Utilizing clay minerals to remove atmospheric CO_2

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To limit the rise in global temperatures to 1.5°C above pre-industrial levels under the UNFCCC requires *accelerated* transition to a low carbon economy, large-scale implementation of carbon capture and sequestration (CCS), and massive deployment of atmospheric CO_2 removal technologies. With ~85% of present-day energy being generated by fossil fuels a transition to low carbon economy remains in distant future. The growth of atmospheric CO_2 can be slowed down though CCS or by directly removing atmospheric CO_2 (Direct Air Capture, DAC). Unfortunately, CCS technology has shown limited success and DAC technology is in its nascent stage. Creative out-of-the box solutions are thus urgently needed to combat problems associated with global warming and ocean acidification.

The present rate of atmospheric C growth is 4.7 Pg yr^{-1}. In comparison, marine biological pump removes 5-12 Pg yr^{-1} of atmospheric carbon in the form of particulate organic matter (POM). The pump is highly inefficient, however, in burying carbon below the euphotic zone. More than 90% of the sinking POM is oxidized back to CO_2 by marine biota as it falls through the upper 1000m and thus can more readily return to atmosphere. A significant improvement in the transfer efficiency of POM through the upper 1000m could therefore remove a much larger fraction of POM to the deep-ocean where it can be stored for over centuries to millennia. Based on geological and modern observations I surmise that continental dust-delivered clay minerals have been involved in removing atmospheric CO_2 and sequestering it below the euphotic zone by: a) providing nutrients to silica-shelled phytoplankton (diatom), b) directly absorbing dissolved organic matter, c) reducing bacterial activity, and d) increasing the mean depth of respiration by changing the composition of POM and its settling velocity ("ballasting").

The above observations suggest a radically different approach to sequester atmospheric CO_2 that would bypass the difficulties associated with ocean iron fertilization, and that can be scaled up to deploy on a very large scale in a reasonably short time. Certain regions of the ocean surface could be spiked with clay minerals from air to improve productivity and/or POM transport efficiency. I will discuss work done in my laboratory. If successful it will lay a foundation for larger scale experiments that would ultimately help check the relentless rise of atmospheric CO_2.