Slave Electromagnetic studies

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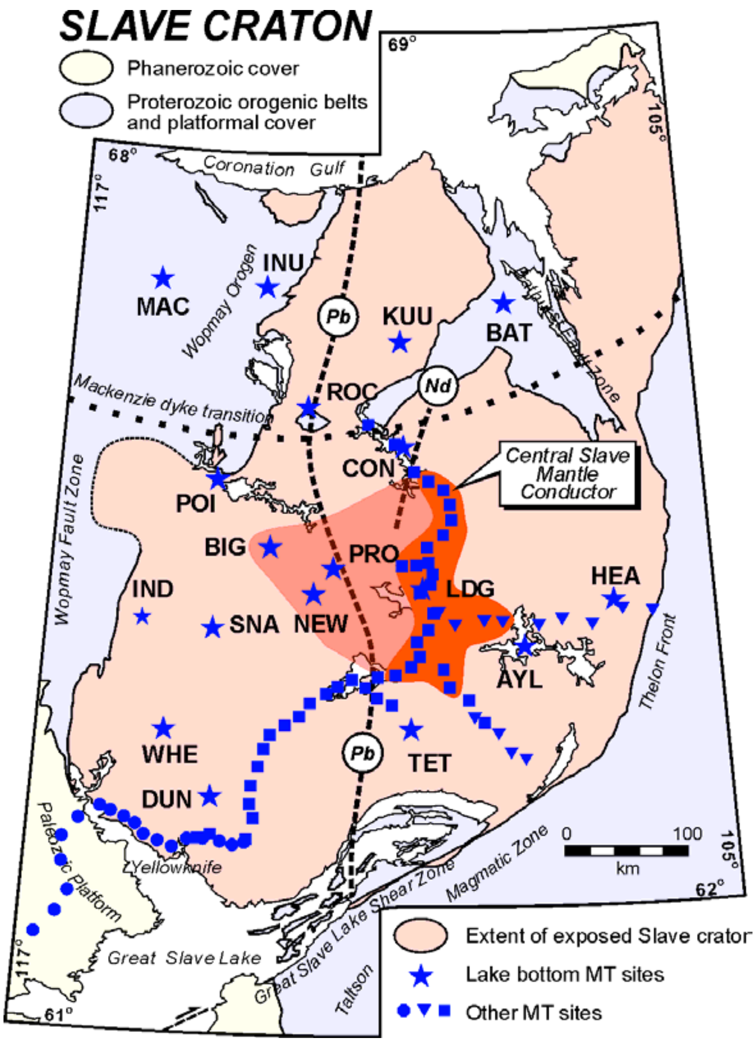
The Archean Slave craton is an ideal natural laboratory for investigating lithosphere formation and evolution processes, and has become an international focus of broad geoscientific investigation following the discovery of economic diamondiferous kimberlite pipes. Four deep-probing electromagnetic surveys, using the nautral-source magnetotelluric (MT) technique, have recently been carried out on the craton using novel acquisition procedures (Figure 1). These surveys have resulted in reconnaissance level 3-D coverage of the craton, with dense spacing along 2-D profiles.

The first survey (blue circles on Fig. 1) involved conventional MT acquisition along the only all-weather road on the southwestern extremity of the craton. Fifteen sites are equi-distantly-spaced on the exposed craton, from Tibbit Lake to the east to Rae to the west.

The second survey was a three-part series of acquisition along the winter roads with the electrodes lowered through the ice to the lake bottoms and the magnetometers on land. The former ensured low resistance ground contact for electric field measurements, and the latter avoided motion noise in the period range 10-100 s caused by movement of the lake ice. Measurements were made at a total of forty-four locations (blue squares on Fig. 1), from Tibbit Lake to the south to the northern end of Contwoyto Lake to the north, and along the two side roads to Snap Lake and Kennady Lake.

The third experiment involved deploying seafloor MT instrumentation into lakes around the craton from a Twin Otter float plane with a purpose-built winch. The ten instruments were installed in two arrays, each for one year's duration, for a total of nineteen sites (blue stars in Fig. 1). These data will give 3D control of the conductive structure of the craton. A companion poster (Evans et al.) describes the initial results.

The fourth involved installing fifteen long-period MT instruments on land during the summer of 2000, using float planes and helicopters. The sites (inverted blue triangles on Fig. 1) were chosen to determine the eastern lateral extent of the central Slave mantle conductor (CSMC) defined by the other surveys.



The MT responses reveal an unexpected and remarkable anomaly in electrical conductivity, collocated with the Eocene kimberlite field, which is modelled as a spatially confined upper-mantle region of low resistivity (<30 m) beginning at a depth of 80-100 km (Jones et al., 2001). The spatial location of the central Slave mantle conductor, as determined by the available data, is shown in Fig. 1 in red. There is the implication from the preliminary analyses of the lake bottom data (Evans et al., 2001) from site BIG that the high phase region extends westwards to at least that location (indicated by the light red region).

Given plausible mechanisms for conductivity enhancement, we interpret this conductivity anomaly as due to carbon in graphite form, or, less likely, dissolved hydrogen. This is discussed further in the paper by Craven and Jones (2001). The geophysically anomalous upper-mantle region is also spatially coincident with a geochemically defined ultradepleted harzburgitic layer thought to be trapped Archean oceanic material. Both of these anomalous regions are in the central Slave, and suggest an East-West three-part subdivision of the sub-continental mantle lithosphere. Such a subdivision is also consistent with the SKS results published to date.

The tectonic processes that emplaced this CSMC structure are possibly related to the lithospheric subduction and trapping of overlying oceanic mantle at 2630-2620 Ma. Davis et al. (2001) discuss this in further detail.

Reference

Craven, J.A., & Jones, A.G., 2001. Comparisons of Slave and Superior electric lithosphere. Presented at the Slave-Kaapvaal workshop, Merrickville, Sept. 5-9.

Davis, W.J., Bleeker, W., MacLaughlin, K. & Jones, A.G., 2001. The late tectonic rvolution of the Slave Province and its relevance to formation of its Tectosphere. Presented at the Slave-Kaapvaal workshop, Merrickville, Sept. 5-9.

Evans, R.L., Chave, A.D., Jones, A.G., & Filloux, J.H., 2001. Deep Lake Bottom Magnetotelluric sounding in the Slave Craton. Presented at the Slave-Kaapvaal workshop, Merrickville, Sept. 5-9.

Jones A.G., Ferguson I.J., Chave A.D., Evans R.L. & McNeice G.W., 2001, Electric lithosphere of the Slave craton, Geology, 29, 423-426.