In Situ Recovery: Hydrologic Aspects of Producing a Deposit with a Fault System

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Prior to In-Situ Recovery (ISR) production from roll-front type uranium deposits, intensive site characterization occurs. ISR involves dissolution of uranium in groundwater often combined with complexing agents and oxidants. The pregnant solution is pumped to the surface where chemical processing recovers the uranium. ISR requires a deposit to be permeable to the injected solution and to have saturated conditions. As a result of these ISR characteristics, the site hydrology needs to be well understood for effective operations and environmental control.

Roll-front uranium deposits are commonly hosted in stacked sedimentary sequences of aquifers and aquitards. Understanding the sedimentological and stratigraphic controls of site hydrology is crucial and requires appropriately scaled site data. The potential for depositional structures at scales smaller than drill spacing, e.g. channels, requires consideration; such depositional structures where present may have macrodispersive effects on groundwater flow, as preferential pathways may affect wellsweep efficiency.

Structural data from core- and gamma-log correlations allow uranium geologists to identify displaced horizons. In some locations, roll-front deposits are cross-cut by, associated with, or located adjacent to fault systems. Fault characteristics, such as damage-zone thickness and variability, and presence of subsidiary structures such as fault splays, need to be defined. Such fault systems may produce variable hydrologic effects along strike and with depth related to the type of hydrologic boundary conditions the structure creates. This structural and fluid-flow information is highly pertinent to well-field design.

Site pump tests combined with hydrologic modeling can provide high quality information about the hydrologic character of a fault system. Transmissivity and “effective transmissivity” values obtained from longer term pump tests on either side of a fault are likely to vary spatially, potentially by orders of magnitude; Storativity values may also be affected. Static water levels are used to contour hydraulic gradients, and horizontal and vertical hydraulic gradients are calculated. The change in hydraulic gradient with depth will indicate the potential for vertical flow up or down, which would result in discharging up from host aquifers or recharging down to deeper aquifers, should aquitard discontinuities exist.

Fault systems may behave as barriers, conduits or as a combination of both, temporally and spatially. Where a fault acts as a barrier to groundwater flow along part of its length, groundwater elevation contrasts across the structure may exist. Conduit fault systems may be characterized by fracture flow. Consideration of regional groundwater flow and vector trends will illuminate the extent to which a fault system is exerting local hydrogeologic influence.