

Serpentinite as a resource for carbon capture and storage by mineralisation

A. M. Lacinska (1,2), M. T. Styles (1), P. D. Brown (2), J. Naden (1), M. Maroto-Valer (2), S. J. Kemp (1), A. J. Benham (1,3)

(1) British Geological Survey, UK (antony.benham@nottingham.ac.uk), (2) Nottingham University, UK, (3) Nottingham Centre for CCS, UK

The anthropogenic release of CO₂ into the atmosphere has substantially augmented the natural greenhouse effect. To mitigate the effects of “man-made” climate change, technologies for CO₂ capture and storage are being developed and refined, particularly storage within deep geological formations. An alternative solution for carbon capture and storage is mineralisation (CCSM) [1]. Two CCSM technologies are presently being considered: *in situ* and *ex situ*. The *in situ* technology aims at the direct injection of CO₂ into mafic or ultramafic rock where it reacts with fractured rock to form carbonate. The *ex situ* technology involves quarrying and transport of rock to a processing plant, chemical and physical pre-treatment and subsequent carbonation, with final disposal or utilization of the reaction products. Whichever CCSM technology is ultimately utilized, it will always involve the reaction between the CO₂ and silicate minerals to form carbonate.

Previous CCSM research usually treated serpentine minerals as a group [2], or utilized one serpentine mineral only *e.g.*, antigorite [3] or lizardite [4], therefore making a direct comparison between the crystal structure and the ease of cation release during pre-treatment, under a set of experimental conditions, impossible. Our recent research indicates that polymorphic and polytypic complexity of serpentine minerals controls mineral reactivity but the underpinning reaction mechanism is poorly understood. Accordingly, to develop a better understanding of reaction controls, we have devised two sets of controlled laboratory experiments combined with a detailed mineralogical and crystallographic study of reactants and products. The experiments will involve: 1) short term (3h, 100°C, 1Bar) batch reaction - acid leaching of pure serpentine polymorphs to obtain data on crystal structure changes during Mg release and the leaching efficiency; 2) long term (12-18 months, ca 50°C, 150Bar) reaction between dissolved CO₂ and selected peridotite samples to simulate the underground conditions for the *in situ* injection. The data derived from these experiments and mineralogical analysis will provide insights into the factors that govern Mg-release from different polymorphs and polytypes when subjected to various chemo-mechanical treatments.

The mineral carbonation reaction is thermodynamically favorable; it is exothermic and occurs spontaneously in nature. However, if CCSM is to be commercially viable and implemented on an industrial scale, it will need to be based on a low energy, intensive process, with high reaction kinetics for high efficiency carbonation. Currently, the majority of CCSM costs are associated with mineral pre-treatment, involving aspects of rock grinding, acid leaching and heat activation. Gaining improved understanding of the reaction controls will help overcome the high energy penalties.

References

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