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Geology of the Canadian Arctic Islands and Arctic Alaska restored to Jurassic relative positions using GIS tools

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Summary

We used Arc GIS software in order to compare spatial geological data, such as bedrock maps, between the Canadian Arctic Islands and the Arctic Alaska terrane. These two areas share conjugate rifted margins that face the Arctic Ocean (Canada Basin). A tectonic model was first chosen and then bedrock geology of the Arctic Alaska terrane was translated and rotated so that the continental shelves were restored to a pre-rift, pre-Jurassic position.

Theory / Method / Workflow

Offshore of the western rifted margin of the Canadian Arctic Islands is the Amerasia Basin. Rifting to form the Amerasia Basin was Jurassic and the lithospheric breakup event was Lower Cretaceous. In theory, the conjugate margin to the western Canadian Arctic Islands is the northern slope of Arctic Alaska (e.g., Grantz et al., 1979). The Jurassic and older position of Arctic Alaska should therefore have been adjacent to the western Canadian Arctic Islands. In order to visualize and spatially correlate the geology of Alaska relative to the western Canadian Arctic we sought to spatially translate the GIS shapefiles of Arctic Alaska to a restored position.

The first step was to estimate the plate motion of the Arctic Alaska microplate using the software GPLATES. The Euler pole for the plate motion was modified from the typical location near the Mackenzie Delta in order to be orthogonal to fracture zones that are oblique (Dossing et al., 2020) to the interpreted spreading axis in the Canada Basin (Gaina et al., 2014). After a general restored position was determined from gplates, we then used the shape of the conjugate continental margins to fine tune the fit.

GIS shapefiles for the geology of the Arctic Alaska terrane were selected with the bathymetry of the continental shelf and by using simple rotation and translation tools in ArcMap these were restored to the continental margin of the western Canadian Arctic Islands.

Results, Observations, Conclusions

The resulting map allows for spatial GIS data of Arctic Alaska to be displayed in a Jurassic, and older, position relative to the Canadian Arctic Islands. At present these are the bedrock geology shapefiles from Biekman (1970). Simple rotation of geological maps plotted in a typical map projection would have resulted in large spatial distortions due variations in east-west and north-south scales are that inherent in these projections, especially at high latitudes. Rotation of the shapefiles in a GIS format maintains the correct spatial dimenions and therefore results in spatially accurate maps.

We intend to use this map restored in a GIS format to compare geological elements of the Arctic Alaska terrane and the Canadian Arctic Islands such as: the geometry and history of mapped faults; bedrock distributions that define sedimentary basins, volcanic domains, and sub-terranes; and variations in all these elements as they are constrained in geological time (e.g., Paleozoic vs Mesozoic).

Acknowledgements

References

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