Melting of iron to 290 gigapascals

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The Earth’ s core is composed mainly of iron. Since liquid core coexists with solid core at the inner core boundary (ICB), the melting point of iron at 330 gigapascals offers a key constraint on core temperatures. However, previous results using a laser-heated diamond-anvil cell (DAC) have been largely inconsistent with each other, likely because of an intrinsic large temperature gradient and its temporal fluctuation. Here we employed an internal-resistance-heated DAC and determined the melting temperature of pure iron up to 290 gigapascals, the highest ever in static compression experiments. A small extrapolation indicates a melting point of 5500 ±80 kelvin at the ICB, about 500–1000 degrees lower than earlier shock-compression data. It suggests the upper bound for the temperature at the core–mantle boundary (CMB) to be 3760 ±180 K. Such present-day CMB temperature combined with the recently-proposed nominal core cooling rate suggests that the lowermost mantle was no longer globally molten, at least in the early Proterozoic Eon, consistent with the recycling of subducted crustal materials originally formed more than 1.5 Gyr ago.

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