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Effective conductivity depth imaging of Archaean cratonic margins and complex high-grade Proterozoic orogenic belts

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Tectonic reconstructions based on conventional geophysical, geological and geochemical techniques have led to a remarkable advance in our understanding of important processes that shaped the earth's crust in deformed regions currently exposing upper crust and ophiolite-decorated sutures of Precambrian age (Stern, 1994). Reconstructions are difficult and much less certain in regions of strong ductile deformation and high-grade metamorphism which typically expose complicated mid-lower crustal orogen (Kroner et al 2003) that probably would furnish vital information on earth evolution. Steep geological features including major shear zones are common in these high-grade belts and the relevant research question here is: can we reliably image the deep structure and accurately determine the presence or influence of heterogeneity on flow/transport processes in the deep crust and mantle of such highly deformed belts using a non-seismic approach?

Important and in some respects unique information about the crust and upper mantle can be obtained from measurements of electrical conductivity. Magnetotelluric (MT) electrical conductivity depth imaging (CDI) is steadily emerging as a powerful tool for studying the deep structure of deformed regions (Chen et al. 1996; Bai & Meju, 2003) but requires adequate attention to be paid to the problem of geological heterogeneity and 'static-shift' of the data caused by heterogeneous weathered overburden (Groom & Bailey 1989) in order to adequately image the deep crust and mantle. An accurate method for accurate removing the MT static-shift caused by the weathered layer, *sensu stricto*, uses supplementary information provided by collocated multi-geometry transient electromagnetic (TEM) soundings (Mohamed et al. 2002; Sakkas et al. 2002; Meju et al. 2003; Manzella et al. 2004).We posit that the combined TEM-MT approach is an effective tool for imaging high grade belts with steep shear zones and test this hypothesis in the Ribeira belt (RB) in southeastern Brazil and the Mozambique belt (MB) in East Africa where tectonic reconstructions based on traditional methods face difficulties (Kroner et al. 2003).

We draw on observations and two-dimensional CDI of data from combined broad-band MT and TEM surveys conducted (1) along a 300 km profile extending from the Archaean Sao Francisco craton (SFc) in the NW to the Atlantic Coast of SE Brazil, and (2) along a 400 km transect near the Kenya-Tanzania border, extending from the eastern shores of Lake Victoria on the Archaean Tanzanian craton to the east across the Rift Valley. Each investigated region exposes mid-lower crustal rocks in contrast to its northern lateral continuation of the orogen exposing upper crust and ophiolitic sutures (e.g. Stern 1994; Pedrosa Soares et al. 1998; Kroner et al. 2003).

Our models are statistically robust and structurally consistent. They document, for the first time, the geometry and style of deformation at inaccessible mid-lower crust and upper mantle depths in these orogenic belts. The results for both belts show evidence of large-scale heterogeneity in the electrically resistive upper mantle and suggest the presence of oppositely dipping subduction zones separated by a distinct resistive mantle wedge underneath each transect. The lower crust is characterised by large-scale fold structure (ductile deformation?) near the cratonic margin and steep structures 200 km away from it, possibly indicating some kind of strain partitioning down to the lower crust. The lower crust is of lower electrical resistivity than the confining mid-crustal and upper mantle blocks which are themselves separated by steep relatively conductive zones. Major faulting in the electrically resistive mid-crustal basement blocks (brittle deformation?) appear to be better developed over the up-folded zones of the lower crustal layer into which they ultimately sole. The middle crust evokes a picture of westward thrusting of whole orogen onto the craton in both regions. Geological and geochemical data (see Heilbron and Machado, 2003) suggest the presence of a magmatic arc in the same geographical position as the CDI inferred mantle wedge in the RB. Since this mantle anomaly is seen in both the RB and MB images, we interpret our results as providing geophysical evidence that arcs and/or microcontinents were involved in the Precambrian tectonic evolution of these two high grade belts. We suggest that comparable MT conductivity structures can be found in the Dhawar craton and the surrounding mobile belts of peninsular India (Gokarn et al. 2004).

References

Bai, D. & Meju, M.A.,2003, Deep structure of the Longling-Ruili fault zone underneath Ruili basin near the Eastern Himalayan syntaxis: insights from magnetotelluric imaging. *Tectonophysics*, **364**,135-146.

Chen L., Booker J.R., Jones A.G., Wu N., Unsworth M.J., Wei W. & Tan H., 1996. Electrical conductive crust in southern Tibet from INDEPTH magnetotelluric surveying. *Science*, 274,1694-1695.

Kroner, A.,Muhongo, S., Sommer, H., & Vogt, M. 2003. The East African Orogen: Accretion versus collision. Geophysical Research Abstracts, Vol. 5,European Geophysical Society, 2003.

Gokarn, S.G., Gupta, G. & Rao, C.K., 2004. Geoelectric structure of the Dharwar craton from magnetotelluric studies: Archean suture identified along the Chitradurga-Gadag schist belt. *Geophys. J. Int*., 158, 712-728.

Groom, R.W. & Bailey,R.C.,1989. Decomposition of the magnetotelluric impedance tensor in the presence of local three-dimensional galvanic distortions. *J. Geophys. Res*. 94, 1913-1925.

Heilbron, M. & Machado, N., 2003. Timing of terrane accretion in the Neoproterozoic -Eopaleozoic Ribeira orogen (se Brazil). *Precamb. Res*., **125**,87-112.

Manzella, A., Volpi, G., Zaja, A., and Meju, M.A., 2004. Combined TEM-MT investigation of shallow-depth resistivity structure of Mt. Somma-Vesuvius *J. Volcanol. Geotherm. Res*. **131**,19-32.

Meju, M.A., Gallardo, L.A. & Mohamed, A.K., 2003. Evidence for correlation of electrical resistivity and seismic velocity in heterogeneous near-surface materials. *Geophys. Res. Lett*., **30**, (7), 1373-1376.

Mohamed, A.K., Meju, M.A. & Fontes, S.L., 2002. Deep structure of the northeastern margin of Parnaiba basin, Brazil, from magnetotelluric imaging. *Geophysical Prospecting*, **50**, 589-602.

Sakkas, V., Meju, M.A., Khan, M.A, Haak, V. & F.Simpson, 2002. Magnetotelluric images of the crustal structure of Chyulu Hills volcanic field, Kenya: *Tectonophysics*, **346**, 169-185.