The potential impacts on biogeochemical cycles of ocean CO_2 sequestration

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The ocean covers 70% of the earth's surface and has absorbed roughly 30% of anthropogenic CO_2 emissions into the atmosphere. Ocean CO_2 sequestration (injection to and storage in the bathypelagic layer of 1,000-3,000 m depth) is a climate change mitigation option to curb the rapid increase of atmospheric CO_2 that actively utilizes the long-term potential of the ocean to retain extremely large amounts of CO_2. While geological CO_2 storage is the option to entrap CO_2 in confined space, ocean sequestration utilizes open environments of the ocean. More rigorous cautious assessments of the potential impacts of the marine environments are needed. As well as the acute influence on marine organisms and habitats, considering a long-time and large scale operation of ocean CO_2 sequestration, it is essential to assess the chronicle impacts on marine biogeochemical cycling which maintains the carbon storage potential of the ocean.

The bathypelagic layer is recognized as the important site of various biogeochemical processes in conjunction with oceanic carbon transport and transformation, including dissolution of sinking particles, degradation of organic matter and regeneration of nutrients. In promotion of ocean CO_2 sequestration, careful and sufficient assessments are needed for the impacts of the elevated CO_2 concentration and acidification of seawater on these processes. We have investigated the potential impacts of ocean CO_2 sequestration on rates and extents of dissolution of $CaCO_3$ particle and bacterial activities by laboratory experiments and model simulations. Model simulation of dissolution kinetics of $CaCO_3$ particle for a practical case scenario of ocean CO_2 sequestration in the western Pacific revealed that the influence on sinking flux of $CaCO_3$ is quite moderate. Activity of bacteria, the major promoters of organic matter degradation in marine biogeochemical cycle, was relatively invariable within the range of predicted acidification due to ocean CO_2 sequestration, while the community structure was supposed to be changed in the relative abundance of eubacteria and archaea.

In this presentation, we will review above previous studies and introduce some newly interesting findings in our laboratory experiments on some biogeochemical parameters of ocean CO_2 sequestration: 1) the effect of acidification on the activities of hydrolytic enzymes including leucine aminopeptidase, alpha-glucosidase, beta-glucosidase, lipase and phosphatase and 2) degradation and transformation of model substances of organic matter. The results suggested that CO_2 related acidification leads 1) suppression of degradation of some peptidic components, 2) production of organic aggregates and change in relative abundance of bacterial living forms (free and attached).