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Tectonic model for the evolution of the Arctic Ocean

Kazmin, Y.B.[1], Brekke, H.[2], Petrov, E.I.[3]

[1] Russian Ministry of Natural Resources and Environment, Moscow, Russia;

[2] Norwegian Petroleum Directorate, Stavanger, Norway

[3] Russian Agency for Mineral resources, Moscow, Russia

It is universally accepted that the Arctic Ocean developed in two major steps: the polyphasal rifting and opening of the Amerasian Basin, followed by the continental break-up and establishment of the current seafloor spreading of the Eurasian Basin. Until recently, most tectonic models for the formation of the Arctic Ocean assumed fan shaped opening of the Amerasian Basin of by seafloor spreading in the Canada Basin accommodated by sinistral strike slip along the Amerasian flank of the Lomonosov Ridge [1] [2]. The great increase in the volume of geoscientific data from the Arctic Basin during the last 15 years, however, provide much better constraints to the tectonic structuring, crustal character, magmatism and timing of events as will be presented. The tectonic models for the Amerasian Basin are now subject to reconsideration. The current data point to a complicated, prolonged history of rifting and high extension of the continental crust, relatively short lived pulses of magmatism, and limited seafloor spreading.

The area between the Eurasian Basin and the Canada Basin is a complex of submarine basins and highs, here called the Central Arctic Complex, in which most of the basement is hidden under large volumes of magmatic rocks. This complex, which includes the Lomonosov ridge, is elevated relative to the basins on each side (the Amerasian and Eurasian Basins) and include features like the Alpha Ridge, the Mendeleev Rise, the Chukchi Plateau, and the Chukchi, Podvodnikov and Makarov Basins. The magmatic rocks belong to the High Arctic Large Igneous Province (HALIP) that was formed by hot spot activity associated with an underlying mantle plume. Age dating of rock samples from this complex now show that the HALIP was probably developed in two main episodes in the Cretaceous; the first at 130 – 120 Ma and the second at 100 – 80 M. Analyses show that the first episode represents volcanism with a chemical signature similar to Deccan Traps and continental plateau basalts, while the second episode was probably dominated by alkaline basalt volcanism. The HALIP is a regional feature that extends into the shallow shelf areas adjacent to the Arctic Ocean. Together with the results from the 2004 ACEX drilling

on the Lomonosov Ridge this is all evidence that the magmatic complex was intruded into and extruded onto pre-existing, partly highly attenuated continental crust within the Central Arctic Complex.

The new multi-beam bathymetry and the multichannel seismic show that the all the tectonic elements of the Central Arctic Complex is dominated by block faulting and extensional tectonics. Together with the crustal characteristics referred to above, this shows that the Central Arctic Complex constituted the rifted continental margin of the Barents and Kara Seas in the Cretaceous. In the adjacent Canada Basin oceanic crust is restricted to an area centred within the middle of the basin surrounded by highly attenuated transitional and continental crust [3]. Three different trends of structural grain may be identified reflecting a systematic anti-clockwise rotation of the extension direction through time in the development of this continental margin, which includes the intermittent pull-apart regime forming the Makarov Basin. A model for the tectonic development of the Arctic Ocean is presented accordingly.

References:

[1] Rowley D B and Lottes A L (1988) Tectonophysics 155: 73-120

[2] Grantz A et al. (1990) Geology of North America vol 1, Geol. Soc. Am. Bull: 379-402

[3] Hutchinson D et al. (2015) Geophysical Research Abstracts Vol. 17, EGU2015-5543