DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
MONTANA BUREAU OF MINES AND GEOLOGY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1509-D

Base from U.S. Geological Survey, 1956, revised 1981
100,000-foot grid based on Montana coordinate system, cental and north zone, and Idaho coordinate system, west zone

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

QUADRANGLE LOCATION

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1986—G85355

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

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.

GEOCHEMICAL MAP SHOWING DISTRIBUTION OF STREAM-SEDIMENT SAMPLES THAT CONTAIN ANOMALOUS CONCENTRATIONS OF PARTIALLY-EXTRACTABLE ANTIMONY, BISMUTH, COPPER, LEAD, SILVER, AND ZINC IN THE WALLACE 1° x 2° QUADRANGLE, MONTANA AND IDAHO

By
D. L. Leach and D. M. Hopkins
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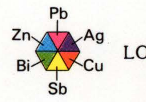
MA 4-D

EXPLANATION



LOCALITY OF ANOMALOUS SAMPLE—At center of hexagon. Colored segments indicate anomalous metals present in nonmagnetic heavy-mineral concentrate. Arrow shows correct location of symbol displaced to avoid overprint. Square outline indicates **Cu-Ag** anomaly not related to stratabound **Cu-Ag** occurrence

• SAMPLE LOCALITY

CORRELATION OF MAP UNITS

QTs			QUATERNARY AND TERTIARY
Tv			TERTIARY
TKg, TKd			TERTIARY AND CRETACEOUS
Unconformity			
€s			CAMBRIAN
Unconformity			
ZYd			LATE AND MIDDLE PROTEROZOIC
Yps	Missoula Group	Belt Supergroup	MIDDLE PROTEROZOIC
Ywh		Belt Supergroup	MIDDLE PROTEROZOIC
Yeb	Ravalli Group	Belt Supergroup	MIDDLE PROTEROZOIC
Yp		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)

€s — 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

INTRODUCTION

This map is part of a folio of maps of the Wallace 1° x 2° quadrangle, Montana and Idaho, prepared under the Conterminous United States Mineral Resource Assessment Program (CUSMAP). The publications in this folio are given in a U.S. Geological Survey Circular (Harrison and others, 1986b). Background information on the geology, mineral deposits, geochemical methods, and mineral assessment techniques are found in the pamphlet accompanying this map. It is recommended that the pamphlet be read prior to further study of the geochemical data.

This summary geochemical map shows the locality of minus-80-mesh (180 μm) stream sediments with anomalous concentrations of weak hydrochloric partially extractable silver, bismuth, copper, antimony, lead, and zinc. Some potentially useful elements (for example, cadmium and molybdenum) are not included on this map because only a few samples contained detectable concentrations of these elements with the analytical method used. The purpose of this report is to summarize the data for partially extractable metal concentrations that have been used in part to produce a series of interpretative maps for some of the mineral resource occurrence models. The distribution of the most significant geochemical anomalies with respect to some of the resource models is briefly discussed.

DISCUSSION

Stream sediments in the quadrangle are derived from a variety of rock types as well as from distinct types of mineral deposits. For purposes of resource appraisal, anomalous concentrations of signature elements in stream sediments are arbitrarily defined as those in the top 5 percent of the data. For some elements, the anomalous percentile range was adjusted slightly from the 95th percentile to accommodate distinct breaks in the frequency distribution of the data. The concentration ranges we defined as anomalous are given in table 1.

Table 1.—*Anomalous concentrations of partially extractable metals in samples of stream sediment*

Element	Lower limit of anomalous concentration (ppm)	Maximum concentration reported (ppm)	Percentile
Pb	56	10,000	95
Ag	0.26	90	94
Bi	2	11	90
Cu	42	1,620	95
Sb	3.0	820	95
Zn	83	7,660	95.5

Our objective is to apply broad-scale data to define regional geochemical patterns that relate to mineral resources. The broad sampling may not pinpoint individual undiscovered ore bodies or some known mineral occurrences. Many factors determine the sensitivity of reconnaissance-scale geochemical data to detecting the presence of mineral resources in an area. The most important consideration is the geochemical nature of the particular resource—the size and exposure of the geochemical system and the relative mobility of the ore-associated elements present. For example, the probability of detecting a geochemically complex porphyry-molybdenum system that has a geochemical aureole of several kilometers is higher than that of detecting a geochemically simple stratabound copper occurrence of 100 meters or less.

STRATABOUND COPPER-SILVER

The geochemical signature of samples that may be related to stratabound copper-silver is anomalous concentrations of copper or silver with lead as a permissible addition. Sample localities where we detected the presence of anomalous concentrations of zinc, antimony, bismuth, or arsenic in samples of stream sediment or heavy-mineral concentrates were not included as localities with a stratabound-type geochemical signature. Six of the many sample localities that contain only anomalous copper or silver in the stream sediments are not considered to be stratabound copper-silver sites because of the presence of additional anomalous metals in another sample media; these sites are indicated by a square outlining the map symbol. The stratabound copper-silver geochemical signature (Cu, Ag ± Pb) can also be derived from the many basic sills in the quadrangle as well as from some veins with simple mineralogy. Several samples in the southwestern part of the quadrangle may reflect the anomalous concentrations of copper in basic sills. However, most of the sites with a stratabound copper-silver signature lie within outcrops of the most favorable host rocks (Harrison and others, 1986b). Therefore, we are confident that most of the sites with the stratabound signature do lie within drainages containing some stratabound copper-silver minerals. In general, the sites with the stratabound copper-silver signature are widely scattered throughout the quadrangle, reflecting the widespread nature of the mineral occurrences.

EPITHERMAL SILVER

Epithermal high-grade silver deposits are associated with a small Tertiary volcanic center in the northeastern part of the Wallace quadrangle (area A). Veins and pockets of primary ore occur in fumerole holes and tubes and at contacts between porphyry plugs and their host rocks. Samples from this area are characterized by anomalous concentration of partially extractable zinc. One sample contains an anomalous concentration of partially extractable silver. Samples with this geochemical signature are widely scattered in the Wallace quadrangle; however, because the geologic setting of this deposit type is unique to the quadrangle, the other anomalies outside this area probably reflect other geochemical associations.

STOCKWORK-PORPHYRY MOLYBDENUM-TUNGSTEN

The single known occurrence of a stockwork-porphyry molybdenum-tungsten deposit in the Wallace quadrangle is approximately 6 km north of the mouth of the Thompson River. The deposit is associated with a buried intrusive body, which is indicated by a prominent positive aeromagnetic anomaly. Samples of stream sediment in this area (area B) are characterized by anomalous concentrations of partially extractable silver, bismuth, copper, and zinc. Notably absent from this suite are antimony and lead. This suite of elements is also characteristic of some other types of deposits in the quadrangle—particularly the many occurrences of mesothermal veins. The most reliable geochemical signature for the stockwork-porphyry molybdenum-tungsten deposit type is anomalous concentrations of bismuth, tungsten, and molybdenum in the heavy-mineral concentrates. This suite of elements in the heavy-mineral concentrates was used to assign geochemical favorability for this deposit type.

SULLIVAN-TYPE STRATABOUND LEAD-ZINC

Sullivan-type stratabound lead-zinc deposits have not been identified to date within the Wallace quadrangle. However, some of the geologic characteristics of the Sullivan deposit, British Columbia, occur in the lower Prichard Formation—which is stratigraphically equivalent to the host formation (Middle Proterozoic Aldridge Formation) of the Sullivan deposit. We considered samples of stream sediment with anomalous concentrations of partially extractable zinc and (or) lead underlain, in drainages at least in part by the Prichard Formation, to have some potential for Sullivan-type mineral occurrences. Other anomalous elements in the stream sediments that are permissible in addition to lead and zinc include antimony, silver, copper, and cadmium. This suite of elements may also be produced from mesothermal vein systems—therefore the geochemical signature is permissible for both occurrence models.

A group of sample localities that meet our criteria for Sullivan-type mineral occurrences is located in area C. These samples are located in drainages containing rocks of the Prichard Formation and contain anomalous concentrations of partially extractable zinc. Many of the samples of stream sediment in the eastern part of area D, underlain by the Prichard Formation, contain anomalous concentrations of total zinc and lead. Some samples of the Prichard Formation from this area are also anomalous in lead and zinc, but all contain anomalous concentrations of partially extractable lead—a permissible element for the Sullivan-type ores but also a signature element for mesothermal veins. Distinctions between these two deposit types in areas of Prichard rock are difficult, if not impossible, particularly in the Coeur d'Alene district where there are many occurrences of mesothermal veins.

MESOTHERMAL BASE- AND PRECIOUS-METAL VEINS

This descriptive model includes a wide variety of lead, zinc, and copper veins that may carry significant amounts of silver, gold, and antimony. These veins include those of the Coeur d'Alene as well as those in the greater Coeur d'Alene mineral belt, which extends from Coeur d'Alene, Idaho, to Superior, Montana. The Coeur d'Alene district also contains stratabound copper-silver deposits and fine-grained, disseminated galena-tetrahedrite-sphalerite ore bodies. The wide variety of deposits in the district results in a complex geochemical signature in which nearly all possible combinations of anomalous lead, silver, copper, antimony, zinc, and bismuth are observed in samples of stream sediment. Vein deposits similar to those of the Coeur d'Alene district also occur in an area near Superior, Montana. In addition, numerous lead, zinc, and copper veins with variable amounts of silver, gold, or antimony occur over a wide area in the Wallace quadrangle. "Coeur d'Alene" type veins overlap and duplicate that of other base- and precious-metal veins in the Wallace quadrangle. Therefore, we have combined the veins present within the Coeur d'Alene district and the widespread base- and precious-metal-bearing veins into a single category.

Common to the mesothermal veins is the general persistence of antimony. Antimony-bearing veins form a crude outer zone around the Coeur d'Alene district and also occur at other places in the greater Coeur d'Alene mineral belt. This element is not part of the geochemical signature of any other types of mineral occurrence in the Wallace quadrangle—although it is a permissible element for the Sullivan-type model. Samples that contain anomalous concentrations of partially extractable antimony may thus reflect some potential for mesothermal veins (and possibly Sullivan-type mineral occurrences), but its presence can be considered as definitely unfavorable for the other resource models in our study. However, the absence of anomalous antimony in a sample does not necessarily imply a lower favorability for mesothermal veins.

The geochemical signature of some of the other mineral resource models may be very similar to the mesothermal vein signature. Therefore, any samples with anomalous metal concentrations that have not been assigned to the stratabound copper-silver, epithermal silver, and the stockwork-porphyry molybdenum-tungsten systems may relate to mesothermal veins. Samples that also meet the criteria for Sullivan-type lead-zinc deposits must also be considered as possibly related to mesothermal vein occurrences because of the similar geochemical signatures.

Although a single isolated anomaly sample may be significant, more importance should be given to samples with multielement anomalies and areas with clusters of anomalous samples that define anomalous belts or zones. Significant clusters of anomalous samples occur southeast of the Coeur d'Alene district and in a wide zone extending north and northeastward from the Coeur d'Alene district to the quadrangle boundary. Although some of the anomalous samples in this northeast-trending zone have a stratabound copper-silver geochemical signature (Cu or Ag ± Pb), many are also characterized by anomalous concentrations of zinc, lead, or antimony. The geochemistry of this zone, considering the limited number of scattered mines and prospects in the area, suggests a potential for undiscovered mesothermal vein systems. Clusters of samples with anomalous concentrations of lead, silver, zinc, antimony, or copper occur in area D near Superior, Montana. Mesothermal veins occur in this area, but the area of anomalous sample localities is significantly larger than the known deposits, which suggests a larger mineralized area may exist. North and northeast of the known stockwork-porphyry molybdenum-tungsten deposit (area B) are a number of sample localities that contain anomalous antimony, lead, bismuth, or zinc. These anomalies are generally more isolated and less complex than in the other areas mentioned above. Elsewhere in the quadrangle many isolated samples with one or two anomalous elements occur. Some of these may relate to mesothermal veins, but it is difficult to assess.

REFERENCES

Harrison, J. E., Domenico, J. A., and Leach, D. L., 1986a, Resource appraisal map for stratabound copper-silver deposits in the Wallace 1° x 2° quadrangle, Montana and Idaho: U.S. Geological Survey Miscellaneous Investigative Series Map I-1509-F.

Harrison, J. E., Leach, D. L., Kleinkopf, M. D., Long, C. L., Rowan, L. C., and Marvin, R. F., 1986b, The Conterminous United States Mineral Resource Assessment Program. Background information to accompany folio of geologic, geochemical, geophysical, remote sensing, and mineral resources maps of the Wallace 1° x 2° quadrangle, Montana and Idaho: U.S. Geological Survey Circular 920, 13 p.

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225
Explanatory pamphlet accompanies map