

SRALLA, BRYAN, Hewitt Mineral Corporation, Ardmore, Oklahoma*

Present address XTO Energy, Inc. 810 Houston Street Fort Worth, Texas 76102

Structural Geometry, Kinematics, and Hydrocarbon Exploration Potential of Sapsuk Lake Anticline, Herendeen Bay Region, Alaska Peninsula

Abstract

A 20-mile long anticline located southwest of Herendeen Bay is cored by Upper Jurassic Naknek Formation. The axial trace of the anticline is oriented approximately N80°W, and is coincident with an unnamed valley that is informally referred to as "Doe". The backlimb of the anticline dips 5-10 degrees to the south. The forelimb dips 25-30 degrees northward into a major fault zone. This major fault (Herendeen Bay Fault) is interpreted to verge northward, dip 70 degrees, and accommodate right-lateral oblique reverse slip. Geometric analysis indicates that the fault is basement-involved, and propagates upward from depths of at least 20 miles. Backlimb thrusting is also noted, but is of a smaller magnitude. A second-order basement-involved antithetic backthrust may be exposed east of Canoe Bay, and accommodate significant slip. Herendeen Bay Fault separates the lowlands of the Bristol Bay basin to the north from the interior mountainous region of the Alaska Peninsula.

Sapsuk Lake anticline is doubly plunging. Upper Cretaceous Chignik Formation wraps around the west plunge-end. Dips in excess of 25 degrees were measured. The east plunge-end is complicated by an oblique-trending anticline/syncline pair extending parallel to Buck Valley. These second-order folds are cored by Upper Cretaceous Chignik and Hoodoo Formations. Very few faults crosscut Sapsuk Lake anticline. The structural style contrasts greatly with that observed to the east on the opposing side of Herendeen Bay along the highly-faulted Staniukovich Mountain anticline.

The Naknek Formation is pervasively jointed. The predominant regional set of joints trends N20°W. These are interpreted to have formed in response to a NNW-SSE oriented horizontal compressive stress field (σ_1). An orthogonal joint set is also evident. Joints in close proximity to Herendeen Bay Fault show varying orientations.

The subsurface geometry of Sapsuk Lake anticline was modeled utilizing parallel dip-domain projection of a closely-spaced grid of 2-D cross sections constrained by surface mapping. The resulting 3-D model reveals a fault-bounded structural closure covering over 60 square miles. Along the crest of the anticline, the top of the Upper Triassic Kamishak Formation is projected to occur at a subsea depth of -12,500 feet.

Petroleum exploration potential exists across the Herendeen Bay Region. Below the Quaternary cover, Sapsuk Lake anticline links up to the west with the Black Hills Uplift. This entire uplift extends offshore into the Bering Sea. Important data pertaining to the hydrocarbon system comes from the Amoco Cathedral River #1, drilled along the Black Hills Uplift. Several significant mudlog gas shows were recorded in the Middle Jurassic Kialagvik Formation at depths ranging from 10,000-12,000 feet. Gas flowed to the surface on three separate drill-stem tests run between 10,225-12,000 feet (Kialagvik Formation). Test rates were low; measuring to a maximum of 193 mcf/d. No formation water was recovered with these gas flows. Recorded pressures indicate a normally-pressured regime, indicative of conventional-type buoyancy-driven trapping. Although commercially viable reservoir rock was not found in this well, the hydrocarbon flows indicate a viable petroleum system with source, seal, and trap operating effectively. A calculated thermal maturity equivalent to $R_o=1.47$ was measured at a depth of 10,990 feet, indicating that source rocks are within the gas window at depths ranging from 10,000-16,000 feet.

The Cathedral River well was not drilled deep enough to test the Upper Triassic Kamishak Formation. Sample interpretation indicates that the well likely bottoms in the Lower Jurassic Bidarka Formation. Upon visual inspection, Haga and Mickey noted a shift from Type III to Type II oil-prone kerogen near the bottom of the well.

At Puale Bay, the Kamishak Formation is typified by thick, organic-rich calcareous shale and nodular limestone, and a basal zone of partially-dolomitized, fractured, biostromal carbonate.

Permian-Triassic carbonate rocks hold promise as a deep frontier exploration target for natural gas along the broad surface anticlines exposed in the Herendeen Bay/Black Hills region. Penetration of these targets will require drilling depths in excess of 15,000 feet.