Paleo-Ballantyne Strait of the Sverdrup Basin - Late Paleozoic and Early Mesozoic Gateway to Alaska*

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Abstract

The Sverdrup Basin of Arctic Canada formed in Early Carboniferous and was an active area of subsidence and deposition until Late Eocene. Throughout the basin history, the main sediment source areas lay to the south and east and consisted primarily of Devonian clastic strata. From Carboniferous to Middle Jurassic, that is, before the opening of the oceanic Amerasia Basin, the Sverdrup Basin was flanked to the northwest by a land mass known as Crockerland. Facies relationships in the far northeastern portion of the basin, demonstrate that the Late Paleozoic -Mesozoic seaway continued northeastward between the two landmasses and linked up to the seaways in the Barents Sea region.

Before any well or seismic data were available, there was uncertainty regarding the continuation of the Late Paleozoic-Mesozoic seaway to the west past the present day Canadian Arctic Islands. The well and seismic data in the southwestern corner of the basin show that, from Carboniferous through early Middle Jurassic, the seaway did indeed continue to the west and that the basin axis in this area was oriented west-northwest. This axis now hits the current Arctic Ocean (Amerasia Basin) margin at right angles. Because this axis occurs within present day Ballantyne Strait, we have called the narrow seaway between the Paleozoic Fold Belt to the south and Crockerland to the north, Paleo-Ballantyne Strait.

The occurrence of this narrow seaway, which hits the Amerasia Basin at right angles, provides an important constraint on any proposed model for the opening of the Amerasia Basin. In any proposed reconstruction, a continuation of the seaway must be present on the crustal block that is placed adjacent to this portion of the Canadian Arctic margin. Notably, a very similar, narrow Late
Paleozoic to Mesozoic seaway called the Central Chukchi Basin is present west of northern Alaska. The axis of the Central Chukchi Basin also hits the Amerasia Basin at right angles. Restoration of northern Alaska and adjacent northeast Russia against the Canadian margin by clockwise rotation results in a perfect match of these two basin axes. It seems reasonable to conclude that the Amerasia Basin opened by counterclockwise rotation and that Paleo-Ballantyne Strait was the Gateway to Alaska. Given this, the geology of the southwestern Sverdrup Basin has much to offer those who are contemplating exploration in the Chukchi Basin.

References

Carey, S.W., 1958, The tectonic approach to continental drift, in S.W. Carey, (ed.) Continental Drift, A Symposium: Geology Department, University of Tasmania, Hobart, p. 177-356.


Website

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Geological Survey of Canada
Three Models for Opening Amerasia Basin
Carey’s 1958 Rotation Hypothesis for Arctic Ocean
Carey’s (1958) Closure of the Arctic Ocean
Pre-1980 Interpretation of Mesozoic paleogeography, northern Alaska. Brosge and Tailleur, 1969
Pre-1980 Interpretation of post-Devonian Basins, northern Alaska

Grantz et al., 1975
Tailleur and Brosge’s 1969 attempt to use facies relationships to support the rotation of Alaska
1980 Birth of the Paleo-Ballantyne Strait Concept
Discovering the Hanna Trough

Grantz et al, 1982
RESTORATION OF BASIN AXIS BY ROTATION
Matching Basin Axes, Grantz and May, 1990

270 km Strike Slip
Beware of model-driven interpretations. Careful review of data sources is necessary to ensure interpretations follow from data.

Larry Lane, 2007
Late Permian to Middle Jurassic Isopach
Sherwood et al, 2002
Geological Provinces
Canadian Arctic Islands
Middle Triassic Control Points and Isopach
Reflection seismic database
shotpoints clean and derived from horizontal field notes (brown area)
data are GIS enabled with ownership and other metadata
DB includes attribute indicating filename of seg-y or raster image
Reflection seismic database

RED – Re-processed data in SEG-Y

YELLOW – original stacked tapes reformatted to SEG-Y

GRAY – paper copy, microfiche or unavailable
Early Triassic Basin Axis

Early Jurassic Basin Axis

Early Triassic Basin Axis
HT Axis

PBS Axis

Base from Harland, 1984
Grantz and May, 1990
Erosional Edges on NE Flank of Hanna Trough
Erosional Edges southern flank Paleo-Ballantyne Strait
Alignment of Erosional Edges

Toro et al, 2004
Early Triassic Facies
Correlation of a well on eastern flank of Hanna Trough with a well on the southern flank of Paleo-Ballantyne Strait.
Paleomagnetic results from oriented cores in Valanginian Sandstones demonstrating that Northern Alaska has moved relative to NA
Paleomagnetic results from oriented cores in Valanginian Sandstones demonstrating that Northern Alaska has moved relative to NA.
“Smoking Gun” Evidence for Counterclockwise Rotation of Northern Alaska

1. Match of Sverdrup Basin (Paleo-Ballantyne Strait) and Hanna Trough Axes

2. Match of erosion edges of Carboniferous, Permian, Early Triassic and Early Jurassic

3. Match of Early Mesozoic facies belts

4. Match of Kuparuk paleomagnetic pole with NA pole
“Smoking Gun” Evidence for Counterclockwise Rotation of Northern Alaska

When two or more pieces of “smoking gun” evidence point to the same interpretation, go with it.
Conclusions

1. Seismic data and well data have allowed a placement of the axis of the SW Sverdrup Basin within Paleo-Ballantyne Strait.

2. The location of the axis of the Hanna Trough is also well established.

3. The two basin axes closely align when the Amerasian basin is closed by clockwise rotation of the Arctic Alaska plate.
Suggestions

I suggest we accept the counterclockwise rotation of Alaska interpretation and examine weaker, seemingly contradictory, evidence in light of this well established phenomenon.

I also suggest the geology of the western Sverdrup Basin may be very instructive for those looking at exploring in the Chukchi Sea.
Thank You for Your Attention

Close Encounters with the Amerasia Basin