south of upper Atoka sandstone on north limb beneath a regional detachment.

Combined shortening estimated by all the thrusts encountered in the Waveland Field is estimated to be between 53,000–66,000 ft. The thrust solely involving the upper Borum duplex zone has approximately 20,000 ft of net horizontal offset. No major imbricate thrusts offset the upper Atoka Formation immediately north of the Ranger Anticline. The transfer of the shortening at Ranger Anticline is interpreted to continue northward and laterally westward toward the Washburn Anticline (Fig. 1).

UPPER BORUM CORRELATION

In the Waveland Field, many wells have intersected the two productive upper Borum thrust sheets and encountered two complete upper Borum sections. Figures 6A and 6B are two stratigraphic cross sections of the upper Borum formation. The profiles are strike oriented for each thrust sheets. The profiles cover a two-mile horizontal distance. The two sections use the same wells but are split above and below by a major thrust. The sections are interpreted as unfaulted between the major thrusts in the shales at the base and top of the section. Each profile uses the top of the upper Borum as a datum. The closest spacing based on current drilling in the field is approximately 765 ft.

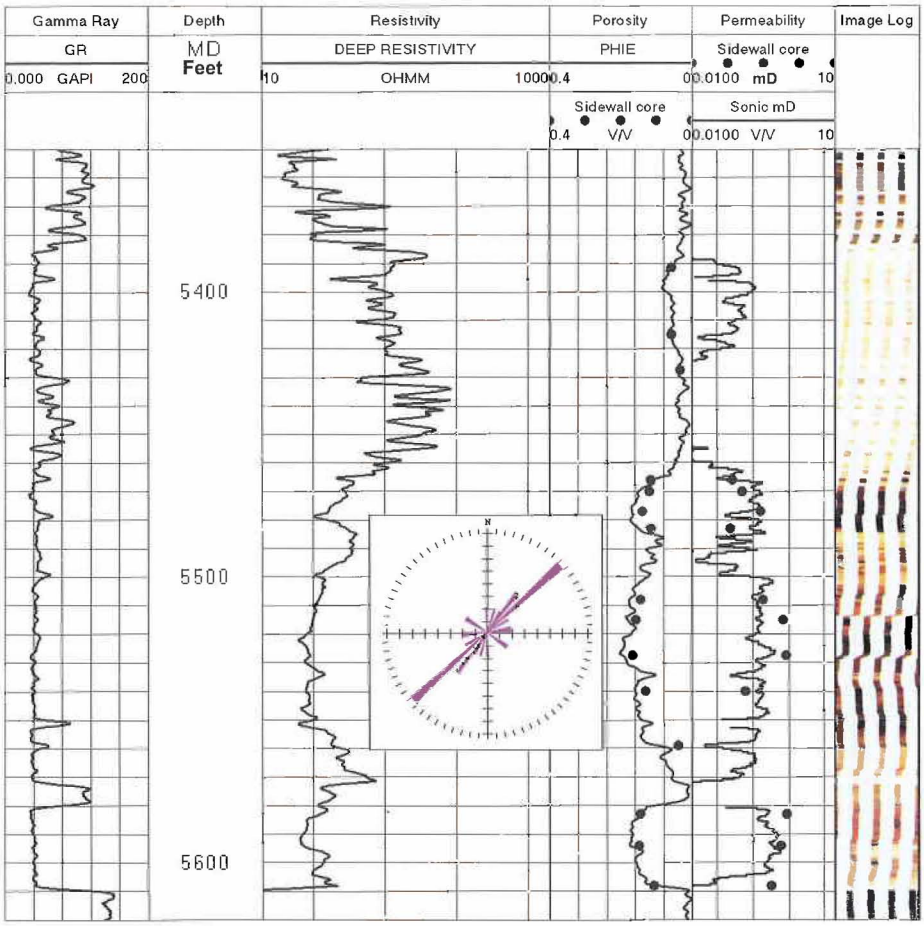

Figure 5. Type-log reservoir characteristics, Brasher #1–11 upper Borum A sand. Reservoir sands have a gamma ray value less than 70 API units. Sidewall-core porosity (solid circles) ranges from 3% to 17% (log porosity >8% shown by gray fill). Sidewall-core permeability (solid circles) ranges from <0.001 to 1.09 millidarcies. Dipole sonic (black line in Permeability track) shows estimated log permeability. Schlumberger oil-based mud images (OBMI) delineates 1–2 ft bed sets. Dark OBMI bands reflect lower resistivity and higher porosity zones, not shale. Fracture strike from the image log is represented in the Rose diagram as predominantly northeast–southwest. GAPI=gamma ray in American Petroleum Institute standard units, OHMM=ohm-meters, PHIE=calculated effective porosity V/V = decimal values, mD=millidarcies.

Gamma-ray interpolation is initially used to correlate the internal units of the upper Borum formation and identify the sand-prone units. This method maps the digital values of the gamma-ray log and extrapolates it toward the adjacent wells to distinguish clay content. Gamma-ray units less than 70 API units equate to sands. Shaly sands and silts are approximately 70–100 API units. Shales are more than 100 API units.

The initial interpolation of the upper Borum formation indicates the internal sands and shales expand or contract between the top and base. The base of the upper Borum is consistently the contact between clean Borum shale and the lowermost blocky upper Borum sandstones. The top of the upper Borum is at the peak of an upward-thinning gamma ray profile and the Turner formation shales.

Three internal parasequence units are defined in the upper Borum formation. From base to top, the sequences are the C, B and A sands. The parasequences are based on coherent packages of upward-thinning clastic sequences and overlying conformable shales. The parasequence units can be delineated into thinner units, but for practical hydrocarbon management, reservoir sands are defined as a coherent package in pressure communication. Matrix permeability of juxtaposed sand beds and vertical fractures link bedding across thin shales.