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Three dimensional lithospheric magnetization structures beneath Australia derived by inverse modeling of CHAMP satellite magnetic field model

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We present an inversion algorithm for magnetic anomaly data in spherical coordinates to image the three dimensional (3-D) susceptibility distributions in the lithosphere. The method assumes that remanent magnetization is absent and that the magnetic anomalies are solely the result of lateral variations in magnetic susceptibility. To take into account the curvature of the Earth, the 3-D model is comprised of a set of spherical prisms (referred to as tesseroids), each of which has a constant isotropic susceptibility. The inversion method is formulated with a specifically designed model objective function and radial weighting function in spherical coordinates. A Tikhonov regularization technique is used to obtain an optimal solution with data misfit consistent with the estimated error level. Results for regional synthetic models with different magnetized inclinations and declinations are presented to demonstrate the capability of the method to recover large scale lithospheric magnetic structures.

We have applied the algoithm to study the lithospheric susceptibility structures in the Australia region using magnetic anomaly data from the GRIMM_L120v0.0 model, which is based on ten years of CHAMP satellite data. As a self-constrained inversion, the maximum depths variation of magnetization layer is estimated first and then incorporated to the three dimensional (3-D) inversion. Results showed that the susceptibility anomalies concentrate in the depth range from 25 km to 45 km, i.e. focused in the lower crust. In addition, the results showed that the susceptibilities in continental lithosphere are higher than those in oceanic lithosphere. The inverted 3-D susceptibility distribution in the region of Australia reveals significant features related to tectonics, surface heat-flux, crustal thickness and Curie isotherm depths. In general, the higher susceptibility anomalies correlate with Precambrian rocks, and the lower susceptibility anomalies correlate with younger orogenic belts, suture zones and modern uplifts. In details, the inverted susceptibility distribution shows differences in the magnetic structures between the eastern and western parts of the Yilgarn Craton, and three lower susceptibility belts from north to south in the Eromanga Basin and the Gawler Craton with high susceptibility that extend to the ocean and then to the west.