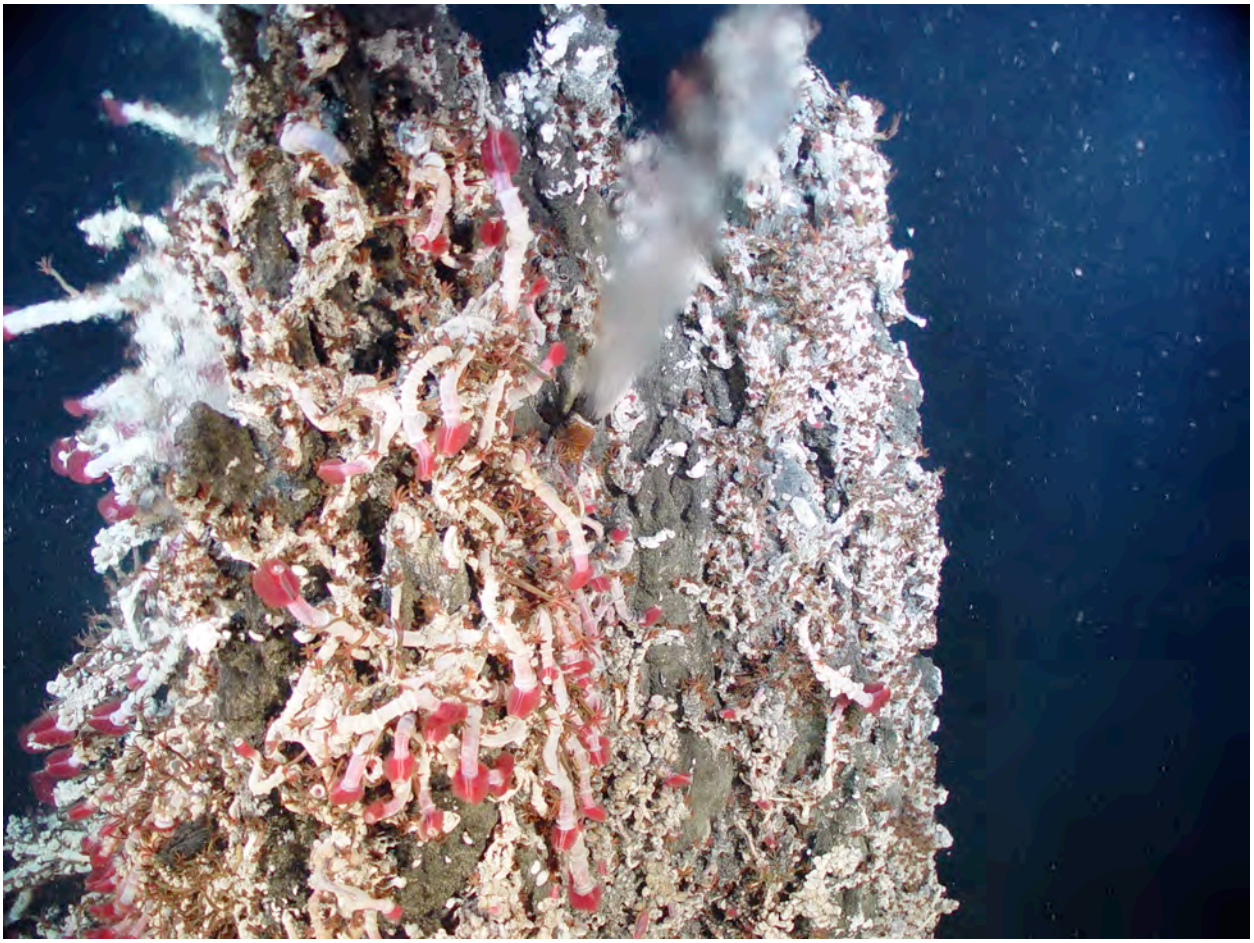
R/V Thomas G. Thompson
Cruise Report for Leg TN-209
July 31 - August 13, 2007

A Joint University of Washington Student and NEPTUNE Canada Cruise in Support of Cabled Observatory Studies in the Northeast Pacific Ocean

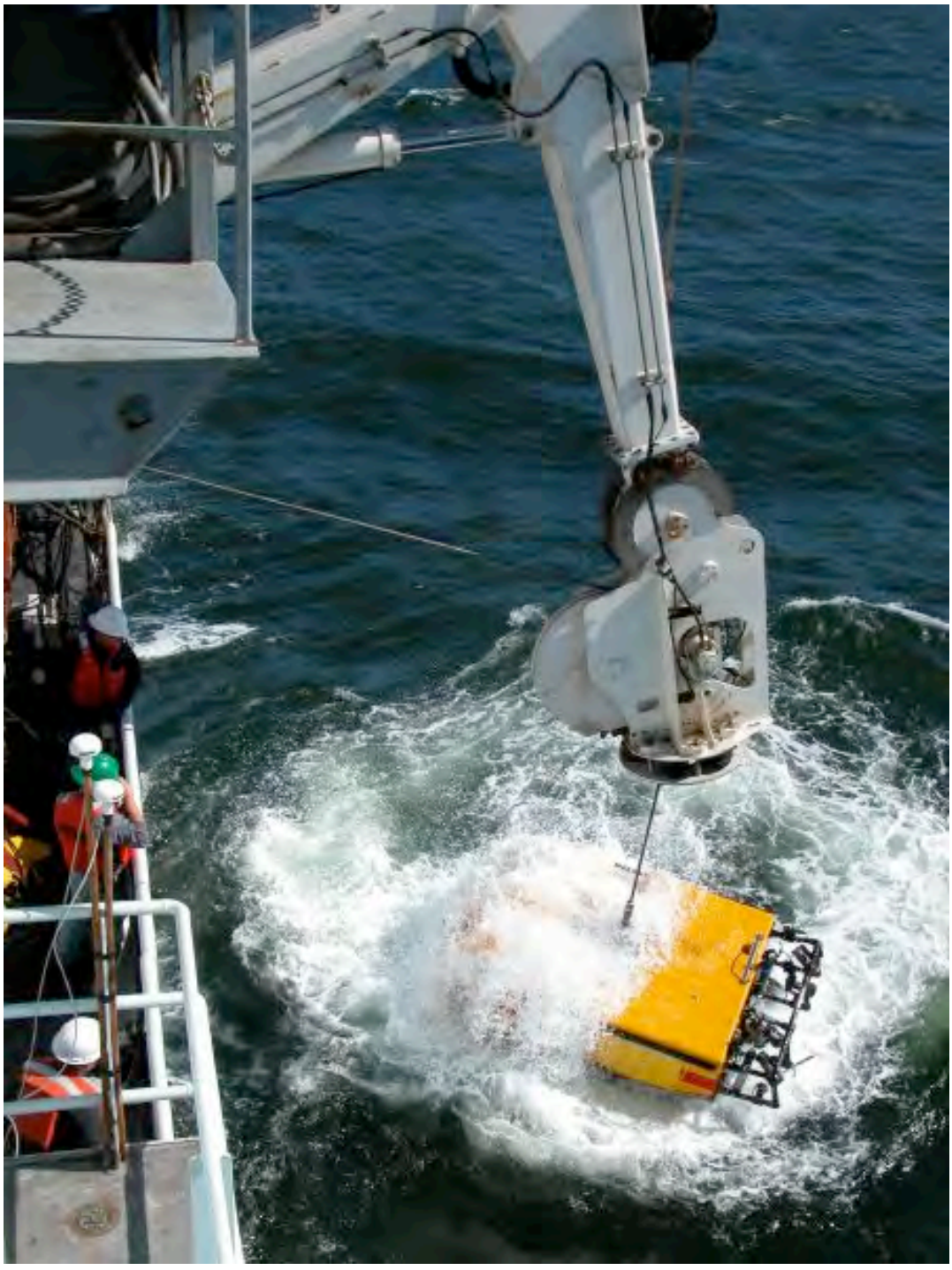


Chief Scientist
William Wilcock
University of Washington

Co-Chief Scientist
Deborah Kelley
University of Washington

Acknowledgements

The Chief Scientists would like to thank Captain Al and the crew of the R/V Thomas G. Thompson for their outstanding work in support of the cruise objectives. We also thank the ROPOS team for their hard work and dedication to helping us complete our science. As always it was a pleasure sailing and working with both teams.



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Scientific Goals

This cruise is one of many that are being conducted to support the development of cabled observatories in the Northeast Pacific.

The W. M. Keck Foundation provided a 5-year grant to the University of Washington to conduct NEPTUNE prototype cabled observatory experiments. The basic premise is that when rock deforms, the nutrient-rich fluids set in motion are capable of supporting microbial blooms in adjacent portions of the crust or within the overlying ocean. While it is not possible to fully test this hypothesis without a permanent presence on the seafloor, the goals of the Keck experiment are (1) to initiate such tests by deploying state-of-the-art networks of sensors and samplers at two locations on the northern boundary of the Juan de Fuca plate; and (2) to develop critical new chemical and biological sensors that provide the complete set of time-series observations necessary for longer-term studies.

The NEPTUNE Canada program is installing an 800-km-long cabled observatory on the northern Juan de Fuca Plate to address scientific questions that fall within five themes: (1) plate tectonic processes and earthquake dynamics; (2) dynamic processes of fluid fluxes and gas hydrates in the sea bed; (3) regional oceanic/climatic dynamics and effects on the marine biota; (4) deep-sea ecosystem dynamics; and (5) engineering and computational research.

Operational Objectives

The operational objectives of this cruise were to use the remotely operated vehicle (ROV) ROPOS on the R/V Thomas G. Thompson to:

- Survey two portions of the NEPTUNE Canada cable route along the Cascadia Margin near ODP Site 889 and Barkley Canyon.
- Recover eight Ocean Bottom Seismometers (OBS) deployed on the Endeavour Segment of the Juan de Fuca Ridge as part of the Keck experiment.
- Survey and image sulfide structures in the Main Endeavour, Mothra and Sasquatch vent fields on the Endeavour Segment to monitor temporal changes in their characteristics.
- Survey and image a stockworks system located on the west valley wall to the south of Mothra on the Endeavour Segment.
- Obtain CTDs in the hydrothermal plumes above the Endeavour vent fields.
- Test the Remotely Operated Cable Laying System (ROCLS) that is being developed for the ROV ROPOS for laying secondary cables for NEPTUNE Canada.
- Provide 12 undergraduates with the opportunity to participate in a research cruise using a state-of-the art scientific ROV.

Operational Outcome

All the objectives were met and in addition bathymetric data were collected in Barkley Canyon and a bottom survey was completed of the cable route and primary node site east of the Endeavour Segment.

Cruise Narrative

July 31, 2007: Transit to Victoria

The R/V Thompson sailed from Pier 90 (Terminal 91) in Seattle at ~0830 for the transit to Victoria B.C., Canada. Midway through the transit, one of the Z drives on the Thompson was temporarily lost due to a cooling fan failure and this delayed the ships arrival in Victoria from 1500 to 1630. The Thompson docked at the southern end of the Coast Guard Base dock with the bow facing out to sea. The ROPOS team commenced loading of the crane base and crane, which had already arrived from the East Coast. The remainder of the equipment arrived overnight.

August 1, 2007: Mobilizing of ROPOS

ROPOS loading recommenced again at 0700 and it went very smoothly, except that Steve Bucklew injured his hand and required seven stitches in one of his fingers. The UW Regional Scale Nodes (RSN) team, representatives from JOI, and the NEPTUNE Canada team met all day on board in the science lab.

August 2, 2007: Mobilizing of ROPOS continued and Transit to ODP889

ROPOS completed their loading and pre-cruise testing shortly after lunch and the ship left the dock at 1420. The ROPOS team conducted a short dunk test at 1630 in the Straits of Juan de Fuca outside the shipping lanes. Everything went well except one light failed. The ship then transited to ODP Hole 889 (Figure 1) to conduct a cable route survey.

August 3, 2007: Dive R1074 – ODP 889

At 0530, ROPOS entered the water for Dive R1074 (Figure 2) to survey a 40-km-long section of the NEPTUNE Canada cable route across the continental slope near ODP Hole 889 from 1500 m to 250 m water depth. Dive operations consisted of visually surveying the bottom with brief stops at spacings ranging from 100 m to 1 km to obtain a 360° scan with the Kongsberg Mesotech 675 KHz scanning sonar and to probe the sediments with a 1-m-long rod. The dive went very smoothly with an average transit speed for ROPOS of 0.7 kt (1.3 km/s) significantly exceeding the 0.5 kt (0.9 km/hr) speed predicted by the ROPOS team prior to the dive. Occasional trawl marks were observed near the maximum depth and they were very common in shallower regions. Two cables were crossed. The terrain was less severe than anticipated.

August 4, 2007: Dive R1074 continued and R1075 – Barkley Canyon

Early in the morning the wind speeds briefly picked up from about 25 kt to 35 kt, which triggered discussions about aborting Dive R1074. However, the wind speed decreased and the dive continued until the survey was completed. ROPOS was recovered at 1600. A sticky hydraulic valve left ROPOS hanging in mid-air over the ships side for several hours during which time the ship began transiting to the next dive site at Barkley Canyon (Figure 1). The valve was eventually fixed with the aid of a hammer blow. Dive R1075 to survey the vertical

profiler cable extension route near Barkley Canyon (Figure 3) commenced just after 2100, beginning at a water depth of 450 m.

During the day we communicated with the R/V Atlantis, which was already at the Endeavour Segment, about experimental plans. They were hove-to due to weather. They planned to deploy two 50-m moorings for Daniela Di Iorio's acoustic scintillation experiment in the Main Endeavour Field and careful planning was required to ensure that the southern mooring to the south of Grotto did not block access to the seismometer. The R/V Atlantis was also planning a mapping survey of the axial valley with MBARI's AUV D. Allen B. and there were concerns that this would impede ROPOS dives because the Atlantis wanted to follow the AUV with a 2 nm (later reduced to 1 nm) exclusion zone.

August 5, 2007: Dive R1075 continued and R1076 – Endeavour Flanks

Dive R1075 along the Barkley Canyon vertical profiler extension route went very smoothly. ROPOS averaged 0.7 kt (1.3 km/hr) over the bottom despite stopping for 75 seconds every 100 m for a sonar scan. After securing ROPOS, the ship left station at 0700 for a 10-hour transit to the Endeavour Segment (Figure 1). There was a brief disruption midway through the transit when the ROPOS navigation pole on the starboard side of the ship was found to be loose and rattling against the side of the ship: it was secured without any damage. Dive R1076 (Figure 4) to recover seismometers at KENE and KENW on the outer flanks northeast and northwest of the High Rise Field, respectively, commenced at 1800 and lasted 10 hours. The dive was uneventful except that the logger at KENE, the first seismometer to be recovered, had dropped its weight and was floating on the sensor cable. This complicated the second recovery of KNEW because one manipulator arm had to hold the KENE logger throughout the dive.

August 6, 2007: Dive R1077 – Mothra, and R1078 – Sasquatch

Communications in the morning with R/V Atlantis indicated that the AUV survey was cancelled because the seas were still too rough for a safe recovery. At 0700 Dive R1077 (Figure 4) began to recover seismometers KESW and KEMO and to survey the Faulty Towers Complex in the Mothra vent field. The recovery of KESW was uneventful - the seismometer orientation was measured at 200±5° before removing the sensor and abandoning the concrete monument. The KESW instrument was set down by station KEMO, ~ 50 m east of the Towers Complex. KEMO had also dropped its anchor weight. Photo mosaics were obtained for the Rowan, Finn, Shi Shi, Tower and Giraffe structures. A temperature of 303°C was measured in Hot Harold at the northern end of the Faulty Towers complex, and the vent Shi Shi had grown ~13 m over the past year. The two seismometers were secured and the dive finished at 1630.

While preparing for the next dive, a single CTD was obtained at Jonathan Kellogg's Progressive Vertically Oscillating Cast (PVOC) waypoint PV12. It was realized that it was unrealistic to obtain (PVOC) casts at all 23 sites that he had recommended. Jonathan Kellogg was contacted and it was decided to conduct one CTD above each vent field and one at an off-axis station.

Dive R1078 (Figure 4) started at 2045 with the objectives of recovering KESQ, making a geological transect, and surveying the Sasquatch vent field. Station KESQ was recovered without incident and the first part of the transect to the vent field was completed.

August 7, 2007 Dive R1078 – Sasquatch continued, and Dive R1079 - Stockwork

The seismometer was set down prior to visiting the Christmas Tree, Beehive, Marker C and Pico Vents. The Hobo temperature logger could not be found. A photo mosaic of Christmas tree was obtained before knocking it down. The seismometer was then reacquired and the geological transect completed before ending the dive at 0400. Upon inspection, it was found that the stainless steel anchor wire on KESQ had a brass crimp that had largely dissolved - the reason why several seismometers had dropped their anchors.

Following the dive, CTDs above Sasquatch (PV20), Salty Dawg (PV16) and Mothra (PV2) were completed while ROPOS installed new batteries in Kim Juniper's McLane sampler, repaired the temperature probe and installed the bio-box.

Dive R1079 (Figure 4) to the stockwork system south of Mothra started at 1300. There was a delay mid-way through the water column because the ROPOS winch had relay problems, but 3 hours after the launch ROPOS reached the seafloor, The vehicle landed ~300 m northeast of the stockwork area found in 2007 by Kelley during an Alvin in this area while exploring for a new venting site. ROPOS then traversed southwards along the axial valley's west wall. The stockwork systems here are spectacular and significant time was spent delineating their extent, obtaining photographs and photo mosaics, and sampling. The stockwork extends ~200 m along the west wall and can be traced ~100 m vertically to the top of the wall, which is overlain by rounded sulfide mounds, and well lithified metalliferous sediments. After exploring the stockwork deposits the dive continued south along the wall, passing numerous extinct chimneys on the valley floor. The dive was completed by traversing northwards to the top of the west valley wall, passing the locations of several CTD targets identified on an earlier cruise as potential venting sites.

August 8, 2007: Dive R1080 and R1081– Broadband Recovery

Immediately after ROPOS was recovered the ship headed to the High-Rise field and a CTD was obtained at station PV13.

Dive R1080 (Figure 4), to recover the broadband seismometer, started at 0700 and went smoothly until the final step. The cover plate for the caisson was set down near the sensor and the seismometer quickly unplugged. The most difficult task was unburying the cable, which was accomplished by carefully lifting the exposed cable in the magnum arm. At times it appeared that the cable was nicked but on recovery it was found to be in good condition. The beads were evacuated efficiently from the caisson, the sensor removed from the hole, the plate set on the hole with cable staples (wickets) on top and the sensor secured. The final task was to clip the recovery rope onto the logger package so that it could be lifted beneath the vehicle. This appeared to go smoothly and the dive left the seafloor at 1215. Upon recovery, the logger was not with the vehicle, however. Because tie-wraps holding the lifting rope were not broken it was

believed that the logger had slipped the snap-hook at the seafloor and was still at its deployed location.

Dive R1081 (Figure 4) was a bounce dive to recover the logger and it went uneventfully until ROPOS reached the surface. The 1800-lb line holding the logger beneath the ROV broke when snapped by a large swell only seconds after a second line had been secured. After a frantic few minutes the package was lifted by crane onto the upper deck at 1830.

After completion of the dive, a CTD was obtained above the Main Endeavour Field (PV8). ROPOS then encountered significant problems with the Magnum arm, which delayed the next dive several hours.

August 9, 2007: Dive R1082 – Main Endeavour Field and NE Endeavour flank

Dive R1082 (Figure 4) commenced just before midnight at the start of August 9 with the objectives in the Main Endeavour Field (MEF) of deploying Pete Girguis' osmosampler experiment, imaging vent structures, surveying NEPTUNE Canada cable routes and instrument sites, and recovery of the seismometer KEMF, followed by a survey eastwards out of the axial valley to the NEPTUNE Canada primary node site and the recovery of the seismometer at station KESE. ROPOS first visited Hulk in the northern portion of the field and successfully deployed the Osmosampler experiment near the SW corner of the structure. The site was marked with the Marker 'Co'@ to aide recovery with Alvin during a follow-on program late August. ROPOS then transited to the SE corner of Hulk and placed the Marker I, on a small pagoda/parasitic chimney off of Hulk that hosts an osmosampler linked to a sulfide microbial incubator that will also be recovered by Alvin in August-September 2007. A photo mosaic was obtained of the experimental site.

ROPOS headed east and then south along the main fissure in the MEF and acquired the homer on Daniela Di Iorio's southern scintillation mooring (#44) and then visited Smoke and Mirrors (S&M). The mooring rests on a small down-dropped bench east of the main plateau between the Bastille complex and the Hulk complex. S&M has changed significantly over the years with well-developed low-lying flanges. ROPOS obtained photo mosaics of the northern and eastern faces and looked for an appropriate site to place a camera for deployment on NEPTUNE Canada. ROPOS transited to Easter Island to look for a camera site. Images of Dave Butterfield's Remote Access Sampler were obtained while exploring the area. Diffuse venting at this site was greatly diminished from previous years and is no longer suitable for a camera deployment. ROPOS returned to S&M and then drove down the east side of the fissure looking for an appropriate cable route. ROPOS turned the corner near Milli-Q and obtained a photo mosaic of the chimney. Milli-Q was for the most part inactive with only a small orifice that was venting nearly clear fluid from the top of the edifice. ROPOS transited to Salute, but similar to Easter Island, it was not suitable for a camera deployment long term. The transit continued to Sully where a photo mosaic was completed. The lush tubeworm communities previously found at this site were no longer active and venting was limited to nearly clear fluids. Puffer was also imaged and was also greatly subdued compared to prior years. A good camera site was found on the south side of S&M near a low-lying flange. The final operation in the vent field was to recover the KEMF seismometer.

ROPOS next surveyed the proposed route from the Main Field to the primary node on the east flank. The terrain out of the valley was very rough, including several fault scarps and talus piles at the angle of repose. Two dead sulfide structures were found near the top of the east wall. ROPOS transited to the proposed node site in the water column and then conducted a bottom survey around the primary node site. The terrain is quite complex. Some areas are relatively flat and mostly sediment covered while others are rough with a lot of exposed basalt. There are significant fissures and scarps both parallel and perpendicular to the ridge axis and some time was spent assessing the best location for and route to the primary node.

The final task was to recover station KESE. The seismometer was removed from the concrete seismonument and secured on the porch, but when the anchor wire on the logger was touched it released and went to the surface with the seismometer trailing behind it. ROPOS was on board around 1630 and the seismometer was then recovered from the water shortly thereafter.

Once ROPOS and the seismometer were secured, the Thompson steamed to the site of the Remotely Operated Cable Laying System (ROCLS) test at the Barkley Canyon profiler site, stopping 17 km off-axis for a CTD to characterize background ocean water

August 10, 2007 Dives R1083 and R1084 - Testing of ROCLS

Midway through the transit it became apparent that ROPOS would not be ready for water testing of the ROCLS system upon arrival at Barkley Canyon so an EM-300 survey was undertaken of the upper reaches of the Canyon in an area that had not previously been mapped (Appendix G).

After extensive preparations and testing on deck, ROPOS was launched at 1630 for a short dunk test (Dive R1083) with the cable laying tool sled attached to test its buoyancy. The cable reel was then attached with no cable loaded. After testing the functions on deck Dive R1084 commenced at 2030. During this dive, the ROPOS team measured how far the vehicle could deflect horizontally from the ship with the cable reel attached, tested the latching and unlatching of the cable cage, tested the cable spooling mechanism, and used the cargo winch to right the upended cable reel.

August 11, 2007 Dive R1085 - Testing of ROCLS

At 0930 ROPOS was launched for Dive R1085 with 1000 m of cable on the cable reel. After detaching ROPOS to anchor one end, this cable was successfully laid along a course that simulated a path around obstructions and included a test of the ability to rewind 100 m of cable. ROPOS then detached from the cable reel to simulate plugging in the cable end. The cable test was deemed a complete success and after securing one end of the cable to ROPOS, the vehicle was recovered at 1500. The final step was to recover the cable onto a reel on deck, a process, which took several hours because the cable had to be reeled by hand. At 1800, the ship departed the site for Esquimalt while the ROPOS team started the work to prepare ROPOS for offloading. Just before mid-night the ROPOS crane knocked off a outflow spigot for the hydraulic fluid for the ship's port crane, an accident that was undoubtedly facilitated by the need to work without

the ships work lights while in the shipping lanes. Hydraulic fluid spilled out onto the port aft lower deck and onto the ROPOS equipment.

August 12, 2007 ROPOS offloading in Esquimalt

The ship's crew and the ROPOS team worked effectively to stem the leak and as a result only 60 gallons rather than 160 gallons of hydraulic fluid was spilled. Clean up activities took all night but were completed before the ship docked at Esquimalt at 0700. The ROPOS equipment was offloaded by early afternoon and the ship sailed at 1800 for Seattle

August 12, 2007, Return to Seattle

The ship docked just after 0600 at the UW dock. The ship cleared customs and immigration about 1 hour later and offloading was completed by mid-morning.

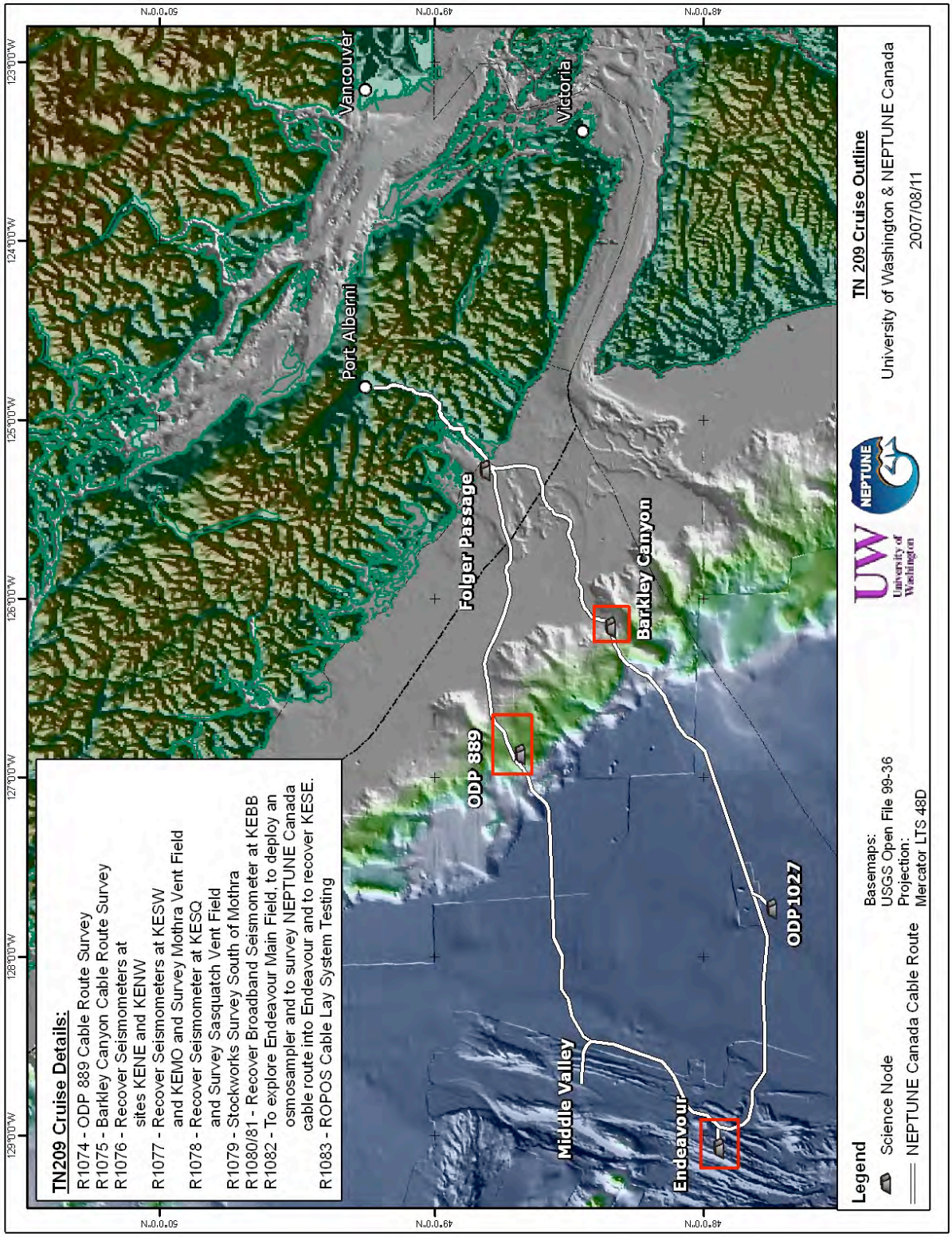

Figure 1. Working locations during this cruise (red boxes)

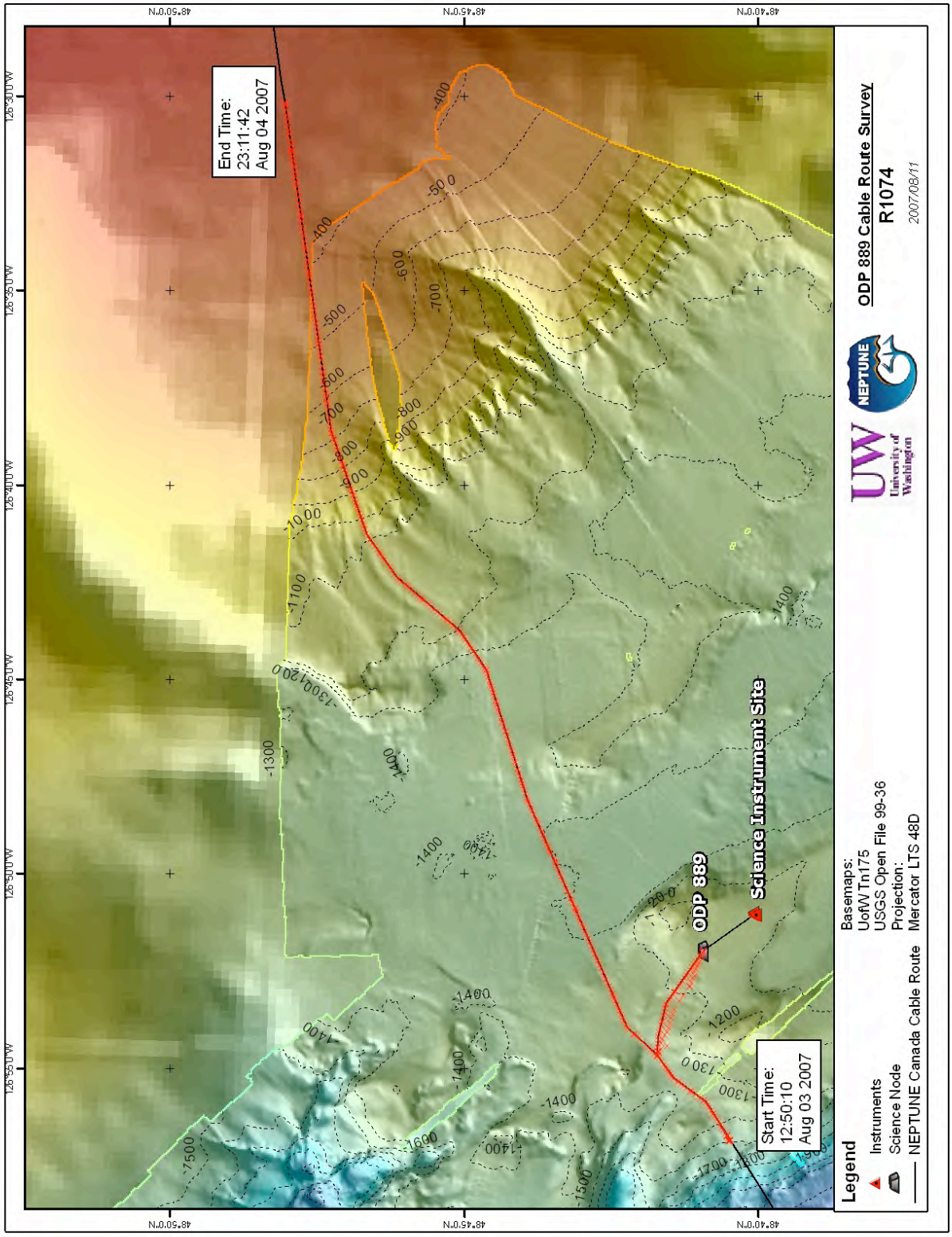

Figure 2. ODP 889 cable route survey.

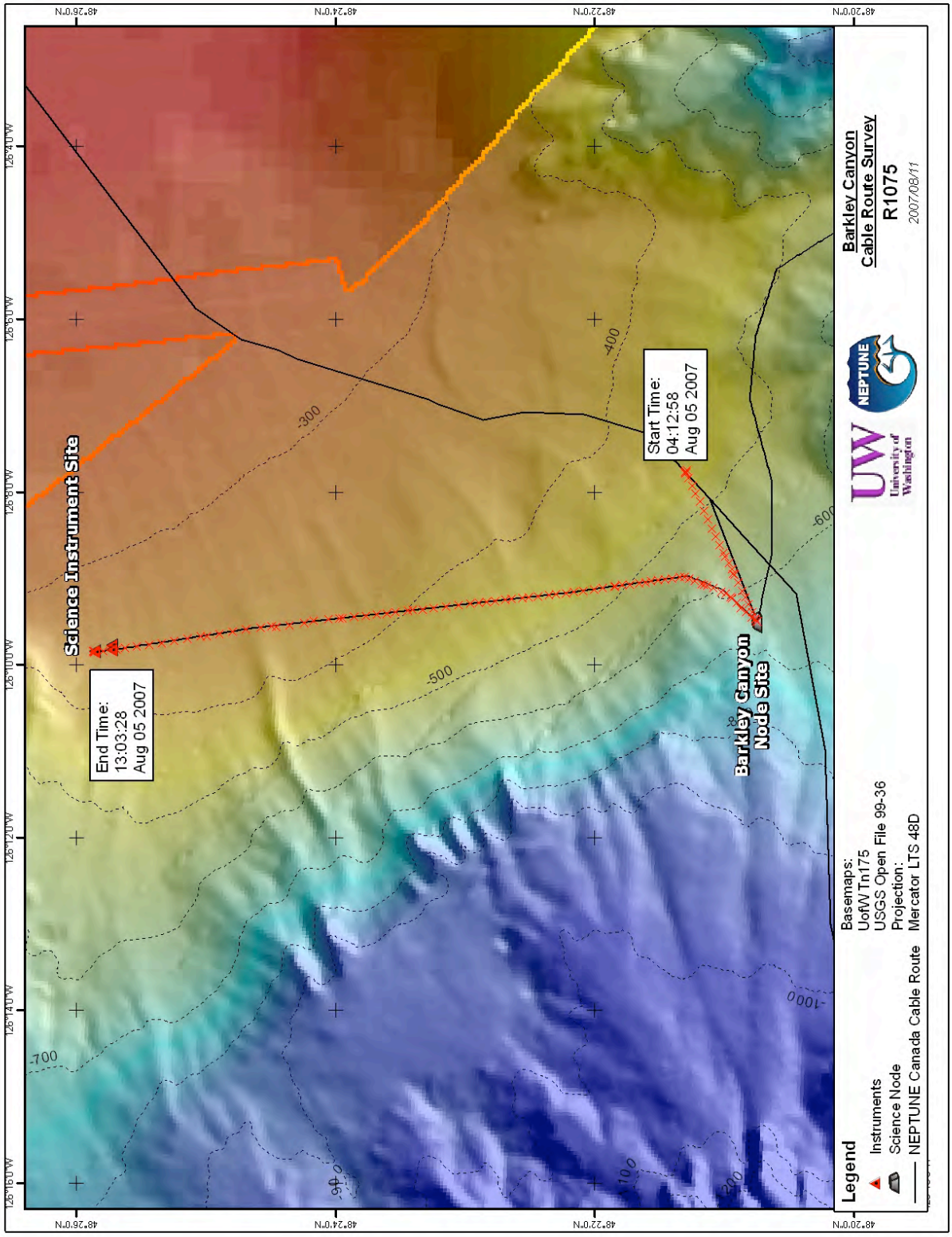

Figure 3. Barkley Canyon cable route survey.

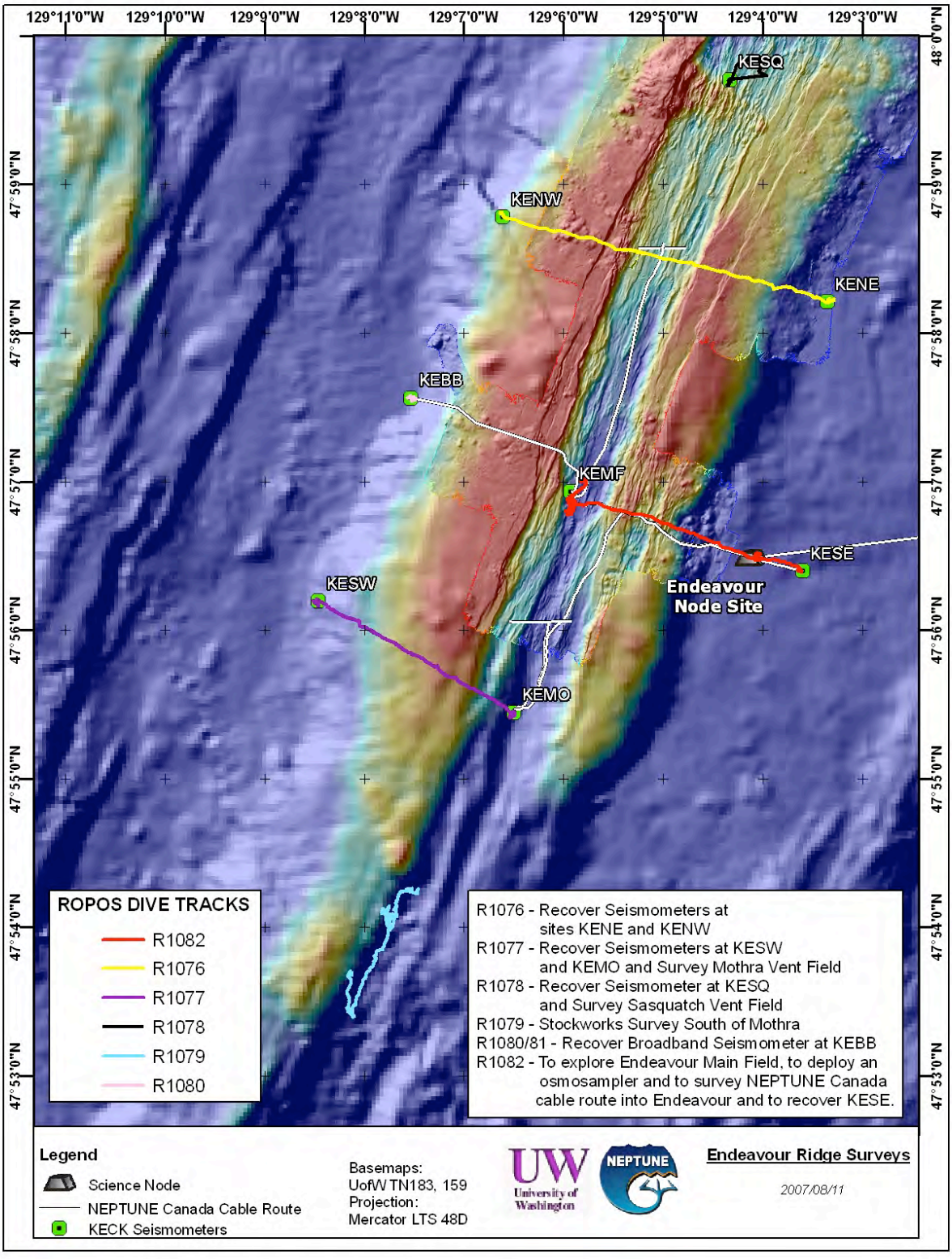

Figure 4. Endeavour track lines and CTD sites.

Appendix A: Dive Summary Table

Date	Dive #	Description of Dive
8/03/2007	R1073	ROPOS test dive.
8/03/2007	R1074	Dive to scout NEPTUNE cable route and ODP889 node.
8/05/2007	R1075	Dive to scout NEPTUNE cable route and Barkley Canyon node.
8/06/2007	R1076	Recovery of seismometers KENE and KENW.
8/06/2007	R1077	Mothra field visited, photo mosaic of Faulty Towers complex. Seismometer KEMO and seismonument KESW recovered.
8/07/2007	R1078	Sasquatch field visited. Photo mosaics of Christmas Tree and Beehive complex. Seismometer KESQ and Homer 22 recovered.
8/07/2007	R1079	Exploration of stockwork zone south of Mothra field.
8/08/2007	R1080	Recovery of broadband seismometer KEBB.
8/08/2007	R1081	Recovery of KEBB data logger package.
8/09/2007	R1082	Main Endeavor field visited. Photo mosaic of Hulk, S&M, and Milli-Q structures. NEPTUNE cable route and node site scouted. KEMF seismometer and KESE seismonument recovered.
8/10/2007	R1083	ROPOS test dive with skid.
8/11/2007	R1084	ROPOS test drive with skid and spool.
8/11/2007	R1085	ROPOS ROCLS test near Barkley Canyon.

Appendix B-I: Dive R1074 - ODP 889 Cable Route - August 3, 2007

Objectives and Methods:

ROPOS dive R1074 began on 2007-08-03 at 12:50:10.0 UTC with the goal of surveying the proposed cable route for the NEPTUNE Canada cabled observatory. The seafloor was visually inspected over a distance of about 40 km for obstructions or other hazards to cable laying and burial. The depth of easily yielding substrate was regularly measured using a one-meter probe.

Dive summary:

KP 199 to KP 198
48˚40.4946' N, 126˚56.814' W to 48˚40.7046' N, 126˚56.274' W
1494 to 1378 m on continental slope

ROPOS reached the seafloor at the start of the line in 1494 m water depth. The seafloor was generally flat and muddy, with light bioturbation. The depth probe penetrated 5-10 centimeters into the sediment. Leaving the start of the line, numerous coral ridges were observed transverse to the route, implying harder substrate at shallow depth (Figure B-I-1). Hard substrate was occasionally exposed, with visible soft sediment less than a few centimeters thick above.

KP 198 to KP 195
48˚40.7046' N, 126˚56.274' W to 48˚41.4996' N, 126˚55.1106' W
1378 to 1385 m on continental slope

The seafloor appeared smooth and moderately to highly bioturbated in general. Several natural elongate depressions were transverse to the cable route (Figure B-I-2). No evidence of underlying hard substrate was observed. Probe penetration depth ranged from 40 to 75 cm. Bioturbation created occasional hummocks with ~10 cm relief.

KP 195 to KP 194
48˚41.4996' N, 126˚55.1106' W to 48˚41.7198' N, 126˚54.6258' W
1385 to 1371 m on continental slope

Numerous trawl scars crossed the bottom **(**Figure B-I-3). Between scars, thick sediment with moderate bioturbation was observed. Probe penetration in the area of thick sediment was ~75 cm, but these areas alternated with areas of coral, indicating harder substrate underlying the sediment (Figure B-I-4); probing in the area of harder substrate penetrated into the sediment to ~50 cm.

KP 194 to End of Node (Spur)
48˚41.7198' N, 126˚54.6258' W to 48˚40.9284' N, 126˚51.9558' W
1371 to 1258 m on continental slope

Several small cobbles 5 to 10 cm in size were observed, and the sediment was generally coarser and gravelly. Bioturbation was limited. Scattered corals were indicative of shallow hard

material, possibly more cobbles. Probing achieved full penetration of 1 m, throughout the spur line. From Station 5 until the survey to the end of the node sediment was generally sandy with little bioturbation; several small trawl marks were observed with 10 to 15 cm troughs. Many of the trawl marks were concentrated around the proposed node site for ODP889 (Figure B-I-5).

KP 194 to KP 185
48˚41.7198' N, 126˚54.6258' W to 48˚43.9218' N, 126˚48.0654' W
1371 to 1384 m on continental slope

The seafloor was generally smooth and composed of a sandy mud, with some hummocky terrain associated with bioturbation. Penetration was the full 1 m throughout this section of the survey. Occasional trawl scars were evident. A large concentration of bivalve shells may have been indicative of a methane seep (Figure B-I-6). Underlying sediment was generally darker than the surface layer throughout the shell field.

KP 185 to KP 180
48˚43.9218' N, 126˚48.0654' W to 48˚44.7624' N, 126˚44.448' W
1384 to 1329 m on continental slope

The seafloor varied between hummocky areas with a granular appearance and areas that appeared soft and undulating with shallow relief. Penetration with the probe was the full 1 m throughout; the sediment was especially soft. *At 48˚44.094' N, 126˚47.286' W a palette of unexploded ordnance was observed*. Eight 8-inch artillery shells were stacked on the bottom (Figure B-I-7). At 48˚44.6442' N, 126˚44.7066' W a large conifer trunk was observed.

KP 180 to KP 172
48˚44.7624' N, 126˚44.448' W to 48˚47.2128' N, 126˚38.826' W
1329 to 700 m on continental slope

Undulating soft sediments that appeared muddy to slightly sandy characterized the area deeper than 1100 m. Little bioturbation was observed. Penetration of the probe was the full meter and sediments were noted to be quite soft. Sediment color transitioned from gray through yellow to brown. A noticeable transition in the benthic community occurred, but no organisms indicative of harder substrate were observed. From 1100 m upwards trawl marks became abundant and extremely dense, creating hummocky topography (Figure B-I-8). Relief due to trawling ranged from 20 cm to 1 m. Sediment was still quite soft with 1 m of penetration by the probe; most benthic communities were absent.

KP 172 to KP 161
48˚47.2128' N, 126˚38.826' W to 48˚48.045' N, 126˚30.1752' W
700 to 254 m on continental shelf

Cobbles and boulders were more common, with some quite large boulders near the end of the line; sizes ranged from 0.5 m to 4 m, with the mode ~1 m (Figure B-I-9). Sediment appeared rougher than previous segments. Probe penetration varied between 70 cm and full penetration, but this area was more resistant to probe insertion. Fewer, but regular trawl scars were observed.

The dive ended at 23:04:0, and ROPOS was recovered onboard at 25:00:00.0 on 2007-08-04.


Figure B-I-1


Figure B-I-2


Figure B-I-3


Figure B-I-4


Figure B-I-5


Figure B-I-6


Figure B-I-7


Figure B-I-8


Figure B-I-9

Appendix B-II: Dive R1075 - Barkley Canyon Cable Route - August 5, 2005

Goals

ROPOS Dive R1075 occurred on 5 August 2007 with the goal of surveying two fiber optic cable routes on the Barkley Canyon North-East Pacific Time-Series Undersea Networked Experiments (NEPTUNE) cable ring. Part of the survey covered a spur route directed toward a node junction, and the other portion of the survey continued from the node junction to the planned site of a vertical profiler and other instrumentation sites (Figure B-II-1).

Dive Report

The node cable route was surveyed by the ROPOS ROV to collect information about sediment characteristics, potential obstructions, and cable placement, and to note the presence of bottom fishing trawl activity that could impact the future cable placement. Along each of the two routes, the ROV periodically stopped at selected intervals to collect photos of bottom sediment characteristics and drove a 1-meter probe into the sediment to determine the depth of maximum resistance.

Spur alignment

The ROPOS ROV was in the water at 0415 and reached bottom to begin the survey at 0437. The survey began at a depth of 450 m along a spur alignment radiating ENE from a node location in 650 m of water and proceeded on a southwesterly course. The relief change between the initial starting point and node site was 200 meters and the bottom slope was approximately 8 degrees. The bottom sediment at the 450 m depth was a sandy mud with smooth surface relief. A small area of cobble and pebbles was encountered at 464 m. The ROV inserted a probe 50 cm into the sediment. Below the 500 m depth, the sediment had a little more relief which include small 10 cm mounds created by benthic activity. A probe test at the 529 m depth penetrated 40 cm into the sediment. Approaching 550 m the sediment was a fine sandy mud with very low relief. Isolated patches of small cobbles were documented between the 565 m and 579 m depth. A probe test penetrated 80cm at the 570 m depth. Unusual mounds of gray clay rising up 30 cm to 40 cm were observed at one location and it was suggested that these may be hydrate related relief. A probe penetrated 40 - 50 cm probe penetration at the 630 m depth. At the 650 m depth, the sediments remained a fine sandy mud. A solitary observation of currents noted a NW to SE flow direction.

Boulders and large cobble were observed individually and in small groupings along the spur alignment. Many of the boulders were angular with sizes ranging from 10 cm to 100 cm across. Boulders sightings were frequent from 450 m to the 525 m depth, with random sightings between the 560 m and 600 m depth. It was suggested that the boulders are of glacial origin.
Scars in the sediments from trawling activity were evident along the entire spur alignment transect. Initially a few trawl scars were observed between the 450 m and 500 m depth. At depths above 500 m to the end of the spur transect trawl scars were common and trawl troughs were typically 10 cm to 30 cm deep.

Benthic and epi-benthic organisms were prominent along the entire alignment route. Evidence of bioturbation was observed along survey route including stretches with protruding worm tubes, small sediment mounds and burrowing depressions. Epi-benthic organisms sighted along the spur alignment included brittle stars, blue sea cucumbers, anemone, urchins and some species of starfish, sole and skates. Pelagic free swimmers such Rockfish and squid were prominent. Blue sea cucumbers first appeared around the 450 m depth and were occasionally observed along the entire spur transect. Abundant mats of benthic worm tube communities were observed at the 550 m depth along with first appearance of skate. Numerous brittle stars and rare observations of pink sea urchins began around 550 m and continued down to the node location at 650 m. The ROV survey of the spur alignment ended at 0632 and the ROV changed course to begin the next part of the survey

N**orthern Instrumentation Alignment**

Following completion of the spur alignment survey, the second leg of dive 1075 required the ROV to proceed approximately 9000 m along the bottom in a northerly direction from the node site location to the vertical profiler & instrumentation site located at a water depth of 350 m. The first 1500 meters of the route originating from the node was up a 7-degree slope heading northeast to a depth of 550 m. The remaining 7500 meters of the survey was to the north up a 2-degree slope ending at a 350 m depth. Beginning at the node location and following a northeasterly course, the ROV encountered occasional rock and sediments that appeared gravelly. A probe penetrated 67 cm at the 580 m depth. Near the 580 m dept, the sediments were a smooth sandy mud with numerous shallow benthic-burrowing mounds. The burrowing mounds were commonly observed up to the 560 m depth in areas of fairly flat relief. At the 552 m depth the test probe penetrated 75 cm. Prominent bioturbation signs were observed around 498 m. The remainder of the transect was fairly flat with smooth undulating sandy mud. The probe penetrated 75 cm at the 430 m depth and 62 cm at the 400 m depth. The northernmost portion of the transect was very flat.

Large cobble and boulders were sporadic along the entire northern alignment. Large angular boulder and cobble ranging in size from 10 cm to 100 cm across were encountered. From 650 m to the 600 m depth the seafloor consisted of small cobbles and boulders. Larger boulder sizes began to appear upslope of the 540 m depth where boulders were occasionally observed up to the end of the transect at the 350 m depth.

Trawl scars were evident along the entire route of the Northern Instrumentation alignment. Trawl marks varied from very deep to quite shallow and were common between the node location and the 500 m depth. Trawl marks in the shallower region were less common. Benthic and epi-benthic organisms were observed along the entire alignment route except between the 550 m and 350 m depth: indications of bioturbation were still noted at these depths. Beginning at the node depth (650 m), brittle stars were fairly numerous with notable thinning out around 580 m. At shallower depths, brittle star were less common. Blue sea cucumbers and large aggregates of sea urchins were observed in increased numbers until they were no longer observed at depths shallower than 480 m. Roughly the last 100 m of the transect up to the end at the 350 m depth there were more random sightings of epi-benthic organisms. These included sea urchins, white sponges, anemone and occasional sea whips, skate and sole. Pelagic free

swimmers included hake, rockfish, ratfish , octopus and large squid. With the exception of octopus and squid most of the pelagic fish were observed shallower than 500 m. The ROPOS ROV completed the survey and ascended to the surface at 1303 (UTC).

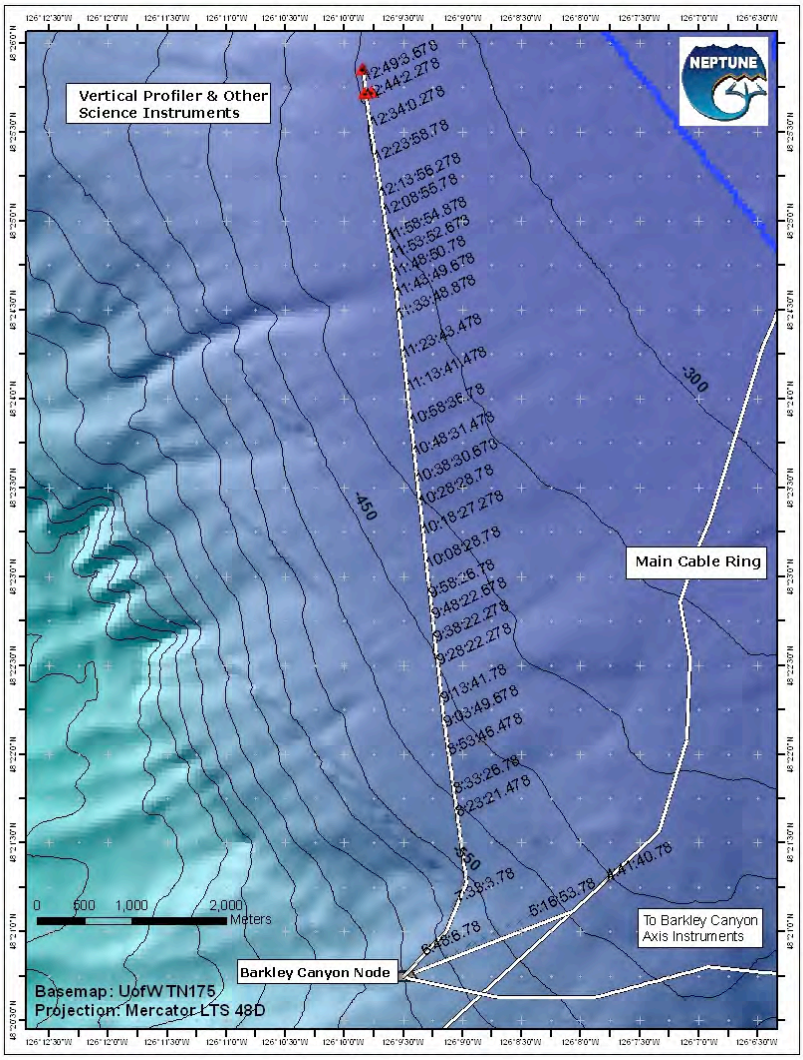

Figure B-II-1. Map of ROPOS ROV survey R1075, shows the two alignments surveyed by an ROV; A spur route radiating north-northeast of the Barkley Canyon Node and the northward route to the proposed site of a vertical profiler and other scientific instruments. Survey times (UTC) at selected intervals are marked along the transects.

Appendix B-III: Dive R1076 - KENE & KENW Recovery - August 6, 2007

Goals

Recover corehole seismometers from sites KENE and KENW at the Endeavour.

Dive Report

ROPOS was launched at 01:05 UT above the KENE site. The bottom was reached at 2330 m at 2:44 UT and the data logger was spotted immediately. The logger had dropped its weights because the copper crimp that held the stainless steel anchor cable had corroded. The logger was floating above the sensor, tethered to the instrument by the sensor cable. Since the anchor weights must be recovered to maintain proper ROPOS buoyancy, the vehicle landed close to the weights. The core hole plug was unsecured from its tray and placed on one side of the porch. Then, the weights were picked up and placed on the porch. Next, the data logger was grabbed by the polypropylene rope loop on top of its hard hat and secured in the Magnum arm. The sensor was then pulled out and the core hole plug was fully inserted in its place. Finally, the sensor was secured by placing it in the tray and pulling the bungee cord over it. The entire recovery operation took about 74 minutes.

ROPOS embarked on an approximately 4 hour-long transit to the KENW site, flying above the seafloor for 4 km. During the transit a particulate was obtained with McLane sampler over the eastern edge of the axial valley site at 2000m depth. The entire pumping operation took 89 minutes and 104.4 L of water was pumped.

Upon reaching KENW at 7:16 UT, the instrument was found quickly and unlike KENE, it had not dropped its anchor weight. Before removing the instrument it was necessary to rearrange the front porch. The PVC plug was removed from the tray, but the marker and its rope were entangled with the bungee chord and it took about twenty minutes to separate them. After moving the KENE anchor weight to one side of the porch and placing the KENE sensor in the back tray, the KENW sensor was removed from the hole and placed in the front half. The PVC plug was then placed in the hole but did not fully insert. It was decided to add white marks to the plugs for future recoveries in order to better measure the insertion distances.

Once the equipment was secured on the ROPOS, the logger had to be grabbed. The KENW logger was acquired with the left arm and the two spheres were brought towards each other. After some manipulations, both the spheres were secured in the right arm. Some time was then spent attaching the safety line to both spheres with a snap hook. Once this was done, the anchor weight was picked up and placed on the porch. This marked the end of recovery at KENW and ROPOS ascended to the surface and was secured on deck at 10:55 UT. The entire recovery operation took 104 minutes.

Appendix B-IV: Dive R1077 – Mothra Field and KESW & KEMO Recovery - August 6, 2007

Goals

The goals of this dive were to recover the short-period seismometers KESW and KEMO and survey/video mosaic the Mothra hydrothermal site.

Dive Report

The dive began at 1405 and took under two hours to reach the bottom at a depth of 2367 m. Almost immediately, pillow basalts were observed as well as a blue sea cucumber. Seismonument KESW was located with the data logger still tethered to its anchor about five minutes after reaching the bottom. Ten minutes after locating the seismonument, the KESW sensor was removed from the seismonument. Once the sensor was secured to the ROV's front porch, both the data logger and its anchor were recovered. At 1623 the ROV was set on a westerly course toward the KEMO seismometer and Mothra.

The transit time to the KEMO seismometer lasted just over 2 hours. Upon arrival at the KEMO seismometer, it was noted that the data logger was decoupled from its anchor. It was decided to recover the KEMO seismometer later in the dive and to head Faulty Towers (about 50 m to the NW) to complete photo mosaics of the chimneys. The KESW seismometer was also left behind to better facilitate photographing the structures. It was left resting on a mixture of pelagic and hydrothermal sediment.

At 1853, the edge of a fault scarp and lobate flows came into view and an area with hydrothermal staining. The ROV arrived at Giraffe shortly after, which was covered with bright red tube worms, limpets, palm worms and scale worms. ROPOS transited to the north end of Faulty Towers to Hot Harold at the base of the main edifices. Horizontal white lines were observed on the edge of Hot Harold that represented leaking. Areas of diffuse flow were also observed with tube worms present near the base. After about 15 minutes of maneuvering and taking photos, a temperature reading was taken on the vent fluids at north Harold. During the temperature reading, the probe cable parted due to damage taken from the heat. After inspecting the cable, the end of the cable was then reinserted into Hot Harold where a temperature of 304^{o}C was measured.

Roughly the next half hour was spent exploring the immediate area of Faulty Towers and obtaining photo mosaics of the chimneys. The young structure called Shi Shi, near the base of Roane, had grown nearly 13 m since 2006. Following the photo mosaic of this chimney, an attempt was made to do a photo mosaic of Finn. However, currents pushed the ROV out of position; during a second attempt the Finn mosaic was completed and the ROV headed back to Giraffe and the Tower, and conducted photo mosaics of both chimneys. At 2101 ROPOS transited back to the seismometer sites to recover them. It took nearly an hour to recover and stow the seismometers before heading to the surface. The dive concluded at 2332.

Appendix B-V: Dive R1078 - Sasquatch - August 7, 2007

Goals

The goal of this dive was to conduct a geologic survey between the KESQ short-period seismometer and the Sasquatch hydrothermal field, survey and mosaic the Sasquatch vent site, and recover the ocean bottom seismometer KESQ.

Dive Report

ROPOS sited the bottom at 3:45:59 GMT, near the short-period seismometer. The original plan for the survey of the Sasquatch vent site was to land near the short-period seismometer KESQ at WP 1 (Table B-V-1), retrieve it, and then complete the survey. However, after discovering that the state of the shackles on the logger were not in the best condition - the logger had broken free of the weights and was hanging vertically - plans were changed to survey, mosaic, and then return at the end of the dive for recovery of the seismometer.

Transiting northward, ROPOS imaged areas of lobate flows and fissures and the ROPOS descended a slope heading to WP 2 (Table B-V-1). The seafloor along the transit hosted lobate ridges, pillow basalts and a few sponges. After waypoint 1, ROPOS turned east and discovered extinct hydrothermal chimneys and sulfides. Once over this ridge, ROPOS descended a deeper slope into a heavily sedimented basin (with a maximum depth of 2188m) filled with collapsed zones, drain-back features and increased amounts of lobate flows. Halfway through the basin about 70m across (total length 140m), there was an increase in pillow basalts, talus, “bathtub rings” and collapsed regions. The terrain was very chaotic with multiple ridges throughout the basin.

As ROPOS ascended the other side of the basin, there were increased signs of vent activity as indicated by an increase in hydrothermal sediment. The color of the sediment was orange indicating oxidation, and there was sulfide debris on the slope. The Sasquatch vent site was observed at the top of the slope at 5:56:34 GMT. The structure “Christmas Tree” was the first vent to come into view, followed by Marker C and a “beehive” chimney. A photo mosaic of Christmas Tree was taken by Mitchell Elend. There were dense colonies of tube worms on Christmas Tree and visible flanges. ROPOS then obtained a photo mosaic of the “beehive” chimney, and then accidentally “decapitated” Christmas Tree by knocking off the top half of the chimney. ROPOS then headed north in search of the Pico vent site. The area was filled with old sulfide structures, sulfide talus, and pillows. A photo mosaic of Pico vent site was completed and ROPOS continued to head east to the next waypoint 215m away with a heading of 90°.

Almost immediately after leaving the Sasquatch vent site, Homer #22 was discovered. This homer had been forgotten and it was decided that it would be picked up on the way to WP 5 (Table B-V-1). The ROV then continued east over truncated lobate flows, faults and fissures. At the base of the vent site ridge, there was another heavily sedimented basin to the east with collapsed zones and oxidized sediment and basalt. The collapsed pit was floored with ropy basalt, rubble and bathtub rings. In the center of the basin, there was an extinct chimney field with oxidized sulfides and ropy basalt. As the ROV continued through the basin on the other side

of the extinct sulfides, there was an increase in ropy lava and basalt as well as sediment that was so extensive that it obscured the basaltic floor. ROPOS ascended to the top of the slope which hosted lobate flows and talus ramparts. After crossing a pillow basalt ridge, ROPOS reached WP 3 at 7:42:31 GMT (Table B-V-1). ROPOS then went due south into a series of collapsed zones marked in part by bathtub-drain back features. There were also pillow basalts and lobates in the collapsed zones. ROPOS then reached WP 4 at 7:47:01 GMT (Table B-V-1), and headed due west.

ROPOS ascended a ridge that was covered in heavy sediment, sulfides, pillow basalts and lobates. At the bottom of the ridge was a collapsed zone marked by drain-back features and pillow basalts. There was no evidence of chimneys. After reaching N 47° 59.8092, W –129° 3.9168, ROPOS headed back to the vent site for Homer #22's retrieval.

The transit back to Homer #22 was marked by stained sediment, truncated lobates and pillow lava. The retrieval of the homer was simple and ROPOS headed south to rejoin the original survey lines and to reach WP 5 (Table B-V-1). ROPOS crossed numerous extinct hydrothermal chimneys on the transit from Homer #22 to WP 6. There were extensive sulfides and oxidized sediment all along the ridge accompanied by regions of intermixed basalt and sulfide once ROPOS reached WP 6 with an orientation of 204° (Table B-V-1).

After reaching WP6 at 8:34:58 GMT, the ROV headed southeast. There were little pieces of tube worms as ROPOS headed up slope to localized hydrothermal seeps. There was only basalt in this region; sulfides were absent. As ROPOS crossed this basaltic ridge, it headed down slope across talus slopes that ended in lobate flows. At the base of the ridge at WP 7 (Table B-V-1), there was ropy lava where ROPOS obtained a sample of the glassy flow. The rock proved to be basaltic glass and it was rather difficult to obtain a sizeable sample. However the arm was able to break off a large piece that shattered when it fell into the "bio box" on ROPOS (See sample log for details).

ROPOS then transited west to collect the short-period seismometer KESQ. The first half of the survey line back to KESQ was characterized by massive mounds of sulfide deposits, pillow basalts and faults with oxidized sediment covering all of these features. The second half of the line was in a heavily sedimented basin. There were multiple collapsed regions marked by drain-back features and lobate flows.

Recovery of OBS KESQ was difficult. Last year one of the loggers had flooded and could not be retrieved because of safety considerations. Homer #22 was placed on the seafloor while ROPOS recovered KESQ. The weight and floating sensor were placed on the front porch of ROPOS and the seismometer was grabbed by the arm. Homer #22 was then picked up again, and ROPOS headed to the surface at 10:21:05 GMT. Upon arrival at the surface, it was realized that Homer #22 had been dropped and ROPOS would have to be redeployed to retrieve it from the seafloor. Luckily it was not far from where the seismometer had been located. ROPOS returned to the surface and was secured on deck at 11:58:00 GMT.

Waypoint:	Latitude (N):	Longitude (W):
WP 1	47° 59.70833	129° 4.32750
WP 2	47° 59.83333	129° 4.20833
Vent Sites	47° 59.83333	129° 4.00000
WP 3	47° 59.83333	129° 3.81417
WP 4	47° 59.81042	129° 3.81417
WP5	47° 59.81042	129° 4.00833
WP 6	47° 59.75667	129° 4.04417
WP 7	47° 59.73333	129° 3.96917

Table B-V-1. Waypoint for Dive R1078.

Appendix B-VI: Dive R1079 - Stockwork System South of Mothra - August 7, 2007

Goals

The goal of this dive was to investigate an area ~ 4 km south of the Mothra vent field for a previously discovered "stockwork" system exposed of hydrothermally altered basalts and to look for sites of active venting.

Summary

Dive R1079 started at 12:15 UTC, but according to the computer generated dive log it started at 12:07. This difference was due to a software glitch and was rectified before reaching the bottom. ROPOS stalled at 1226 meters due to a hardware malfunction, which was fixed after 20 minutes. After ~1 hour ROPOS reached the bottom in a sedimented basin about 300-400 meters to the north of the stockwork area. The plan was to drive west to the axial wall and turn south until the exposed hydrothermal system was reached.

On the way to the axial wall numerous pillow basalts were viewed with rare fissures across the axial valley floor. After ten minutes of searching the talus slope, marking the western axial valley wall, was encountered. The ROV then turned south-southwest to search for hydrothermally altered rocks. During the transit, old sulfide deposits, which were probably the remnants of chimneys, were observed. As ROPOS continued south, some altered basalts were present as isolated blocks. Massive sulfide from old chimneys dominated the landscape. A sample from a small a stockwork block was collected at 23:35 hosting a small animal, which was knocked off during recovery. ROPOS continued south to continue looking for the stockwork area, traversing across the sedimented valley floor and back to the wall in a meandering zigzag pattern.

Because of apparent navigational offsets between ROPOS and the Alvin 2006 dive, a decision was made to go farther south and overshoot the target. To the south, an area of extensive old sulfide chimneys was encountered with extinct chimneys averaging 3.5 meters in height. Even farther to the south ~ 20 m, an 8 meter tall chimney was observed: this was believed to be the same area surveyed by Alvin in 2006 and confirmed that ROPOS was ~50-100 meters away from the stockwork system. At 00:26 a sample was taken from this area.

ROPOS then turned north and headed uphill in search of the elusive outcrop. After 15 minutes an extensive outcrop of intact hydrothermally altered basalt was encountered that was very similar in appearance to that discovered in 2006. The area is characterized by, mass intact truncated pillow basalts. The pillow flows are white with rare areas of bright green mineralization from oxidation of copper. Red, oxidized iron deposits infill the interstices of the basalt flows that are heavily mineralized with pyrite and zinc sulfides. After examining this area, the decision was made to continue to the top of this outcrop at 2245 m to obtain an estimate of the vertical extent of the stockwork system. A sample #004 was taken at the top of the altered stockwork material. ROPOS then panned north along the wall to get to the stockwork area found in 2006. After

transiting ~ 20 m to the north a massive outcrop of pervasively altered pillows was found. At this site, there was a dramatic contact between the altered and less altered pillow basalt. Perfectly preserved pillow basalts were viewed over an area that extends ~ 50 m across. After ten minutes of traversing (which direction) ROPOS reached the edge of the stockwork, marked by darker, partially oxidized basalts (Figure B-VI-1). At the top of the ridge valley at 2190 m, ROPOS turned south again to head back into the zone of alteration. A detail mosaic of this area of the stockwork zone was obtained and a sample of a pillow with green oxidized copper was sampled. ROPOS traversed the edge of the zone and reached the top of the outcrop marked by unaltered rocks that sat immediately adjacent to the altered pillows.

At 01:39, ROPOS moved farther along the outcrop at a heading of 315 to obtain additional samples. A rock rich in pyrite was recovered at 2:15 at a depth of 2205 m along with another sample that wasn't in such good quality, which was later identified to be sulfide. Additional samples containing oxidized copper were also sampled. ROPOS then traversed to the summit of the stockwork system, which was characterized by small mounds of massive sulfide that hosted an extensively oxidized rind. The sulfide and underlying basalts were covered in a thick coating of metalliferous sediment that in places was well lithified.. Because there is a general lack of lava chemistry from this area, a sample was taken from a small drain back area of basalt. ROPOS then traversed to an area 50 meters higher, where numerous faults were observed and truncated flows that hosted deep-sea corals. A sample of a spherical shaped basalt, along with two other cylindrical shaped rocks were taken. They were later identified as basalt glass and replaced basalt.

After approximately 45 minutes. ROPOS transited down the cliff face and head south about 700 meters to an area where CTD anomalies were observed in 2006. At about 400 meters south of the main stockwork outcrops, more extinct sulfides were observed 03:27. The abundance of sulfide material and extinct chimneys increased to the south. A mosaic of a nine meter tall chimney was obtained at 03:30. The chimney had a rounded humped look indicating that it been around for a while. Flanges on some of the extinct chimneys were also observed. This area is extremely sedimented as were additional areas to the south, which also hosted sulfide stained areas (Figure B-VI-2). At 03:37 ROPOS turned west to head up the wall, starting at 2340 m water depth. At about 1/3 of the way up the wall at a depth of 2320 m, ROPOS stopped to start the McClain pump for Kim Juniper. ROPOS then turned northwest following faults and with the pump running. The pump was stopped about 25 minutes later at 04:15 with 100 liters of water. This area was characterized by pillow basalts cut by fissures that were ~6.5 meters deep. A sample of basalt was taken at 04:33. As ROPOS followed the axial valley wall north, sulfide stained sediment was encountered along with talus at the top of the valley wall at 2203 m. The dive was ended at 06:15 after an hour of searching this area with no result.

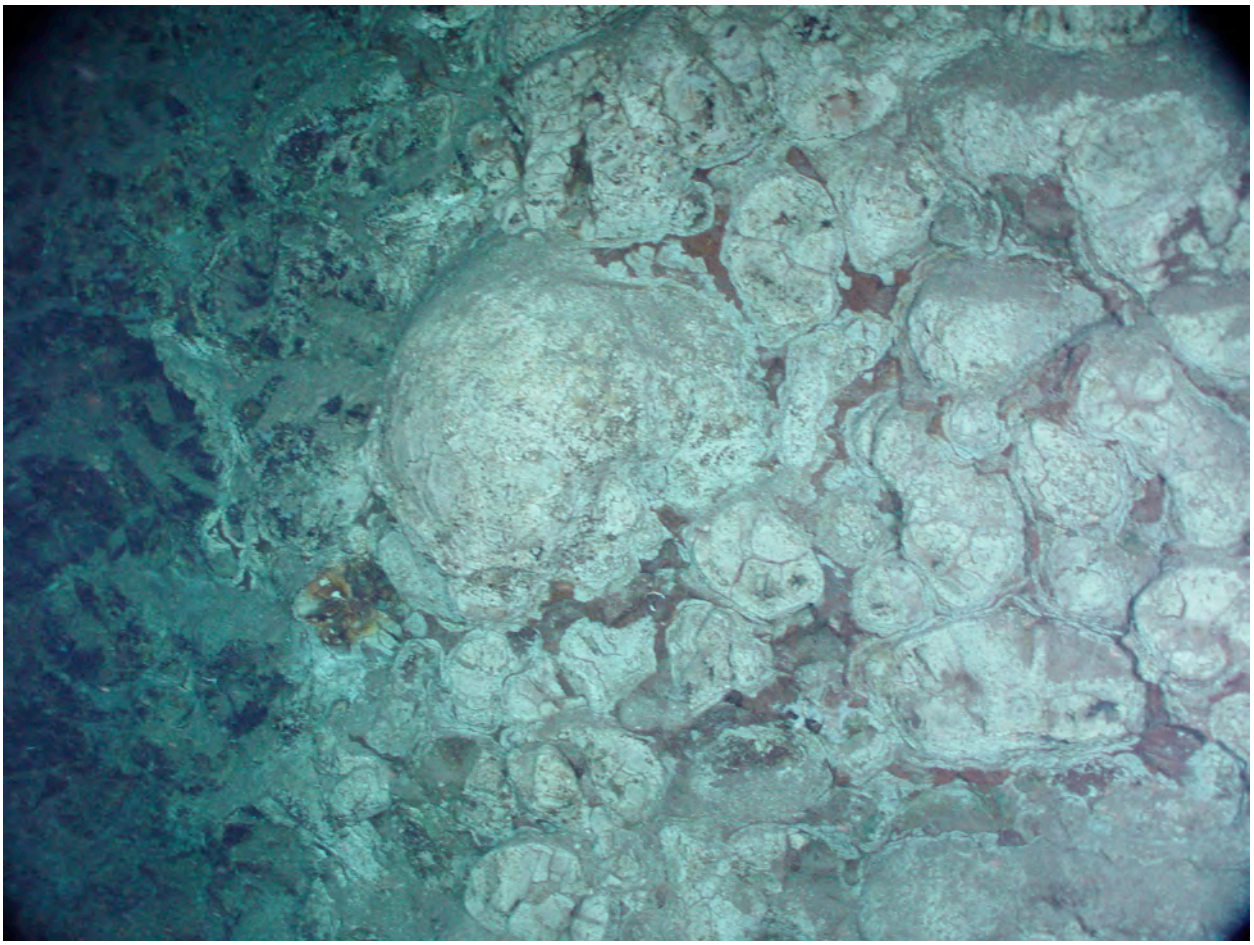

Figure.B-VI-1: Photograph of the stockwork system showing altered pillow basalts adjacent to less altered basalts on the left. The boulder in center is 1.5 meters

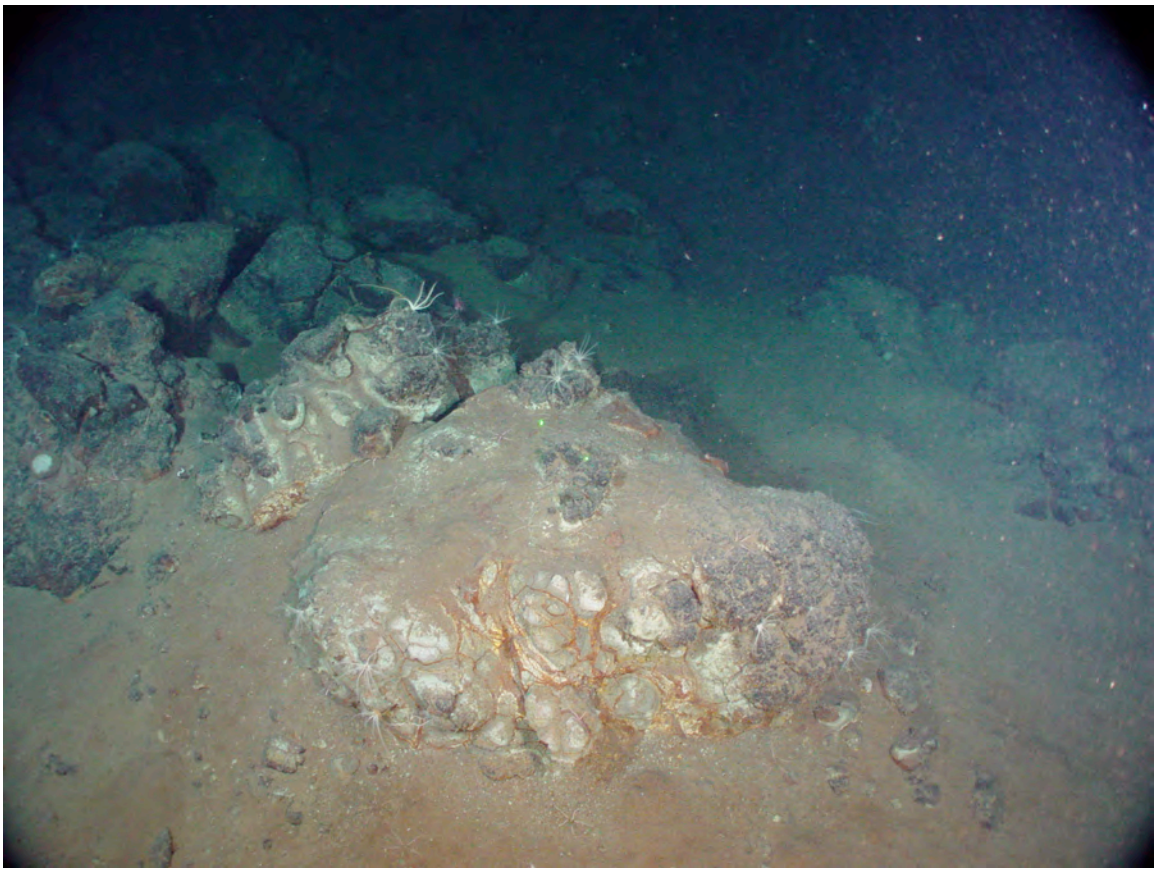

Figure. B-VI-2: A small stockwork block, adjacent to less altered pillow basalts. A thick deposit of oxidized hydrothermal and pelagic sediments cover the underlying basaltic axial valley floor.

Appendix B-VII: Dive R1080/1081 - KEBB Recovery - August 8, 2007

Goals

Recover Broadband Seismometer and data logger package KEBB located on the western flank off the Axial High in a sedimented region, ~2.5 km WNW of the Main Endeavor Field. Cover up seismometer caisson with a PVC plate for NEPTUNE Canada future usage.

Dive Report

ROPOS launched Dive R1080 at 13:58 UTC. After a 1 hour and 41 minute descent to the bottom, the data logger package was located at 15:46 UTC. The ROV followed the cable connecting the data logger to the buried seismometer. The plate and marker, which would cover the hole was placed off to the side. At 15:56 UTC the ROV went back to the data logger to unplug the seismometer. Unplugging the sensor was challenging, since the logger was on an inclined slope and tilted 20°. At 16:20 UTC the ROV put the plug into the holster on the porch and secured it with a bungee cord.

Removing the seismometer required a few steps. First the ROPOS used the Magnum arm to lift the cable and remove the 4 wickets that held down the cable connecting the seismometer to the data logger, a process that took ~ 17minutes. The wickets were temporarily placed on the porch. At 17:21 UTC, the ROV vacuumed up the glass beads that covered up the seismometer, a process that took ~ 14 minutes. Using the ROPOS Raptor arm, the seismometer was lifted out of the PVC caisson and temporarily placed on the seafloor. The ROV secured the plate and marker over the PVC caisson. At 19:13 UTC, wickets were placed on top of the plate for extra weight and future use. The ROV then put the seismometer on the front porch and secured it with the Magnum arm. Finally the ROV attached a snap hook to sling the data logger and battery package beneath the ROV and started to ascend.

Upon ascending the ROV started to collect microbes using a McLane filter pump at a depth of ~1978 meters. The ROV pumped 100 liters of seawater at a flow rate setting of 7 liters/minute, ending at a depth of 1411 meters.

ROPOS surfaced at 21:00 UTC, for a total dive time of 7 hours, including ~ 3.5 hours of bottom time. It was then discovered that the logger package was not hanging below ROPOS ,because the tie wraps on the slip line for the logger were not broken, the snap hook must have disconnected from the data logger package before it lifted from the seafloor.

One hour later at 22:00:00 UTC, Dive R1081 was launched to recover the KEBB data logger package in a 3 hour bounce dive. The data logger package was sitting in the same spot where it had been unsuccessfully attached to the ROV. The sling line was attached to the data logger package with a smaller snap hook. The homer was turned on 100 meters above the seafloor to check that the logger was attached to the ROV. When ROPOS surfaced, the 1800 lb. line attached to the logger snapped in a heavy swell, only seconds after it had been secured with a line from the ship. After a few tense minutes, two additional lines were attached and the logger was recovered with the ships crane.

Appendix B-VIII: Dive R1082 - Main Endeavour Field and KEMF & KESE Recovery - August 9, 2007

Goal

The goal of this dive was to image the sulfide incubator at the Hulk vent in the Main Endeavour Field and deploy an osmosampler in an adjacent diffuse flow site, to photo-mosaic Easter Island, Sully, S&M, survey the NEPTUNE Canada cable path and node site, and to recover the KEMF and KESE short-period seismometers.

Summary

ROPOS was deployed from the surface at 0348 on 9 August 2007 and traversed around Hulk structure starting at the east face – the sulfide incubator was found almost immediately at the southeast corner of Hulk at 2195 m. The vehicle then traveled to the northwest moving past Gremlin. At the northwest corner of Hulk an osmosampler was deployed at a diffuse flow site with the Marker Co. ROPOS circled back down to the southeast corner to image the sulfide incubator that will be retrieved at the end of August-early September 2007 by Alvin. The northern end of Hulk comprised diffuse flow whereas the southwest region contained flanges. Smaller, newer chimneys were discovered on Hulk and black smokers were noted on the site. ROPOS transited to the east out of the Hulk area and then southward, traveling just east of Dante and Dudley. To the east of Dante are sheet flows and to the northeast of Dudley is an old sulfide chimney. The vehicle then moved further south of both structures toward S&M searching for Daniela Di Iorio's southern scintillation mooring (marked by Homer # 44). The mooring was encountered south of Dudley on a small bench that is slightly down-dropped from the main plateau that separates the Bastille complex and the Hulk complex.

ROPOS arrived at S&M at 0948, and a mosaic was taken on the north side starting from the bottom. Clear pools were observed under the flanges of S&M. Another mosaic was obtained on the east face and the northern flange. A beehive structure was observed at S&M. To the west of S&M were lobate planes and the figure cut-out known as "Dudley". To the southeast of S&M are sulfide pinnacles. ROPOS moved west, to Easter Island, at 1115 coming into contact with the western axial valley wall. Marker 55 was passed along this route. The Remote Access Fluid sampler deployed by Dave Butterfield was imaged and Easter Island was survey for an appropriate camera site for Neptune Canada. Venting in this area has dramatically decreased since 2000 and no good deployment sites could be found because of the lack of abundant vent fauna in this area. The vehicle stopped at JB2 -1 then continued on to revisit S&M at 1144 for more photos.

Following completion of photos of S&M. the ROV surveyed to the east of S&M for an appropriate cable route for NEPTUNE Canada. The vehicle traversed down to the south, past Milli-Q. ROPOS then move to the northeastern side of Salut at 1227. Two pinnacles were active, but the pagoda shaped pinnacle was more so than the other. Markers were noted in this area. ROPOS then moved from Salut to Milli-Q, arriving at the base of Milli-Q at 1248. Sulfide blocks were observed, notes were made regarding inactivity, and a mosaic was created on the north face. The structure was clearly dying, covered in brown tube worm casings and only a small

orifice was observed at the summit venting nearly clear fluid. ROPOS transited northward to Sully by way of Tara, which was discovered to be devoid of activity at 1320. ROPOS arrived at Sully at 1322. The southern end of Sully exhibited clear smokers and a mosaic was created. ROPOS continued to the target south of Grotto via Puffer and S&M at 1338. A survey for a potential camera site for NEPTUNE was taken at S&M at a low-lying flange on the south face Locally flat basalts in this area may provide an adequate platform for the camera. The west side of S&M contains too much debris for a camera location.

ROPOS then transited to the north to the seismometer KEMF, which was retrieved successfully at 1416 and a McLane Pump sample was started as ROPOS headed back south of S&M. A possible cable crossing site was noted while heading south of S&M and on the south end of Salut.

At 1850 ROPOS arrived at the proposed NEPTUNE Canada node location for the Endeavour Segment with heavy sediment deposits on location with 40 to 50 cm relief. There was shallow bedrock to the southeast. At 1932 another potential node site was discussed in a heavy sedimented area. A potential spur route was followed in sedimented terrain with exposed pillow basalt and 1 to 2 meters of relief and developing rugged outcropping of pillow basalt. ROPOS moved due east across a fissure to find an improved path for the spur cable. A node location was investigated to the southwest. The node and spur location investigation was completed at 2003. Actual sites to be determined at a later date.

The KESE short-period seismometer was retrieved 3 km east of the vent fields at 2039. The rusty chain on the data logger broke and the data logger floated to the surface. The sensor was not found on the porch. ROPOS left the bottom at 2059. The data logger was found on the surface at 2255 and recovered from a distance of 300 feet from the ship. This dive was completed in approximately 19 hours.

Appendix C. Sample List

Table C-1 on the following three pages provides a summary of rock and McLane pump samples collected during the cruise.

Table C-1. Sample list.

Sample number generated in dive log	Sample number assigned (dive_mmddyy_hhmm_type)	Time/date (UTC)	Location	Latitude	Longitude	Depth	Heading	Sample type	description
R1076 - Endeavour-0001	R1076_080607_0355_fluid_filter	03:55:44 Aug 06 2007	2000m depth during east-west transit across ridge axis from seismometer KENE to KENW	47.97173	-129.06186	1970	293.2	fluid filter	Pumped from KENE site to edge of axial valley. Pump stopped at edge of axial valley to avoid hydrothermal plume influences; pumped 104.4 liters
R1078: Sasquatch & KESQ Recovery-0001	R1078_080707_0847_rock	08:47:00 Aug 07 2007	near Sasquatch field	47.99555	129.06613	2174.5	111.5	rock	basalt glass
R1079-0001	R1079_080707_2335_rock	23:35:57 Aug 07 2007	stockwork field south of Mothra	47.90198	-129.12824	2299.6	279.8	rock	altered basalt
R1079-0002	R1079_080807_0026_rock	00:26:10 Aug 08 2007	stockwork field south of Mothra	47.90028	-129.12884	2328.6	183.8	rock	sulfide
R1079-0003	R1079_080807_0112_rock	01:12:12 Aug 08 2007	stockwork field south of Mothra	47.90123	-129.12967	2276.3	324.1	rock	massive sulfide
R1079-0003	R1079_080807_0113_rock	01:13:12 Aug 08 2007	stockwork field south of Mothra	47.90123	-129.12967	2276.3	324.1	rock	sulfide with basalt
R1079-0004	R1079_080807_0139_rock	01:39:39 Aug 08 2007	stockwork field south of Mothra	47.90166	-129.12993	2242.2	340.2	rock	altered basalt with copper oxide
R1079-0005	R1079_080807_0215_rock	02:15:19 Aug 08 2007	stockwork field south of Mothra	47.90153	-129.13033	2205.1	339.5	rock	massive sulfide
R1079-0006	R1079_080807_0217_rock	02:17:41 Aug 08 2007	stockwork field south of Mothra	47.90152	-129.13035	2204.9	342.1	rock	altered basalt
R1079-0007	R1079_080807_0219_rock	02:19:10 Aug 08 2007	stockwork field south of Mothra	47.90152	-129.13037	2205.1	340.2	rock	altered basalt

Table C-1 cont.

Sample number generated in dive log	Sample number assigned (dive_mmddyy_hhmm_type)	Time/date (UTC)	Location	Latitude	Longitude	Depth	Heading	Sample type	description
R1079-0008	R1079_080807_0236_rock	02:36:32 Aug 08 2007	stockwork field south of Mothra	47.90166	-129.13038	2197.5	96.3	rock	sulfide
R1079-0009	R1079_080807_0242_rock	02:42:40 Aug 08 2007	stockwork field south of Mothra	47.90167	-129.13037	2197.1	91.3	rock	replaced basalt
R1079-0010	R1079_080807_0250_rock	02:50:55 Aug 08 2007	stockwork field south of Mothra	47.90184	-129.13032	2191.6	77.3	rock	basalt glass
R1079-0011	R1079_080807_0305_rock	03:05:31 Aug 08 2007	stockwork field south of Mothra	47.90206	-129.1302	2189.3	73	rock	basalt
R1079-0012	R1079_080807_0307_rock	03:07:01 Aug 08 2007	stockwork field south of Mothra	47.90207	-129.1302	2188.9	75.1	rock	basalt
R1079-0013	R1079_080807_0308_rock	03:08:29 Aug 08 2007	stockwork field south of Mothra	47.90208	-129.13018	2189	75.8	rock	basalt
R1079-0014	R1079_080807_0349_fluid_filter	03:49:23 Aug 08 2007	2320m depth south of Mothra field and south of stockwork, near foot of western wall	47.89749	-129.13026	2320.3	217.6	fluid filter	Pumped while submersible traversed near bottom in search of venting previously detected by CTD; pumped 100 liters
R1079-0015	R1079_080807_0433_rock	04:33:21 Aug 08 2007	stockwork field south of Mothra	47.89279	-129.1341	2318.2	196.3	rock	basalt
R1079-0016	R1079_080807_0522_rock	05:13:10 Aug 08 2007	stockwork field south of Mothra	47.89008	-129.13535	2326.5	60.2	rock	basalt with plagioclase phenocrysts

Table C-1 cont.

Sample number generated in dive log	Sample number assigned (dive_mmddyy_hhmm_type)	Time/date (UTC)	Location	Latitude	Longitude	Depth	Heading	Sample type	description
R1080-0001	R1080_080807_1930_fluid_filter	19:30:58 Aug 08 2007	over broadband seismometer site on western flank of ridge	47.95934	-129.1247	2009.4	163.3	fluid filter	Integrated sample from 2000m to 1400m depth during recovery of submersible over broadband seismometer site on western flank of ridge; pumped 1000 liters
R1082 - KEMF & KESE-0001	R1082_080907_1504_fluid_filter	15:04:53 Aug 09 2007	Integrated sample from Main Endeavour Vent field. 2200m depth	47.94845	-129.09866	2200.8	335.6	fluid filter	Pumped during transit along western edge of central fissure in MEF, between south of Hulk and Tara; pumped 1000 liters
R1082 - KEMF & KESE-0002	R1082_080907_1602_fluid_filter	16:02:04 Aug 09 2007	Integrated sample from near seafloor during transit away from Main Endeavour vent field	47.94733	-129.09687	2215.4	124.6	fluid filter	Pumped during transect along extension cable route from MEF to eastern edge of axial valley; pumped 100 liters
R1082 - KEMF & KESE-0003	R1082_080907_1643_rock	16:30:51 Aug 09 2007	near Main Endeavour Field	47.94688	-129.09202	2119.4	120	rock	basalt
R1082 - KEMF & KESE-0004	R1082_080907_1645_rock	16:41:46 Aug 09 2007	near Main Endeavour Field	47.94671	-129.09028	2106.5	105	rock	basalt

n/a - not applicable.

Appendix D-I. Description of Instruments

a. Short-Period Seismometers

Short-Period Sensors. The short-period sensors contain model BH-1 corehole geophones manufactured by GEOSense. The BH-1 is a three-axis sensor with a flat frequency response from 1 Hz to 100 Hz. It is designed to fit into a horizontal corehole on the ocean bottom, thus obtaining excellent mechanical coupling to the seafloor.

The sensor is contained in an MBARI-designed titanium pressure housing 6.3 cm in diameter and 40 cm in length, and rated to a depth of 2500 m. In addition to the geophone, the housing contains a battery-powered electronic level sensor used to properly orient the sensor during deployment. Two LEDs, one red and one green, will flash when the geophones are within 5 deg of vertical in pitch and roll. The sensor has a single 8-pin underwater connector to carry electrical signals back to the data logger.

For sites that do not have a suitable corehole, the sensor is deployed in a steel-reinforced concrete block (a "seismonument") that weighs 64 kg in air and 37 kg in water. Azimuthal orientation is determined by optically sighting along the sensor axis during installation.

Short-Period Data Loggers. The short-period data logger is a GEOSense LP-1 housed in a 43 cm glass Benthos sphere. The logger stores 16 bit, 128 Hz data on four 8 Gbyte, 2.5 inch disk drives, commonly used in laptop computers. Because the logger consumes only about 220 mw of power, it can be powered for one year with 32 Electrochem 3B36 lithium double-D cells, which contain a total of about 3.2 kWh of energy. All the cells fit into the Benthos sphere with the LP-1, making a very compact package for deployment. An 8-pin Seacon penetrator and five-meter cable connects the logger to the corehole sensor.

b. Broadband Seismometers

Broadband Sensors. The broadband sensor is a Guralp CMG-1T, with a frequency response of 2.8 mHz (360 sec period) to 100 Hz. The three-axis sensor contains an automatic leveling system, which can accommodate tilts induced during installation and subsequent settling of the sensor package.

The sensor is contained in a MBARI-designed 45 cm titanium sphere, which is rated to a depth of 4000 m. During deployment the housing is buried beneath the ocean floor to prevent water currents from shaking the sensor. This is accomplished by sinking a 61-cm diameter by 61-cm long PVC caisson into the sediment, and then suctioning the contained sediment away to leave a hole. After the sensor is placed into the hole, the caisson is filled with 0.8 mm glass beads to immobilize the sensor. An 8-pin electrical penetrator and a 20-m cable connect the sensor to the data logger.

Broadband Data Loggers. The broadband data logger is based upon the same LP-1 as the short-period systems, although it is running modified software and has an additional circuit board to accept the serial data stream from the Guralp sensor. Because the Guralp sensor itself consumes

over 2 w of power (almost ten times the power of the complete short-period system), the broadband data logger batteries are much larger. There are three Tadiran 10 kWh lithium batteries each in their own Benthos spheres, for a total of 30 kWh of energy. Connections to the Guralp sensor and to the ROV are made with Nautilus 8-pin underwater-mateable connectors manufactured by Ocean Design.

Appendix D-II. Recovery Sheets

Broadband Seismometer Recovery
Station : KEBB **Date** 2007-08-08 **Dive#** 1080/1
Sensor Location confirmation (Lat, Lon, Depth)
47º 57.565'N 129º 07.522'W 2378
47.95942 -129.12537
Site as found
Homer: ok
Sensor area: ok
Logger frame: partially buried in sediment, sharply tilted
Cables: 20m seismometer cable visible in places along the route
Recovery procedures
Disconnected seismometer from frame: ok
Pulled up cable/staples to find seismometer: tedious but ok
Pumped beads to expose top of sensor: ok
Site as left
Caisson covered with ½" PVC sheet ok
Four rebar staples left on sheet ok
Syntactic foam marker with reflective tape anchored to cover ok
Instruments on deck
Physical inspection
Sensor sphere: ok
Logger frame: very corroded where sediment covered frame. Corner wend almost compromised, corroded half way though steel base, in one place all the way though.
Anchor cable: ok
Connectors: ok
Cables: ok
Note: the rope used to lift frame out of water broke
Operational inspection
Scream commands ok
Clock drift 201.345 sec slow at 8/9/2007 00:33:59
Batteries (open circuit voltages, separate spheres)

Sphere	Pack	Pack
1	1) 14.32 V	2) 14.31 V
2	11) 14.07 V	22) 14.16 V
3	111) 12.37 V	222) 14.55 V

note differing voltages in the same battery pack in sphere 3.

Short Period Seismometer Recovery
Station: KEMF **Date:** 8/9/07 **Dive#** 1082
Sensor Location (Lat, Lon, Depth)
47º 56.9064'N 129º 05.9224'W 2201
47º.948441' -129.098708'
Serial Numbers
Sensor BH-1-114
Logger LP1-K13
Homer 97, s/n 213798-04
Site as found
Sensor
condition ok
azimuth(heading) 220º
Homer ok
Logger ok
Anchor cable ok
Seismometer Cable ok
Recovery routine
Site as left
Corehole plugged? yes
Corehole flagged? yes
Seismonument n/a
Instruments on deck
Physical inspection
Logger sphere polygonal lines inside sphere
Anchor cable two copper crimps were used to connect anchor to logger- this may have prevented them from corroding and releasing the logger
Connectors Pin 2 on the seismometer connector is dark, the rest look ok
Cables ok
Operational inspection
Batteries 0.0009 V and 0.0008 V
Logger rebooted when powered
Clock dead
Deployment
Time 2005/10/01 16:38:00
Drift 0.00 sec

Recovery
Time 2007/08/09 14:20:00
Drift clock dead

Short Period Seismometer Recovery
Station Name: KEMO **Date:** 8/6/07 **Dive#** 1077
Sensor Location (Lat, Lon, Depth)
47º 55.439'N 129º 06.495'W 2286
47.923999 -129.108262
Serial Numbers
Sensor BH-1-20
Logger LP1-K11
Homer 10
Site as found
Sensor
Condition ok
Azimuth(heading) 41º
Homer ok
Logger ok
Anchor cable ok
Seismometer Cable ok
Recovery routine
Site as left
Corehole plugged? yes
Corehole flagged? yes
Seismonument n/a
Instruments on deck
Physical inspection
Logger sphere: polygonal lines on inside of sphere
Anchor cable: ok
Connectors: logger end pin 2 was dark. The rest were bright around seal but had deposits. Number 4 had white and green stains on face. Sensor end pins on #2 were darkened, # 3 was discolored, # 6,7,8 had copper stains
Cables ok
Operational inspection
Batteries: 11.37 V and 11.38 V
Logger: ok
Clock: -64.425 sec slow at 08/06/07 03:21:50
Deployment
Time 10/2/05 02:14:00
Drift 0.00 sec
Recovery
Time 8/6/07 21:23:00
Drift -64.425 sec slow at 8/6/2007 03:21:50

2

Short Period Seismometer Recovery
Station Name: KENE **Date:** 8/5/07 **Dive#** 1076
Sensor Location (Lat, Lon, Depth)
47º 58.202'N 129º 3.3616'W 2341
47.970045 -129.056027
Serial Numbers
Sensor BH-1-15
Logger LP1-KO5
Homer 58
Site as found
Sensor
Condition: ok
Azimuth (heading): 182°
Homer: ok
Logger: ok
Anchor cable: copper crimping corroded and broke causing anchor cable to fail and logger to pull against sensor
Seismometer Cable: pulled taught between logger and sensor. Connection between cable and sensor severely bent but no damage was apparent
Recovery: slightly abnormal. ROV had to grab rope on top of hard hat and pull down to secure data logger because the anchor had failed
Site as left
Corehole plugged? yes
Corehole flagged? yes
Seismonument: n/a
Instruments on deck
Physical inspection
Logger sphere: hexagonal lines inside sphere, condensation in the interior after opening
Anchor cable: copper crimp was corroded through, releasing anchor.
Connectors: tarnished some copper colored spots
Cables ok
Operational inspection
Batteries 11.46 V and 11.41 V
Logger ok, but after removing batteries the logger would not boot with application of power. This may have been due to condensation. Days later, it booted normally.
Clock ok
Deployment
Time: 9/19/2005 03:06
Drift: 0.00sec
Recovery
Time: 8/6/2007 03:26
Drift: not measured because we didn't know to press Enter in order to get logger out of low power mode.

Short Period Seismometer Recovery
Station: KENW **Date:** 8/5/07 **Dive#** 1076
Sensor Location (Lat, Lon, Depth)
47º 58.785'N 129º 06.605'W 2161
47.97976 -129.110095
Serial Numbers
- **Sensor** BH-1-09
- **Logger** LP1-K04
- **Homer** 12

Site as found
- **Sensor**
  - **condition** good
  - **azimuth(heading)** 148°
- **Homer** ok
- **Logger** anchored-ok
- **Anchor cable** stainless steel clasp prevented anchor cable failure
- **Seismometer Cable** ok

Recovery routine
Site as left
- **Corehole plugged?** yes
- **Corehole flagged?** yes
- **Seismonument?** n/a

Instruments on deck
- **Physical inspection**
  - **Logger sphere** ok
  - **Anchor cable** ok
  - **Connectors** subcon connector had corrosion deposits on female end and around male pins. 3 pins had copper etch around base
  - **Cables** ok
- **Operational inspection**
  - **Batteries** < 1 mV in both batteries
  - **Logger** rebooted when powered
  - **Clock** dead (no time sync possible)
    - **Deployment**
      - **Time** 9/20/2005 02:26:00
      - **Drift** 0.00 sec
    - **Recovery**
      - **Time** 8/6/2007 09:10:00
      - **Drift** clock dead

Short Period Seismometer Recovery
Station: KESE **Date:** 8/9/07 **Dive#** 1082
Sensor Location (Lat, Lon, Depth)
47º 56.396'N 129º 03.618'W 2344
47.939943 -129.060308
Serial Numbers
- **Sensor** BH-1-09
- **Logger** LP1-K03
- **Homer** 96, s/n 213798-03

Site as found
- **Sensor**
  - **condition** ok
  - **azimuth(heading)** 228º
- **Homer** ok
- **Logger** ok
- **Anchor cable** ok-but anchor was only 30 cm from seismometer
- **Seismometer Cable** cable from logger was touching seismonument

Recovery: Abnormal. During recovery the logger sphere broke free of its anchor and rose to the surface, breaking the bungee cord holding seismometer to ROV and dragging the instrument to the surface as well. The logger and the seismometer were recovered. The seismonument and the anchor were left on the seafloor.

Site as left
- **Corehole plugged?** n/a
- **Corehole flagged?** n/a
- **Seismonument** abandoned

Instruments on deck
- **Physical inspection**
  - **Logger sphere** sphere had hexagonal lines inside surface
  - **Anchor cable** broken
  - **Connectors** pin 2 very dark. other pins not very bright. connector is bent.
  - **Cables** ok
- **Operational inspection**
  - **Batteries** both at 0.01 V
  - **Logger** rebooted when powered
  - **Clock** dead
    - **Deployment**
      - **Time** 10/2/2005 16:07:00
      - **Drift** 0.00 sec
    - **Recovery**
      - **Time** 8/9/2007 20:45:00
      - **Drift** clock dead

Short Period Seismometer Recovery
Station Name: KESQ **Date**: 8/7/07 **Dive#** 1078
Sensor Location (Lat, Lon, Depth)
47º 59.701'N 129º 04.352'W 2164
47.995003 -129.072534
Serial Numbers
- **Sensor** BH-1-16
- **Logger** LP1-KO4
- **Homer** 54, s/n 67389-02

Site as found
- **Sensor**
  - **Condition** ok
  - **Azimuth(heading)** 103º
- **Homer** ok
- **Logger** ok
- **Anchor cable** ok
- **Seismometer Cable** ok

Recovery routine
Site as left
- **Corehole plugged?** yes
- **Corehole flagged?** yes
- **Seismonument** n/a

Instruments on deck
- **Physical inspection**
  - **Logger sphere** ok hexagonal lines in interior
  - **Anchor cable** ok
  - **Connectors** ok but pin 8 darkened
  - **Cables** ok
- **Operational inspection**
  - **Batteries** 11.37 V and 11.37 V
  - **Logger** ok
  - **Clock** fast 6.146 sec
    - **Deployment**
      - **Time** 9/19/2005 13:53:00
      - **Drift** 0.00sec
    - **Recovery**
      - **Time** 8/7/2007 09:40:00
      - **Drift** 6.146075 sec at 8/7/2007 16:55:00

Short Period Seismometer Recovery
Station: KESW **Date:** 8/6/07 **Dive#** 1077
Sensor Location (Lat, Lon, Depth)
47º 56.210'N 129º 08.474'W 2383
47.936837 -129.141238
Serial Numbers
- **Sensor** BH-1-10
- **Logger** LP1-K13
- **Homer** 13

Site as found
- **Sensor**
  - **condition** ok
  - **azimuth** not measured
- **Homer** ok
- **Logger** ok
- **Anchor cable** ok-still attached
- **Seismometer Cable** ok

Recovery routine
Site as left
- **Corehole plugged?** n/a
- **Corehole flagged?** n/a
- **Seismonument** abandoned

Instruments on deck
- **Physical inspection**
  - **Logger sphere** ok
  - **Anchor cable** ok
  - **Connectors** white and green salt deposits just outside contacts, contacts look bright
  - **Cables** ok
- **Operational inspection**
  - **Batteries** 10.27 and 10.51 V
  - **Logger** in low power mode
  - **Clock** still running
    - **Deployment**
      - **Time** 9/26/2005
      - **Drift** 0 seconds
    - **Recovery**
      - **Time** 8/6/2007
      - **Drift** 5.333 seconds fast at 8/7/2007 02:21:40, note that clock drift measurement occurred the day after recovery

Appendix D-III. Network Summary

Table D-III-1 on the following page provides a summary of the seismic network.

Table D-III-1. Network Summary

Station	Latitude	Longitude	Depth (m)	Azimuth (deg)	Date Installed	Date Recovered	Drive A (Gb)	Drive B (Gb)	Drive C (Gb)	Drive D (Gb)	Total (Gb)
KEBB	47.95942 47º 57.565' N	-129.12537 129º 07.522' W	2378	0*	9/26/2005	8/8/2007	0.00	0.00	0.001	2.268	2.269
KEMO	47.92400 47º 55.439' N	-129.10826 129º 06.495' W	2286	41*	10/2/2005	8/6/2007	7.83	7.83	7.83	7.83	31.32
KENW	47.97976 47º 58.785' N	-129.11010 129º 06.605' W	2161	148*	9/20/2005	8/6/2007	7.83	7.83	7.83	7.83	31.32
KESQ	47.99500 47º 59.701' N	-129.07253 129º 04.352' W	2164	103*	9/19/2005	8/7/2007	7.83	7.83	7.83	7.83	31.32
KEMF	47.94844 47º 56.906' N	-129.09871 129º 05.922' W	2201	220*	10/1/2005	8/9/2005	0.00	0.00	7.73	7.79	15.52
KENE	47.97005 47º 58.202' N	-129.05604 129º 3.361' W	2342	182*	9/19/2005	8/6/2007	7.87	7.83	7.83	1.02	24.50
KESE	47.93994 47º 56.396' N	-129.06030 129º 03.618' W	2344	195 +/- 5**	10/2/2005	8/9/2007	7.83	4.14	0.00	0.00	11.97
KESW	47.93684 47º 56.210' N	-129.14124 129º 08.474' W	2383	200 +/-5	9/26/2005	8/6/2007	7.83	7.83	7.83	4.61	28.10

* Measured on a previous cruise.
**Previously measured as 228º.

Appendix D-IV. Operational Issues

The recovery of the seismometers went very well overall with only a few significant problems. We discovered that the steel cable holding the short period data loggers to the anchor was clamped with a copper crimp, which corroded over time. This caused the loggers to detach from their anchors and to use the seismometer as their new anchor. The eroded copper clasp was commonly still attached to the cable with green copper oxide in the bottom of the logger package. We recommend clamping the data logger cable with a nonreactive metal in the future. The two cables with stainless steel clasps had no evidence of corrosion.

We also occasionally discovered corrosion on the pins on the connector between the seismometer and the data logger. We found green and white deposits on and near the pins. Some pins had also turned black, while others were shiny as new. However, not every plug pin displayed this corrosion.

Corrosion was also present on the stainless steel broadband frame. The frame was partially buried in the sediment, which may have contributed to the corrosion.

We also had one case of a cable which had not been uncoiled when the instrument was deployed. This meant that the logger anchor and the seismometer were only about 30 cm apart, raising the likelihood that current generated noise would be communicated to the seismometer. The cable coils were held together with a rubber band, which was apparently difficult for the ROV to break. We recommend finding a tie that does not harden unexpectedly under the temperatures and pressures of the seafloor.

It may be wise to run a Kevlar line between the logger sphere and the seismometer, to which the electrical cable would be strapped. This would prevent damage to the cable and possible flooding of the instrument should situations arise (such as on this cruise) that would cause the electrical cable to be under tension.

An alternative to re-bar staples to hold down the seismometer cable on the broad band might be advisable. Locating these used an unreasonable amount of time. Possibilities include mats with handles, or weighted line.

Distance/depth markings on the suction device would help in judging the amount of material removed from the caisson, during both deployment and recovery.

Appendix E: CTD Summary

Seven CTD casts were collected at the Endeavour for UW graduate student Jonathan Kellogg with the goal of identifying temperature and other physical anomalies associated with hydrothermal plumes. Six casts were sites along the axial valley and one was at an off axis reference site. The plan for each cast was to launch the CTD to 10 meters above the seafloor while a complete profile of the water column was obtained. At selected sites, Joseph Chao and Andrew Holle from Arizona State University collected water samples from the 10L Niskin bottles attached to the Rosette. The CTD was brought to the surface and the profiles were saved under different file names.

Two CTDs cast were launched as part of the bathymetry survey at Barkley Canyon by Cheryl Katnik and Brian Bornhold.

The CTDs are summarized in Table E-1

Table E-1. CTD Casts

Date (UTC):	Station #:	Location:	Depth (m):	Samples (y/n):	Comments/Sample Details:
8/7/07	PV12	Station 12 on-axis Near High Rise N 47° 57.9291 W 129° 05.3764	2,196.6	n	
8/7/07	PV20	Sasquatch vent field along axis N 47° 59.8537 W 129° 03.9516	2,183	n	
8/7/07	PV16	Salty Dog vent field on-axis N 47° 58.9094 W 129° 04.7266	2,163	n	Weather picking up
8/8/07	PV2	Mothra vent field on-axis N 47° 55.3428 W 129° 06.5436	2,295.2	y	Log was not filled until half-way through the cast. Depths of Niskin fired: 2,277m, 2,030m
8/9/07	PV13	High Rise vent field on-axis N 47° 58.1654 W 129° 05.2027	2,161.7	y	Depth of Niskin fired: 1,997m
8/9/07	PV8	Main Endeavour vent field on-axis N 47° 56.0193 W 129° 05.9352	2,222	n	
8/9/07	EDG17	Off-ridge axis 17km N 47° 56.9823 W 128° 51.1434	2,474.3	n	Much noise and errors in profile
8/10/07	801	Barkley Canyon N 47° 56.4237 W 126° 05.8683	1,245.62	n	
8/11/07	901	Barkley Canyon N 48° 18.1446 W 126° 03.0687	999.07	n	

Appendix F: McLane Pump Samples

Kim Juniper collected five samples with McLane Water Transfer System pumps for molecular characterization of background microbial communities on the Endeavour Ridge. This is to support a future study of microbial communities associated with the different vent faunal assemblages. Analysis of the background samples will permit easier identification of vent associated microbes and characterization of the microbial communities in different faunal habitat. The McLane pumps were operated during ROPOS transits along or above the seafloor, Microbes were concentrated by pumped 100 liters of seawater through 0.22 μm Sterivex filter cartridges. Filters were then frozen for analysis.

Collected samples comprise:

i) Eastern flank of ridge at 2000m depth during transit across axis
ii) Western flank of ridge near broadband seismometer site
iii) Stockwork area south of Mothra vent field
iv) Transit within Main Endeavour vent field
v) Extension cable route east of Main Endeavour field

Appendix G: Barkley Canyon Bathymetric Survey

On Friday, August 10, 2007 the R/V Thompson (TN-209) conducted an EM-300 bathymetry survey in an area of Barkley Canyon that had not previously been surveyed with a multibeam system. This data is contiguous with the high-resolution bathymetry already gathered in the area on TN-175. The track lines are shown in Figure G-1

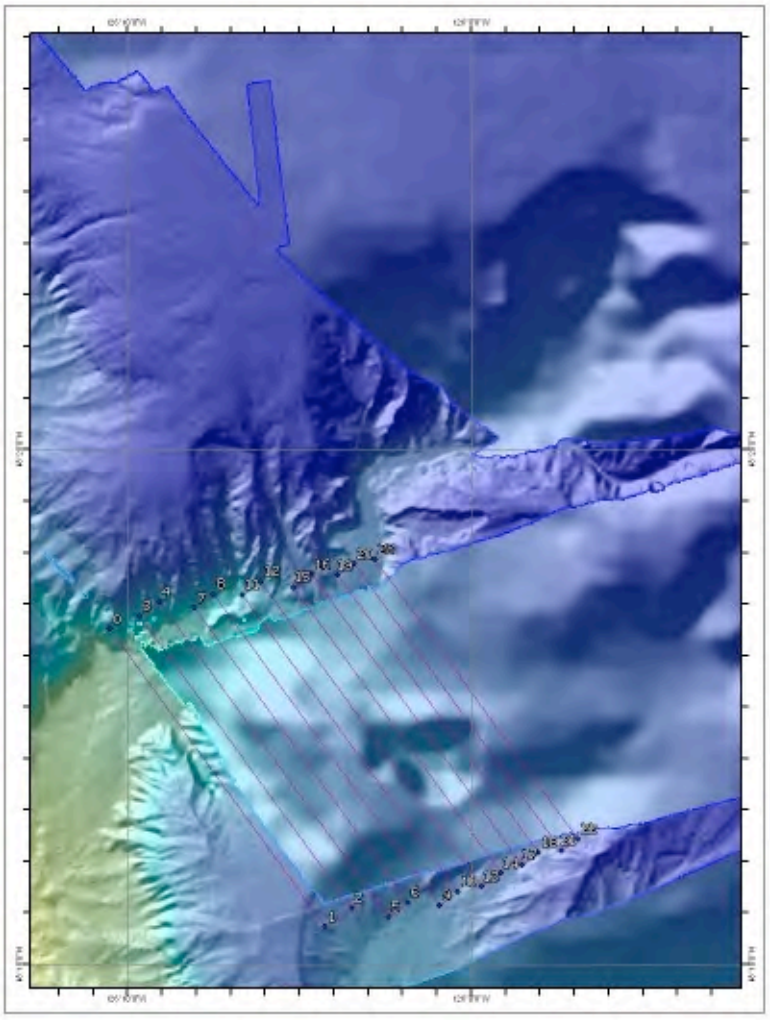

Figure G-1. Map of Barkley Canyon showing waypoints and area of TN-209 EM-300 survey

Appendix H: Remotely Operated Cable Laying System (ROCLS)

About 2 days of the cruise was spent conducting a highly successful test of the newly designed Remotely Operated Cable Laying System (ROCLS) developed for ROPOS. The following is a brief summary of the tests extracted from an article written by Keith Shepherd for the September 2007 NEPTUNE Canada Newsletter (see http://www.neptunecanada.ca/Newsletters2007.htm).

"The Canadian Scientific Submersible Facility (CSSF) owns and operates the ROPOS ROV. In addition, the CSSF was funded by NEPTUNE Canada to design, build and sea trial a Remotely Operated Cable Laying System (ROCLS) that allows the ROV to deploy ocean floor observatory cables. The ROCLS is an ROV mountable tooling package and storage drum designed and built by CSSF to assist in the infrastructure installation of NEPTUNE Canada's subsea observatory. ROCLS allows instruments to be installed up to 8 km from main junction boxes, giving scientists and wet plant managers greater flexibility in the location of equipment deployments.

The object of the sea trials was to test ROCLS's ability to lay cable and connector systems on the seafloor in a controlled manner and to find any and all weaknesses in the system's design or deployment methods. The reliability and functionality of the electrical, hydraulic and mechanical systems were all tested subsea.

The ROCLS sea trials were successful, proving the system reliability and capabilities. Problems found were minimal and mostly concerned lighting and camera configurations. These were changed to better view the cable touchdown and latching process. The overall capability of the system was proven and will allow the cable to be connected to the Node (or instrument), laid, connected to the instrument (or Node), and the drum frame recovered, all during a single dive. As planned, during lay operations the as-laid cable route was easily deflected with the vehicle alone and obstacles were easily identified and avoided.

This new cable laying capability, combined with the ROPOS ability so carry large and heavy instruments to and from the seafloor, proves ROPOS' ability as an efficient and versatile observatory installation and servicing system."

Further information about the ROCLS system can be found on the ROPOS website (http://www.ropos.com and "http://www.ropos.com/documents/ROCLS paper.pdf")

Appendix I. Cruise Web Site

As part of the Oceanography 411 curriculum, participating University of Washington oceanography undergraduates created a webpage to document their experiences on the 2007 Juan de Fuca ROPOS cruise (http://www.ocean.washington.edu/courses/oc411/, will likely be moved to http://www.ocean.washington.edu/courses/oc411_2007/ at some future date). The web page used a modified version of a template that was downloaded from Website Style (http://www.websitestyle.com/). The student webpage contains scientific staff biographies, descriptions of project equipment, student daily journals entries and cruise photos. The web page also contains individual narratives for the NEPTUNE Canada cable alignment routes, the OBS seismometer recoveries, the Endeavour hydrothermal vent field and individual Endeavour vent clusters visited during the cruise. Links were also provided to access a glossary site, external links to project participants, University of Washington and Web search link.

Post –cruise suggestions concerning the web-site were encouraged from the participating undergraduates to help improve the future implementation of this course web page. A helpful suggestion included holding a one or two day workshop prior to each cruise with a goal of selecting a useable web page template and completing it prior to vessel departure. A listing of individual writing assignment duties should be created and initiated prior to leaving for the cruise. Cross training of the participating undergraduates on the web page construction and maintenance should be ongoing during the cruise. It was determined that the time required to create the web page from scratch and stand watches made the option of an interactive website impractical for this cruise. Having a functional web page prior to beginning the field cruise would make this possible.

Appendix J. Science Complement and Crew List

Science Complement

William Wilcock, Chief Scientist	UW
Deborah Kelley, Co-Chief Scientist	UW
Rodger Adamson	CSSF/ROPOS
Vincent Auger	CSSF/ROPOS
Justin Bergquist	UW
Brian Bornhold	UVic
Daniel Bowman	UW
Steven Bucklew	CSSF/ROPOS
Shih-hui Chao	Arizona State University (ASU)
Matthew Chien-Hom	UW
Daniel Cormany	CSSF/ROPOS
Mitchell Elend	UW
Nathalie Forget	UVic
Robert Hagg	UW MarTech
Andrew Holle	ASU
Evan Howard	UW
Stanley (Kim) Juniper	UVic
Cheryl Katnick	UVic
Brittany Kimball	UW
George Laszuk	Canadian Broadcasting Corp
Michelle (Deni) Malouf	UW
Robert Meldrum	Canadian Geological Survey
Reuben Mills	CSSF/ROPOS
Ray Morgan	CSSF/ROPOS
Sharmila Pal	UW
Michael Realander	UW MarTech
Keith Shepherd	CSSF/ROPOS
Dean Steinke	CSSF/ROPOS
Chase Stoudt	UW
Justin Sweet	UW
Keith Tamburri	CSSF/ROPOS
Bruce Titus	UW
Douglas Toomey	UO
Robert Weekly	UW

Transit from Seattle to Canada Only

Peter Barletto Jr.	UW
John Delaney	UW
Mike Harrington	UW
Michael Kelly	UW
Rosalyn Lunde	JOI
Deirdre Meldrum	ASU
Alexander Talalayevsky	JOI

Crew

Alan McClenaghan	Captain
John Wilson	Chief Mate
Thomas Drake	2nd Mate
Eric Haroldson	3rd Mate
Paul Morrissey	Chief Engineer
Marvin Woody	1st Engineer
Richard Leonard	2nd Engineer
John Washburn	3rd Engineer
Brian Clampitt	AB
Lawrence Mezzano	AB
Larry Branovitch	AB
Frank Spetla Jr	AB
Pamela Blusk	AB
John Crowley	AB
Richard Lajoie	Oiler
Michael Koch	Oiler
Mario Yordan	Oiler
Larry Nelson	Wiper
Anthony Balbon	Chief Steward
Shawn Stranger	2nd Cook/Baker
Hasheem Bell	Mess Attendant