Sea-surface shape by satellite

Even if there were no winds, no waves and no currents in the ocean, the sea surface would not be flat and smooth. Just as there are hills and valleys on land, so there are large bulges and depressions — a real topography — to the surface of the ocean. The shape of this surface is dictated by the different gravitational tugs from the undersea mountains, ridges, troughs and other structures of varying mass that are distributed unevenly over the seafloor. "The ocean surface is like a blanket thrown over all that rugged terrain," says James G. Marsh. "... [T]he water will be pulled in or piled up around the mountains, causing a bump in the ocean surface." Likewise, troughs as deep as 60 meters form in the sea surface over submarine trenches because there is less mass in the trenches to attract the water.

Using satellite data, Marsh, a geophysicist at NASA Goddard Space Flight Center in Greenbelt, Md., and his co-workers have recently generated a new map of the global ocean surface, which reveals features on a much finer scale than any previous such map. Maps like these provide badly needed data on the southern oceans and remote ocean areas for which reliable information on the bathymetry (depth), gravity field and seismic imaging of the ocean bottom is scarce. And in better-studied areas, sea-shape maps enable scientists to infer the density and strength of the seafloor below. The maps also reveal new details of the ocean bottom. The most recent data show, for example, that the Eltanin fracture zone system in the South Pacific is much longer than previously thought, according to Marsh.

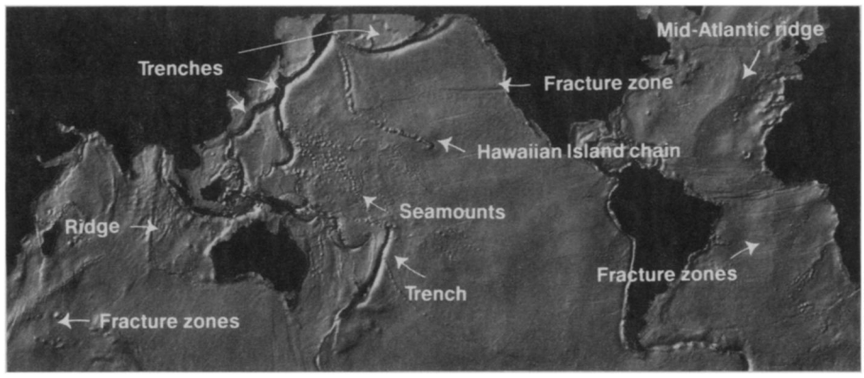
"The data set has been a very important augmentation to other geophysical data," he says. The recent measurements have "provided a global, uniform set of data so that we can now look at the oceans and earth as a whole."

Marsh's group worked with data collected during the flights of GEOS-3 (Geodetic Earth Observing Satellite) launched in 1975 and the SEASAT satellite launched in 1978. Each satellite carries an altimeter that uses radar pulses to measure the distance between the satellite and the ocean surface. The satellite's position relative to the earth's center of mass is also carefully tracked. The difference between the altimeter reading and the distance to the satellite at any one point gives the topography or height of the ocean relative to a reference surface in the shape of an ellipsoid.

Scientists using such data over the last decade have measured sea-surface bumps and depressions that deviate from the ellipsoid by as much as 100 meters. Because these larger features have been well documented, Marsh's group focused on detecting smaller features such as the shape of the water above fracture zones that slice through mid-oceanic ridges. "The computations are good enough to reliably see a feature that has an amplitude as small as 10 centimeters," a precision two to three times better than that of previous maps, according to Marsh. The sizes of features shown in the new map range from the 10-centimeter-high steps over some fracture zones to the 25-meter-deep troughs over trenches.

Much of the recent improvement in precision is due to advances in the determination of satellite orbits; these advances have also been responsible for the remarkable progress in geodetic studies, such as those measuring the motion of the earth's tectonic plates (SN: 12/21&28/85, p. 388). Scientists are looking forward to even greater precision with the TOPEX (Ocean Topography Experiment) satellite, which, if given the go-ahead in NASA's fiscal year '87 budget, would be scheduled for launch in 1991 (SN: 10/19/85, p. 250).

Unlike SEASAT and GEOS-3, which provided an averaged "snapshot" of the sea surface, TOPEX is designed to map the ocean shape as a function of time. This will enable scientists to watch ocean currents, which also produce a topographic relief on the sea surface. While many scientists are interested in learning about the ocean bottom from sea-surface studies, "there's even more excitement about using the altimeter for studies of the circulation of the ocean," says Marsh. "We're sitting on pins and needles waiting to see what Congress does [with TOPEX]." — *S. Weisburd*



NASA Goddard

Computer-generated image of the surface of the world's oceans. The topography of the water surface generally reflects the ridges, troughs and other features of the ocean floor. Satellite data were used to calculate the mean sea surface every 15 kilometers. Computer processing simulates the effect of light shining from the northwest.

Cleaning coal to cut acid rain

The Reagan administration has taken another step toward officially acknowledging that acid rain is a serious environmental problem that crosses national boundaries. In a report released last week, President Reagan's special envoy Drew L. Lewis, former transportation secretary, and William G. Davis, former premier of Ontario, recommend that the United States spend $5 billion over a five-year period to develop and apply new techniques for cleaning coal to reduce sulfur dioxide emissions.

"There should be no doubt that acidic air emissions are being transported through the atmosphere and over the U.S.-Canadian border," Lewis says to Reagan in a letter accompanying the report. "[T]ransboundary air pollution is causing serious environmental concern in both countries because of the ecological, economic and cultural value of the resources at risk."

The envoys argue that the development of cheaper yet highly efficient coal-cleaning methods would make it easier to formulate broad acid-rain control policies. Half of the funds for the proposed demonstration program would come from industry. However, whether the federal government can come up with its share during a period of automatic budget reductions isn't known. "Where are we going to get the money?" one official asked.

The report also drew complaints from environmental groups, including the Sierra Club. They were disappointed that it didn't set specific targets for reductions in sulfur dioxide emissions.

In contrast, electric utilities and the National Coal Association (NCA), based in Washington, D.C., endorsed the Lewis-Davis plan. Says NCA's Carl E. Bagge, "It is the only response that can be justified at this time, based on emission trends and continued scientific uncertainty." — *I. Peterson*