Geological and Geomechanical Aspects of Caprock Integrity Assessment in Alberta for Thermal Recovery Projects

Pat McLellan*, Kevin Gillen, Chris Podetz, and Ulrich Zimmer
Advanced Geotechnology Inc, 1540, 521–3rd Ave SW, Calgary, AB T2P 3T3
mclellan@advgeotech.com

ABSTRACT

An integrated geological-geomechanical methodology has been developed and applied by AGI to several caprock assessments in Alberta over the past decade. Questions of caprock integrity often arise in a variety of subsurface injection processes, including: cyclic steam stimulation (CSS) and steam-assisted gravity drainage (SAGD); produced water disposal at or near the fracture pressure; gas storage operations; produced sand and fines disposal; acid gas disposal, and CO_2 sequestration.

This poster will illustrate examples of core and borehole image log studies used to characterize natural fractures and bedding in a variety of shales and mudrocks in Alberta. Stochastic network modeling of natural fractures and other discontinuities has been used to investigate potential flow pathways from underlying injection or disposal intervals. Principal in-situ stress magnitudes and orientations have been analyzed for many settings using logs and dedicated well tests. High horizontal stresses at shallow depths of typically less than 300 m in parts of northeastern Alberta are an important control on the orientation and growth of induced hydraulic fractures during injection operations. Geomechanical rock properties are derived from specialized laboratory tests, full-wave sonic logs, and correlations developed with AGI's ROCKSBank database.

Examples will be shown of analytical and numerical approaches to determining the propensity for slippage on a set of natural fractures, pre-sheared bedding or fault reactivation in a caprock. Coupled reservoir-geomechanical simulations to predict deformations in caprocks and overlying strata associated with heave during SAGD will be illustrated. Stress changes in an oil sands reservoir and flow pathways developed in fractured rock with changing stress conditions have also been modeled and will be described on the poster.

In-situ and surface monitoring techniques, including microseismic sensors and tiltmeters, have been used for tracking movements in many injection operations. Examples of these techniques will also be described and compared.