Oil, minerals found at hot vents on sea floor

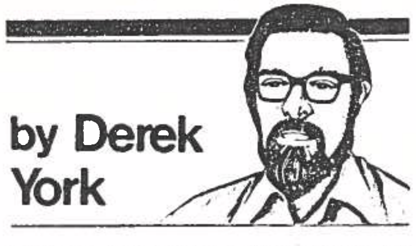
Space exploration may be cooling down, but underwater exploration is heating up.

Professor Steve Scott, associate chairman of geology at the University of Toronto, has just returned from the sea-bottom of the Gulf of California where he and an international team of scientists were able to see how oil and mineral deposits are formed.

Dr. Scott was able to watch at close-hand the gyrations of the recently discovered 3-metre long (10-foot-long) tube worms, and the intricate inter-play of these with giant crabs and clams.

The purpose of the expedition was to visit the great crack in the ocean floor that runs the length of the Gulf of California. The crack is part of a globe-girding oceanic ridge system which is essentially a huge submarine mountain chain down the middle of which runs a large rift. The ocean floors are like underwater escalators

Steve Scott



by Derek York

emerging from those rift systems as lava flows.

The exciting feature of the rifts that has been discovered in the past five years is extremely hot water laden with important metals is venting from chimneys scattered along the rifts. What's more, the areas surrounding the vents teem with life. The discoveries were made by oceanographers going down to the ocean floors in miniature submarines.

Last month, Dr. Scott spent two weeks in the Gulf of California as an invited member of the Guyamas Basin Project, which is directed by oceanographer Peter Lonsdale. It is paid for by the U. S. National Science Foundation with input from the Scripps Institute of Oceanography (La Jolla, Calif.,) and Woods Hole Oceanographic Institute in Massachusetts. The purpose of the expedition was to study the remarkable geological and biological features of these so-called hydrothermal vents.

Ten dives in all were made and Dr. Scott went down in one of them, curling his 6-foot, 4-inch frame along with two others inside the 2-metre-diameter (7-foot diameter) metal sphere that lies at the heart of Alvin, a submersible owned by the U. S. Navy and operated by Woods Hole.

Sharing the cramped quarters with Dr. Scott were Mr. Lonsdale and Bob Brown (the pilot) of Woods Hole.

After about an hour's descent, Alvin reached the bottom, where it hovered among the geothermal chimneys while Dr. Scott and the others observed the remote creatures that cling to life in those aquatic oases.

They took thousands of photographs of the eerie scene, measured the temperatures, and, very importantly, collected samples of the vent material for detailed analysis later.

Dr. Scott, who was invited because he is an international authority on sulphide deposits, said he had no feeling of claustrophobia during the six hours he spent at a depth of 7,000 m (1.24 miles).

"I had no feeling of being down deep — I could have been 10 feet down with the lights out — until you actually get down to the sea floor and see this incredible life around these vents."

One thing he did remain aware of, however, was the temperature reading on the thermometer attached to the outside of the hull. Normally, this would record about 3 degrees Celsius (37 degrees Fahrenheit) at the ocean floor, but the temperature of the water gushing from some of the vents was as much as 315 C (about 600 F). Because the observation windows would begin to soften at 80 C (176 F) it was critical that Mr. Brown steered the craft well clear of the chimneys.

Despite that worry, the explorers were able to use Alvin's two remote-controlled arms to collect samples of the chimneys and surrounding rocks, and tube worms, crabs and clams.

The tube worms, which have only been known for about five years, are extraordinary creatures, which can grow up to 9 m (30 feet) long, poking vivid red ends out of white plastic-like tubes.

Dr. Scott was struck by the remarkable architecture of some of the black smoking chimneys. Not all were simple spires like earlier known ones. "We saw things we were calling pagodas and 'CN towers.' The pagoda is a central tube with skirts coming off it. It may be about 17 m (56 feet) high and about 7 m (23 feet) in diameter at the base. Tube worms cover the vertical parts except near the top where it's too hot for them near the belching smoke. If you break the side, hot water comes jetting out." On the bottom surface of what would be the pod atop the 'CN tower,' beautiful pyrrhotite (iron sulphide) crystals are forming."

It was the sulphide and oil deposits down there that most fascinated Dr. Scott. The processes going on "enable us to understand better how ore deposits form. Geologists look at end products always. We look at dead rocks. We don't see the process." There they could actually see in action aspects of what ore geologists usually only speculate on.

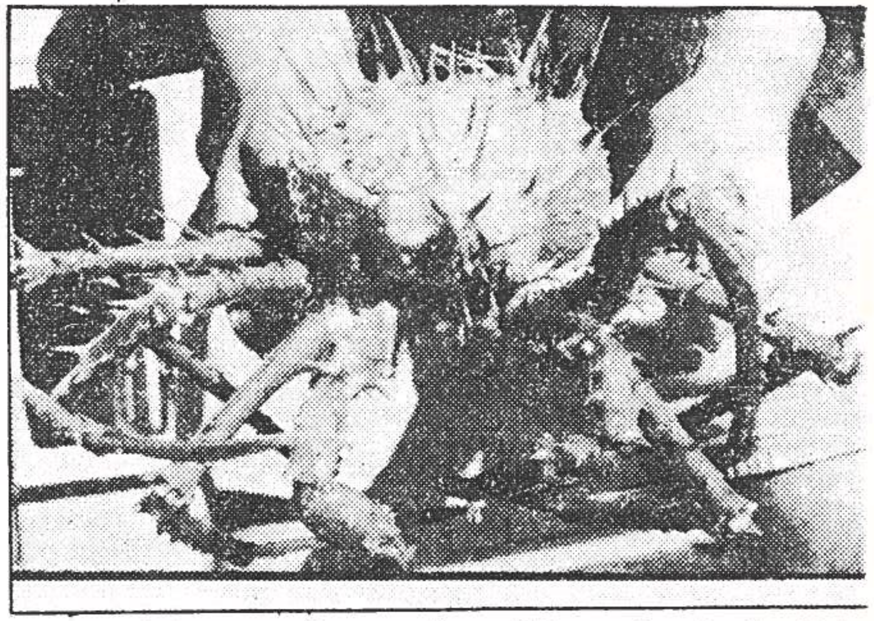
The deposits appear to form in the following way: Cold ocean bottom water seeps down deep into the oceanic crystal rocks until it reaches local hot spots. The water warms up and expands and rises like a hot-air balloon.

The rising hot water leaches metals from the lavas and sediments comprising the ocean floor. Meanwhile, what was originally ocean water sulphate, has changed into hydrogen sulphide.

This whole hot (300 C, 570 F) mixture finally bursts out of one of the vents into the cold ocean water.

Very rapid turbulent mixing occurs and the metals become heavy, dark sulphides and give the typical rises for a while and then gradually spread and fall onto the bottom, forming a carpet of metallic sulphides — an incipient ore deposit. But, Dr. Scott points out, more than this is needed to build up a large layer of metals.

It is vital that the layer be covered by sediments before the vent dies out, because if this does not happen, the metal sulphides become oxidized as



Large crab from sea floor was brought to surface by the Alvin.

the temperature falls following a vent's death, and the metal oxides will break up and be dispersed by ocean-bottom currents.

In the Gulf of California, sedimentation rates are very high and conditions are excellent for preservation of ore layers. The processes going on in the gulf mirror closely those proposed by Dr. Scott to explain the so-called Besshi-type mineral deposits which are found in many parts of the world.

While it had previously been found that metallic sulphides were being precipitated near other oceanic rift vents, the formation of oil in those environments requires the special combination of circumstances found in such a place as the Gulf of California. There, a thick layer of organic sediment has been built up in the valley of the rift in the recent past. The high heat flow associated with the rift has gradually been converting the organic material into oil, showing, as Dr. Scott says, that "under special circumstances, perhaps, oil is a renewable resource."

The water flow patterns tend to transport oil to the hot-water mounds where the heat cracks the oil and appears to form what look like greases or "a beautiful red wax." On the television monitor inside Alvin, Dr. Scott even saw a large globule of oil break out of a chimney and float off towards the surface.

Back on the surface, he found that many of his metallic sulphide samples were "dripping with oil."

Years of exploration of the world's rift system remain to be carried out. However, for a country such as Canada, whose economic stability depends on minerals and oil, it is critical that it participate in the explorations.