

## **Stratigraphic and Depositional Controls on Field Production. Challenges and Future Opportunities in the Borealis Field, Northern Alaska.**

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### **ABSTRACT**

The Borealis oil field produces from Kuparuk shoreface sands of early Cretaceous age. The field began production in 2001 and is anticipated to achieve a recovery factor of approximately 35%. The field is a waterflood development; water injection began in 2002 and miscible gas injection in 2004, into a combination of vertical and horizontal wells. Faulting is pervasive at Borealis. There are two main fault set trends; an older northwest to southeast and a younger trending north south. Production data demonstrates faults do not generally seal where there is sand on sand juxtaposition. The depositional stacking patterns of the shoreface sands have a significant impact on production and several techniques are being considered to maximize recovery. The Kuparuk C sands contain more than 95% of total field pay. Located in the Kuparuk Trough, the C sands were deposited immediately above the Lower Cretaceous Unconformity. Shoreface transgression and regression within the C sands impacted the spatial distribution of reservoir quality sands. There is a clear relationship between good reservoir quality, field segment recovery factor and wellbore injectivity. The good quality sections are focused in L pad and northern V pad where the thickest, proximal prograding sands within the C3 and C2 are found and recovery factors are up to 40%. The lower quality sections are located in northern L pad where the shoreface sands consist of distal deposits and in Z pad where the progradational C2 and C3 packages are not deposited and there is abundant Siderite cementation. Recovery factors can be as low as 10%. A recent multi-stage frac well in Kuparuk sands in the neighboring Aurora field (S-42A) has demonstrated excellent productivity from these poorer quality, uncemented distal sands, where permeabilities are 15-20mD. The depositional history has impacted the distribution of horizontal permeability by layer. High permeability is found in the shallowest portions of the reservoir in the C4 and Upper C3 and the deeper C1 interval. The high permeability contrasts have caused a significant amount of the lower quality C2 and Lower C3 sands in L pad and V pad to be poorly swept, as observed by recent logging in a 2015 well (L-01A). Developing these low permeability sands is technically and economically challenging and options for this are being considered. Post depositional Siderite cementation has dramatically reduced wellbore productivity in some southern V pad and northern Z pad wells. The distribution of Siderite cemented sands is highly uncertain and the nature and concentration can vary quite rapidly between wellbores. This leads to additional risk when drilling infill wells.