Reports

from Albert and Alice Weeks Postdoctoral Fellows

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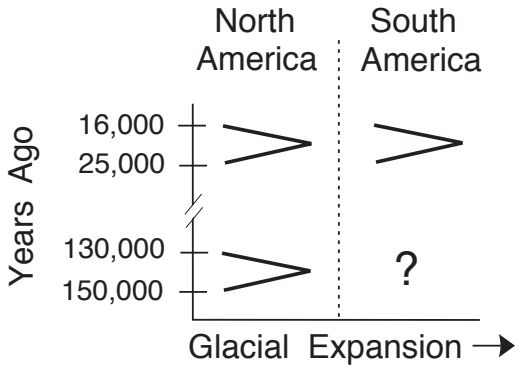
I am now in my second year as a Weeks Postdoctoral Fellow. A fundamental question my research is addressing is whether the ice ages in the Southern Hemisphere occurred at the same time as the ice ages in the Northern Hemisphere (for example, in Wisconsin). One might not expect ice-age conditions to be global in nature given that, over time, the amount of solar energy received is out-of-phase between the Earth's polar hemispheres (e.g., the seasons are out of phase). Despite over a century of research, there are still many areas on Earth, such in South America, where we still have a limited knowledge of when glaciers expand and retreat and when ice-ages occurred, even in the "relatively recent" Late Quaternary Period. This lack of knowledge can often be attributed to dating problems; simply, fossil organic material for carbon-14 dating cannot be found in many areas or glacial deposits are older than the upper limit of this chronologic method which is about 40,000 years. Towards this end, my project, with Professor Bradley Singer and PhD student Daniel Douglass, is using state-of-the-art methods to determine the ages of the various glacial deposits, and thus glacial events, in mid-latitude Argentina and Chile. In this region the geologic record of glacial expansion is one of the most complete in the world. We are collaborating with scientists at the Woods Hole Oceanographic Institution (WHOI), in Argentina, and in Chile.

I am primarily employing a relatively new method to determine the ages of the glacial deposits, younger and older than 40,000 years, that does not require organic material such as needed with carbon-14 dating. Rock surfaces exposed to the atmosphere are continuously bombarded by cosmic radiation, producing a variety of cosmogenic nuclides in mineral lattices including ^{10}Be and ^{26}Al. The duration of exposure to the atmosphere is determined by measuring the number of cosmogenic nuclides that have accumulated in minerals and dividing by reasonably well constrained production rates. This method has successfully been used by geologists to date glacial deposits, rates of fault movement, and the timing of earthquakes, floods, and landslides. In my first year as a Weeks Postdoctoral Fellow, I set up a facility in the Department of Geology and Geophysics for extracting ^{10}Be and ^{26}Al from rock samples. Last spring, the actual measurements on our Argentine samples were carried out on an accelerator mass spectrometer, in Livermore, California, only a few of which exist in the world for such analyses.



The main finding, based on this initial set of measurements, is that glaciers underwent major expansion in South America between about 25,000 and 15,000 years ago. The significance of this finding is that ice-age conditions occurred despite a period of rising and peak solar energy received in the Southern Hemisphere. However, this period coincides with the timing of low solar insolation and major glacial expansion in North America. In other words, evidently, both hemispheres experienced synchronous ice-age climate changes that were paced by how much solar energy was received in the Northern Hemisphere. I presented these results and the implications at three international meetings. I was an invited speaker at two of these meetings, in La Serena, Chile, and the other at the Lamont Doherty Earth Observatory of Columbia University in New York. The third meeting was the Geological Society of America National Meeting in Boston. In addition, D. Douglass presented the results along with his soils research in the area.

The present phase of my research is testing the hypothesis that "global ice ages" are the rule and not the exception, despite differences in solar energy received between the hemispheres. I am determining the age of the glacial deposits older than 25,000 years. Our ultimate goal is to understand how glacial periods and ice-age climates relate between the Northern and Southern hemispheres. Understanding to what extent, and why, the Northern Hemisphere may have dominated the entire Earth's climate during glacial periods will require adequate global spatial coverage of well-dated geologic records such that obtained by our group in Argentina. Finally, such studies, of the past climate system, provide the best context in which to compare any recent and future environmental changes, such as the human-induced global warming.