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Science Research Bldg. 1, 4th floor.

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Keywords

1. Martian lower mantle
2. Partial melt
3. Seismic velocities



Experimental constraints on the bulk composition of a partially molten Martian lower mantle

NASA's InSight mission on Mars was launched in 2018 and from early 2019 its SEIS broadband seismometer has continuously recorded the planet's seismic activity, operating until late 2022. These unprecedented data have shed new lights on the planet's internal composition and structure. Among the many discoveries, the presence of a thick layer of basal magma existing on top of the Martian core (Khan+ 2023, Samuel+ 2023) has surprised the science community. The presence of a gravitationally stable basal melt layer would have some important implications for the bulk chemical composition and mineral proportions and compositions in the lowermost part of the Martian mantle. The Martian lower mantle at subsolidus conditions is thought to be mainly composed of ringwoodite (Rw) and majorite (Mj) garnet, both richer in Fe than the Earth's mantle (Bertka & Fei 1997). However, when partial melting occurs, Fe-content of both phases decrease while (Mg,Fe)O magnesio-wüstite was observed as an accessory phase (Duncan+ 2018). Most experimental work on the Martian mantle solidus has been conducted under relatively reducing conditions, leaving the effects of more oxidizing conditions and the effect of partial melting on the composition of Rw and Mj largely unaddressed.

Here we present high P and high T melting experiments on a Martian mantle aggregate at 20 GPa and 2000 °C using ORANGE2000 and ORANGE3000 at GRC. High-P experiments were conducted using a double capsule technique, with the sample placed in either metallic or graphite inner capsule while fine-grained oxides was placed in the outer capsule to influence different fO_2 conditions. The recovered samples consisted of Rw and Mj, intergrown with Fe-rich (~30 wt.% FeO) silicate melt at their grain boundaries. The chemical composition of the constituent phases were constrained as function of fO_2 and seismic velocity models of the Martian lower mantle were constructed and compared with InSight's seismic data.