Geophysical Research Abstracts
Vol. 15, EGU2013-12641, 2013
EGU General Assembly 2013

Re-evaluating the Amerasian Basin tectonic and sedimentation history with new geophysical data

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A new wave of geophysical data acquisition in the high Arctic as part of extended continental shelf mapping programmes permits re-evaluation of the Arctic Amerasian Basin tectonic and sedimentologic history. In the past seven years, 15,000 line-km of new seismic reflection data and coincident refraction data and 38,000 line-km of shipborne gravity data and >50,000 line-km of airborne gravity and magnetic anomaly data were acquired in Amerasian Basin and over Lomonosov Ridge by Canadian, US and Danish expeditions.

These new data support a limited rotational opening model for southern Canada Basin around a pole located about 64.6ºN and 130.8ºW; south of existing rotational models thus requiring less rotation (32 deg vs 66 deg). Gravity anomaly data reveal a central basement ridge and valley. Coincident symmetric magnetic anomalies and blocky basement morphology are consistent with an extinct spreading center. This interpretation is further supported by refraction observations of oceanic crustal velocities within this zone. To the flanks, crustal velocities suggest significant areas of stretched serpentinized continental crust. The consequence of these findings is that new oceanic crust accounts for about 13.2 deg or rotation with about 20 deg accounted for by stretching (Beta factor of 5).

Basement elevations within the Canada Basin deepen to the south, mostly due to sediment loading, where sediment thicknesses exceed 15 km. The sedimentary sequence thins to the north and west. The seafloor and underlying sedimentary succession of Canada Basin is remarkably flat-lying. Reflections that correlate across the basin comprise most of the succession and on-lap bathymetric and basement highs. They are interpreted as representing deposits from unconfined turbidity current flows. Isopach maps reveal three distinct depositional patterns, documenting the migration of sediment sources during the basin's history. Initially, probably late Cretaceous to Paleocene, synrift and orogenic sediments derived from the Alaska and Mackenzie-Beaufort margins. This unit onlaps underlying unconformities with a younging trend towards Alpha and Northwind ridges; likely a response to contemporaneous subsidence. Sediment source direction appeared to shift to the Canadian Arctic Archipelago margin for the Eocene and Oligocene due to uplift of Arctic islands during the Eurekan Orogeny. The final stage of sedimentation appears to be from the Mackenzie-Beaufort region for the Miocene and Pliocene when drainage patterns shifted in the Yukon and Alaska to the Mackenzie Valley. Upturned reflections at onlap positions may indicate syn-depositional subsidence. There is little evidence, at least at a regional seismic data scale, of contemporaneous or post-depositional sediment reworking, suggesting little large-scale geostrophic or thermohaline-driven bottom current activity.