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Permeability of Westwater Canyon Member of Jurassic Morrison Formation, Southern San Juan Basin

The Westwater Canyon Member of the Morrison Formation is the potential source of major supplies of both uranium and ground water in the San Juan basin; development of the uranium is expected to have great impact on the potentiometric surface associated with the water in the Westwater Canyon, and therefore on the supplies available. Most permeability determinations of the unit have been in or near orebodies and appear to have anomalously high values. Comparison of logs indicates that resistivity may be a better guide than so-called "porosity" logs, and that typical values away from areas of ore emplacement may be lower than the averages usually used in analysis of pumping effects. Such values may result in smaller ultimate volumes required for mine dewatering, and may indicate that the value of the aquifer for major supplies is less than formerly thought.

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Paleotectonics and Hydrocarbon Accumulation of Powder River Basin, Wyoming

A subtle northeast-trending paleoarch extends across the central part of the Powder River basin, Wyoming, from the Salt Creek-Meadow Creek structural province to the Black Hills uplift. The Belle Fourche arch is the result of differential vertical uplift, primarily during Cretaceous time, on numerous northeast-trending structural lineaments. Lineament trends are identified from structural offsets in the Black Hills monocline, offsets in well-defined linear topographic escarpments, and by linear drainages which connect trends between the monocline and the escarpments. Underlying basement zones of weakness are thought to be Precambrian age shear zones analogous to the Mullen Creek-Nash Fork shear zone of southeast Wyoming. Stratigraphic evidence suggests that the structural lineaments which form the Belle Fourche arch have been rejuvenated periodically throughout the Phanerozoic. Subtle movements along the lineaments have affected depositional environments and hydrocarbon accumulation in virtually all significant reservoirs in the northern two-thirds of the basin. Evidence includes: (1) localization of Minnelusa Formation (Permian) hydrocarbon production along the crest of the arch; (2) localization of Dakota Formation (Cretaceous) alluvial point-bar production on the crest of the arch; (3) localization of lower Muddy Formation (Cretaceous) channel deposits parallel with, and on the downthrown side of, lineament trends; (4) abrupt change in depositional strike of upper Muddy Formation (Cretaceous) marine bars close to the arch; (5) superposition of Turner Sandstone (Cretaceous) channel deposits along exactly the same trends as those of Muddy channels; and (6) localization of virtually all significant Upper Cretaceous Shannon and Sussex Formation offshore marine-bar production along the crest of the arch. Subtle uplift along the arch has been persistent from at least lower Muddy through Sussex deposition, a period of about 35 m.y.

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Overpressured, Low-Permeability Gas Reservoirs in Green River, Washakie, and Great Divide Basins, Southwestern Wyoming

Upper Cretaceous and lower Tertiary "tight" ($<$ 0.1 md) gas-bearing sandstone reservoirs are being investigated in deep basins in the Rocky Mountain region. The reservoir rocks were deposited in fluvial, deltaic, and marginal marine environments. The marginal marine sandstones are generally better sorted and higher in quartz content, and generally have slightly better porosity ($>$10%) and permeability than fluvial and fluviodeltaic reservoirs. The greatest thickness ($>$10,000 ft, $>$ 3,048 m) of gas-bearing intervals is in the fluvial sequences in the Upper Cretaceous Mesaverde Group and Lance Formation and the overlying lower Tertiary Fort Union Formation.

Normal reservoir pressures are in the range of $\pm$0.43 psi/ft ($\pm$9.73 kPa/m). However, broad areas of the deeper Washakie, Great Divide, and Green River basins have reservoir pressures in excess of 0.5 psi/ft (11.31 kPa/m) and, locally, pressures higher than 0.8 psi/ft (18.10 kPa/m) have been recorded. The thermal maturation level of organic matter in cores and cuttings from six deep wells drilled in the Washakie and Green River basins has been determined. In addition, present-day subsurface temperatures and pressures have been compiled for many other wells. This work indicates that the overpressuring occurs in sequences of tight sandstones enclosed in humic-rich shales and/or in association with coals having present-day temperatures greater than 190°F (88°C). The 190°F (88°C) isotherm surface ranges in depth from about 9,000 to 11,500 ft (2,743 to 3,505 m). We interpret the overpressuring to be due mainly to pressure maintenance caused by present and recently active generation of natural gas in organic-rich sequences subjected to temperature levels greater than 190°F ($>$88°C).

Operators have had difficulty in completing wells in zones deeper than 12,000 ft (3,568 m) in the study area. Successful completion of deep wells will require innovative drilling and completion techniques that address the problems of proppant crushing, formation damage, high-formation temperatures, and well-log analysis. A substantial geologic and engineering research effort is needed to exploit this potential major gas resource.

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Some Chemical Characteristics of Uranium-Vanadium Deposits in Ambrosia Lake Area, Northwest New Mexico

Comparison of the elemental abundances of six suites of ore-bearing sandstones from the Upper Jurassic Morrison Formation suggests that certain elements form haloes around these deposits. Field relations and uranium contents were used to classify approximately 700 samples of sandstone from the Morrison Formation in the Ambrosia Lake area, New Mexico, into the following groups: (1) primary U-V ore (prefault or trend), (2) secondary U-V ore (postfault or stack), (3) reduced rock adjacent to ore, and (4) oxidized rock adjacent to ore. The chemical characteristics of each of the groups were compared with each other and with the characteristics of two control groups of samples taken farther from ore deposits. One of these was a suite of 70 samples of Morrison sandstones from the Thoreau area; the other consisted of approximately 200 samples of Morrison sandstones from various locations in the southern San Juan basin. Differences in the geometric means of the elemental abundances indicate that relative to the control groups, the primary ores are enriched in Fe, Mg(?), Ca, Mn, Ba, Be, Cu, Mo, Pb, U, V, Y(?), Na, Se, Sr, organic C, and carbonate C; the secondary ores are enriched in Fe, Ca, Mn, Ba, Cu, Na, Sr, U, V, and carbonate C. The data indicate that Ca, Ba, Sr, V, and carbonate C are more concentrated in the secondary ore than in the primary ore. Barren rocks adjacent to the ore are enriched in Ca, Ba, Cu(?), Sr, V, U, Na, Se, and carbonate C, compared with barren rock farther from the deposits. Both the enrichment of these elements in the vicinity of the deposits, and the better correlation of them (except for U) with eU than with U, suggest that these elements are mobile and form haloes that may be useful exploration guides. The data also suggest that Ga is depleted in and around the ore. Thus, a decrease in Ga might be an indication of proximity to a deposit.

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Permian White Rim Sandstone Member of Cutler Formation: Coastal Dune Field, Utah

The White Rim Sandstone Member of the Permian Cutler Formation in Canyonlands National Park, Utah, was deposited in a coastal eolian environment. This conclusion is based on sedimentary structures, petrologic features, and stratigraphic relations. The White Rim consists of two major genetic units. These units may represent a coastal dune field and related interdune ponds. Distinctive sedimentary structures of the coastal dune unit include large to medium-scale, unidirectional, tabular planar cross-bedding; high-index ripples paralleling dip direction of the foresets; raindrop impressions; slump marks; and coarse-grained lag layers. Also, a predominant northwest to southeast orientation of the cross-bedding agrees with the paleowind direction proposed in this area for Permian time. Distinctive sedimentary structures of the interdune pond unit include wavy, horizontally laminated bedding, adhesion ripples, and desiccation(?) polygons. These features may have been produced by water-table fluctuations.

Petrologic characteristics of the White Rim help to define the depositional environment as coastal. A crinoid fragment was identified at one location; heavy minerals are present in both units; and small amounts of well rounded, reworked glauconite are present throughout the study area.

The White Rim Sandstone Member was deposited during a period of changing sea level and migrating strandlines. Continental sedimentation was dominant in eastern Utah, along the ancestral Uncompahgre Mountains; and marine deposition was prevalent in western Utah. Rocks deposited in the two environments interfinger in the Canyonlands area. Previous authors have proposed that the White Rim represents either a shallow-marine or eolian facies equivalent to both the upper part of the Toroweap Formation and the Gamma Member of the Kaibab Limestone. Results from this study suggest that the White Rim more likely represents eolian deposition on a prograding shoreline characterized by a semiarid climate and predominantly onshore winds.

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Unsaturated Flow Conditions Beneath Lined Tailings Disposal Ponds

The uranium milling industry may soon dispose of substantial volumes of liquid waste in lined evaporation ponds. The potential for seepage through the low-permeable liner to contaminate ground water can only be assessed by analytic and numeric models. These models predict that, prior to reaching the water table, the liquid phase of the flow region will be unsaturated, except where perching may occur just above very low-permeable strata. None of the models actually simulate the effects of fractures in consolidated sediments.

Because seepage beneath the pond is predicted to occur under partly saturated conditions, piezometers usually employed in ground-water studies generally will not be effective monitoring tools. However, neutron moisture probes, suction lysimeters, and tensiometers well known to soil physicists could be used to monitor unsaturated flow. Unfortunately, none of these instruments is likely to be highly reliable in fractured-rock environments or in heterogeneous sound rock with a limited number of monitoring points. In fractured and nonfractured rock the primary means of detecting seepage losses exceeding model predictions should be from a mass balance of inflow rate minus evaporation.

Owing to unsaturated conditions beneath the pond, a well completed within the seepage zone could not produce water. This satisfies the NMEID mandate to protect future ground-water users after operations cease unless the seepage fluids contaminate the regional aquifer. Two- and three-dimensional numeric models show that seepage spreads beyond the perimeter of the pond; this may not be compatible with USEPA solid-waste-management regulations.

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Preliminary Report on Age of Uraniun-Ore Deposition and Host-Rock Formation at Lilljuthatten, Sweden

Analyses of 6 mineralized and 4 unmineralized samples from drill holes in the uranium ore deposit at Lilljuthatten, Sweden, yield an apparent Pb-Pb age of 425 ± 6 m.y. (errors at 95% confidence level). This age corresponds with the youngest phase of the Caledonian orogeny in central Sweden, indicating that the ore deposit probably formed during this event.

The age of the host granite has not been determined quantitatively because the Caledonian event has disturbed (and in some places completely reset) all the isotopic systems investigated thus far. Four new and 7 published Rb-Sr analyses approximate an isochron of 1,540 m.y., but two samples from near the ore zone have been reset to much younger apparent ages.

Isotope systematics in the Th-Pb and U-Pb systems are highly complex, but U-Pb data for a few samples suggest a host-rock age of approximately 1,500 m.y. If this age and thorium immobility are assumed, there is a suggestion that the host granite was extremely rich in uranium (30 to 50 ppm) at the time of intrusion and that the ore deposit may have formed by concentration of uranium from the host granite.

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Low-Temperature Geothermal Development and Monitoring at Gila Hot Springs, New Mexico

The combination of hot water (150°F; 65.5°C) from the Gila Hot Springs and cold water (50°F; 10°C) from the West Fork of the Gila River makes a 10-KW Rankine-Cycle turbine-generator feasible. Plans call for the installation of a generator during November 1980 and for the systematic monitoring for 1 year of both environmental parameters (water temperature, chemistry, streamflow, springflow, etc) and generator performance. The results of the monitoring program will become