Carbon Dioxide Removal via Mineralization and Enhanced Rock Weathering

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Limitation of the global average surface temperature to 1.5°C, as stated in the Paris Agreement, requires deep decarbonization of the global economy. This can be accomplished by aggressive carbon emission reductions, including carbon avoidance and removal. Carbon removal (CDR) combined with permanent solid carbon storage via enhanced rock weathering and CO_2 mineralization in mafic and ultramafic rocks have the potential to remove substantial amounts of CO_2 on a decadal timescale[1]. My presentation focuses on two different CDR approaches: In-situ CO_2 mineralization in geologic reservoirs and enhanced rock weathering of industrial mineral waste. Recent pilot and commercial CO_2 injection tests into subsurface reservoirs in Iceland (www.carbfix.com) and Oman (www.4401.earth) demonstrated rapid CO_2 mineralization in basaltic and peridotitic rocks. Mass balance calculations using environmental and deliberately injected chemical tracers revealed that up to 95% of the injected CO_2 has been mineralized over a period of one to two years, resulting in the permanent and safe storage of anthropogenic CO_2 emissions[2,3]. A second promising CDR approach is the enhanced weathering of alkaline mineral waste from the global mining industry. Alkaline waste, such as mine tailings from diamond, platinum group element and chromium mining, reacts with CO_2 in an exothermic reaction to form carbonate minerals, resulting in permanent carbon storage. Using the mineral waste production data of the global mining industry illustrates the gigaton scale CO_2 capture potential of these waste material[4].

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[2] Matter, JM., et al. (2016) Rapid carbon mineralization for permanent disposal of anthropogenic carbon dioxide emissions. *Science* 352 (6291), 1312-1314, (doi:10.1126/science.aad8132).
[3] Snæbjörnsdóttir et al. (2017) The chemistry and saturation states of subsurface fluids during the in situ mineralization of CO_2 and H_2S at the CarbFix site in SW-Iceland. Int. J. Greenh Gas Cont 58, 87-102 (doi:10.1016/ijggc.2017.01.007).
[4] Bullock, L.A., James, R.H., Matter, J., Renforth, P., & Teagle, D.A.H. (2021) Global carbon dioxide removal potential of waste materials from metal and diamond mining. *Front. Clim.* 3:694175. (doi:10.3389/fclim.2021.694175).