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Insights into structure of Carbonate Glass under High Pressure from Time-resolved Fluorescence Spectroscopy

The presence of carbonates in the mantle is supported by various evidence from seismology, experiments, inclusions in diamonds , and calculations [1]. While the pressure-induced structural changes in crystalline carbonates are relatively well understood, little is known about the P-induced structural changes in carbonate melts due to technical challenges in direct measurements of melt properties. To a certain extent, glasses can serve as a proxy for melts under high P [2], and experimental studies on carbonate glasses may provide valuable insight into the structure and properties of deep carbonate melts.

Here we report on the structural characteristic of Mn^{2+}-doped carbonate glass probed by time-resolved laser fluorescence in a diamond anvil cell. The wavelength, intensity, and lifetime of Mn^{2+} is sensitive to coordination number (CN) by oxygen and symmetry of the Mn^{2+} site, and shows a strong pressure dependence. To interpret the pressure-induced changes in Mn^{2+} fluorescence we performed references experiments on calcite and magnesite‘ (also doped with Mn^{2+}), whose high-pressure behavior is well-documented.

Our results show that upon compression the median CN of Mn^{2+} increases from ~6 (at 1 atm) by ~30% (at 13-14 GPa). More broadly, time-resolved laser fluorescence experiments offer a novel spectroscopic probe into the local structure of geologically-relevant glasses at mantle pressure conditions.

[1] Jones et al. (2013), Rev. Mineral. Geochem.75, 289–322
[2] Seifert et al. (1981), Geochim. Cosmochim. Acta. 45, 1879–1884

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