Meso-Cenozoic Evolution of the Chukchi Borderland - Constraints on the Tectonic Development of the Amerasia Basin, Arctic Ocean*

Ibrahim Ilhan¹ and Bernard J. Coakley¹

Search and Discovery Article #11056 (2018)**
Posted March 19, 2018

*Adapted from oral presentation given at 2017 AAPG Pacific Section Annual Meeting, Anchorage, Alaska, May 21-24, 2017
**Datapages © 2018 Serial rights given by author. For all other rights contact author directly.

¹University of Alaska, Geophysical Institute, Fairbanks, Alaska  (ilhan@alaska.edu)

Abstract

Any model for the tectonic development of the Amerasia Basin requires structures to accommodate the continental Chukchi Borderland in a plate-tectonic framework. We have interpreted 2D multi-channel seismic reflection profiles and tied these data to the late 1980's Crackerjack and Popcorn exploration wells in order to: (1) develop a tectono-stratigraphic framework for the Chukchi Shelf and Borderland, and (2) test existing models for the development of the Amerasia Basin.

Based on sequence stratigraphic principles, we have mapped four regional unconformities. These subdivide the basement and basin fill into tectono-stratigraphic sequences. These sequences are: (1) pre-Brookian deformed strata (Mesozoic–Paleozoic), (2) pre-Brookian Syn-rift #1 and Dipping Reflections, (3) Post-rift #1, inferred condensed section and lower Brookian orogenic sediments (Barremian–Pre-Cenozoic), (4) Syn-rift #2 (inferred Upper Cretaceous–Paleocene), (5) Post-rift #2, upper Brookian progradational wedge (Cenozoic), and (6) Glacio-marine (Quaternary). The angular relationship between the inferred Lower Cretaceous unconformity and the underlying Syn-rift #1 sequence along the north-striking normal faults of the Chukchi Plateau is inconsistent with clockwise rotation of the Borderland away from the East Siberia. This falsifies one popular model for the Borderland and its role in the development of the Amerasia Basin. The Dipping Reflections underlying the Lower Cretaceous unconformity are associated with volcanism that may be concurrent with east-west rifting of the Borderland. The recognition of condensed section and continuity of the overlying Cretaceous–Cenozoic orogenic sediments across the southern Borderland substantially constrains other models that require significant discontinuity between the Chukchi Shelf and Borderland since the earliest Cretaceous proposed for tectonic development of the Amerasia Basin, Arctic Ocean.
References Cited


Meso-Cenozoic evolution of the Chukchi Borderland | Constraints on the tectonic development of Amerasia Basin, Arctic Ocean

Ibrahim Ilhan and Bernard J. Coakley | ilhan@alaska.edu
University of Alaska Fairbanks, Department of Geosciences and Geophysical Institute

Acquisition of multi-channel seismic reflection profiles in 2011 by the R/V Marcus G. Langseth across the transition from the Chukchi Shelf to Borderland

Frontier Exploration in the Arctic Offshore, 2017 AAPG Pacific Section Annual Meeting
21-24 May, 2017 | Anchorage, Alaska
Wrangel–Herald Arch thrust front (Drachev et al., 2010 after Grantz et al., 2009)

Sediment transport directions (Houseknecht and Bird, 2011)

Stratigraphy of Chukchi Shelf
Sherwood et al. (2002)
Stratigraphy of Chukchi Shelf
Sherwood et al. (2002)

- Platform
  - 170° - 165° - 160°

- MBu
- CENOZOIC
- Upper Brookian
- Lower Brookian
- Cretaceous
- Jurassic
- Triassic
- Lower Paleozoic
- Upper Paleozoic
- basement

- Sediment transport directions (Houseknecht and Bird, 2011)

- Wrangel–Herald Arch thrust front (Drachev et al., 2010 after Grantz et al., 2009)

- Northern limit of Brooks Range frontal thrust belt (Paleogene)

Jakobsson et al. (2012)
Sub-division of the upper Brookian strata have been revised from biostratigraphic reports (Mickey and Haga, 2003; Bujak, personal comm.) Cenomanian unconformity (Cu; Craddock and Houseknecht, 2016)
Chukchi Abyssal Plain
Canada Basin
Arctic Platform
Chukchi Platform
180° 
175° 170° 
60° 
50° 
40° 
30° 
20° 
10 km (6.2 mi.) VE = -2.5
10 km (6.2 mi.) VE = -2.5
VE = -2.5
Wrangel–Herald Arch thrust front (Drachev et al., 2010 after Grantz et al., 2009)

Sediment transport directions (Houseknecht and Bird, 2011)
Exploration Wells

- Crackerjack
- Popcorn

Upper Cretaceous
- Sagavanirktok Fm.

Torok Fm., Nanushuk Fm. (Aptian-Albian)

Wrangel-Herald Arch thrust front (Drachev et al., 2010 after Grantz et al., 2009)

Northern limit of Brooks Range frontal thrust belt (Paleogene)

Sediment transport directions (Houseknecht and Bird, 2011)
Exploration Wells

North Chukchi Basin

Toll Basin

Chukchi Plateau

Northwind Basin

---

North Chukchi Basin

- Upper Cretaceous
- Nanushuk Fm.
- Torok Fm.

- Post-rift#7a
- Post-rift#7b
- Post-rift#7c

- Toll Basin
- Upper Cretaceous
- Nanushuk Fm.

- Pre-Brookian SDRs
- Pre-Brookian pre-rift/syn-rift#1

- Northwind Basin
- Glacio-marine

---

- Basement
- Upper Mantle
- Pre-Brookian SDRs
- Pre-Brookian pre-rift/syn-rift#1

- Post-rift#1a
- Post-rift#1b
- Post-rift#1c
- Syn-rift#2a-b
- Post-rift#2a-b
- Post-rift#2c
- Glacio-marine
Jurassic-Early Cretaceous

- Pre-Brookian pre-rift/syn-rift
- Pre-Brookian SDRs
- Basement
- Moho

- Wrangel-Herald Arch thrust front
- Chukchi Abyssal Plain
- Northwind Basin
- Canada Basin
Paleocene-Miocene

- Post-rift#2
- Syn-rift#2
- Post-rift#7

Pre-Brookian pre-rift/syn-rift#1
Pre-Brookian SDRs

Basement
Moho

Wrangel-Herald Arch thrust front
Northern limit of Brooks Range
Cretaceous frontal thrust belt (Paleogene)
Jurassic (195-140 Ma) counter-clockwise rotation of the Arctic Alaska-Chukotka microplate away from the Canadian Arctic Islands.

Grantz et al. (2011)
Pre-Valanginian (145.5-140 Ma) clockwise rotation of the Chukchi Borderland away from the East Siberian Shelf.
The total amount of rotation: 65–70 degrees (Halgadahl and Jarrard, 1987)

The age of the Kuparuk formation: Valanginain-Hauterivian (139-131 Ma) (Masterson and Eggert, 1992)

Grantz et al. (2011)
Conclusions

We argue the fixity of Chukchi Borderland relative to Chukchi Shelf for the following reasons:

- **inconsistency of timing** and **structural constraints** for the postulated pre-Valanginian clockwise rotation of the Borderland away from the East Siberian Shelf;
- **absence of substantial structural discontinuity** between the Chukchi Shelf and Borderland;
- **recognition of condensed section** and **continuity** of the Cretaceous - Cenozoic orogenic sediments.

These observations are consistent with fixity of the Borderland relative to Chukchi Shelf **since the earliest Cretaceous**. This new constrain on the relative position of the Borderland requires a new model for the development of the Amerasia Basin.