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RMAG Core Symposium: Upper and Middle Three Forks Formation, Williston Basin

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ABSTRACT

The Devonian Three Forks Formation contains at least two of the proven reservoir units within the Bakken Source System. These reservoirs are found below the lower source bed within the Bakken and are separated from the lowest source bed by the Pronghorn member. A variety of stratigraphic nomenclatures have been proposed, either formally or informally, for subdividing the Three Forks. Based on the recognition of regionally extensive erosional surfaces by Dumonceaux (1984) and Bottjer et al. (2011), the Three Forks Formation may be subdivided into an upper, middle, and lower member. The members to the Three Forks are each considered to represent a shoaling upward succession of shallow water deposits capped by paleosols.

The Three Forks lies conformably upon the Devonian Birdbear Formation. The contact is marked by a significant increase in the proportion of siliciclastics and a corresponding increase of the baseline on the gamma-ray log. Siliciclastics within the Three Forks consists primarily of silt to mud-sized quartz, clays (illite and chlorite) and varying amounts of feldspar. The sharp increase in siliciclastics suggests a significant influx of clastic material during Bakken and Three Forks time. The persistence of anhydrite through the lower member and in places middle member of the Three Forks suggests that hypersaline conditions moderated during the course of Three Forks deposition. Moving up-section, especially into the middle and upper members the amount of anhydrite decreases significantly in favor of silt to mud-sized dolomite.

The transition from anhydrite dominated sedimentation to dolostone dominated environments coincides closely with the top of the lower member. The top of the lower member is different from the sequence boundaries at the top of the middle and upper members in that there is frequently a half meter thick blanket of arkosic silt containing calcite that is associated with the unconformity.

This transition from evaporite to less evaporite settings coincides with a regionally extensive drop in PE values upsection. Presumably this is caused by the greater abundance of anhydrite in the lower member but it may also be caused by the addition of calcite to the mix. In any event, the top of the lower unit marks a significant change in lithology. Above the lower member dolomite is by far the dominant if not the only carbonate mineral present.

The middle and lower members of the Three Forks are capped by mudstones containing, subrounded to angular gravel-sized clasts floating in a massive mudstone matrix. Both of these tops are associated with pronounced gamma-ray signatures that extend across at least the Williston Basin of North Dakota.

There are several meter scale intervals within the upper two members that contain a repeating set of fabric patterns. Near the base, fabrics consist of massive dolomicrite sometimes with relict crossbedding. These textures are usually associated with contorted lenses and nodules of dolostone that may be pseudomorphic after anhydrite. Textures become less contorted, more planar and without lenses or nodules up-section. The capping interval consists of thin interbeds of massive green dolomicrite and laminated to finely cross-bedded tan dolostones . Flat pebble, intraformational conglomerates, ripples including climbing ripples, small scale hummocky crossstratification, fluid escape features and mud cracks are common. The progression of textures suggests that primary sediment structures within the lower portions of these assemblages episodically experienced liquefaction which disrupted and in some cases obliterated the original structures.

The top of the Three Forks is marked by a regional scale unconformity that is covered by onlapping and overstepping members of the Bakken Formation and along the edges, the Lodgepole Formation

REFERENCES

Bottjer, R.J., Sterling, R., Grau, A., and Peter Dea, 2011, Stratigraphic relationships and reservoir quality at the Three Forks-Bakken unconformity, Williston Basin, North Dakota, *in*, Robinson, J.W., LeFever, J.A., and S. B Gaswirth, eds., The Bakken-Three Forks Petroleum System in the Williston Basin: Rocky Mountain Association of Geologists, Denver, CO.

Dumonceaux, G.M., 1981, Stratigraphy and depositional environments of the Three Forks Formation (Upper Devonian), Williston Basin, North Dakota: University of North Dakota Master's Thesis, 202 p.

33-053-03358-0000
SWSE Sec. 22, T152N, R99W
Continental Resources, Inc.
#1-22H Charlotte
KB = 2352

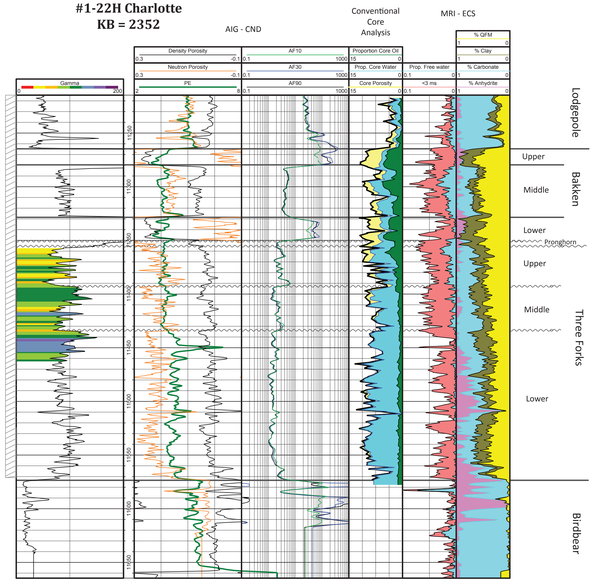
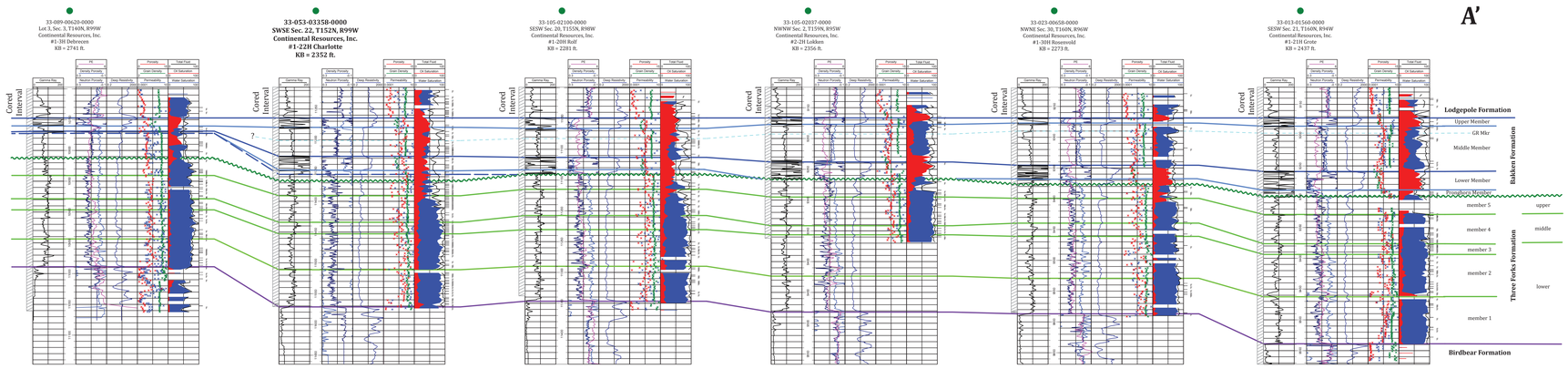
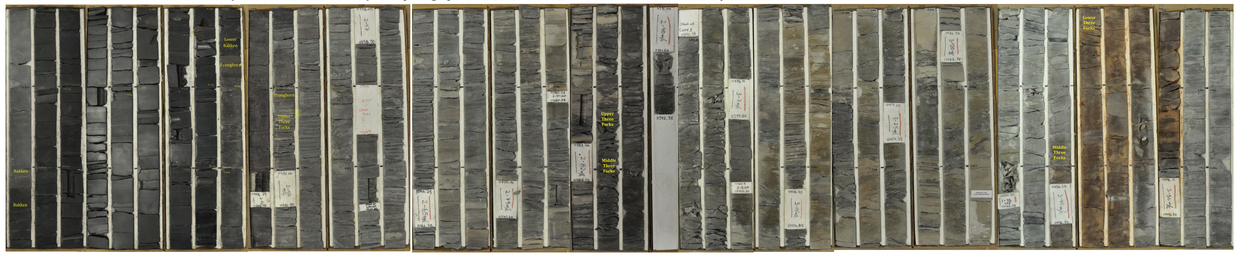


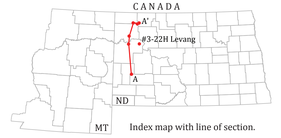
Figure 1

Core + 7 = Log



Continental Resources, Inc. - #1-22H Charlotte (SWSE Sec. 22, T152N, R99W) - Core photographs from 11319 to 11415 feet. Members are indicated in yellow text.





Index map with line of section.

A - A' - Cross-section from Stark to Burke counties showing core and fluid saturations. Provisional breakdowns are indicated on the right.

Figure 2 - Photograph of the core from the Continental Resources, Inc. - #1-22 Charlotte (SWSE Sec. 22, T152N, R99W) showing the current breakdown of the stratigraphy.

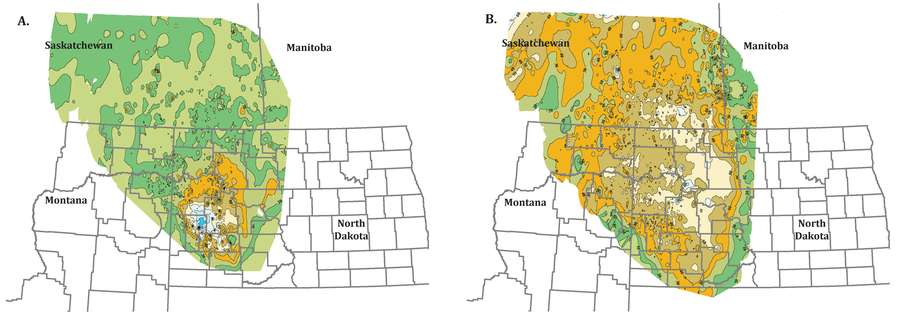


Figure 2 - A) Isopach map of the upper Three Forks. B) Isopach map of the middle Three Forks.

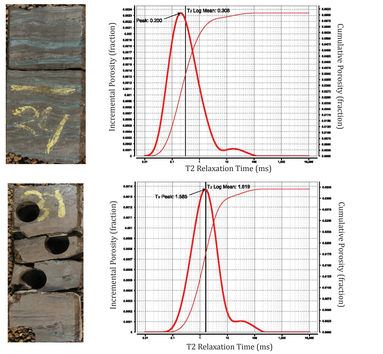


Figure 3 - Helis Oil & Gas Company - #3-22 Levang (NENW Sec. 22, T150N, R95W) - Core photographs and received NMR. T2 relaxation times suggests a difference in the distribution of fluid/pore sizes with facies association.

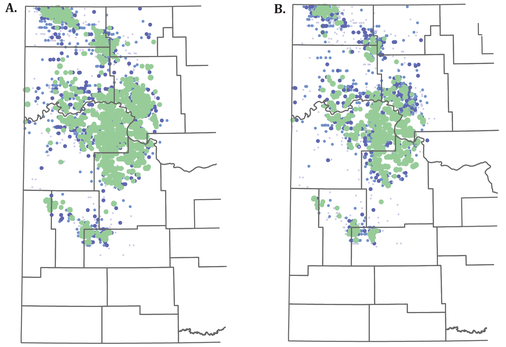


Figure 4 - Statewide production of the Three Forks Formation. A) Cumulative production. B) 12 -month production.