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Central Arctic Crustal Modeling Constrained by Potential Field data and recent ECS Seismic Data

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2-D gravity and magnetic models have been generated for several transects across the Alpha-Mendeleev ridge complex to study the regional variability of the crustal structure and identify large scale lateral changes. The geometry and density parameters for the models have been constrained using recently acquired seismic reflection and refraction data collected jointly by Canada and the United States as part of their collaborative Arctic ECS programs.

A total of fifteen models have been generated perpendicular to the ridge complex, typically 50 to 150 km apart. A minimalist approach to modeling involved maintaining a simple, laterally continuous density structure for the crust while varying the model geometry to fit the observed gravity field. This approach is justified because low amplitude residual Bouguer anomalies suggest a relatively homogenous density structure within the ridge complex. These models have provided a new measure of the regional variability in crustal thickness. Typically, models with thinner crust correspond with deeper bathymetric depths of the ridge which is consistent with regional isostatic equilibrium.

Complex “chaotic” magnetic anomalies are associated with the Alpha-Mendeleev ridge complex, which extends beneath the surrounding sedimentary basins. Pseudogravity inversion (magnetic potential) of the magnetic field provides a quantifiable areal extent of $\sim$1.3 x10^6 km^2. Forward modeling confirms that the magnetic anomalies are not solely the result of magnetized bathymetric highs, but are caused to a great extent by mid- and lower crustal sources. The magnetization of the crust inferred from modeling is significantly higher than available lab measurements of onshore volcanic rocks.

Although the 2-D models cannot uniquely identify whether the crustal protolith was continental or oceanic, there is a necessity for a significant content of high density and highly magnetic (ultramafic) material. Based on the crustal thickness estimates from our regional 2-D gravity models and the two possible protoliths, we determine volumetric estimates of the volcanic composition to $\sim 6 \times 10^6$ km^3 for the mid- and upper-crust and between 10×10^6 and 14×10^6 km^3 within the lower crust — for a total of at least $\sim 16 \times 10^6$ km^3. This exceeds any estimates for the onshore circum-Arctic HALIP by more than an order of magnitude.