Low density of Earth's core due to oxygen and silicon impurities

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During accretion and differentiation of the Earth, chemical interactions in a silicate magma ocean and liquid iron drove silicon and oxygen impurities into what went on to become the liquid outer core. Contrasting with previous research, which suggested that silicon and oxygen would only appear in very low concentrations (less than 1 percent by weight) in the liquid iron, Tsuno et al. find that at the base of a magma ocean 1,200 kilometers (750 miles) deep, these light elements could reach concentrations as high as 5 percent oxygen and 8 percent silicon by weight, simultaneously. Such impurity levels would decrease the density of the outer core, accounting for the so-called "density deficit" identified in previous research, whereby the outer core is roughly 10 percent less dense than a pure iron-nickel alloy.

The researchers also propose that at the present-day core-mantle boundary, high temperatures would drive additional silicon and oxygen into the core, creating a light, element-rich, buoyant layer on the top of the liquid outer core. They suggest that evidence for such a layer may have been observed in seismic studies.

Using a multianvil press, the authors drove a mixture of iron, magnesium silicate, silicon dioxide, and the iron oxide wüstite to 25 gigapascals (6.2 million pounds per square inch) of pressure and temperatures from 2,700 to 3,080 Kelvin (4,400 to 5,084 degrees Fahrenheit). They find that at temperatures below 3,000 Kelvin (4,940 degrees Fahrenheit), silicon and oxygen in the iron melt were mutually exclusive, with concentrations not rising above the low levels identified in previous research.

Above 3,000 Kelvin (4,940 degrees Fahrenheit), however, they find that the presence of oxygen actually enhanced the partitioning of silicon into the iron, with the concentrations of both silicon and oxygen increasing.

More information: Simultaneous partitioning of silicon and oxygen into the Earth's core during early Earth differentiation, *Geophysical Research Letters*, doi: 10.1029/2012GL054116, 2013 onlinelibrary.wiley.com/doi/10 … 012GL054116/abstract

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