Three-dimensional electrical conductivity structure beneath the Slave Craton

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Nineteen long period magnetotelluric (MT) sites were collected on the floors of lakes throughout the Slave craton from 1998 to 2000 as an addition to Lithoprobe. After preliminary bounded influence data processing, high quality MT and magnetic Z/B responses have been obtained for periods ranging between 80 and 5000 s, thus allowing mantle penetration to depths as great as 400 km. The lake bottom data have been analyzed for the dimensionality of the deep conductivity structure, integrating in addition the data from other soundings collected along the winter road during 1996-2000.

A parameter that is a function of the longer period MT data indicates qualitatively the presence of anomalous conductivity zones. This has served to guide elucidation of the three-dimensional (3-D) structure in the deep crust and mantle. This 3-D induction strength parameter (see figure), reaches its largest values at Big and Providence Lakes and is still large to the SW at Snare Lake and to the NE at Contwyto Lake, suggesting that a conductor oriented NE-SW is traced at mantle depths beneath the center of the craton.

The data from the sites to the east, located near the Great Slave Lake shear zone and Bathurst fault (Healy in figure), are also affected by strong 3-D induction but at all periods. This suggests that the fault(s) have a high conductivity signature and reach substantial depths.

A 3-D conductivity model is in development, considering the qualitative information mentioned above, constructed by trial and error to fit the magnetic transfer and MT response functions. Interpretations of preliminary 2-D modeling of the MT data from the winter road state that the existence of a high conductivity zone encounters at depths of 80-120 km beneath the central Slave craton spatially coincides with the ultadepleted harzburgitic layer in the upper mantle, which may be related to an oceanic subduction slab emplaced during early tectonism. The 3-D model in preparation here traces this conductor as a NE-SW oriented mantle structure, with its centre located beneath Big and Providence lakes at a possible depth range of 50-250 km. The model includes also a more conducting layer in the northern Slave craton below the 40 km depth, subducting to the SSE and converging into the Slave mantle conductor at a depth of about 140 km. In the eastern craton, the model contains highly conductive crustal sheets beneath the Bathurst fault, steeping sub-vertically to the west and possibly converging into the Slave mantle conductor, suggesting the presence of conducting graphite films within a deep dipping fault zone.

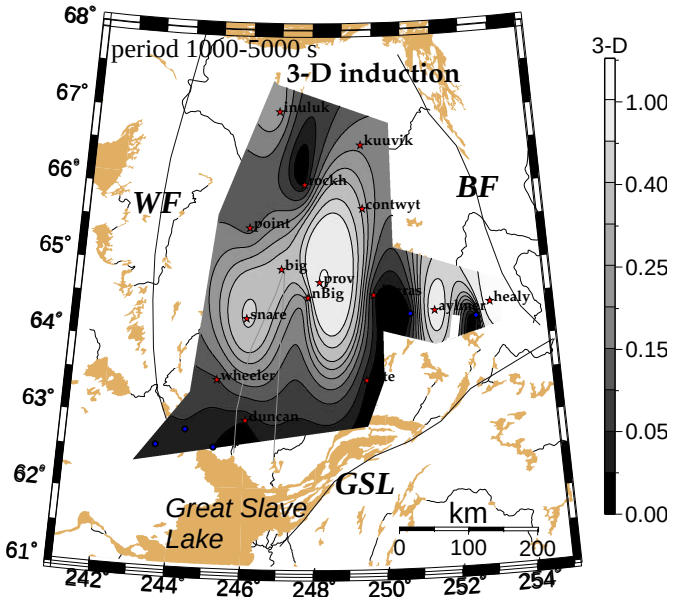

Fig. :
3-D induction strength parameter of magnetotelluric data from the Slave craton. Greater values (light grays) are indicative of anomalous conductivity zones.
WF : Wopmay fault zone.
BF : Bathurst fault zone.
GSL: Great Slave Lake shear zone.