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CHAPTERS E - J

RESOURCE ANALYSIS SYSTEM FOR THE WALLACE 1° x 2° QUADRANGLE, MONTANA AND IDAHO

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GENERAL PHILOSOPHY

This CUSMAP folio presents basic geologic, geochemical, geophysical, mineral occurrence, and remote sensing data at a scale of 1:250,000 for the Wallace 1° x 2° quadrangle, Montana and Idaho. These data are applied to a geologic, as distinguished from an economic, evaluation of its metallic mineral resource potential. The folio contains maps presenting the basic data and interpretative maps showing our assignment of mineral resource potential. We attempt to define, based on the data available, subareas of the quadrangle having various levels of favorability for occurrence of specific types of mineral resources. Because the sampling net of our data base is coarse and most metallic ore deposits are small, we cannot pinpoint any possible undiscovered ore bodies or marginal resources or even predict how many bodies of a certain size might be discovered. When possible, we indicate the size and grade of ore bodies or resources we believe might be found in the quadrangle, the areas in which they are likely to occur, and the probability of their occurrence.

DATA BASE

Our reconnaissance-scale data include geology, aeromagnetics, gravity, stream-sediment and panned-concentrate geochemistry, background rock geochemistry, side-looking radar and earth-orbiting satellite (EROS) lineaments, and known metallic mineral occurrences. Our geochemical coverage is incomplete on the Flathead Indian Reservation, where we were asked not to sample stream sediments. An audio-magnetotelluric survey was completed for a part of the quadrangle, and geochemical data on samples of mineralized rock associated with stratabound mineral occurrences were collected from many scattered outcrops in the quadrangle. All exposed major intrusive bodies and one that is buried were dated by isotopic methods. Data and samples graciously provided to us by ASARCO and Noranda mining companies from newly explored ground in the quadrangle were also used in the assessment. We assume this data base is sufficiently complete to make a resource assessment of the entire quadrangle.

TYPE OF DEPOSIT

KINDS OF DIAGNOSTIC DATA	Placer gold	Stratabound copper-silver	Sullivan-type lead-zinc-silver	Porphyry molybdenum-tungsten	Platinum-group metals	Epithermal silver	Mesothermal base- and precious-metal veins
Geologic							
Lithology	X	X	X	X	X	X	X
Structure							X
Geochemical							
Stream sediment		X	X			X	X
Panned concentrate	X	X		X			X
Rock		X	X		X		
Geophysical							
Aeromagnetic				X		X	X
Gravity				X		X	X
Audio-magnetotelluric			X	X			X
Known mineral occurrences							
As indicators of favorable ground	X	X		X	X	X	X
As sources for secondary deposits	X						
Lineament intersections				X			
Cu/Ag ratio in mineralized rock		X					

Figure 1.—DIAGRAM SHOWING KINDS OF DIAGNOSTIC DATA USED TO EVALUATE DIFFERENT TYPES OF METALLIC DEPOSITS IN THE WALLACE QUADRANGLE.

PROCEDURE

Seven types of metallic deposits that may occur in the quadrangle are listed in figure 1, together with the kinds of data that were collected to evaluate the ground favorable for their occurrence.

Our mineral resource appraisal involved a series of steps that are outlined in a flow chart in figure 2. Those steps are:

1. We described an "occurrence model" for each type of known or probable metallic deposit in the quadrangle. Most of the occurrence models are nongenetic. 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 nearby as possible. Because the occurrence models are tailored closely to the local geology, they are not worldwide prospecting models; indeed, some of them are unique. The occurrence model is designed to help identify broadly favorable ground, but it lacks sufficient detail to locate specific ore bodies or marginal mineral resources.

2. From the occurrence model, we developed criteria to identify a range in favorability for each of the kinds of diagnostic data. For example, in considering lithology, we might recognize that rock type A is more favorable than B and that both are more favorable than C; for the geochemical data, we might recognize that stream sediments from some areas have all the signature elements expected for the deposit type, whereas those in other areas have few or none. We assigned favorability scores to the criteria that form subdivisions within each of the kinds of diagnostic data. The point scores range from positive numbers through zero to negative numbers and were deliberately kept low for each of the kinds of diagnostic data. Thus, a few broad subdivisions could be used for classifying the reconnaissance data. Many more specific categories, though desirable, would require more detailed information than was available in the quadrangle.

The different kinds of diagnostic data were weighted according to their relative importance, and maximum point scores were assigned for each of the kinds of diagnostic data. The highest scores were given to the diagnostic data considered most reliable in assessing the mineral occurrences. In general, the geologic and geochemical data were given a higher weighting than geophysical data, which in turn were given a higher weighting than data on known mineral occurrences (see fig. 3). For some deposit types, there are other categories of data; our relative confidence in the degree the other categories indicate favorability can be seen by comparing their highest scores with those of the highest values for other favorability characteristics of the deposit.

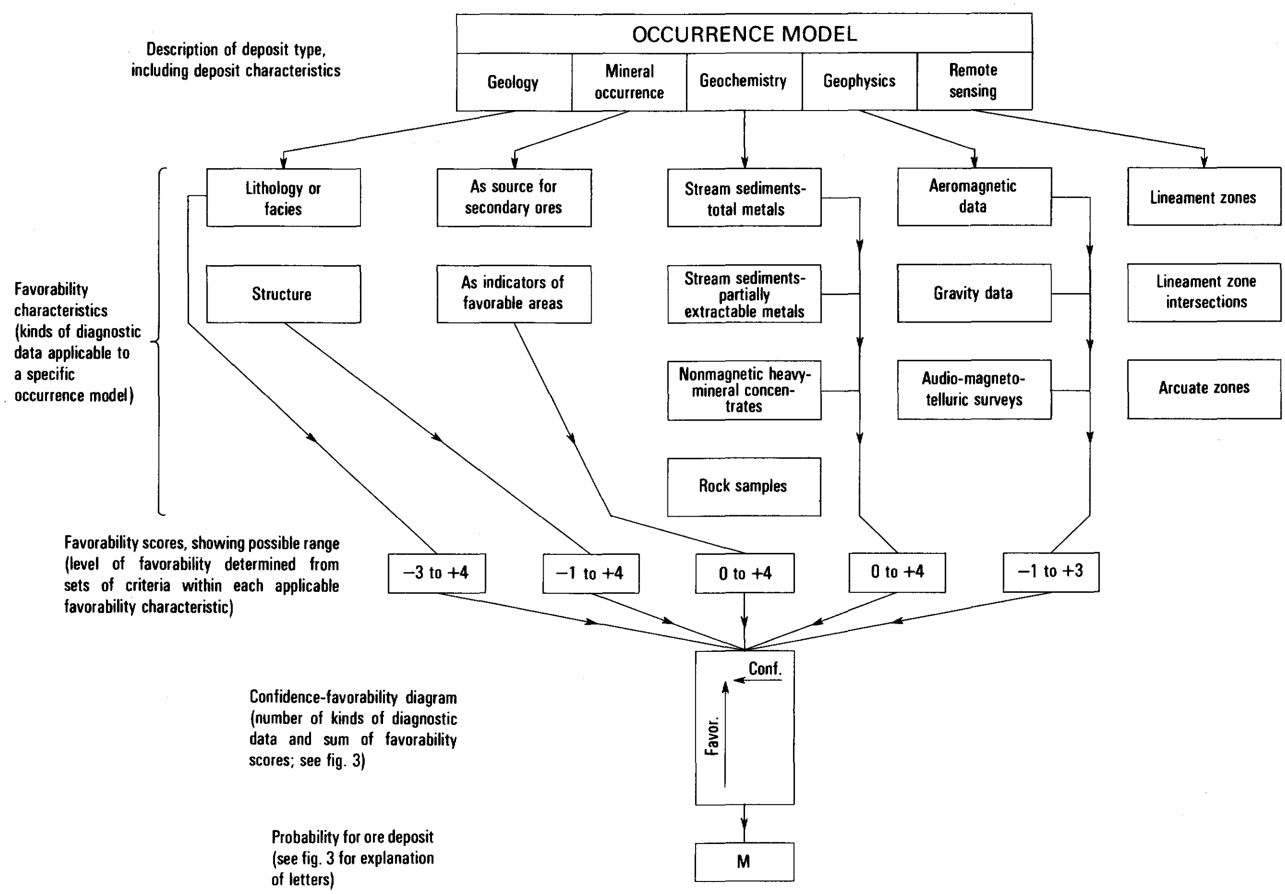


Figure 2.—GENERALIZED FLOW CHART FOR RESOURCE APPRAISAL, USING APPRAISAL FOR MESOTHERMAL VEINS AS AN EXAMPLE.

3. Subareas of the quadrangle, such as those exhibiting specific lithologic units or geophysical anomalies, were identified, outlined, and assigned favorability scores according to the criteria that had been established. Point-source data for known mineral occurrences or analyzed rock samples were added where appropriate.

Many of the resulting maps are complex, because they display three or four factors that have a bearing on resource appraisal and that commonly overlap geographically. The maps also show the total favorability scores for the subareas; these are derived simply by arithmetic summing of all favorability scores for a given area. We indicate the points we assigned to the various pieces of ground either by formula (for example, "3+2+0" for scores for geology, geochemistry, and geophysics) or by numbers along boundaries between areas of different favorability scores.

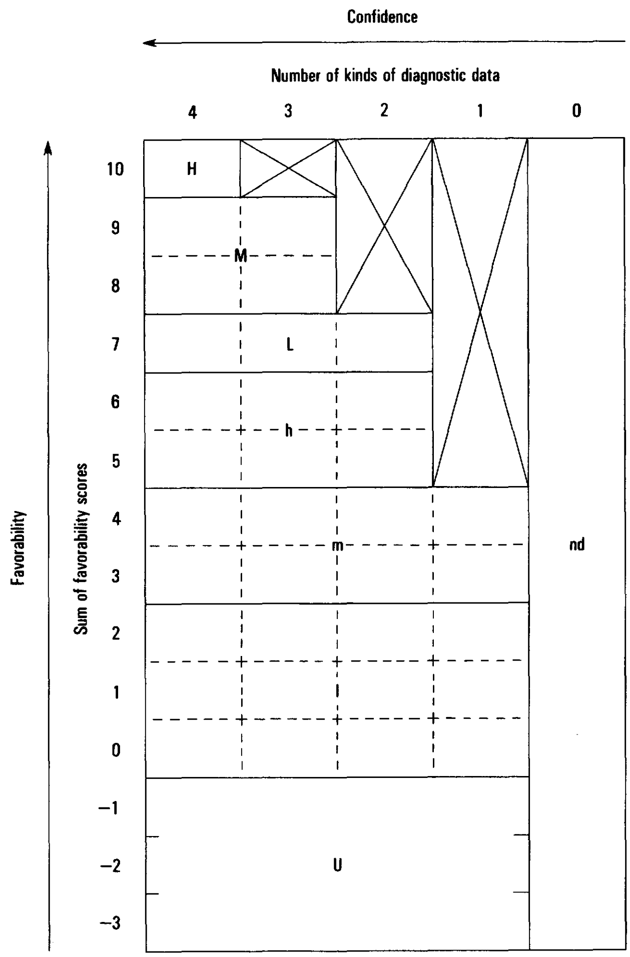
Control of data boundaries drawn on the resource appraisal maps varies with the type of data. Geologic contacts have the most observation points and are reasonably precise at the scale of the maps. Precision of the geochemical boundaries is variable and depends on several factors that include stream and landscape characteristics, as well as the local variability of a particular element with respect to a regional variability. A high local variability, as determined from closely spaced samples, implies that widely spaced reconnaissance samples may not accurately locate groups of stream basins that reflect anomalous amounts of the element in rocks or ores of the basins. Either we have not used such elements to establish geochemical boundaries, or we have used them with caution. Typically, the reconnaissance geochemical sample sites are two miles apart, but they are as much as five miles apart in some areas. The uncertainty of a boundary between two samples, therefore, typically will be two miles, but in some areas will be as much as five miles. Boundaries around geophysical data are clearly subjective within reasonable limits, which we judge to be plus or minus two miles at best.

4. Finally, the number of kinds of diagnostic data and the sum of favorability scores were entered onto a matrix diagram that shows increasing levels of confidence and favorability, which combine to establish a measure of probability for occurrence of an ore deposit. An example of such a diagram is shown in figure 3.

For a given subarea, confidence in our appraisal increases directly with the number of kinds of diagnostic data that we have applied to it. The favorability of that subarea is a function of the sum of the favorability scores for each of the kinds of diagnostic data.

Broad categories of probable mineral potential are identified by letter symbols, which have also been used on the resource appraisal maps. The probability of occurrence of an ore deposit of the type being evaluated is coded into three categories of a diagnostic level ("H, M, and L"), three of a suggestive level ("h, m, and l"), and one for an unfavorable level ("U"). Where we do not consider our data to be indicative of either favorable or unfavorable ground, we assign it to a category labeled "nd."

The diagrams vary from one type of deposit to another. Sources of variation include: (1) the number of kinds of diagnostic data, which range from three to four among the deposit types; (2) total favorability scores, which differ among the deposit types; and (3) our judgment as to the highest probability that we feel is proper for a given deposit



Probability of ore deposit occurrence
H, highly diagnostic
M, moderately diagnostic
L, slightly diagnostic
h, highly suggestive
m, moderately suggestive
l, slightly suggestive
nd, no diagnostic data
U, unfavorable

Favorability characteristics	Range of favorability scores
Geologic	−2 to +4
Geochemical	0 to +3
Geophysical	−1 to +2
Known mineral occurrences	0 to +1
Total range	−3 to +10

Figure 3.—EXAMPLE OF A CONFIDENCE-FAVORABILITY DIAGRAM USED TO ESTABLISH A MEASURE OF PROBABILITY FOR OCCURRENCE OF AN ORE DEPOSIT.

type in the quadrangle. If the occurrence model in our judgment can be fully described in terms of all the favorable characteristics that are found in the quadrangle, then the diagram will include letter designations ranging from "U" (lowest) to "H" (highest) probabilities. For some types of deposits, however, only part of the range is shown, either because our criteria are inadequate to define the highest levels of probability (the upper range may quit at "L") or because we are evaluating only the more favorable ground around a unique ore occurrence (lowest and only letter may be "H" or lower range may stop at "m").

COMMENTS

Interpretation of the total scores in these matrix diagrams and of the probability we assign to these scores will vary with the purpose of the user. For example, in the sample diagram (fig. 3), a probability of "h" (highly suggestive) indicates a total point score of five or six. That score may result from high scores in only two types of data we might have to apply, from modest scores in all types of data, or from high scores in some types of data combined with negative scores in others. The explorationist will wish to examine the data on which the assessment is based in order to determine by his own criteria whether a given subarea that is classified as "h" is worthy of further study to look for specific sites for ore deposits. The land-use classifier, on the other hand, may decide that any ground classified as "h" either does or does not have sufficient mineral potential to warrant consideration in his land classification scheme. Similar decisions are required from individual users for all areas classified by us as anything but "U" (unfavorable).

The procedure used to arrive at the rating for probability of ore deposits in any specific subarea is neither mysterious nor hypothetical. Favorability scores for each of the types of data applied to the ground being analyzed are shown on each map that involves a resource appraisal. The criteria for selecting the favorability scores, which are based on a described occurrence model for each type of deposit, also accompany each map. The appraisal process for most types of deposits is complex, but the data, assumptions, and rationale used in making the assessments can be found in maps of the Wallace CUSMAP folio.

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