

GALLOWAY, W. E., *Bur. Econ. Geol., Univ. Texas, Austin, Tex.*

Deposition and Early Hydrologic Evolution of Westwater Canyon Wet Alluvial-Fan System

The Westwater Canyon Member is one of several large, low-gradient alluvial fans that comprise the Morrison Formation in the Four Corners area. Morrison fans were deposited by major laterally migrating streams entering a broad basin bounded by highlands on the west and south. The Westwater sandstone framework consists of a down-fan succession of (1) proximal braided channel, (2) straight bedload-channel, (3) sinuous mixed load-channel, and (4) distributary mixed load-channel sandstone bodies. Regional sandstone distribution and facies patterns are highly digitate and radiate from a point source northwest of Gallup, New Mexico.

Early groundwater flow evolution within the Westwater fan aquifer system can be inferred by analogy with Quaternary wet-fan deposits and by the interpreted paragenetic sequence of diagenetic features present. Syndepositional flow was controlled by the down-fan hydrodynamic gradient and high horizontal and vertical transmissivity of the sand-rich fan aquifer. Groundwater was abundant, fresh, and slightly alkaline; dissolution and transport of soluble humate would be likely. With increasing confinement of the aquifer below less permeable tuffaceous Brushy Basin deposits and release of soluble constituents from volcanic ash, flow patterns stabilized and relatively more saline, pregnant groundwater permeated the aquifer. Uranium mineralization occurred during this early postdepositional, semiconfined flow phase. Exposure, erosion, and possible further flushing of proximal fan deposits had little apparent effect on the aquifer. Development of overlying Dakota swamps suggests a shallow water table indicative of regional discharge or stagnation. In either event, only limited downward flux of acidic water is recorded by local bleached, kaolinized zones where Westwater directly underlies the Dakota. Subsequent groundwater flow phases have further obscured primary alteration patterns and caused some local oxidation and redistribution of uranium.

GREEN, MORRIS W., *U. S. Geol. Survey, Golden, Colo.*

Disconformities in Grants Mineral Belt and Their Relation to Uranium Occurrence

At least two major, regionally extensive, intraformational disconformities and numerous local ones are present in sedimentary rocks of Triassic, Jurassic, and Cretaceous ages in the Grants mineral belt. These disconformities, some of which have been known for many years, have proven useful in stratigraphic correlation and in differentiating genetically related rock sequences in the mineral belt. In addition, two of these disconformities, one local and the other regional, are significantly associated with the distribution of sandstone-type uranium deposits in the Jurassic Morrison Formation and the overlying Cretaceous Dakota Sandstone.

The Westwater Canyon Member and laterally equiv-

alent beds of the Recapture and Brushy Basin Members of the Morrison Formation are separated from underlying Jurassic rocks by an intraformational disconformity which marks a major change in depositional environment from predominantly sabkha-eolian dune to fluvial-lacustrine within the Jurassic sequence. This disconformity is economically significant in that all of the large uranium deposits in rocks of Jurassic age in the mineral belt occur within fluvial sandstone facies of the Morrison above the disconformity. Recognition of this disconformity in outcrop and in the subsurface is important in delineation of exploration target areas and resource assessment in the San Juan basin.

Uranium deposits in the basal part of the Dakota Sandstone are associated with the well-known regional, southward-beveling disconformity present at the lower boundary of the Dakota throughout the San Juan basin and adjacent region. In the western part of the mineral belt, impermeable Brushy Basin shales have been truncated at this disconformity and uranium-bearing groundwaters from the Morrison Formation have migrated into basal organic-rich sandstone of the Dakota to produce several small to medium-sized uranium deposits.

HAYSLIP, D. L., G. E. FULLER, P. W. LEVY, *Brookhaven Natl. Lab., Upton, N. Y.*, and J. R. RE-NAULT, *New Mexico Bur. Mines and Mineral Resources, Socorro, N. M.*

Thermoluminescence of Uranium Host Rocks in Ambrosia Lake Area

Exposure to radiation during the formation or redistribution of uranium ore deposits is expected to affect the thermoluminescence (TL) properties of the host rock. For example, TL measurements on samples from a traverse of a Wyoming roll-type deposit display the following intensity-versus-distance pattern. Starting from barren oxidized ground the intensity increases gradually with decreasing distance to ore, is extremely high in ore, and drops abruptly with distance in reduced ground to a level substantially below that in oxidized ground. This pattern is in accord with current hypotheses concerning the genesis of this type of deposit.

Measurements of both natural and artificial TL made on quartz separates from drill cores and samples collected underground in the Ambrosia Lake area, because of the intensity and structure of their respective glow curves, permit discrimination among oxidized ground, reduced ground, and mineralized areas. In addition, samples from oxidized ground show TL intensities and glow-curve characteristics that have been correlated with structural features that controlled the redistribution of ore. Although the data show some statistical variation, the general intensity-versus-distance pattern has been observed in many cases. All currently available results suggest that TL can be developed into a viable tool for uranium exploration.

HUFFMAN, A. CURTIS, JR., ALLAN R. KIRK, *U.S. Geol. Survey, Denver, Colo.*, and R. JAMES CORKEN, *Northern Arizona Univ., Flagstaff, Ariz.*

Depositional Environments as Ore Controls in Salt

Wash Member of Morrison Formation (Upper Jurassic), Carrizo Mountains, Arizona and New Mexico

Uranium deposits in the Salt Wash Member of the Morrison Formation in the Carrizo Mountains area appear to be closely related to depositional facies. In the vicinity of the Eastside mines, southeastern Carrizo Mountains, the Salt Wash consists of a lower part, 10 to 15 m thick, and an upper part, 55 to 60 m thick. The lower part contains mudstone and silty sandstone interpreted as overbank and partially abandoned channel-fill deposits. It also contains a few large lenticular channel sandstones deposited by meandering and possibly braided streams. Uranium deposits are uncommon in the lower part.

The upper part of the Salt Wash contains a much greater percentage of braided-stream-deposited channel sandstones, many of which coalesce to form prominent continuous ledges. The finer grained low-energy deposits are very limited in extent, commonly being less than 200 m long, 20 m wide, and 2 m thick. They have a lenticular cross section and a scour base. They consist of interbedded mudstones, claystones, and sandstones and are interpreted as abandoned and partially abandoned channel fills. Subsequent scouring of these beds has resulted in clay-clast conglomerates which were incorporated as lag deposits in the bases of overlying channel sandstones. Detrital organic debris is uncommon but is present in some channel-lag deposits as well as in some of the bedded mudstones. Uranium deposits in the Carrizo Mountains area are associated with abandoned and partially abandoned channel fill and with clay-clast lag conglomerates adjacent to major channel sandstone systems in the upper part of the Salt Wash.

JENKINS, J. T., JR., and S. B. CUNNINGHAM, Gulf Research & Development Co., Houston, Tex.

Depositional Environment of Poison Canyon Sandstone in Gulf Mariano Lake Mine

A study of the depositional environment of the Poison Canyon Sandstone (Brushy Basin Member of the Upper Jurassic Morrison Formation) in the Mariano mine was undertaken to determine the relation of uranium occurrence to the depositional environment. An analysis of the sedimentary structures, paleocurrent measurements, isopach data, and electric-log shapes has led to the interpretation that the Poison Canyon Sandstone in the Mariano Lake mine vicinity is a sequence of bed-load deposits of a fluvial system. Paleocurrent measurements taken in the mine and at three outcrops of the Poison Canyon confirm findings from earlier work that indicated eastward current flow. The dominance of tabular cross-beds, channel scours, and trough cross-beds, the geometry of the Poison Canyon sandstones, and the chaotic sedimentary structures corroborate deposition in a braided-stream environment.

The Poison Canyon sandstones may be subdivided into two lithofacies. A cross-bedded unit is characterized by large-scale tabular cross-beds, scour surfaces, medium to coarse grain size, poor sorting, angular to subangular grains, an abundance of feldspar grains, and clay rip-up clasts. A second unit is dominated by lami-

nar bedding, fine grain size, moderate sorting, sub-rounded grains, and an abundance of quartz. The source area for the sands had been dominated by plutonic rocks. These facies cannot be separated on the basis of electric-log shape. Uranium ore occurs in both facies but is more abundant in the cross-bedded unit.

The complexities of the braided-stream system greatly complicate any study of the interrelation of the uranium and the depositional environment. Obvious conclusions are that the grain size does not greatly influence the emplacement of the uranium, that the orebody at the Mariano mine is epigenetic, and that the sheetlike nature of the Poison Canyon sandstones suggests that the limiting factors on the ore boundaries are geochemical rather than stratigraphic.

KELLY, T. E., R. L. LINK, and M. R. SCHIPPER, Geohydrology Associates, Inc., Albuquerque, N. M.

Effects of Uranium Mining on Groundwater in Ambrosia Lake Area, New Mexico

The principal ore-bearing zone in the Ambrosia Lake area of the Grants uranium district is the Westwater Canyon Member of the Morrison Formation of Jurassic age. This is also one of the major artesian aquifers in the region. Significant declines in the potentiometric head within the aquifer have been recorded, and digital modeling shows that declines may locally approach 3,000 ft (900 m) in the vicinity of a mine. Loss of potentiometric head in the Westwater Canyon Member has resulted in the interformational migration of groundwater along fault zones from overlying aquifers of Cretaceous age. This has resulted in local deterioration in chemical quality of the groundwater.

LANGFORD, FRED F., Univ. Saskatchewan, Saskatoon, Sask.

Stratigraphic Control of Uranium Deposits

The restricted stratigraphic distribution of economic uranium deposits is one of their most consistent characteristics. Even the occurrence of uraniferous pegmatites in Saskatchewan and Ontario appears to have been stratigraphically controlled. Quartz-pebble conglomerate deposits are placers, but other deposits in sediments are chemical precipitates, characterized by thorium-free primary uranium minerals with vanadium and selenium. In marine sediments these minerals form low-grade, disseminated, widespread deposits that are obviously syngenetic. In terrestrial sediments, chiefly fluvial sandstones and associated vein deposits, the concentration of uranium varies widely, the high-grade portions constituting ore.

Genesis is important in deciding how rigorously to limit exploration to certain stratigraphic situations. Genetic processes can only be inferred, but if deposits in diverse situations are compared, then features held in common are likely to be critical and others incidental. Thus vein deposits in Saskatchewan and Australia have common structural, mineralogic, and stratigraphic features, but differ in their basement host rocks. Their mineral assemblages, lack of zoning, and association with fluvial sandstones are also common to the Colorado-