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LETTER

A novel carbon bonding environment in deep mantle high-pressure dolomite

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ABSTRACT

The main source of carbon entering the deep Earth is through subduction of carbonates, including $CaMg(CO_3)_2$-dolomite. We examine the high-pressure structure and stability of dolomite to understand the means through which carbon can be sequestered as it enters the deep Earth carbon cycle. Dolomite is investigated to 86 GPa using Raman spectroscopy at room temperature: this includes spectroscopic characterization of dolomite-III, a phase stable at deep mantle pressures and temperatures. Between 63–86 GPa, within the dolomite-III structure, we observe spectroscopic evidence for the evolution of a subpopulation of carbonate ions characterized by *weaker* C-O bonds, with anomalous pressure shifts: this abnormal bonding change is explained by the onset of a 3+1 coordination of the carbon in some of the carbonate ions in the dolomite-III structure, confirming an earlier prediction of Merlini et al. (2012). The wide suite of carbonate ions (both normal threefold and 3+1 coordinate) within this phase at the highest pressures should give rise to a large variety of cation sites; as such, dolomite-III could represent a major host for incompatible elements in the deep mantle, implying that incompatible element distribution may be closely linked to carbon cycling within the deep Earth.

Keywords: Dolomite, high pressure, Raman spectroscopy, carbon, distorted cation sites, deep Earth