

**Deposition Environment, Mineralogy and Sequence Stratigraphy of the late
Devonian Sanish member (Upper Three Forks),
Williston Basin, North Dakota**

Brian Berwick, Samson Resources

Sixteen Late Devonian Upper Three Forks and Lower Bakken Shale cores were described in a selected area in North Dakota. Five lithofacies were identified in the Upper Three Forks and one lithofacies in the Lower Bakken Shale. Beds in the upper part of the Upper Three Forks Formation were informally named the Sanish member.

Locally, the base of the Upper Three Forks is red shale and siltstone that were deposited in continental sabkha environments (Facies A). In the study area, Facies B is commonly at the base of the Upper Three Forks and is dolomitic shale with rip up clasts created by very shallow marine reworking. The Sanish member consists of three facies. Facies C is highly deformed and brecciated silty dolomite that was deposited in tidal mud flat and sabkha environments. Facies D is silty dolomite, dolomitic siltstone, and shale that was deposited in tidal flat and sabkha environments. Locally, Facies E caps the Sanish member and is burrowed dolomitic and silty shale. Deposition was in shallow subtidal environments. The Lower Bakken shale unconformably caps the Sanish member and is black, organic-rich shale that was deposited in a water-stratified marine basin.

X-ray diffraction, scanning electron microscopy, and thin-sections analyses were performed on representative samples from all facies. In order of abundance, Sanish detrital mineralogy consists of quartz, potassium feldspar, illite, dolomite, muscovite, and biotite. Authigenic minerals include potassium feldspar, dolomite, chlorite, quartz, biotite, calcite, and pyrite. The clay-sized fraction contains potassium feldspar, dolomite, illite, and chlorite. The Sanish member has fair to poor porosity, and bedding plane and cross-cutting microfractures enhanced permeability.

Bathymetric shifts occurred during late Devonian and Early Mississippian time creating flooding at the base of the Upper Three Forks, periodic exposure of Facies C and D of the Sanish, local flooding at the top of the Sanish (Facies E), and finally transgression of the Lower Bakken Sea across the Sanish member.

Construction of a cross-section in the study area indicates that the top of Facies D and Facies E is at an angular unconformity. The top of the Sanish member was subaerially exposed and this surface was inundated by the Lower Bakken Sea. The unconformity and transgression clearly separated the Three Forks and Sanish depositional systems from the Lower Bakken system.