Micro-Raman investigations of diamond genesis during slab-mantle interaction

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Magnesite is proposed to be a major oxidized carbon storage phase in the mantle due to its wide *P-T* range of stability [1-2]. The presence of magnesite in the Earth's interior will depend on the redox state of the Earth's interior. Large part of the deep mantel is considered to be significantly reduced with considerable amount of FeO dispersed in rocks [3]. During slab-mantle interaction, subducted carbonates in the slab will undergo redox reactions with metallic Fe. However, the mechanism of this interaction is not well understood.

In order to understand diamond genesis during the slab-mantle interactions, we have conducted high-pressure and high-temperature experiments in a 2000-ton multi-anvil high-pressure press on samples containing $MgCO_3$ and iron foils (50 µm thick) in BN capsules. The samples under pressures from 10 to 16 GPa were heated to 1200–1700 K. The samples were quenched under pressure and the quenched samples were polished and then analyzed with multi-wavelength micro-Raman spectrometers using 785, 514.5 and 532 nm laser excitations. Micro-Raman investigations show that the iron foils reduce $MgCO_3$ to various sp^2 carbon phases, mainly graphite, followed by the transformation to diamond upon long-duration heating. The transformation to diamond is driven by the temperature. For example, in the Run number PL066 with staring material containing magnesite and two Fe foils heated to 1400 K at 10 GPa for 24 hrs, and quenched, the run products were [Mg,Fe]O, and diamond and graphite. The sample PL044 with staring material containing magnesite and three Fe foils heated to 1600 K at 14 GPa for 12 hrs, the run products were larger size (~10 µm) diamonds, iron carbide and small amount of graphite. Our results indicate that in slow subduction (T~1500 K) all carbonates will be converted in diamond and iron carbide. Under rapid subduction of the slab, the carbonate will survive and be carried to greater depth. The inclusions of [Mg,Fe]O in diamonds, however, do not necessarily indicate that this phase is of lower mantle origin.

[1] Mülle et al. (2017) *Eur. J. Mineral.* 29: 785-793. [2] Dorfman et al. (2018) *Earth Planet. Sci. Lett.* 489: 84-91. [3] Frost., McCammon (2008). *Annu. Rev. Earth Planet. Sci. Lett*. 36: 389-420.