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Field Evaluation of Olivine-Enhanced Weathering: Assessing the Impact of Grain Size and Mycorrhization in Belgian Croplands

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At the 2015 Paris Climate Summit, all parties committed to limiting global warming to below 2°C by 2100. Yet, even the most ambitious emission reductions fall short without integrating atmospheric Carbon Dioxide Removal (CDR) approaches. Enhanced Silicate Rock Weathering (ERW) is a low-tech CDR method that harnesses naturally occurring silicate dissolution reactions followed by carbonate formation. However, the first reaction of dissolution is intrinsically slow. To accelerate weathering, ERW proposes spreading easily-weatherable minerals such as olivine on croplands. Uncertainties in carbon sequestration estimates largely stem from the effects of soil microbiota on silicate weathering. Mycorrhizal fungi, for instance, are expected to boost ERW potential [1], though field validation is lacking. In this study, we report on an ERW field experiment conducted in loessic soil at the Jardin experimental Jean Massart in Brussels (Belgium), beginning in spring 2022. We evaluated the impacts of plant presence, enhanced mycorrhization, olivine addition, and grain size (fine: <3 mm; coarse: 2–6 mm) using common wheat (*Triticum aestivum* L.) and endomycorrhizal inoculum (*Glomus spp*.) in 64 randomized 50×50 cm plots (2 kg/m² olivine, controls excluded). Geochemical parameters (pH, electrical conductivity) were monitored, and chemical extractions of Mg, Ni, and Cr from soils and wheat biomass were performed annually. Complementary Sr isotopic analyses provided further insights into olivine weathering dynamics, while thermogravimetric analyses (TGA-MS) probed the formation of secondary carbonate phases. Our results indicate that the fine olivine treatment (< 3 mm) initially enhanced wheat biomass, increased pH and exchangeable Mg concentrations, and moderately raised Ni levels in the soils. However, differences in geochemical parameters between plots amended with olivine and controls without olivine diminished over subsequent years, suggesting a potential slowdown in olivine weathering.

[1] Bonneville, Morgan, Schmalenberger, Bray, Brown, Banwart, Benning (2011) Geochimica et Cosmochimica Acta, 75, 22, 6988-7005. https://doi.org/10.1016/j.gca.2011.08.041.