The Devonian Three Forks Formation: Manitoba’s Newest Oil Play

Michelle P.B. Nicolas
Manitoba Geological Survey
Manitoba Science, Technology, Energy and Mines
Winnipeg, Manitoba

Abstract
The Devonian Three Forks Formation is a significant source of hydrocarbons in the central part of the province of Manitoba. The formation is divided into four units, each with its own characteristics and reservoir potential.

Introduction
The Three Forks Formation is a cyclical transgressive-regressive formation that was deposited along a temperate, carbonate tidal flat that grades basinward towards an unrimmed carbonate platform. The formation is divided into four units, each with its own characteristics and reservoir potential.

Stratigraphy and Deposition
The Three Forks Formation is a cyclical transgressive-regressive formation that was deposited along a temperate, carbonate tidal flat that grades basinward towards an unrimmed carbonate platform. The formation is divided into four units, each with its own characteristics and reservoir potential.

Sedimentology
The Three Forks Formation consists of interlaminated siltstone, argillaceous dolomites and silty dolomitic shales with thick subunits of highly distorted and brecciated dolomitic siltstone. Unit 4 is subdivided into three subunits; from bottom to top they are named subunits 4a, 4b and 4c. Unit 4 is the primary and most productive reservoir at Sinclair Field and is a small isolated BEACH.

Porosity and Porosity Occlusion
Porosity development and occlusion occurred were early and late stage diagenetic alterations. A complex sequence occurred at early and middle stages of diagenesis. Porosity development and occlusion occurred were early and late stage diagenetic alterations. Mineralogical and physicochemical analysis using SEM, X-ray diffraction (XRD), and stable isotope techniques showed porosity development was controlled by a combination of early and late stage diagenetic alterations.

Techniques
Porosity development and occlusion were studied through the use of core samples and well-log data. Scanning electron microscopy (SEM) and X-ray diffraction (XRD) were used to study the mineralogy of the formation. Stable isotope techniques were used to study the isotopic composition of the formation.

Three Forks Exploration
Exploration of the Three Forks Formation in Manitoba has been combined with the Bakken Formation exploration. The two formations are often considered a continuous, commingled reservoir system. Exploration efforts should be targeted northward and eastward to exploit the potential of the formation. The primary reservoir (Unit 4) of the Three Forks Formation east and west of the SBZ margins, while secondary reservoir unit (Unit 2) was exposed as a plateau on the BWA. The preservation of Unit 4 in some wells east of the SBZ margin opens up the possibility that, in addition to scanning electron microscopy (SEM), X-ray diffraction (XRD), and stable isotope techniques. Karasinski (2006) and others have identified key components of the formation.

Conclusions
Development of Three Forks and Bakken plays has the potential to extend the life of the Sinclair Field and northern expansion of the Sinclair Field and northern expansion of exploration. The Three Forks Formation was influenced by transgressive and regressive cycles, periods of exposure, gravity flows (Karasinski, 2006), and basin tectonics.

References

Figure 1: Portraits: sequence of Three Forks and Middle Bakken diagenesis. (Karasinski, 2006)

Figure 2: Schematic diagram displaying the distribution of Three Forks facies along an extended carbonate platform and high-energy carbonate tidal flat. (Karasinski, 2006)

Figure 3: Stratigraphic Cross-section A-A'.

Figure 4: Structural map showing postulated fault lines.

Figure 5: Isopach and Structure Contour Map of the Three Forks Formation.

Figure 6: Tectonic map showing postulated fault lines.

Figure 7: Stratigraphic Cross-section A-A'.

Figure 8: Isopach and Structure Contour Map of the Three Forks Formation.

Figure 9: Three Forks exploration targets.
### Unit 1

**Unit 1 Characteristics**
- Interbedded dolomite, argillaceous dolomites and siltstones with shale interbeds.
- High-quality reservoir, good to excellent core quality.
- Poorly sorted, fine-grained dolomites.
- Shows evidence of bioturbation and localized bioturbation.
- Core recovery and exposure limited.

**Location and Exposure**
- Shale interbeds and relict structure at the subcrop edge.

**Oil Production**
- Producing with Middle Bakken.
- Reservoir is productive in the Eastern Province.
- **Average** K = 3.7 mD
- **Average** Ø = 12.8%

### Unit 2

**Unit 2 Characteristics**
- Interbedded siltstone, shales and claystones; massive and brecciated in places.
- Partially oxidized.
- Porosity decreases with depth.
- Isopach: 1-19 m
- Average: ~15 m

**Subcrop Edge**
- Roughly follows the eastern boundary of the BWA & SBZ.

**Oil Production**
- Commingled with Middle Bakken.
- Primary reservoir at Daly.
- Secondary reservoir at Sinclair.

### Unit 3

**Unit 3 Characteristics**
- Red-brown highly oxidized silty dolomitic shale.
- Rare reduced halos.
- Thinnest unit, averaging 3.5 m.
- Distribution follows Unit 4 closely.
- More section preserved in isolated wells in the east.
- Not a good reservoir, but productive when at unconformity at Sinclair.

### Unit 4

**Subunit 4b**
- 4-29-8-29W1
- Oil Production:
  - Primary, most productive reservoir unit of the Three Forks Formation.
  - Production commingled with Middle Bakken.
  - Primary reservoir at Sinclair, as well as minor production at Daly and Kirkella Fields.

**Subunit 4c**
- 2-8-8-29W1
- **Primary Reservoir Unit - Sinclair Field**
- **Secondary Reservoir - Sinclair Field**

**Unit 4 Distribution Map**

**Three Forks Formation Reference Log**

**Figure 4:** Core photos taken in white (left) and ultraviolet (right) light. Yellow fluorescence is oil, and blue fluorescence is anhydrite.

**Figure 3:** Three Forks Formation reference log with correlating core photos of subunits.