
Horizontal Drilling in the Bakken: Boom or Bust?

To determine the economic applicability of horizontal drilling technology to the Bakken, a detailed study of both vertical and horizontal Bakken completions in the heart of the Bakken horizontal play (Golden Valley, Billings and McKenzie Counties) was initiated in early 1989. This study reviewed in detail the reserves associated with Bakken completions and especially the effect of stimulation on oil reserves to be found in the Bakken. Particular attention was paid to horizontal well bore length and direction to determine their effect on IP and estimated ultimate reserves. Significant cases of interference between recent horizontal completions and existing vertical wells were investigated and some very interesting observations made.

Against this study of Bakken reserves and reserve timing was thrown a detailed investigation of horizontal drilling theory and mechanics especially currently observed practices and costs and expected costs with experience. Finally, interpretation of observed and expected well economics are presented showing what the key economic parameters are in this play and what they may be in other types of reservoirs.

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Reservoir Properties of the Bakken Shale

Three dominant fracture types occur within the Bakken Formation: structural related tectonic fractures, stress related regional fractures and expulsion fractures associated with overpressuring due to hydrocarbon generation. The expulsion fractures are found throughout the basin on a macro and micro scale.

Lithology differences within the shale control the degree and type of fracturing. Composition of the shale consists of quartz, feldspar, dolomite, pyrite, clay and minor calcite. The greatest degree of variation of composition is noted in the quartz and clay content. An influx of the quartz and feldspar content is associated with the higher clay content as opposed to the higher quartz and feldspar rocks, which have lower organic content. As expected, expulsion fractures are closely associated with higher clay content. These lithology changes can be tied into neutron density log responses.

Because the expulsion fractures are closely associated with the generation of hydrocarbon, they are immediately filled with oil when created. Cementation or the creation of druse surfaces is not possible. However, one theory suggests that the acids associated with thermal maturation of hydrocarbons are present and are capable of dissolving silicate and carbonate minerals. This process produces a micro porous surface identified only by SEM, and is useful in distinguishing true from induced fracturing.
Micro porosity and the kerogen network could contribute to the reservoir. The micro porosity is accessed by the micro fractures. A previous published paper suggests that oil can easily (but slowly) flow through the kerogen network.