Melting of the Fe alloys at core pressures and the thermal structure of the Earth

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The Earth's core is mainly composed of Fe and Ni with an amount of light element, such as Si, S, and O. The melting behaviors of Fe-Ni-light element alloys are very important to understand the temperature of the Earth, the Earth's heat flow, the evolution and age of the core, and the geodynamo. Here, we measured the Hugoniot and melting temperatures for a model core composition, Fe-Ni-Si alloy, up to the core's pressures under shock loading. The melting temperatures for the Fe/Fe-Ni alloyed with light elements, such as Si, O, and Si, are investigated and compared with each other at high pressures, combined the dynamic and static experiments. The results show that adding limited light elements into Fe/Fe-Ni would affect the melting temperature in the core, but the light elements have different effects on depressing the melting temperature of Fe/Fe-Ni at the whole core pressures. The Si in Fe makes relatively small effects on the melting temperature depressing, ~200-300 ± 200 K and ~600-800 ± 500 K at CMB and ICB, respectively, while the O follows; the S causes the largest melting temperature depression among Si, S, and O. The ICB temperature would be in the range of ~4700 to 5600 K with different light elements in the core. Considering that the recently reported higher thermal conductivities of Fe and Fe alloys, the adiabatic geotherm and the heat flow across CMB would be constrained further based on these results.