Experimental evidence for direct gas-solid carbonation of enstatite: implications for CO_2 sequestration in early Mars

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Carbonates identified in Martian meteorites and in the Nili Fosae, Leighton and Gusev craters suggest a formation scenario in subsurface hydrothermal systems, probably through reaction of olivine and/or secondary minerals with CO_2-rich liquid water. However, isotope analyses suggest an origin from an atmospheric reservoir. In any case, such mechanisms have been proposed as potential contributors to the thinning of an early Noachian atmosphere. This work reports on mineral direct gas-solid carbonation experiments carried out on olivine and enstatite, at pressures of 5 bar, with 1% water vapor, and reaction times of up to 2 weeks. X-ray photoelectron spectroscopy of enstatite carbonation products, confirms the presence of carbonates forming a thin layer on the surface of the original mineral. Focused-ion beam imaging (Fig. 1) also shows carbonates embedded in a ~200 nm silica-rich coating. On the other hand, lizardite was identified by Raman spectroscopy as a reaction product of olivine (pure forsterite), indicating that hydration did take place; however no carbonates were detected in this case. Results suggest that direct gas-solid carbonation of silicates may have also played a significant role in the formation of carbonates under early Mars atmospheric localized surface conditions.

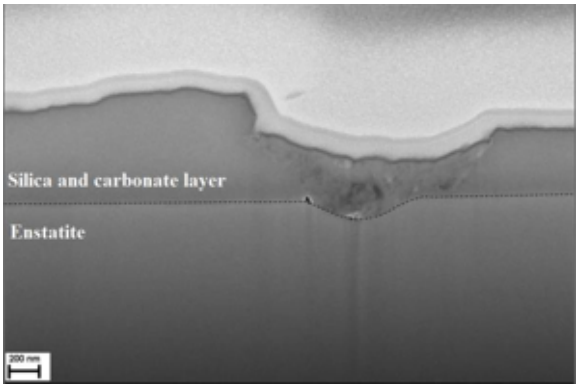

Fig. 1. FIB imaging of carbonated enstatite cross section.