Garnet pyroxenites explain high electrical conductivity in the East African deep lithosphere

*Thomas P. Ferrand¹, Emily J. Chin²

1. Institut für Geologische Wissenschaften, Freie Universität Berlin, Berlin 12249, Germany, 2. Geosciences Research Division, Scripps Institution of Oceanography, UC San Diego, La Jolla, USA

In Tanzania, the deep lithospheric mantle (>70 km depth) is characterized by significantly higher electrical conductivity within the cratonic root than in the Mozambique belt. Such contrasts are typically attributed to changes in volatiles and/or melt content, with changes in mineralogy deemed insufficient to impact conductivity. To test this assumption, electrical conductivity measurements were conducted at pressure-temperature conditions relevant to the Tanzanian lithosphere (1.5 and 3 GPa; from 400 to >1500°C) on xenoliths from Engorora, Northern Tanzania. Once garnet becomes stable in fertile mantle rocks (>60 km, 1.7 GPa), it nucleates at grain boundaries, forming the backbone of a conductive network. At 3 GPa, such garnet-rich networks increase conductivity by a factor of 100 regardless of temperature. Numerical models demonstrate that the observed low (<10⁻² Sm⁻¹) and high (>10⁻¹ Sm⁻¹) conductivity values are best explained by low and high degrees of garnet connectivity, respectively. Such high electrical conductivities in cratonic roots can be explained by the presence of connected garnet clusters or garnet pyroxenites, suggesting mantle refertilization. Our results are consistent with long-term craton stability, but the garnet-rich network likely results from metasomatism due to plume impingement and may represent an unstable structure prior to loss of cratonic lithosphere.

Keywords: Tanzanian craton, Lithospheric mantle, Electrical conductivity, Grain-boundary network, Garnet pyroxenite, Hydrogarnet