earth sciences

From our reporter at the meeting of the American Geophysical Union in Washington

An upside down North America

Past travels of a continent can be inferred from the magnetism of its ancient rocks, which gives the continent's position relative to the pole at the time the rock solidified. For the Precambrian era, which ended 600 million years ago, few rocks have been found, and data on which continental paths for this era can be reconstructed is therefore sparse. Paths that have been reconstructed show sudden, radical changes in direction.

Edwin E. Larson, Richard Hoblitt and Richard Reynolds of the University of Colorado and Felix E. Mutschler of Eastern Washington State College analyzed a number or Precambrian rocks from Colorado, Arizona and Wyoming and added their new data to previous data for North America. Then, instead of drawing a single line through these data points, they did a statistical analysis to derive a wide path within which there was a 95 percent probability that the continent had traveled. Their method smoothed out sharp curves, giving what they believe is a much more logical motion. Their results show that at 2.5 billion years ago the continent was in the "southern" hemisphere and was upside down. It then moved northward in a wide curve, undergoing first clockwise and then counterclockwise rotation over a period of 3 billion years.

What data there are for the other continents, says Larson, show a similar path. The researchers believe the continents were together during the Precambrian and Paleozoic eras (to 230 million years ago) and that continental breakup was a catastrophic and anomalous event that first occurred 200 million years ago. Explanations of mountain-building and other large-scale tectonic processes that occurred before this time should, they contend, be based on mechanisms other than relative motions between plates.

Volcanism and ocean currents

Ash from volcanic eruptions that has become trapped in ocean sediments has been used to infer not only past volcanism but also movements of continents. W. F. Ruddiman and L. K. Glover of the U.S. Naval Oceanographic Office propose that some volcanic sediments can also reveal past ocean circulation.

In North Atlantic sediments are two zones of glassy volcanic shards, the result of Icelandic eruptions 6,500 and 65,000 years ago. These shards are too large to have been carried so far (up to 1,800 kilometers from the source) by wind. Also, the ash distribution patterns are inconsistent with wind transport: for example, there are places between the source and areas of peak abundance where there are no shards at all. The researchers believe that the shards fell on ice near the volcano and that the ice then floated southward, dropping shards as it melted.

From the distribution of these shards over the North Atlantic, the researchers infer that the ice floated in a counterclockwise path, first to the south-southwest and then eastward into the North Atlantic basin. From planktonic animals and algae mixed in with the ash sediments, they conclude that at the time of both eruptions the climate was colder than at present, enabling sea ice to drift farther southward that it now does.

Patterns of manmade particulates

One way of indexing the level of particulate matter suspended in the atmosphere is to monitor the atmosphere's electrical conductivity: the more aerosol, the greater the conductivity.

Conductivity measurements from ocean research vessels, reports William E. Cobb of the National Oceanic and Atmospheric Administration, confirm previous observations that most oceanic regions, far from sources of manmade aerosols, are maintaining a natural aerosol level unchanged by the activities of mankind. There are significant exceptions, however. Paths of aerosol pollution extend eastward from the United States over the North Atlantic, eastward from Japan over the North Pacific and southward from Asia over the northern Indian Ocean.

Cobb believes that because the trend is toward control of aerosol emissions, the manmade aerosols now detectable in ocean regions will begin to decline by the end of the century and any global climatic changes due to the current increase will be insignificant.

Sea-floor spreading in the Solomon Sea

The Woodlark Basin in the Solomon Sea may be a site of previously undetected sea-floor spreading. W. B. Bryan, Ken C. MacDonald and Bruce P. Luyendyk of Woods Hole Oceanographic Institution report that a number of newly discovered geophysical clues point to that conclusion. The area is just east of the eastern tip of New Guinea.

For one, shallow earthquakes and magnetic anomalies occur along an east-west line. The sea-floor topography is very rugged and also has an east-west grain, as well as a central ridge. There is no sedimentation in the central part of the basin, and scattered heat flow measurements in the basin show above average values. Finally, fresh basalt of an oceanic type has been dredged up near locations where, according to these other clues, spreading may be occurring.

Magnetic anomalies suggest a spreading rate of 2.0 to 2.5 centimeters per year. From this rate and the width of the basin, the Woods Hole oceanographers estimate that spreading may have been occurring in the basin for 3 million years.

Revising magnetic polarity chronology

Knowledge of the chronology of reversals of the earth's magnetic field is essential to proper interpretation of magnetic polarity evidence for past movements of the continents.

To add greater detail to the early Cenozoic (70 million to 55 million years ago) paleomagnetic time scale, Richard J. Blakely of Stanford University analyzed magnetic profiles of ocean crusts of that age from widely separated regions of the North Pacific. His evidence suggests that at least three new polarity events, lasting less than 0.3 million years, occurred during that period. He points out that addition of these events to the time scale will affect statistical models of the reversal process, which are based on the frequency of occurrence and lengths of polarity intervals.