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CRACKING THE CRETACEOUS CODE

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Fluid distribution and frac efficiency in deltaic sandstones of the Dunvegan in the Kaybob area

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ABSTRACT

Fluid distribution in low permeability reservoirs has in many cases shown unusual distributions, especially in relation to coeval higher permeability reservoirs. While permeability affects migration of the different fluids and hydrocarbon charge, several cases in migrated continuous petroleum systems unexpectedly shown higher liquid content in the lower permeability than the higher permeability reservoirs.

The Kaybob South Pool is a legacy gas pool developed with vertical wells producing from lowstand deltaic sandstones of the Cretaceous Dunvegan Formation. In the last decade, multistage fracked horizontal wells have been targeting a light oil play in the prodelta sandstones on the southern edge of the legacy pool. The boundary between the oil and gas producing areas intersect structural contours a high angle within. To address controls on this boundary, a multidisciplinary study of cores, core analysis data, well logs was completed and integrated with test and production data to identify controls on fluid production.

The thick deltaic sandstones in the central part of the South Kaybob Dunvegan Pool have permeabilities of 10 to 100mD, with the wells producing several to 10's of BCF of gas. Surprisingly, the wells produce very low amounts of liquids, although core extracts show the presence of significant oil. Several vertical wells targeted the oil charged prodelta deposits, however with limited production. This likely reflects the significantly lower permeabilities of rarely exceeding 5mD in the finer grained prodelta sandstones. Further, interbedded mudstone beds inhibited vertical and later fluid flow. However, since 2012, oil horizontal wells have successfully targeted these prodelta reservoirs. although these HZ wells occur at similar structural elevation as the legacy vertical gas producers. However, these horizontal oil wells show significant variability in production, reflecting the heterogenous character of these deposits between the wave and fluvial dominated portions of the delt, likely affecting the fracture stimulation.

The fluid distribution with high gas saturation in the higher permeability delta sandstones, with immobile oil and water, and higher oil saturation in the lower permeability prodelta deposits, likely reflect stages of different hydrocarbon fluids migration. With continuing deeper burial of the source rock, likely Fish Scale Formation, an increase in gas generation followed the peak oil window. This led to late-stage migration of predominant gas that preferentially migrated within higher permeability strata and fractures and displaced earlier emplaced oil resulting in reservoirs with high GOR in the higher permeability sandstones. These counterintuitive observations with higher liquids production from lower reservoir quality can significantly improve the play economics and allow better prediction of fluid distribution in many plays, such as observed in several other tight sandstone plays such as in the Cardium, Montney, etc.