North America's remarkable margin

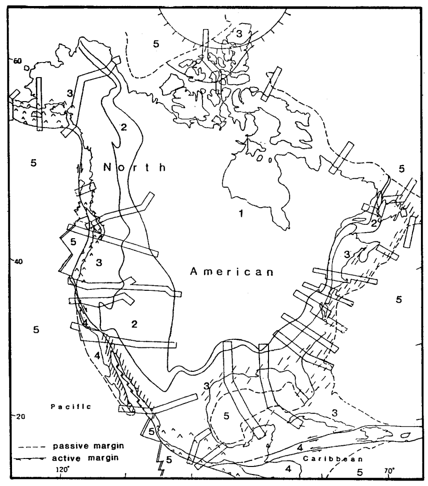
The map projected onto a screen facing hundreds of attentive geologists at last week's meeting of the Geological Society of America in New Orleans showed more than just the coastline. For their purposes in reconstructing the margin between the continent and the ocean, North America includes islands within the Arctic Circle and land beneath waters well off the coast of Baja California. It cradles the Gulf of Mexico like an enormous swimming hole between the southern states and Mexico.

The map represents the first synthesis of geophysical and geological data collected as part of the two-year-long North American Continent-Ocean Transects Program. More than 100 scientists worked in teams that focused on assorted chunks of the continental margin. They drew a total of 26 transects — vertical slices 100 to 200 kilometers wide — that slash across as many different kinds of earth structures along the margin as possible. Their goal is to increase understanding of the structure, motion and evolution of the continent between the thickest, most stable part — the North American craton — and the oceanic crust.

This vast transitional region embodies some of the thornier problems in geology. For more than 10 years, many scientists have thought that the theory of plate tectonics is too simple to explain some features apparent on the land masses. According to tectonic theory, as new, hot crustal material rises along ridges in the oceans, it pushes crustal plates apart. The plates head toward subduction zones where cold older crust is drawn back down into the mantle and recycled. The lighter continents are carried on top of the plates. After millions of years, they crash into each other, only to drift apart again with new oceans filling in the gaps.

For the most part, it is widely agreed, the theory is correct. But it turns out that plate tectonics is more than head-on collisions. There is lateral movement, too, as some pieces of land move parallel to continents, in the way that California west of the San Andreas fault is edging toward Alaska. As scientists study the complexities of tectonic history, they are finding that much of the land — for example, between the Pacific and the eastern edge of the Rockies — is made up of distinct pieces, or terranes, of rock that are not native to North America (SN: 11/17/79, p. 341; 1/3/81, p. 10). The main process at work is accretion as new material is pasted to the continent's edge. Scientists still are not clear what happens when a piece of land converges with the mainland, snuggling up to it rather than colliding.

The leader of the transects project, Robert Speed of Northwestern University in Evanston, Ill., commented that one benefit of the project is that it is more apparent to all participants that while different processes are building the eastern and western parts of North America, each side can be viewed, at least in part, as a reflection of the geologic past or future. The Atlantic margin is referred to as "passive," meaning that sediments are spilling from the land into the sea, but no subduction is occurring. Wide basins thick with sediment are forming at the same time as the crust beneath them stretches out in response to plate movements. When the Atlantic begins to close up again (it is opening now) these sediments will be deformed and shoved up in a replay of the process that brought us the Appalachians 700 million years ago. The land that makes up the Appalachians was once flat...a sedimentary basin.



North American Continent-Ocean Transects Program

Map of North America shows the most ancient part of the land mass (1), parts of that mass deformed in the last 600 million years. (2), ancient displaced pieces of land (3), land fragments in transit (4), and oceanic crust (5). Geometric-shaped swaths indicate study areas that transect the ocean-continent margin.

The margin along the West Coast and Central America is "active" where the Pacific Plate is being pushed beneath North America in much the way that the Atlantic margin was active millions of years ago. "We can't make direct one-to-one comparisons between the simple present-day margins and the ancient margin of North America," says Darrell Cowan of the University of Washington in Seattle. The value of the various transects, he says, is that they provide a cumulative impression: despite their different histories, they all share in the long sequence of plate movements.

The tangible products of the program will be the map of North America and two sets of cross sections that depict each transect in three dimensions. One set describes the upper five kilometers of crust — the zone in which geologists can be fairly confident about their interpretations. The other set, which shows what the researchers believe the swaths of land look like down to at least 50 kilometers, requires much bolder interpretations, Speed says, because relatively little is known of what occurs at depth.

— *C. Simon*

Sun starts to warm as spots fade

"The solar constant" is the technical term for the amount of solar energy per unit area arriving at the top of the earth's atmosphere. The very name testifies that astronomers used to have a high opinion of the constancy of the sun's output. In recent years the constant has no longer seemed so stable. Astronomers were told by William Livingston of Kitt Peak National Observatory that the sun was in fact cooling off (SN: 2/25/78, p. 118).

It seems now that any apprehensions about an indefinite continuance of this cooling can be put aside. Livingston reports in a recent announcement by Kitt Peak that the sun's temperature decline, which had amounted to about 5 kelvins, bottomed out in early 1981 and the temperature is now again on the rise. The conclusion comes from a reanalysis of data that Livingston recently completed. It took so long to notice the rise because scatter in the data made statistical analysis difficult. As Livingston puts it, "There is a lot of scatter in the individual observations and I need a long time base in order to confidently see any trends in the sun's temperature."

Livingston has been monitoring the sun's temperature since 1975 (SN: 11/13/76, p. 315). The method is to record the strength of an absorption line in the sun's spectrum (an ionized carbon line at 5,380 angstroms) that is very sensitive to temperature. Observations began at a time of sunspot minimum. The upturn came at the tail end of a sunspot maximum. (The spot count peaked in 1979, but remained high for months thereafter.) So the changes are being attributed to the number of sunspots. Sunspots are cool areas, and it does not seem unreasonable that the sun should look cooler to us when there are more spots on its face.

Sunspots are also magnetic phenomena, and there is a general theory by E. A. Spiegel of Columbia University and N. O. Weiss of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., that holds that high magnetic fields on the sun should cause a certain suppression of the outflow of solar radiation. Thus, when solar magnetic fields and sunspots are at a minimum, more energy should get through than when they are at a maximum. At the moment the data seem to be conforming to this expectation. Monitoring will continue to see whether they follow it over the rest of the cycle and perhaps longer.

—*D. E. Thomsen*