The North Atlantic upper mantle: linking gravity anomalies to mantle chemical heterogeneity

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We use satellite gravity data to calculate mantle residual gravity anomalies (RMG) in the North Atlantic region. Our results reveal strong heterogeneity in the upper mantle residual gravity anomalies. Significant regional variations in RMG anomalies, which may have thermal and/or compositional origin.

We compare RMG with regional geochemical data (Korenaga and Kelemen, 2000) and find a striking correlation between RMG and anomalies in εNd and iron-depletion. This correlation suggests that compositional heterogeneity of the North Atlantic mantle provides a significant contribution to mantle gravity anomalies. We identify three zones in the North Atlantic mantle: the Southern zone (south of Iceland) with negative RMG and Mg#~0.87; the East Greenland magmatic province with positive RMG and Mg#~0.855, and the Northern zone (north of Iceland) with negative RMG and Mg# >0.88. Different magma sources and compositional anomaly in the mantle has been proposed for the Southern and Northern zones, based on the analysis of primary melts (Korenaga and Kelemen, 2000). However, this dichotomy cannot be seen in mantle residual gravity anomalies: regions with compositional anomalies have similar RMG values. By combining this observation with our analysis of the RMG-ocean age correlations, we propose different contributions of thermal and compositional anomalies to RMG north and south of Iceland. Southern zone has a “normal” oceanic mantle, whereas mantle gravity anomalies beneath Iceland are affected by a strong thermal signal, and the upper mantle of the Northern zone has both elevated temperatures and a strong compositional contribution to gravity anomalies.