and can only obtain that oil at the expense of other countries.

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Lacustrine Humate Model—Sedimentologic and Geochemical Model for Tabular Uranium Deposits

Facies control of some tabular uranium deposits in sandstone implies that certain inherent features in the depositional environment set the stage for uranium mineralization. The lacustrine-humate model was developed to explain the facies control of uranium in fluvial-lacustrine units of the Salt Wash Member of the Morrison Formation in south-central Utah and in the Stockton Formation of the Newark Group in the eastern United States. In both of these areas, a close spatial relation exists between offshore-lacustrine primary gray mudstones and uranium-bearing fluvial and marginal-lacustrine sandstones. The primary gray mudstones lie directly above, below, or a short lateral distance from the tabular uranium deposits within the sandstones. This proximity suggests a model in which alkaline pore waters containing dissolved humic substances (humic and fulvic acids) were expelled by compaction or seepage from the gray mudstones into the adjacent sandstone beds where they were fixed as tabular humate deposits. Uranium carried by groundwater that flowed toward the lakes was then concentrated by the humate to form tabular uranium deposits. Thus, the sedimentologic setting of the host rocks was an important factor in the mineralization process.

Because the dissolved humic substances are thought to be expelled from certain types of mudstones, the nature of these beds becomes important in using the model as an exploration guide. Mudstones deposited in reducing alkaline conditions are considered favorable, because reducing conditions would favor preservation of humic matter in the pore waters of the lake sediments, and alkaline conditions would favor solubilization of the humic substances so that they could be expelled with the pore fluids.

A second important aspect of the model is the means by which humic substances are fixed in the sandstone beds following their expulsion from the mudstones. Formation of organo-clay complexes, with the organic materials interacting with clay coats on sand grains, has been suggested as a possible mechanism. The nature of these complexes has been unclear because of the negative charge associated with both the clays and the humic and fulvic acid molecules. Iron and aluminum hydroxides coating clay surfaces may have formed "bridge linkages" between the clay films and the organic acids because the hydroxides carry a positive charge below pH 8. The hydroxides, abundant in near-surface sediments during early diagenesis, are most effective in fixing humic substances at pH 7, which is within the range of normal groundwaters.

The lacustrine-humate model differs from others in that the humic substances are believed to have migrated only short distances from mudstone beds that lay near the ore-bearing sandstone beds. The model is also an attempt to work within the constraints developed during facies analysis; pore-water and groundwater chemistry and flow patterns are based on reconstruction of sedimentary facies and are consistent with what would be expected in a natural system.

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Sedimentology of Volcaniclastic Deposits from 1971-1974 Eruption Cluster of Volcano Fuego, Guatemala

Volcaniclastic sedimentation during and subsequent to the 1971-74 eruption cluster of the Volcano Fuego in Guatemala has occurred in four distinct phases which are part of a 15 to 25 year cycle of sedimentation. In phase 1, the eruption cluster generated 6×10^8 cu m of tephra, one-third in the form of glowing avalanches, the remainder as an elongate airfall ash blanket west-southwest of the cone. Glowing avalanches with a volume of 5×10^7 cu m formed two fans, each 1 to 3 m thick, east and west of the crater. Further avalanches flowed down seven narrow canyons radiating to the south of the crater forming 40-m-thick deposits totaling 1.3×10^8 cu m. During phase 2, debris flows and flash floods removed about one-third of the phase 1 canyon deposits in the first 2 years following eruption. Fan deposits remained intact. Three digitate, 1 to 2.5-m-thick, debris-flow deposits (2.2×10^7 cu m) and two 1-m-thick flood fans (1.8×10^7 cu m) formed south of the crater. In phase 3, terraced, meandering, suspended-load streams were metamorphosed to braided, aggrading, bed-load systems annually eroding 6 million tons of phase 1 and 2 debris, primarily from the canyon deposits. Transport of about two-thirds of this debris to the sea has produced rapid coastal progradation. During phase 4, 15 to 25 years of phase 1 and 2 activity will remove canyon avalanche deposits, redistributing the material in stable fans on the lower volcanic slopes. Phase 1 and 2 processes become inactive while stream incision produces discontinuous terracing. Fluvial systems return to meandering, suspended-load streams.

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Solution Mining of Uranium and Its Effect on Exploration

In-situ uranium leaching substantially increases the volume of the subsurface from which uranium can be mined and therefore the scope of a uranium exploration program. There are however many limiting factors that restrain the application of in-situ leaching. These factors include formation permeability and porosity, the chemistry and hydrology of the interstitial fluids, host-rock and ore mineralogy, and the depth to the deposit. A knowledge of these factors is essential in any exploration program where the target is an in-situ leachable orebody.

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Geology and Current Development Activity at Little Knife Field, North Dakota