

Petroleum filling history of central Alaskan North Slope fields

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The petroleum filling history of the central Alaskan North Slope was reconstructed with burial history models that were calibrated with source rock and oil geochemistry in the area surrounding the Prudhoe Bay, Kuparuk, West Sak, Pt. McIntyre, Tarn, and Alpine Fields. Prudhoe Bay and Kuparuk are the two largest currently producing oil fields in the United States. Oil in the Prudhoe Bay Field is interpreted as a mixture co-sourced from three source rocks: Upper Triassic marine carbonate, shale, and phosphorite (Shublik Formation), Lower Cretaceous marine shale (HRZ Formation), and Lower Jurassic marine shale (Kingak Shale). The total expelled oil volume within the Prudhoe Bay Field fetch area of 4,000 square miles is modeled to be 168 billion barrels and consists of 59% Shublik, 28% HRZ, and 13% Kingak source rock contribution. The carbon isotopic composition, API gravity, and sulfur content of the Prudhoe Bay main field oil accumulation closely match the modeled oil composition in the Prudhoe Bay fetch area. The estimated 40 to 50 billion barrels of original oil in place in the Prudhoe Bay and West Sak Fields imply a Prudhoe Bay fetch area migration efficiency of 25 to 30%. Spillage of Prudhoe oil into the West Sak Field occurred during post-Eocene uplift and 1-2 degrees of eastward tilting that decreased the hydrocarbon column at Prudhoe Bay Field from 2400 to 1000 feet and created the structural trap at the Prudhoe Bay West End. The Prudhoe Bay main field tar mat formed when gas deasphalted the oil column in Tertiary time, and carbonates in the Carboniferous Lisburne Formation are interpreted as the source of most of the carbon dioxide in the Prudhoe Bay gas cap. Kuparuk Field oils were predominantly sourced from Shublik source rock. The HRZ Formation is interpreted as the primary source for Tarn Field oils and the Kingak Shale is interpreted as the primary source for Alpine Field oils. The West Sak Field accumulation is interpreted as a mixture of moderately biodegraded oil that spilled from the Prudhoe Bay Field and lightly biodegraded gas/condensate that leaked from the underlying Kuparuk Field.