

In southeastern Saskatchewan the Mississippian strata dip south-southwest and are progressively truncated northward against the post-Mississippian erosion surface. Impermeable "red beds" of the Watrous Formation unconformably overlie the Mississippian carbonate sequence.

The Benson field is a structural and stratigraphic trap in which oil has accumulated in dolomite layers of the Midale Beds beneath the erosion surface. The dolomite rocks which are microsucrosic and commonly burrowed have good to excellent intercrystalline and moldic porosity. Dolomite layers are present at several stratigraphic positions within the lagoonal carbonate rocks of the Midale Beds and range from 0.1 to 3.2 m in thickness. Either limestones (wackestones and micritic packstones), highly calcareous dolomites (microsucrosic), or anhydritic dolomites (cryptocrystalline) provide the caprocks and the bottom seals for the porous layers. Laterally, the dolomites grade into highly calcareous dolomites and/or wackestones. The porous layers result from selective dolomitization of carbonate sediments.

Close to the erosional edge, porosity in the dolomites has been reduced or obliterated by secondary anhydrite.

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New Look at Oil and Gas Resources of Denver-Julesburg Basin

The Denver-Julesburg basin, with approximately 1,000 Lower Cretaceous fields and over 30,000 wells, presents a unique opportunity for statistical analyses of its exploration history. Comparison of an analysis of the current activities in the basin with a similar analysis made 20 years ago by J. J. Arps provides an interesting perspective of the known distribution of field sizes, as well as speculations on the basin's exploration future.

Five years ago 12,200 exploratory wells had been drilled in this basin and resulted in the discovery of 820 fields. As a result of the known field-size distribution in the basin at that time, the average size of an undiscovered field was predicted to be on the order of 1 million bbl of recoverable resources. Since then, more than 5,000 additional exploratory wells have been drilled, and the average size of the 125 new fields discovered is in the predicted range. Exploration statistics indicate that the rate of oil discovery has declined in the past 5 years, even though the frequency of wildcat drilling has accelerated. Newly discovered fields are generally located in the heavily drilled areas as opposed to the sparsely drilled or "under developed" areas of exploration.

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Uranium Geology of Morton Ranch Property, Southern Powder River Basin, Wyoming

The Morton Ranch uranium deposits are located along the southern axis of the Powder River basin approximately 22 mi (35 km) northwest of Douglas, Wyoming. The property encompasses approximately 26,000

acres (10,400 ha.) of private and state lands and is divided into two separate tracts: North Morton and South Morton.

The uranium deposits are restricted to two bedrock units—Wasatch Formation (Eocene) and Fort Union Formation (Paleocene). Both rock units consist essentially of fluvial sediments of interbedded and highly lenticular silty claystone and sandy siltstones that contain lenses of coarse, cross-bedded, arkosic sandstone.

Most of the uranium mineralization is restricted to three sandstone units within the Fort Union Formation. The ore sands are continuous throughout the area and range in thickness from 2 to 80 ft (0.6 to 24 m). On South Morton, the ore sands crop out in the Box Creek area but for the most part lie at a depth of 40 to 300 ft (12 to 90 m) below the surface. On North Morton, the ore sands are 550 to 700 ft (165 to 210 m) below the surface.

The uranium orebodies are present typically as geochemical-cell or "roll-front" deposits. Of less importance are tabular and elliptical or dish-shaped orebodies, primarily present on South Morton.

Surface (open pit) and possibly adit-level underground mines are planned for South Morton and underground mines for North Morton. In-situ leaching may be used as a recovery method in some areas of the property.

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United States and World Energy Outlook for the 1980s

An assessment of energy supply and demand for the United States and the world to the year 1990 is presented as balanced volumetric energy flows disaggregated over the primary sources and major consuming sectors. On the national scene, some of the projections and conclusions are (1) between now and 1990 the world demand for oil will grow more rapidly than United States demand; (2) most of the energy to be consumed in the United States over the projection period will be supplied as domestically produced fossil fuels; (3) oil imports will increase to about 10 million BOPD throughout the decade of the 1980s, coming more and more from OPEC; (4) coal will supply an increasingly greater fraction of total U.S. energy consumption, primarily in the utility and industrial sectors; (5) new sources of energy will be developed, but before 1990 will have only a small impact on total supply; (6) nuclear power, while growing less vigorously than estimated in past projections, will be important to the nation's economy; and (7) the successful balancing of long-term U.S. energy futures is contingent on our ability to achieve significant reductions in energy consumption growth rates.

On the international scene, it appears that: (1) unemployment may be the largest single factor affecting the international economy, (2) the majority of the oil reserves are in communist countries and the Middle East, (3) over 60% of the gas reserves are in communist countries, (4) and the same is generally true for coal reserves, (5) the United States will have to compete with the rest of the world for the available interregionally traded oil,

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 dur-

ing 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