Sounding out the way fish hear

To submarine commanders, fish have an enviable ability to detect the sounds of predators and prey without necessarily making their own presence felt. In contrast, a submarine's sonar system, which sends out acoustic pulses and then detects reflections from nearby objects, signals the submarine's location as clearly as it finds its targets. Perhaps the U.S. Navy can learn a lesson from the way fish hear.

As part of a Navy effort to study fish hearing, researchers at the Georgia Institute of Technology in Atlanta have invented an underwater, ultrasonic technique for measuring how a fish's sound-sensitive organs respond to low-frequency sound waves. This technique is better than previous methods, says Georgia Tech's Mardi Cox, a mechanical engineer, because the fish's organs do not have to be removed or exposed for study. Experiments can be done on live fish.

Almost all fish have a swim bladder — a skinlike sack filled with gas, which allows a fish to adjust its density and control its distance from the water surface. In goldfish, a row of tiny bones called otoliths connects the swim bladder with the fish's inner ear. The swim bladder seems to function as a sound amplifier and transmitter.

"There's little information about how these organs respond to acoustic waves," says Cox, who with her colleague Peter H. Rogers described their research at last week's Acoustical Society of America meeting.

In their experiments, the researchers scan the immobilized body of a goldfish with a 10-megahertz sound source while subjecting the fish to a low-frequency sound wave of about 200 hertz. The fish's swim bladder oscillates in response to the low-frequency sound. A detector picks up the resulting echo. This signal reflects the swim bladder's motion.

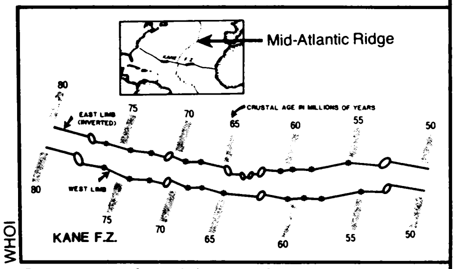
So far, the researchers have demonstrated that the system works. Swim bladder motions are clearly visible, although otolith movements have not been detected yet. Eventually, Cox and Rogers hope to detect displacements as small as 25 angstroms when the sound waves are focused to a spot on the fish only 0.2 millimeter across.

Rogers is particularly interested in testing a new hypothesis suggesting that a bony fish actually processes some data in the ear itself rather than in its central nervous system, as most theories had assumed. Rogers proposes that a goldfish's otolithic organs act somewhat like accelerometers, which provide information about a body's velocity in various directions. This would help fish "calculate" where sound sources may be located.

—I. Peterson

Crustal kinks record plate motions

The seafloor has been likened to a giant tape recorder, because as it is churned out conveyor-belt-style at mid-oceanic ridges, it becomes imprinted with the earth's changing magnetic field. The resultant "magnetic stripes" that line the ocean floor enable scientists to reconstruct the past positions of the continents as they, and the plates upon which they sit, move around the globe.



WHOI

Blockages (ovals) and changes in orientation (stars) of the fault trace occurred at the same times in these west and east limbs of the Kane fracture zone.

But these magnetic lines are not the only oceanic record of relative plate motions. Recent studies by Brian E. Tucholke and Hans Schouten at Woods Hole (Mass.) Oceanographic Institution indicate that the motions are reflected on a much finer scale in the structure of fracture zones that cut across ocean basins, perpendicular to mid-oceanic ridges. While Tucholke and Schouten have focused on one fracture zone, they suspect the structures of all fracture traces are very similar. What's more, the researchers think they see evidence in fracture zone structure for global changes in plate motions every few million years. They presented their findings at the recent meeting of the Geological Society of America in Orlando, Fla.

Using seismic reflection and bathymetry (seafloor depth) data, Tucholke and Schouten examined the detailed structure of two 700-kilometer-long segments situated on each side of the Mid-Atlantic Ridge. The researchers located spots where the fracture zone had changed direction or where it had been blocked — perhaps by the upwelling of molten rocks at times when changes in plate motion caused the crust near the ridge axis to be stretched out. They found that the kinks and bends on the western segment correlated remarkably well with similar structural changes in the eastern limb.

Tucholke and Schouten also compared a 450-km-long Kane segment straddling the ridge with similar segments in the Pacific and Indian oceans. "There are plate motion changes recorded in all of these oceans at roughly the same times — at about 4.5 million years, 2.5 million years and 1 million years," says Tucholke. "So what we're seeing at the Kane fracture zone is a global response."

Tucholke expects that more detailed studies will show crustal structure to be an extremely precise indicator of changes in plate motion. But what causes these changes is anyone's guess. "Perhaps the plates move like bumper cars and get hung up every 2 million to 3 million years," says Tucholke. "Where and why this happens is the $64,000 question."

—S. Weisburd

Bering ice: No floe flow


American Geophysical Union

The 86-kilometer-wide Bering Strait, between Alaska's Seward Peninsula and Siberia's Chukchi Peninsula, is normally a watery highway for the ice flowing north and south with the winds and currents. Satellite imagery shows that single arches of ice form across the strait many times during the winter season, but they are quickly destroyed by moving ice. However, smaller double arches that block the southward flow of ice were first seen on satellite photos from March 1979 (left). Review of satellite data, reported in the October Geophysical Research Letters, *found only seven episodes of double-arching during the past 11 years, each lasting from three to 27 days. The arches, with a common footing on the Diomede Islands in the center of the strait, apparently fail only when ice flux switches northward. Scientists postulate that the blockage, which occurs only between February and May, may modulate whale migration in the area.*