EVALUATION of the Debolt formation of N.E. British Columbia

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Husky Oil recently undertook an extensive study of Foothills gas reservoirs of the Mississippian Debolt Formation in the Sikanni/Grassy area of N.E. B.C. The reservoirs are dolomitized, heavily fracturedand have low average porosity. This study was initiated to resolve a difference between material balance reserve estimates and the volumetric reserves calculated from log analysis. Refinement of the petrophysical evaluation was achieved by utilizing data from special core analysis and from the study of drill cuttings from these wells and similar data from the surrounding area. Five wells were chosen for special core analysis. The measurements were made at ambient and reservoir conditions. These reservoir conditions included irreducible brine saturation, temperature and net over burden pressure. Porosity measured at ambient conditions remained effectively unchanged at reservoir conditions, while permeability values were dramatically reduced by a factor of 10 to 1000. Values of m and n, of Archie's equation, were derived and yielded an average n of 0.94 and m of 1.47. Capillary pressure data, obtained with saturated brine, showed that the gas/water transition zone averaged 150 metres in height and 52% water saturation. Furthermore, irreducible water saturation ranged between 25% and 30% for reservoirs with 1-5% porosity. This data was then compared to a more extensive capillary pressure database which includes the Debolt, Pardonet/Baldonnel and Nahanni/Arnica formations. Petrographic studies showed that porosity in the Debolt Formation is associated with the presence of fractured dolomite and is comprised of intercrystalline and moldic type porosity. Limestone sections are mostly tight but also locally fractured.

The insights gained from this study were then used to refine the petrophysical analysis in the a-63-H/94-G-3 well. A net pay of 40 metres, with an average porosity of 3.5% and an average water saturation of 27%, would yield a volumetric reserve that best fits the material balance reserve estimate.

The original analysis of the a-63-H well was generated using a deterministic, crossplot driven method which yielded 82 metres of net pay, using a 2% porosity cutoff. A net pay of 38 metres was achieved by applying a volume of dolomite cutoff. This cutoff was justified since the petrographic studies showed that the reservoir was associated with the dolomitized matrix. Following this a more comprehensive analysis technique was applied. This technique uses an inverse matrix type solution, which simultaneously solves for the mineral volumes and pore space fluids, and gives a more accurate matrix corrected effectiveporosity. A net pay of 39 metres and an average porosity of 3.4% was obtained with this technique.

Water saturation was calculated using a variable m technique, which compares the flushed zone water saturation, from an EPT measurement, to that calculated from the MSFL. This variable m technique resulted in a more desirable average water saturation of 27.5%. The saturation exponent n was set to 2 because of the questionable nature of the core analysis. Core measurements of n are generally less accurate than measurements of m, since n is dependent on fluid properties and reservoir conditions which can be difficult to simulate.

The correlation between images obtained from the Formation Micro Scanner and the evaluation log, were excellent. Pervasively fractured intervals had m values less than 2, while zones with vugs had m values greater than 2.

In conclusion, special core analysis combined with petrographic studies, improved the petrophysical interpretation by providing calibration points and helping in the selection of the appropriate lithology and porosity cutoffs. In addition, this study clearly highlights the advantages of utilizing the variable m interpretation technique.

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