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Melting of iron-bearing bridgmanite: Implications for the internal structure of super-Earths

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Melting is a key process in planetary interiors and strongly influences differentiation during the early history of a planet. The melting curve of $(Mg,Fe)SiO_3$ may determine the temperature at the core-mantle boundary of the super-Earth planet, affecting heat flux and the generation of its internal magnetic field. Super-Earths are believed to complete their accretionary phase in a molten state. Hot super-Earths are likely molten at the surface, possessing magma oceans that may extend to the deep interior. The mantle evolution from a fully molten state to a solid will depend on the relationship between a planetary adiabat and the melt curve at ultrahigh pressures. Incorporating iron into the Mg-silicate end-member is expected to lower the melting temperature and influence the depth of a magma ocean. However, the extent of this effect has not been quantified experimentally. Bridgmanite, which is expected to contain 8-11% Fe in the pyrolite composition model of the lower mantle, has no experimental data for the melting of iron-bearing silicates at the extreme conditions relevant to the deep interiors of super-Earths, and extrapolated melting temperatures from experiments and the calculated melting curves are discrepant. In this study, we performed shock-compression experiments on iron-bearing bridgmanite $(Mg_{0.92},Fe_{0.08})SiO_3$ in the range of ~450 GPa to constrain its melting point on the Hugoniot at the Z-facility. Our Hugoniot sound velocity measurements will allow for interpreting the melting point of Mg-rich silicates and offer insights into impact processes relevant to planetary formation and evolution.