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ANNUAL PROGRESS REPORT DOE CONTRACT NO DE-AT06-79EV10206
GEOCHEMICAL DETERMINATION OF BIOSPHERIC CO₂ FLUXES TO THE ATMOSPHERE

Principal Investigator: Minze Stuiver

Contract Starting Date: June 1, 1979

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The objective of the research is to increase the knowledge of past biospheric carbon reservoir changes that have resulted in increases, or reductions, of atmospheric CO₂ levels. The research program was approved in July 1979. This progress report covers about 7 months of work. The research has been mainly developmental, and includes the following:

1. Tree sections were obtained from several Pacific coastal areas. Isolated trees were sampled because carbon dioxide produced under a forest canopy, by soil and root respiration, can influence the ¹³C/¹²C record in tree-rings. Several tree sections were collected from remote islands near Kodiak island, and near Sitka, Alaska; Graham Island, British Columbia, and Vancouver Island, British Columbia. Tree sections were also collected on Tierra Del Fuego, Chile, and in the El Paine national park on the mainland. The carbon isotope ratios of the Chilean samples especially should reflect marine conditions because the vegetation is sparse and there is nearly always a very strong circulation of marine air. Trees growing at our preferred sites (near the coast, with prevalent sea winds, and isolated, with canopy effect) tend not to become very old. The ages of the oldest trees collected at the above sites are about 150 years. Such ages are sufficient for the study of 19th and 20th century anthropogenic effects, but do not provide information on long term natural variability in ¹³C isotope content. For the study of long term changes one has to resort to trees grown under more favorable conditions. Several trees, (Douglas Fir and Sequoia) up to 2000 years old, are in our possession for the study of long-term ¹³C variations. Sections of bristlecone pine trees also are being acquired. The collected tree sections were dendrochronologically dated by Harriet Garfinkel of the University of Washington's Department of Forestry under the supervision of Dr. L. B. Brubaker.

2. A CO₂ sample preparation line was constructed during the first few contract months. Chris Bowler was hired as a technician in October. Testing of the sample line showed initially insufficient reproducibility of isotope ratios. Subsequently, the CO₂ purification portion of the sample line was improved, and with the additional experience of our technician ¹³C ratios can now be reproduced within 0.05 per mill for fixed amounts of cellulose. One remaining problem is the dependency of the measured isotope ratio on the amount of sample material. This problem is not critical for our measurements because the same amount of material will be used for all samples. It could, however, explain some of the so-called inter-ring ¹³C sample variability experienced by others. The dependence of ¹³C isotope content on sample weight is still being investigated. New parts for our 1965 vintage mass spectrometer were acquired. Some parts that were already ordered in the summer of 1979 have still not been delivered. The units will be installed upon receipt of all components.

3. In cooperation with Dr. Strain at Duke University, a series of Douglas Fir trees were grown under controlled environmental conditions. The first set of trees were harvested during the week of February 10-17. The experiments will provide critical information on the relationship between ¹³C/¹²C isotope ratios and temperature.

4. R. L. Burk finished late November his thesis entitled "Factors affecting ¹⁸O/¹⁶O Ratios in Cellulose" at the University of Washington. This work shows the relative importance of temperature and humidity changes on oxygen isotope ratios in tree rings. The use of oxygen isotope ratios, in conjunction with ¹³C/¹²C ratios, will add important climate information to the CO₂ research.

5. A Carle Analytical Gas Chromatograph for the determination of absolute atmospheric CO₂ levels has been acquired, and is presently installed. As a

post-doctoral fellow, R. L. Burk will be in charge of those aspects of the program where biospheric CO₂ fluxes are monitored in conjunction with the isotope ratio studies in cellulose.

6. N.S.F. funded research resulted in two major papers: M. Stuiver and P. D. Quay, Changes in Atmospheric Carbon-14 Attributed to a Variable Sun, Science, 1980, 207, 11-19 and M. Stuiver, Solar variability and Climatic Change during the Current Millennium, Nature, in press. The knowledge gained is presently applied to the DOE research. Through carbon reservoir modeling, we are now deriving a baseline for the natural atmospheric ¹⁴C levels of the twentieth century. Also a fifty odd high-precision ¹⁴C measurements have been made on the Douglas Fir wood of the 20th century. These measurements, in conjunction with the natural ¹⁴C base line study, will provide, for the first time, an estimate of the real change in ¹⁴C level that can be attributed to fossil fuel CO₂ release. The work is at an advanced stage, and a paper should be ready in 1980.