

Laboratory Investigation of the Mechanical Properties of the Bakken Formation

Christopher D. Hawkes, Donna L. Beneteau, Luis Buatois
University of Saskatchewan

Summary

This paper presents the results of research project pertaining to the mechanical properties of the Bakken Formation in southeast Saskatchewan. The project's main objective was to measure mechanical properties on Bakken Formation core samples, and to investigate the relationships between mechanical properties and geological attributes. The project investigated both reservoir and caprock samples, so as to advance our understanding of vertical height growth of hydraulic fractures.

Core samples were taken from the lower, middle and upper members of the Bakken Formation from two wells: Hodgen Midale 31/13-03-007-11W2/0 [18 sample depths]; and Innova Freestone 11/16-28-008-07W2/0 [8 sample depths]. At most sampling depths, both full-diameter samples were taken (which were later drilled down to 50.7 mm diameter sub-samples for tensile strength [41] and fracture toughness [12] tests), and 24.8 mm plugs were drilled for unconfined compression tests [18 completed]. Testing also included permeability and porosity measurement of selected samples, and compressional and shear wave acoustic velocity measurements on all samples. Wireline geophysical logs for these two wells were also analyzed to provide context for the laboratory testing.

The shales of the upper and lower members of the Bakken Formation tend to have mechanical properties that differ notably from the middle member. Most importantly, in terms of properties affecting fracture height growth, both the tensile strength and fracture toughness of the shales are consistently lower than the values measured on adjacent strata present in the middle member. These results suggest that out-of-zone height growth would not be mitigated by the shales. The implications of dynamic elastic properties on fracture height growth, however, are less clear. Published microseismic monitoring data available for a three-stage hydraulic fracture treatment of the Bakken Formation strongly suggest that the shales of the upper and lower members are not effective barriers against vertical height growth.

Recommendations are provided for future laboratory and field-based analyses which should be undertaken to further our understanding of hydraulic fracturing in the Bakken Formation in southeastern Saskatchewan.