Evidence for water in the lower mantle from ferropericlase included in diamond

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Earth's deep water cycle plays a critical role in the long term geochemical evolution of our planet. Recent developments from high-pressure experiments and regional seismic studies, geochemical evidence from magmas, and the discovery of a natural hydrous ringwoodite have affirmed early theoretical predictions that the components of water can persist in minerals and melts as deep as the mantle transition zone (410-660 km depth). The lower mantle (660-2800 km depth) constitutes roughly half the planet's mass and is thus the largest potential reservoir of H_2O in the Earth. However, the water storage capacity of the dominant lower-mantle mineral assemblage, bridgmanite-$(Mg,Fe)(Si,Al)O_3$ (~80% vol.) and ferropericlase-(Mg,Fe)O (~20% vol.), is 10-15 times lower than in the transition zone. Contrast in H_2O storage capacity between the transition zone and lower-mantle can produce volatile-rich magmas by dehydration melting below 660 km depth and could act as a factory for diamond formation. Here we show evidence for the presence of brucite-$Mg(OH)_2$ precipitates in a natural ferropericlase crystal contained within a diamond from São Luíz, Brazil, an indicator of reaction with water during the inclusion process. The ferropericlase also exhibits exsolution of magnesioferrite, subsequent to inclusion, which places the origin of this assemblage within the lower mantle. The brucite precipitates in ferropericlase included in diamond, together with the magnesioferrite exsolution of the host provide direct evidence for the presence of water-bearing fluid below the 660-km boundary in the lower mantle.