Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

WHAT GOES AROUND COMES AROUND

LEAD FORMED AT ONE HYDROTHERMAL VENT FOLLOWS CIRCUITOUS PATH TO ANOTHER.

Scientists studying hydrothermal vents have found something all too familiar: pollution.

Marine geologist George Kamenov of the University of Florida at Gainesville and colleagues discovered an "anthropogenic influence" at the Marsili Seamount in the southeastern Tyrrhenian Sea. They published their results in the June 2006 issue of the journal *Marine Geology*.

Examining deposits retrieved from this underwater volcano near Italy, the researchers found lead that did not come from underlying rocks or from, said Kamenov, "any possible source in the nearby region, or anywhere in Europe."

Instead, he traced the lead to an Australian lead mine thousands of miles away. "This is another piece of evidence of how widespread our disturbance in the environment is," said Kamenov. "The fact that we can influence hydrothermal vent systems speaks for itself."

Hydrothermal vents lie far from land, thousands of feet below the ocean surface. Heated seawater in the vents naturally extracts metals from volcanic rocks. "Vent sediment is loaded with iron, lead, copper, zinc, and other metals," said Kamenov. "Hydrothermal venting is how some of the world's largest on-land metal deposits were once formed."

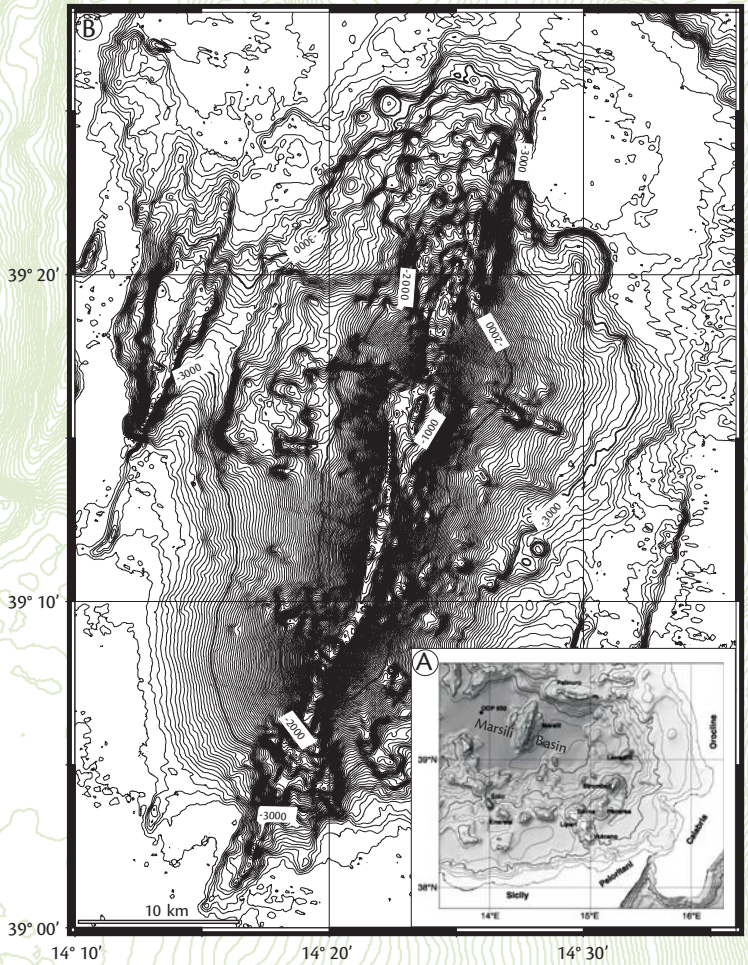
But when he and colleagues measured four lead isotopes in sediments from the Marsili Seamount, they discovered that the ratios didn't match those of any lead found nearby—"or found anywhere else in Europe," said Kamenov.

"The process is essentially the same as working with DNA," he said. "You take DNA from a strand of hair, then compare it to known DNA to see where it came from. That's how we used lead isotopes."

The Marsili Seamount lead, it turned out, is similar to that at one of the largest lead mines in the world—Australia's Broken Hill, the "capital of the Outback" in New South Wales.

How did it get into Sicilian waters?

Kamenov thinks the most likely scenario is that the lead was unearthed at Broken Hill and shipped to Europe, where it was added to gasoline, burned by cars and emitted into the air. "From there," he said, "the lead probably found its way into the sea, then to the Marsili Seamount, where it traveled with wa-



ter down into the Earth and then re-emerged via the hydrothermal vents."

The lead-containing sediment samples were taken from recent hydrothermal iron-oxyhydroxide precipitates (also called ochres) along the northeast part of the Marsili Seamount. The Marsili ochres, said Kamenov, resemble other iron-oxyhydroxide deposits from different tectonic settings in the world's oceans: off-axial seamounts at divergent plate margins, back-arc spreading centers, and arc settings. "The lead isotope signatures of these ochres tell us that not only is most, if not all, of the lead derived from anthropogenic sources, but allow us to conclude that most of these ochres were formed within the last 150 years," said Kamenov. "The time line is anywhere between the present day, and the beginning of Australian lead imports by Europe."

The researchers were able to detect the lead, they said, because the seamount's relatively low-temperature hydrothermal waters didn't dissolve it from underlying rocks.

Pollution from lead that came from Australia is well known in Europe, said Kamenov, "but this is the first time anyone has seen it in a hydrothermal vent.

"It's a 'nothing gets lost' tale. Millions of years ago, this lead was once hydrothermally precipitated in Australia. Then people extracted it, released it into the environment, and the same lead became recycled in another hydrothermal vent system and ended up in a different hydro-thermal deposit."

What goes around truly does come around.

AVOIDING TROUBLE IN THE DEEP SEA

Swift and wide-ranging actions are needed to conserve the world's deep seas, amid concerns that our exploitation of the open oceans is passing the point of no return, states a recently released (June 16, 2006) report by The World Conservation Union (IUCN): *Ecosystems and Biodiversity in Deep Waters and High Seas*.

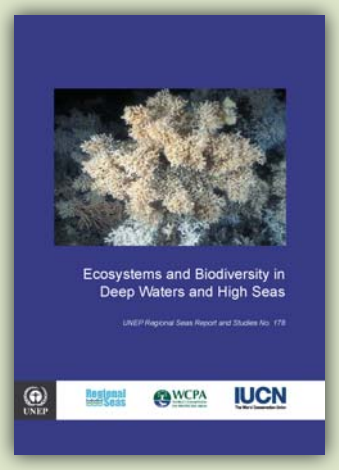
The call is made to governments around the world by the United Nations Environment Programme (UNEP) and IUCN. The report argues that the many lessons learned in conservation of nearshore, coastal ecosystems should be adapted and applied to the deep-sea and open ocean.

"Once largely limited to shipping, commercial activities in the open ocean and deep sea are rapidly expanding," said Kristina Gjerde, high-seas policy advisor to IUCN.

Among the report's findings are that conservation of marine biodiversity beyond national jurisdictions requires all nations and peoples to act together. For example, highly migratory species, the report states, "cannot be safeguarded without protecting their whole distributional range both in national and international waters."

Political will is particularly important, say Gjerde and colleagues who authored the report. "International coordination and cooperation at all levels is essential if we are to balance conservation and sustainable use," they found. "It should be considered whether and how actions taken in territorial and EEZ (Exclusive Economic Zone) waters could reinforce international action beyond national jurisdictions, and vice versa."

Implementing ecosystem-based management is critical, with an update needed of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), the legal framework applicable to all activities in oceans and seas.



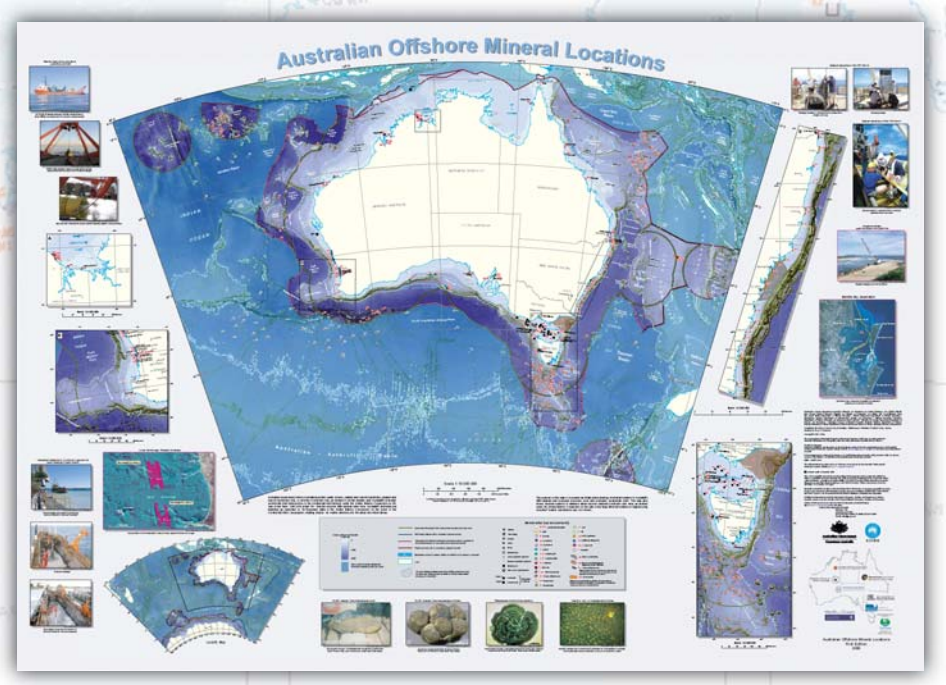
Management of the deep sea and open ocean should reflect ecological boundaries, according to the report, "and not just political boundaries"; incorporate best practices for ecosystem-based and precautionary management; address the full range of human impacts; identify areas in need of enhanced management to ensure a higher level of protection for vulnerable species and biologically significant areas; enable a system of Marine Protected Areas (MPAs); provide compliance and enforcement mechanisms; and "enable sustainable and equitable use today, while respecting the right of future generations to enjoy and prosper from the ocean's bounty."

Fostering the involvement of developing countries; improving data collection and exchange; accelerating scientific research; and raising awareness of the importance and value of deep-sea and open-ocean biodiversity, says the report, are crucial to conservation of these realms.

The future of organisms like the rare cold-water coral (*Lophelia pertusa*), shown on the report's cover, "depends on how we proceed today," said Gjerde.

The report may be found at: http://www.unep.org/pdf/EcosystemBiodiversity_DeepWaters_20060616.pdf.

DIAMONDS IN THE SEA'S DEPTHS



A COUNTRY'S BEST FRIEND?

X marks treasure on a map of the sea bottom off Australia, say some.

The world's first map showing the location of offshore minerals was released on August 10, 2006, by Australia's CSIRO (Commonwealth Scientific and Research Organization).

The map points the way to copper, gold, silver…and diamonds. The effort is a result of a research initiative between CSIRO's Wealth from Oceans Flagship and Geoscience Australia, along with CSIRO Exploration and Mining, and state and territory geological surveys.

"The Australian Offshore Minerals Locations map provides the first understanding of mineral locations on the seafloor around Australia," said Geoff Garrett, CSIRO chief executive. "At present, exploration and mineral production on land is a massive industry here, but Australia is only beginning to look at similar operations on the seafloor. There is now an exciting potential for a possible future marine minerals industry."

Wealth from Oceans Flagship director Craig Roy said that although Australia is the first country to develop an offshore map of this type, its development is, perhaps, overdue: "Australia's earliest recorded terrestrial [mineral] resource map was produced in 1799, so it has taken more than two centuries to refocus our attention. By building a picture of seabed minerals in tandem with ecological knowledge of these areas, we can ensure that we address any activities in a responsible manner, taking into account the long-term implications to our economy and the environment.

"The release of this map is an important and critical first step in developing public, government, and industry interest in offshore minerals."

The mission of Wealth from Oceans Flagship, according to government documents, is to "position Australia by the year 2020 as an international benchmark in the delivery of economic, social, and environmental wealth, based on leadership in understanding ocean systems and processes. Wealth from Oceans Flagship aims to provide Australians with access to the vast economic and social wealth of our ocean territories."

Australia's oceans now generate about $A52 billion per year, or about eight percent of the country's gross domestic product.

The oceans surrounding Australia make up almost twice the size of the nation's land area. "But 96 percent of this rich resource remains unused," state Flagship reports.

The Australian Offshore Mineral Locations map shows mineral deposits within Australia's 200-nautical-mile Exclusive Economic Zone and extended continental shelf.

Australia will have one of the largest marine jurisdictions in the world (14.4 million square kilometers) if the United Nations Commission on the Limits of the Continental Shelf agrees to Australia's submission on the outer limit of its extended continental shelf. This area is greater than Australia's total land area (13.6 million square kilometers).

CSIRO's Wealth from Oceans Blue GDP research program is also involved in the project. "Ocean-based industry development and growth—the 'Blue GDP'—has real potential to deliver huge economic and social outcomes to Australia," according to CSIRO reports. At present, a large component of Blue GDP's research focuses on oil and gas. Current estimates are that 89 percent of Australia's gas reserves and 86 percent of its oil reserves lie offshore.

Particular research on which Blue GDP scientists are concentrating involves developing environmentally friendly strengthening materials for use in drilling for gas and oil; investigating ways of extracting oil and gas without traditional platforms, especially in waters too deep for conventional technologies; tapping microbes to improve oil recovery; and finding new ways of detecting and mapping buried minerals.

On the recently released map, minerals shown include manganese nodules and crusts, shellsand, construction aggregate, heavy mineral sand, phosphorites, diamonds, tin, copper, gold, and coal.

The map makes it possible, said Garrett, to identify features such as manganese crusts and nodules on the East Tasman Plateau and South Tasman Rise, and shellsand and cobalt crust on the edge of the Ceduna Terrace where it descends to the South Australian Abyssal Plain.

For those with prospecting in their blood, the map may be viewed at http://www.ga.gov.au/image_cache/GA8484.pdf.

A VOLUNTARY CLOSURE OF DEEPWATER TRAWLING

FISHING COMPANIES FORM THE WORLD'S FIRST VOLUNTARY DEEP-WATER TRAWLING CLOSURES.

Fools' Flat, it's called, this deep-sea bank in the southern Indian Ocean. Here, strong upwelling currents sustain extensive coral beds and a profusion of other marine life.

But Fools' Flat, East Broken Ridge, Atlantis Bank, and eight other deep-sea areas almost became fools' gold: their resources were set to be trawled by deep-sea fishers, leaving little but broken coral in their wake.

In a global first, however, four major fishing companies announced on July 6, 2006, that they have called a voluntary halt to trawling in 11 deep-sea areas of the Indian Ocean. The action, it's believed, will conserve the marine life of the sea-bottom there in one of the world's largest marine protected areas.

"By setting aside an area almost equal to Australia's Great Barrier Reef National Park, these businesses are sending a clear signal that they want to keep fish on people's plates for generations to come," said Graham Patchell, a scientist at the Southern Indian Ocean Deepwater Fishers' Association (SIODFA). The association represents four companies: Austral Fisheries Pty Ltd (Australia); Bel Ocean II Ltd (Mauritius); Sealord Group (New Zealand); and TransNamibia Fishing Pty Ltd (Namibia), the main trawling operators in the Indian Ocean.

Using knowledge gathered over a decade of fishing activity in the Indian Ocean, and in consultation with scientists in the Fisheries Department of the United Nations Food and Agricultural Organization (FAO), SIODFA members have set aside 309,000 square kilometers of ocean floor where their vessels will no longer trawl. The combined zones form an area approximately equal to the size of Norway.

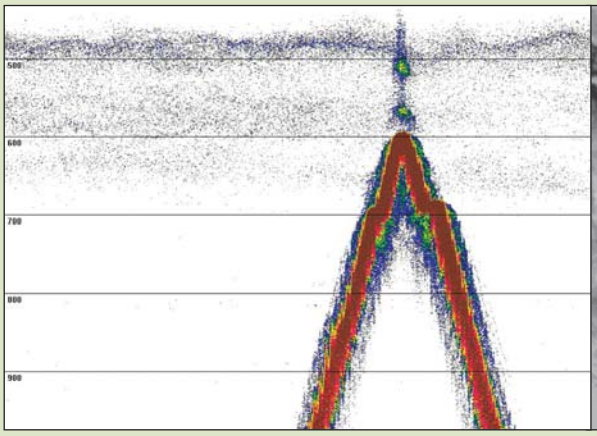
"Such deep-sea habitats are among the least-known areas of the oceans; by pledging not to fish in them, these companies have taken a great step toward sustainability," said Carl Gustaf Lundin, head of the Global Marine Programme of the IUCN.

To verify compliance with the self-adopted restrictions, the companies state that they will track their vessels' locations and activities via a satellite monitoring system. They have also agreed to share data collected when they formerly fished in these regions.

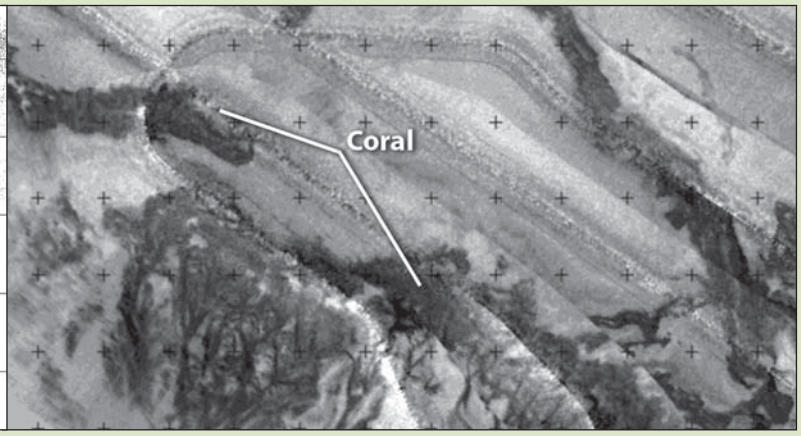
"The voluntary closures are a unique innovation for effectively managing and conserving deepwater biodiversity in high-seas areas, places where there are no management arrangements in place," said Graeme Kelleher of the IUCN's High Seas Task Force.

Commercially important deepwater species fished in the Indian Ocean include the very slow-growing orange roughy (*Hoplostethus atlanticus*) and three oreos (*Allocyttus niger, Neocyttus rhomboidalis, Pseudocyttus maculatus)*. In some areas, deepwater shrimp such as royal red shrimp (*Haliporoides spp., Solenoceridae*) may also have exploitable populations, although they have not supported ongoing fisheries.

Before these closures, the southern Indian Ocean had some 200 marine protected areas covering 77,000 square kilometers, but all were in national Exclusive Economic Zones. The seafloor areas voluntarily closed to bottom trawling cover almost four times that area. All are located in high-seas waters.



Sonardata Echoview acoustic echogram of a knoll on Broken Ridge, Indian Ocean, in the Benthic Protected Area (BPA) "Rusky." The two circular blobs are small schools of alfonsino (Beryx splendens) *and boarfish* (Pseudopentaceros *spp.). Image credit: Sealord Products Ltd.*



Side-scan sonar image of a Fool's Flat BPA (next to Rusky) on Broken Ridge, Indian Ocean. There are extensive coral beds here. The coral beds tower over the side of the ridge, and stand 30-m high in places. On echosounder records, these beds look like schools of fish, but they do not move. Hence, the region was called Fool's Flat. Extensive sediment and coarse sands cover the seafloor. Side-scan system used was the MR1 (12 kHz) of the Hawaii Mapping Research Group. Source: Graham Patchell.

CHERYL LYN DYBAS (cdybas@nsf.gov) is a staff member in the U.S. National Science Foundation's Office of the Director and is a marine scientist and policy analyst by training. She also writes on a freelance basis about the seas for *The Washington Post*, *BioScience*, *National Wildlife*, and many other publications.