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Carbon Dioxide Sequestration

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Abstract

Predictions of increasing levels of anthropogenic carbon dioxide (CO₂) and the specter of global warming have intensified research efforts to identify ways to sequester carbon. A number of novel avenues of research are being considered, including bioprocessing methods to promote and accelerate biosequestration of CO₂ from the environment through the growth of organisms such as coccolithophorids, which are capable of sequestering CO₂ relatively permanently.

Calcium and magnesium carbonates are currently the only proven, long-term storage reservoirs for carbon. Whereas organic carbon is readily oxidized and releases CO₂ through microbial decomposition on land and in the sea, carbonates can sequester carbon over geologic time scales. This proposal investigates the use of coccolithophorids ? single-celled, marine algae that are the major global producers of calcium carbonate ? to sequester CO₂ emissions from power plants. Cultivation of coccolithophorids for calcium carbonate (CaCO₃) precipitation is environmentally benign and results in a stable product with potential commercial value. Because this method of carbon sequestration does not impact natural ecosystem dynamics, it avoids controversial issues of public acceptability and legality associated with other options such as direct injection of CO₂ into the sea and ocean fertilization. Consequently, cultivation of coccolithophorids could be carried out immediately and the amount of carbon sequestered as CaCO₃ could be readily quantified. The significant advantages of this approach warrant its serious investigation. The major goals of the proposed research are to identify the growth conditions that will result in the maximum amount of CO₂ sequestration through coccolithophorid calcite production and to evaluate the costs/benefits of using coccolithophorid cultivation ponds to abate CO₂ emissions from power plants.

Table of Contents

	Page Number
Title Page	1
Disclaimer	2
Abstract	3
Table of Contents	4
Introduction	5
Experimental	5
Results and Discussion	5
Conclusion	6
References	6

Introduction

The objective of this project is to determine the efficacy of using coccolithophorid CaCO_3 production in CO_2 removal technology. This project will determine the methods and biological and chemical conditions needed to optimize the native ability of coccolithophorid algae to sequester CO_2 in the form of CaCO_3 . The initial task of the research, which has been initiated, is to identify the species, cell strain and the specific growth conditions (e.g., temperature, light intensity, nutrient concentrations) that maximize population growth rates and rates of calcification. Different coccolithophorid species (including the bloom-forming species, *Emiliana huxleyi* and *Gephyracapsa oceanica*, and large-celled and low salinity tolerant *Pleurochrysis carterae*) will be tested to determine which species and, if appropriate, cell line, has the maximum growth rate under specified conditions.

Experimental

We have obtained two cell lines of the coccolithophorid *Emiliana huxleyi* and one cell line of the coccolithophorid *Gephyracapsa oceanica*. All three cell lines calcify and we are in the process of obtaining additional cell lines. We have ordered equipment and supplies to conduct experiments that investigate cell growth rates as a function of various growth media. We will determine which growth media yields the highest growth rate for each of the cell lines. These experiments will involve using different nitrogen sources (nitrate alone, ammonia alone, or both nitrate and ammonia), different concentrations of nitrogen, and different concentrations of trace elements. In addition, we plan to use these cell lines to test the hypothesis that coccolithophorids have an absolute requirement for selenium, as reported in the literature (Danbara and Shiraiwa, 1999).

Results and Discussion

We have begun tests of our methods to accurately measure calcification rates in coccolithophorids. Our data indicate that different methods must be used depending on 1) the population growth stage and concentration of discarded coccoliths in the water, 2) the cell density, and 3) the calcification rate of the cells.

Plans for the next six months include:

- o Obtain additional cell lines of calcifying coccolithophorids;
- o Continue experiments to test methodology for the accurate measurement of calcification rates;
- o Initiate experiments to determine if the addition of selenium enhances cell growth rates;
- o Determine the nitrogen source and concentration in growth media that provides the highest rates of growth in the three species and various cell lines of *Emiliana huxleyi*; and

- o Initiate experiments to investigate the effects of different phosphorus loadings on coccolithophorid growth rates.

Conclusion

During this initial period, we have acquired three cell lines of two different species of coccolithophorids. All three cell lines consist of calcifying cells. We have order equipment and supplies needed for experiments to determine which growth media yields the fastest growth rate for each of the cell lines. Initially, we are focusing on the effects of different nitrogen sources and total nitrogen concentrations and different concentrations of trace elements. In summary, the project has been initiated and a plan of work for the next quarter has been developed.

References

Danbara, A. and Shiraiwa, Y. (1999) The requirement of selenium for the growth of marine coccolithophorids, *Emiliania huxleyi*, *Gephyrocapsa oceanica* and *Helladosphaera* sp. (Prymnesiophyceae). Plant Cell Physiol. 40(7): 762-766.