THE USE OF MULTIELEMENT ANALYSIS AND DATA PROCESSING IN MINERALS EXPLORATION

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ABSTRACT: This paper describes a system of multielement analysis and in-house computer data processing that was developed to aid in primary minerals exploration. Rapid, low-cost emission spectrographic analysis results in semi-quantitative geochemical data for 35 elements, including 7 major rock-forming elements. The large amounts of multielement data then are processed and presented by computer in forms that permit the geologist more time for geology and provide information to aid exploration decisions regarding areas of interest in geochemical reconnaissance and drilling programs. Geological, geophysical, and engineering data may be incorporated into the data processing. The multielement and other data first are listed in statistical summaries, including averages, standard deviations, ranges, linear correlation coefficients, and histograms; these data then are presented by such computer-generated maps as point plot maps, contour maps, perspective diagrams, and trend surface and residual maps. Applications of the technique can be useful in the petroleum industry, industrial minerals development, quality control, and environmental studies. Although this is a field requiring new association with many little-used elements, they always have been part of the chemistry recognized in mineralogic and alteration suites, and now can become available and useful in the search for new ore deposits.

INTRODUCTION

The integration of geology, geochemistry, and geophysics is of primary importance in making sound minerals exploration decisions. As more data from these fields (i.e., geology, geophysics, etc.) are made available, it is becoming difficult for geologists to fully utilize all of the information at their disposal. Thus, the need has arisen for the development of computer data processing related to minerals exploration techniques. The data processing system described in this paper was designed to produce, integrate, and systematically present a large amount of geochemical, geophysical, geologic, and engineering data in useful forms. Exploration for deeper mineral targets requires study of fundamental rock chemistry and routine analysis of numerous elements. The multielement spectrographic analysis method described provides, routinely and rapidly, 35-element analytical information in a readily usable form and gives the geologist engaged in minerals exploration considerably more information, yet allows him more time for geologic studies and interpretations.

This system was developed for use in metallic minerals exploration by William A. Bowes, Specomp Services, Steamboat Springs, Colorado. Examples of data presentation techniques are drawn from spectrographic, engineering, and geophysical data obtained from various projects.

The Need For Multielement Analysis In Minerals Exploration

During the past twenty years, porphyry-type mineral deposits have been the most important type of ore deposit sought by mining companies, including those companies producing from small-to-moderate tonnage underground mines. Porphyry-type deposits are defined as very large tonnage, uniform, low-grade ore disseminations or fracture fillings in intrusive rocks or intruded host rocks. The large horizontal dimensions of commercial deposits necessitate mining by open-pit or block-caving methods. Minerals exploration personnel will continue to concentrate on porphyry-type deposits because of their high profit potential. The philosophy of those investing money in such exploration will continue to be "we need to find only one good one." However, it is important to point out that other economically significant mineral environments probably have gone unrecognized because of the lack of multielement analytical data.

The use of multielement analysis in minerals exploration is designed to permit the geologist adequate quantitative chemical values to define drill targets in those innumerable places where no surface ore segments ever have been found. The geologist in this case will study alteration and surficial oxidation effects by multielement chemistry, aided by geophysics, and will define buried mineral targets for deep testing of economic value. Drill depths will be ascertained by zonal patterns characteristic of similar mineral assemblages in the region.

Multielement analysis as used in this article is limited to 35 of the most reliably analyzed and geologically useful elements applicable to D. C. arc emission spectrographic analysis. This group of elements includes seven out of eight of the major rock-forming elements; therefore, in this case the usual geochemical...