

Caprock Integrity Determination at the Christina Lake Thermal Recovery Project, Alberta

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Abstract

The Cenovus-ConocoPhillips Christina Lake oilsands project uses steam-assisted gravity drainage (SAGD) to recover bitumen from the Lower Cretaceous McMurray Formation at depths between 300 and 400 m. The McMurray at Christina Lake consists of fluvial to estuarine sands and shales capped by marine shales and sands of the Wabiskaw member of the Clearwater Formation. The SAGD process involves injecting steam under pressure to melt the bitumen, which is then pumped to the surface. The reservoir pressure is expected to be contained by the caprock. In the event of a failure of the caprock to contain these pressures the steam and oil will escape to shallower units and possibly the surface. This is not a desired outcome.

Caprock core was taken in the B15 Leismer 15-10-76-6 well to determine the sealing characteristics of the Wabiskaw member at Christina Lake in order to prevent an uncontrolled steam escape. Petrography and mineralogic work indicates that the Wabiskaw consists of marine feldspathic litharenites and arkosic shale or argillaceous arkosic silts and muds with porosities from 3% to 34% and permeabilities between 0.047mD for muds and 429 mD for silts.

Caprock mini-frac tests at Christina Lake indicate a peak (fracture initiation) tensile strength of 13-14 MPa This is well above the operating pressure of 2.5 MPa and is above the average startup pressure of 4.5-5.0 MPa.

Rock mechanics tests indicate caprock compressional yield strength (the stress required to initiate plastic deformation; a conservative measure of failure) is between 9.2 and 14.2 MPa at in-situ pressures. This is well above reservoir operating and startup pressures.

Microseismic and surface heave monitoring support the conclusion that injection pressure does not exceed caprock strength.