Fluid flow perspective of a fault system within Lost Creek uranium roll front deposit, Wyoming

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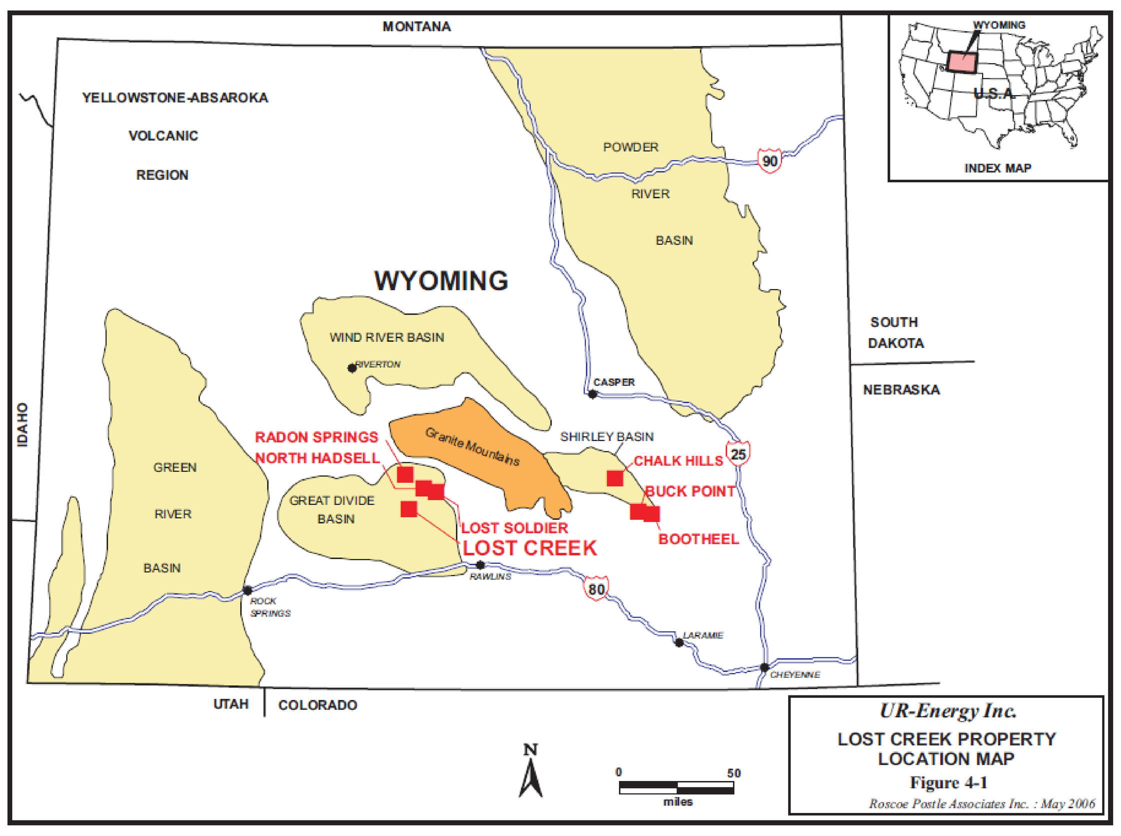


Figure 1: Lost Creek deposit location map (Petrotek, 2009).

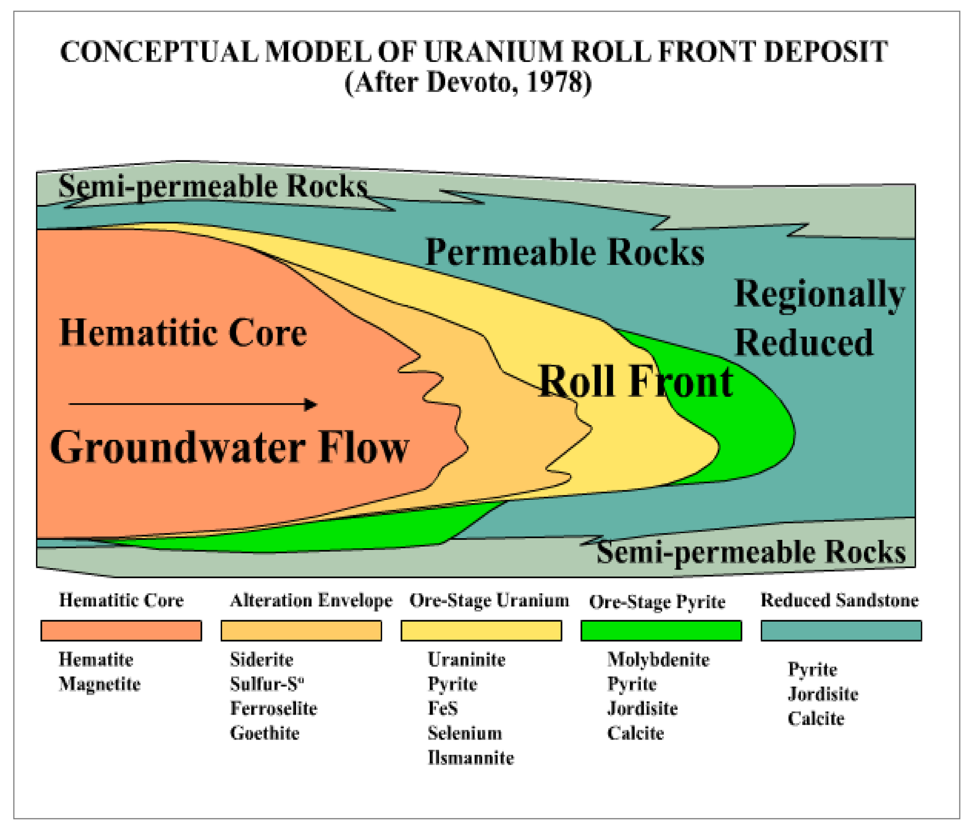


Figure 2: Conceptual Model of a uranium roll front (Wyoming Mining Association, 2008 (after De Voto, 1978)).

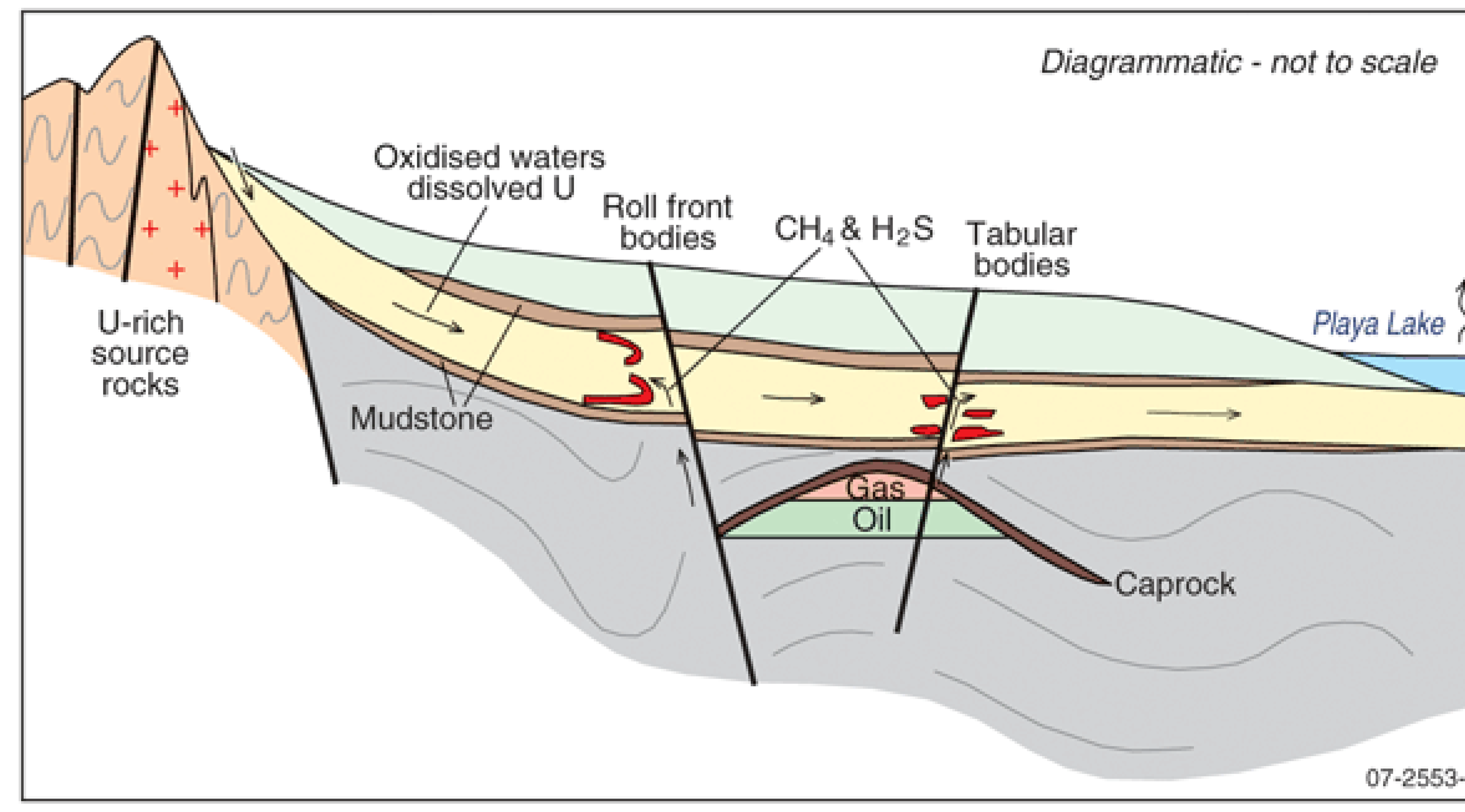


Figure 3: Two fluid system with structural control model of uranium roll front formation (Jaireth et al., 2008).

Introduction

The Lost Creek uranium roll front deposit is located in Sweetwater County, Wyoming (Figure 1). The deposit occurs in the lowest part of the asymmetric Great Divide Basin, at 6,500-7,500 feet above sea level, in a Laramide basin. The host sediments thicken to the northeast, and probably derive from the Granite Mountains (Pipiringos, 1955; Roehler, 1992). At the end of the Tertiary the region was uplifted to start the present cycle of erosion and minor normal faulting caused partial collapse of the Laramide uplifts (Keefer, 1970). Such normal faults near Lost Creek south of the Granite Mountains can be described as post-Oligocene or -Miocene, and are sometimes associated with local folding, (Love, 1960). This late tectonic activity produced variable subsidence and uplift, and the deposit host was tilted approximately 3° (Surdam et al., 1996). Lost Creek stratigraphy comprises arkosic sandstone uranium hosting aquifers, confined by laterally persistent mud- and claystones which have lower permeability from a combination of original depositional environment, compaction and diagenesis. Structure-related permeability reduction near the fault could exist from pore collapse, crushing, grinding and / or grain size reduction in addition to the possible smearing, growth, or plastic deformation of clays.

ABSTRACT

Uranium distribution patterns within the Lost Creek roll front system, Wyoming, indicate the interplay between facies and fault structures in controlling fluid flow in the development and preservation of the deposit. A 3-D geological model of the deposit was built using Petra integrating mineralogy and alteration, hydrofacies, and structural data; these data are used to consider a hierarchy of uranium controls in a roll front system at the deposit scale, in comparison to the present uranium distribution between both lithological units and across the fault. A possible genetic role of the trend-coincident normal fault system at Lost Creek was to 'pond' groundwater against the up hydraulic gradient side long enough to favour uranium deposition. A potential second role of the fault in ore genesis is through the steepening of local hydraulic gradients within the fault core and damage zone, and through fault-associated folding of the host aquifers. The fluid flow perspective of uranium mineralization trends gained at Lost Creek will be applicable to other deposits, through refinement of the roll front model defined by Fischer and Adler. The geological models of the deposit will assist In Situ Recovery (ISR) production at Lost Creek, and uranium exploration around the deposit and at other locations in the Great Divide Basin.

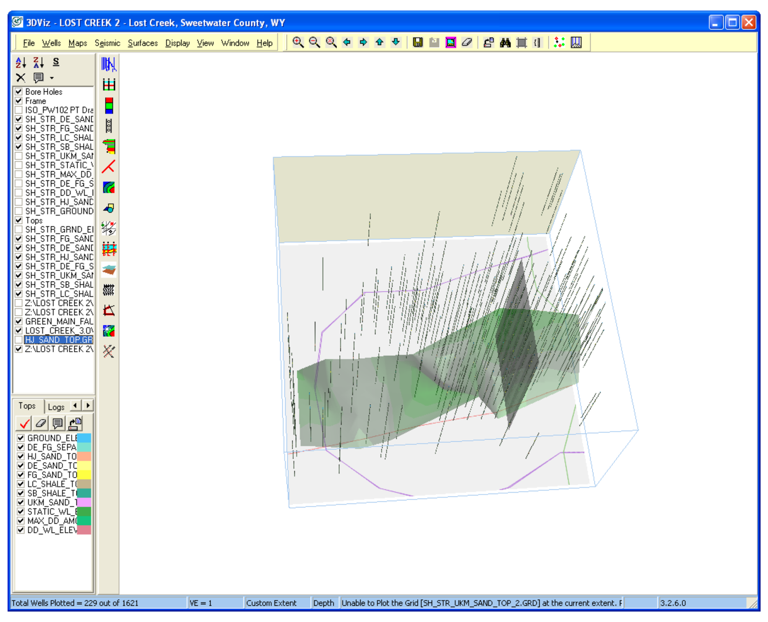


Figure 7: Producing a 3-D fault plane

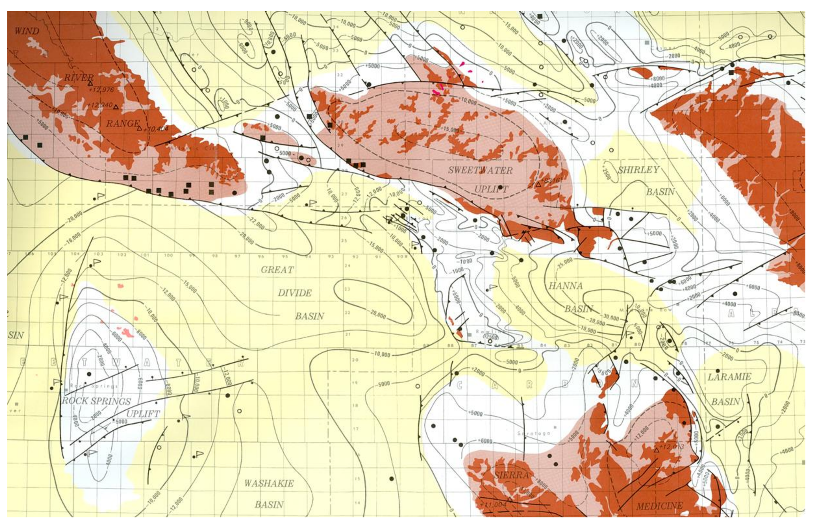
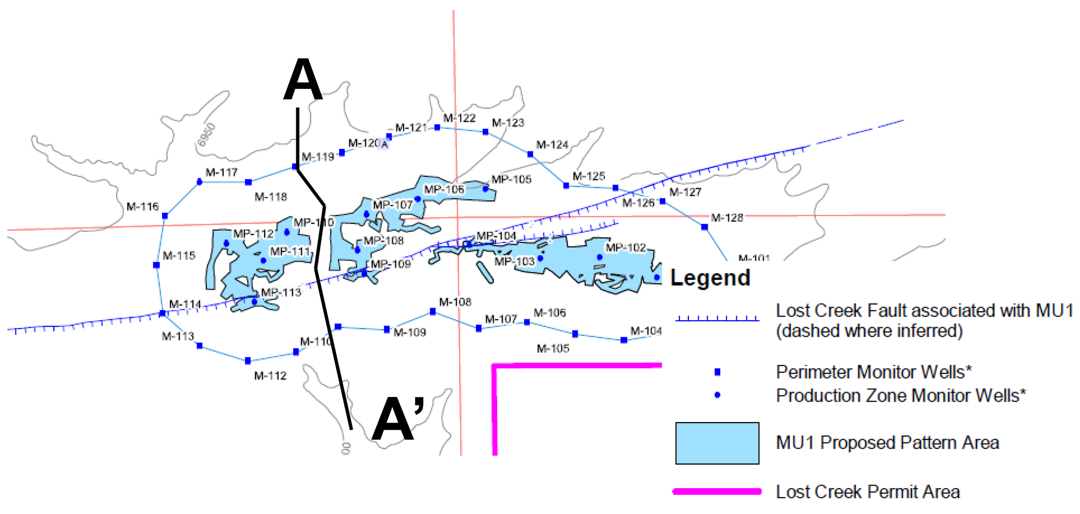


Figure 6: Structural Map of Wyoming (Blackstone, 1993)



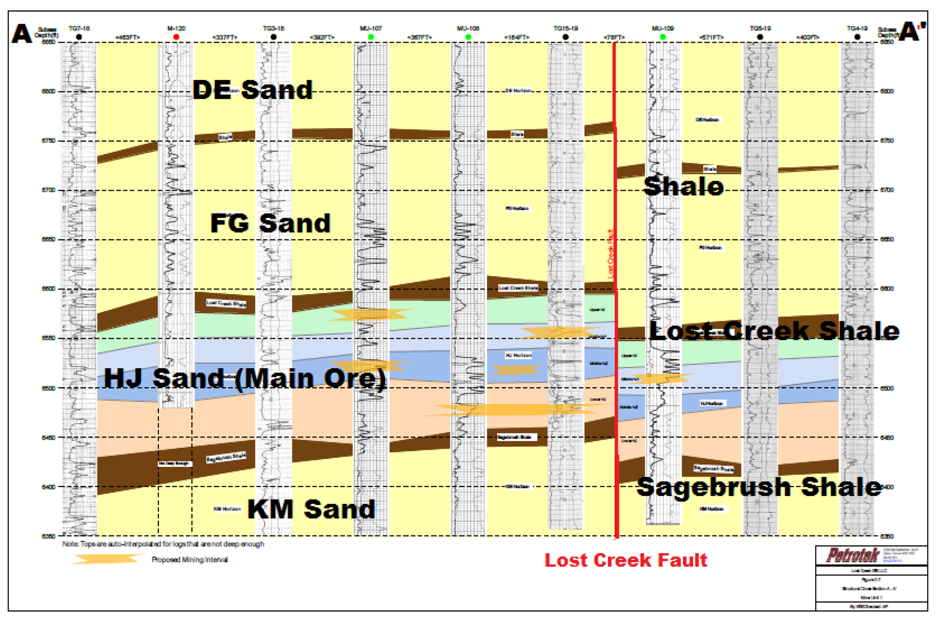


Figure 4a: Lost Creek map (Petrotek, 2009), Figure 4b: Generalized Cross Section A-A' (Petrotek, 2009), and, Figure 4c: Ore Grade Uranium distribution around the fault in a similar section to Figure 4b.

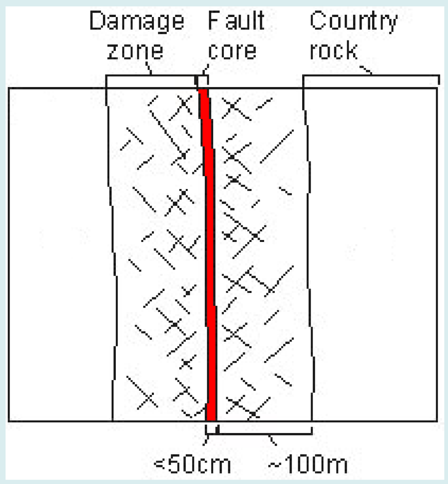


Figure 5: Structure of a fault with core and damage zone (Caine et al., 1996)

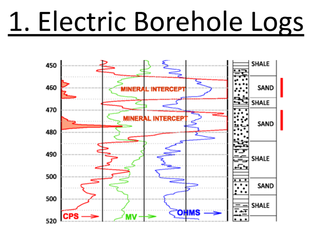
Methods

The Lost Creek deposit was modeled using Petra from geophysical log correlation. Stratigraphic offsets indicate the presence of faults, which is modeled in 3D for the first time. Four DC resistivity profiles were obtained perpendicular to the ore trend and are used to confirm the position of the fault.

Lost Creek deposit mineralogy and redox facies were described from core. Uranium chemical assay data from laboratory testing and field Prompt Fission Neutron (PFN) profile data form the basis of a model uranium grade distribution in 3D in Petra. A uranium distribution example is presented in cross section(Figure 4), with the majority of the uranium located on the up-hydraulic gradient side of the Lost Creek Fault within a few sandstone units, notably the HJ Sand (Figure 2).

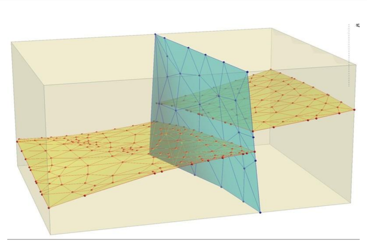
Work Flow :Hydrology of 3-D Fault

1. Electric Borehole Logs

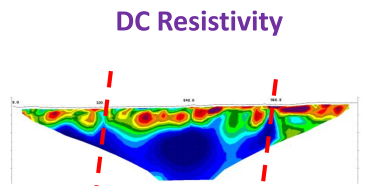


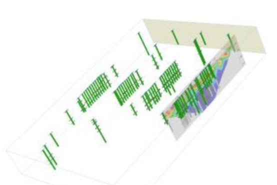
Gamma
Resistivity
SP
U3O8e

2. Construct Fault Planes



3. Integrate Stratigraphy, Geophysics & Fault Planes





4. Detailed hydrologic model

Discussion

There are many factors affecting immobilization of uranium including groundwater flux, which is influenced by both hydrofacies distribution, and the boundary conditions, which are locally modified by the presence of the Lost Creek Fault. The fault increases the local potentiometric gradient, which is reflected in both the direction and rate of regional groundwater flow.

Variable transmissivity is produced between units from varying thicknesses and permeability. The presence of the Lost Creek fault alters transmissivity by throw increasing the vertical anisotropy, and through fault damage producing differing properties. The throw on the Lost Creek Fault is a maximum of 60 feet. As a fault grows its properties evolve through time and space (Evans et al., 1997), and the Lost Creek fault could have been an early conduit and late barrier. The importance of a leaky fault is in fluid focusing and (as at Lost Creek) in clastic rocks the fault core is likely to be thin or discontinuous and therefore will partially inhibit fluid flow (Barnicoat et al., 2009).

CONCLUSION: Uses of 3-D Geology and Fault Model

Refine Lost Creek deposit model (structure, stratigraphy, mineralization and redox), **with detailed 3D fault system model** (Figs. 4, 7).

- ✓ **Test relative importance of structure and stratigraphy on uranium distribution at Lost Creek**
- ✓ **Hydrologic modeling reflecting stratigraphy and structure**
  - ✓ Calculate **effective transmissivity values spatially** of different stratigraphic horizons and along the fault trace using pump test results from both sides of the fault
  - ✓ Calculate **Fault Conductance** from fault geometry and thickness

References

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