Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37165

A partially equilibrated initial mantle and core indicated by stress-induced percolative core formation through a bridgmanite matrix

LIN WANG[1], YUN LIU[2] AND YINGWEI FEI[3]

[1]Institute of Geochemistry, Chinese Academy of Sciences
[2]Institute of Geochemistry, CAS
[3]Carnegie Institution for Science

The core-formation mechanism can affect the abundance of the mantle siderophile elements and core light elements. Previous scientists focused on the equilibrium between liquid metal and liquid silicates in the magma ocean process. They ignore the equilibrium between liquid metal and solid silicates based on the results of percolation experiments under hydrostatic conditions.

However, the initial Earth is not under hydrostatic conditions. The giant impact and mantle convection make the mantle a dynamic system. Therefore, whether percolation can occur in a deforming bridgmanite matrix is still an open question. Here we report a novel method to determine the core melt connectivity in a bridgmanite matrix under Earth's lower mantle condition. The method provides direct measurements of interconnectivity by mapping the distribution of a tracer element (Pt) in the melts. The experimental results, for the first time, demonstrate the formation of an interconnected melt network under deformation at the lower mantle conditions, contrary to the conventional understanding of melt percolation in the lower mantle based on hydrostatic experiments.

The time scale of this stress-induced percolation meets the time constrain of core formation and the mantle and core composition could have been changed by this mechanism. In our model, the abundance of mantle moderately siderophile elements and core light elements can be explained by the partially equilibrium of liquid iron and solid silicate indicated by this percolation mechanism. Furthermore, the highly siderophile elements (HSE) abundance in the Earth's mantle can be explained by the trapped core-forming melts due to the percolation mechanism. These implications emphasize the importance of the post-magma ocean process on the Earth’s elements distribution and would challenge us to reevaluate the origin of elements distribution on the Earth.