Geologic Controls of In-Situ Processing of Tar Sands, N.W. Asphalt Ridge, Utah

The Laramie Energy Technology Center completed three in-situ oil-recovery experiments from tar sands at N.W. Asphalt Ridge, Utah. The 10-acre (4 ha.) tract is part of the Sohio Shale Oil Co. "D" tract located west of Vernal, in Uintah County. Asphalt Ridge, lying on the northern boundary of the Uinta basin, is a northwest-southeast-trending ridge. The area on the northwest is structurally a monocline dipping southwest. The 3.28 to 14.75 m thick experimental tar-sand zones are in the Rim Rock Sandstone Member of the Mesaverde Formation of Cretaceous age. The beds dip 28°SW, and overburden thicknesses range from 89 to 164 m. Two known faults, with throws up to 66 m, bound the tract.

Three experiments were performed at the tract on varying partial acreages from 1975 to 1980. Two combustion tests using reverse combustion and a combination reverse and forward combustion were completed in a tar-sand bed 3.28 to 3.93 m thick. Recovered oil and water for the experiments ranged from 65 to 580 bbl and 167 to 600 bbl, respectively. The third test used steam injection on a 14.75 m thick bed. Production was 1,150 bbl of oil and 6,250 bbl of water. Tar-sand analyses yielded the following range of data for the three tests: extracted porosity, 26.1 to 31.1%; absolute air permeability, 651 to 2,175 md; oil saturation, 62 to 75% pore volume; water saturation, 2.4 to 7.9% pore volume. Various geologic controls can determine the effectiveness of the extraction process. These include the dip of the beds, reservoir thickness, water and oil saturation, porosity, permeability, vertical and horizontal continuity of section, confinement of zone, and potential fractures and faulting in area.

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Early Cretaceous Depositional and Structural Development of Wyoming-Idaho-Utah Foreland Basin

Early Cretaceous deposition in the western Wyoming, eastern Idaho, and northeastern Utah region reflects the interplay of tectonic and eustatic controls during the early development of the thrust belt in this area. A major marine withdrawal at the close of the Jurassic was closely preceded by initial movement of the Paris-Willard thrust. Two subsequent pulses of eastward movement along this thrust occurred: a poorly dated event in Early Cretaceous time and a final movement during Late Cretaceous (Turonian). These periods of uplift on the western margin of the foreland basin are reflected by the eastward progradation of coarse fluvial clastic wedges into the Cretaceous seaway.

Between pulses of thrust movement, tectonic quiescence was coupled with a decrease of clastic influx into the subsiding basin. During periods of marine regression, broad marl-dominated lacustrine depositional systems developed in the foreland basin. In contrast, during transgressive periods, depositional environments were characterized by mixed fluvial and lacustrine systems bordered down paleoslope by extensive marsh-dominated systems. Basin subsidence, instigated by tectonic loading of the Paris-Willard thrust allochthon and further enhanced by sediment loading of the coarse clastic wedges, controlled the distribution of lacustrine systems during periods of marine regression.

The Paris-Willard thrust allochthon throughout the Early Cretaceous was dominated by upper Paleozoic strata. Subsequent to the final movement of the thrust, the allochthon was carried passively eastward and uplifted by ramping along steps of the more eastern Absaroka thrust. This uplift resulted in the exposure of upper Precambrian and lower Paleozoic strata which dominate the allochthon today.

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Geometry of Modern Anastomosed Channel Deposits and Potential Hydrocarbon Traps

The anastomosed fluvial model, interpreted from modern deposits in the upper Columbia River valley between Radium and Golden, British Columbia, consists of aggrading, multiple, low-gradient, low-sinuosity, thick, sand-filled channels laterally contained by levees, crevasse splays, and various wetland deposits. While active aggrading cross-valley alluvial fans controlled sedimentation in the upper Columbia valley, basin subsidence and/or regional tilting were controls for probable ancient anastomosed fluvial rocks, such as in the Cretaceous Western Interior molasse basin. The uniqueness of anastomosed fluvial style compared to that of meandering rivers is attributed to regional rapid aggradation, which subsequently favors anastomosed deposits for deep burial and preservation.

In the Columbia valley, the cross-valley profile of anastomosed channel deposits consists of vertically and laterally multiple stringers of channel sand, longitudinally interconnected at different stratigraphic levels. Individual channel cross sections consist of mud-contained, thick channel fills with multistoried textural cycles dominated by planar, tabular cross-bed structures. The upper ¼ to ⅓ of each channel fill consists of either mud or sandy point bar, contained laterally by mud resulting from waning river discharge.

Several different trapping processes may account for hydrocarbon accumulations in ancient anastomosed fluvial sandstones, based on core observations from modern deposits in the Columbia valley. The most common trap occurs in upper channel fill point-bar sands contained laterally and above by mud. A less common trap is a sand-filled channel segment plugged at both ends with a mud-filled master channel and capped with lacustrine mud. Two other traps result from differential compaction of mud versus sand: (1) deep scour holes at the downstream confluence of two channels allow the thicker sand-filled scour to form a domelike "compaction high" when capped with mud; and (2) a cross overlap of two stratigraphically different channels results in an anticline of the upper channel where it crosses over the lower channel.

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Anastomosed River Deposits—Modern and Ancient Examples in Western Canada

Depositional facies of two Canadian modern anastomosed river systems, the upper Columbia River and lower Saskatchewan River, occur in intermontane and plains settings, respectively. Both systems contain low-gradient, multiple, interconnected, laterally stable sand-bed channels, with adjacent splay, levee, and shallow wetland deposits, all aggrading in accordance with channel sedimentation. While aggrading cross-valley alluvial fans or subsidence tend to control sedimentation rates in intermontane valleys, basin subsidence and/or regional tilting controls deposition rates in plains settings.

Deposits in the upper Columbia River valley (120 × 1.5 km) consist of low-sinuosity multistoried stringers (textural cycles) with planar tabular cross-bed sets of channel sands and numerous sandy crevasse-splay deposits. Channel deposits are laterally contained by deposits of levee silt and lacustrine mud, and when buried are vertically mud encased. Aggrading at an average rate of 60 cm/100 years over the past 2,500 years, the anastomosed system is very dynamic, exhibiting many avulsions and channel