

Enhanced olivine weathering in permeable sandy sediments from the North Sea – a laboratory study using flow-through reactors

MALE KÖSTER¹, ALEXANDER DIEHL^{2,3}, WOLFGANG BACH^{3,4} AND SABINE KASTEN^{1,5,6}

¹Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

²University of Bremen, Faculty of Geosciences

³MARUM – Center for Marine Environmental Sciences, University of Bremen

⁴MARUM, University of Bremen

⁵MARUM – Center for Marine Environmental Sciences, Faculty of the University of Bremen

⁶Faculty of Geosciences, University of Bremen

Presenting Author: male.koester@awi.de

The Earth's climate is increasingly warming due to ongoing anthropogenic carbon dioxide (CO₂) emissions. In order to mitigate the human-made climate change and to meet the Paris Agreement goals of limiting the warming below 2°C, active carbon dioxide removal (CDR) from the atmosphere is of great importance in addition to massive CO₂ emission reductions. A possible CDR method is rock weathering and the associated dissolution of minerals in the ocean, which leads to marine alkalinity enhancement and, thus, an enhanced flux of CO₂ from the atmosphere into the ocean. In the framework of the project RETAKE, a consortium of the German Marine Research Alliance (DAM) research mission CDRmare, we investigate the potential, feasibility and side effects of olivine dissolution in high-energy coastal environments where strong currents and advection of seawater through permeable sediments have been proposed to accelerate weathering of silicate rocks.

Here, we present data from laboratory experiments with flow-through reactors that are filled with permeable sandy sediments from the North Sea amended with different amounts and grain sizes of olivine. Permeable sediments are generally characterized by advective pore-water flow. Under advective conditions, higher weathering rates than those found in diffusion-controlled depositional settings are expected since the reaction products are rapidly removed and the formation of authigenic mineral coatings on olivine grains is prevented. The flow-through experiments are conducted under oxic conditions whereby air-saturated natural seawater is continuously pumped through the reactors. In addition to the permanent measurement of oxygen, pH and temperature, the circulating water is regularly sampled and alkalinity, dissolved inorganic carbon, major cation and trace metal (e.g., nickel) concentrations are analyzed. Preliminary results indicate an increase in alkalinity up to 3.2 mM in the reactor with the largest amount of olivine while the alkalinity in the control reactor (without olivine addition) is close to background seawater concentrations of 2.3 mM. Similarly, highest dissolved nickel concentrations were found in the reactor

with highest olivine contents added. In order to detect and characterize secondary minerals that possibly formed, the sediment/olivine mixtures are sampled after completion of the experiments and analyzed with respect to the mineralogical and chemical composition.