How Earth’s early magma ocean captured mantle carbon

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Summary
Why does Earth’s mantle contain so much carbon compared to other gas forming elements such as nitrogen and hydrogen? Our recent work (see right) shows how carbon could have been incorporated into the mantle during the magma ocean stage of Earth’s formation. Collisions with planet-sized objects would have caused large-scale melting with magma oceans extending many thousands of kilometres deep. Our high-pressure experiments revealed that partly oxidised iron (ferrous iron) disproportionates in molten silicate to fully oxidised iron (ferric iron) and reduced iron (iron metal). During Earth’s formation when iron metal was removed to the core, a gradient in mantle oxidation state would have developed with an oxidised upper layer and reduced lower region. Carbon dioxide in the atmosphere would then have partly dissolved in the magma ocean and be reduced to diamond as it was convected downwards. This mechanism was probably important for removing carbon dioxide from Earth’s early atmosphere and implies that diamonds may still exist that date back to Earth’s formation.