ice. The ocean's most frigid waters might have retreated far enough northward to allow continental midlatitudes (including Devils Hole) to warm, but not so far as to allow wholesale glacial melting, he says.

Winograd, though, continues to think that Devils Hole might be recording global climate changes. He says that if Edwards had checked more coral ages, the marine record might have fallen into line with Devils Hole. He notes that some corals from places such as Hawaii, Australia, and the Bahamas put the interglacial sea level rise as early as 134,000 years ago, and some maintain a high sea level as late as 110,000 years ago. "These dates, if correct, are clearly incompatible with [orbital] forcing," says Winograd. "If Edwards had re-dated these, that would have been new."

Edwards will be extending his testing of coral ages beyond Barbados, but he suspects that the anomalous ages found elsewhere will not hold up. Geochronologist James Chen of the California Institute of Technology, who produced some of the older dates, agrees with Edwards, saying those dates can be "peculiar" and "should not be taken too seriously."

Other records are also yielding new support for the orbital theory. Oceanographer Maureen Raymo of the Massachusetts Institute of Technology has dated marine cores without using the shorter orbital cycles to measure time. She simply assumed that sediment accumulated steadily between the oceanographers' three traditional dates and then combined the oxygen isotope records of 11 cores longer than 800,000 years. The average ages of the seven ice-age deglaciations in that interval came "very, very close to SPECMAP ages," she says.

Even a terrestrial source—Jewel Cave, 1500 kilometers north-northeast of Devils Hole in the Black Hills of South Dakota—seems to be lining up on the side of orbital pacing. Cave carbonates analyzed by Derek Ford and his colleagues at McMaster University in Hamilton, Canada, and Joyce Lundberg of Carleton University in Ottawa, put the end of the penultimate ice age between 131,000 and 129,000 years ago, with the interglacial warmth lasting until about 119,000 years ago. "We've got it pretty much nailed exactly where the ocean-core people put it," says Ford. If such claims hold up, the orbital theory of the ice ages will win a second round.

–Richard A. Kerr

MEDICAL IMAGING

New Technique Maps the Body Electric

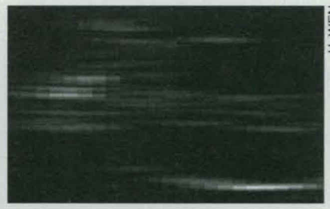
Medical imaging is built on gifts from physics, among them x-rays, nuclear magnetic resonance, and radioactive decay. Now, yet another imaging technology may be emerging from the physics world. At last month's Vancouver meeting of the International Society for Magnetic Resonance in Medicine, two National Institutes of Health scientists introduced Hall-effect imaging (HEI), a strategy for combining ultrasound with magnets and electrodes to map variations in the electrical conductivity of tissues.

Those variations may allow clinicians to distinguish tumors, fatty plaques, or areas of ischemia from normal tissue, something that's difficult with ordinary ultrasound. The technique also should provide better contrast than ultrasound, while retaining a cost advantage over magnetic resonance imaging, say the developers, Han Wen and Robert Balaban, of the National Heart, Lung, and Blood Institute. So far, the most complex specimen that Wen and Balaban have imaged is a pig kidney, but other medical-imaging specialists believe their technique could eventually have broad applications.

"This has the potential to be a very valuable approach to imaging," says Nathaniel Reichek, head of cardiology at the Allegheny General Hospital in Pittsburgh and a leader in the field of cardiac imaging. He notes, however, that "the approach stands just on the doorstep of development. It's a very long path from there to widespread use."

The method makes use of the Hall effect. Electric charges (for example, ions in biological tissue) follow curved paths when they move in a magnetic field. Because positive and negative charges curve in opposite directions, they diverge, giving rise to a so-called Hall voltage. In biological tissue, an ultrasound beam can create the motion while an external magnet imposes the field. The size of the resulting Hall voltage is determined largely by the tissue's conductivity.

To maximize the signal-to-noise ratio, Wen actually runs the system in reverse—applying voltage pulses through electrodes and picking up the resulting vibrations with an ultrasound detector. After some mathematical manipulation, the ultrasound signal gives a profile of the conductivity along the direction the detector is pointed. As with conventional ultrasound, the detector must be moved to collect a full three-dimensional image.



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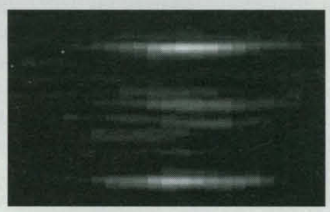

Lighting up. In a pig kidney *(above)*, Hall-effect imaging maps conductivity variations *(lower right)*, while conventional ultrasound *(upper right)* is sensitive to density.

Like ultrasound, HEI requires a continuous acoustic path from skin to imaged tissue, so it cannot see through bones or the air in lungs, for example. The technique also requires a magnet and a voltage pulser, which aren't needed for conventional ultrasound. But because HEI stimulates acoustic waves in the tissue, the ultrasound needs to travel only one way rather than round trip, as in conventional ultrasound imaging. That should give HEI deeper penetration and better resolution. Wen believes, however, that the method's real strength is its sensitivity to conductivity variations.

He explains that when conventional ultrasound imaging of the interior of a blood vessel reveals a bulge, for example, "it's very hard to tell whether that bulge is just a harmless fibrous lesion, or whether it's actually a more dangerous fatty plaque. Now, potentially you could use this technique, because there's a big difference in conductivity between these two types of tissue." Wen and Balaban also propose using HEI to observe the stages of tumor development, to diagnose ischemic (oxygen-deprived) heart tissue, and perhaps to distinguish breast tumors from cysts.

Last summer, Wen tested the system on a slice of bacon and found that it revealed the fat and muscle layers with greater contrast than ultrasound could; he has since moved on to pig kidneys. Before applying the system to entire animals, he wants to add an improved voltage pulser and real-time image processing. (Currently, the analysis must be done after the data are collected.) He plans to begin imaging animals within the next year.

Reichek thinks it's a worthwhile effort and hopes eventually to use HEI to diagnose scar tissue and other abnormalities of the heart: "Genuinely novel approaches to biological imaging don't come along all that often, and this is one of them."

–David Ehrenstein

David Ehrenstein is a science writer in Bethesda, Maryland.