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TITLE: Electrical conductivity of continental lithospheric mantle from an integrated geophysical and petrological approach: application to the Kaapvaal Craton, southern Africa

PRESENTATION TYPE: Assigned by Committee (Oral or Poster)

CURRENT SECTION/FOCUS GROUP: Study of Earth's Deep Interior (DI)

CURRENT SESSION: DI05. Understanding the Electrical Conductivity of Earth's Mantle: Insights from Imaging, Experiments and Joint Interpretation

AUTHORS (FIRST NAME, LAST NAME): Javier Fullea¹, Mark R Muller¹, Alan G. Jones¹

INSTITUTIONS (ALL): 1. Geophysics section, Dublin Institute for Advanced Studies, Dublin, Ireland.

Title of Team:

SPONSOR NAME: Javier Fullea

ABSTRACT BODY: The magnetotelluric (MT) method makes use of the relationship between the temporal variations of the Earth's electric and magnetic fields to infer the subsurface conductivity distribution. A caveat of most MT inversions is that even if they derive perfectly valid conductivity models (i.e., models that satisfy the MT observations), it is generally not clear whether these models correspond with physically plausible or meaningful petro-physical conditions inside the Earth, i.e., the chemical (e.g., iron and water content), temperature and pressure conditions. Nor is it clear in general whether these conductivity models are consistent with other geophysical observables. The link between the modelled subsurface conductivities and subsurface physical properties, calibrated by laboratory measurements, is therefore often missed.

The electrical conductivity of mantle minerals is highly sensitive to parameters that characterize the structure and state of the lithosphere and sub-lithospheric mantle and mapping its lateral and vertical variations gives insights into formation and deformation processes. We review state-of-art conductivity models based on laboratory studies for the most relevant upper mantle minerals and define a bulk conductivity model for the upper mantle which accounts for temperature, pressure and compositional variations. The bulk electrical conductivity model has been integrated into the software package LitMod, which allows for petrological and geophysical modeling of the lithosphere and sub-lithospheric upper mantle within an internally consistent thermodynamic framework.

We apply our methodology to model the upper mantle thermal structure and hydrous state of the western block of the Archean Kaapvaal Craton in southern Africa, integrating different geophysical and petrological observables: namely elevation, surface heat flow, magnetotelluric, and xenolith data. We find that to fit the measured magnetotelluric responses in the Kaapvaal Craton the uppermost depleted part of the lithosphere has to be wetter than the lowermost melt-metasomatized and refertilized lithospheric mantle. We estimate a present-day thermal lithosphere-asthenosphere boundary depth of 230-260 km for the western block of the Kaapvaal Craton. The depth of the present-day thermal LAB differs significantly from the chemical LAB, as defined by the base of a depleted mantle, which might represent an upper level of melt percolation and accumulation within the lower lithosphere.

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INDEX TERMS: [3914] MINERAL PHYSICS / Electrical properties, [8124] TECTONOPHYSICS / Earth's interior: composition and state, [5109] PHYSICAL PROPERTIES OF ROCKS / Magnetic and electrical properties, [8103] TECTONOPHYSICS / Continental cratons.