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Distribution of samples of nonmagnetic heavy-mineral concentrates having anomalous concentrations of bismuth, molybdenum, tin, and tungsten from the Wallace 1° x 2° quadrangle, Montana and Idaho

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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). This summary geochemical map (plate 1) shows the location of nonmagnetic heavy-mineral concentrates with anomalous concentrations of Bi, Mo, Sn, and W in the Wallace 1° x 2° quadrangle. The purpose of this report is to summarize the geochemical data that have been used in part to produce a resource assessment for porphyry molybdenum-tungsten deposits in the Wallace 1° x 2° quadrangle. Users of the Wallace CUSMAP folio may refer to this report to gain further insight into the data used to arrive at the mineral resource appraisal and to make their own interpretation for porphyry molybdenum-tungsten deposits (Harrison and others, 1984). The distributions of the most significant geochemical anomalies with respect to the porphyry molybdenum-tungsten resource model are briefly discussed.

SAMPLING AND ANALYTICAL METHODS

A heavy-mineral concentrate sample was collected at 1,004 locations on small-order stream drainages in the quadrangle. The Flathead Indian Reservation, located in the eastern part of the quadrangle was not included in this study. In addition, we generally avoided sampling streams that contain mines within the stream catchment area, which explains the few sample sites located within the most active part of the Coeur d'Alene district. However, samples were collected and analyzed from selected streams whose drainage basins contain various types of ore deposits present in the Wallace quadrangle to characterize the geochemistry for each type of deposit. Commonly, 3 to 4 kg of stream sediment would yield the desired 30 to 60 gm of concentrate. At the laboratory, the sample was air dried, and the highly magnetic material was removed by a magnet. Any lightweight material remaining in the concentrate was separated by allowing the heavier fraction to settle through bromoform (specific gravity 2.82). The resulting heavy-mineral fraction was separated into a nonmagnetic and magnetic fraction using a Frantz Isodynamic Separator at a setting of 0.6 ampere, with 15° forward and 15° side settings. The nonmagnetic fraction was pulverized in an agate mortar before analysis.

Each nonmagnetic heavy-mineral-concentrate sample was analyzed semiquantitatively for 31 elements using an optical emission spectrograph according to the method outlined by Grimes and Marranzino (1968). The semiquantitative spectrographic values are reported as the approximate geometric midpoints--1.0, 0.7, 0.5, 0.3, 0.2, 0.15 (or appropriate powers of ten)--of ranges whose respective boundaries are: 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12 (or appropriate multiples).

Most of the samples of nonmagnetic heavy-mineral concentrates had concentrations of Bi, Mo, Sn, and W below the limit of determination for the analytical techniques used in this study. Anomalous concentrations of Bi, Mo, and W were defined as those at or above the limit of determination (table 1), whereas the anomalous concentration of Sn was arbitrarily selected at the 95th percentile of the Sn data.

Table 1.--Anomalous concentrations of elements in samples of nonmagnetic heavy-mineral concentrates

Element	Lower limit of determination (ppm)	Lower limit of anomalous concentration (ppm)	Maximum concentration reported (ppm)	Percentile
Bi	20	20	1000	93
Mo	10	10	100	98
Sn	20	100	2000	95
W	100	100	10,000	95

MINERAL RESOURCE ASSESSMENT PHILOSOPHY

The mineral resource assessment of the Wallace quadrangle is based upon several mineral resource (nongenetic) models for each type of known or probable metallic mineral resource in the quadrangle. The models are derived from observed characteristics of ore deposits inside the Wallace quadrangle or, if there are no known occurrences inside the quadrangle, from characteristics of deposits as near as possible. For each of these occurrence models, a suite of elements has been identified that best characterize the most common geochemical signatures for each. In addition, criteria have been established for a range in favorability for each geochemical signature, and favorability scores have been assigned to the criteria that form subdivisions within each. The point score ranges from 0 through positive numbers that were deliberately kept low for each geochemical signature. The geochemical favorability scores for subareas of the quadrangle were combined with favorability scores from other kinds of geologic data to establish a measure of probability for the occurrence of an ore deposit.

Stockwork porphyry molybdenum-tungsten model

The single known occurrence of a stockwork porphyry molybdenum-tungsten deposit in the Wallace quadrangle is near Liver Peak, approximately 6 km north of the mouth of the Thompson River. This type of deposit is the most important type of deposit in the Wallace quadrangle and therefore is the only type discussed. The deposit is associated with a buried intrusion, which is indicated by a prominent positive aeromagnetic anomaly. Samples of stream sediment in this area are characterized by anomalous total and partially extractable concentrations of Bi, Ag, Cu, Zn, and Cd (Leach and others, 1982). Notably absent from this suite are Sb and Pb. This suite of elements includes those characteristic of other deposit types--particularly the mesothermal base- and precious-metal veins in the quadrangle.

The most reliable geochemical signature for this deposit-type is anomalous concentrations of Bi, W, and Mo (table 1) in the heavy-mineral concentrates. This suite of elements is not consistently present in samples from other deposit types in the Wallace quadrangle. Tin was included with Bi, W, and Mo in assigning geochemical favorability for this deposit-type because it is commonly associated with the highly differentiated intrusives characteristic of the Liver Peak stock. The geochemical favorability scores and the criteria for this deposit-type is given below:

+3 Anomalous concentrations of W, Mo, and Bi in samples of nonmagnetic heavy-mineral concentrates

+2 Two of the above three elements ± Sn in sample of nonmagnetic heavy-mineral concentrates

+1 Sn plus one of either W, Mo, or Bi in samples of nonmagnetic heavy-mineral concentrates

0 Single element anomaly of W, Mo, Bi, or Sn

RESULTS

A complete tabulation of the data for each sample collected in the Wallace quadrangle has been provided by Leach and others (1982); this report also presents a detailed discussion of the sampling and analytical methods, and includes statistical summaries of the data. A tabulation of the data is also available on computer tape from the National Technical Information Service (McDanal and others, 1982).

On the map we show the locations of the approximate stream catchment areas that contain samples with anomalous concentrations of two or more of Bi, Mo, Sn, and W. The concentrations of these signature elements in these samples are given in table 2. In addition we show the location of samples with anomalous concentrations of Bi, Mo, Sn, or W (open symbols). Samples that also contain anomalous concentrations of other ore related elements are indicated by a solid symbol.

Samples of nonmagnetic heavy-mineral concentrates collected near the buried porphyry molybdenum-tungsten deposit at Liver Peak consistently show anomalous concentrations of Bi, W, and Mo. These samples include 2211 through 2215 (table 2). Only one other sample in the quadrangle contains anomalous Bi, W, and Mo (sample 3155). This sample was collected in a drainage west of White Pine, Montana, that contains a small area of exposed granitic stock. Other areas that contain two of the three signature elements are scattered throughout the western part of the quadrangle.

There are numerous samples scattered throughout the quadrangle that contain only one of the three signature elements. Many of these scattered samples probably represent local concentrations of minerals containing Bi, Mo, or W that are indigenous to the clastic Belt rocks. Samples with anomalous tungsten show a particularly close association with exposure of Prichard rocks and somewhat lesser extent to Wallace rocks. Many of the samples that also contain anomalous concentrations of other ore-related elements may be associated with the many occurrences of base- and precious-metal veins in the quadrangle. Samples probably related to base- and precious-metal veins are clearly abundant near the Coeur d'Alene district and Superior, Montana.

Table 2.--Samples that contain some combination of anomalous concentrations of Bi, Mo, Sn, and W in samples of nonmagnetic heavy-mineral concentrates.

[N = below limit of determination]

Sample Number	Concentration (ppm)				Other elements present in anomalous concentrations in samples of nonmagnetic heavy-mineral concentrates
	Mo	W	Sn	Bi	
1617	20	N	<20	100	
1816	N	N	1000	20	Sb, Cu, Pb
1825	70	N	50	500	
1832	10	200	N	<20	Sb
2208	10	200	50	150	
2211	100	2000	30	1000	
2212	50	1500	30	300	
2213	15	1000	N	100	
2214	50	5000	20	300	
2215	70	10000	20	300	
3028	N	100	150	N	
3029	N	150	100	N	
3034	N	N	>2000	30	Sb, Cu, Pb
3038	N	100	100	N	Au
3042	N	150	100	N	Au
3065	N	200	70	70	Ag, Sb, Au, Pb
3068	N	N	500	30	As, Pb
3127	70	N	N	1000	Sb, Ag, As
3155	100	100	30	50	Zn
3643	N	150	200	N	Ag, Cu
6826	20	N	N	20	Zn, Cu
7002	20	N	N	150	Ag
7018	10	300	N	N	Ag

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