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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	5
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 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.

Experimental

Since the last quarterly report dated September 10, 2001, we have continued a suite of experiments designed to determine the optimal growth media for the three coccolithophorid species (including several cell lines of the bloom-forming species, *Emiliania huxleyi* and *Gephyracapsa oceanica*, and a species which was isolated from low-salinity water, *Pleurochrysis carterae*) we currently maintain in culture. Specifically, we are investigating the impact of different forms and concentrations of nitrogen, phosphorus, trace metals, and chelator enrichments on growth rate and extent of cell calcification.

Results and Discussion

Preliminary data indicate that most, if not all, of our cell lines grow faster in K media (Keller *et al.*, 1987), as opposed to F/50 media (Guillard, 1975). The major differences between K media and F/50 media are that, relative to F/50 media, K media contains more chelators, contains nitrogen in the form of ammonium as well as nitrate, and contains selenium. Of these differences, preliminary experimental results suggest that the addition of selenium is particularly important. Thus far, our early results suggest that individual cells in noncalcifying cell lines are larger and grow faster in media containing selenium. We are in the process of testing whether selenium produces similar results in calcifying cell lines of coccolithophorids.

Conclusion

We have continued experiments to develop a growth media for specific cell lines of previously acquired coccolithophorids that will maximize cell growth rate and calcification. These experiments investigate the affects of different forms and concentrations of nitrogen, phosphorus, trace metals and chelator enrichments on cell growth rate and calcification. We plan to continue these experiments in the next quarter.

References

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