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Sulfur and Hafnium Isotope evidence for Early Horizontal Tectonics in Eoarchean Peridotites

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The origins of Eoarchean peridotites found in the Itsaq Gneiss Complex (IGC) of southern West Greenland represent a crucial record of igneous and geodynamic processes on the early Earth. The igneous and geodynamic origins of these rocks have, however, been the subject of controversy, with some researchers arguing that they represent the first known slivers of mantle emplaced by tectonic processes in the crust and others contending that they represent cumulates associated with the local basalt units. The geodynamic context for the formation of these rocks has also been disputed, with some researchers arguing that they formed in a horizontal tectonic setting analogous to a modern subduction zone, while others propose a vertical tectonic origin for all Eoarchean rocks. Here, we provide new insights into the history of these peridotites using multiple sulfur isotope signatures combined with Hf isotope compositions. Anomalously high ϵ_{Hf} values in some IGC peridotites identified in previous studies [1], as well as in metabasalts with boninite-like compositions [2] found in the Isua Supracrustal Belt (ISB) within the IGC, point to contributions from a mantle source already depleted in the Hadean [2]. The multiple sulfur isotope data of the IGC peridotites found south of the ISB reveal small but significant $\Delta^{33}\text{S}$ anomalies, consistent with incorporation of surface-derived material of Archean age or older. Furthermore, correlations between sulfur isotope data and major and trace element abundances as well as initial Hf isotope values of IGC peridotites support the hypothesis that high-degree melt depletion occurred under hydrous conditions, followed by variable degrees of melt metasomatism. The involved fluid and melt components precipitated sulfides that incorporated surface-derived sulfur with different depositional origins. We propose that these findings are best explained by a horizontal tectonic regime similar to modern arc settings.

1. van de Löcht, J., et al., *Preservation of Eoarchean mantle processes in B_8Ga peridotite*

enclaves in the Itsaq Gneiss Complex, southern West Greenland. *Geochimica et Cosmochimica Acta*, 2020. **280**: p. 1-25.

2. Hoffmann, J.E., et al., *Highly depleted Hadean mantle reservoirs in the sources of early Archean arc-like rocks, Isua supracrustal belt, southern West Greenland.* *Geochimica et Cosmochimica Acta*, 2010. **74**(24): p. 7236-7260.