VENTS AND SEEPS

HYDROTHERMAL VENTS ARE SIMILAR to hot springs on land. Located near ocean ridges and rifts, at an average depth of 7,000 ft (2,100 m), they spew out mineral-rich, superheated seawater. Some have tall chimneys, formed from dissolved minerals that precipitate when the hot vent water meets cold, deep-ocean water. The mix of heat and chemicals supports animal communities around the vents—the first life known to exist entirely without the energy of sunlight. Elsewhere, slower, cooler emissions of chemicals called hydrocarbons occur from sites known as cold seeps.

DISCOVERY

DISCOVERING WHITE SMOKERS

The first hydrothermal vents that scientists observed from *Alvin*, a submersible, in 1977, were black smokers. Scientists then explored other sites near mid-ocean ridges and found more vent systems. Some looked different: their fluids were white, cooler, and emerged more slowly from shorter chimneys. These were called white smokers (see right).

DISTRIBUTION OF VENTS AND RIDGES
Since their discovery in 1977, hydrothermal vents have been found in the Pacific and Indian oceans, in the mid-Atlantic, and even in the Arctic, always near mid-ocean ridges and rifts.

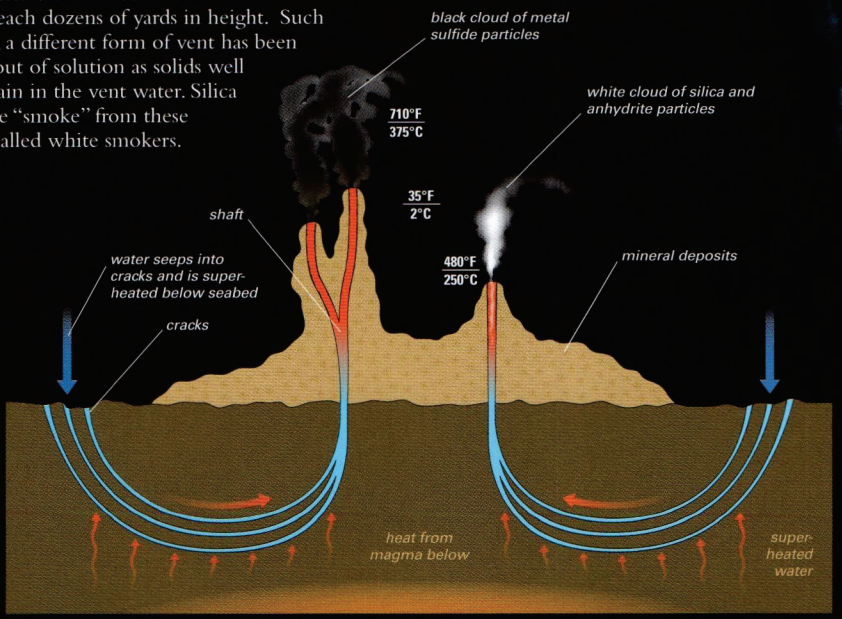
HYDROTHERMAL VENTS

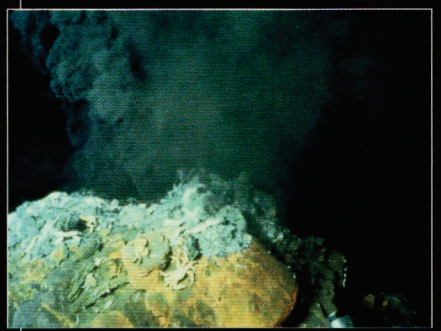
Hydrothermal vents always form close to mid-ocean ridges and rifts (see p.185), where new ocean crust is forming and spreading, and where magma from Earth's mantle lies relatively close to the surface. Seawater seeps into rock cracks opened up by the spreading sea floor. It penetrates several miles into the newly formed crust, close to the hot magma below. This heats the water to 660–750°F (350–400°C). The high pressure at these depths stops it from boiling, and it becomes superheated, dissolving minerals from the rocks that it is passing through, including sulfur, which forms hydrogen sulfide. The hot water rises back up through cracks and erupts out of the vents as a hot, shimmering haze, complete with its load of minerals.

BLACK AND WHITE SMOKERS

As superheated water erupts from a hydrothermal vent, it meets the colder water of the ocean depths. This causes hydrogen sulfide in the vent water to react with the metals dissolved in it, including iron, copper, and zinc, which then come out of solution in the form of sulfide particles. Sometimes these form pools on the seabed. However, if the water is particularly hot, it spouts up a little before being chilled by the surrounding seawater, and the metal sulfides form a cloud of black, smokelike particles. Some of these minerals form a crust around the "smoke" plumes, building up into chimneys that can reach dozens of yards in height. Such vents are called black smokers. More recently, a different form of vent has been discovered. In these, the black sulfides come out of solution as solids well beneath the sea floor, but other minerals remain in the vent water. Silica and a white mineral called anhydrite form the "smoke" from these chimneys, which, because of their color, are called white smokers.

THE FORMATION OF A SMOKER
Water, heated by magma deep beneath the sea-bed, dissolves minerals from the rocks. When it erupts through vents, the water is chilled by the surrounding sea. This makes minerals precipitate as smoky clouds, which can be white or black; other minerals are deposited to form chimneys.





SMOKING CHIMNEYS
The minerals from black smokers, like this one, can increase the height of a chimney by an incredible 12 in (30 cm) a day. However, the chimneys are fragile, and they collapse when they get too high.

LIFE WITHOUT SUNLIGHT

The first biologists to explore hydrothermal vents were amazed at the life they saw. Masses of limpets, shrimps, sea anemones, and tube worms cluster close to the vents, beside unusually large clams and mussels. White crabs and a few fish, such as the eelpout, scrabble among them. Not every vent system is the same: in the Atlantic, there are no tube worms, clams, or mussels, but lots of white shrimp. Some animals that live in darkness depend on sunlit waters for their food supply, but vent animals are remarkable in that they do not need sunlight for energy. White mats of bacteria around vents are the key. They oxidize sulfides from the vent water to make energy, and are the vent animals' food source. Some animals have the bacteria living inside their bodies.

VENT FISH
This fish, called an eelpout, feeds on mussels, shrimp, and crabs living around vents.

GHOSTLY CRAB
The hydrothermal vent crab is one of many vent creatures. Each year, about 35 new species living around vents are being described by scientists.

DIFFERENT ANIMAL COMMUNITIES
Animal communities vary between vent systems. Vents on the Mid-Atlantic Ridge are inhabited by swarms of rift shrimp (shown here), feeding on sulfide-fixing bacteria, but there are no giant clams.

OCEAN SMOKER
This black smoker, seen from *Alvin*, is similar to the one that scientists first observed in 1977, spewing out dark fluids from deep in the ocean crust.

COLD SEEPS

The discovery of hydrothermal vents proved that not all deep-sea life depends on sunlight for energy. Soon, other seabed communities were found that could survive in the dark. In the Gulf of Mexico, diverse animal colonies live in shallow waters near where oil companies drill for petroleum. Here, seeps of methane and other hydrocarbons (compounds containing carbon and hydrogen) ooze up from rocks beneath the sea. Mats of bacteria feed on these cold seeps, providing energy for a food chain that includes soft corals, tube worms, crabs, and fish. Other animal communities in deep-sea trenches off the coasts of Japan and Oregon rely on methane, which is released by tectonic activity. Cold-seep communities may be more common than first thought at depths below 1,800 ft (550 m), although there is often no obvious seepage. Such communities may instead rely on chemical-rich sediments exposed by undersea landslides or currents.

LIFE ON A SEEP
Mussels containing methane-fixing bacteria live alongside tube worms, soft corals, crabs, and an eelpout at this cold seep, 9,800 feet (3,000 m) down on the seabed near Florida.

WORM WITHOUT A MOUTH

The vent tube worm (below) can be 6 ft (2 m) long and as thick as a human arm. It has no apparent way of feeding. However, its body sac contains an organ called a trophosome, filled with grape-like clusters of bacteria. The worm's crimson plumes collect sulfides from vent water, and the bacteria use these to produce organic material, which the worm absorbs as food.