



SCRIPPS INSTITUTION OF OCEANOGRAPHY

UC San Diego

EARTH MATTERS *at* SCRIPPS

SCIENTISTS AT SCRIPPS OCEANOGRAPHY PIONEERED EARLY SCIENTIFIC EXPLORATION OF THE FUNDAMENTAL PROCESSES THAT SHAPE OUR



EVER-CHANGING PLANET. TODAY, EARTH SCIENTISTS AT SCRIPPS CONTINUE TO REVOLUTIONIZE OUR UNDERSTANDING OF EARTH—FROM SURFACE TO CORE—BY DEVISING NEW AND NOVEL APPROACHES TO STUDY IT FOR THE BENEFIT OF SOCIETY.



SCRIPPS SCIENTISTS ARE EXPLORING SOME OF THE MOST REMOTE ENVIRONMENTS ON EARTH, FROM DEEP-SEA VOLCANOES ERUPTING ALONG THE SEAFLOOR TO MAJOR EARTHQUAKE FAULTS LOCALLY THAT MAY PRODUCE THE NEXT “BIG ONE.” THROUGH RESEARCH, TEACHING, AND PUBLIC OUTREACH, SCRIPPS SCIENTISTS CONTINUE TO EXPAND OUR AWARENESS OF THE NATURAL PROCESSES THAT DRIVE OUR PLANET.





SCRIPPS' EARLY EXPLORERS



IN 1950, EARLY SCRIPPS EXPLORERS EMBARKED on the MidPac expedition in search of new understanding of oceanic processes and geology of the seafloor. Along the way, they discovered the Mid-Pacific Mountain Range and confirmed Charles Darwin's theory about the origin of atolls. Research on heat flow conducted during the expedition posed fundamental questions that were later resolved by the theory of plate tectonics.

Scripps scientists Harald Sverdrup and Walter Munk established the fundamental wave forecasting techniques that were used by Allied meteorologists during World War II to carry out the Normandy invasion.

In 1939, Sverdrup led an expedition to the Gulf of California aboard the Scripps research vessel *E.W. Scripps*, changing the scientific view of the region's seafloor by showing its southern part was comprised of steep ridges and deep basins and troughs.

CONTEMPORARY EXPLORERS

TODAY, SCRIPPS SCIENTISTS are building upon the strong foundation laid by early Scripps scientists to explore the earth in search of a greater understanding of the past, present, and future of the planet.

Helen Amanda Fricker, Scripps associate professor of geophysics, uses satellites and other remote sensing techniques to keep a watchful eye on rising sea levels worldwide.

A recent discovery beneath the West Antarctic ice sheet by Fricker has caused her to rethink the mechanisms that control the flow of ice streams into the ocean and their role in controlling sea-level rise.

Fricker and her colleagues uncovered a previously unknown system of subglacial lakes lying under the ice sheet, providing the first evidence that a connected system of lakes moves water quickly into and out of reservoirs underneath the ice. This activity may play a major role in controlling the rate at which ice moves off the continent and is part of an ongoing debate on rising sea levels worldwide as a result of global warming.

Some 90 percent of the world's ice is locked away in Antarctica's ice sheets. As rising atmospheric temperatures cause the ice to melt, Fricker and other Scripps scientists seek to improve the understanding of the region and what a future ice sheet collapse would mean to rising sea levels.

Jeff Babcock, Scripps geophysicist, heads a new center that melds geophysical and marine biological research to look deep inside San Diego Bay.

In response to growing environmental pressures on San Diego Bay and surrounding coastal regions, Babcock



and colleagues at the newly formed Center for Bay and Coastal Dynamics are using cutting-edge seafloor imaging techniques to develop the first detailed map of the geological features and biological habitats of San Diego Bay.

This research can improve scientific understanding of the relationships among physical dynamics, habitats, and marine life, and how natural and man-made sediment transport, from tidal forces to dredging, shapes the bay over time.

These scientific data can assist communities charged with managing the bay to make better-informed decisions to protect its natural environment and marine resources.



REMOTE PLACES

California's Shaky Future

SCRIPPS SCIENTISTS ARE ANALYZING the southern San Andreas Fault near the Salton Sea in Imperial County, Calif., a region of high-earthquake probability and known as one of the most tectonically active places in North America.

The team led by Scripps geophysicists Neal Driscoll and Graham Kent is using cutting-edge technology to study the scars and cracks along the bottom of the lake caused by the motion of faults. The Salton Sea is flanked by two major faults—the San Andreas and San Jacinto—and recent studies have revealed that the region has experienced magnitude-7 earthquakes roughly every 200 years for the last thousand years. Scripps researchers say it's been 335 years since the last quake, which suggests that a major earthquake in Southern California is imminent.

Information being uncovered by Scripps scientists at the Salton Sea as well as in other seismically active regions in California, such as Lake Tahoe, and around the world can help communities better prepare for the next “Big One.”

A Global Perspective

Scripps' Project IDA is the oldest, continuous network of seismometers in the world measuring the earth's vibrations. The information collected from the 40 stations is rapidly

improving scientific understanding of earthquakes and provides new information to assist in tsunami prediction systems and emergency response efforts. Scripps geophysicists Jonathan Berger and Peter Davis lead the network, which operates stations as far away as Kwajalein Atoll in the Pacific to the nearby Scripps Piñon Flat Observatory.

Early Warning of Earthquakes

From detection to warning, Scripps researchers are helping prepare for Earth's natural hazards.

Scripps scientist Yehuda Bock is testing a promising early-warning system for earthquakes and other geological hazards that could help save lives when the expected major earthquake finally happens in Southern California. Transmissions from the system, which consists of more than 80 GPS stations throughout Southern California, could outpace seismic waves, giving cities precious seconds to prepare.

NOVEL RESEARCH TOOLS

Monitoring Hotspots

SCRIPPS RESEARCHERS ARE EMPLOYING state-of-the-art ocean bottom seismometers to study the dynamic processes taking place along the seafloor.

By deploying a network of 64 seismic instruments on the ocean bottom off the coast of Hawaii and 10 portable seismic instruments on land for 15 months, Scripps researchers Gabi Laske and John Orcutt led the PLUME Experiment to detect changes occurring in one of the most prominent hotspots in the Pacific. About 50-70 hotspots exist throughout the world and the submerged hotspot of volcanic activity near Hawaii can be traced back to the Kamchatka peninsula in the Russian far east where the oldest, long extinct submarine volcano existed 80 million years ago.





CO₂ Buried at Sea

Scripps Oceanography researchers designed and built remotely-operated gravimeters to monitor carbon dioxide being sequestered beneath the ocean floor of the North

Sea. The CO₂ sequestration experiment is one of the largest attempts to lock away the greenhouse gas before it reaches the atmosphere.

Interest in CO₂ sequestration is growing as the United States and countries around the world look for ways to reduce their carbon footprints. Scripps researchers are learning how to apply similar techniques to monitor sequestration projects in other parts of the world.



Remote Magnetism

A pair of Scripps geophysicists has taken to the skies to explore the deep earth in a novel way.

Scripps researchers Jeff Gee and Steve Cande are using unmanned airborne vehicles (UAVs) to collect magnetic field data preserved along the seafloor in an effort to improve scientists' ability to map fluctuations in Earth's magnetic field.

The team used a pneumatic catapult to launch nine GPS-equipped UAVs from Scripps' research vessel *Melville* in a remote area of the southwest Pacific. The vehicles flew alongside the research vessel as it collected bathymetric and sea-surface magnetic data using traditional surface-towed magnetometer methods.

How You Can Help

Scripps Institution of Oceanography receives less than 14 percent of its budget from the state of California. We must rely on private gifts for new buildings, student fellowships, endowments, seed funding for new programs, and matching funds. With so many possibilities and challenges ahead, your support is more meaningful than ever.

Opportunities to support earth sciences at Scripps include

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