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Geochemical Favorability for Meosthermal Veins in the Wallace 1° x 2° Quadrangle, Montana and Idaho

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DISCUSSION

The accompanying 35-mm color transparency shows the geochemical favorability for mesothermal base- and precious metal-veins in the Wallace 1° x 2° quadrangle, Montana and Idaho. The information presented here is part of the Wallace CUSMAP (Conterminous United States Mineral Appraisal Program) project conducted by the United States Geological Survey. This color transparency can be projected onto the geologic map of the Wallace quadrangle (Harrison and others, 1981). The corner marks on the slide correspond to the corners of the geologic map.

Mesothermal veins include those of the famed Coeur d'Alene district as well as numerous base- and precious-metal veins throughout the quadrangle. The mesothermal veins in the Coeur d'Alene district yield a wide variety of trace elements from stream-sediment samples. But the mesothermal veins of the district, and mesothermal veins throughout the Wallace quadrangle, also can have a very simple chemistry, yielding stream sediments that show only anomalous amounts of lead, zinc, copper, or silver. This simple suite of anomalous elements may also be derived from other types of mineral occurrences, such as stratabound copper-silver (which can have Cu ± Ag ± Pb) or stratabound Sullivan-type occurrences (which can have Pb + Zn ± Ag). The probability is low, however, for occurrences other than mesothermal veins to show consistently all four elements.

In identifying favorable ground for mesothermal veins, I considered the total concentrations of lead, zinc, copper, and silver as signature elements in samples of stream sediments. Cadmium, which is commonly present in anomalous concentrations in stream sediments near mesothermal veins, was not used. Cadmium is so clearly related to zinc, commonly in sphalerite, that use of both zinc and cadmium would in effect give double weight to a single factor. Bismuth, also common to some mesothermal veins, was not used because it has a high local variability in the quadrangle. Such erratic behavior limits bismuth's usefulness in defining regional geochemical trends. Some other potentially useful elements for trace-element signatures in stream sediments, such as arsenic, molybdenum, and gold, also were not included in the generalized signature for mesothermal veins because only a few samples contained amounts of those elements that were detectable by the analytical methods used.

Unique to mesothermal veins is the general persistence of antimony. Antimony-bearing veins form a crude outer zone around the Coeur d'Alene district and occur at other places in the Greater Coeur d 'Alene mineral belt. In the quadrangle, partially extractable antimony is more closely related to mesothermal veins than is the total concentration of antimony in the same stream-sediment samples. The element is not part of the trace-element signature of any of the other types of mineral occurrences identified in the Wallace quadrangle.

I also used a suite of elements that show anomalous concentrations in samples of nonmagnetic heavy-mineral concentrates to help identify ground favorable for mesothermal veins. This suite consists of lead, zinc, copper, silver, antimony, and arsenic.

The identification of favorable ground using geochemical data included three successive steps. First, all the 1,229 samples of stream sediments collected from the Wallace quadrangle were ranked according to their individual content of lead, zinc, copper, and silver. For example, the sample having the greatest concentration of lead according to atomic-absorption analysis, was assigned a rank of 1,229; the sample having the second greatest concentration was assigned a rank of 1,228, and so on. Where samples had the same concentration, they were given the same rank. This ranking procedure was completed for all four elements; then each sample was assigned a number that represented the sum of the ranks for lead plus zinc plus copper plus silver and another number that represented the sum of ranks for lead plus zinc. Each sum gives an estimate of the relative enrichment of the four-element suite and of the two-element suite. The sum of the ranks was used to give equal weight to each element. For example, actual values for silver rarely exceed a few parts per million, whereas values for lead are commonly in the hundreds of parts per million. If we used total metal content (sum of the acutal values), then lead would be unintentionally weighted by tens of times more than silver, whereas the sum of the ranks gives lead the same weight as silver for significance in the geochemical signature. The numbers representing the sum of the ranks were divided into seven percentile classes that had upper limits of 100, 99, 95, 90, 85, 75, and 50. Geographic groups of sample sites that could be characterized as being in the 85th percentile or higher for lead plus zinc plus copper plus silver were identified and assigned a favorability of high, medium, or low as outlined in the criteria described below. This same procedure was applied to the number for the sum of the ranks for lead plus zinc, which identified additional groups of sites that possibly represent lead-zinc veins that contain little or no silver or copper. With the exception of the Sullivan-type occurrence model, sample sites assigned to other models were excluded from consideration in assigning favorability to mesothermal veins. In addition, isolated single sample sites were not included unless they were within the top five percent of the rankings. The boundaries for the areas that contain groups of sample sites in the higher percentiles were generalized and drawn around drainages that contain those favorable samples.

Secondly, the data for nonmagnetic heavy-mineral concentrates were examined for presence of anomalous concentrations of lead, zinc, copper, silver, antimony, and arsenic. Groups of sample sites showing various combinations of these signature elements were classified into categories of high, medium, and low favorability as described below. Many of these sites correspond in location and level of favorability to the areas outlined in step one. Where they do not, commonly around the edges of the first-step boundaries, the boundaries were expanded to include favorable areas indicated by the data from the nonmagnetic heavy-mineral concentrates. The favorability boundaries for each kind of data are shown on the slide and the favorability scores are shown in color.

Finally, areas in the quadrangle showing an enrichment of partially extractable antimony in stream sediments were identified. The enriched areas were found by computer contouring of weighted averages at the corners of a square grid that enclosed 10.4 mi^2; the weighted averages are determined by an unpublished computer program that gives decreasing weight to values based on the distance away from the counting point. I then identified areas where the weighted values exceed the geometric mean for all data (1.2 parts per million for antimony). These relatively high areas for antimony are believed to show another indication of favorable ground. Most areas of antimony enrichment correspond to areas already identified as favorable in steps one or two, or serve to expand them slightly. On the slide we show the highest level of favorability found for an area in any step of our three-step procedure.

Favorability scores that range from +4 to 0 were assigned to the areas showing various levels of potential for mesothermal veins as interpreted from the geochemical data. The scores and criteria for them are listed below:

+4 (Red Areas) Stream-sediment samples predominantly in the 90-95th percentile for summed signature elements; at least 1/3 are in the 95+ percentile. Nonmagnetic heavy-mineral concentrates from groups of sites have anomalous amounts of three or more signature elements, and antimony is present; also a single site shows four signature elements without antimony.

+3 (Orange Areas) Stream-sediment samples are predominantly in the 85-95th percentile for summed signature elements; at least 1/3 are in the 90+ percentile. Nonmagnetic heavy-mineral concentrates from groups of sites either have anomalous amounts of two signature elements other than antimony or are single sites that contain antimony plus at least one other signature element.

+2 (Dark Green Areas) Stream-sediment samples are predominantly in the 85-90th percentile for summed signature elements; at least 1/2 are in the 85+ percentile. Nonmagnetic heavy-mineral concentrates from groups of sites have anomalous amounts of a single signature element, or a single site has two or more signature elements.

+1 (Light Green Areas) Stream sediments enriched in partially extractable antimony.

0 Stream-sediment samples are predominantly below the 85th percentile for summed signature elements. Isolated single-site anomalies for one signature element in the nonmagnetic heavy-mineral concentrates. Partially-extractable antimony in the weighted concentrations is less than the geometric mean value of 1.2 part per million.

REFERENCES CITED

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 Map MF-1354-A, scale 1:250,000.