'Black smokers' offer great potential

by Steven Dawson

"On the ocean floor there are mines of zinc, iron, lead, silver and gold that would be easy to exploit."

This quotation from one of Jules Verne's visionary novels may seem far-fetched. However, researchers such as Prof. Steven Scott of the University of Toronto are proving otherwise. He and other marine geologists are finding polymetallic, potentially economic deposits exactly where the French novelist said they would be.

The term used to describe these underwater anomalies is "black smokers," because of the hot, sulphide-bearing, black smoke that vents from the top of their hydrothermal mounds, spires and chimneys. Sulphides precipitate to create these formations, which contain potentially rich concentrations of zinc, copper, lead, barium, silver and gold.

Scott began researching black smokers after studying massive sulphide deposits on land. As he puts it, "I began asking questions of the rocks and did not get answers."

Steven Scott

Upon learning of an interesting discovery off the Californian coast in 1982, he went on the U.S. manned submersible ALVIN and observed black smokers at a depth of 2,000 metres on the 21°N East Pacific Rise. He was the first Canadian ore deposit geologist to witness the spectacle.

"It was an incredible revelation that had a tremendous impact on my thinking," he said.

Scott then led expeditions which were responsible for the discovery of the Axial Seamont Ridge and, later, the Explorer Ridge.

Black smokers are now known to occur in more than 100 settings, primarily along plate boundaries in the Pacific Ocean.

Scott has gone on to study other black smokers, as well as giving short courses on modern and ancient counterparts, all over the world. He believes research into them is important from a practical, as well as an academic, viewpoint, adding that the knowledge will prove invaluable for future exploration, both on land and at sea.

Exploration for underwater black smokers is similar to that

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for base metal deposits on land. Initially, a bathometric map is produced by towing side-looking sonar equipment from a ship on the ocean surface. Information produced from this survey can be likened to air photos used to identify regional structures with the potential to host mineralization.

Other equipment is then used to narrow the search area. "We then tow an instrument that determines information such as the oxygen content, pH (measure of hydrogen ion concentration) and metal content of the ocean water," Scott explained.

The professor likens this to using geochemical surveys on land to track down orebodies. "In one instance," he said, "this survey led to the discovery of a black smoker plume in the southwest Pacific Ocean, which we could follow for 10 km."

At this point, submersibles are used to go down and investigate the formations.

Most of the known occurrences are small, compared with orebodies mined on land. Typically, they are a few tens of metres in diameter, a few metres thick and topped with spires up to 30 metres in height. They average 1,000 tons.

At many sights, however, a large concentration of these smaller formations can be found. At the 13°N East Pacific Rise, for example, more than 100 mounds are scattered along an 18-km length of the ridge axis.

Although most deposits are small, six have been found that are estimated to contain more than 1 million tons each.

The largest known sea floor orebody is the Atlantis II Deep deposit in the Red Sea. It was the first polymetallic sulphide deposit to be found, and questions soon arose regarding the potential for base and precious metal production from black smokers.

A successful attempt at mining the Atlantis II was made in the 1970s when the Saudi-Sudanese Red Sea Commission, together with the German company Preussag, developed a pilot project. The deposit was found to contain 85 million tonnes averaging 2.07% zinc, 0.45% copper, 39 grams silver and 0.5 grams gold per tonne. Since then, several other deposits have been found, though none has been exploited.

Few samples have been taken from black smokers to determine typical grades. Assay results from grab samples of 15 deposits range between 4% and 36.7% zinc, 0.2-7.8% copper, 0.03-12.1% lead, 9-1160 grams silver and 0.11-4.9 grams gold.

For funding, Scott has relied on the Bank of Nova Scotia, which provided a grant of $500,000 to be spent over 10 years, as well as the National Science Research Council. These funds enabled the researcher to develop and direct the renowned Scotiabank Marine Geology Research Laboratory at the University of Toronto.

Mining companies, however, have generally shown little interest in Scott's research.

At presstime, Scott was in the north-central Pacific observing the newest forming island in the Hawaiian chain. The island, Loihi, is about 1,200 metres below sea level and is exhibiting indications that black smokers are forming.

A native of Fort Frances, Ont., Scott attended the University of Western Ontario and received his PhD in geochemistry and mineralogy from Pennsylvania State University.