Summary of Recent North Slope Studies—Lower Cretaceous Southern Colville Basin
Introductory Comments:

This material was presented at a Department of Natural Resources Technical Review Meeting held in Anchorage on March 26th, 2008. This public gathering was aimed at creating a venue to formalize the rapid communication data and results from ongoing work by the Division of Geological & Geophysical Surveys (DGGS) and Division of Oil & Gas (DOG). Additionally, this meeting sought to stimulate discussion on the petroleum geology of northern Alaska.

The following presentation was created and delivered by Marwan Wartes (DGGS). The version included here is only slightly modified from the original; in the absence of a speaker, some slides have been annotated to improve clarity and any animations have been removed.

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Timing of Key Events

Known Oil Accumulations in Brookian Turbidites

Exploration Wells
- NPRA 2000-2002
- Other

Well Penetrations of Torok Formation
- Partial
- Complete
- Torok Core

USGS Seismic Grid

Torok Outcrop Belt

Oil-Stained Torok Outcrops

Courtesy of David Houseknecht
Timing of Key Events

- Deposition of Torok-Nanushuk: 110-94 Ma
- Generation of Liquid Hydrocarbons: 100-85 Ma
- Generation of Gas: 95-45 Ma
- Superposition of Younger Fold-Thrust Belt: 65-60 Ma
- Additional Structuring in FTB: 45-40 Ma
- Main phase of Brookian Shortening and subsidence ~140-95 Ma

Courtesy of David Houseknecht
2007 Program Focus

• Proximal Foreland Basin
2007 Program Focus

- **NORTHERN (East-central North Slope)**
  - Sedimentology and Sequence Stratigraphy of Upper Cretaceous and Tertiary Exposures in the Sagavanirktok River Area
  - Stratigraphy, Structural Geology, and Depositional Setting of Albian-Turonian Rocks in the Gilead Area

- **SOUTHERN (Proximal Foreland Basin)**
  - Reconstruction of the Lower Cretaceous Depositional System, Southern Colville Basin
  - Structural Evolution of the Brooks Range Foothills—Constraining Burial History and Timing in the Foothills Province

- **GENERAL**
  - Controls on Brookian Sandstone Reservoir Quality
  - Source Rock Quality and Hydrocarbon Occurrence
  - Geologic Mapping
Okpikruak Formation (Berriasian-Valanginian)

- Earliest record of Brookian orogenesis
- Probable upward transition into Fortress Mountain Formation
- Locally overlies Kingak Shale in Section Creek area
- Identified several new coquinoid limestone localities (key marker bed)
Fortress Mountain time

Okpikruak time

Courtesy of W. Wallace
Phosphatic-Manganiferous Shale (informal unit)

- Enigmatic early Brookian mudstone
- Probable record of change in basin polarity (sediment dispersal direction)
- Correlative to Beaufortian Pebble Shale unit (Barremian-Aptian(?))
Cobblestone Ss
(Barremian(?) – Aptian(?)

- Basal Fortress Mountain
- Amalgamated sediment gravity flows
- Unique petrology
- Probable correlative with “Kfmv” unit

Cobblestone Creek

Nanushuk River

Kfmv unit (Tiglukpuk Creek)
Fortress Mtn. Formation (Barremian(?) - early Albian)

- Facies Analysis
- Depositional Model
- Reservoir Quality

Wartes, 2008
Nanushuk Formation (middle Albian – Cenomanian)

Multi-year Study:
- Sedimentology
- Facies analysis
- Biostratigraphy
- Ichnology
- Sequence stratigraphy

LePain et al., in press
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Aptian(?)-Albian proximal topset facies (fan delta front)
Basinward dipping foresets
Relationship between the Fortress Mtn. and Nanushuk Formations
LePain et al. – Colville River
Nanushuk Fm. sedimentology and stratigraphy
Colville River, near confluence with Awuna River
Correlation into subsurface...
Correlation into subsurface...
Aupuk Gas Seep -- Colville River

- Composition:
  - 86.98% Methane
  - 1.20% Carbon dioxide
  - 11.77% Nitrogen
  - 0.05% Oxygen

- Thermogenic gas, condensate- or oil-associated origin

- Probable generation at oil window maturity

- Carbon and Deuterium methane isotopes:
  - $\delta^D$ $\delta^{13}C$
  - -195 -39.3

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Plot format after Schoell, 1983
Ikpikpuk 1:250,000 Quadrangle
(Mull et al., 2005)
Ikpikpuk 1:250,000 Quadrangle
(Mull et al., 2005)
Detailed Geologic Mapping (1:63,360 Scale)
Siksikpuk River Geologic Map (Peapples et al, 2007)
Sedimentology and Sequence Stratigraphy of the Lower Cretaceous Fortress Mountain and Torok Formations Exposed Along the Siskikup River, North-Central Alaska

By David W. Houseknecht, Christopher J. Schenk, and Marwan A. Wartes

Abstract

An exposure of the Lower Cretaceous Fortress Mountain and Torok Formations along the Siskikup River in north-central Alaska provides a rare opportunity to observe the stratigraphic contact between these two formations and to interpret the depositional facies and sequence stratigraphy of the exposure. The Fortress Mountain Formation at the base of the measured section includes braided-fluvial and continental-sediment deposits in a lowstand systems tract, and an overlying succession of mostly shallow marine deposits in the basal part of a transgressive systems tract. The overlying Torok Formation includes a thick, upward-deepening succession of marine-shelf marine and slope deposits dominated by tidal flats and estuarine channels, which extend up to the top of the section.

The Fortress Mountain Formation is characterized by well-developed terrestrial facies and is dominated by braided-fluvial deposits. The overlying Torok Formation includes a thick, upward-deepening succession of marine-fluvial deposits, and the transition between these two facies is a key feature of the stratigraphic record. The overlying Torok Formation is characterized by well-developed shallow marine deposits and is dominated by tidal flat and estuarine channel deposits.

The sequence stratigraphy of the area is characterized by an upward-deepening sequence of deposits, with the Torok Formation being the uppermost unit. The sequence stratigraphy is characterized by a progradation of continental deposits, followed by a transition to shallow marine deposits.

Introduction

The upper part of the section is characterized by a well-developed marine shelf and slope setting, which is dominated by tidal flat and estuarine channel deposits. The transition between these two facies is a key feature of the stratigraphic record. The sequence stratigraphy of the area is characterized by an upward-deepening sequence of deposits, with the Torok Formation being the uppermost unit. The sequence stratigraphy is characterized by a progradation of continental deposits, followed by a transition to shallow marine deposits.

Geologic Setting

The study area is located in the southern foothills of the Brooks Range, an area of mostly Lower Cretaceous foreland basin deposits deformed by northwest-southeast fault trends and folds. The section includes braided-fluvial deposits in a lowstand systems tract, and an overlying succession of mainly shallow marine deposits in the basal part of a transgressive systems tract. The overlying Torok Formation includes a thick, upward-deepening succession of marine-shelf marine and slope deposits dominated by tidal flats and estuarine channels, which extend up to the top of the section.

Lithofacies, Age, and Sequence Stratigraphy of the Carboniferous Lisburne Group in the Skimo Creek Area, Central Brooks Range

By Julie A. Dumeo, Michael T. Whalen, and Anita G. Harris

Abstract

The Lisburne Group, a mainly Carboniferous carbonate succession that is widely distributed across northern Alaska, contains notable amounts of oil and gas at Prudhoe Bay. Detailed studies of the Lisburne in the Skimo Creek area, central Brooks Range, delineate its lithofacies, age, and sedimentary environments, and sequence stratigraphy in the Skimo Creek section, which is 700 m thick, is composed largely of interbedded limestones and sandstones intercalated with intervals of thin- to thick-bedded bioclastic packstones and grainstones. Some of the units are partially or completely dolomitized and/or replaced by chert. A distinctive, 10-m-thick zone of black, organic-rich shale, lentic limestones, and phosphorite is exposed in 170 m below the top of the Lisburne. The sequence includes a transgressive systems tract characterized by a well-developed marine shelf and slope setting, which is dominated by tidal flat and estuarine channel deposits. The transition between these two facies is a key feature of the stratigraphic record. The sequence stratigraphy of the area is characterized by an upward-deepening sequence of deposits, with the Torok Formation being the uppermost unit. The sequence stratigraphy is characterized by a progradation of continental deposits, followed by a transition to shallow marine deposits.

Organic-rich calcareous shale in the shale and phosphorite unit is a cumulative thickness of at least 15 m and an interval of 500 m, which is indicative of the potential for hydrocarbon source rock in the Lisburne Group. The best potential reservoir facies is the Lisburne Group, which is characterized by a well-developed marine shelf and slope setting, dominated by tidal flat and estuarine channel deposits. The transition between these two facies is a key feature of the stratigraphic record. The sequence stratigraphy of the area is characterized by an upward-deepening sequence of deposits, with the Torok Formation being the uppermost unit. The sequence stratigraphy is characterized by a progradation of continental deposits, followed by a transition to shallow marine deposits.
Midnight sun on overturned Lisburne Group – view from Galbraith Lake