The University of Texas at Austin
Environmental Science Institute

Hot Science - Cool Talk # 7

Voyage to the Bottom of the Sea

Dr. Henrietta N. Edmonds
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H.N. Edmonds, Alvin 2465, 1991

Hydrothermal Vents

High temperature (350˚C) geysers on the ocean floor — known as “black smokers” due to the presence of black particles which form when the hot water exits chimney-like structures and mixes with seawater

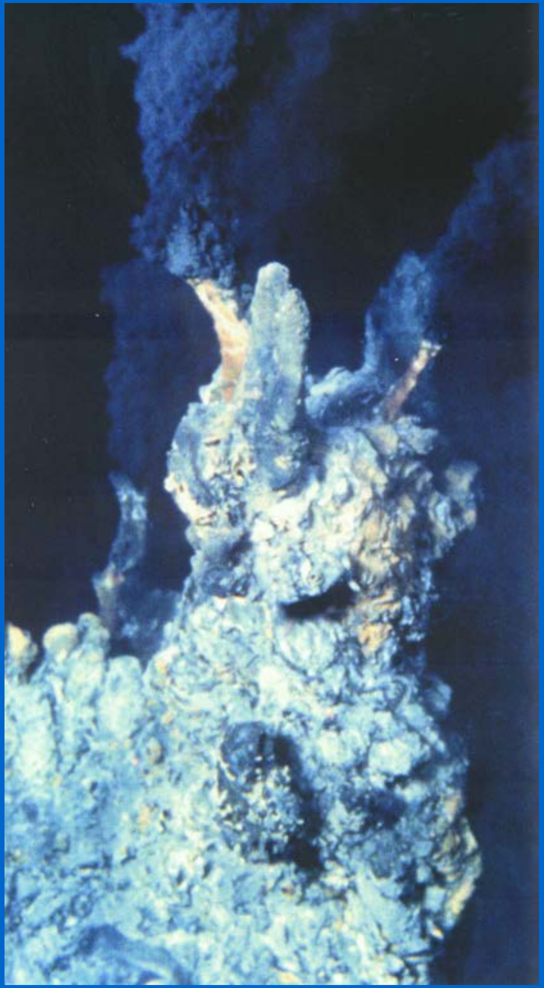


photo from Oceanus magazine, 1998

Hydrothermal Vents

Fantastic communities of never before seen — or imagined — creatures

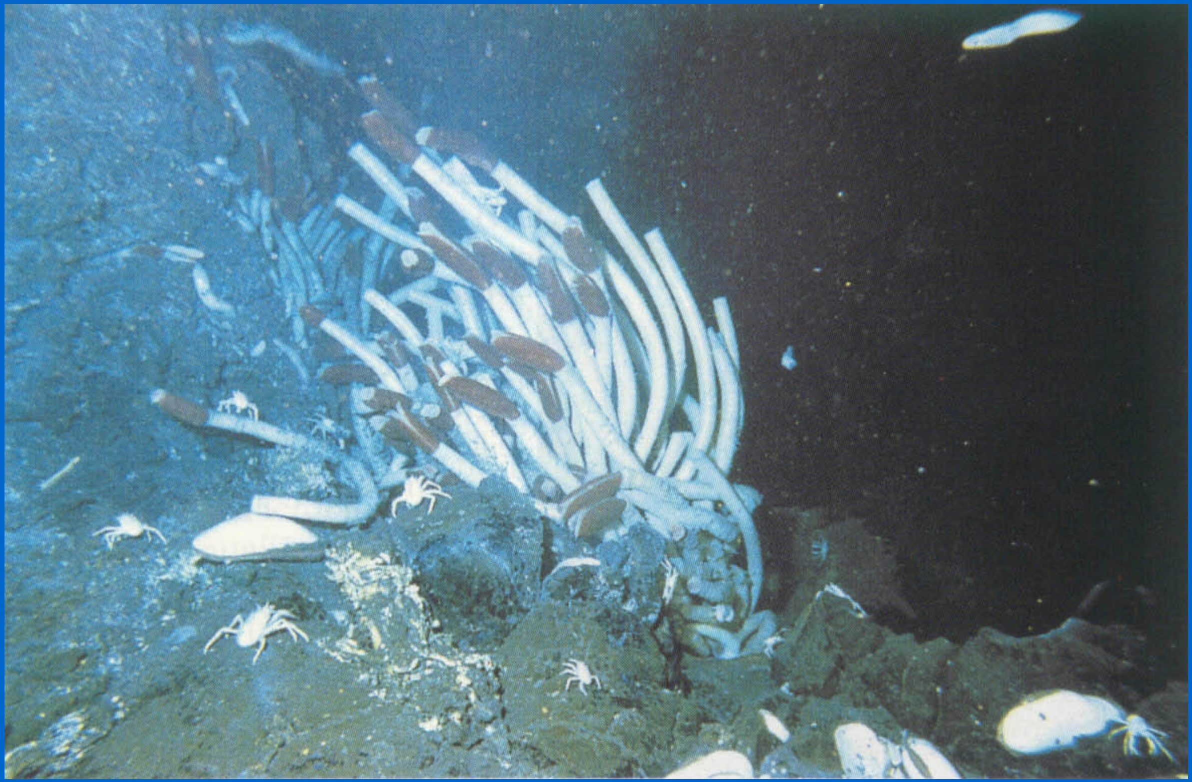


photo by Rich Lutz, Rutgers University

How did we get here?

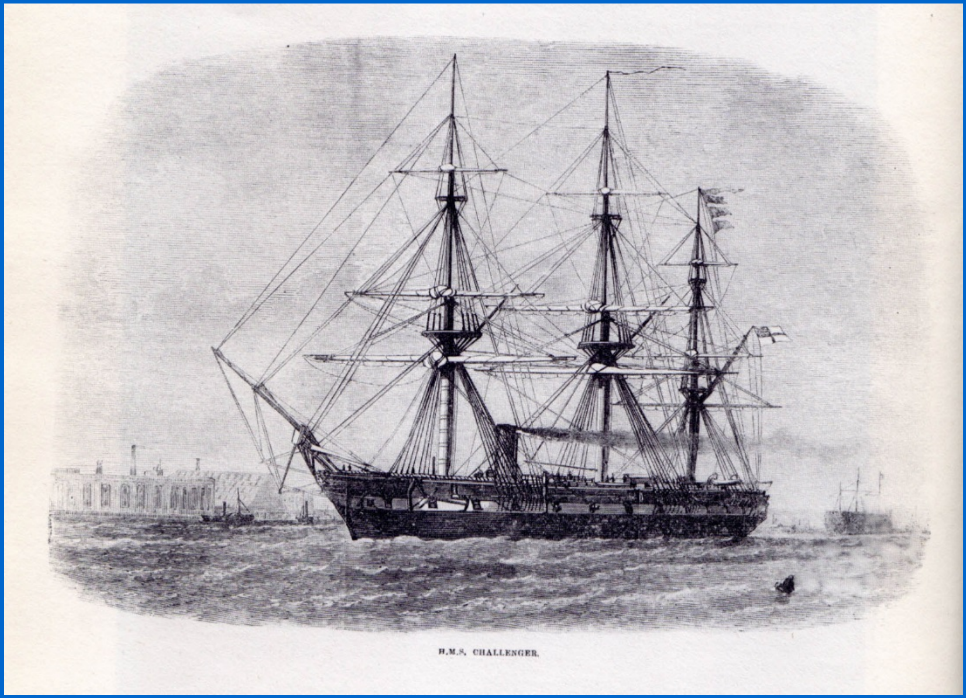
- Hydrothermal vents were discovered in 1977, high-temperature black smokers in 1979
- Some aspects of these discoveries were expected, even predicted, but others, especially the biology, were totally new.

Old ideas about the deep ocean

- It was dark
- It was cold
- It was featureless
- There was very little life below the surface, and what was there must be very primitive

How did we learn about the deep ocean?

Early oceanographers relied completely on what must really be called "remote sensing" (the term we use today for studies of the Earth from satellites).

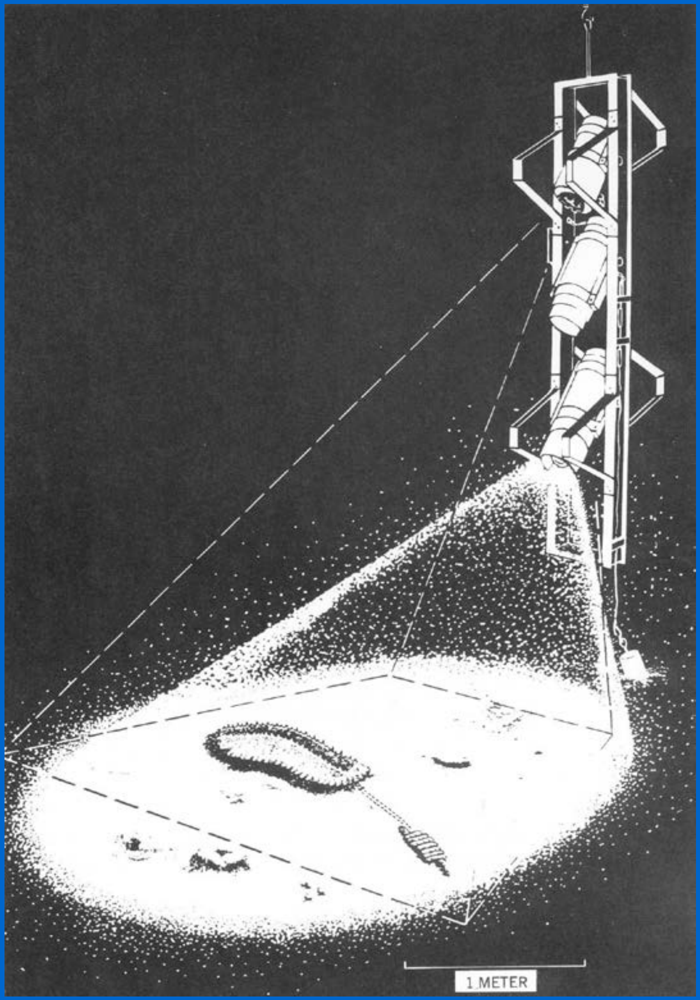


We could sample the oceans and seafloor with nets, trawls, dredges, sediment grabs, and corers, but not see it.

photo from "Voyage of the Challenger"

Deep sea photography

This is a sketch of a type of camera that was widely used, beginning in the 1950s and 60s, to improve geologists' and oceanographers' understanding of the ocean floor.



sketch from Heezen and Hollister, 1971

A typical photograph of the sea floor

photo from Heezen and Hollister, 1971

Color:

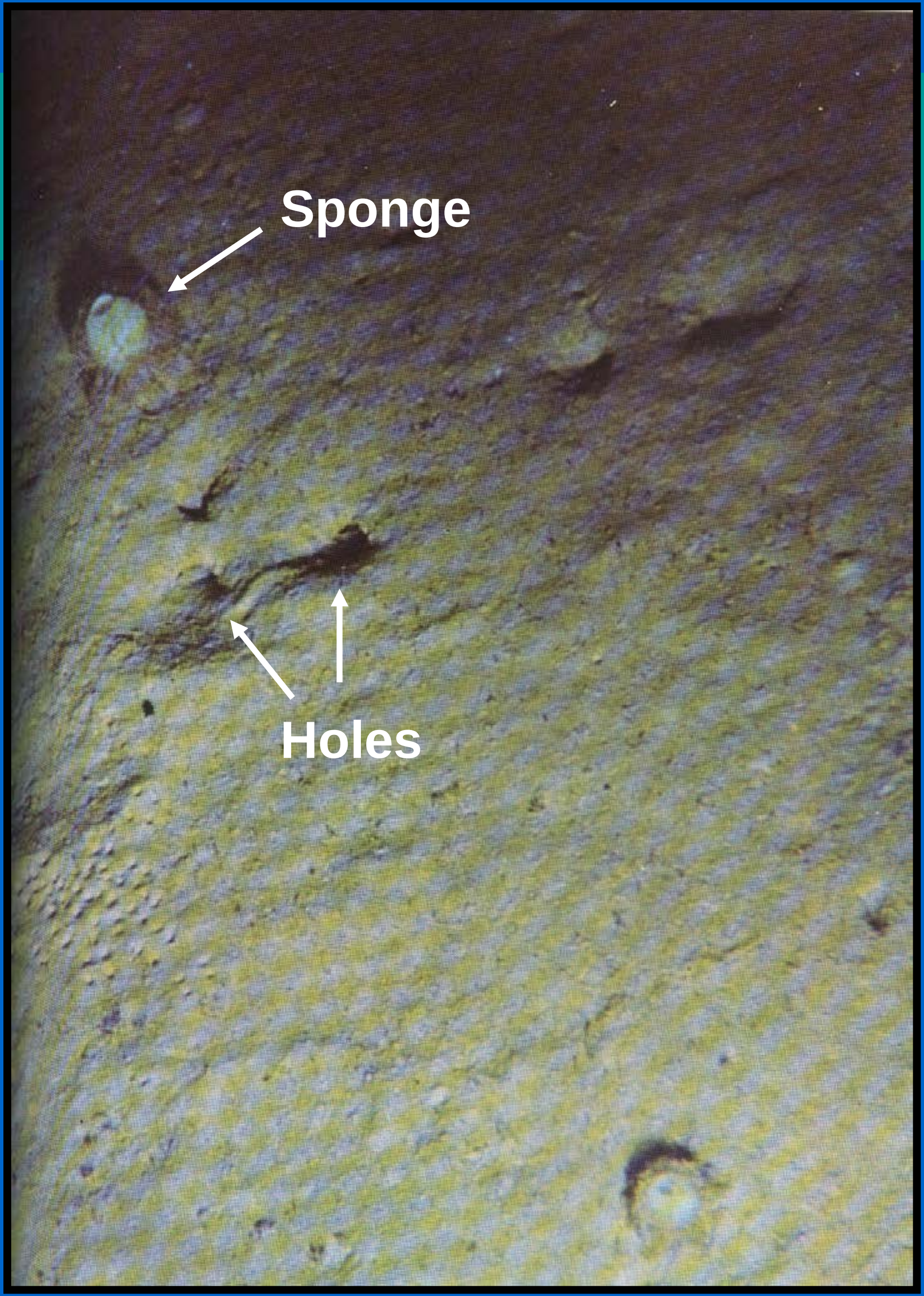


photo from Heezen and Hollister, 1971

Sediments with animal tracks

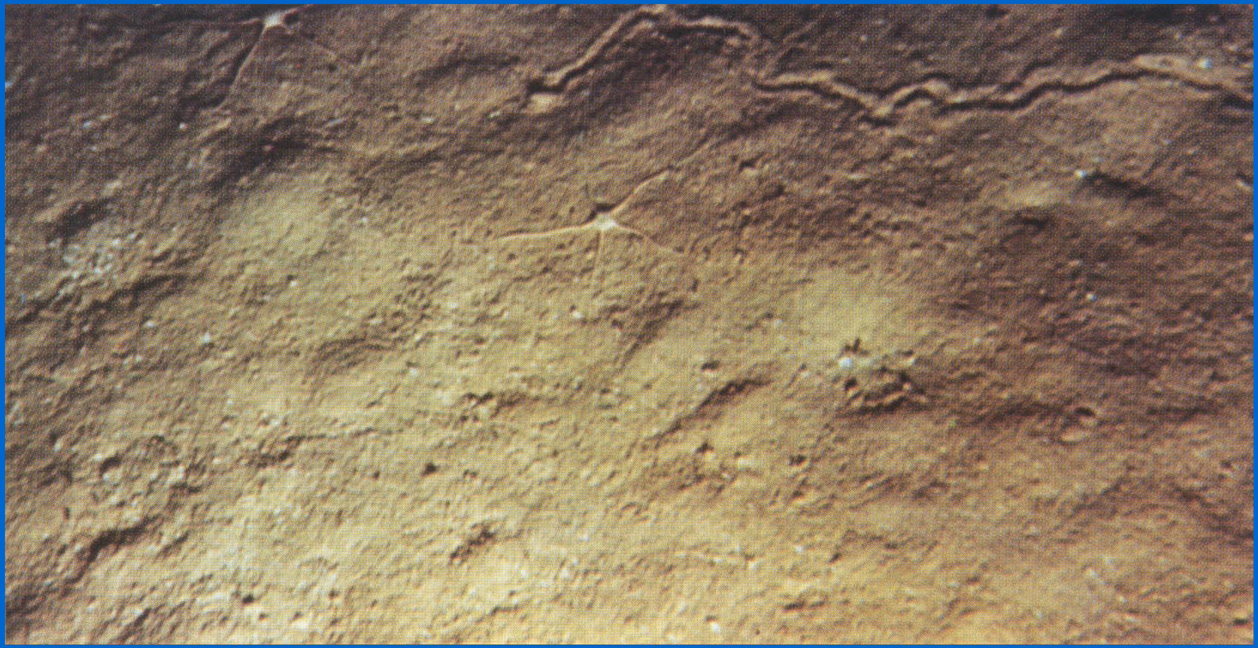


photo from Heezen and Hollister, 1971

The deepest ocean: red clay

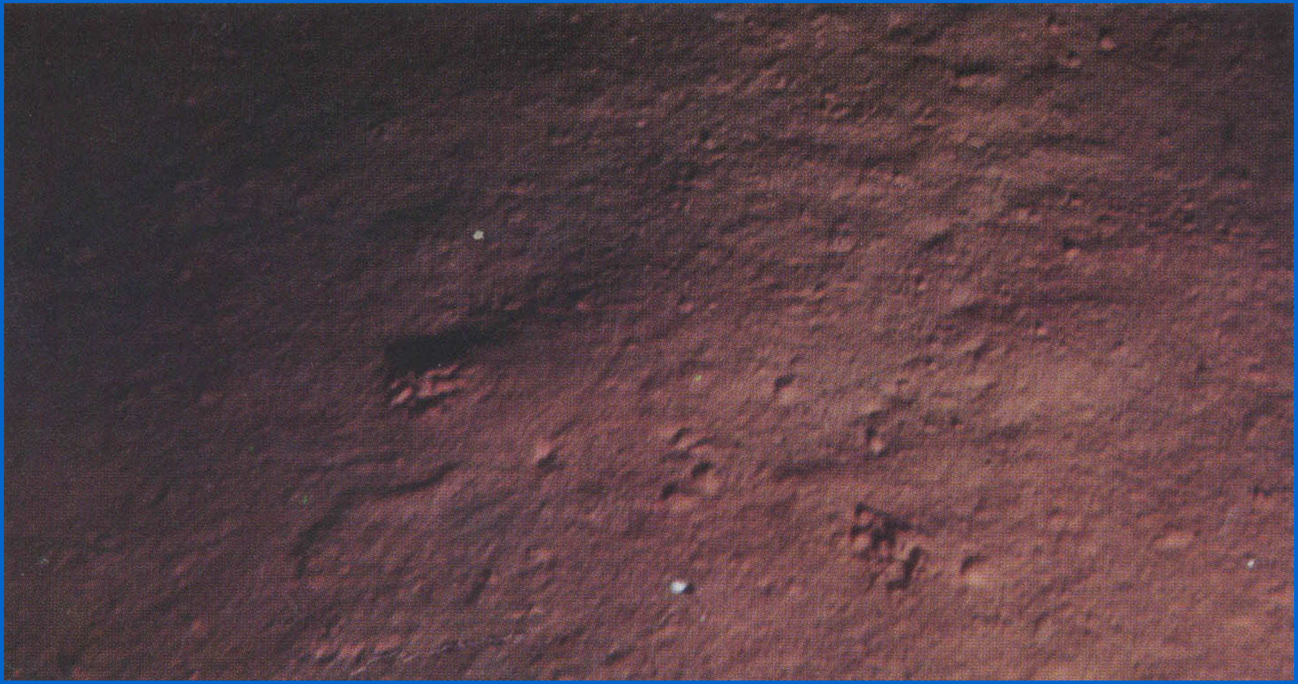


photo from Heezen and Hollister, 1971

Manganese nodules

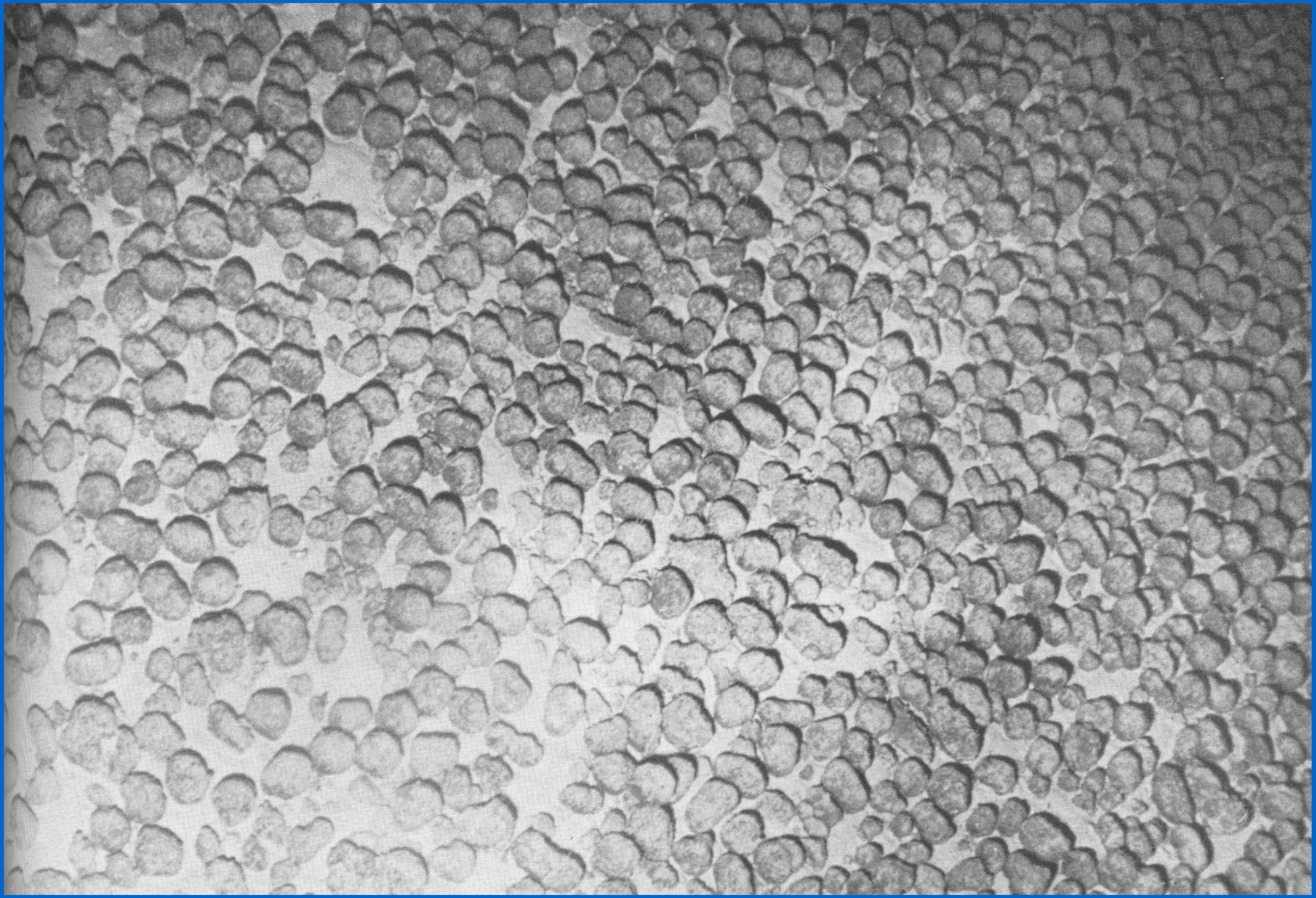


photo from Heezen and Hollister, 1971

Effects of currents

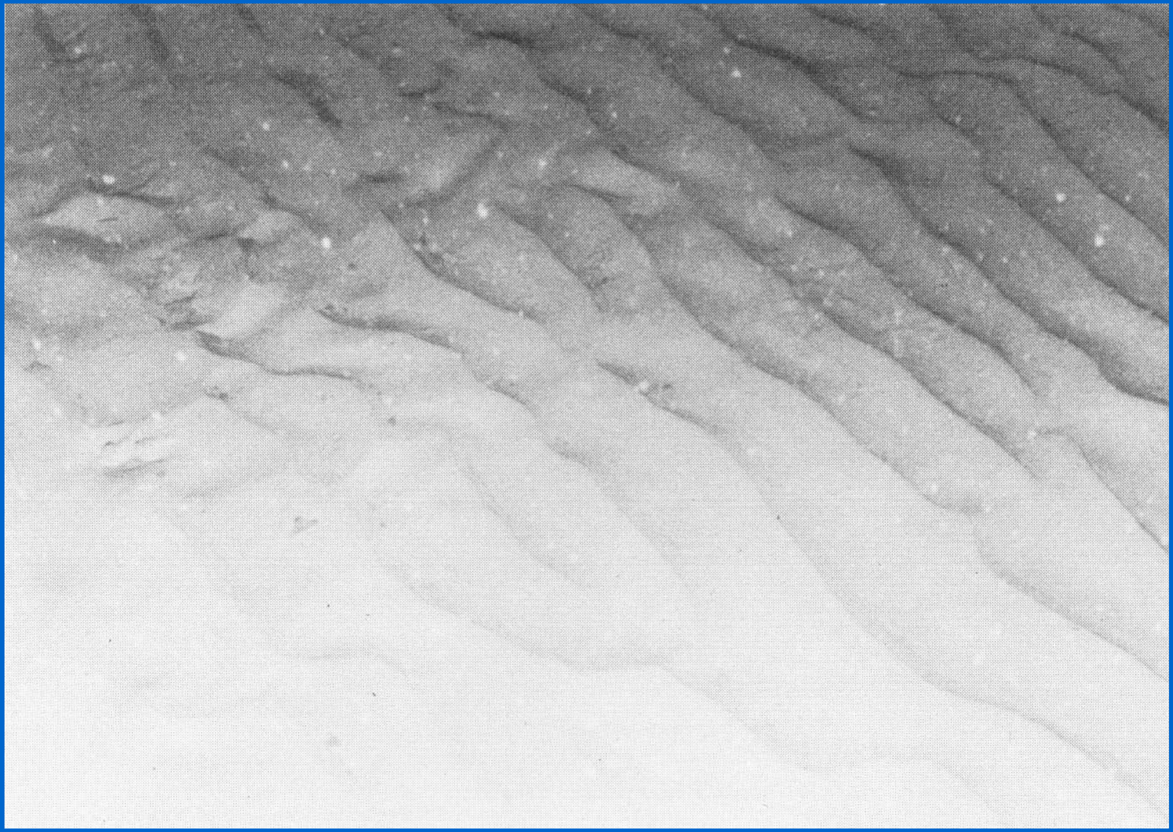


photo from Heezen and Hollister, 1971

Basalt on the mid-ocean ridge

Basalt is a rock formed from volcanic eruptions

photo from Heezen and Hollister, 1971

Basalt on land

photo by H.N. Edmonds

Going there in person: visiting the seafloor

- In parallel with this increasing understanding of the deep ocean, and eventually contributing to it, was an increasing desire to see the bottom of the oceans for ourselves.
- These interests included scientific (biological, geological), military, and commercial interests, and plain old curiosity.

William Beebe's bathysphere

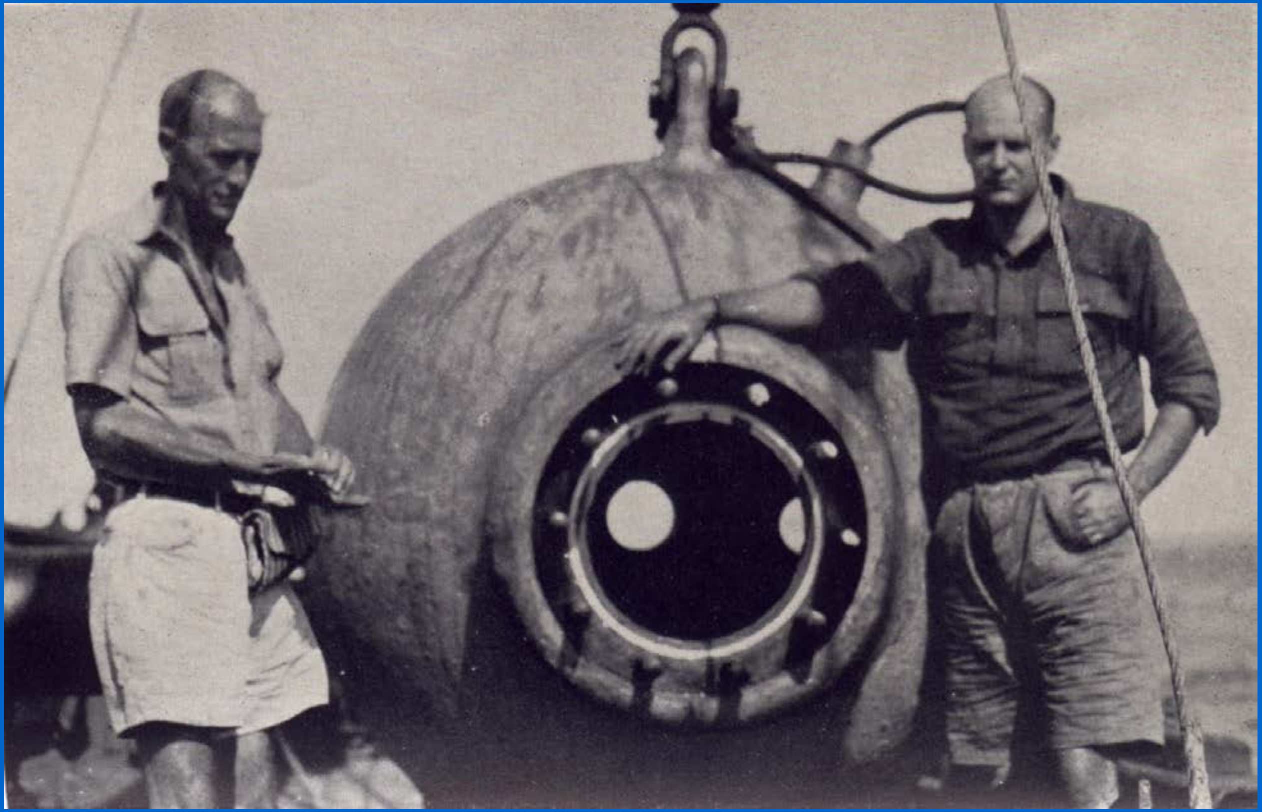


photo from "Half Mile Down," Beebe, 1934

Auguste Piccard and the Trieste

Auguste Piccard (1884-1962) was a Swiss physicist, who was the first man to reach the stratosphere in a balloon, then turned his eyes towards the deep.

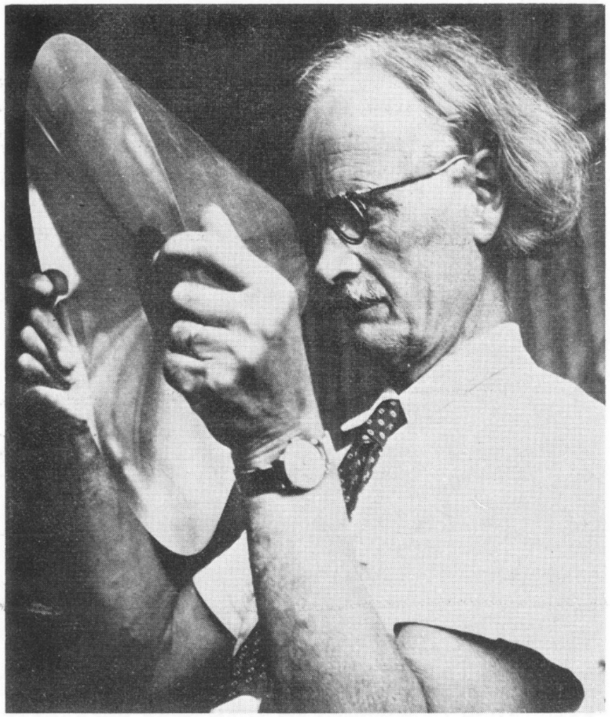


Fig 3.4 Professor Auguste Piccard inspecting an acrylic plastic viewport, one of his many contributions to deep submergence. (Jacques Piccard)

photo from "Manned Submersibles," Buby, 1976

The bathyscaphe Trieste

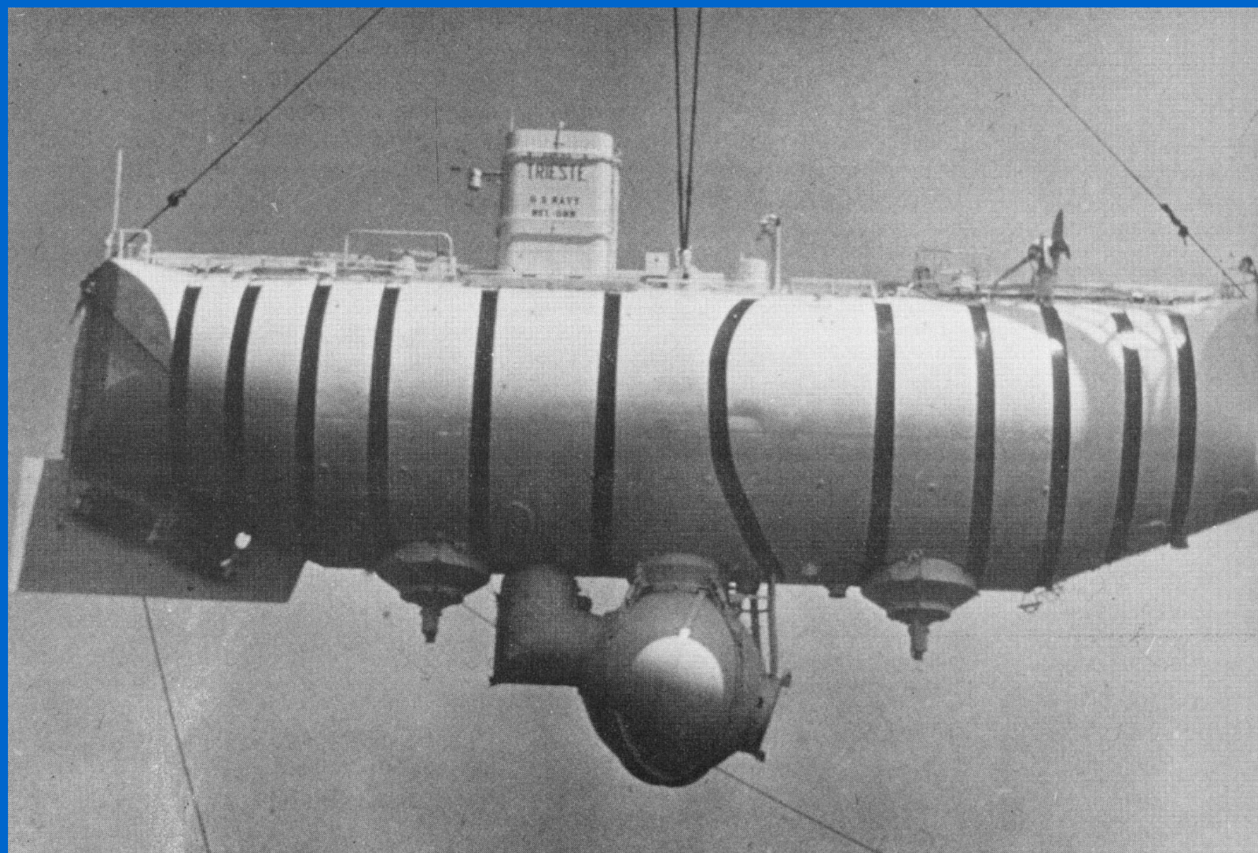
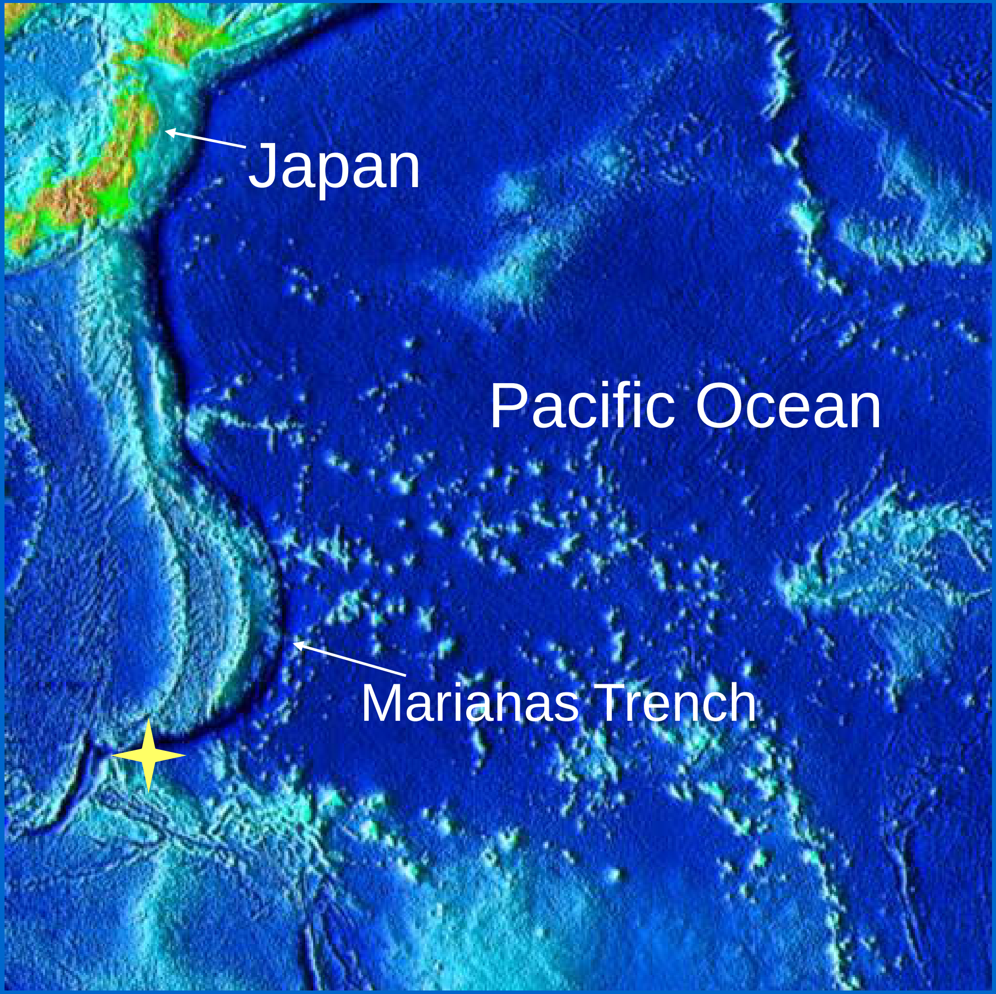


photo from "Manned Submersibles," Busby, 1976

The deepest dive in history



Challenger Deep

Image from NOAA

Submersibles and science: **Alvin**

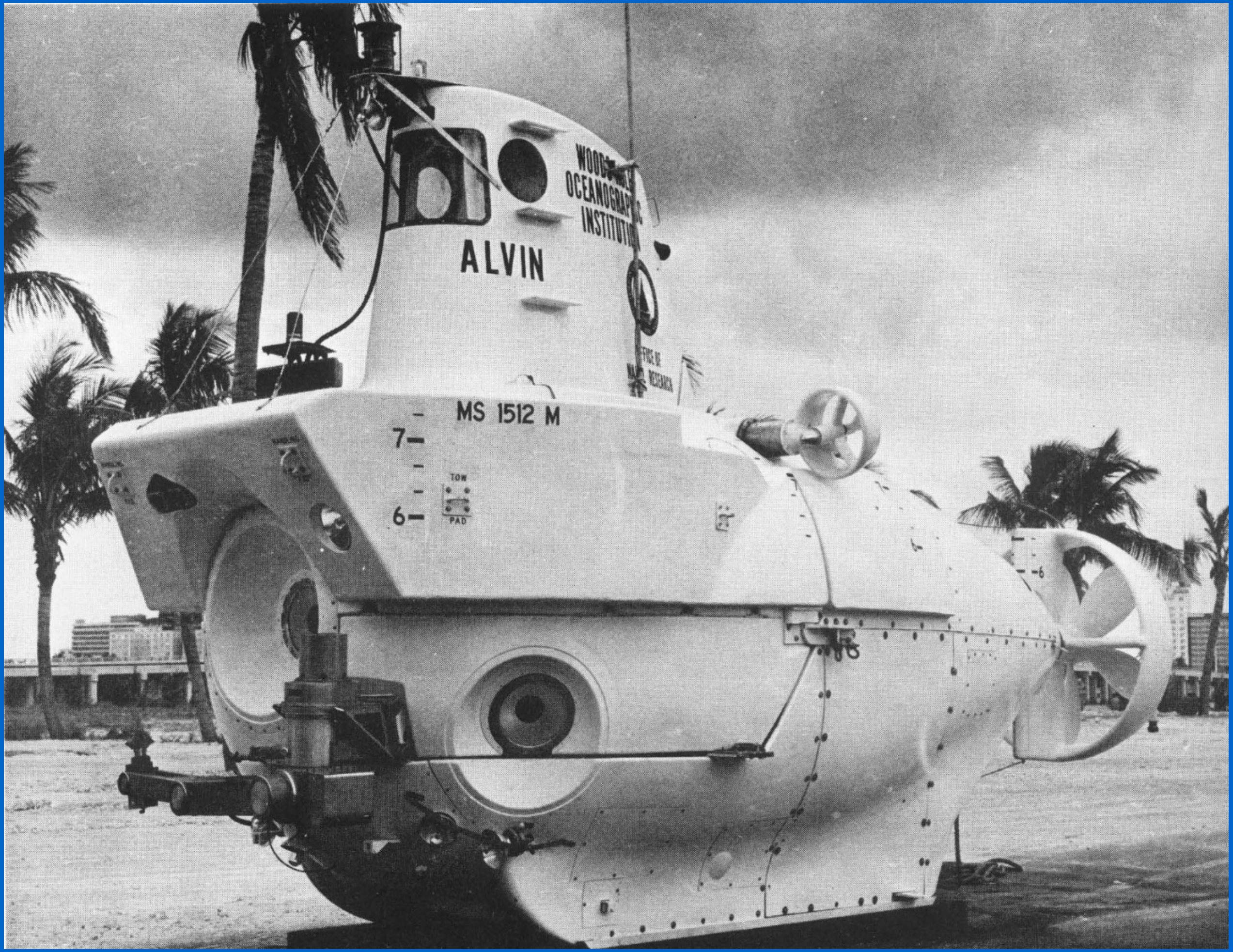


photo from "Manned Submersibles," Busby, 1976

The discovery of hydrothermal vents

This photograph is the first ever taken of a high temperature black smoker. It was taken by *Alvin* pilot Dudley Foster at 21˚N on the East Pacific Rise in 1979.

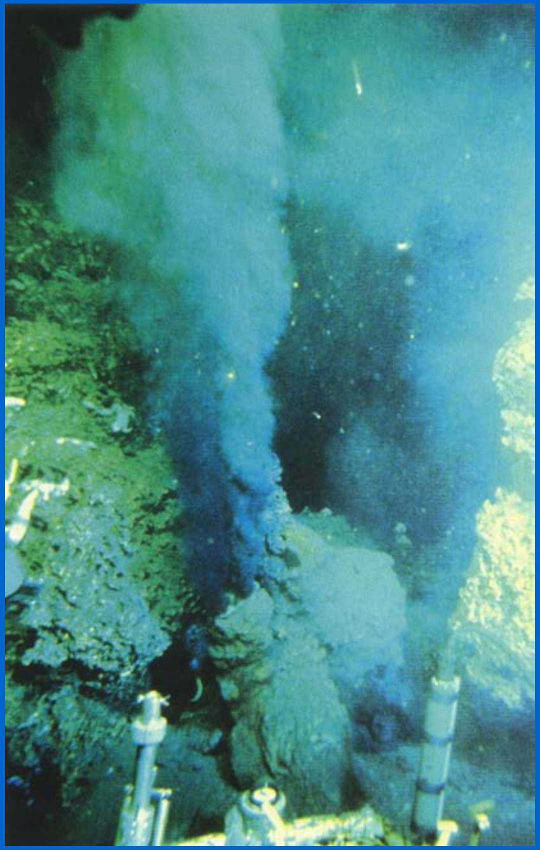


photo from Oceanus magazine, 1998

Plate tectonics

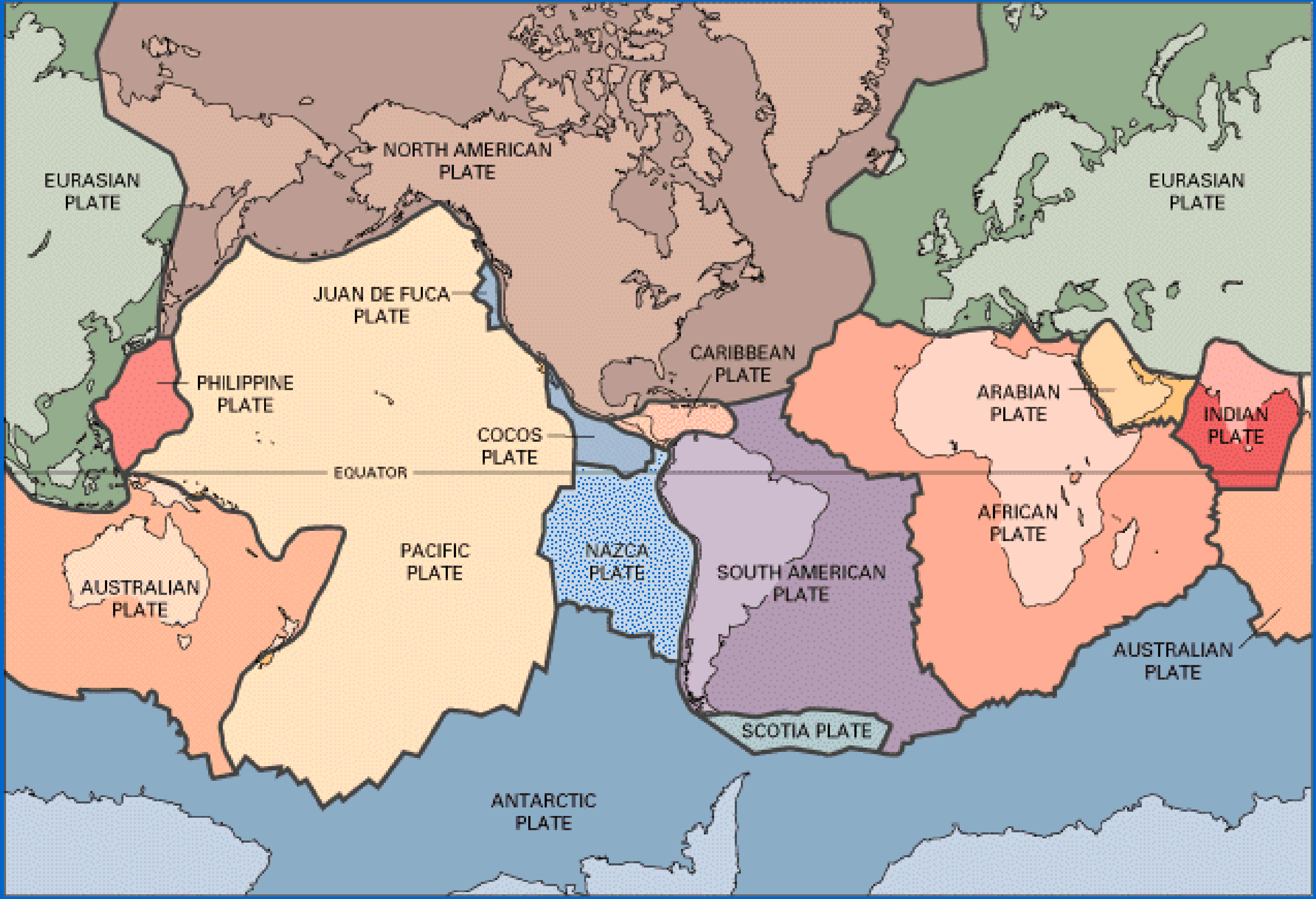


image from "This Dynamic Earth," USGS

Plate motions

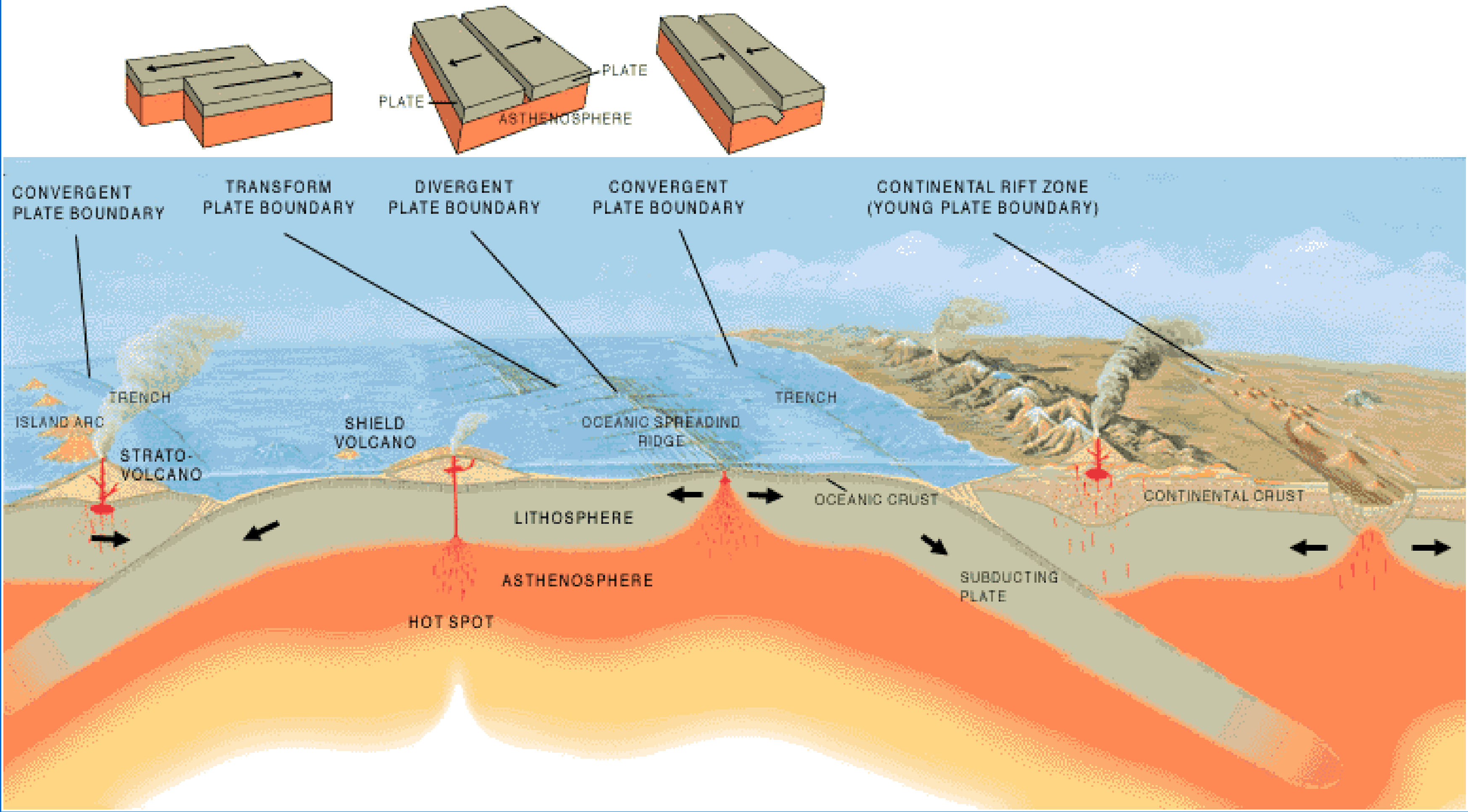


image from "This Dynamic Earth," USGS

The mid ocean ridge system

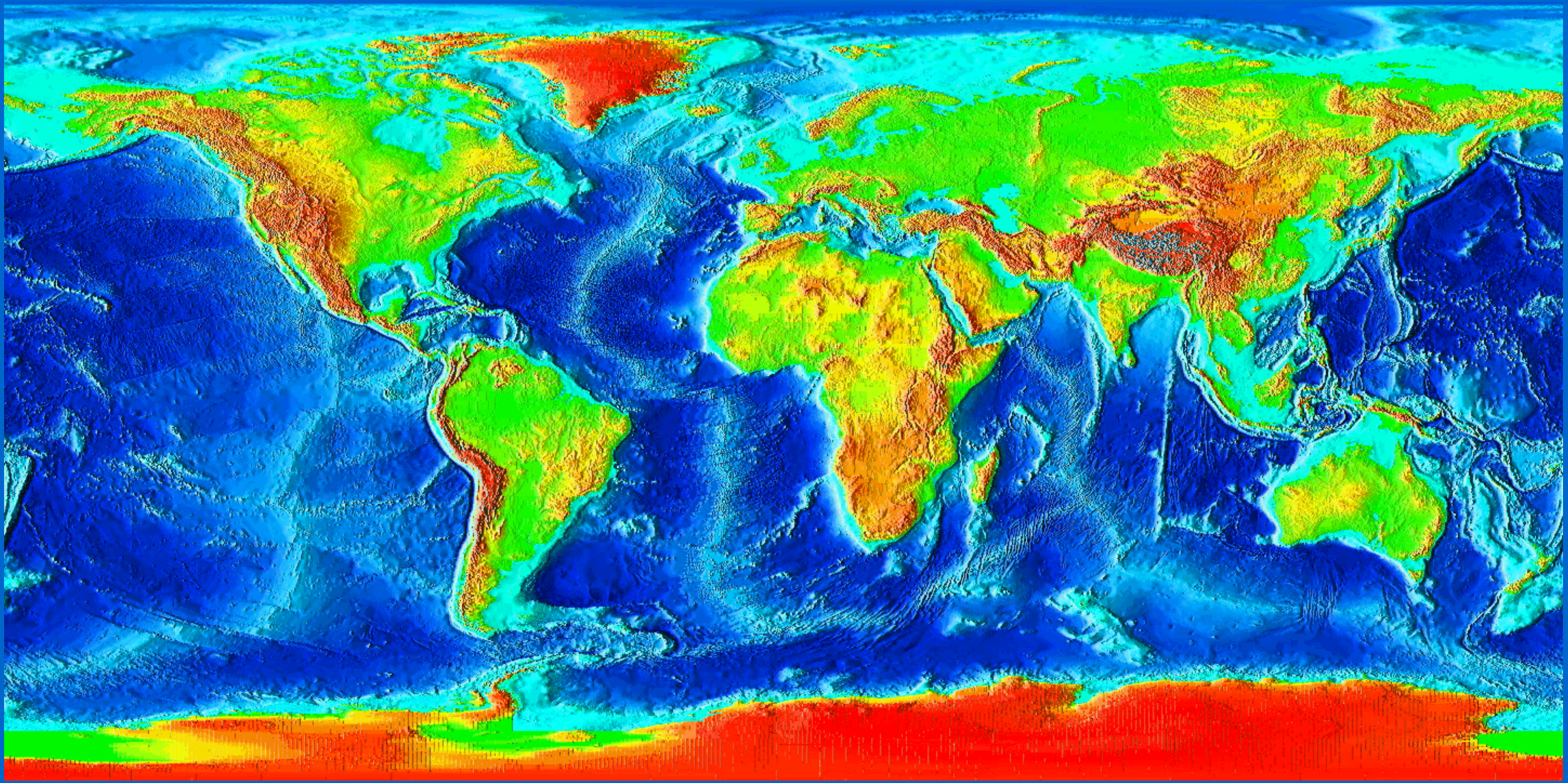


image from NOAA

The FAMOUS Expedition, 1973-74

French bathyscaphe *Archimède* and submersible *Cyana*, and *Alvin*, made a total of 45 dives in a 20 mile long section of the Mid-Atlantic Ridge rift valley south of the Azores

photo from Ballard and Moore, 1977

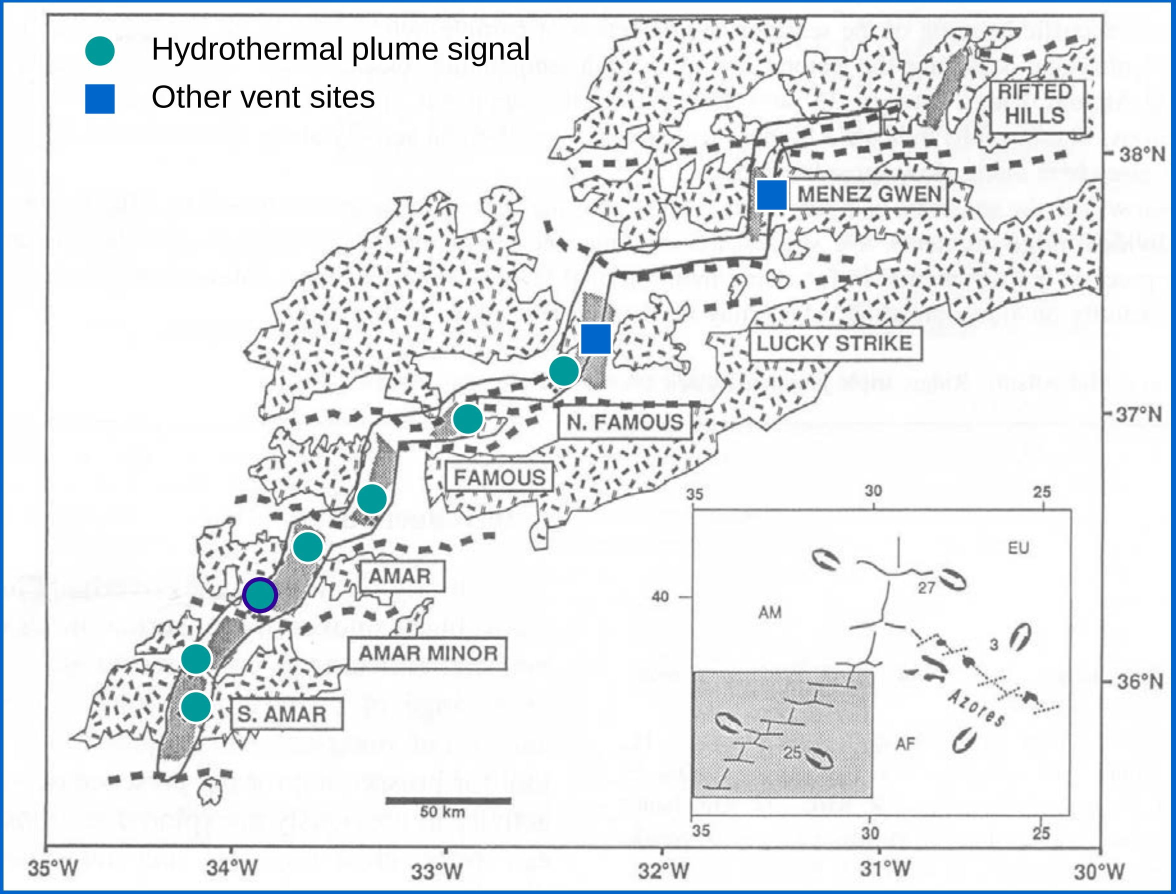
Basalt photographed during FAMOUS

photo from Ballard and Moore, 1977

Another basalt on the Mid-Atlantic Ridge

photo from Ballard and Moore, 1977

The location of FAMOUS



map from German et al., 1996

Predictions leading to the discovery of seafloor hydrothermal vents

photo by H.N. Edmonds

Hydrothermal systems: ingredients

The basic requirements for hydrothermal circulation are

- A source of heat
- A source of water
- A pathway for the water to circulate

photo from JASON Foundation for Education

Castle Geyser, Yellowstone

photo from JASON Foundation for Education

Iceland

photo by Dr.Dan Barker

Seafloor hydrothermal circulation

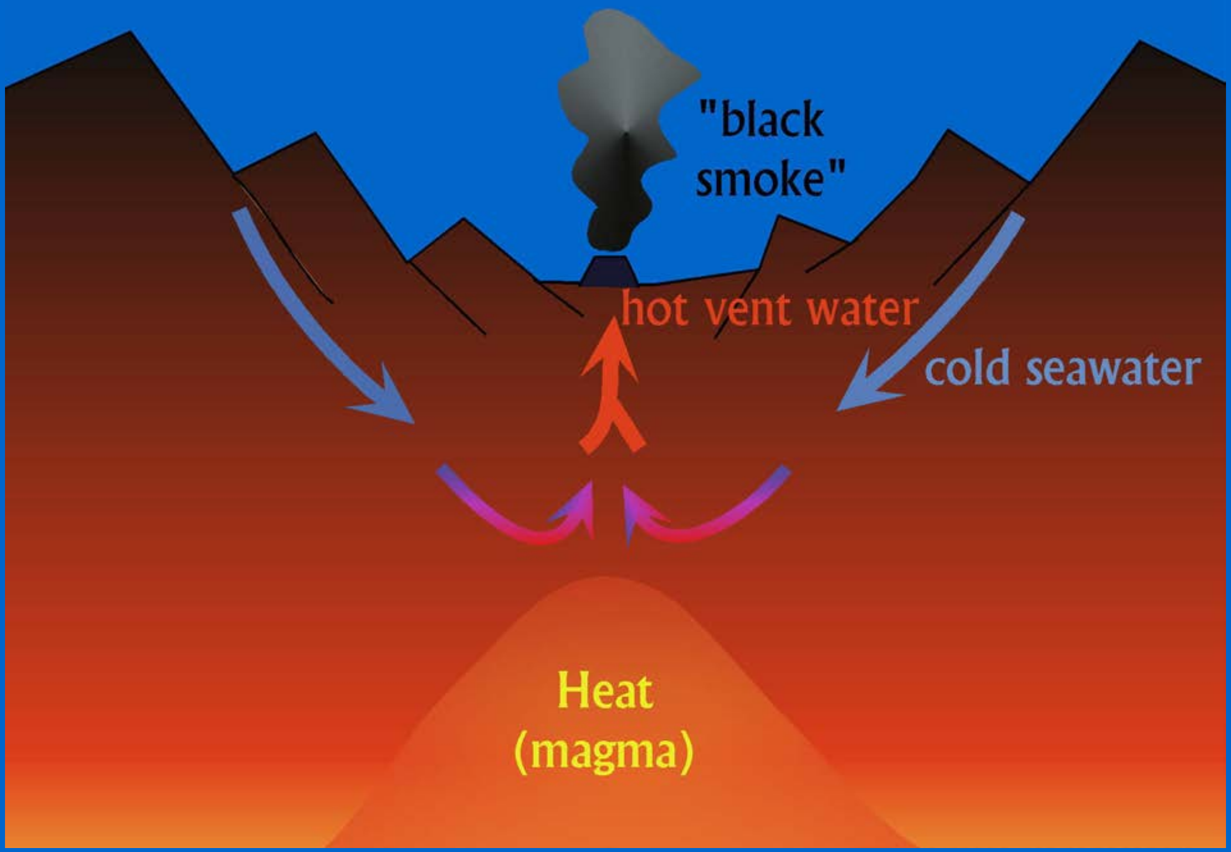


illustration by H.N. Edmonds

Vent chimneys

photo by Woods Hole Oceanographic Institution

How chimneys &“black smoke” form

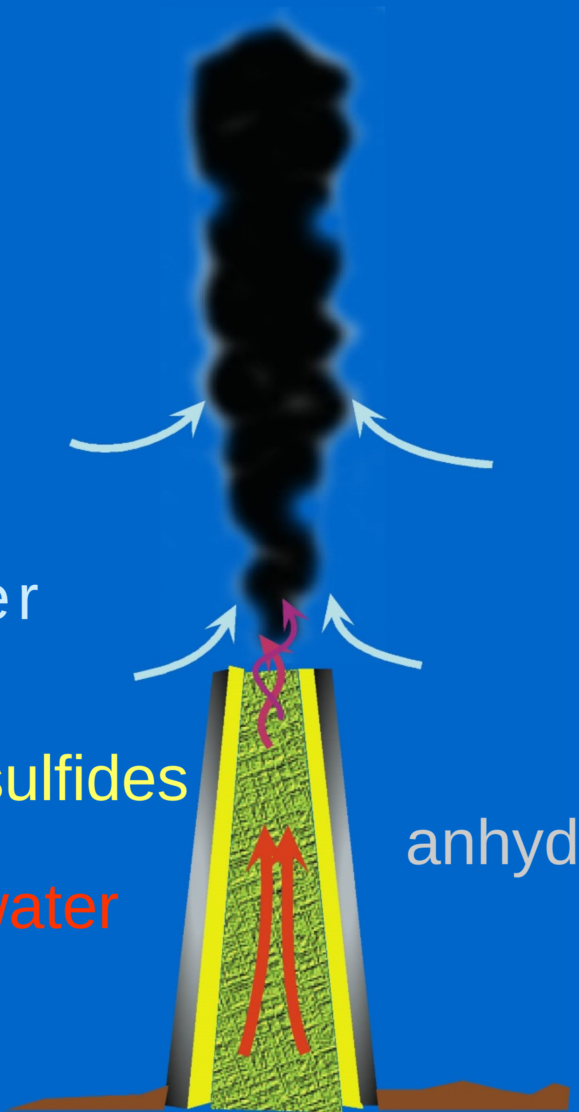


illustration by H.N. Edmonds

Life at hydrothermal vents

photo by Rich Lutz, Rutgers University

Chemosynthesis supports large communities

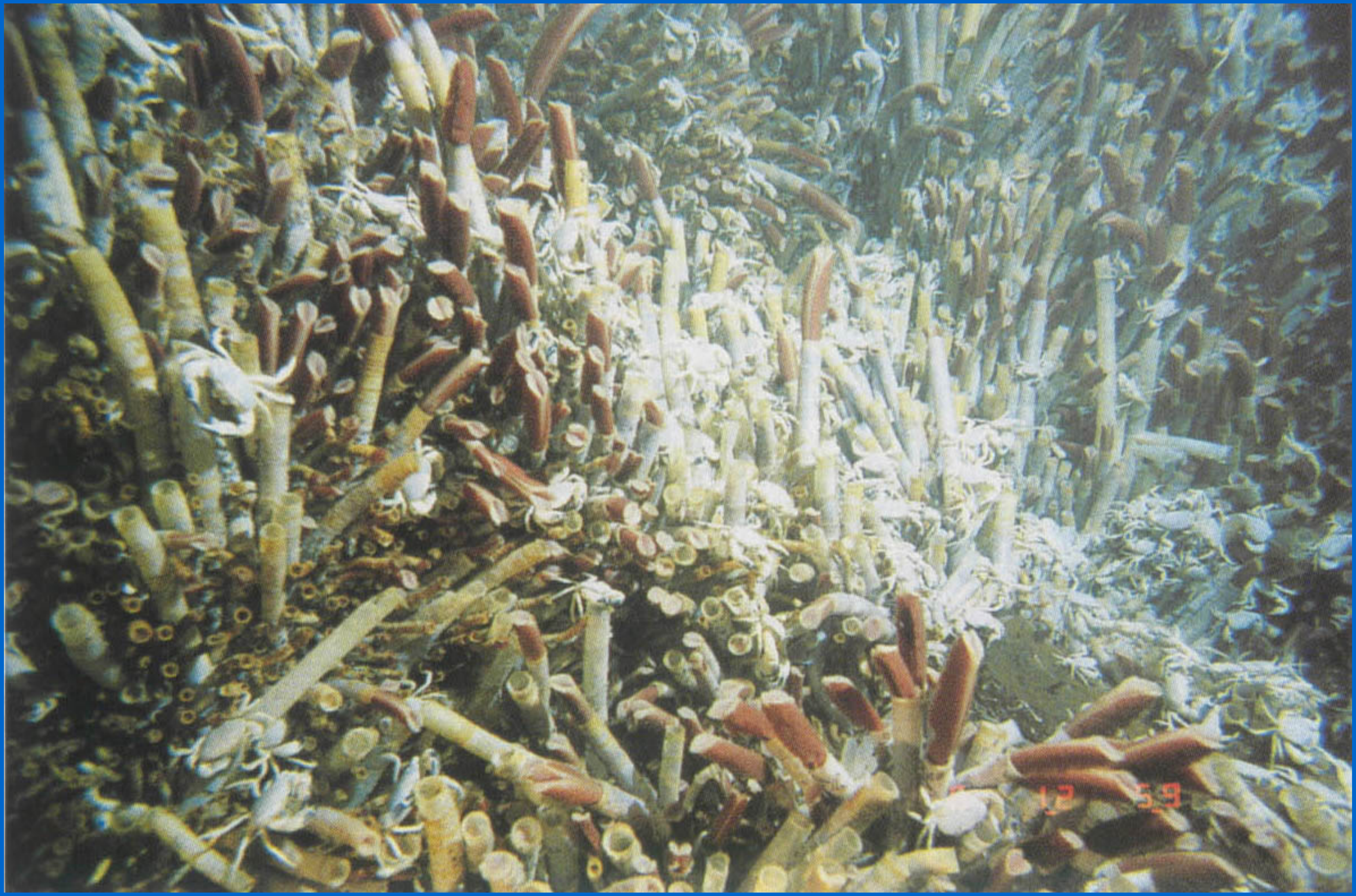


photo by Rich Lutz, Rutgers University

A dive on the Mid-Atlantic Ridge

The following sequence of photographs are from a research cruise to the TAG (Trans-Atlantic Geotraverse) hydrothermal site that I participated in in 1995.

photo by H.N. Edmonds

Landing in the rift valley

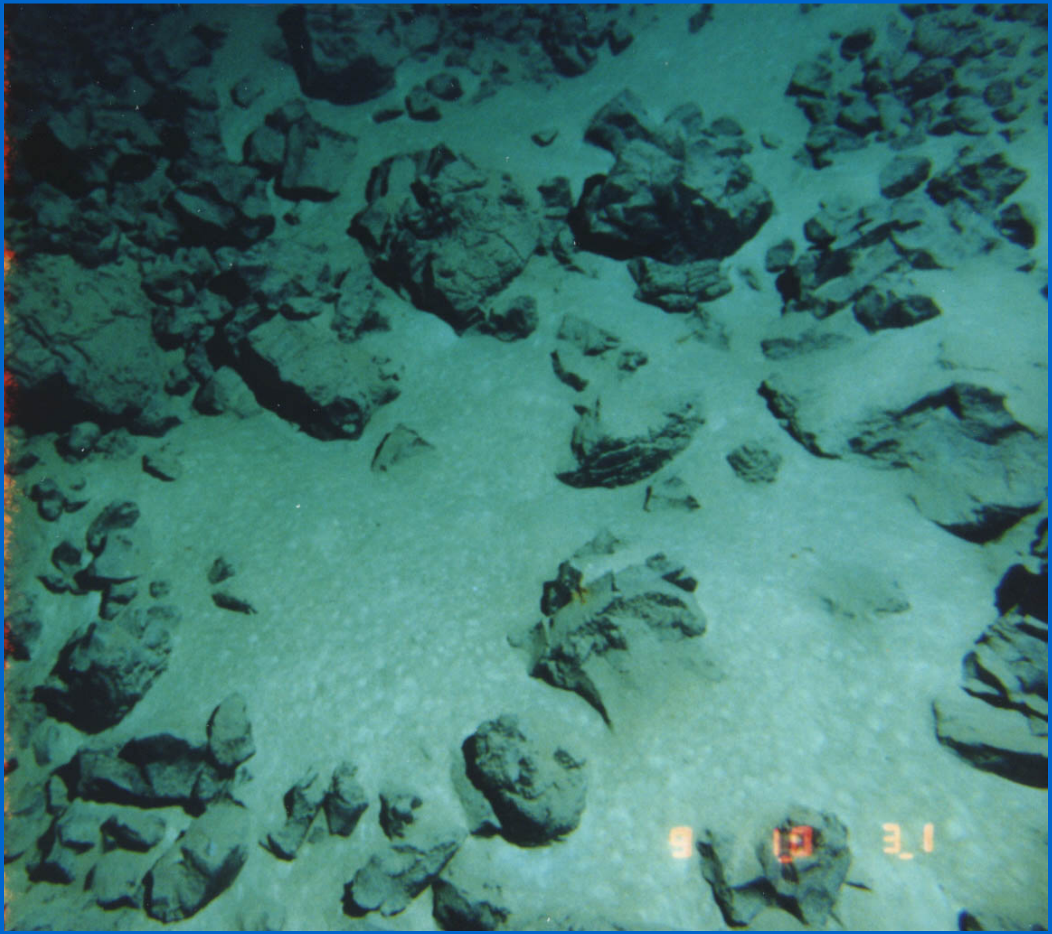


photo by H.N. Edmonds

Signs of life

photo by H.N. Edmonds

Old chimneys

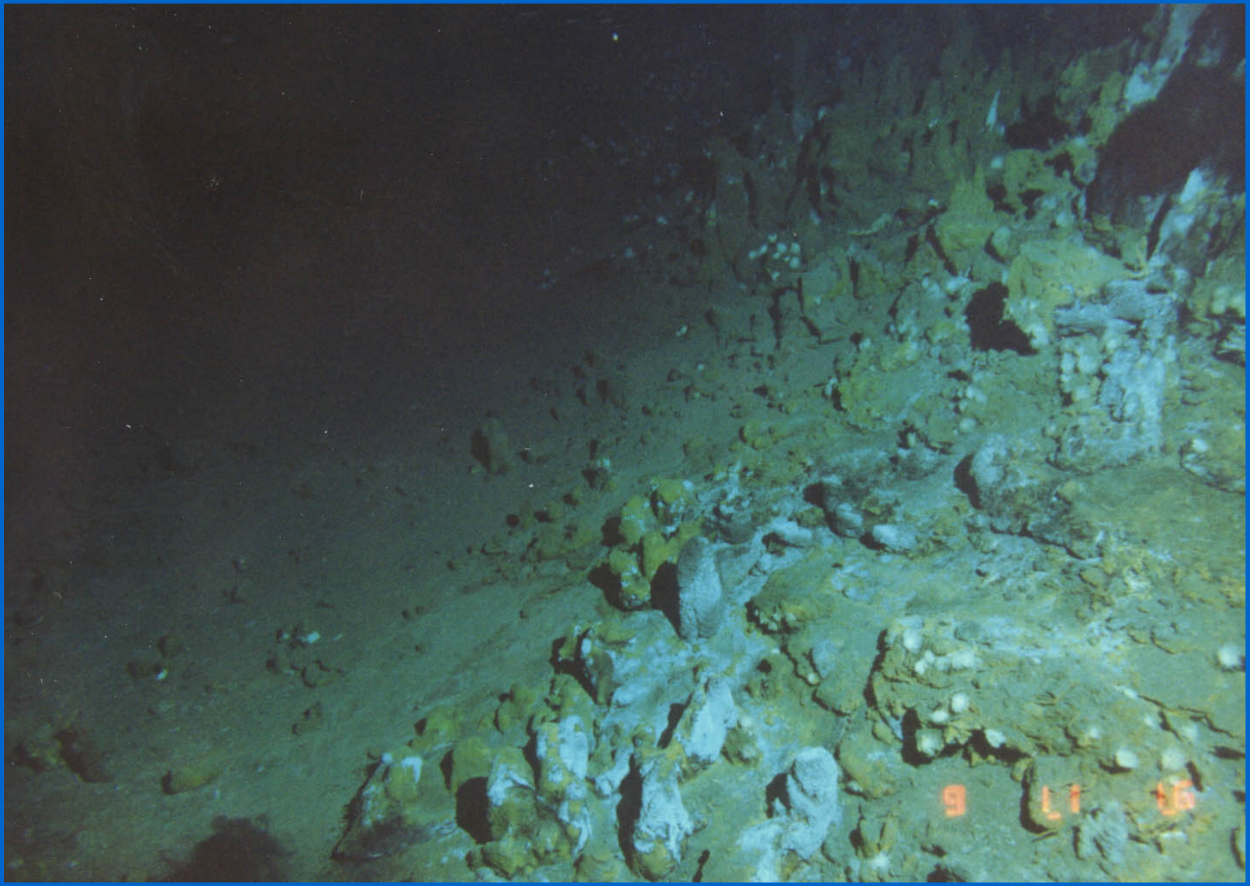


photo by H.N. Edmonds

The anemones increase

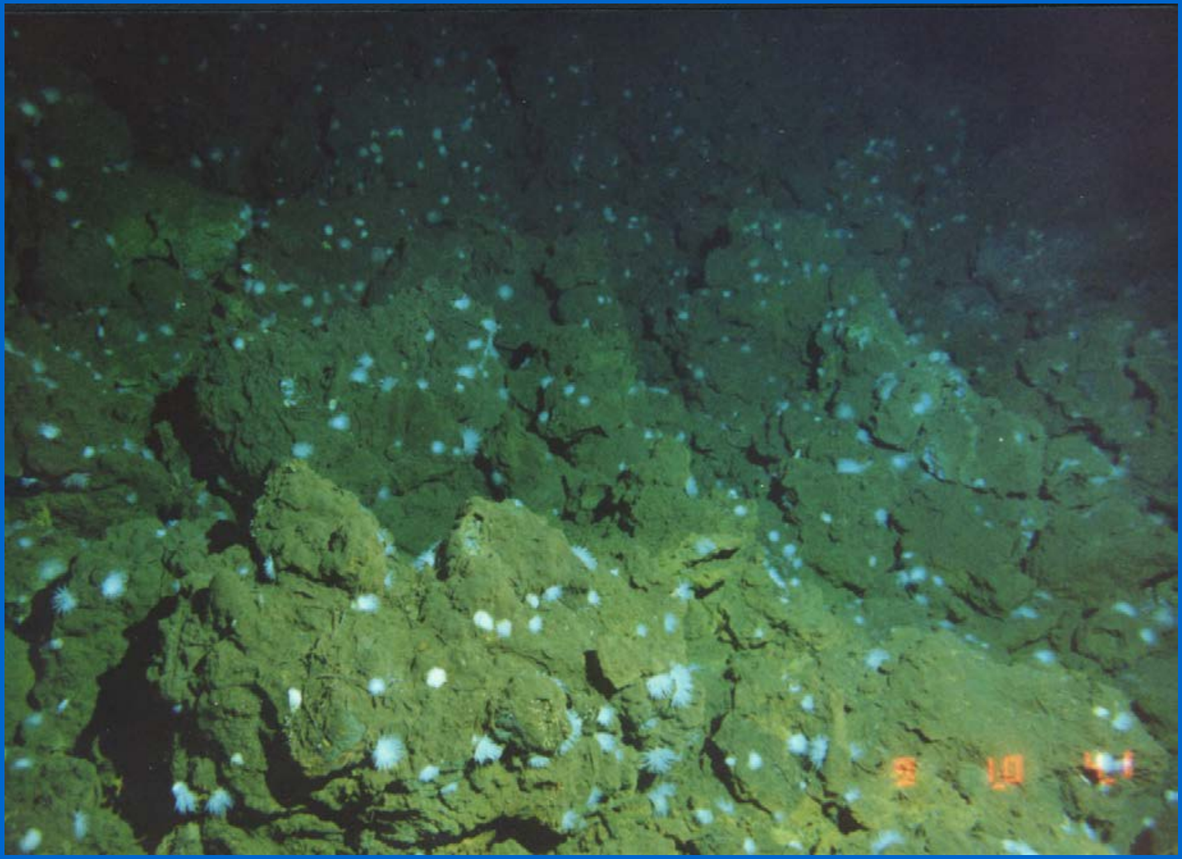


photo by H.N. Edmonds

More and more anemones

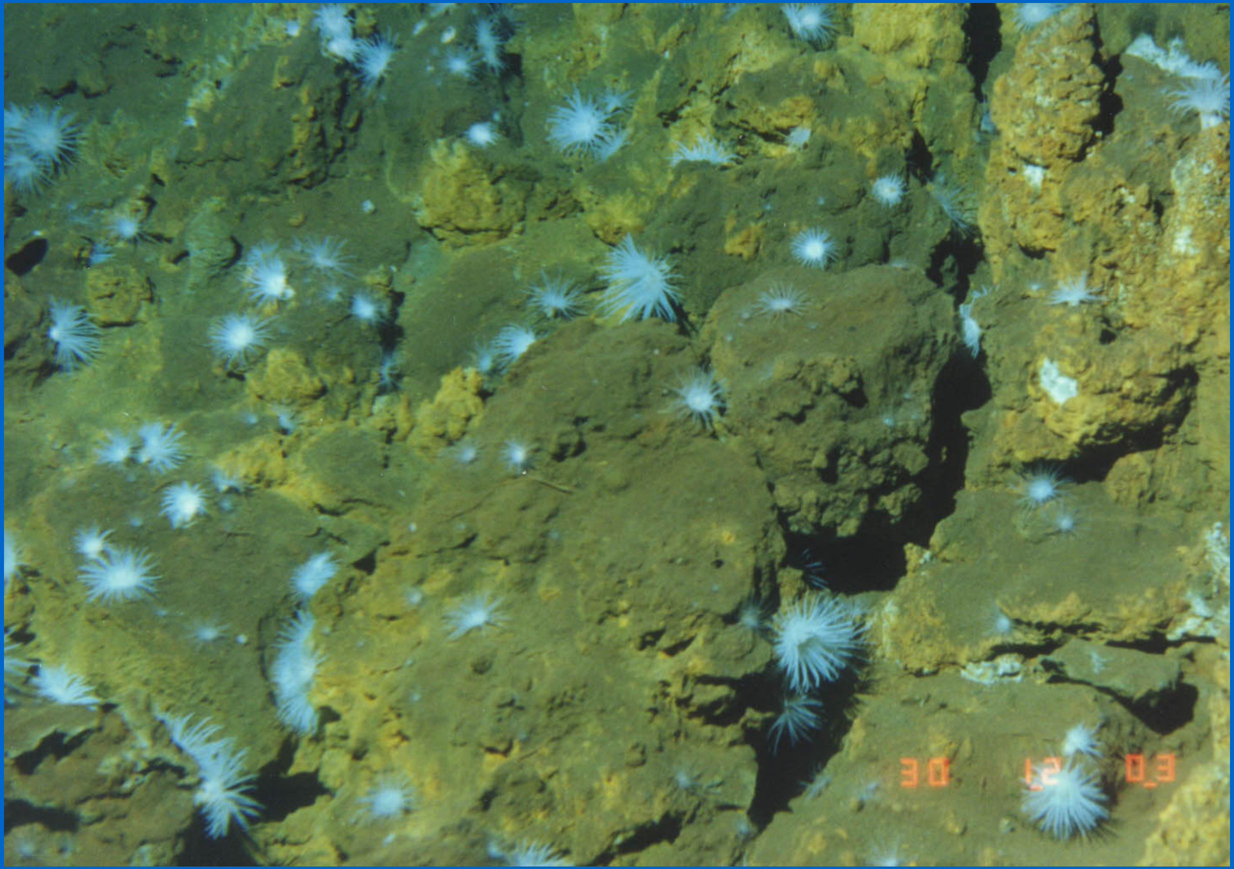


photo by H.N. Edmonds

Black smoker and lots of shrimp

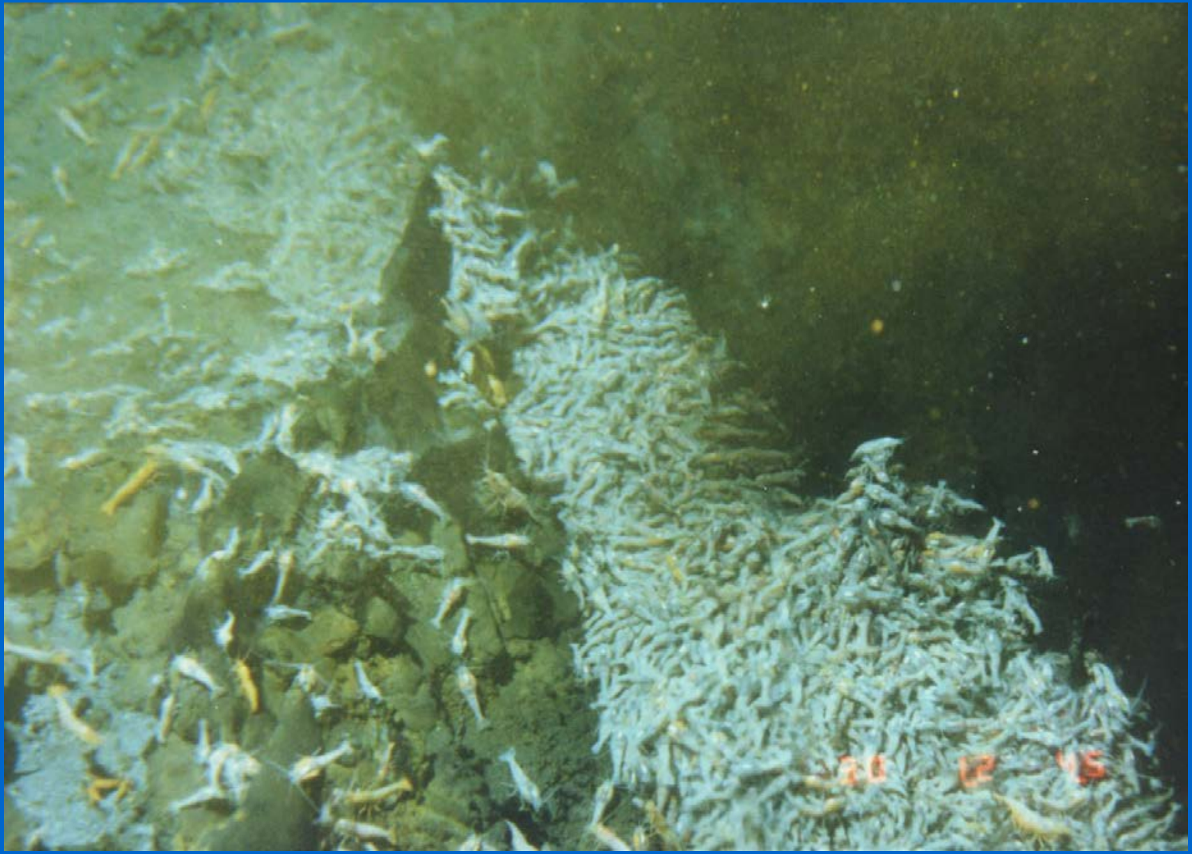


photo by H.N. Edmonds

Another view of the black smoker

photo by H.N. Edmonds

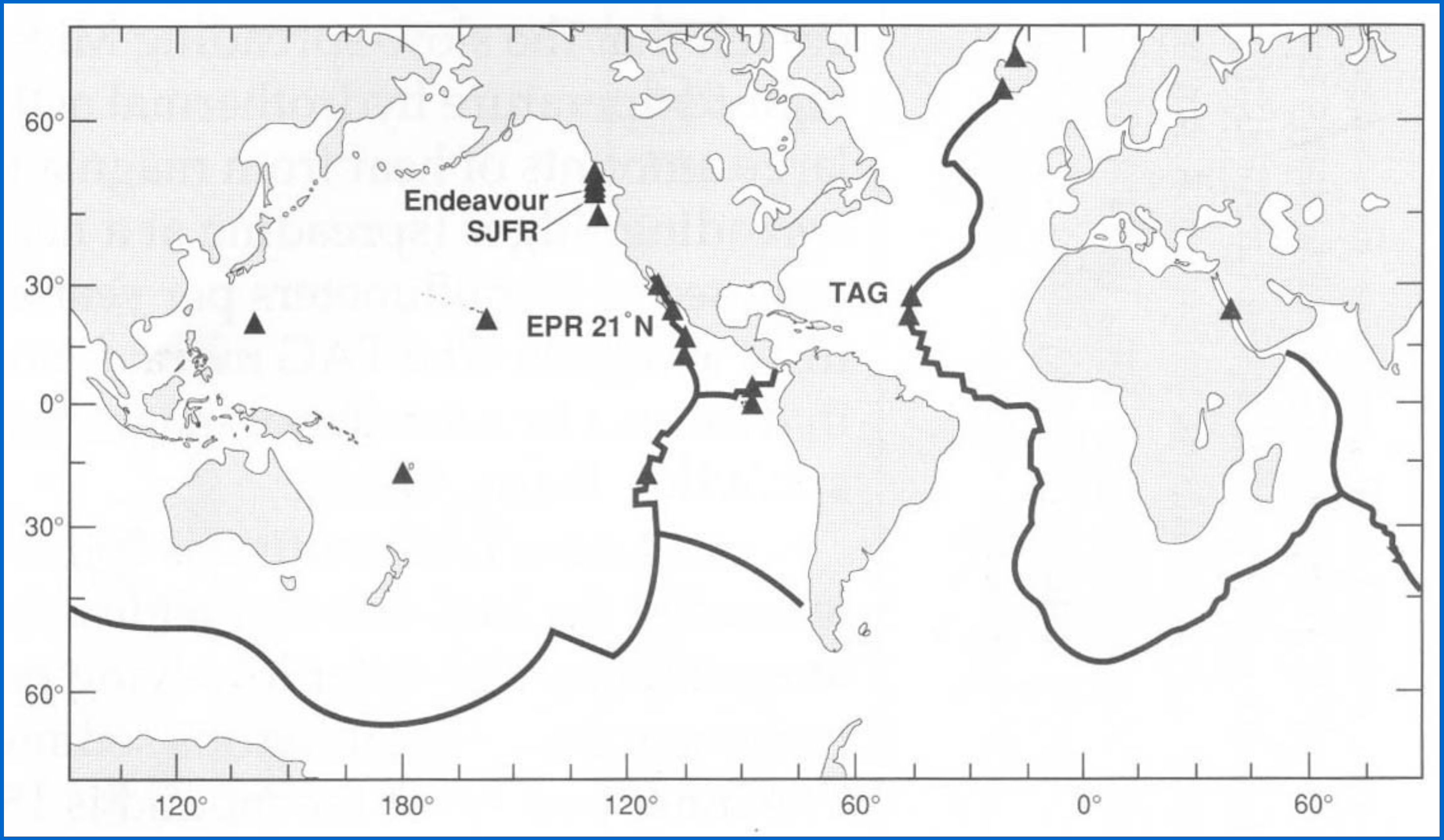
A less active part of the mound

photo by H.N. Edmonds

Ongoing research

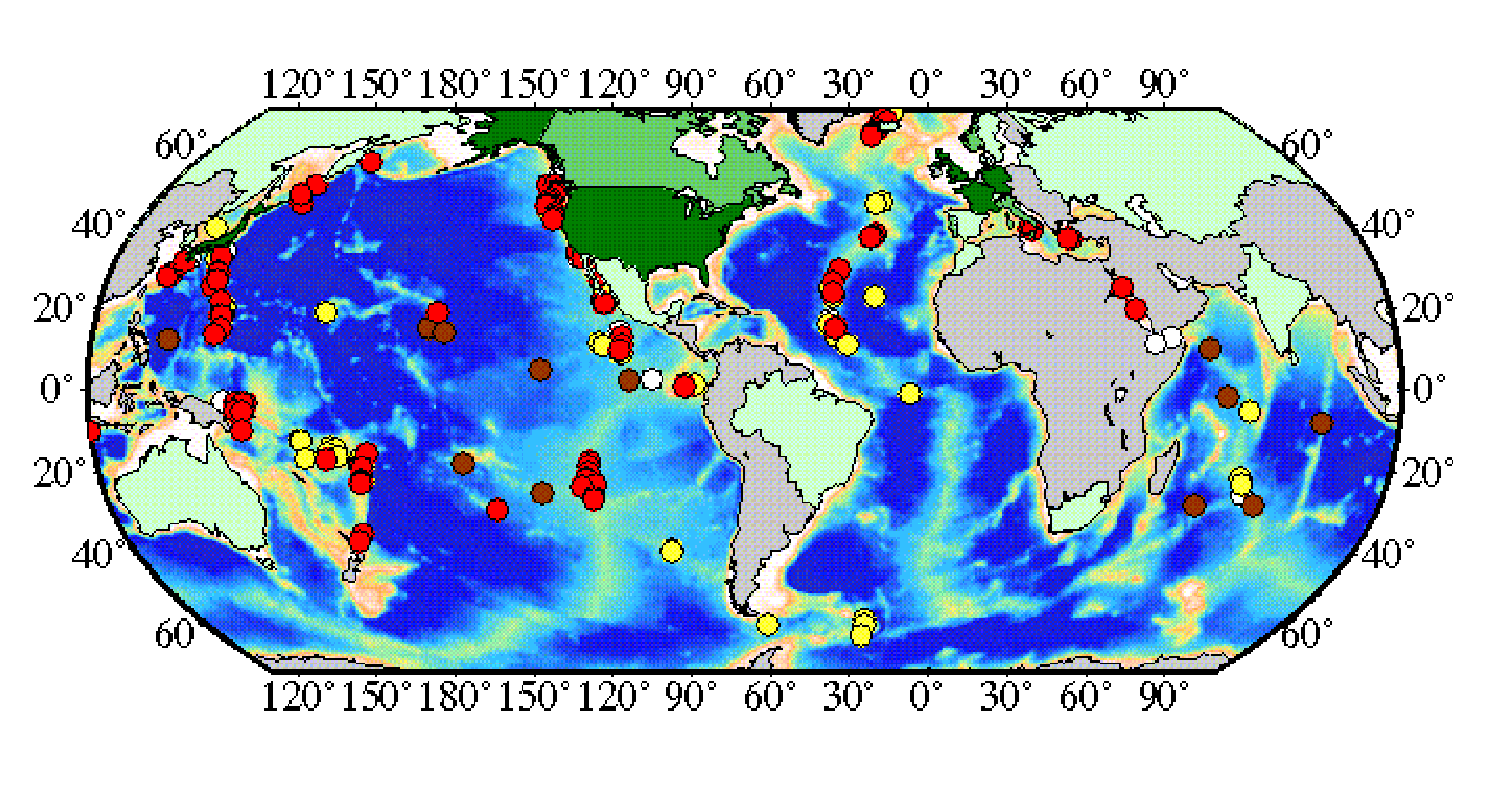
photo by Rich Lutz, Rutgers University

Known vents: 1991



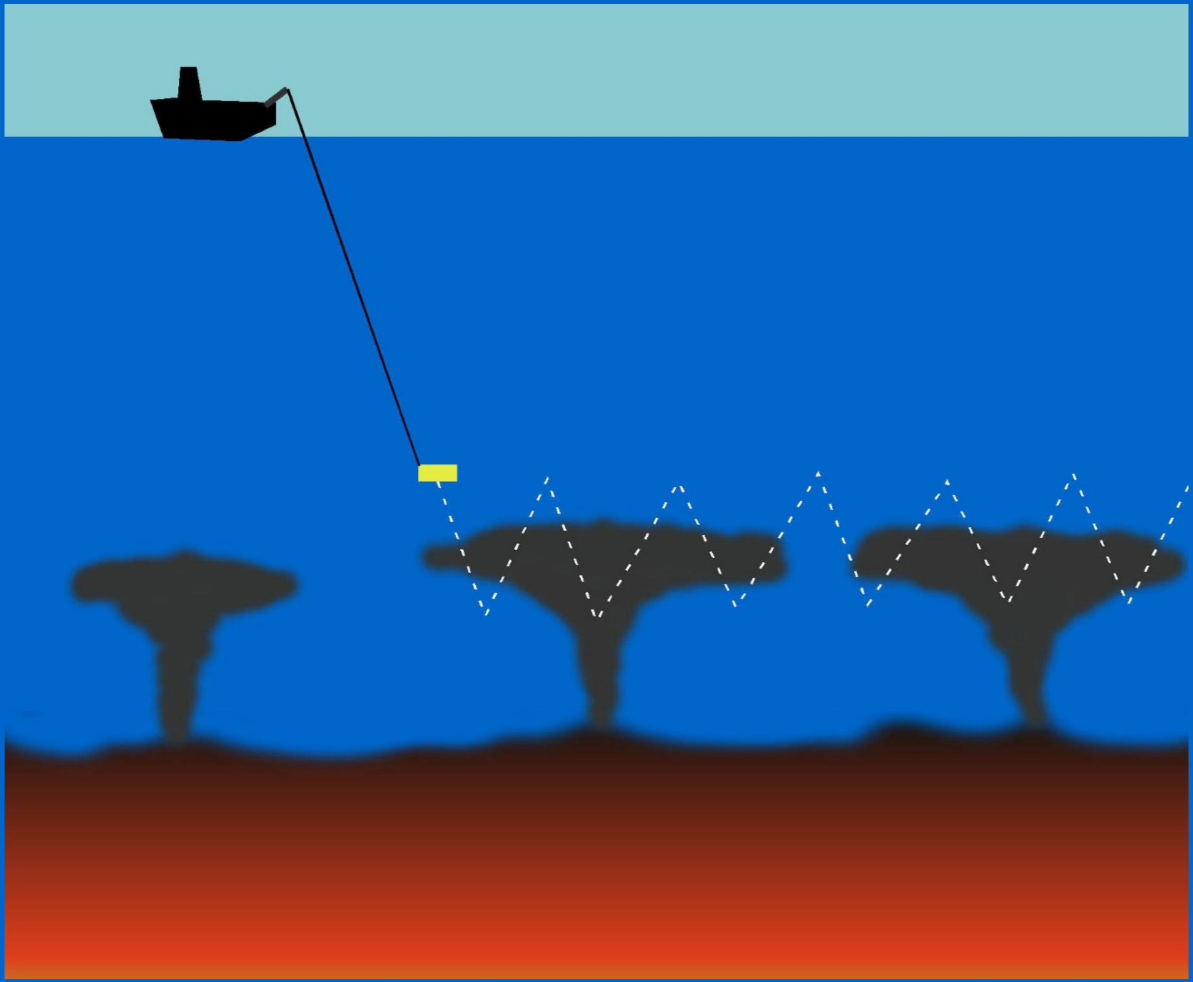
map from Oceanus magazine, 1991/92

Known vents: 2000



map from InterRidge web site

Finding hydrothermal vents



drawing by H.N. Edmonds

A continuing story

photo by H.N. Edmonds

Dr. Henrietta N. Edmonds

Henrietta N. Edmonds is a Research Scientist at the Marine Science Institute and an Assistant Professor in the Department of Marine Science of The University of Texas at Austin, located on the gulf coast in Port Aransas. She received her B.S. in chemistry from Yale University in 1991 and her Ph.D. in oceanography from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography & Applied Ocean Science and Engineering in 1997. She did postdoctoral research at the Graduate School of Oceanography (University of Rhode Island) and the Southampton Oceanography Centre in the United Kingdom before joining the faculty at UT in 1999. Her research covers two major topics: the use of natural chemical tracers to study ocean circulation (primarily in the Arctic and North Atlantic Oceans), and mid-ocean ridge hydrothermal systems. She has participated in nine oceanographic research cruises and has made five dives in deep submersibles to hydrothermal vents. She has published eight papers in scientific journals and has-been asked to contribute an article to the forthcoming Encyclopedia of Ocean Sciences. She teaches undergraduate courses in Marine Chemistry and Marine Geology as well as graduate courses in the Department of Marine Science.