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Distribution of Uranium as Function of Sediment Particle Size

Uranium concentrations as a function of size were determined for 100 samples from the Estancia Valley, New Mexico, 100 samples from northeast of the Grants mineral belt, and 46 samples from the Black Hawk mining district, southwestern New Mexico. For the Estancia and Grants samples, statistical analysis shows uranium concentrations in stream sediments size fractions greater than 0.125 mm to be nearly independent of particle size whereas uranium concentration increases with decreasing particle size less than 0.125 mm. The standard deviations of uranium concentrations from both areas vary only slightly for all size fractions. For the Black Hawk mining district the uranium concentrations are strongly dependent on sediment particle size with uranium increasing rapidly with decreasing particle size. A correlation coefficient of 90% is calculated for increasing uranium content with surface area of sedimentary particles. In contrast, a much lower correlation coefficient for uranium-to-surface area is observed for the Estancia and Grants samples. We propose that the observed statistical differences are related to the fact that the stream sediments of the Black Hawk mining district represent control by mechanical disintegration of igneous and metamorphic rocks with little effect of chemical weathering, whereas the sediments of the Estancia Valley and Grants area are more chemically mature. The data imply that the nature (maturity) of the sediments sampled must be considered when sampling on a large grid, such as one sample/10 km^2, or else risk false anomalies (positive or negative) or masking any anomalies which may be present.

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Model for Uranium, Humate, and Silica Fixation in Lacustrine Carbonaceous Sediments at Anderson Mine, Western Arizona

Sedimentation at the Anderson mine in western Arizona was dominated by subaerial and subaqueous debris-flow and lacustrine-turbidite processes. The typical debris flow at the mine is 30 to 100 cm thick, massive, internally chaotic, composed of various amounts of reworked tuff, mica, quartz, and silicified plant and shelly detritus, and has undergone varying degrees of zeolitization and silicification. These debris flows grade laterally to thinner debris flows with graded bedding and laminated lacustrine turbidites that are rich in carbonaceous organic detritus. The more distal flows and turbidites are the principal uranium host at the mine. Uraniferous silica, amorphous uranium silicate, and coffinite are commonly associated with internally structureless though crudely stratified organic matter (humate?) in the carbonaceous siltstones. Uranium is not associated with fragments of coaly plant debris. Uranium, silica, and humic(?) material were probably leached from proximal subaerial and subaqueous debris-flow facies and transported to the anoxic lake-bottom environment where reducing conditions, low permeability, and porosity prevailed. In the anoxic environment, uranium, silica, and humate all tended to precipitate from open water at an Eh-pH boundary zone either at the sediment-water interface or at some depth in the sediment. The carbonaceous laminated lacustrine turbidites were the favorite host, but individual orebodies cross lithologic boundaries, suggesting that uraniferous silica apparently precipitated wherever reducing conditions existed on the lake bottom.

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Evaluation of Geothermal Potential, Albuquerque Area, New Mexico

The first comprehensive evaluation of the geothermal potential of the Albuquerque, New Mexico, area, recently completed, included gravity and magnetic surveys, electrical resistivity measurements, temperature logging of water wells and of shallow (25 m) temperature-gradient boreholes, and geochemical analysis of local waters. Local seismic history and temperature records from municipal water wells were also analyzed. Geothermal anomalies of the Albuquerque area were delineated if temperature gradients in excess of 35°C/km were detected, as this figure is the average temperature gradient for the Rio Grande rift.

Temperature logging of city water wells resulted in the identification of two well fields having anomalously warm water at shallow depth. The Walker well field, on Albuquerque's north side, has 32°C water at a depth of 320 m, representing a gradient of 53°C/km. At the West Mesa well field, on Albuquerque's west side, recent pumping prevented the obtaining of an accurate temperature gradient. However, repeat measurements at selected depths suggest a gradient of approximately 65°C/km.

A third site, about 8 km west of Albuquerque, was found to have shallow temperature gradients in excess of 120°C/km. Near this site, magnetic surveys indicated that several igneous bodies are buried beneath 300 m of alluvial sediments. Because no water wells exist at this remote location, shallow boreholes were drilled for temperature logging. The resulting values of temperature gradient show a distinct high of greater than 120°C/km superposed on a background of 60°C/km.

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Stratigraphic Relations of Type Section of Lower Triassic Dinwoody Formation in Wyoming to Exposures in Idaho Overthrust Belt and Northwest Utah

The Lower Triassic Dinwoody Formation, the oldest Triassic unit in the Cordilleran miogeosyncline, rests unconformably on underlying Permian rocks. The type section of the Dinwoody is on the northeastern flank of the Wind River Mountains in Wyoming. As this locality is near the eastern margin of the Early Triassic depositional basin, the formation is relatively thin (52 m) and largely composed of clastic sediments. To the west, the Dinwoody thickens abruptly and the amount of interbedded limestone increases.

In the Bear Lake-Montpelier region of the southeastern Idaho overthrust belt, the thickness increases to about 380 m. Although significant amounts of interbedded carbonate are present here, intertonguing red beds and evidence of periodic shoaling also characterize this transitional area. In northwest Utah, the Dinwoody thickens to 410 m and includes numerous interbeds of limestone.

Conodont biostratigraphic zonation of the Dinwoody Formation permits detailed correlation and establishes the timing of the Early Triassic transgression eastward over the Wyoming shelf. This short-lived event was followed by westward progradation of terrigenous sediments from the shelf into the depositional basin.

On the basis of color change of conodont elements, which relates to depth and duration of burial, thermal maturity of the Dinwoody Formation increases southwestward. The color alteration index (CAI) ranges from 1 at the type section to 1.5 to 2 in transitional and basinal areas. Because CAI values of 1 to 2 correspond to the thermal interval of oil generation, a vast area of Lower Triassic rocks has productive potential.

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Newly Discovered Inlier of Ordovician Phi Kappa Formation, South-Central Idaho

An inlier of Ordovician Phi Kappa Formation at Meridian Creek, Custer County, Idaho, provides new information on the distribution and character of this formation. The exposure, which trends 2.3 km along the drainage and ranges up to 0.5 km in width, is isolated from other Phi Kappa outcrops by Tertiary Challis Volcanics. Although the rocks here are similar in age and general lithology to the Phi Kappa exposed 7.1 km northwest in the East Pass Creek window and 5.2 km south on the North Fork of the Lost River, there are significant differences.

The Ordovician at Meridian Creek has a minimum thickness of 210 m. About 150 m is graptolite-bearing, Middle Ordovician (Caradocian) shale and calcareous siltstone, whereas the remainder consists of thick (30 m) units of dolomitic limestone and radiolarian-bearing chert. The carbonate unit, which consists of medium to thick beds of fine to medium-grained, dolomitic limestone with clasts of mudstone up to 1 cm long, is coarser grained and thicker than carbonates in Ordovician rocks in nearby areas. The limestones seem to be turbidites, but this interpretation is difficult to reconcile with potential carbonate sources.

The uppermost Phi Kappa at Meridian Creek is intensely deformed. Similar relations are present in adjacent areas where the Mississippian Copper Basin Formation is thrust over the Ordovician. Although Mississippian rocks are absent along Meridian Creek, it seems a Copper Basin thrust plate once extended across this area. Regional considerations also suggest that the Ordovician rocks at Meridian Creek are allochthonous.

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Exploration Guides for Uranium in Volcanic Environments

Exploration for volcanogenic uranium deposits in the United States is a relatively new endeavor, but it is not new in other countries in the world. The Soviet Union, Italy, Yugoslavia, Canada, Brazil, and Mexico have substantial reserves in volcanic host environments. Few volcanogenic uranium deposits have been discovered in the United States, but they may be indicators of larger, more favorable environments.

Volcanogenic systems that evolve from mantle-derived, hydrous, alkaline, magmas than can be enriched in Li, Be, Mo, and Hg, are most likely to develop favorable host environments. Rocks that develop in these host environments exhibit regional enrichment of uranium and thorium. The tectonic settings of these systems are extensional and are related to rift systems and transverse zones in the Basin and Range province of the western United States.

Uranium mineralization processes active in the volcanogenic system produce deposits in both high-temperature and low-temperature regimes. High-temperature deposits form from pneumatolytic, magmatic-hydrothermal, and meteoric-hydrothermal processes; the deposits may be fumaroles, breccia pipes, brecciated margins of intrusives, fractured and porous country rock, and porous zones along ash-flow contacts. Diagenetic and reduction-oxidation processes work in conjunction to form low-temperature deposits, commonly in sedimentary environments where oxidizing ground-water flow can introduce labile uranium into reducing environments.

Sierra Pena Blanca, Chihuahua, Mexico, is a preserved part of an alkaline volcanic complex that formed in a rift system active in late Eocene through early Oligocene time. Although detailed mapping is still underway, the number of uranium and thorium enriched alkaline and peralkaline ash-flows suggests several eruptive centers nearby. Enrichment of other metals in these ash-flow sheets suggests regional enrichment of lithophilic elements. Sierra Pena Blanca has pneumatolytic uranium deposits in fumarolic ash flows, magmatic and meteoric hydrothermal deposits in interbedded ash flows and invaded country rock, and low-temperature deposits forming in closed basins adjacent to the volcanic complex.

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Stratigraphy and Petroleum Trapping Mechanisms of Upper Jurassic Entrada Sandstone, Northwestern New Mexico

Extensive outcrops and 14 measured sections of the Upper Jurassic Entrada Sandstone and overlying Todilto Formation in the southern Chama basin Echo Amphitheater–Ghost Ranch area show long, parallel, eolian transverse dune buildups in the upper Entrada perpendicular to the dominant wind direction as shown by cross-bed foresets. Some bevelling of the buildups occurred prior to the evaporitic deposition of limestone and gypsum of the Todilto Formation and this deposition preserved the buildups, filling in the low interdune areas.

The subsurface Entrada-Todilto of the southeastern San Juan basin was mapped over an area including 20 townships. An isopach of the Todilto Formation shows that essentially the same trend of Entrada dune buildups is present here as in the outcrop area.

Support for the mechanism of trapping in Entrada oil fields as proposed earlier by Bryant is present both in the surface and subsurface where relief created by eolian buildup of sand is preserved by the infilling of the Todilto. However, structural dip counter to regional dip along the axis of dune buildups is needed to trap oil. This dip can be provided by syndepositional faults cutting across the buildup axis as in the outcrop area where there is sudden thickening of the Todilto and of the Entrada downthrown to the fault.

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Distribution and Stratigraphic Correlation of Burro Canyon(?) Formation, Chama and Northern San Juan Basins, New Mexico

The Lower Cretaceous conglomerate sandstone, sandstone, and mudstone interval stratigraphically between the Upper Cretaceous Dakota Sandstone and the Upper Jurassic Brushy Basin Member of the Morrison Formation in the Chama and northern San Juan basins, New Mexico and Colorado, is tentatively called the Burro Canyon(?) Formation. In this area the Burro Canyon(?) consists of a basal fluvial sequence deposited in braided-stream environments and an upper fluvial sequence deposited in braided to meandering-stream environments.

The Burro Canyon(?) is unconformably overlain by the Dakota Sandstone and may disconformably overlie the Brushy Basin Member of the Morrison Formation. The Burro Canyon(?) thins southward from the Chama and northern San Juan basins because of truncation of the formation under the