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NEWSLETTER FOR THE

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Joint German-Canadian Research on Seafloor Hydrothermal Activity in Antarctica: Sonne Cruise SO-155

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In February–March, 2001, two Natural Resources Canada (NRCan) scientists from the Geological Survey of Canada travelled to the Bransfield Strait in Antarctica, as part of the German-Canadian global research project on Seafloor Minerals. The project, led by scientists from the German universities of Freiburg and Kiel in cooperation with scientists from the Geological Survey of Canada, is investigating submarine hydrothermal activity in diverse volcanic and tectonic settings on the ocean floor. This work has direct implications for understanding the formation of economically valuable mineral deposits in ancient terranes now preserved on land.

The Bransfield Strait, which lies along the western Antarctic Peninsula in the King George Basin, bordering the South Shetland Islands (Fig. 1), is one of the few locations on the modern ocean floor where active rifting of a continental margin can be observed. Submarine volcanic and intrusive activity from rifting of the basin floor causes widespread geothermal activity (Klinkhammer *et al.*, 1999) which leaves distinctive deposits of zinc, lead and copper mineralization. The deposits form where submarine volcanoes discharge hot (>300°C) metal-bearing fluids onto the seafloor. Many large base metal deposits, like the Bathurst mining camp in New Brunswick, are thought to have formed the same way.

Several hundred million years ago, the Bransfield Strait region was geologically contiguous with the southern Andes. Since then, subduction of the paleo-Pacific ocean beneath the Antarctic Peninsula has caused rifting of the continental

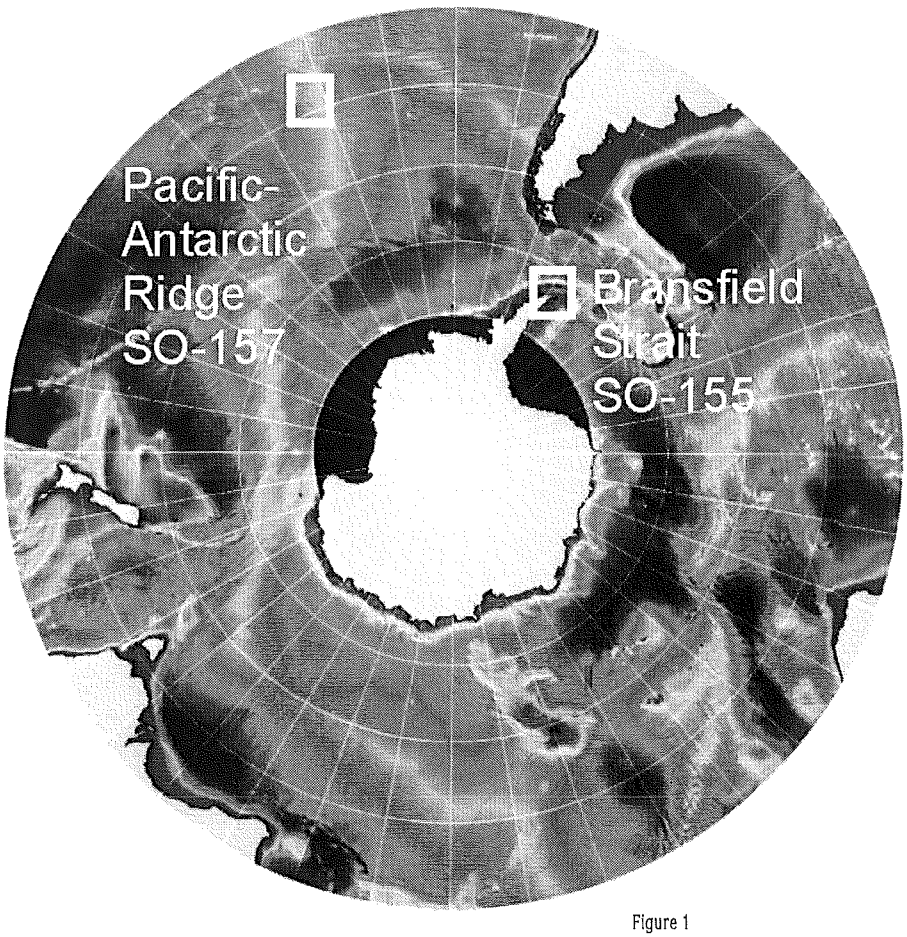

Figure 1
Locations of Sonne research cruises SO-155 (Bransfield Strait) and SO-157 (Pacific-Antarctic Ridge). Predicted seafloor bathymetry from Smith and Sandwell (1997) courtesy of the National Geophysical Data Center (www.ngdc.noaa.gov).

margin and the formation of the Shetland Islands. The volcanic arc was gradually separated from the Antarctic peninsula by the Bransfield Basin. The present-day Bransfield Strait is still an active rift, extending for more than 200 km from Elephant Island in the north to Deception Island in the South. Submarine volcanoes have recently been discovered in a linear array extending along the length of the basin. These volcanoes are associated with active geothermal venting which attracted the research team to the area. (see Fig. 2).

Using the German research vessel *Sonne*, the scientific team, including Prof. Peter Herzig, University of Freiburg, Prof. Peter Stoffers, University of Kiel and NRCan scientists, mapped and sampled the submarine volcanoes and carried out detailed surveys of the seafloor. These included bathymetric mapping of volcanic features on the seafloor, bottom photography and video using towed camera arrays, and sampling with a TV-controlled grab. Deposits of zinc sulfides and barite were located on one of the volcanoes at a depth of 1,100 m. In addition, evidence for older, pre-rift arc-related hydrothermal activity was found at a depth of more than 2000 m in the northern part of the basin. The nearby Deception Island caldera was also investigated. Deception Island is the largest and most active volcano in the region. In the mid-1970s, eruptions in the caldera destroyed a British research station located on the island, but the 300-m

deep caldera is still accessible to ships through a small channel. The team spent several days documenting ongoing geothermal activity on the caldera floor. Through this research, the team has determined that ancient submarine hydrothermal systems responsible for large base metal deposits could have developed in a similar environment.

In June–July 2001, three NRCan scientists participated in a second research cruise (SO-157) to investigate hydrothermal activity along the Pacific-Antarctic Ridge (Fig. 1), where the Pacific and Antarctic plates are actively spreading apart. The expedition located black smoker hydrothermal vents on the southernmost extension of the East Pacific Rise, where it joins the Pacific-Antarctic Ridge. The team is also doing research in the Arctic, investigating the offshore extension of the neovolcanic zone of Iceland.

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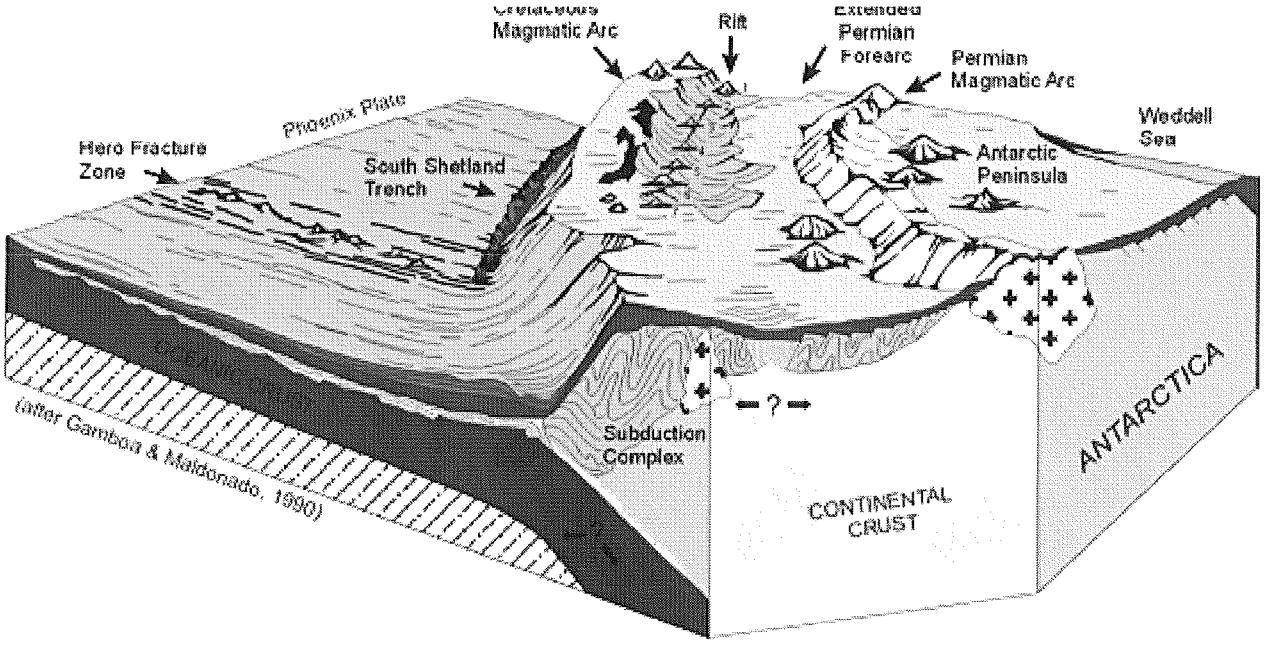
Figure 2
Tectonic model of the Bransfield Strait (modified from Gamboa and Maldonado, 1990), showing the opening of the rifted basin adjacent to the Antarctic Peninsula. For the last 4 million years, the Pacific margin of the Antarctic Peninsula has been a passive margin, but during the Mesozoic-Cenozoic it was part of an active subduction zone. The South Shetland island arc volcanoes were formed by the subduction of the Phoenix plate (proto-Pacific Ocean) along the South Shetland. This convergence ceased when the spreading centre of the Phoenix plate became inactive, about 4 million years ago. In the last million years, volcanism has renewed on at least four of the islands (Deception, Livingston, Greenwich, and King George), coincident with rifting and volcanism in the adjacent Bransfield basin. The newly discovered submarine volcanoes in the Bransfield Strait occur along-strike from Deception Island and are likely centered on the same basement faults.



References

Gamboa, L.A. and P.R. Maldonado, 1990. Chapter 9, Geophysical investigations in the Bransfield Strait and in the Bellingshausen Sea, Antarctica, In: B. St. John, ed., Antarctica as an Exploration Frontier – Hydrocarbon Potential, Geology and Hazards, Circum-Pacific Council Series. American Assoc. of Petrol. Geologists, Studies in Geology, 31, pp. 127–141.

Klinkhammer, G.P., C.S. Chin, R. Keller, A. Daehlmann, H. Sahling, G.Sarthou, S.Petersen, F. Smith and C. Wilson, 1999. Discovery of hydrothermal vent sites in Bransfield Strait, Antarctica. EOS, v. 80, no. 46, p. 1174.

Lawver, L.A., M. Ghidella, R.P. Von Herzen, R.A. Keller and G.P. Klinkhammer, 1996. Distributed active extension in Bransfield basin, Antarctic Peninsula: Evidence from multibeam bathymetry. Geolog. Society of America, Today, v. 6, no. 11, pp. 1–5.

Smith, W.H.F. and D.T. Sandwell, 1997. Global Sea Floor Topography from Satellite Altimetry and Ship Depth Soundings. Science, vol. 277, no. 5334.