

Steam Chamber Development, Residual Oil Saturation, and Drainage Patterns Associated with Mudstone Beds at Christina Lake.

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The Christina Lake Steam Assisted Gravity Drainage (SAGD) project has been in operation since 2002. Steam chamber development has been monitored by the collection of data from a number of observation wells drilled within the associated pad. This data has been incorporated with 4D Seismic and evaluated to understand the heterogeneity of the reservoir and its effect on steam chamber development. This information and its interpretation play a significant role in effective reservoir management and in understanding reservoir performance, including production history matches and reservoir simulations.

In 2010, after 8 years in operation, two steam chamber cores were cut adjacent to two existing cored observation wells (10 meters away) over the A01 Pad. Core quality was very good, and various analyses have been done on both sets of core. The oil saturation from the Pre-Steam core and the residual oil saturation from the Post-Steam core have been compared and contrasted to evaluate the effect of mudstone barriers within the steam chamber and the IHS (Inclined Heterolithic Stratification) interval above the steam chamber.

In 2011, after 5 years of operation, two steam chamber cores were cut adjacent to two existing observation wells (10 meters away) over the B01 and B02 Pads. These steam chamber cores differ from the 2 drilled in 2010 as they do not have IHS bedding and have a relatively clean sand facies throughout the SAGD pay zone.

The data collected at Christina Lake has shown that the steam chamber has never developed into the IHS interval; however, results from the steam chamber core show that conductive heating has allowed oil to drain from up to 12 m into this interval. Cenovus has also observed a “shadow effect” in the cores, both in the steam chamber interval and in the IHS interval. The shadow effect is characterized by low residual oil saturation below mudstone baffles and higher residual oil saturations above. This suggests that oil has been drained laterally along the slope of the mudstone beds. Other SAGD projects in industry have suggested the potential for inducing fractures in mudbeds due to the heat and pressure changes associated with steam chamber development; however, the Post-Steam core shows no vertical fracturing in the mudstone beds at Christina Lake. Core analyses from well developed portions of the steam chambers show residual oil saturations as low as 10%, resulting in a 87% recovery factor within the steam chamber.