Uranium Exploration Systems Case Study—Copper Mountain, Wyoming

Regional surveys, including studies of rock chips and aerial radiometrics and magnetics, focused within an area of 400 sq km on the Canning stock, found enrichment in U, Th, and K. Stream-sediment data indicated an anomalous block adjacent to and including the North Canning and Fuller deposits. A subregional soil survey noted overlapping anomalies of eU, xU, Pb, Cu, and Ba in the vicinity of the North Canning deposit. This was confirmed by overlapping anomalies of eU, xU, Pb, Cu, and Ba in the rock-chip survey. Integrated radon and soil helium data were ineffective in delineating drilling targets at the subregional scale. The subregional magnetic, VLF-EM, and resistivity data confirmed the presence of a fractured and crushed zone within the host granite of the North Canning deposit. This interpretation is based on the presence of an overlapping low resistivity zone and a magnetic depression of about 40 gammas. Core holes were sited within an area of 25 sq km that included the North Canning deposit, the leachable-uranium-in-rock-chip anomaly, the aerial radiometric anomaly, and overlapping geochemical (xU, eU, Ba, He, Rn, As, Ni, and Pb) anomalies in the detailed soil survey. These holes, logged with a multispectral (K-U-Th) probe, show zonation of K, eU, and eTh in the monzonite and granitic host rock and indicate both directional and genetic information related to the origin of the uranium deposit.

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Biogenic Structures as Indicators of Depositional Rate

Distinctive blue-gray shales characterized by a homogeneous texture, blocky weathering, and an abundant trilobite fauna (*Flexicalymene, Isotelus*) are found at various stratigraphic positions in the Upper Ordovician near Cincinnati, Ohio. Whole and fragmentary trilobite body fossils are randomly oriented within the shale, bivalves are common, and biogenic structures (*Chondrites*) are locally abundant. Limestones and siltstones above and below the shales are more extensively burrowed and contain at least two ichnogenera, *Chondrites* and *Diplocraterion.*

The absence or relatively low density of biogenic structures in shale traditionally has been interpreted as (a) an inhospitable environment for burrowing organisms during shale deposition or (b) rapid deposition of the shale, which prevented disruption of the original fabric by burrowers. The abundance of trace fossils in lithologies below and above the "trilobite shales" implies favorable conditions for burrowers before and after shale deposition. The abundant pelecypod fauna and low organic content of these shales suggest the muds were well-oxygenated. The relatively low density and localized occurrence of biogenic structures in these shales, then, reflect rapid deposition of the shales. Paleontologic criteria, including the excellent preservation and random orientation of trilobites, support the interpretation of rapid deposition for the shales.

The "trilobite shales" represent events in which a turbid layer of silt and clay swept over the shelf, killing and rapidly burying the trilobites. Burrowers, also disturbed during the event, reestablished themselves and exploited the new substrate after it had stablized. Rapid, recurrent influxes prevented extensive disturbance by burrowers.

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Permeability of Clay and Shale

Permeability is a critical factor in the maintenance of abnormal fluid pressures. The permeability of "tight" geologic materials is difficult to measure, particularly in situ. Both the laboratory and in-situ methods require special techniques when the permeabilities are less than 10^{-10} cm/sec (10^{-7} darcys).

Permeability can be measured: (1) on rock samples in the laboratory; (2) in situ, using well-test procedures; and (3) on a regional scale, using a hydrodynamic analysis of the entire system.

Special techniques have been used to measure permeabilities in the Cretaceous Pierre Shale in South Dakota. Comparison indicates that the regional permeability exceeds the local permeability by two to three orders of magnitude. This suggests that secondary features, probably fractures, control the regional permeability.

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Lower Cretaceous Lacustrine Source Beds from Early Rifting Phases of South Atlantic

Significant amounts of oil are produced from Lower Cretaceous pre-evaporite, nonmarine sequences of these west African marginal basins: Gabon, Cabinda, Congo Brazzaville, and Angola. Organic-rich lacustrine source beds attain thicknesses up to 900 m. Their geometry and sediment similarities among several basins indicate a small number of large Early Cretaceous lakes extending along the South Atlantic rift with dimensions and conditions similar to Lake Tanganyika. The organic-rich facies is underlain by a sandy facies deposited during initial rifting. The lacustrine phases deposited green clays and fluviolacustrine-deltaic sands, which were abruptly terminated by marine incursions in the Aptian.

Our study of conventional whole cores from the Melania Formation of Gabon provides further evidence that these source beds were deposited in brackish to freshwater environments in a deep lake. Logs show characteristic low bulk densities and high resistivity which allow correlations over 80 km. Large-scale cyclic preservation of organic matter in a stable, low energy environment with anoxic bottom conditions is interpreted. There is little clay in the organic-rich "shales" which typically comprise finely laminated, carbonaceous and dolomite-rich rhythmic couplets. Bulk organic carbon concentrations up to 20% are not uncommon. Palynomorphs, ostracods, and algae also indicate temperate conditions around a low salinity environment. The slope sequences are richest in uniform laminates with