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Is the Postglacial artificial?

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Abstract—Interglacial temperature maxima for which radiometric dating has provided absolute ages appear to have occurred at times of high orbital eccentricity, high axial obliquity, and when northern summer occurred at perihelion. The present high-temperature interval (the Postglacial) is anomalous for, today, eccentricity is low, obliquity is intermediate, and northern summer occurs at aphelion. It is suggested that the Postglacial may have been caused not by natural events but by widespread forest burning by prehistoric humans. A new technique is described that can test this hypothesis. It involves simultaneously determining the concentration of inorganic particulate carbon in deep-sea sediments and its isotopic composition.

INTRODUCTION

THE PEAKS OF THE oxygen isotopic curve obtained from deep-sea cores, corresponding to major interglacials, occurred at times when both the eccentricity and obliquity of the Earth's orbit were high and when northern summer occurred at perihelion (EMILIANI, 1978, Fig. 2). On the other hand, the minima, corresponding to major glaciations, occurred at times when both eccentricity and obliquity were low (the Earth's orbital position during northern summer was evidently unimportant at times of low eccentricity). Isotopic stages 1, 3, and 4 are different. The glaciation of stage 4, as shown by the isotopic curve, was considerably less significant than that of stage 2 and of the earlier even stages. This apparently resulted from obliquity being low but not eccentricity (BERGER, 1978). Stage 3, with conditions intermediate between glacial and interglacial, coincided with a time of low eccentricity, high obliquity, and the occurrence of northern summer at aphelion. As for stage 1, which exhibits an isotopic maximum as high as those of stages 5, 7, and 9, there is no coincidence of high eccentricity, high obliquity, and the occurrence of northern summer at perihelion.

Today, the northern ice is gone (Greenland excepted) and temperature is high, but eccentricity is low, obliquity is intermediate, and northern summer is occurring at aphelion. The Postglacial should not have happened: semi-glacial or glacial conditions should have continued until the next coincidence of the three astronomical parameters, not due to occur for another 60,000 (or perhaps 160,000) years (BERGER, 1978, Fig. 4e). The present should have been the longest ice age of all, with a total duration of 100,000 years or more.

THE POSTGLACIAL

Instead of a continuing ice age, deglaciation began about 16,000 years ago. Oxygen isotopic analysis of Gulf of Mexico cores indicates that the waning of the North American ice sheet accelerated between 16,000 and 12,000 y BP, with giant floods down the Mississippi Valley (KENNETT and SHACKLETON, 1975; EMILIANI *et al.*, 1975, 1978; LEVENTER *et al.*, 1982; SHAW, 1989). Tundra was rapidly replaced by coniferous and broadleaf forests in both Europe and North America during the Allerød-Two Creeks interval (12,000 to 11,000 y BP). The discharge of the Mississippi decreased by 30% between 11,000 and 10,000 y BP, when retreating ice opened the St. Lawrence waterway (EMILIANI, 1957; BROECKER *et al.*, 1989). After a minor readvance (Cochrane, 8500 y BP), possibly an ice surge, deglaciation went to completion.

The Allerød-Two Creeks interval was a time of affluence for prehistoric humans, who had spread through both the Old and the New World, finding abundant wildlife everywhere. Prehistoric humans appear to have used fire extensively to flush animals out of the forests. A 200 km-long burnt layer, dating from 12,550 y BP, has been found along the Nile valley (WENDORF and SAID, 1970); and carbon-rich sediment layers dating from 11,000 to 10,000 y BP are found along a belt reaching from western North America through Europe to eastern Siberia (see BRACKENRIDGE, 1981, for a summary). The use of fire continued as agriculture developed, to clear land and for slash-and-burn cultivation.

Forest fires produce both carbon particles (graphitic carbon) and soot (particles consisting of carbon plus organics, resulting from incomplete combustion). Soot and graphitic carbon particles range

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in radius from 0.01 to 1 μm. Graphitic carbon and mineral particles (dust) in this size range scatter, rather than absorb, solar radiation. Soot, with the virtual portion of the index of refraction as high as 0.7 (BACH, 1976), is, on the other hand, a powerful absorber of both solar radiation and radiation backscattered from the ground (ANDREAE, 1983). It has the effect of warming up the lower troposphere (ENSOR *et al.*, 1971; KELLOGG, 1980) as it is mainly confined to this atmospheric layer (CRESS, 1982). Is it possible that, by burning forests each summer, the expanding human population caused the disappearance of the ice from the northern continents and created in fact an artificial interglacial?

We suggest that the burning of a few percent of the mid-latitude forest each year may have been sufficient to terminate the last ice age. Some 1.04×10^5 km^2 of timberland, representing 1.1% of the country's surface, were burned in the United States by wildfires in 1968, destroying 10.9×10^6 tons of plant matter (BACH, 1976). For a particle production efficiency of 0.032 (TURCO *et al.*, 1983), 3.5×10^{11} g or 3.5×10^{11} cm^3 (density $\sim$1 g/cm^3) of particles were produced. For a residence time in the atmosphere of one week (JAENICKE, 1981) and a mean particle radius of 0.05 μm (TURCO *et al.*, 1983), the surface covered by the standing crop of particles in 1968 was 3.5×10^{15} cm^2 (*cf.* ROSEN and NOVAKOV, 1983) or 3.7% of the surface of the United States. Albedo was proportionately reduced, depending upon the background terrain.

In late glacial times, the summer system of prevailing winds would tend to transport smoke particles over the residual ice sheets to the north in both North America and Eurasia, thus reducing the ice sheet albedo by several percent. In addition, forest fires are likely to have occurred mainly during the summer, providing a greater concentration of particles during the ablation season, with particles surviving for a while on the ice surface and continuing to affect albedo even after removal from the atmosphere. An important, related factor contributing to the temperature increase is the rapid addition of CO_2 to the atmosphere from the reduction in biomass (REINERS and WRIGHT, 1977) and as a release from the warming ocean surface. The forest fires also would have had the effect of destroying a major habitat of the northern megafauna.

Once the northern ice was gone, the Earth would have been in an interglacial mode in spite of the adverse astronomical configuration. The subsequent climatic evolution appears to have been largely conditioned by such human activities as deforestation and the injection of pollutants into the atmosphere. The climatic effects of these activities have been the object of numerous investigations. Contrary to the simple forest burning of prehistoric humans, these activities are multiform as well as inadvertent and, therefore, should tend to cancel out. Should one effect become climatically dominant, however, climate will be driven in the corresponding direction. In the short range (decades to centuries), continued CO_2 injection into the system and the time delay in ocean floor carbonate sediment reaction may lead to warmer temperatures and ice melting; in the longer range, when the tropical forest is removed and injection of pollutants in the atmosphere is reduced, glacial conditions could be reestablished. Here, we are not considering, of course, the "nuclear winter" of TURCO *et al.* (1983), which would result from a massive and instantaneous injection of smoke particles into the troposphere. (It should be noticed that, as the Earth is already in a glacial mode, a "nuclear winter" followed by rapid glaciation may require a much more modest nuclear event than the one envisioned by TURCO *et al.*, 1983.)

AN EXPERIMENT TO TEST THE HYPOTHESIS

The suggestion that the Postglacial may be artificial is subject to experimental verification. SMITH *et al.* (1973) found significant amounts (0.02 to 0.1 dry weight percent) of elemental carbon particles in the top 5–15 cm in deep-sea cores from the North Pacific and the North Atlantic, as well as much smaller amounts (<0.01 dry weight percent) at lower latitudes. We applied for, and received, a grant from the National Science Foundation to study the downcore distribution of carbon particles and compare it with the trend of the oxygen isotopic curve. We hoped that this study would yield a record of forest burning stretching back several hundred thousand years, against which the known climatic oscillations could then be gauged. At the same time, this study would test the suggestion that the postglacial may be artificial. For a start, of course, we had to develop a technique to isolate the smoke particles from all other sediment components, including kerogen. For a while this seemed to be an impossible task, but eventually we succeeded. The technique we have developed is straightforward and allows us to simultaneously determine the concentration and the isotopic composition of carbon particles in deep-sea sediments. This technique is detailed in Table 1.

The work we proposed to do on deep-sea cores could not be done, however, because a series of actions by the provost's office engulfed our depart-

Table 1. Preparation of Globigerina-ooze samples for elemental carbon analysis

1. Dry samples at 80°C
2. Weigh
3. Determine bulk density
4. Disintegrate in triple distilled water
5. Add 10 cc of 1 N HCl
6. Heat to 80°C in water bath for 30 minutes
7. Rinse five times (centrifuge) in distilled water
8. Dry at 80°C in oven
9. Weigh and determine the percent of carbonate and salt
10. Add 5 cc of 1 N HF and 1 cc of 1 N HCl
11. Heat to 80°C in water bath for 30 minutes
12. Dry at 80°C in oven
13. Weigh and calculate the percent of silicates
14. Make concoction of 30% H_2O_2 and KOH to make pH 12
15. Add 10 cc of concoction to well ground, dry sample
16. Let stand for 24 hrs at room temperature
17. Rinse five times (centrifuge) in distilled water
18. Dry in oven at 80°C
19. Transfer residue to glass tube
20. Add 0.5 g of cuprous oxide
21. Flame to convert to CO_2
22. Analyze the CO_2 gas in mass spectrometer

Calibrated mass 44 peak height gives amount of CO_2 in sample, while the 45/44 ratio gives the carbon isotopic composition.

ment, destroying its infrastructure. Because it was not possible for us to complete the proposed research, we have decided to publish at least the technique that we have developed (Table 1) so that others may benefit (*cf.* WOLBACH and ANDERS, 1989, footnote).

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