A NEW GLOBAL MAGNETIZATION MODEL: VALIDATION AND SCIENCE RESULTS

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ABSTRACT/RESUME

Global magnetization models represent an integration of compositional and thermal models of the crust and mantle with long wavelength crustal magnetic field measurements from satellite. We have used the 3SMAC model of the crust and mantle as a starting model, and then modified it in an iterative fashion with satellite magnetic data. We report here on the use of improved seismic models of the North American lithosphere [1] to locally improve the 3SMAC starting model. Previous attempts predict negative magnetic crustal thicknesses over the southeastern US if 3SMAC alone was used as a starting model. The improved seismic model eliminates this problem, and result in a much improved crustal thickness model.

1. MAGNETIZATION MODELS OF THE CRUST

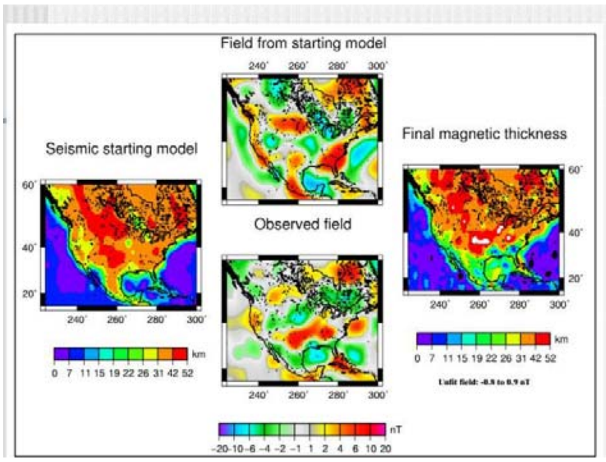

Figure 1. Combining seismic [1], thermal and material properties [3], and magnetic [2] models of the lithosphere has resulted in improved models of the lithosphere[4].

2. SUMMARY

Global magnetization models represent an integration of compositional and thermal models of the crust and mantle with long wavelength crustal magnetic field measurements from satellite. Both forward and inverse approaches are currently under development. For example, we have used the 3SMAC compositional and thermal model of the crust and mantle as a starting model, and then modified it in an iterative fashion with the satellite data until the magnetic field predicted by the model matches the observed magnetic field. A unique magnetic crustal thickness solution is obtained by assuming that induced magnetizations dominate in continental crust, using a model to describe the oceanic remanence, and assuming that vertical thickness variations dominate over lateral susceptibility variations. A starting model is necessary to constrain wavelengths obscured by overlap with the core field, and to ensure that most magnetic crustal thicknesses will be non-negative. We report on the use of improved seismic models of the North American lithosphere [1] to locally improve the starting model. The magnetic field is calculated from this starting model under the assumption of a constant magnetic susceptibility of 0.04 SI, and long wavelength fields (spherical harmonic degree < 15) are removed, simulating a main field removal. The observed and modeled satellite fields are differenced, and the difference is inverted to a magnetic crustal thickness. The starting model is then updated to reflect this change, and the process continues until convergence is achieved. The process is non-linear because the total anomaly field is used, and because of the high-pass filter. After three iterations of this technique the maximum residuals to the observations are less than +-1 nT. The final magnetic crustal thickness is negative (minimum of -6 km) over a few small regions in the ocean, and this could be a consequence of remanent magnetic fields. Final magnetic crustal thicknesses exceed 52 km, the maximum seismic crustal thickness, over a few small regions in the mid-continent region where they approach 60 km. We have previously applied this approach over North America, and found that if 3SMAC alone was used as a starting model, negative crustal thicknesses were found over the southeastern U.S. landmass. Modification of the starting model to place the major crustal thickness change near the Coastal Plain/Piedmont boundary resulted in more realistic crustal thicknesses. This new result suggests that, as the magnetic and seismic/thermal observations improve, they are also converging. We discuss the implications of this new model for heat flux, geologic, and tectonic studies of North America.

3. REFERENCES

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