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Conference Reports

Canada Venezuela Oil Sands Symposium 77

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The 1977 Oil Sands Symposium covered a very wide range of oil sands related technologies which included geology, environmental studies, chemistry, hydrocarbon upgrading, in-situ extraction and numerical modelling. Geoscience related contributions to the symposium were limited to a large scale overview of the geology of oil sand deposits and studies in the areas of geochemistry and geotechnical engineering.

The multidisciplinary nature of the conference and the predominance of engineering and extraction papers may in part be explained by the growth of interest in oil sands as an alternate energy resource and the resultant shift in emphasis in research from cataloging the oil sands resource to finding new and better means of recovering and utilizing it.

Geology

Appropriately for the joint Canada-Venezuala sponsorship of the symposium, the leadoff papers included an excellent comparison of the geological settings of oil sands deposits in Alberta and Venezuela (as well as others in Russia).

The oil sands deposits of Alberta and Venuzuela are remarkably similar geologically speaking. Demaison reviewed the common attributes such as age (Cretaceous and younger), setting (foreland or intercontinental basin), distribution (updip on a gently-dipping, regional homocline), depositional environment (nearshore-deltaic) and overlying sediments (marine shales). The implication of the geological distribution of the Alberta and Orinoco oil sands is that hydrocarbons migrated updip out of the deep basin as a light phase carried by water. The light oil could then migrate into the permeable deltaic sediments and eventually be trapped by updip convergence and the impervious marine shale cap. The inferred mode of origin would allow light oil to be brought to a shallow depth where it could be degraded by biological activity and fresh water flushing to heavier oil or bitumen, a mode of formation heavily favoured by geochemical evidence.

In other papers James and Oliver described in some detail the deltaic depositional environments of the Athabasca oil sands while Gutierrez described details of the deltaic sediments of the Orinoco Petroleum Belt. Gutierrez also commented on the very different nature of the basement underlying the oil sands of Orinoco Petroleum Belt in comparison to the Alberta Oil Sands. The Orinoco Petroleum Belt is underlaid by several small but deep basins. Some of these basins reach 4000 metres in depth and contain Paleozoic sediments. The oil sands in Alberta for the most part, lie unconformably on Devonian carbonates whose surface was controlled by karst erosion and underlying salt solution.

The overall impression of these papers was to suggest that the great accumulation of bitumen in oil sands is not an isolated phenomenon but rather the result of repeatable geological processes.

Geochemistry

A unique geological concern in oil sands in-situ extraction technology is the interaction of oil sand and the injection fluid. At the temperatures and pressures of the deposit fluid-rock geochemical reactions occur at very slow rates. However in-situ techniques such as steam injection, fire flooding, or combination processes give rise to elevated temperatures and / or higher pressures and these conditions are possibly conducive to mobilizing minerals in the oil sands. This mechanism has the potential for changing oil sand permeability as well as altering the chemical composition of the groundwater. Attempts to separate those factors, such as bitumen, pH, temperature and salinity, which account for the changes in chemical composition of the formation fluids under conditions of steam injection were described in two papers by Hitchon and Boon. Boon specifically concentrated on the dissolution-precipitation of silica under conditions of steam injection of the Athabasca oil sands. At the increased temperatures the silica solubility was increased but the rates of solution lagged behind the solubility.

Bennion and co-workers undertook a study of mineral changes occuring during fire flooding of Athabasca oil sands. The degradation and ultimate destruction of illite and kaolinite were determined as a function of temperature. The purpose of research is to use clay mineral composition as an index of formation temperature during fire flooding for post burn analyses.

In general the papers on fluid-rock interactions were all preliminary in content and clearly this line of research has a long way to go.

Geotechnical Engineering

Moving from large-scale regional geology, papers were presented on those geotechnical properties of oil sands dependent on microstructure.

Natural exposures of oil sands can exhibit stable slope angles of up to 60°. How can the oil sands have high shear strengths and yet have no cementation or cohesion? Dusseault reported work on oil sand microstructure in which he found that the sands of the McMurray Formation were highly compacted and the sand grain fabric was interlocking. This structure was also found in McMurray sands having no bitumen saturations. The grain structure is highly resistent to shear and a prior condition for failure is the dilation of the grain matrix through a physical separation of the sand grains. This result indicates that the inherent strength of the oil sands is not a function of the bitumen but only of the mineral matrix.

The directly opposite question of what natural process overcomes this shear strength of oil sands was also addressed in the symposium by Harris. He presented the view of oil sands as being composed of four phases; sand, bitumen, water, and gas. Frequently gas is overlooked as a constituent of oil sands because it is largely dissolved in the bitumen. However, Harris points out that upon excavation and exposure of oil sand, with the consequent decrease in stress and increase in temperature, gas evolves from bitumen, forms discrete bubbles and increases the volume of oil sands. This gas evolution is the driving mechanism for dilation of the oil sand fabric and the reduction of oil sand shear strength.

These two papers explain a great deal about the visual observation of oil sand outcrops standing at very high slopes which react to exposure by surface slabbing rather than full face failure. The papers are also a good example of work offering an insight into the basic physical properties of oil sand and at the same time answering specific geotechnical engineering design problems.

Based upon the papers presented at the symposuim, one can make several observations on geosciences as they relate to oil sands. Like the whole field of oil sands technologies, geoscience has no major breakthrough to offer. However, there appears to be a steady growth and a pronounced broadening of knowledge into areas such as geochemistry and geotechnique which will be useful in developing new extraction and recovery technology.

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