

Could 4D Petroleum System Modeling Have Predicted Failure of the Mukluk Wildcat Well, North Slope, Alaska?

Peters, Kenneth E.^{*1}; Schenk, Oliver²; Bird, Ken J.³; Magoon, Leslie B.³

(1) Schlumberger, Mill Valley, CA.

(2) Schlumberger, Aachen, Germany.

(3) USGS Emeritus, Menlo Park, CA.

Debate persists over the reasons for failure of the Mukluk wildcat well, offshore North Slope, Alaska. The Mukluk structure was estimated to contain 1.5 billion bbl of recoverable oil in a structural-stratigraphic trap at the time of drilling in 1979. Although subsurface imaging was uncertain due to difficulty in assessing seismic velocities, play fairway maps along the Barrow Arch and close proximity of the structure to the prolific Prudhoe Bay field contributed to the decision to drill. The well was an economic failure, although drill cuttings showed extensive oil stain in the target formation.

We created a three-dimensional (3D) petroleum system model through time (4D) to determine whether this new technology could have predicted the failure of the Mukluk well. Key features of the model include diachronous deposition of Brookian overburden from the southwest to the northeast across the North Slope, tilting of strata along the Barrow Arch due to episodes of uplift and burial, and mapped sandstone bodies deposited above the Lower Cretaceous Unconformity that served as thief zones for re-migrating petroleum. Our 4D petroleum system model shows that petroleum accumulated in a four-way closure, but spilled from the structure to the southeast through thin Kuparuk Sand layers toward the Kuparuk River field and to the northwest along the Orion High during Tertiary tilting. Loss of additional petroleum by leakage through the top seal may have occurred, but is not necessary to explain the failure. Our results emphasize that (1) play fairway maps are present-day snapshots that ignore the critical role played by the relative timing of petroleum system events and processes, and (2) dynamic basin and petroleum system modeling is a powerful tool that can be used to reduce exploration risk.