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The adsorption of Ni on the surface of olivine and its implications for enhanced weathering processes

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The potential use of olivine [$(Fe,Mg)_2SiO_4$] as a mean for carbon capture and storage through the enhancement of weathering processes, introduces uncertainties relating to the release of transition metals, abundant in this mineral. One such metal is Ni, which is present in natural olivine in concentrations up to several thousand ppm. Upon dissolution of olivine, which is the desired outcome from enhanced weathering processes, this Ni is expected to be released to the surroundings as a potential toxic element [1]. However, the mechanism with which Ni is released to the surroundings, and whether Ni can act as a proxy for olivine dissolution is still debated [2,3]. Part of these uncertainties can relate to whether Ni is adsorbed to the olivine surface in significant amounts, thus resulting in overall incongruent dissolution and a slowing of the Ni release.

In this study, we use high-forsterite (high Mg to Fe ratio) olivine from the Seqi Ultramafic Complex [4] in SW Greenland to test the adsorption efficiency of Ni on the olivine surface. This olivine-rich complex is specifically explored for use in carbon capture and storage projects, and it is thus ideal for testing Ni adsorption capacity as nickel has been highlighted as a challenge associated with such applications.

The experimental work entails adding different amounts of Ni to an olivine-water suspension to later create a Langmuir-based isotherm describing the adsorption capacity of Ni on olivine. To include the effect from fluid chemistry, we run adsorption experiments using various fluids representing both pure ion-free waters, groundwaters and sea water conditions. The dissolved Ni concentrations are subsequently analysed using an ICP-MS system optimized for such analyses and by ICP-OES to monitor possible cation content changes. The resulting isotherms can subsequently be used to estimate the maximum adsorption capacity of Ni on the surface on olivine, which can aid future studies on the environmental impact of carbon capture and storage involving high-forsterite olivine.

[1]Shahzad et al. (2018), Plant Physiol. Biochem. 132, 641-651; [2]Montserrat et al. (2017) Environ. Sci. Technol. 51.7., 3960-3972; [3]Fuhr, et al. (2022), Front. Clim, 39; [4]Szilas et al. (2018), *Geosci. Front.* 9.3, 689-714.