



Impact of geoengineering with olivine dissolution on the carbon cycle and marine biology

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We investigate the potential of a specific geoengineering technique: the carbon sequestration by artificially enhanced silicate weathering via the dissolution of olivine. This approach would not only operate against rising temperatures but would also oppose ocean acidification. If details of the marine chemistry are taken into consideration, a new mass ratio of CO₂ sequestration per olivine dissolution of about 1 is achieved, 20% smaller than previously assumed. We calculate that this approach has the potential to sequester up to 1 Pg of C per year directly, if olivine is distributed as fine powder over land areas of the humid tropics, but this rate is limited by the saturation concentration of silicic acid. These upper limit sequestration rates come at the environmental cost of pH values in the rivers rising to 8.2 in examples for the rivers Amazon and Congo (Köhler et al., 2010).

The secondary effects of the input of silicic acid connected with this approach leads in an ecosystem model (RECOM2.0 in MITgcm) to species shifts away from the calcifying species towards diatoms, thus altering the biological carbon pumps. Open ocean dissolution of olivine would sequester about 1 Pg CO₂ per Pg olivine from which about 8% are caused by changes in the biological pumps (increase export of organic matter, decreased export of CaCO₃). The chemical impact of open ocean dissolution of olivine (the increased alkalinity input) is therefore less efficient than dissolution on land, but leads due to different chemical impacts to a higher surface ocean pH enhancement to counteract ocean acidification. We finally investigate open ocean dissolution rates of up to 10 Pg olivine per year corresponding to geoengineering rates which might be of interest in the light of expected future emission (e.g. A2 scenario with emissions rising to 30 PgC/yr in 2100 AD). Those rates would still sequester only less than 20% of the emission until 2100, but would require that the nowadays available shipping capacity of tankers and bulk carriers is entirely used for olivine dissolution ten times a year.

Reference

Köhler, P.; Hartmann, J. and Wolf-Gladrow, D. A. (2010) Geoengineering potential of artificially enhanced silicate weathering of olivine, Proceedings of the National Academy of Science 107, 20228-20233, doi: 10.1073/pnas.1000545107.