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GEOLOGY OF THE PINALENO MOUNTAINS, ARIZONA: A PRELIMINARY REPORT

By
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surveys based on analyses of nonconcentrate-sediment samples. This interpretation is difficult, however, because of erratic high values found in the region. Some clusters of rather high values of beryllium, tin, and niobium may be related to groups of sheet-mica pegmatite deposits, even though no minerals of tin or niobium were found, and few occurrences of beryl were found during examination of more than 100 such mica deposits. High values for beryllium found in sediments of the Carolina slate belt suggest that previously unsuspected deposits of beryllium may be in that region, a suggestion that is reinforced by the finding by Henry Bell of chrysoberyl in South Carolina, not far to the south.

Geochemical sampling, Iron River 1°×2° quadrangle, Michigan and Wisconsin

In the Iron River 1°×2° quadrangle, Michigan and Wisconsin, H. V. Alminas found a number of hydromorphic geochemical patterns strongly indicative of felsic intrusives at depths that have been delineated by B-horizon soil sampling. These areas are defined by an enrichment in Fe, Mg, Ca, Mn, Cr, Sc, Sr, Be, and V. Abnormally high Be/Sr and Mg/Fe ratios are characteristic, and anomalous values in Cu, Co, Ni, Mo, and Ag are associated with these zones. These zones generally occur along or at intersections of gravity and (or) Landsat-imagery-derived lineaments.

Mineral potential, Rolla 1°×2° quadrangle, Missouri

Using spectrographic analyses R. L. Erickson, E. L. Mosier, and S. K. Odland found anomalously high amounts of Mo, As, Pb, Cu, Ni, Co, and Ag in insoluble residue samples of a shallow-water reef and calcarenite facies of the Cambrian Eminence and Potosi Dolomites in the subsurface in southern Missouri in the Rolla 1°×2° quadrangle. The samples are from two drill holes in Douglas County and two in Ozark County. The metal suite is similar to that found in the Viburnum Trend lead deposits except that the molybdenum content is commonly an order of magnitude higher than in the Trend. The principal residence of the metal suite is in or intimately associated with iron sulfide. The shallow-water reef and calcarerite facies of the Eminence and Potosi are lithologically similar to, and may be analgous to, the "white-rock" facies of the ore-hosting Bonneterre Formation in the southeast Missouri lead district. These geochemical and stratigraphic data together suggest that an unknown and untested belt of favorable ground for mineral discovery may be present in the subsurface in southern Missouri.

Mineralization in the Williams Fork, Colorado

P. K. Theobald observed that the headwater area of the Williams Fork in the central Colorado Rocky Mountains has suffered a sequence of chemical and mechanical, rock-destructive events that effectively obscure mineral deposits from discovery by conventional methods of search. Hydrothermal alteration associated with Tertiary mineralization has reduced the erosion resistance in pervasively altered areas that are increasingly numerous toward the east and southeast and in and adjacent to veins and fault zones throughout the area. A period of lateritic weathering proceeded the earliest recognizable glacial features and further reduced the rocks to saprolite beneath an ancient land surface for depths of as much as 100 m. Successive cycles of glacial erosion were most effective where alteration and weathering were most extensive. Major valleys were eroded along the larger altered fault zones. Residual accumulations of ground and lateral till effectively obscure evidence of mineralization along or adjacent to the faults. Altered and weathered zones above the active glacial valleys yielded through periglacial mass movement, producing large terranes of jumbled and slumped ground, again obscuring evidence of mineralization.

Residual accumulation of heavy minerals related to mineralization, fluorite, pyrite, galena, molybdenite, scheelite, powellite, and gahnite, yields fairly coherent patterns of distribution in alluvial deposits reworked from the till along the lower walls of the major valleys. Soils collected along ridge and spur traverses have yielded only occasional erratic, high values reflecting the generally unaltered, unmineralized relics that form the highlands. More direct evidence of mineralization beneath the extensive blankets of transported debris will be required to establish a reliable resource appraisal.

Geochemical anomalies, Silver City 1°×2° quadrangle, Arizona-New Mexico

A geochemically enriched area, which measures approximately 235 km², was found in the southern Pinaleno Mountains, Ariz., in the Silver City 1°×2° quadrangle, Arizona-New Mexico. This area is situated on and adjacent to a major regional tectonic feature; but mines in the area do not exist and prospects are few. This geochemical feature was recognized because heavy-mineral geochemical techniques were employed. The intensity of many of the analytical values, using enhancement techniques, suggests that local concentrations of possible ore grade do exist. Leakage along dike-host rock contacts within the many rhyodacite dike swarms

Pinaleno Mts / Graham Cty

in the area appears to be a main process of metal dispersion. The major regional tectonic feature is the Stockton Pass fault, which trends northwesterly, with a horizontal left-lateral displacement. It is approximately 1.6 km in width and appears to localize metallization because geochemical anomalies in Mo, Bi, W, Ag, Au, As, and the mineral fluorite show close spatial relation to the zone. It also may have controlled the occurrence of a volcanic center to the south that contains geochemical anomalies in the same metals, most prominently for molybdenum and bismuth.

Geochemical survey, Richfield 1°×2° quadrangle, Utah

W. R. Miller, J. B. McHugh, and W. H. Ficklin made a geochemical survey using ground water in the Beaver basin in the Richfield 1°×2° quadrangle, Utah. The results of raw data plots, principal-component analysis, and a solution-mineral equilibria study demonstrate that the chemical environment of the Beaver basin is favorable for the occurrence of sandstone-type uranium deposits. Several areas were identified as possible targets for exploration. The methods described in this study can be used to evaluate other basins in the western United States.

Geochemical sampling of water, Colorado Plateau, Utah

Using field and laboratory data, J. C. Antweiler and J. B. McHugh showed that in some environments water, when available, is superior to other geochemical sampling media for detecting evidence of concealed mineralization. An excellent example is the Long Gulch area of the Colorado Plateau in the Escalante River canyons country, Garfield County, southern Utah. Several uranium prospects have been located in outcrops of the Moenkopi and Chinle (Shinarump Member Formations) (all Triassic in age), but no significant uranium mineralization has been found in the overlying Jurassic rocks such as those in Long Gulch. However, numerous seeps and small springs occur in a fault zone in Long Gulch for a distance of at least 16 km. Water samples from several of those springs carried uranium in amounts up to 480 ppb compared to background levels of about 1 ppb. Fine-grained stream sediments, pan concentrates, and rocks suggested either no or very weak geochemical anomalies. Anomalies of several other cations and anions also are recognized easily by modern analytical techniques applied to water. In areas where the only exposed rocks are thick sequences of Jurassic sandstone, such as in the Escalante River canyons country, water from seeps, springs, intermittent drainages, and fault zones is an excellent sampling medium because it often provides access to mineralization that is entirely concealed. Uranium mineralization is known to occur in Triassic rocks, which in much of the area are not exposed.

Gold anomalies, Butte 1°×2° quadrangle, Montana

Preliminary interpretation of geological and geochemical data by J. C. Antweiler, W. L. Campbell, and R. T. Hopkins, Jr., suggests the presence of several gold resource targets in the Butte 1°×2° quadrangle, Montana.

Several drainages west of the Coloma Mining District in the western part of the Garnet Range were found to contain gold anomalies. Gold compositional studies suggest that gold-source veins may be gold tellurides in some areas and skarn deposits with possible tungsten mineralization in other areas. The Frog Pond basin area in the southern part of the Sapphire Mountains has numerous gold anomalies in drainages west, north, and east of the basin. Other areas that should receive further attention are at least seven target areas of Tertiary gold deposits, including Tertiary pediments on the Sapphire Range and on the flanks of the Flint Creek Range and Tertiary deposits downslope from the Blackfoot and Datlton Mountain stocks. Gold compositional analyses, together with other analytical data, suggest that modeling of suites of anomalous metals may lead to the discovery of unknown mineralized areas.

Geochemical studies of batholiths, Dillon 1°×2° quadrangle, Idaho and Montana

Detailed review of geochemical studies indicated a genetic relation between stockwork molybdenum deposits and leucocratic granitic phases of sodic series (Tilling, 1973) calcalkaline batholiths in the Dillon 1°×2° quadrangle, Idaho and Montana. The leucogranites are commonly two-mica granites and are the youngest phases in the evolutionary history of the batholiths. Earlier granodiorite phases of the batholiths produced tungsten- and copper-bearing skarns, tin-bearing magnetite skarns, and copper-molybdenum gold porphyry-type systems. Complex base-metal sulfide and precious-metal vein occurrences are associated with all of the porphyry-type deposits and may have tin minerals in economic quantities at some localities as suggested by geochemical analyses of ore samples.

Preliminary results from process studies on the movement of trace elements in the weathering environment indicated that streams in southwestern Montana draining areas where there is no significant mineralization reach a steady state with respect to chemical speciation with about 80 percent of the trace elements being

Graham Cty, AZ USGS Research 1980, PP 1175

Petersburg and Port Alexander quadrangles, Alaska, by J. B. Cathrall indicates that the suite of Cu, Pb, Zn, and Ba outline a possible massive volcanogenic sulfide trend and that the additional suite of Cu, Ag, Sn, W, and Mo indicate areas of potential polymetallic contact metamorphic mineralization. Likewise, suites of elements associated with thorium, molybdenum, and lanthanum suggest a potential for uranium.

Geochemical lineament, Iron River 2° quadrangle, Michigan and Wisconsin

In the Iron River 2° quadrangle, Michigan and Wisconsin, H. V. Alminas interpreted chemical data from samples of B-horizon soils that delineate a set of northeast- and northwest-trending geochemical lineaments. These geochemical trends generally transect the predominant geologic fabric within this quadrangle and are independent of the soil types occurring along them. A high correlation between the lineaments based on Landsat imagery and gravity data and the geochemical lineaments is evident. Lineament intersection areas as well as areas of lineament-favorable rock unit intersections are frequently anomalous in copper content.

Geochemical features, Pinaleno Mountains, Arizona

K. C. Watts identified a geochemically enriched area in the southern Pinaleno Mountains of Arizona measuring approximately 235 km^2. This area is situated on and adjacent to a major regional tectonic feature, but mines do not exist in the area, and prospects are few. Much of the area contains dispersed metallization, but the magnitude of many of the analytical values (using enhancement techniques) suggests that local concentrations of metal of ore grade are possible. Leakage along dike-host rock contacts within the many rhyodacite dike swarms in the area appears to be the mode of metal dispersion. The major regional tectonic feature, the Stockton Pass fault, trends northwesterly, and displacement is left-lateral. This fault also appears to have localized metallization because geochemical anomalies in Mo, Bi, W, Ag, Au, As, and the mineral fluorite show close spatial relation to the zone, which is approximately 1.6 km in width. The fault zone not only appears to have localized metal concentrations, but also it may control the occurrence of a volcanic center south of it that contains geochemical anomalies of the same metals, most prominently molybdenum and bismuth.

Geochemical reconnaissance studies, Papago Indian Reservation, Arizona

Using reconnaissance studies on the Papago Indian Reservation, Ariz., J. H. McCarthy, Jr., observed significant variations between concentrate fractions of stream sediment samples. The higher concentration of many elements in the nonmagnetic (sulfide) fraction reflects the dominant physical weathering in this arid environment and indicates that geochemical dispersion patterns are more easily detected and followed using these media. Geochemical zoning patterns in bedrock samples reveal both regional and local trends that indicate areas of high potential for both base and precious metal deposits. These data provide a base for evaluating the effectiveness of geochemical exploration in this part of the Basin and Range province.

GEOCHEMICAL PROCESSES

Movement of trace elements in weathering environment

Studies by B. R. Berger on processes that control the movement of trace elements in the weathering environment indicate that streams in southwestern Montana draining areas where there is no significant mineralization reach a steady state with respect to chemical speciation. The results show that about 80 percent of the trace elements were transported as silicates or oxides and that most of the remainder were complexed by organics. Where significant mineralization occurs, the steady state was disrupted at the point of entry of the metals into the stream, and most of the trace metals were complexed by organic matter. Downstream from the metal source, the speciation moved systematically back towards the steady-state condition of dominantly silicate and oxide complexing. The amount of metal also decreased downstream. The rate at which the metal anomaly disappeared was a function of the mineralogy of the metal complexes entering the streams. Organic complexes appeared to flourish on a carbonate substrate, removing metals more quickly than either sulfides or oxides.

HYDROGEOCHEMICAL PROSPECTING

Arsenic, copper, and molybdenum, Baboquivari Mountains, Arizona

G. A. Nowlan extended a hydrogeochemical study of well waters that he reported last year to include all of the Baboquivari Mountains both on and off the Papago Indian Reservation. The extended study shows definite areal patterns of arsenic, copper, and molybdenum. Some of the patterns are related to various bedrock units within the mountain range, but one of the patterns, which was made up of anomalous molybdenum in the center, anomalous copper on one side, and anomalous arsenic on the opposite side, appears to be related to mineralization. The area of anomalous molybdenum contains old tungsten mines, and the area of anomalous copper is an old precious- and base-metal mining district.

Graham Cty, AZ
USGS Research 1980 PP 1275

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