. 25, no. 4, p. 713–735.

Earhart, R. L., Van Loenen, R. E., and Whipple, J. W., 1980, Unpublished U.S. Geological Survey data on mineral resources of the Flathead Indian Reservation, Montana.

Harrison, J. E., 1972, Precambrian Belt basin of northwestern United States: Its geometry, sedimentation, and copper occurrences: Geological Society of America Bulletin, v. 83, no. 5, p. 1215–1240.

________1974, Copper mineralization in miogeosynclinal clastics of the Belt Supergroup, northwestern United States, *in* Gisements stratiformes et provinces cupriferes: Geological Society of Belgium Special Paper, p. 353–356.

Harrison, J. E., Griggs, A. B., and Wells, J. D., 1981, Generalized geologic map of the Wallace 1° x 2° quadrangle, Montana and Idaho: U.S. Geological Survey Miscellaneous Field Studies Map MF–1354–A.

Harrison, J. E., Kleinkopf, M. D., and Wells, J. D., 1980, Phanerozoic thrusting in Proterozoic Belt rocks, northwestern United States: Geology, v. 8, no. 9, p. 407–411.

Harrison, J. E., and Reynolds, M. W., 1979, Preliminary geology of the Blacktail Mountain drilling site, Flathead County, Montana: U.S. Geological Survey Open-File Report 79–938, 36 p.

Leach, D. L., Hopkins, D. M., Domenico, J. A., and Dawson, H. E., 1983, Distributions of total copper in samples of nonmagnetic heavy-mineral concentrate and of total and partially extractable copper in samples of stream sediment from the Wallace 1° x 2° quadrangle, Montana and Idaho: U.S. Geological Survey Open-File Report 83–307.

Leach, D. L., Hopkins, D. M., Domenico, J. A., and Goldfarb, R. J., 1983, Distributions of total silver in samples of nonmagnetic heavy-mineral concentrate and of total and partially extractable silver in samples of stream sediment from the Wallace 1° x 2° quadrangle, Montana and Idaho: U.S. Geological Survey Open-File Report 83–309.

Thompson, R. I., and Panteleyev, Andrejs, 1976, Stratabound mineral deposits of the Canadian Cordillera, *in* Wolf, K. H., ed., Handbook of stratabound and stratiform ore deposits: Amsterdam, Elsevier Scientific Publishing Company, p. 37–108.

RESOURCE APPRAISAL MAP FOR STRATABOUND COPPER-SILVER DEPOSITS IN THE WALLACE 1° x 2° QUADRANGLE, MONTANA AND IDAHO

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1986

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