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Direct evidence of CO_2 drawdown through Enhanced Rock Weathering in carbon rich soils

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The ability of engineered Enhanced Rock Weathering to impact atmospheric CO_2 has been challenging to demonstrate due to the many processes occurring in soils and the short time span of current projects. Here we report the soil water chemistry, mineralogy and carbon balance in an Icelandic Histic/Gleyic Andosol that has received large quantities of basaltic dust over 3,300 years, providing opportunity to quantify the rates and long-term consequences of Enhanced Rock Weathering. The added basaltic dust has dissolved continuously since its deposition. This dissolution has been promoted by the precipitation of Al-Si-minerals such as allophane, and organic anion ligands released from organic decay. The soil water pH, alkalinity and the concentrations of most major elements increased with depth as the water became more reduced. Numerous toxic trace metals are initially released to the fluid by dissolution of basalt near the surface but are scavenged at depth likely due to their uptake by secondary minerals [1]. The alkalinity of the soil waters is more than 10-times higher than in equivalent basalt-dust-free soils [2]. After accounting for oxidation and degassing when the soil waters are exposed to the atmosphere, the annual CO_2 drawdown due to alkalinity generation is 620 kg CO_2 ha^{-1} yr^{-1} equal to 62 g CO_2 m^{-2} yr^{-1}. This study validates the ability of fine grained mafic mineral addition to soils to attenuate increasing atmospheric CO_2 by alkalinity export. If the results of our studied field site are representative, the removal of 1 Gt yr^{-1} CO_2 from the atmosphere through alkalinity production alone would require a total of 16 million km^2 of surface. This is larger than the total surface area of the United States. Induced changes in soil organic carbon storage, however, likely dominate the net CO_2 drawdown of Enhanced Rock Weathering efforts. At our Icelandic site the rate of organic carbon storage is estimated to be 1.5 to 3 times larger than that of alkalinity storage.

References

[1] Linke, et al. (2024a) *GCA* 370, 66-77.
[2] Linke, et al. (2024b) GPL *in press*.