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Pacific Coastal & Marine Science Center

Gorda Ridge Hydrothermal System

Massive copper-, zinc-, and gold-rich sulfide deposits occur on numerous spreading segments of the Gorda Ridge (entirely within the U.S. EEZ). This project investigates the distribution, quantity, and composition of these hydrothermal deposits in both sediment-covered and sediment-free environments.

Sidescan sonar and single channel airgun profiling on the NOAA ship *Discoverer*

Cruise D1-96-NC July 16 - August 9, 1996

On July 16, 1996, the NOAA ship *Discoverer* sailed from Seattle, Washington with 25 scientists (116 kb) from the USGS, NOAA and Williamson and Associates aboard. The cruise (D1-96-NC), with Robert Embley (NOAA, Newport, Oregon) and Kim Klitgord (USGS, Menlo Park, California) as co-chief scientists, successfully completed sidescan sonar studies of the Co-Axial segment of the Juan de Fuca Ridge (NOAA VENTS Program) and the Escanaba Trough on the southern Gorda Ridge. The AMS-60SI (98 kb) sidescan sonar system and 4.5 kHz sub-bottom profiler system leased and operated by Williamson and Associates were used for both surveys. At Escanaba Trough, nearly 350 km of near-bottom sidescan sonar and 4.5 kHz sub-bottom penetration data and surface towed airgun seismic reflection data were acquired on a grid of 18 lines over the Northern Escanaba (NESCA) hydrothermal system within the axial valley of Escanaba Trough.

A tight grid of 1 to 2 km spacing swaths in both the NNW and NE directions provided two complete sidescan mosaics with different image angles for interpreting the surficial geologic character of the 18 km x 25 km region centered on the hydrothermal mounds that are the drill target for the ODP Leg 169 on the ship *Joides Resolution* with Rob Zierenberg (USGS, Menlo Park, California) as co-chief scientist. The sidescan sonar data, seabeam swath bathymetry and sub-bottom data were all processed (95 kb) on board ship by the scientists. The completed sidescan mosaics and sub-bottom profiles will be used on the ODP cruise.

The 4.5 kHz seismic system routinely imaged over 50 meters below the seafloor and provided a superb stratigraphic record of the interlinked volcanism, deformation and turbidite deposition within Escanaba Trough. USGS scientists used these records to identify features that had been seen on previous cruises by submersible vehicles and an underwater towed cameras.

The 160 cu.in. single channel airgun data provided an excellent image of the entire sediment column and basement structures for the entire area, at times exceeding 1000 m of penetration. The Escanaba Trough survey revealed a narrow 4-km wide zone of neotectonic activity with the most active faulting and volcanic activity.

The recent basaltic flows provided bright sidescan targets enabling scientists to map their areal extent and to identify their likely eruption source a fissured volcanic hill 2 km east of the hydrothermal Central Hill of NESCA. The hydrothermal fields on the Central Hill and Southwest Hill were clearly identifiable. Growth faults in the 4.5 kHz data provide a fine data base for establishing the faulting history within the neotectonic zone to complement the volcanic history.

This was the last cruise for the *Discoverer*, ending a 30-year career of oceanographic research. The ship was escorted in by the Chief Seattle (70 kb), a fire boat, spraying water as the ship approached the locks into Lake Union. Approximately eighty family members and friends of the crew boarded in Everett, Washington to ride the ship through the locks (74 kb) into Lake Union, where the *Discoverer* is docked at NOAA's Pacific Marine Center.

An abstract about the data collected on this cruise was presented at the December '96 American Geophysical Union Meeting in San Francisco, California.


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Gorda
Ridge

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Launching of the AMS-60SI sidescan sonar fish from the back deck of the Discoverer


Sidescan sonar data acquisition system

Gorda Ridge

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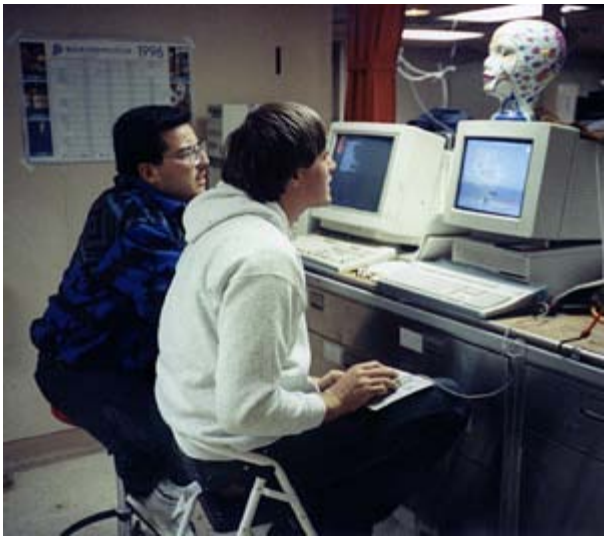

USGS scientists processing sidescan sonar data from the AMS-60SI system

USGS scientists processing sub-bottom data from the AMS-60SI system

Gorda Ridge

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The ship was escorted in by the Chief Seattle, a fire boat, spraying water as the ship approached the locks into Lake Union.

Gorda Ridge

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Entering the locks into Lake Union

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This abstract was submitted to the American Geophysical Union Meeting in San Francisco, California in December, 1996.

New Sidescan Imagery of NESCA Site at Escanaba Trough,
Southern Gorda Ridge

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Escanaba Trough, Gorda Ridge, is one of the few known sediment-covered seafloor spreading center segments and contains at least six large sediment-hosted massive sulfide deposits. Discrete volcanic edifices occur at 5-10 km intervals along this slow spreading ridge. Basaltic magma intrudes the sediment fill of the axial valley, creating uplifted sedimentary mounds and in some areas erupting onto the seafloor. New sidescan sonar imagery of the northern Escanaba volcanic edifice (NESCA, about 41\(deN lat.) shows a 4 km-wide zone of neotectonic activity, with sharply delineated areas of disturbed sediment and volcanics, bordered by uplifted fault benches covered with undisturbed sediment. Recent volcanic activity within this neotectonic zone has created two distinctly different tectonic features: an uplifted sedimentary hill (possibly related to sill injection) and an adjacent small volcano with an extensive surface flow.

Two complete sidescan mosaics with different look angles were collected in summer, 1996, with a deep-towed 60 kHz system. Swath bathymetry was calculated from sidescan phase interferometry; 4.5 kHz seismic profiles provided high resolution subbottom (~50 m) structure and stratigraphy.

The primary active hydrothermal system is located on Central Hill, a 1.5 km-wide circular hill of uplifted sediments. The hill is bound by both ridge-parallel basement faults and a concentric set of faults that rim the top of the hill and may be associated with sill intrusion. Hydrothermal deposits (with up to 217\(deC fluids) have been found along parts of this concentric fault system and sidescan sonar data indicate that there may be deposits along the entire system. Central Hill is one of the primary drill sites for the recent ODP Leg 169. A generally continuous area of volcanic flows east of Central Hill appears as a distinct, bright sonar reflector stretching for approximately 6 km along axis. A fissured and apparently inflated volcanic hill about 2 km east of Central Hill is the likely eruptive source of these flows which are underlain by sediments and bound on the east by a faulted sediment covered bench. Tilted sediment-covered fault blocks within the neotectonic zone constrain the flows to the north, south, and west. Cross-cutting lineations to the southwest of Central Hill have offsets that indicate oblique basement faulting or mass wasting has occured more recently than ridge-parallel faulting.

Gorda
Ridge