Athabasca oilsands caprock integrity: a regional minimum principal stress model

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Summary

Caprock integrity is critical for successful thermal recovery processes in oilsands reservoirs. Knowledge of caprock integrity helps inform the design and operation of thermal projects, in order to minimize the risk of losing steam containment and consequent adverse impact on safety and the environment.

Caprock integrity depends both on the mechanical properties and the in-situ stress state of the caprock. In this paper, regional pore pressure data and fracture closure measurements from SAGD operations are synthesized into a simple model which explains the variation in minimum principal stress through the Cretaceous stratigraphy of the Athabasca oilsands area. At the shallow depths of the oilsands reservoirs and caprocks, the presence of an additional horizontal stress to what is predicted by the Eaton equation (1969) is a significant factor; consequently there is a change in the regional stress regime from horizontal to vertical fractures at a depth of approximately 150m. Regional borehole breakout azimuths suggest that the additional horizontal stress is of tectonic origin.

The modified Eaton equation provides a good regional estimate of minimum principal stress for the Athabasca oilsands reservoirs and caprocks using typical Poisson's ratios for sands and shales. Using the model, a regional map has been produced which highlights areas of low minimum principal stress where caprock integrity may be a significant risk for typical SAGD operations.

Reference

Eaton, B. A., 1969, Fracture gradient prediction and its application in oilfield operations. Journal of Petroleum Technology, v. 21, p. 1353–1360