UPPER MANTLE ELECTRICAL STRUCTURES BENEATH A STABLE CRATON AND ATTACHED COLLISIONAL TERRAINS

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The electromagnetic properties of the upper mantle can be probed by higher vertical and lateral resolutions afforded by the combined use of advanced long period magnetotelluric sensors and geomagnetic deep soundings. Major contributions have included the definition of provinces with characteristic electromagnetic properties and anisotropic directions and the mapping of the depth to the top of the upper mantle thermal boundary layer that defines the thermal lithosphere (Jones, 1999). Such results have implications for the elaboration of mantle models constrained by density, elastic, and mineralogical properties defined from geoidal modelling, seismic tomography and petrology of xenolith suites of mantle origin. Thus, they provide indirect depth restraints for graphite and diamond stability fields. In such context, a long term research program is currently underway with a main focus on the understanding of deep lithospheric-scale processes in the geophysically poorly-known shield of south-central Brazil. The investigation is carried out through analyses and interpretations of data obtained from deep-probing wide-band and long-period Magnetotelluric (MT) methods, and Geomagnetic Deep Soundings (GDS). Primary objectives are the mapping of the depth to the thermal lithosphere-asthenosphere boundary and the detection of lateral variations of electrical anisotropy in provinces with distinct lithosphere evolution. These goals are reasonably attainable by the use of induced geomagnetic methods applied in the deep upper-mantle, made possible by advanced equipments and improved data processing capabilities currently available. The study area covers the highlands of the southern Archean São Francisco Craton and adjacent amalgamated Neoproterozoic fold belts of Brasiliano-Pan African age. The area was selected for detailed investigations because of their distinct geologic/tectonic characteristics and recent advancements on their seismic, tectonic and knowledge of Earth mass and petrologic anomalies in the upper-mantle. The area consists of a large core largely composed by Archean rocks, which was affected by lithospheric-scale Cretaceous magmatic and tectonic processes leading to sedimentation over its central portion and to mafic-ultramafic/alkaline/kimberlitic magmatism in the uplifted and partly eroded metasedimentary belts that were encroached around the cratonic border as a consequence of the Neoproterozoic Braziliano Orogeny. Deep seismic tomography indicates relatively high upper-mantle velocities to depths beyond 100 km in general and particularly to depths below 200 km under the São Francisco Craton. This behaviour, however, presents a notable exception with low velocities at the depth range of 200-600 km under a region in the NE border of the Paraná Basin (VanDecar et al., 1995). Gravimetric data, on the other hand, show an accentuated positive anomaly of the geoid in the proximity, but to the NE, of the mapped low seismic velocity zone. With a circular format, the anomaly of the geoid has a diameter of about 800 km centered at the southeastern border of the São Francisco Craton (Molina & Ussami, 1999). The significant questions that the investigation is seeking to unravel are related to deep geologic-tectonic processes accountable for vertical and lateral movements and stresses, deep-seated magmatic source material and Earth mass anomalies, and the mapping of diamond stability field. Results from a preliminary inversion of MT data along a NE-SW profile, from the SW border of the São Francisco Craton to the Brasilia Fold Belt, in the upper Cretaceous kimberlites that occur in the Alto Paranaiba Igneous Province (APIP), in the state of Minas Gerais, Brazil, disclose high mantle conductivities, down to a deep-seated low conductivity layer. The latter is possibly correlated with the base of the thermal lithosphere and presents a slight undulation having the deepest point underneath the town of Coromandel (Minas Gerais), However, soundings in the Mantiqueira Plateau, in the southeastern portion of the São Francisco Craton, show much lower crustal conductivities than the values observed in the SW border of the craton. Thus, the conductivity depth variation in the SE of the study area resembles more the results obtained along the Serra do Mar Plateau (Fontes et al., 2000) than the SW border. The preliminary results obtained so far are not entirely comparable with published upper mantle models defined in tectonically similar regions of the world (Schultz et al., 1993; Boerner et al., 1999). The continuation of the study will complement and possibly corroborate deep-mantle seismic and petrologic data and, thus, could verify prevailing mantle-related interpretations and contribute to a better knowledge of structural, igneous and metamorphic crustal processes, which might have some impact on strategies of mineral search.

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