

Clearwater Fm Caprock Integrity Assessment, Saleski, Alberta

Queena Chou*, Weatherford, Calgary, Alberta, Canada

queena.chou@ca.weatherford.com

and

Mark Rabin, OSUM Oil Sands Corp., Calgary, Alberta, Canada

A single vertical borehole in Osum's Saleski East project area in north-central Alberta was examined to evaluate caprock competency in preparation for a commercial development in the Grosmont Formation. In the study area, the Late Devonian carbonate bitumen reservoir of the Grosmont Formation is overlain unconformably by the Early Cretaceous Clearwater Formation which includes, at its base, the Wabiskaw Member. The Wabiskaw Member is the caprock for the proposed thermal development and the focus of this investigation. Comprised of shales interbedded with silty sandstones, the Wabiskaw Member forms two distinct strata that are correlatable over the study area and are interpreted to be parasequences of a prograding distal shoreface. The Wabiskaw Member is overlain by shale of the unnamed upper member of the Clearwater Formation and records an overall marine transgression.

The vertical study well 1AA/02-30-85-18W4 was drilled in 2011 and 31 meters of the caprock was cored and preserved to prevent desiccation. In addition to a standard suite of openhole well logs, resistivity image logs and full waveform sonic logs were acquired over the caprock interval. Nine shale samples were selected and prepared for testing; three were tested for shear strength, three were tested for unconfined compression, and three were tested for triaxial compression. In the direct shear test, at peak normal stress of 3.0 MPa, a peak strength of 2.7 MPa was achieved, and a 40° peak friction angle was calculated using the Mohr-Coulomb method. During the residual portion of the test, a 1.3 MPa residual strength was measured, and a 24° residual friction angle was calculated. Test results showed unconfined compressive strengths ranged from 0.8 to 1.8 MPa. Confining pressures at 0.5, 1.0, and 3.0 MPa were applied to the samples during destructive tests. At peak confining pressure, a peak strength of 26.6 MPa was achieved for the shale. From Mohr-Coulomb analyses of test results, peak strength friction angle was calculated to be at 55°, and residual strength friction angle was calculated to be at 36°. One whole diameter core section consisting of tight argillaceous siltstone was selected and four siltstone plugs were prepared from this single core section. Each plug sample was tested at a designated confining pressure. One sample was tested at zero confining pressure, i.e., an unconfined compression test, two samples were tested at 1.0 MPa, and one sample was tested at 2.5 MPa. Unconfined compressive strength for the siltstone was measured at 53.6 MPa. At maximum confining pressure of 2.5 MPa, peak strength was measured at 82.9 MPa. Mohr-Coulomb analysis using the results from the four tests in this siltstone lab program calculated an angle of internal friction of 58°.

Openhole well logs were used to estimate elastic and mechanical properties of the caprock. Static values of the rock property estimates were derived from calculated dynamic rock properties and the results are presented as a caprock property well log profile for this borehole. Processed resistivity borehole image log data from the caprock section was examined for fracture presence. Whole-diameter core recovered from the borehole was examined for fracture presence in congruence with the image log data. No fractures were observed in the caprock at this location on image log or in core. Measured rock properties show the shales and siltstones have the expected rock strengths for the Clearwater Formation at these depths. The Wabiskaw Member at this location has the geomechanical properties to be a viable caprock for Grosmont thermal development in the Saleski area.