Computerized Methods for Interpreting Reconnaissance Geochemical Surveys

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ABSTRACT

The principal purpose of computerized methods for interpreting reconnaissance data is to extract and lucidly display the greatest amount of information relating specifically to potential ore deposits. An important by-product is the considerable reduction in the labour of manual collation, interpretation and plotting.

The procedures used for interpretation aim at the separation of the chemical "signal" caused by ore deposits from other signals and from random noise. At present, perhaps the most generally useful technique is to contour by computer the residuals from a low-order polynomial trend surface. The trend surface removes the gradual variation due to regional lithologic change, climate, vegetation and topography; the moving average approach utilized in computer contouring reduces the effect of random noise and reveals zones of consistent local variation. The choice of the most appropriate form of trend surface and of the parameters of the contouring method remain highly subjective, and thus the comparison of the effectiveness of other surface-fitting methods is urgently required. The many methods developed for communications theory and other sciences offer considerable scope for the geochemist. Because, in most reconnaissance surveys, material is sampled at intervals along linear drainage features, such techniques as Markov schemes are of potential application. Apart from these sophisticated techniques, simpler methods may often be quite effective in separating the signals. For instance, if the rocks of an area can be subdivided into a few, relatively homogeneous lithologic types, the element concentrations in each sample may be normalized using the mean and variance of all samples overlying that particular rock type.

The above methods utilize the relationship between the concentration of one element in a sample to the concentrations of the same element in surrounding samples to differentiate the signal of interest from other sources of variation. A different approach to separating the signals is to use multivariate techniques which employ the relationship between the different elements contained in the samples. The methods that have sparked most interest are component and factor analysis, although other methods may prove to be more effective. Each factor that is extracted hopefully represents the variation that is due to but one geological or geochemical process, rather than the sum of processes that is usually represented by the concentration of an element. Scores may be computed measuring the influence of every factor on each sample, and these data may be trend-surfaced, contoured and plotted in the same fashion as the original element data. It may often be useful to apply component or factor analysis to the residuals from a trend surface, as the trend surface may be effective in removing some "factors", thus simplifying the task of the multivariate procedures.

Notwithstanding the above, factor analysis may often be inappropriate for the interpretation of reconnaissance data. The methods are designed to extract a set of factors operating within a single population. If the area studied is heterogeneous in terms of its geology and assemblage of mineral deposits, there may be a very large number of different factors or processes acting upon the same variables, which is quite beyond the ability of factor analysis to resolve. The interpretation given by factoring these conditions may be quite misleading. Such effects may be tested by subdividing the data by subarea and determining whether the factor matrices are reasonably constant between the subareas. The second impediment to utilizing factor analysis for reconnaissance surveys is that six to eight elements may be too few to significantly resolve the factor structure, which remains constant, irrespective of the number of elements that may be determined.

It is perhaps not generally appreciated that the introduction of such powerful statistical methods may require changes in other aspects of the reconnaissance survey. For instance, to get the best results from trend-surface and contouring methods demands a reasonably even distribution of samples over the area and more attention to optimizing the sampling interval in terms of both economics and the size of the expected anomalies. In general, the utility of factor analysis increases with the number of variables factored. More attention should be given to determining major elements simultaneously with the trace metals (as may be done with a direct-reading optical spectrometer). Factoring of such data would considerably reduce the effect of variation of the trace indicator metals that is due to varying quantities of major minerals in the sediment.