Researchers analyse 'rock dissolving' method of geoengineering

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(Phys.org)—The benefits and side effects of dissolving particles in our ocean's surfaces to increase the marine uptake of carbon dioxide (CO_2), and therefore reduce the excess amount of it in the atmosphere, have been analysed in a new study published today.

The study, published today, 22 January, in IOP Publishing's journal *Environmental Research Letters*, assesses the impact of dissolving the naturally occurring mineral olivine and calculates how effective this approach would be in reducing atmospheric CO_2.

The researchers, from the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, calculate that if three gigatonnes of olivine were deposited into the oceans each year, it could compensate for only around nine per cent of present day anthropogenic CO_2 emissions.

This long discussed 'quick fix' method of geoengineering is not without environmental drawbacks; the particles would have to be ground down to very small sizes (around one micrometre) in order to be effective. The grinding process would consume energy and therefore emit varying amounts of CO_2, depending on the sort of power plants used to provide the energy.

Lead author of the study Peter Köhler said: "Our literature-based estimates on the energy costs of grinding olivine to such a small size suggest that with present day technology, around 30 per cent of the CO_2

taken out of the atmosphere and absorbed by the oceans would be re-emitted by the grinding process."

The researchers used a computer model to assess the impact of six different olivine dissolution scenarios. Olivine is an abundant magnesium-silicate found beneath the Earth's surface that weathers quickly when exposed to water and air – in its natural environment it is dissolved by carbonic acid which is formed from CO2 out of the atmosphere and rain water.

If olivine is distributed onto the ocean's surface, it begins to dissolve and subsequently increases the alkalinity of the water. This raises the uptake capacity of the ocean for CO2, which is taken up via gas exchange from the atmosphere.

According to the study, 92 per cent of the CO2 taken up by the oceans would be caused by changes in the chemical make-up of the water, whilst the remaining uptake would be down to changes in marine life through a process known as ocean fertilisation.

Ocean fertilisation involves providing phytoplankton with essential nutrients to encourage its growth. The increased numbers of phytoplankton use CO2 to grow, and then when it dies it sinks to the ocean floor taking the CO2 with it.

"In our study we only examined the effects of silicate in olivine. Silicate is a limiting nutrient for diatoms – a specific class of phytoplankton. We simulated with our model that the added input of silicate would shift the species composition within phytoplankton towards diatoms.

"It is likely that iron and other trace metals will also impact marine life if olivine is used on a large scale. Therefore, this approach can also be considered as an ocean fertilisation experiment and these impacts should be taken into consideration when assessing the pros and cons of olivine dissolution," continued Köhler.

The researchers also investigated whether the deposition of olivine could counteract the problem of ocean acidification, which continues to have a profound effect on marine life. They calculate that about 40 gigatonnes of olivine would need to be dissolved annually to fully counteract today's anthropogenic CO_2 emissions.

"If this method of geoengineering was deployed, we would need an industry the size of the present day coal industry to obtain the necessary amounts of olivine. To distribute this, we estimate that 100 dedicated large ships with a commitment to distribute one gigatonne of olivine per year would be needed.

"Taking all our conclusions together – mainly the energy costs of the processing line and the projected potential impact on marine biology – we assess this approach as rather inefficient. It certainly is not a simple solution against the global warming problem." said Köhler.

More information: 'Geoengineering impact of open ocean dissolution of olivine on atmospheric CO_2, surface ocean pH and marine biology', Peter Köhler et al 2013 *Environ. Res. Lett.* 8 014009. iopscience.iop.org/1748-9326/8/1/014009/article

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