CHAPTER 6

Summary and Conclusions

A new model for the tectonic evolution of Greenland has been explored through the development of Moho undulation and geopotential models. Moho depth estimates were determined from compensated terrain gravity effects, which required accurate models of the rock, ice and water components. To estimate the marine bathymetry as well as possible, Chapter 2 considered the implementation of the gravity-geologic method (GGM).

Seafloor estimates were obtained by this method that were superior to available bathymetric data sets from the ETOPO5U and JGP95E data sets. They also were superior to bathymetric estimates made by Smith and Sandwell [1997], as well as estimates derived simply from gridding the available bathymetric data using a minimum curvature algorithm. These depth estimates were used to refine models for the rock topography and ocean thickness necessary for estimating the Moho depths in Chapter 3.

Gaussian Legendre Quadrature integration (GLQ) was used to model the gravity effects of these ocean and rock topography models, as well as those of the ice mass on Greenland. These terrain gravity effects (TGE) were spectrally correlated with free-air gravity anomalies (FAGA). The most terrain-correlated components (TCFAGA) of FAGA were removed from TGE to estimate the compensated TGE components

(CTGE). These gravity effects of the compensated terrain are not observed in the FAGA and hence were assumed to have an annihilating counterpart (ACTGE) generated by the density contrast between the crust and mantle at the Moho boundary. The Moho was estimated from ACTGE by GLQ-based inversion using sparse seismic constraints on Moho depths. This model was tested both against these seismic estimates and values determined for independent data along a profile on the glacial surface around the margin of Greenland. The modeled crustal structure suggested the presence of rifted continental crust along the southwestern Greenland coast, which is contrary to the requirement for oceanic crust that has been suggested by a kinematically determined model for the evolution of the region [Srivastava and Tapscott, 1986].

In Chapter 4, the magnetic and gravity anomalies were processed to emphasize the components related predominantly to lateral variations of magnetic susceptibility and density, respectively, within the crust. These intracrustal anomalies were compared to highlight regions where positively, negatively and null correlated features predominate. These features were analyzed in the context of the density and magnetic susceptibility properties for the known lithologies occurring in the geologic provinces of Greenland, and a map of the possible extents of these provinces was inferred. Of particular interest were the anomalous crustal regions along the southwestern Greenland margin determined in Chapter 3, where the variations of magnetic susceptibility and density suggested the presense of exhumed mantle subparallel to the coast. These features were most prominent along the southwestern Greenland margin but extended further northwards along the Greenland coastline.

Based on these mapped structures and other evidence from available seismic surveys, a new theory was proposed to explain the inferred structures and the tectonic evolution of the region. This new model suggests that the opening of the Canada

Basin between 135 and 115 Ma [Grantz et al., 1998] may have resulted in rotational crustal extension in the midcontinent region of Laurasia that generated the extensively rifted continental crust along the Greenland and Labrador coasts. Subsequent rifting and seafloor spreading during the opening of the North Atlantic Ocean occurred in this weakened region starting at about 63 Ma when the first magnetic isochrons can be clearly defined in the oceanic crust. This new model is supported by the crustal interpretations of seismic surveys along profiles and by regional paleostress models. Further, the rifting of continental crust could possibly have exhumed upper mantle or lower continental rocks and serpentinized them to account for magnetized crustal features interpreted by Srivastava and Roest [1995] as magnetic isochrons 33 and 31.

Increased understanding of the formational history of Greenland and the origin and nature of crustal features will permit the determination of improved models for crustal density and Moho depths. In turn, the gravity and magnetic effects of these modeled features can be removed to permit a more refined analysis of the remaining crustal features. These models may be further enhanced by incorporation of future gravity and seismically determined Moho depth data, as well as use of alternative isostatic compensation models such as a Vening-Meinez model. New depth data could be used to better constrain the solution or evaluate the Moho depth model, while use of a Vening-Meinez model may better model the isostatic components of the Earth's crust.

As has been shown in this study, the Labrador Sea crust contains important evidence linked to the tectonic evolution of the Arctic. Hence, analysis of the Greenland crust and its tectonic evolution may directly impact the understanding of the development of the Arctic Basin.