Microbial carbonate precipitation under high alkaline condition and its implications in concrete restoration

TINGTING ZHU[1], CARLOS PAULO[1] AND MARIA DITTRICH[1]*

[1]University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4, Canada (*correspondence: mdittrich@utsc.utoronto.ca)

Microbial carbonate precipitation (MCP) has been demonstrated to have a potential in constructional restoration. The repair of concrete by MCP requires microorganisms that can survive high alkaline conditions in the cracks. Although heterotrophic organisms showed promising results in concrete restoration, they generate contamination (e.g., NH_4^+) to the environment. This study aims to examine the potential of phototrophic microorganisms for MCP in the cracks of concrete. Among the several autophototrophic strains, PCC8806 showed the highest rate of biomineralization [1]. However, it is unknown whether they can survive under high alkaline conditions and impact MCP.

In this study, carbonate precipitation by PCC8806 under high alkaline conditions has been investigated. Calcium chloride (50 mM) was added to an initial solution, which was prepared from concrete mix by adjusting the pH to 11.7. Ten ml of washed cells, with a concentration of 3.53×10^9 cells/ml, was inoculated into solution. Another experimental set without bacteria was monitored as control. Samples were taken at the starting point, and after 1h, 2h, 3h, 6h, 18h and 24h to determine the solution composition by atomic adsorption spectroscopy (AAS), and to observe morphology of the precipitates by optical and scanning electron microscopy (SEM), and Atomic Force microscopy. The precipitates were examined by X-ray diffractometry and Raman spectroscopy.

After 24 hours of reaction, the pH dropped 0.5 unit in control and 1 unit with PCC8806. In the presence of PCC8806, the calcium concentration decreased by 5 mM/L by the end of the experiment, while there was no change in control. As it has been confirmed by SEM, a large amount of calcium carbonates with diverse morphologies were formed, some of which were attached to cells. AFM images and Raman spectra indicated that the calcium carbonates were mostly calcites. Our study showed that PCC8806 can survive high alkaline conditions in concrete cracks and strongly impact MCP compared to the abiotic experiments.

[1] Liang *et al*. (2013). Colloids and Surfaces B: Biointerfaces, under review.

Mg and Fe isotope constraints on the genesis of Bayan Obo ore deposits, Inner Mongolia, China

X. K. ZHU, J. SUN AND S. Z. LI

Laboratory of Isotope Geology, MLR, Institute of Geology,CAGS, Beijing, 100037, PR China (XIANGKUN@CAGS.AC.CN)

The giant polymetallic Bayan Obo REE-Nb-Fe ore deposit is the largest REE deposit in the world. Its origin, however, remains controversial. A number of genetic models have been proposed, including sedimentary origin, magmatic origin, hydrothermal origin or origin with multiple processes. Mg and Fe isotope compositions of H8 Dolomite (the ore-bearing bed), carbonatite dykes nearby, mesoproterzoic sedimentary carbonate and micrite from Sailinhudong have been systematically investigated to constrain the genesis of Bayan Obo deposit. The results show that $\delta^{26}Mg_{-DSM3}$ of the H8 dolomite varies from -1.13‰~-0.10‰, with average δ^{26}Mg-DSM3 of -0.53‰, which is closer to those of igneous rocks, but much heavier than micrite carbonate rocks (its δ^{26}Mg ranges from -1.99‰ to -1.93‰). The Fe isotope compositions of the deposit are rather homogeneous with an average in δ^{56}Fe values of -0.03‰, which are very different to those of Precambrian sedimentary Fe ores, but similar to those of igneous rocks.

Overall both Mg and Fe compositions are inconsistent with either sedimentary or hydrothermal origin, but consistent with an igneous genesis.

DOI:10.1180/minmag.2013.077.5.26