Cruise Report

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1.0 CRUISE OVERVIEW (R. Embley)

1.0.1 General Overview

This report details the results of the operations that occurred during the NeMO98 cruise on the NOAA Ship *Ronald H. Brown* from August 25th to September 20th, 1998. The team of 33 chemists, biologists, geologists, and engineers used the scientific remotely operated vehicle *ROPOS* (Remotely Operated Platform for Ocean Sciences) (Shepherd and Juniper, 1997) to investigate in detail the aftermath of the diking event and its effect on hydrothermal chemistry and on the seafloor and subseafloor biological communities. This was a highly leveraged expedition, with substantial operational support coming from several portions of NOAA (WCNURC, Sea Grant, PMEL VENTS) and from the Canadian National Science and Engineering Research Council of Canada (NSERC). Twelve principal investigators and eight graduate students from the U.S. and Canada participated in the expedition. Support for the research of the investigators and graduate students came from a variety of sources, including the NOAA Sea Grant Program, the National Science Foundation, NSERC, the NOAA VENTS Program, and MBARI (the Monterey Bay Aquarium Research Institute). More than 200 samples were collected, 40 experiments were deployed (most for a year deployment), and 15 experiments were recovered during the 252 hours (over 21 dives) of bottom time with *ROPOS*. The extraordinary amount of bottom time (about 100 hours more than an equivalent length submersible dive program) allowed the entire scientific party to participate in a careful exploration of the new eruption site and the other hydrothermal systems on the summit of Axial Volcano.

1.0.2 Background

A major focus of the cruise was the NeMO (New Millennium Observatory) project**.** The primary goal of NeMO is to investigate the effect of dike intrusions and eruptions on the chemistry and micro- and macrobiology of hydrothermal systems (Haymon et al., 1993; Holden et al., 1998; Tunnicliffe et al., 1997; Butterfield, 1997; Delaney et al., 1998). NeMO was conceived in 1996 as a multiyear effort to perform chemical, biologic, hydrographic (plume), and geologic time series studies of Axial Volcano on the central Juan de Fuca Ridge (Fig. 1) (Johnson and Embley, 1990). Axial was chosen for this study because: (1) its shallow depth and large mass of Axial Volcano implies a long-term frequency and volume of volcanic activity significantly higher than the adjacent mid-ocean ridge [Baker, 1992 #60], and (2) hydroacoustic monitoring using SOSUS (Dziak

and Fox, 1997) and an ocean floor pressure gauge (Fox, 1990; Dziak and Fox, 1997) showed that the summit of Axial is the most seismically active site on the Juan de Fuca Ridge (Embley et al., 1990), and (3) intensive seafloor surveys by camera and submersible in the 1980s showed extensive evidence for recent volcanism and hydrothermal activity at its summit.

The approach of NeMO is to combine baseline *in situ* sampling and high resolution mapping with continuous monitoring of the hydrothermal systems over several years with the expectation of several magmatic perturbations occurring within that interval. Extensive seafloor investigations using deep-towed cameras and submersibles took place in the 1980s (CASM, 1985; Johnson and Embley, 1990) and renewed investigations in 1995-97 provided an excellent baseline for the NeMO program. The continuous monitoring aspect of NeMO reached a critical level by 1997, when the instrument suite was expanded to three complementary components: (1) Volcano System monitors (VSMs) to measure vertical crustal motion and seismic tremor, (2) an array of current meter/temperature recorder moorings along the shallowest portion of the south rift zone within the caldera, and (3) deployment of an array of acoustic extensometers (from the R/V *Sonne* in 1996) capable of recording horizontal strain over a 400-500 meter distance across the north rift zone (Fig. 2). Long-baseline-navigated towed camera surveys and CTD casts and tows from the *Sonne* (P. Herzig, Chief Scientist) in 1996 and the *Brown* in 1997 (G. Massoth, Chief Scientist) and several dives with *ROPOS* in the caldera in 1997 (V. Tunnicliffe, Chief Scientist) provided important baseline data and set the stage for the extensive surveys and sampling planned for NeMO-98.

On January 28, 1998, an intense earthquake swarm lasting 11 days began on the summit of Axial. Migration of the seismicity 50 km southward during the first few days revealed the similarity of the event to Icelandic and Hawaiian diking/eruptive events (Dziak and Fox, 1998). After the first two days, virtually all of the events located either on the southwestern part of the summit or at the extreme end of the southern rift zone. In mid-February, a rapid response cruise on the *Wecoma* by NSF and NOAA investigators (J. Cowen, Chief Scientist) found enormous increases in the hydrothermal discharge from the summit of Axial (Baker et al., 1998). In July, 1998, *Alvin* made four dives into the caldera during a combined NSF and NOAA effort (J. Cowen, Chief Scientist), confirming an area of new hydrothermal activity within a zone of young lavas in the SE part of the caldera. The *Brown* completed an extensive plume survey in early August and recovered one VSM (Volcano System Monitor) and two of the three temperature sensor moorings deployed in 1997. Temperature data from two of the water column moorings (Fig. 3) recovered by the *Brown* showed a large heat pulse coincident with the onset of the earthquake swarm and a pressure gauge on the VSM recovered from the center of the caldera showed a 3 meter subsidence of the seafloor (Fox, 1998). The high probability of a summit eruption indicated from these data set the stage for NeMO-98.

1.0.3 New Eruption Site

Much of the bottom time was used to investigate the eruptive site of a new lava flow in the southeast portion of the caldera which erupted along a fissure system at least 3 km long (Figs. 2 and 3). We had an excellent, state-of-the-art set of tools on *ROPOS* to accomplish this. These included: (1) an *in situ* chemical scanner (SUAVE) which measured Fe, H2S, Mn, light scattering, and temperature, (2) a suction device primarily used for taking up to 8 samples of unconsolidated material such as microbial mats, meiofauna, and vent animals, (3) a new vent fluid sampler capable of taking as many as 18 water and particle samples for chemical and microbiological analyses, (4) a pencil beam scanning sonar for detailed mapping, and (5) a 3 chip RGB pan/tilt/zoom video system.

A large percentage of the surface of the lava flow was coated with a brown to tan microbial mat which masked the glassy surface of the new flow and caused some initial uncertainty about the age of the lava. The very recent age of this lava was eventually verified by the partial burial of a seafloor instrument (see below) and a line from a navigation transponder mooring that had been deployed in the summer of 1997. The eruption was in the form of a drained-out sheet flow, in contrast to the (primarily) pillow lava erupted during previously monitored NE Pacific eruptions. Sheet flow morphology is thought to be caused by a higher effusion rate, which is consistent with the enhanced magma supply at Axial. High resolution surveys with the downward-scanning sonar revealed that the source of the eruption was an en echelon series of north-south collapse depressions characterized by lava spires and floored by sheet flow. Camera tows and submersible dives in the 1980s and 1990s found numerous vent communities over several kilometers on the southeast part of the caldera where the south rift zone begins near the eastern wall of the caldera. The *ROPOS* dives showed dramatic changes in the hydrothermal systems on the southeast part of the caldera, most notably the partial burial of the pre-existing vent communities. The eastern part of the lava flow had numerous sites of diffuse venting with extensive white bacterial mats colonized by small polychaete worms and snails (Fig. 3). These sites were devoid of tubeworms except near the eastern edge, where colonization had begun to occur, probably from surviving communities east of the lava flow contact. At one location, dead tubeworms and clams were found partially buried by the lava flow. Farther south, older vent communities still survived just beyond the limit of the new eruption. In one place an older lava drainout area had been penetrated by the new lava. Here, old tube worm communities barely survived on top of lava spires or were dying or dead after the spires had been toppled, possibly by the impinging lava flow and associated seismic activity.

Accompanying the eruption was an intense microbial bloom that was still ongoing in August/September, seven months following the event. A dramatic manifestation of the bloom was the production of large

amounts of white floc, which filled shallow cavities in the lava flow and flowed out in large amounts when the seafloor was disturbed.

1.0.4 Mooring Searches

ROPOS recovered five "prototype extensometer" (PE) instruments (Chadwick et al., 1995), via an elevator mooring. The PE instruments had been recording acoustic range data since they were deployed across Axial's north rift zone in June 1996, at a site about 4 km north of Axial caldera (Figs. 2 and 4). These data (which are still being analyzed) will show any horizontal strain along the north rift zone caused by the dike injection to the south. During the last ROPOS dive of the NeMO98 cruise four PE instruments (the fifth instrument had not worked) were redeployed near the same location across Axial's north rift zone for another year of continuous strain monitoring. Arrays of these instruments are planned for both north and south rift zones over the next several years.

Another role for *ROPOS* was a search for two seafloor instruments deployed in 1997 that could not be recovered during a previous attempt by the *Brown* in early August. A current meter/temperature monitor mooring had not responded to acoustic commands and one of the VSMs ("Rumbleometers") confirmed a release from the deployment weight but subsequent ranging indicated that it remained on the seafloor. ROPOS located this VSM by acoustic ranging (Dive R461) and a careful survey of it revealed that it was apparently overcome by flowing lava which had prevented the package from floating free of its deployment weight (Fig. 3). Subsequent attempts to pry it loose with the *ROPOS* manipulator (Dive R461) and pull it free with a line attached to the cage (Dives R474 and R477) were unsuccessful. An extensive search for the missing water column mooring on R460 and R461 failed to locate it. A bottom search with *ROPOS* at the deployment location of the mooring base (R477) revealed that new lava covered the site, so it seems likely that the mooring base was overrun by the lava flow, possibly resulting in the release of the mooring.

1.0.5 Seafloor Experiments

ROPOS deployed short-term and long-term experiments (Fig. 4). Several types of experiments were deployed for a year duration at the eruption site. These include: (1) two osmotic fluid samplers, (2) a time-lapse camera, (3) five temperature probes, and (4) several microbial mat collectors. The camera, one of the osmotic samplers, a temperature probe, and several microbial collectors were placed at the Marker 33 site, at which the highest flow rate was observed and the highest temperatures recorded. A short-term osmotic sampler was deployed and recovered from the same site as the long-term experiments. These experiments complement additional NOAA instrumentation

emplaced before and after the ROPOS cruise. A replacement VSM was deployed at the eruption site in early August from the *Brown.* Following the *ROPOS* cruise, nine water-column moorings were deployed in and around the caldera from the *Brown*. These moorings include temperature sensors, optical sensors, and current meters to monitor the hydrothermal plume discharge for the next year. Finally, data from a year-long array of ocean bottom seismometers (beginning in July, 1998) at the summit of Axial by Scripps scientists in July 1998 (R. Sohn, S. Webb, and W. Crawford) should provide very valuable correlations between subsurface activity and effects on the hydrothermal system as recorded on the mooring and the *in situ* experiments.

1.0.6 Studies of ASHES and other Vents

The ASHES high temperature vent field in the SW portion of the caldera (Butterfield et al., 1990)(Figs. 2 and 5) was also extensively surveyed and sampled by ROPOS. It is not yet clear whether the 1998 diking event induced significant changes at ASHES vent field, but detailed analyses of the chemical samples will reveal any major changes induced since the last sampling effort in 1995. Several temperature probes deployed at both diffuse flow and high-temperature sites were left and will be recovered in the summer of 1999. A short-term osmotic water sampler was deployed and later recovered from a high-temperature site and several microbial mat collectors were left in place until 1999.

ASHES was also the focus of detailed studies of the macrofaunal communities. Intensive studies of the ecology of the tubeworm and polychaete communities at this site used a combination of video observations, chemical scanning, and sampling to better understand the relationships between chemistry, temperature, and biology. ASHES has been the focus of more than a decade of studies of the macrofaunal communities and continues to be an important study site for hydrothermal ecology.

Other long-term venting sites in and near the caldera visited and sampled by ROPOS included the CASM site (CASM, 1995) located at the northernmost end of the caldera near the intersection of the caldera wall and a small diffuse vent about 5 km north of the caldera along the north rift zone. The chemical and biological samples taken during these dives will establish a firm baseline for future magmatic perturbations occurring on the north rift zone.

1.0.7 Other Operations

Between dive operations included rock coring and CTD operations. These operations provided valuable additional data about Axial Volcano and used the valuable shiptime with maximum efficiency. The rock coring program concentrated on the South Rift Zone.

Very few previous basalt samples had been collected from this site, and extensive analyses of these samples will help put the chemistry of the 1998 eruption into better regional context. The CTD program represented a continuation of the post-eruption plume time series begun in February.

1.0.8 Outreach

A web site (http://www.pmel.noaa.gov/nemo_cruise98/) was updated (A. Bobbitt) on a daily basis with transmissions of still images, an occasional video clip, and descriptions of the latest results. A secondary school science educator (G. Williamson) provided material to a complementary shore-based educator (Mike Goodrich), who then gave daily public lectures on the seagoing activity at the Hatfield Marine Science Center Public Wing and publicized the web site to the educational community. This program will continue in 1999 with Sea Grant funding (V. Osis and W. Handshumaker).

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DISCIPLINE SUMMARIES

2.0 VOLCANOLOGY

2.1 Principal Findings (Bill Chadwick, Bob Embley)

One of the principle findings of the NeMO98 expedition is that the January 1998 earthquake swarm resulted in the eruption of new lavas along the upper south rift zone of Axial volcano. We know that new lava was erupted from the rift zone in at least two locations, 1) the upper most south rift zone between 4555.3' and 4557.2' (129 59.0'), on the SE edge of the caldera where many 1998 ROPOS dives took place, and 2) at a location where a prominent SeaBeam anomaly was found at 4552.0'/130 00.0', about 4 miles south of the caldera where one ROPOS dive was made. It should be emphasized that while we mapped the eastern and western lava contacts in both areas, we never defined the northern or southern limits of the new lava flows in either of these areas. Therefore, the full extent of the 1998 eruption is not yet known, and it is entirely possible that new lava was erupted continuously between the northern and southern study areas. For example, a second, smaller SeaBeam anomaly was found between 4554.5' to 4555.0'. This area was not visited by ROPOS during this cruise, but observations from Alvin dive 3247 in July 1998 suggest that new lava in the northern study area extends at least as far south as 4554.8'.

In the northern study area, it took a while for us to be convinced that new lava had indeed erupted, because in many areas it is covered by a tan/orange deposit of bacterial mat and does not look as fresh and pristine as we have observed at other recent eruption sites. However, by the end of the NeMO98 cruise the cumulative evidence for recent eruption was unequivocal. This evidence includes, 1) the mapping of new/old lava contacts and collapse features in the interior of the new flow in a geologically meaningful pattern from both bottom traverses and Imagenex sonar mapping, 2) a transponder mooring line that was deployed in 1996-97 found to be overrun by new lava along one of the new/old lava contacts, 3) the consistent absence of macrofauna on the new lavas except in new hydrothermal vent areas (contrasted with abundant sponges and other sessile animals on most of the surrounding older lavas), 4) the complete absence of "missing" tubeworm communities that had been photographed by camera tows in 1996 and visited by ROPOS in 1997 and were apparently buried by new lava, 5) the consistent distribution of new hydrothermal vent sites near the center of the new lava flow, and 6) the consistent (and virtually exclusive) association of the tan/orange bacterial mat coatings within the new lavas.

The new lava flow in the northern study area is narrow (300-600 m) and long (at least 3.5 km, but probably more than 4.5 km), and appears to be up to ~5 m thick. It was apparently erupted from a fissure on the rift zone, probably along the entire length of the flow. The lava flow is primarily a lobate sheet flow with extensive areas of roof collapse along its center, where it was thickest before drainout. In the floor of collapse areas are ropy, lineated, and jumbled sheet flows, and many areas with lava pillars up to 4 m in height. Near the margins where the flow is thin it has either lobate morphology or pillows. In places, the new lavas invade and fill in collapse areas in older lavas. The distribution of the tan/orange bacterial mat is variable, but generally it is thinnest near the flow margins and thickest near the center of the flow. The mat distribution is probably related to the way in which heat was dissipated from the new sheet flow as it cooled. The lava flow was hard on instrumentation that had been deployed in the area last summer - it surrounded and partially buried a NOAA/PMEL rumbleometer instrument and apparently buried or caused the premature release of a NOAA/PMEL current meter mooring.

High-resolution bathymetric maps made from data collected during surveys with an Imagenex scanning-sonar over the area show the distribution of collapsed and uncollapsed areas on the new flow, the topographic barriers in surrounding older terrain that limited its lateral extent, and the structural context of vent sites and sample locations. The Imagenex maps show about an order of magnitude higher resolution than hull-mounted multibeam bathymetry and reveal features on the seafloor that would be otherwise impossible to visualize. They will be extraordinarily useful for characterizing the eruption and the distribution of lava types, as well as for assessing the structural interaction between the south rift zone and Axial's eastern caldera wall. Imagenex surveys were also made on the north rift zone of Axial (where the extensometer instruments were recovered) and at ASHES vent field.

Our one ROPOS dive in the southern study area (dive 465) showed that the boundaries of the new lava flow there agreed almost exactly with the edge of the SeaBeam anomaly, which is about 1 mile E-W and 0.5 mile N-S, and is at least 27 m thick. The new flow was clearly erupted along the rift zone and flowed downslope to the east where it increased in thickness. This southern lava flow is primarily formed of pillow lavas, but also has lobate and jumbled sheet morphologies and localized areas of collapse and channelized flow. No active venting was observed on this lava flow, although there was extensive evidence that it had occurred previously.

The volume of lava erupted at Axial in 1998 is definitely larger than that erupted at either the 1993 CoAxial or 1996 Gorda eruptions, judging from the areas we have already mapped. However, we cannot put an upper bound on the eruptive volume until the area between 4552' and 4555' is mapped and the full extent of new lavas is determined.

2.2 Acoustic Extensometers (Bill Chadwick, Bob Embley, Mike Stapp)

The acoustic extensometer instruments were developed by NOAA/PMEL's engineering division with funding from NOAA/NURP and the VENTS Program. They are designed to measure and quantify seafloor spreading events. They do this by acoustically measuring the distance between pairs of instruments very precisely (~1 cm) over a short baseline (100-200 m between instruments). The instruments are deployed in a linear array to span larger distances (up to 1 km). They have enough power and memory to make daily measurements for about a year and a half.

On June 20, 1996 we deployed 5 extensometer instruments on the north rift zone of Axial at about 4601.2'N latitude from the SONNE. We had intended to deploy them with ROPOS that year, but due to the unavailability of the ROPOS winch at the last minute, we were forced to simply drop them from the surface and hope for the best (that they would land in such a way that they would have the required acoustic line-of-sight between them). We had also hoped to recover them in July 1997 from the TULLY, but this was the first shake-down cruise for the new ROPOS and there was not enough dive time available. However, this means they were still deployed when the earthquake swarm occurred on Axial in January 1998, giving us the opportunity to see if the north rift zone was involved in the 1998 eruption.

The five extensometer instruments were recovered by ROPOS and the elevator mooring (equipped with 5 large black plastic tubes) on September 5, 1998, on ROPOS dive 467. By luck, ROPOS landed right on top of instrument #2, after a short test above the bottom with the digital camera. All five instruments were in the elevator with 3.5 hours (surprisingly fast). The instruments had all landed within 9 to 39 m of their drop positions. An Imagenex survey was made of the area where the instruments were located to aid in finding the best sites for their re-deployment and to study the structure of the north rift zone.

Four of the five extensometers recorded data. Instrument #4 would not respond after recovery, and its data could not be retrieved. Of the 4 remaining, one ended up in a hole (#1) and could not see the others for ranging (this is why ROV deployment is so important!). The remaining 3 ranged to each other for about 20 months (until ~March 2, 1998), and luckily spanned the axis of the north rift zone. Of the two range legs between the 3 instruments, one range leg (#5<->#3) spanned the north rift zone and was 300 m in length (the dead instrument was in the middle there) and the other range leg (#3<->#2) was 100 m in length and east of the rift axis.

The good news is that most of the instruments worked. We obtained a good Imagenex sonar survey of the site, and an excellent ROV deployment of the instruments. They will provide an exceptional monitoring baseline for the next year. We deployed the 4 working instruments back on the north rift in about the same location. Future plans call for extensometer arrays on both the north and south rift zones with new instruments that can remain on the bottom for 5 years with annual data retrieval by acoustic modem.

3.0 CHEMISTRY

3.1 Vent Fluid Sampling (Dave Butterfield)

One of the goals of the NeMO 98 Cruise was to understand the connections between microbiology, geology, and chemistry. Specifically, we wanted to address whether fluid chemistry is a controlling factor in the abundance and type of microbes present in hydrothermal vents. This fits in nicely with the studies of vent fauna and how they relate to fluid chemistry. This part of the project requires collecting coordinated samples for fluid chemistry and microbiology, and for that purpose, we constructed the Hot Fluid Sampler (HFS).

3.1.1 Description of the Hot Fluid Sampler

HFS was designed to collect fluid and particle samples from vents with a wide range of temperature and flow rate. The system consists of a titanium intake nozzle with 1mm slits to exclude large particles and a platinum resistance thermometer in a titanium sheath with the sensing tip located about 1 cm above the inlet slits. Hydrothermal fluids are pulled through the intake nozzle, past the temperature sensor, through a ball joint, into a 0.5 inch diameter PEEK plastic tube (~1.5 m long). This flexible tube connects to a 0.5 inch titanium tube (~1.3 m long), which in turn connects to 0.5 inch teflon tubing. A second temperature sensor is located at the junction of the titanium and teflon tubing, in order to assure that the temperature of the fluids has cooled to below 100°C prior to being pulled into the various samplers or passing through the flushing pump. The flushing pump pulls the sample from the intake nozzle past the samplers, and operates at adjustable rates from 1 to 5 liters per minute. The sample pathway is made entirely of titanium, PEEK, and teflon. There are nine teflon cross fittings along the fluid path, allowing a maximum of 18

individual samples to be taken per deployment. By maintaining a constant and smooth inner diameter through the fluid pathway, the system promotes easy flushing of any entrained particles and provides minimal dead spots for particles to accumulate. To protect the flushing pump, we are limited to relatively "clean" samples, i.e. we can't use the fluid sampler as a suction sampler.

A separate sample pump (100 to 250 ml/min) pulls the fluid into the sampler selected by a 25-port valve. The sample pump pulls the backfill water out of the samplers to draw the fluid in, and does not contact the sample fluid, except in the case of the filter samples for particle collection, when filtered water is pulled through the sample pump. In addition to the dive sample number assigned to every ROPOS sample, we assign a water sample number which is the dive number followed by the type of sample (P for piston, B for bag, F for filter) and the valve position number. Pistons are numbered 8-13, with 8 and 9 used for gas sampling. Bag samples are numbered 2-7 and 23 and 24. Filters occupy positions 16-18.

The sampler uses 4 wires: ground, +26-35V DC, and RS232 transmit and receive. The software used to control the sampler runs on a PC under a DOS window. When data logging is on, we record (once per second) temperature, valve position, pump status (on/off), and volume pumped. By tracking the intake temperature of the sample throughout sampling, we get an average temperature for the water sampled, so we can calculate element/heat ratios.

Part of the philosophy of this sampler was to collect a large number of fluid and particle samples on a single dive dedicated primarily to fluid sampling, alternating with dives serving other purposes. Because the sampler is so large, few other operations are possible when the sampler is in use. The sampler is best utilized when there are a number of known targets to sample, or when replicate sampling of a few sites is desirable.

HFS takes 3 types of samples. There are 6 **PVC piston samplers**, 4 with teflon check valves for general water chemistry, and 2 with steel check valves with o-ring face seals for gas sampling. The piston samplers can hold up to 800 ml of sample when full. For gas sampling, we take only 150-200 ml so as not to exceed the capacity of the gas extraction line. There are 8 **bag samplers**, each with a teflon check valve. We have the option of

placing filters in front of the bag samplers to remove particles. Our standard configuration took six filtered samples, with the filters going to Feely's group at PMEL for XRF and SEM analysis. The bags themselves are either Tedlar or laminated, high-density polyethylene-lined, and both types are reasonably impermeable to gases. Finally, we use a variety of **filters** with no fluid collection to trap particles. On this trip we used 3 micron GFF followed by 0.2 micron Sterivex cartridge filters for microbiological work (DNA analysis).

3.1.2 Samples recovered

The fluid sampler was deployed on 4 dives: 468 (shortened by mechanical problem with the 7-function arm), 469, 473, and 479. During these dives, we collected 42 fluid samples. We sampled focused, hot fluids from Virgin Mound, Crack, Mushroom, Inferno, and Hell vents, and diffuse vent fluids distributed throughout the ASHES vent field. We took one sample (20°C) at Tombstone vent located about 500 meters south of the ASHES field. On dive 473, we sampled a wide variety of fluids associated with the new lava flow in the SE corner of the caldera. These samples included the "milky" fluids venting along a line in the northern part (Milky, Easy, Magnesia vents), floc-producing vents (Snowblower near The Pit), clear fluids venting through holes in the roof of drain-back areas (Roof vent), hotter clear-venting fluids (marker 33), and a smoky vent (Cloud). We sampled two of the 3 sites sampled during the July Alvin dives (marker 33 and marker 108). We also found and sampled a hot vent (275°C) near the eastern contact of the new flow. Between the HFS samples, additional water samples collected with the suction sampler and ROV-mounted Niskins, and chemical data from SUAVE scans, we have excellent spatial distribution for vent fluid chemistry. Our assessment of what is actually venting from the recent eruption area at Axial is more comprehensive than the 1993 sampling after the CoAxial eruption.

3.1.3 Preliminary results

Our shipboard analyses included hydrogen sulfide, silica, pH, alkalinity, ammonia, and refractive index for salinity. We found that Virgin Mound still has a very low salinity, and that the salinity at Hell and Inferno has decreased significantly since 1995. This is the first time we have found all the high-temperature fluids to be less than seawater salinity at ASHES. Maximum temperatures measured with the fluid sampler were 297 at Hell, 261 at Virgin, 256 at Inferno, and 179 at Mushroom. (There may be higher temperature fluids venting from other orifices that we did not measure. We did not measure what was the hottest orifice on Inferno, because there was a HOBO temperature probe left in it.)

Many of the samples we collected were very gas-rich. The HFS sample containers hold the gas quite well, so we recovered much more sample than we typically get with the major samplers, which are designed to leak. Castle vent was charged with CO2, with over 5 mM H2S, and low salinity. The present venting at Castle is limited to a small anhydrite chimney near the base of what appears to be a decaying sulfide structure. This gives the impression that the venting at Castle has been rekindled by the recent eruptive activity.

We see a wide range of H2S/heat or H2S/Si ratios in the collected vent fluids. This range is a potential indicator of both differences in the reaction zone temperature and sulfide-consuming reactions in the sub-seafloor. Further study of the vent fluid and particulate chemistry combined with the microbiological results should clarify what processes are involved, and how they relate to the eruptive activity.

Although we saw significant thermal and particle plumes over some distance south of the ASHES field, our one dive there did not turn up much venting. We saw only one large patch of venting with tube worms, anemones, crabs, and other biota, and took one sample there. The sample has a moderate H2S/heat ratio. Because of the length of the transect (over a kilometer) we could not do a thorough search. Overall, we obtained an excellent set of samples that should allow us to learn how the free-living microbes and the mats relate to the vent fluid chemistry.

3.2 SUAVE Studies (Gary Massoth)

3.2.1 Description of Operations

The Submersible System Used to Assess Vented Emissions (SUAVE) was conceived from the need for a better tool to probe the submarine hydrothermal environment. Chemical oceanographers within the NOAA Vents Program require information about the concentration, distribution, and inventory (flux) of key chemical species in seafloor effluents and hydrothermal plumes that has a much higher spatial resolution than that typically afforded by conventional "n-limited" discrete sampling procedures. In situ chemical analyzers or "scanners" of the type first described by Ken Johnson and associates (Johnson et al., 1986) are an ideal solution to this need. By matching high-resolution chemical data provided by scanner technology with continuously-sensed

physical property information, unprecedented insights about processes occurring in the submarine hydrothermal environment are in the offering. Similarly, by coordinating in situ chemical measurements with observations of vent field macro- and micro-biology, the effects of chemistry on hydrothermal biota, and vice versa, can be rigorously evaluated (Sarrazin et al., submitted). Finally, chemical analyzer data collectable over the "operational-day" time scale, both on the seafloor and within hydrothermal plumes, provides both the spatial and temporal resolution necessary to discriminate ephemeral processes critical to understanding the evolution of seafloor hydrothermal systems. These attributes plus the species/concentration-range adaptability, multiple-platform compatibility, reduced opportunity for sample contamination, and "quicktime" feedback inherent to chemical analyzers provided extreme incentive to develop a SUAVE capability within the Vents Program.

SUAVE is an integrated instrument system consisting of an evolved chemical analyzer patterned after the original in situ chemical analyzer, the "scanner"(Johnson et al., 1986), and an array of physical property sensors (temperature, conductivity, pressure, light scattering and/or attenuation). Co-funded by the NOAA NURP and Vents Programs, design and fabrication were initiated in 1991, incorporating modifications suggested by Ken Johnson and Kenneth Coale of the Moss Landing Marine Laboratory, based on their experience with the "scanner." Schematic block diagrams of SUAVE electronics and chemical components are shown in Figure 1. The SUAVE chemical analyzer is based on principals of flow analysis and colorimetric detection. For NeMO 98 SUAVE was configured to measure H2S (simultaneously by two methods: nitroprusside over the range ~50 to 2000 æmol/L and molybdenum blue over the range ~1 to 200 æmol/L), Mn(II) and Fe(II+III) dissolved in vent fluids. Sensors data was recorded for temperature (0 to 120øC), pressure (depth), conductivity (salinity), and light scattering. All data channels logged readings each 5 seconds during deployment.

During NeMO 98 SUAVE was deployed on ROPOS-II during 10 of the 21 dives conducted. SUAVE was engaged in thermochemical surveys of seafloor venting for over 67 hours during which 55 scans (extended measurements for over 5 minutes at a single point in space: 30 along the East Rift eruption mound, 22 at ASHES vent field, 2 at CASM and 1 at the 91 vent field on the North Rift Zone of Axial Volcano) were made. The SUAVE measurements will be used to determine the spatial variability in concentration of the various measured chemical species and their ratios to heat for comparison to historical data. The SUAVE data set will be extended both spatially and elementally by merging with vent fluid data collected by Butterfield. Evidence for selective regional exhalation of H2S, a product of magmatic degassing and dike cooling and also a primary microbial nutrient, will be sought to guide studies of temporal variability of hydrothermal effluents. Identification of signature' ratio values indicative of the recent lava intrusion/eruption at Axial Volcano will be characterized. SUAVE H2S data will be merged with micro- and macro-biological data collected by Juniper,

Tunnicliffe, and Moyer to help define thermochemical niche values for various biological communities.

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3.2.2 SUAVE Summary for Project NeMO (Station list and preliminary results)

Site Tmax Tave H_2S Mn Fe H_2S/Q Mn/Q Fe/Q

°C °C M M M nM/J nM/J nM/J

SE Caldera

ROPAX 97@ huge worm field 6.4 6.4 82 ? BDL 4.8 - -

R460-1 bacteria floc by Milky Vent 2.9 6 BDL (45) 3.7 - (37)

R460-2 MKR N2@ Milky Vent 8.0 8.0 175 40 90 7.9 1.8 1.1

R460-3 MKR N3@ hole in basalt 13 11.5 200 40 40 5.5 1.1 1.1

R460-5 MKR N1@ Pit Vent 13.7 13 180 50 15 3.3 0.9 0.3

R461-1 @ MKR 33 bacteria mat, crack 15 8 470 2 47 9.3 0.04 0.9

R461-2 @ MKR 33 over white mat 11 15 5 2 0.4 0.2 0.1

R461-3 @ MKR 33 over hole in above mat~4.5 ~10 BDL BDL ~1.2 - -

R461-6 @ MKR 33 crack with floc flow 37 26 1000 18 40 7.2 0.1 0.3

R461-7 @ MKR 33 mat @ Bag Creature 17 700 2 5 12.0 0.1 0.1

4R61-8 @ MKR 33 Bag Creature 2.8 75 BDL BDL 62 - -

R461-9 @ MKR 33 Baby Bag Creature 3.1 40 BDL BDL 16.5 - -

R461-10 @ MKR N6 Cloud Vent 27 750 5.5 62 7.6 0.1 0.6

R461-11 @ MKR N4 Cloud Vent 24 750 2 55 8.7 0.1 0.6

R461-12 @ MKR 108 8.1 6.0 230 45 25 10.0 2.0 1.1

R461-13 @ MKR 113 flow @ top of pillar 10 237 BDL 7 7.7 - 0.2

R461-14 @ MKR 113@ Vemco probe tip 10.5 307 BDL 8 8.0 - 0.2

R461-17 @ MKR 113@ bacteria trap 23.5 20 500 -BDL 9 13.0 - 0.2

R461-19 @ MKR 113base of tall tubes 5.7 45 -BDL 8 4.5 - 0.1

R461-21 @ Cirque Vent and hole in 6.5 6.5 87 3.0 57 6.2 0.2 3.5

basalt with Fe floc cover

R461-22 @ Castle Vent@ base of 90 60 1400 18 71 6.1 0.1 0.3

Hi-T vent

R461-23 @ Castle Ventprobe in 5.3 5.0 132 BDL BDL 13.0 - -

tubes @ base

R461-24 @ Castle Vent and MKR N5, 21 19 200 6 19 3.0 0.1 0.3

@ healthy tube worms

R478-1 @ MKR 33 17

R478-2 MKR 33 Near OSMO Sampler 42.2

and MTR

R478-4 20 m SW of MKR 33 13.0

at crack venting floc

R478-5 ~5 m NW of CLOUD VENT 18.7

R478-? Scan 5 at Nascent Vent 23.5

R-478-? Scan 6 at MKR N41 22.7

R478-? Scan 7 on old flow just N of N41 9.5

R478-? Scan 8 on old flow and 16.3 16.1

within big tube worms

ASHES Vent Field

ROPAX 97@ Hat Vent 30.5 90 21 15.5 0.8 0.2 0.1

ROPAX 97@ Phoenix 4.9 93 4 12.5 9.9 .4 1.3

ROPAX 97@ Phoenix 19.5 320 4.8

ROPAX 97@ Phoenix 37.2 150 1.1

ROPAX 97@ Crack Vent 61.6 725 13 55 3.1 0.1 0.2

ROPAX 97@ Wall 80 m W 19.5 4 11.5 0.05 0.1 0.2 0.001

R466-20 @ Inferno near palm worms 5.5 4.0 45 10 45 7.4 1.6 7.5

R466-23 @ Hell front edge pork chop 16 12 1690 70 90 2.8 1.8 2.3

R466-24 @ Hell back of pork chop 19 17 420 60 87 7.3 1.0 1.5

R466-25 @ Hell center of chop 19 17 420 45 85 7.3 0.8 1.5

R466-26 @ Hell tip of chop 19.5 18 650 75 90 10.4 1.2 1.4

R466-5 @ Hillock@ bacteria traps, tubes 15.9 120 7.5 5 3.4 0.1 0.1

R466-10 @ Hillock@ Phoenix I, base 20 16 290 22 68 5.3 0.4 1.3

R466-11 @ Hillock@ Phoenix I, higher 15 11 1170 38 75 34 2.2 2.6

R466-12 @ Hillock@ Phoenix I, higher 6 4 360 15 62 59 2.5 10

R466-13 @ Hillock@ Phoenix II 8 4.5 360 17 67 45 2.1 8

R466-14 @ Hillock@ Phoenix II 4.2 3.0 54 1 8 27 0.5 4.0

R466-15 @ Hillock@ Phoenix II 6.1 4.0 67 4 17 11 0.7 2.8

R466-16 @ Hillock@ Phoenix III 80 65 380 25 70 1.5 0.1 0.3

R466-17 @ Hillock@ Phoenix III 24 22 27 BDL 10 0.3 - 0.1

R466-18 @ Hillock@ Phoenix III 3 2.8 81 3 17 67 2.5 14

R466-6 @ ROPOS@ bacteria trap site 29 24 305 40 80 3.4 0.4 0.8

468 Scan #1 early@ Crack Vent 77 70 1260 45 5 4.6 0.16 0.02

468 Scan #1 late@ Crack Vent >125 105 2120 <0 9 5.1 - 0.02

R466-7 @ Hair-doo at top of worms 14 12.5 125 12.5 8 3.1 0.3 0.2

R466-8 @ Hair-doo where worm 14.8 13.5 180 15 10 4.1 0.3 0.2

roots were

CASM

R480-1 @ T&S Vent base diffuse flow 41.9 37 232 73 >91 1.7 0.5 >.7

R480-5 @ T&S Vent top in lush tube 20.3 16 177 40.5 86 3.3 0.8 1.6

worm community

91 Vent (N. Rift) 4.5 4 124 5 2 14 0.8 0.3

in most intense flow near worms, clams

Through R481:

10 SUAVE Dives

55 SUAVE Scans

67 h of bottom time

3.3 OsmoSampler and OsmoAnalyzer Operations (Geoff Wheat)

Changes in the chemical composition of hydrothermal effluent after a tectonic-volcanic event have been documented (e.g., Baker et al., 1987, 1998; Butterfield and Massoth, 1994; Von Damm et al, 1995; Massoth et al., 1995; Massoth et al., in press; Wheat et al., to be submitted) and a conceptual model has been developed that theorizes the chemical evolution of venting fluids (Butterfield et al., 1997). However, the timing of these changes is uncertain. To date observations of temporal variability in the chemical composition of hydrothermal fluids has relied on repeated submersible operations and the collection of discrete samples. While this technique provides some temporal constraints, a continuous water sampler or analyzer allows one to collect more samples with limited need for costly submersible operations. Our goal for this cruise was to deploy two short-term (two weeks) and two long-term (one year) continuous sampling systems to provide temporal constraints for observing hourly to daily and weekly to monthly chemical cycles in the hydrothermal effluent. Data from these samplers and their comparison to samples

collected using traditional discrete sampling techniques will allow us to determine the temporal scale of chemical change in the hydrothermal effluent as the hydrothermal system evolves and may provide constraints for understanding the physical and chemical conditions at depth and the path for fluid circulation.

Two sampling systems were deployed, OsmoSamplers and OsmoAnalyzers. OsmoSamplers are continuous water samplers that use the osmotic pressure that is created across a semi-permeable membrane by solutions of differing salinity (Theeuwes and Yum, 1976; Jannasch et al., submitted). This pressure drives water across the membrane at a speed that is dependent on the surface area of the membrane, type of membrane, salt gradient, and temperature. An excess of salt is maintained on one side of the membrane, thus only temperature affects the flow of water in the sampler. Pumps in an OsmoSampler are used to continuously draw sample through a small bore (0.8 mm id) tubing that is attached to a 40-cm-long T-handle. An additional pump was used to add acid to the sample stream in most of the OsmoSamplers. A 1.5-m-long section of tubing separates the sample intake from the pump to allow the pump to be placed in an area void of hydrothermal influence and thus minimizes temperature (pump rate) fluctuations. A temperature recorder with a resolution of 0.0018°C is attached to the T-handle to monitor the same water that is being collected by the OsmoSampler. Chemical data are obtained by retrieving the sampler, cutting the sample tubing into sections, extracting the seawater, and analyzing the seawater for chemical species of interest. Time-stamps for individual samples are determined assuming a uniform temperature at the pump that translates into a uniform rate of pumping.

OsmoAnalyzers, in contrast to OsmoSamplers, use osmotic pumps to deliver reagents into a sample stream for in situ analysis (Jannasch et al., 1994). These analyzers are very similar to the SAUVE, which is described above. OsmoAnalyzers were designed to measure concentrations of dissolved iron and manganese at 30-minute intervals for up to six months. These analyzers thus compliment data collected by the SUAVE, which can measure concentrations continuously but only for a maximum of about three days.

Two long-term acid-addition OsmoSamplers were deployed. One was deployed at Milky vent and the other at Marker 33. Each sampler was positioned away from visual flow to decrease the potential in temperature fluctuations at the pump. For example, the SAUVE measured a temperature of 3.0°C, relative to a bottom temperature of 2.7°C, at the sampler deployed at Marker 33. At both sites the sample input was positioned into the most vigorous flow. Temperature recorders were attached to these inputs and will provide a yearly record of temperature at 30-minute intervals. We expect that these OsmoSamplers will provide four 0.5-mL samples per week for the length of the deployment.

Two short-term deployments were conducted and both samplers were recovered. One sampler package was deployed at Marker 33. During the two-week deployment measured temperatures varied from about 10° to 50°C. This vent was sampled using two OsmoSamplers and two OsmoAnalyzers. One OsmoSampler consisted of an acid addition pump and a Teflon sample tubing for shore-based chemical analyses of the

major and minor ions in seawater and several trace metals. 240 0.5-mL samples were collected. The other OsmoSampler had a copper sample tubing. This sampler provided 48 2.5-mL samples for shore-based analyses of dissolved gases. The two OsmoAnalyzers were designed to measure concentrations of dissolved iron and manganese, respectively. On the basis of initial inspection of these analyzers, the iron analyzer work, but the manganese analyzer did not.

The other short-term sampler package was deployed at Hell vent in the ASHES vent field for two weeks. This high temperature black-smoker vent was leveled before the acid addition sampler was deployed. The sampler had a temperature probe attached to the pump and an additional high-temperature (>100°C) probe was placed in the venting hydrothermal fluid. Both probes recorded temperature every 30 seconds for a maximum of about 30 days, however, the high-temperature probe was not recovered. The probe attached to the sampler recorded temperatures of about 3.6°C for the first week, then recorded temperatures of about 10°C for the second week. A total of 301 0.5-mL, one 1.0 mL, and one 1.5 mL samples were collected. Because sulfides were deposited in and on the sample inlet, it is likely that only a portion of these samples are directly from the vent orifice. Altered seawater likely entered through a weak link about 30 cm from the input.

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3.4 Gas Sampling (Lee Evans)

The primary goal of gas sampling during the NeMO '98 expedition was direct sampling of vent fluids by way of Titanium Gastight Bottles and modified gas pistons on the PMEL Hot Fluid Sampler. Approximately 24 useful samples were gathered and their available gas contents extracted and sealed in glass ampoules for chemical analysis. These ampoules will be used for the analysis of helium concentrations and helium isotopes at PMEL, Newport and other gases such as hydrogen and methane at the University of Washington.

The geographic coverage of vent fluid sampling included the east side of Axial Volcano's caldera, Ashes vent field on the west side and CASM vent field at the north end of the caldera. Samples from the east side were largely low temperature diffuse fluids spanning most of the north to south extents of the known vent field. The one high temperature sample was from Castle Vent. At Ashes Vent Field numerous high temperature chimneys and diffuse sites were sampled. Some repeated sampling from July Alvin dives. Only two diffuse vents were sampled at CASM.

Other samples for helium analysis included about 80 samples in crimped copper tubing from 12 hydrocasts. Most were from just above vents which were sampled directly. They are expected to be useful in conjunction with methane analyses from the same Niskin bottles. One of the Osmosamplers consisted of a reel of thin copper tubing. Forming a time series over about 15 days at Marker 33, the reel was segmented into 48 samples, each of which represents about an 8 hour average of what emerged from the vent.

3.5 H_2 and CH_4 Oxidation (Betsy McLaughin-West**)**

A seafloor eruption event can result in any number of effects in existing hydrothermally active areas. The event that occurred at Axial Volcano during February 1998 presented an opportunity for further study of the types of changes that occur as a result of a seafloor eruption. One effect is an elevation of hydrogen concentrations in the venting fluids as a result of increased hot water/rock reactions. This dissolved hydrogen may be a significant energy source for bacteria. Previous work at Loihi Seamount following an eruption showed that microbial hydrogen oxidation rates were elevated in the hydrothermal

plumes found above the seamount immediately following the event but dropped to background seawater levels within a few months. The February 1998 eruption event at Axial Volcano offered a second opportunity to study the microbial response to a sudden change in available hydrogen. During the NeMO 98 cruise, samples were collected from the plumes above Axial Volcano approximately 6-7 months after the event. Microbial hydrogen oxidation rates for these fluids will be determined from the results of radioisotopic uptake experiments performed aboard ship. These rates will be compared with a similar set of measurements made during the Axial Rapid Response cruise in February 1998. Microbial hydrogen and methane oxidation rates will also be determined for samples collected directly from the diffuse venting areas and the buoyant portions of the plumes so that the relative importance of these two gases to the microbial communities can be estimated.

3.6 Determination of Sulfide, Nitrate and Salinity Concentrations Without the Use of Reagents (Elizabeth Guenther)

I am a graduate student at Moss Landing Marine Laboratories, my name is Elizabeth Guenther. Gary Massoth invited me on this cruise. I have been working on a project for my thesis work at Moss Landing with the help of my advisor, Ken Johnson. I have been working on a new method for the determination of sulfide, nitrate and salinity concentrations without the use of reagents. I measure the UV absorbance of a seawater sample and various standards and from that information I am able to predict the concentration of nitrate, salinity or sulfide. The purpose of this cruise was to determine if this method could be applied to vent fluids and if so, what are the possible interferences involved, if any?

I have collected samples from the fluid sampler that Dave Butterfield brought on the cruise as well as from the slurp sampler. These samples were analyzed for sulfide concentrations and will be used to determine if salinity and nitrate can also be calculated. The sulfide concentrations were compared to those predicted by the Methylene blue chemistry performed by Kevin Roe on this cruise. Preliminary examination of the data indicates that this new method may provide good estimates of the sulfide concentrations in the vent fluid samples. These data will be used in the MSC thesis and for publication.

4.0 MICROBIOLOGY

4.1 Non-Mat Microbial Ecology (Jon Kaye and Julie Huber)

We focused on several aspects of vent microbial ecology during this cruise, much of which is geared toward defining time point #1 in a multi-year chemistry-microbiology data set with Dave Butterfield. We have used non-mat microbial samples and have cultured from 2-90°C, covering all thermal classes and many metabolic groups of bacteria and archaea, in order to develop a comprehensive picture of non-mat microbial

ecology at Axial Seamount. In addition, more narrowly focused goals include obtaining novel physiological classes of hyperthermophiles and quantifying halotolerant microbes in the vent environment and the overlying water column. 36 ml of water from all samples was preserved in 3.7% formaldehyde for microbial enumeration.

Hyperthermophiles were cultured in a 0.6% (w/v) organic medium, with and without native sulfur (yeast extract and peptone, YP, and with sulfur, YPS). Positive enrichments (which require confirmation on land) came from Crack, Gollum, Milky Vent, Mushroom, Bubbler #2, Marshmallow, background water in ASHES, Marker 33, Easy Vent, Roof, Castle, Styx, Magnesia, Old Tubeworms, West Caldera Wall, Snowblower, Medusa, Porkchop, near Cloud, Marker 113 Pandora worm slime, other animal inocula, and sulfide rock from Hell. Methanogens were enriched from many of these same locales. The Slurp Sampler and Dave's Fluid Sampler were equally effective for culturing purposes. Overall, hyperthermophiles are ubiquitous in and around ASHES and found in all sampled diffuse fluids in the caldera. However, no hyperthermophiles were cultured in YPS from a putative buoyant plume hit during hydrocast V-98-002 (Niskin #18) above Cloud.

Quantitative enrichments (MPNs, Most-Probable-Number technique) were performed at 90°C from several sites. The table below contains the 95% confidence interval for the abundance of hyperthermophiles that grow in the given media, given in microbes/liter. These data are preliminary and must be confirmed by microscopy on land.

YPS (likely *Thermococcus*) YE (likely methanogens)

Marker 33 >48,000 140-4200

Marshmallow 3000-96,000

"Background" in ASHES 300-7600 <60

Caldera Wall, west of ASHES in progress

Total community DNA was captured from various diffuse flow, high-temperature and background sites and split into free-living (0.2-3 m) and particle-attached (>3m) fractions by filtration. Filters were frozen at -80°C. Enrichments for methanogens, heterotrophic hyperthermophiles, sulfur oxidizers, and sulfate- and nitrate-reducing microbes were performed simultaneously from 2 to 90°C, with the majority at 50 and 90°C. Dave Butterfield, Kevin Roe, and Betsy McLaughlin-West made and will make further chemical measurements at the same sites. Likewise, complementary SUAVE data from Gary Massoth will be correlated with this microbial work.

Diffuse fluids, high-temperature fluids, sulfide rock, homogenized *Paralvinella* specimens, and animal mucus were inoculated into modified high-organic hyperthermophile media (YP and YPS) and incubated at 90°C. Halotolerant hyperthermophiles able to grow in a 5% NaCl YPS medium appear ubiquitous, though media with 0.2% and 8% NaCl did not appear to allow growth. Metal-resistant hyperthermophiles capable of tolerating mM levels of Cd, Hg, Cu and Co were routinely cultured. Confirmation of growth must await phase-contrast microscopy on land.

Eight MPNs for mesophilic halotolerant microbes were performed on diffuse fluids, near-vent bottom water and hydrocast samples. The medium used enriches for heterotrophic bacterial and archaeal aerobes at room temperature. To complement these quantitative enrichments, water was filtered (0.2 m) and the filters frozen for *Halomonas* (a halotolerant bacterial genus) DNA probe work on land.

4.2 Microbiological Sampling for Molecular Microbial Ecology Analysis (Western Washington University, Biology Department: Craig L. Moyer & Karen Pelletreau.)

4.2.1 Introduction

One of the greatest challenges in microbial ecology is the accurate identification and description of microbial populations within their respective communities. This information is central to determining the extent of global microbial diversity, which remains the least understood of all the biological size classes. To address this challenge, molecular biological techniques using small-subunit ribosomal RNA (SSU rRNA) gene sequences have been applied to describe the structure and diversity of different microbial communities. The current endeavor is to examine specific habitats with known biogeochemical characteristics (e.g., S, Fe, Mn) to learn more about the dominant microorganisms residing therein. The focus of this study at Axial Volcano is to estimate

the microbial community structure and diversity to assess the degree of commonality and uniqueness among local hydrothermal vent habitats, (i.e., vent-associated sediments, free-living microbial mats, microbes associated with subsurface floc-ejecta), and to also compare these results with distal hydrothermal vent habitats. This study will also allow for the enhanced development of a comprehensive global perspective regarding the diversity of deep-sea microbial communities.

Selective enrichment culture has severe limitations as an approach to the cultivation of naturally-occurring microorganisms. The majority (typically >90-99%) of microbes in nature have not yet been cultivated using traditional techniques. Consequently, it is very unlikely that collections of microbial isolates are representative of *in situ* diversity and community structure. Furthermore, because relatively nutrient-rich media are generally used for isolations, "weedy" or opportunistic microorganisms may be selected rather than those dominant in the natural community. The approach, herein, is to ascertain a microbial community's primary members through molecular (i.e., cell component) means and then to attempt to further characterize their respective phylogeny or natural history. Obtaining a better representation of microbial community structure and diversity is crucial to aspects of microbial ecology where *Bacteria* and *Archaea* interact with one another and with their environment, e.g., global biogeochemical cycling of matter, succession and disturbance responses, predator-prey relationships, and trophic-level interactions. These lessons can then be used to focus enrichment culture techniques towards ecologically significant taxa. This approach has been successfully used to isolate the dominant iron-oxidizer bacterial taxon found within the microbial community at hydrothermal systems located at Loihi Seamount, North Gorda Ridge, and other habitats (Emerson and Moyer, 1997; unpublished results).

Cell component analyses provide a culture-independent means of investigating microorganisms as they occur at hydrothermal vent systems (Moyer *et al.*, 1994;1995; 1998). While several types of cell components have been analyzed, the SSU rRNA molecule offers an amount and type of information that makes it one of the best culture-independent descriptors or biomarkers of microorganisms. In recent years a detailed theory of evolutionary relationships among the domains *Bacteria, Archaea* and *Eucarya* has emerged from comparisons of SSU rRNA "signature" sequences. For example, each SSU rRNA gene contains highly conserved regions found among all living organisms as well as diagnostic variable regions unique to particular organisms or closely related groups. Additionally, each SSU rRNA gene contains about 1,500 nucleotides of sequence information that can be obtained and utilized to differentiate among closely-related and distantly-related groups of microorganisms. This type of molecular approach allows the autecology of microorganisms to be studied whether or not they can be been cultivated (Moyer *et al.*, 1996). In addition, the phylogenetically described taxa or "phylotypes" can

be placed in a synecology context through the examination of SSU rRNA clone libraries generated from a microbial community and habitat diversity can be analyzed through rarefaction (Moyer *et al.*, 1998). These features make SSU rRNAs particularly useful for studies of molecular microbial ecology, where a broad and unknown range diversity of microorganisms is likely to exist. Currently, over 10,000 SSU rRNA sequences from both cultured isolates and environmental phylotypes have been made available for study through the Ribosomal Database Project at NSF's Center for Microbial Ecology at Michigan State University.

4.2.2 Shipboard Processing and Storage of SamplesA dual approach was used for microbial sampling. First, a "slurp" gun suction device was be used in combination with a rotating rosette of sample bottles to "vacuum" and capture free-living microbial mats from the surface of various hydrothermal vent habitats. Slurp gun samples were successfully obtained from the East-Side of Axial at (1) Marker #33 Vent, (2) Snow Blower Vent near Pit, (3) Milky Vent Floc, (4) Cloud Vent Floc, (5) yellow mats near EZ Vent, and (6) red iron-oxides near Milky Vent. Similar samples obtained in and around the ASHES area include, (1) orange oxides near Gollum Vent, (2) white mat from Gollum Vent, and (3) yellow mat from the West Wall to the northwest from ASHES.

Second, the deployment and recovery of bacterial traps using glass wool as a substrate for microbial growth. Bacteria traps were constructed using a cluster of three 3" sections of 4"o.d. Plexiglas tubing, surrounded top and bottom by a 202 µm nylon mesh (Nytex) to exclude macrofauna grazing. These were placed directly into diffuse vents and were used to collect colonizing microorganisms in an effort to examine community succession. These were deployed with the idea of attempting a time-series with both short-term (days) and long-term (annual) time scales. This objective was partially achieved with short-term recoveries made at Marker #33, Cloud Vent, and Milky Vent on the East-Side of Axial Volcano. Long-term deployments were made at these three sites as well as at EZ Vent, Axial Gardens, Castle Mound, and at four sites within the ASHES Vent Field (Gollum, ROPOS, Hillock, Mushroom). Short-term recoveries from these sites (especially at ASHES) will be attempted again next year, in addition to the long-term recoveries from each of the sites listed above.

Microbial samples collected were each independently processed. Microbial biomass preservation was achieved by quick-freezing in liquid nitrogen and storing on dry ice or ultrafreezer (-80C) until return to the laboratory. These samples will be used for the direct extraction of nucleic acids. A series of sub-samples were also (i) cryo-preserved (again

using liquid nitrogen quick-freezing) with 40% glycerol, and (ii) aliquots were stored at 4C, both for enrichment culture selection. Another series of sub-samples was fixed with 2.5% EM grade glutaraldehyde for examination with SEM and epifluorescence microscopy.

4.2.3 Laboratory Processing and Molecular Biological Analysis

Initially, all samples will be examined by epifluorescence microscopy in an effort to ascertain biomass estimates and examine morphological diversity. A subset of these will also be examined through SEM and an analysis of extractable lipids, which provides an estimate of microbial biomass and initial clues into community structure. The overall molecular biological strategy used will be essentially that of Moyer *et al*. (1994, 1995; 1998) with a few technical and logistical improvements. The first step will be the efficient and direct extraction of high molecular weight nucleic acids from quick-frozen samples. This will be followed by PCR amplification of SSU rDNAs using previously defined conditions to maximize the equal representation from each population contained within a respective community. The concept is to proportionally amplify or make several copies using the total genomic DNA from a natural community serving as the template for oligonucleotide primers that are complementary to universally conserved SSU rDNA sequence positions. Representative SSU rDNA amplification products are cloned generating a clone library. Clone libraries will then examined through the use of Amplified Ribosomal DNA Restriction Analysis or ARDRA and by using rarefaction as a metric for organismal diversity (Moyer *et al.*, 1998). This approach, using tetrameric restriction enzymes, has been shown to detect >99% of the taxa (i.e., phylotypes) present within a model dataset with maximized diversity (Moyer *et al.*, 1996). SSU rDNA sequences will also be subjected to phylogenetic analysis (using distance matrix and maximum likelihood algorithms) to estimate the affiliated ancestral lineage for each dominant community member thereby yielding clues as to their respective evolutionary history and potential physiology.

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4.3 Biomineralization/Lava Mats (Kim Juniper, University of Quebec, Montreal: Steve Scott, University of Toronto)

Early in the cruise we observed extensive deposits of iron-rich floc of possible microbial origin covering the new lavas in the East Rift Zone. The deposits were heavy enough to mask the normally glassy appearance of the new lavas and actually prevented us from confirming the present of the new flow until early in the second week of the cruise. Similar deposits had been observed and sampled on the new lavas at the FLOW site on CoAxial segment shortly after the June 1993 eruption. However, this coverage was much more extensive and was not the same bright orange color as the CoAxial oxide mats. The extent and thickness oxide deposits on the new Axial lavas varied along an east-west traverse across the flow. Heaviest deposits were in the central part of the lava flow where some bright-orange oxide material was still being deposited at a few active vents. At the edges of the flow, oxide material was brownish in color, and was being reworked by deposit feeding invertebrates such as holothurians (sea cucumbers) that had moved in from adjacent older lavas.

A systematic sampling of the putative microbial floc was undertaken during dives 474 and 476 that conducted a series of East-West and West-East traverses of the new lava from beginning in the south and ending near Milky Vent. Samples (7 in all) were both fixed for electron microscopy and frozen for elemental and mineralogical analyses, and measurements of microbial enzyme activity. This work will be carried out by an M.Sc. student at the University of Toronto who will work under the direction Steve Scott, and who will travel to UQAM in Montreal to work with Kim Juniper on biological aspects. The aim of the study will be to characterize the material mineralogically, confirm its

microbial origin and map relative density of the deposits across the lava flow in order to understand the relationship to thickness of the underlying new lavas. The latter information is important to testing a working hypothesis that heating of surface flows by underlying lava caused leaching of reduced iron into the seawater, permitting colonization by iron-oxidizing bacteria.

Samples were also collected of iron-oxide deposits and small oxide mounds near the ASHES field for comparison of mineralogy and microbiology with the oxide material from the East Rift Zone lava flows.

5.0 MACROBIOLOGY

5.1 High Temperature Chimney Biology (Damien Grelon, Christian Levesque & Kim Juniper, University of Quebec, Montreal UQAM)

This work focused on study of the feeding behavior and microbial food resources of the sulfide worm, *Paralvinella sulfincola*, on newly-formed surfaces of sulfide chimneys in the ASHES field. The worm lives in a mucus tube cemented to the sulfide and appears to feed around the opening of its tube by scraping organic material off the mineral surface. Temperatures in excess of 50C have been measured in this habitat and the worm is a prime candidate for a first-ever identified trophic link between thermophilic/hyperthermophilic bacteria and an animal. Field work concentrated on:

1) Making *in situ* video recordings of worm behavior for analysis of feeding behavior and territoriality .

2) Collecting samples of worm populations and chimney material for analysis of population structure, organic matter concentration and stable isotope ratios in food and animal tissues.

3) Acquisition of temperature/chemistry information from the worm's habitat to examine environmental controls on feeding behavior and food abundance

The behavioral and environmental data form the core of an M.Sc. thesis by Damien Grelon while the stable isotope study is part of a M.Sc. project on hydrothermal vent trophic links by Christian Levesque.

We obtained 3-4 hours of recordings of worm behavior from 5 sites in the ASHES field. Worms from all but one of the observational sites were sampled using the ROPOS suction sampler, and either frozen or formalin-fixed prior to analysis at UQAM. One site was designated for time series observations and revisited twice during the cruise to follow worm migration and behavioral changes in relation to changes in fluid flow patterns.

In collaboration with Gary Massoth, a total of 15 SUAVE scans were performed among sulfide worm populations after behavioral observations.

The big surprise was the aggressive territoriality of the worms, in relation to each other. Individuals frequently probed and entered the feeding area of others, and physical contact between residents and invaders often resulted rapid, aggressive striking movements. Both feeding and territorial behavior will be systematically analyzed in relation to organism density, site and environmental factors.

5.2 Stable Isotope Food Web Analyses (Christian Levesque, Damien Grelon & Kim Juniper, University of Quebec, Montreal)

The importance of free-living microbes as a food source for deposit feeding and suspension feeding animals at hydrothermal vents is still poorly understood. The intent of the study was to concentrate on identifying the food resources exploited by two co-occurring polychaete worms that colonize sulfide chimneys in the ASHES field. The working hypothesis was that the sulfide worm (*Paralvinella sulficola*) and the palm worm (*Paralvinella palmiformis*) manage to share the same space by not competing for food. Preliminary data showed clear differences in stable isotope ratios between the two species, confirming apparent differences in feeding behavior with the sulfide worm seeming to deposit feed on surfaces while the palm worm appeared to mainly feeding by trapping suspended particles in turbulent flow. Several collections were made of both worm species as well as of organic material from chimney surfaces. We were also able to

use the ROPOS suction sampler to make 3 collections of suspended particles from above colonies of palm worms. All material will be analyzed for stable isotopes of carbon and nitrogen.

The stable isotope work was also expanded in response to the observation of extensive white bacteria mats at new vents on the lava flow in the East Rift Zone. These mats were being grazed upon by at least two species of scale worm. These first vent animal colonists could be seen to be actively scraping microbial mat from rock surfaces. At a few locations, small vent snails were also abundant and grazing on bacterial mats. Collections of scale worms, snails and bacterial mats were made at several sites for stable isotope analysis to confirm this trophic link. Previous observations at CoAxial suggested the importance of post-eruptive microbial blooms as a resource for vent animals. These samples will permit us to make considerable progress in understanding this early phase of ecosystem development.

5.3 Biology of Low Temperature Sites (Verena Tunnicliffe, Maia Tsurumi and Jean Marcus)

5.3.1 Introduction:

This biology program focused on four study themes: i) evaluation of colonization on the new lavas, ii) nature of the regional distribution of species and populations, iii) the composition of communities in different fluid chemistries, and iv) the biology of the vestimentiferan *Ridgeia piscesae*. We were most fortunate to receive over a dozen samples that had either SUAVE or fluid sampler information with them. To our knowledge, this is the first such coordination of widespread sampling at low temperature sites. Previously, it has been very difficult to obtain environmental information with biological samples. For us, this information is a triumph for the cruise.

5.3.2 Colonization:

The opportunity to observe colonization of new hydrothermal vents so soon after a known eruption is a rare opportunity. From our limited experience at CoAxial, we had predicted small vestimentiferan recruits with three or four other known species. Our dives, however, identified three types of colonization, one of which was the predicted pattern. The others were dense snails and a mix of scale worm species. The large expanse of new lava created geographic separation among the sites. The cause of three distinct

colonization patterns likely relates to either stochastic events governing larval delivery or differing chemical character across the flow. Hopefully, chemical and microbial information will help resolve this issue.

In addition to type of colonization, extent also varied. The most vigorous flows of Milky and Cloud Vents hosted few animals while nearby vents were colonized. To understand more about sources, we were able to sample vents on old lavas. A large field of tubeworms (the SONNE field) was obliterated by the eruption but outlier colonies remained. We can compare composition of these colonies with recruits this year and next. We also have taken samples for a genetic analysis of one species to determine the likely source of the new populations. An interesting complication is that many of the "old" worm colonies are now experiencing rejuvenated fluid flow resulting in morphological changes in the resident worms and new recruitment.

5.3.3 Regional Character:

Axial Volcano is one of the few places on the Ridge that allows us to study discrete well-separated communities. A current question in vent ecology is how populations interchange among sites. We need better description of species distributions in a regional setting. We are finding that some species are curiously patchy and are attempting to apply ecological concepts of metapopulations to model population patterns. To this end, samples from the Eastern Rift (north and south), ASHES, Northern Rift and CASM form five essential contemporaneous points in this model. These samples will be sorted to determine compositional differences as well as including a population genetic analysis of one species.

5.3.4 Local Variation:

Collections at ASHES are to be used in two studies. Firstly, they set the basis for local variability for assessment of regional differences in the study above. Secondly, they provide an important set of samples to complement samples from earlier years in a study of spatial and temporal change. The polychaete species will be examined in detail to relate relative abundances to position and chemical character of the fluids. As little work has been published on "whole communities" this basic step is a useful contribution to understanding vent community dynamics. As part of this work on polychaetes, the unusual scaleworm collected from the new lavas of the Eastern Rift will be examined in detail in conjunction with Juniper's isotope work.

5.3.5 *Ridgeia piscesae*:

The tubeworm forms the basis for the vent communities of Juan de Fuca. As such, there is considerable interest in understanding more about its requirements and basic biology. Samples that were collected with coordinated fluid data will be examined in a study of size, reproductive condition, trophosome condition and juvenile recruitment. The aim is to understand the chemical conditions that are optimal and marginal for both reproduction and recruitment. Specimens were also processed for ultrastructural examination on the beach. Here, the intent is to collect detailed morphological characters to test models of the evolutionary relationships of vestimentiferans. Lastly, specimens of live tubeworms were transported to the Aquatic Facility of University of Victoria to attempt in vitro fertilization of eggs. Study of embryological characters adds information to both phylogenetic studies and dispersal capabilities.

5.3.6 A Final Comment:

The interdisciplinary nature of this cruise has been of considerable benefit to understanding biological features of the vent communities. It is an important learning environment for experienced researchers and students alike. Particularly welcome, is the opportunity to develop collaborations when new opportunities present themselves.

5.3.7 MacroBiological Sample List from Low-Temperature Sites

S=SUAVE; HFS=Hot Fluid Sampler

ASHES

Tube worm grabs

- R466-3: **Mkr L**, tube worm grab of hat-like structure (S)
- R466-8: **Hairdo vent**, huge tube worm grab of bouquet-like structure (S)
- R471-6: **Mkr i,** tube worm grab, left a marker to SUAVE later
- R471-3: **Gollum vent,** tube worm grab (HFS)
- R472-3: **Medusa vent,** tube worm grab (HFS)

EAST RIFT ZONE

Suction Samples from new lavas

- R462-2: **mkr 33**, suction sample of mat and polynoids (S)
- R462-3: **mkr 33,** suction sample of mat and polynoids (S)
- R462-4: **mkr 33,** suction sample of mat and polynoids (S)
- R473-6: **easy vent,** suction sample of polynoids and mat
- R473-18: **mkr 33,** suction sample of new polynoids and mat (S)
- R473-21: **mkr 108**, suction sample for new worm and mat
- R474-3: **mkr N41**, suction sample of tube worms (S)

Tube worm grabs

- R461-15: **mkr 113**, tube worm grab from a new vent on old lavas (S)
- R464-9: **near mkr 113,** tube worm grab of moribund worms on old lavas
- R464-14: **mkr N5,** tube worm grab of live-looking worms on sulfide structure near Castle (S)
- R476-3: **oldworms,** tube worm grab of reinvigorated venting on old lavas (HFS)
- R478-8: **nascent vent,** tube worm grab of new tube worms on new lavas (S)
- R478-11: **old flow,** tube worm grab of reinvigorated venting on old lavas (S)
- R478-13: **large tube worms**, tube worm grab of reinvigorated venting on old lavas (stayed in Pacman until surface) (S)

NORTH RIFT ZONE

Tube worm grab

- R467-4: **Bob vent,** tube worm grab of old venting (S)

CASM

Tube worm grab

- R480-7: **T & S vent,** tube worm grab of healthy worms on sulfide (S)

6.0 HYDROTHERMAL MINERALIZATION (Steve Scott)

Hydrothermal deposits are known from previous expeditions at the ASHES, Southeastern Rift and CASM Vent fields. During the NeMO expedition, considerable work was done

in and around ASHES and USRZ (Upper South Rift Zone). A short visit was made to CASM.

At the ASHES field, Hell, Inferno, ROPOS and Mushroom are sizable hydrothermally active sulfide spires a few meters high. Virgin and Virgin's Daughters are small active anhydrite chimneys. Those who had seen ASHES on previous expeditions commented that Mushroom, Inferno and Hillock had thickened considerably. Hillock, for example, had grown from a small spindle to a much more massive structure. A small chimney and flange were sampled at Hell. The chimney is predominantly iron-rich zinc sulfide (probably wurtzite based on the hexagonal shape of its millimetric crystals) with a central conduit lined by a copper -iron sulfide (probably isocubanite). The flange, although finer grained, appears to have the same mineralogy with the probable isocubanite forming in hot water ponded buoyantly against the underside.

At Southeastern Rift, a sulfide structure that had been seen in a 1996 Sonne camera tow was named "Castle" by the NeMO expedition. The main structure is about 10 m high, 3 m diameter at its base and 5 m at its top. The top is festooned with 50 cm high chimneys which inspired the name Castle. The edifice appears to be sitting on a small pillow mound within what otherwise is a ~5 meter depression. Diffuse venting is occurring in many places on Castle. On its southwest side there is a small anhydrite spire that is actively venting hot water. This was sampled on an early dive and had regrown to its ~50 cm height just 9 days later. About 10 m southeast of Castle there is another sulfide structure of similar size to Castle named "Flat Top" by the NeMO expedition. It, too, has diffuse venting although seemingly not as much as Castle. About 10 m south of Castle is a small spire, about 1 m tall, that appears to be extinct. It could be gathered in its entirety using the elevator.

CASM was a huge surprise. The site is within and adjacent to a 5-10 m wide fissure on the floor of the caldera where the north rift slices the northern wall. When discovered in August 1983 on a Pisces IV dive, there were just a few diffuse vents supporting small colonies of tube worms and other animals. Now, vents such as Shepherd Vent, for example, are much more robust. About 50 m north of Shepherd there are several hydrothermally active spires ~3 m tall and supporting abundant life. Hot focused flow, wide spread diffuse flow and abundant gas bubbles characterize the hydrothermalism. Samples of one spire are predominantly zinc sulfide, with well formed crystals (wurtzite?) in places. Small patches of coarse crystalline copper-iron sulfide are also evident. Despite being very prominent and obvious features within the confines of the fissure, these spires were not seen in 1983 dives nor in 1988 dives (V. Tunnicliffe). They must have formed since 1988.

A quick look was taken at the Lamphere Chimneys about 20 m east of the fissure. The main structure, whose diffuse venting supported abundant life in 1983, is no longer active and is practically devoid of animals.

Is the recent volcanic activity in the caldera reflected in the sulfide deposits? It is tempting to contemplate that the renewed high temperature hydrothermalism at Castle

may be a consequence of the nearby volcanism. There is no obvious effect on the deposits at ASHES (although there may be in the vent fluids themselves, see report by Butterfield). The new (since 1988) CASM chimneys are too large to have been formed since the January-February eruptions.

With three sulfide sites now known (and there may be more) in widely separated places within the caldera, there is now the opportunity to study mineralization processes through time in somewhat different settings and to study the interaction of mineralization and biology at different stages of population development. Also, if the petrological studies (see report by J. Chadwick) demonstrate that there are differences in basalt chemistry at the different sites, the opportunity exists to examine the relation, if any, between the composition of sulfides and their host rocks.

7.0 NON-ROPOS OPERATIONS

7.1 CTD Operations (Jim Gendron)

7.1.1 NeMO'98 CTD Casts

During leg IIb of the NeMO98 Vents cruise a total of 11 vertical casts and 2 tows were completed. Samples that were collected included 55 filters for XRF analysis and 53 salinity samples. Other samples that were collected included He, methane, hydrogen, H2S, O2 and bacteria samples. Samples for particulate organic carbon were also taken.

In general, most of the results of the sampling will not be known until the samples are analyzed on shore. The distribution of the particle plumes that were seen by the nephelometer seemed to follow the same patterns as were found on leg 1. Large concentrations of particles were present over the new vent area southeast of the caldera, at ASHES vent field and south of ASHES. The CASM site showed similar plumes and it is possible that a buoyant plume was detected there on the downcast.

7.1.2 NeMO'98 CTD Cast Locations and Stations Table

Vents98C	Brown leg IIb		cast	latitude	longitude
site	SE caldera		cast 1	45 55.2'	129 59'
date		Aug 27			
station	V98c01				
site	MKR 33		cast 2	45 55.99'	129 58.89'
date	Aug 28				
station	V98C02				
site	BKG		cast 3	46 0.00'	129 55.5'
date	Aug 30				
station	V98C03				
site	CASTLE		cast 4	45 55.58'	129 58.78'
date	Aug 31				
station	V98C04				
site	ASHES		cast 5	45 56'	130 0.84'
date	Sep 1				
station	V98C05				
site	E BKG		cast 6	45 46'	129 44'
date	Sep 2				
station	V98C06				
site	S CALDERA		cast 8	45 54.4'	129 59.6'
date	Sep 6				
station	V98C07				
site	S CALDERA		cast 9	45 54.6'	130 00.0'
date	Sep 8				
station	V98C08				
site	ASHES		cast 10	45 56'	130 0.84'
date	Sep 9				
station	V98C09				
site	CASM		cast 11	45 59.35'	130 1.63'
date	Sep 10				
station	V98C10				
site	MRK 33		cast 13	45 56'	129 58.89'
date	Sep 17				
station	V98C11				
site	W WALL		cast 7	45 54.4'	129 59.92'
date	Sep 4				
station	T98C01				
site	W WALL		cast 12	45 59.96'	130 3.2'
date	Sep 12				
station	T98C02				

7.2 Rock Sampling (John Chadwick, University of Florida)

7.2.1 Operations

Core sampling was performed on the NeMO August/September 1998 cruise to acquire basaltic glass samples during intervals between ROPOS dives. Forty-nine coring attempts were made using the sampler borrowed from Dr. Dan Fornari at Woods Hole Oceanographic Institute. In addition, 22 rock and glass samples were acquired on ROPOS dives, both as large specimens and also small glass shards collected inadvertently by the "slurp sampler" used to obtain biological specimens. Glass from these samples will be analyzed for major and trace element compositions at the University of Florida and laboratories at other universities, including microprobe analysis. Specimens from the January, 1998 flow collected by the ROPOS will be sent to the University of Hawaii for Polonium/Lead age testing.

Six core samples were acquired on the north flank and north rift zone of Axial Volcano, one each on the east and west flanks, one in the Vance segment of the Juan de Fuca Ridge (sediment collected only) and the remaining forty core samples were obtained on the southern flank and southern rift zone. Glass quality ranged from very fresh (found largely on the rift zone directly south of Axial) to very degraded. Fe-sediments, palagonite, and pelagic sediments were commonly associated with the more degraded samples. Fresh glass samples have conchoidal fracture and usually have little or no associated sediment. The degree of degradation of the glass and amount of sediment is a first-order assessment of the age of the basalts, and suggests that the ridge directly south of the caldera has witnessed the most recent activity on the volcano, including the 1998 eruption.

The core sampling was performed on a CTD wire, and bathymetry was acquired in real time using the Bathy-2000 unit on the Ronald Brown. The sampler was sent down at 30 meters/minute for the first 50 meters below the surface, then the speed was subsequently increased to 60 m/min. A 30 second stop was performed about 30 m above the bottom to allow the sampler to settle and the wire angle to decrease to vertical. The sampler was then driven into the bottom at 60 m/min, and an additional 15 m of wire was unspooled to allow for errors in the bathymetry. This method led to a 100% success rate in contacting the bottom in a vertical position and acquiring samples. The sampler was then withdrawn

from the bottom at 20 m/min until off the bottom, then the speed was increased to 50 m/min to the surface.

7.2.2 Rock Core Sample List

Core Samples

sample	map loc.	date	lat	lon	map depth (m)	bathy depth (m)	sample	wire angle	location
98-JDFRC-01	21	8/29/98	45d 53.53'	129d 59.82'	1635	1631	glass	~0	South Rift
98-JDFRC-02	34	8/29/98	45d 51.21'	129d 58.55'	1790	1820	glass+seds	~0	SR
98-JDFRC-03	29	8/29/98	45d 49.72'	130d 00.78'	1775	1770	glass	~0	SR
98-JDFRC-04	28	8/29/98	45d 49.95'	130d 00.70'	1780	1823	glass	~0	SR
98-JDFRC-05	27	8/29/98	45d 49.96'	130d 00.32'	1805	1801	glass	~0	SR
98-JDFRC-06	26	8/29/98	45d 50.18'	130d 00.58'	1760	1930	glass	~0	SR
98-JDFRC-07	15	8/31/98	45d 47.20'	130d 03.58'	1840	1838	seds+grungy glass	~0	SR
98-JDFRC-08	14	8/31/98	45d 47.85'	130d 03.56'	1845	1839	seds+grungy glass	~0	SR
98-JDFRC-09	13	8/31/98	45d 48.07'	130d 03.45'	1840	1979	seds+grungy glass	~0	SR
98-JDFRC-10	36	9/1/98	45d 57.69'	129d 57.80'	1530	1532	seds+glass	~0	E. Flank
98-JDFRC-11	24	9/3/98	45d 51.03'	130d 00.37'	1755	1759	glass+boulder!	~0	SR
98-JDFRC-12	25	9/3/98	45d 50.40'	130d 00.53'	1765	1805	glass	~0	SR
98-JDFRC-13	17	9/3/98	45d 50.64'	130d 01.61'	1785	1869	glass+seds	~0	SR
98-JDFRC-14	37	9/5/98	45d 56.45'	130d 01.50'	1415	1425	grungy glass	~0	SW Flank
98-JDFRC-15	1	9/5/98	45d 53.66'	130d 01.91'	1625	1635	glass	~0	SR
98-JDFRC-16	33	9/6/98	45d 47.54'	130d 01.55'	1845	1865	grungy glass	<5	SR
98-JDFRC-17	32	9/6/98	45d 47.90'	130d 01.70'	1845	1916	grungy glass	<5	SR
98-JDFRC-18	31	9/6/98	45d 48.52'	130d 01.16'	1820	1870	grungy glass	<5	SR
98-JDFRC-19	38	9/6/98	45d 41.52'	130d 02.48'	1840	1823	grungy glass	<5	SR
98-JDFRC-20	39	9/7/98	45d 40.30'	130d 03.30'	1975	2001	seds only	~0	SR
98-JDFRC-21	40	9/7/98	45d 38.20'	130d 04.88	2025	2000	grungy glass	~0	SR
98-JDFRC-22	3	9/8/98	45d 52.24'	130d 02.80'	1670	1700	grungy glass	~0	SR
98-JDFRC-23	2	9/8/98	45d 52.82'	130d 02.50'	1655	1730	glass	~0	SR
98-JDFRC-24	6	9/9/98	45d 51.16'	130d 02.28'	1745	1810	grungy glass	<5	SR
98-JDFRC-25	7	9/10/98	45d 50.60'	130d 02.78'	1765	1770	seds only	~0	SR
98-JDFRC-26	9	9/10/98	45d 50.06'	130d 02.91'	1780	1785	glass	<5	SR
98-JDFRC-27	18	9/10/98	45d 50.05'	130d 01.55'	1785	1791	grungy glass	<5	SR
98-JDFRC-28	43	9/10/98	46d 0.45'	130d 01.50'	1555	1584	glass	~0	N. Flank
98-JDFRC-29	42	9/10/98	45d 59.68'	130d 00.45'	1485	1497	grungy glass	~0	N. Flank
98-JDFRC-30	19	9/11/98	45d 49.27'	130d 02.25'	1785	1786	grungy glass	<5	SR
98-JDFRC-31	20	9/11/98	45d 49.00'	130d 01.66'	1825	1820	grungy glass	~0	SR
98-JDFRC-32	30	9/11/98	45d 48.80'	130d 00.78'	1830	1942	glass	~0	SR
98-JDFRC-33	16	9/12/98	45d 50.62'	130d 01.89'	1800	1802	grungy glass	~0	SR
98-JDFRC-34	8	9/12/98	45d 50.42'	130d 02.85'	1760	1776	glass	~0	SR
98-JDFRC-35	22	9/14/98	45d 51.67'	130d 00.68'	1740	1754	glass	~0	SR
98-JDFRC-36	35	9/14/98	45d 49.58'	129d 57.83'	1915	1925	glass	~0	SR
98-JDFRC-37	44	9/14/98	45d 47.38'	129d 55.48'	2235	2241	seds only	~0	Vance
98-JDFRC-38	41	9/14/98	45d 45.75'	130d 02.25'	1720	1754	seds+glass	~0	SR
98-JDFRC-39	23	9/15/98	45d 51.65'	130d 00.17'	1730	1746	glass	~0	SR
98-JDFRC-40	4	9/15/98	45d 50.40'	130d 04.20'	1860	1860	seds+grungy glass	~0	SR
98-JDFRC-41	5	9/15/98	45d 53.36'	130d 01.74'	1645	1653	seds+glass	~0	SR
98-JDFRC-42	46	9/16/98	46d 01.36'	129d 59.79'	1585	1586	glass	~0	N. Flank
98-JDFRC-43	10	9/16/98	45d 49.86'	130d 02.85'	1785	1786	glass+seds	~0	SR

98-JDFRC-44	11	9/16/98	45d 49.65'	130d 03.00'	1780	1778	glass+seds	~0	SR
98-JDFRC-45	12	9/16/98	45d 48.32'	130d 03.61'	1835	1830	grungy glass	~0	SR
98-JDFRC-46	47	9/16/98	45d 44.90'	130d 01.85'	1700	1740	glass	~0	N. Rift
98-JDFRC-47	48	9/18/98	46d 02.93'	129d 58.97'	1640	1724	grungy glass	~0	N. Rift
98-JDFRC-48	49	9/18/98	46d 03.96'	129d 58.07'	1675	1768	glass	~0	N. Rift
98-JDFRC-49	50	9/18/98	46d 03.74'	129d 57.78'	1680	1771	glass	~0	N. Rift

ROPOS SAMPLE	**latitude**	**longitude**	**hand sample**	**glass subsample**	**comments**
R460-04	45d 56.63'	129d 59.13'	n	y	
R460-06	45d 56.00'	129d 58.90'	y	y	cloud vent
R461-25	45d 55.62'	129d 58.79'	y	y	
R461-26	45d 55.62'	129d 58.79'	y	y	1998 flow **
R461-16	45d 55.36'	129d 59.30'	y	y	marker 113
R462-08	45d 56.00'	129d 58.94'	n	y	marker 33
R462-15	45d 56.00'	129d 58.91'	y	y	cloud vent
R464-06	45d 56.00'	129d 58.91'	n	y	
R465-01	45d 52.16'	129d 59.17'	y	y	
R465-02	45d 52.17'	129d 59.18'	y	y	drip structure
R467-01	46d 01.13'	130d 00.98'	n	y	north rift
R471-04	45d 56.02'	130d 00.82'	n	y	gollum vent
R471-06	45d 56.02'	130d 00.82'	n	y	white vent
R473-18	45d 56.00'	129d 58.93'	n	y	marker 33
R473-21	45d 55.72'	129d 58.98'	n	y	east axial-mkr 108
R473-06	45d 56.73'	129d 59.09'	n	y	easy vent
R474-03	45d 56.16'	129d 58.89'	n	y	1998 flow**
R474-02	45d 55.98'	129d 58.68'	n	y	
R476-07	45d 56.78'	129d 59.10'	n	y	magnesia vent
R476-02	45d 56.76'	129d 59.08'	y	y	1998 flow **
R478-08	45d 56.15'	129d 58.89'	n	y	nascent vent
R479-15	45d 56.00'	130d 00.84'	n	y	medusa vent-ASHES

7.3 SeaBeam 2100 Survey of Brown Bear Seamount (Susan Merle)

A SeaBeam survey was conducted during weather-down time, September 6, 1998. The goal was to survey Brown Bear Seamount along the edge of previous multibeam data, extending our coverage to the west. Only 22 kilometers of the proposed survey were completed, but data were collected while transiting.

SeaBeam was started up shortly after leaving Axial Caldera area. A 30 km line (east to west) took us to the start point of the proposed survey area. A 22 km line (southwest to northeast) brought us over what we presume was the western edge of the seamount summit. At that point the weather cleared, and we steamed back to Axial caldera, a 38 km line (northwest to southeast).

Grid extents: 130deg 43min W, 129deg49min W, 45deg40min N, 46deg10min N.

90 km of tracklines total, including transit. (22 km of the proposed survey completed)

Depth range from 2800 meters to 500 meters.

Most swath data collected with 4500 meter swath width, at shallowest point swath width was 2700 meters.

Ship speed averaged about 12 knots.

Total survey time, including transit: 4 hours.

8.0 NeMO'98 New Millennium Observatory WEB SITE (Gene Williamson, Susan Merle, Andra Bobbitt)

Our goal was to create a web site that would attract the interest of secondary school students and teachers and would allow interested individuals to follow the progress of the expedition to the Axial Seamount. The ship-based portion of the web site was designed with five major components. The first was a daily science summary that was to outlined the work that was being done. The second was a personal perspective written each day by a different member of the investigation team or ship's personnel. The third was a daily perspective and reaction paper written by the "teacher-at-sea." The fourth was a weekly science summary written by the Chief Scientist. The final component was an interactive question and answer section that would allow inquisitive students to funnel questions through Hatfield Marine Science Center (HMSC), at Newport Oregon, directly to the science staff aboard the ship.

The web site was designed, and all of the entries were coordinated, onshore at HMSC. Text and images were sent from the ship to HMSC to be inserted into the NeMO html maintained by Andra Bobbitt in Newport. On shore there were also two complementary

educational components. A teacher working at HMSC who identified or designed hands-on activities for students coordinated with the work being done aboard the ship. These activities were posted to the web for use by classroom teachers or individual students. The teacher on shore was also responsible for using material from the web site to make daily presentations to the general public at HMSC.

While we do not have a count of the number of hits on the web site, we do have a few indicators of how the site was received. Several e-mails received from relatives of science and ROPOS personnel indicated they were very pleased with the ability to know what was happening and how there family member was involved in the process. Likewise, those on board the ship expressed positive reactions to the information that was being posted. We do not have any indication at this time of success in integrating our material into classrooms. We were disappointed by the lack of questions from students to scientists. This was due in part to the fact that most schools opened after we were already at sea. We will need to reassess this part of the program to see if we can improve the performance in the future.

The website has served as a valuable reference tool postcruise. We have received numerous contacts from publications inquiring about the NeMO mission and requesting images and information. The site will remain on the web until our NeMO 99 cruise.

9.0 NAVIGATION

9.1 Navigation Overview (Julia Getsiv)

All ROPOS dives were navigated using long-baseline transponder nets in the Seascape navigation program. The navigation computer had three main inputs into the Seascape navigation program to aid in ROPOS navigation: P-code GPS input from the R/V Brown SCS system, ROV depth data provided by the ROPOS sensor input and the PS8000 data input for the range meter. Transponder deployment and calibration took approximately 22 hours, beginning on August 27th (GMT time) and nine transponders were deployed (six expendables, two NOAA recoverables and one ROPOS recoverable). Three transponder nets were calibrated on a net by net basis using the Seascape Relcal Acquisition program. Transponder ranges were gathered while the ship drove a diamond-shaped pattern,

allowing us to gather range data across each transponder baseline and within the middle of each net. The data were first crunched in the Seascape program Relcal, which determines the relative positions of the transponders to each other. Next, absolute transponder positions were calculated in Abscal, which applies a rotation about the net center to the relative positions of the transponders, ultimately fitting them into the best 'real' space positions.

Navigation of the cage and the ROV on the seafloor went very well and provided excellent navigation for most of the dives. Once the cage reached its final depth and ROPOS drove to the seafloor, the cage depth was manually entered into the Seascape program and was held constant, unless the wire out for the cage changed during the dive. The range meter was attached to the top of the cage, was hard-wired to the hydro lab and triggered by Seascape on the navigation computer. Cage fixes were excellent for most of the dives with RMS errors of 4 or less. Unfortunately, a software bug was discovered a few dives into the cruise, where ROV fixes were calculated based on the *cage* depth, even though sensor data was providing updated ROV depths. This was brought to our attention when we noticed the transponder ranges were all overshooting at the ROV fix, giving RMS errors in excess of 15 to 20. This also meant that there was a significant offset between 4 transponder fixes and 3 or 2 transponder fixes. Testing the ROV fixes using the cage depth in 2-D further confirmed our conclusion on the software error. We then began navigating trying both 3-D and 2-D navigation and finally settled on using 2-D navigation since 3-D navigation was giving ROV depth values off by as much as a few hundred meters. 2-D navigation provided consistent navigation fixes between 2, 3 and 4 transponder fixes with RMS errors as low as 2 in some areas. 2-D navigation did however require periodically updating the ROV depth as we navigated along the seafloor. Navigation fixes are recorded in latitude/longitude and UTM x/y (in meters) in the log files and were processed by Julia Getsiv in the IDL programs navedit2 and navedit3 (written by Bill Chadwick).

9.2 Final Calibrated Transponder Positions

North Rift Net

Transponder	UTM-X (m)	UTM-Y (m)	Latitude	Longitude	Depth
9.5	420814.65	5098603.9	46° 02.1857'	130° 01.3988'	1433.9
10.5	422722.92	5097596.31	46° 01.6548'	129° 59.9096'	1395.43
8.0	420055.52	5095969.44	46° 00.7580'	130° 01.9608'	1377.93
7.5	422074.85	5094971.24	46° 00.2330'	130° 00.3862'	1294.46

ASHES Net

Transponder	UTM-X (m)	UTM-Y (m)	Latitude	Longitude	Depth
11.5	424283.25	5087181.51	45° 56.0418'	129° 58.6011'	1305.4
10.5	424221.58	5084426.79	45° 54.5540'	129° 58.6227'	1340.36
9.5	422490.35	5086188.55	45° 55.4937'	129° 59.9789'	1324.67
11.0	422556.72	5088014.47	45° 56.4800'	129° 59.9453'	1330.85

South Rift Net

Transponder	UTM-X (m)	UTM-Y (m)	Latitude	Longitude	Depth
10.0/G	424339.74	5080575.33	45 52.476'	129 58.494'	1471.69
10.5/ROPOS	421633.49	5080433.39	45 52.380'	130 00.588'	1401.68
12.5/E	423532.00	5078487.15	45 51.342'	129 59.100'	1492.90

9.3 Vents/Markers/Targets Location Table

Target	Latitude	Longitude	UTM X	UTM Y
ASHES Transponder Net				
ASHES and Southeast Caldera				
98V103	4555.977	129 59.056	423694	5087067
ANCHOR	4555.923	129 58.741	424099.8	5086961.7
BLUEGOO	4556.725	129 58.985	423803.2	5088450.7
CASTLE	4555.568	129 58.794	424022.7	5086305.8

CIRCVENT	4555.555	129 58.899	423887	5086283
CLOUD	4556.001	129 58.894	423903.5	5087108.6
CONTAC10	4556.389	129 59.248	423455.7	5087832.8
CONTAC11	4556.505	129 58.917	423885.6	5088041.9
CONTAC12	4556.525	129 59.230	423482.1	5088085.7
CONTACT1	4555.622	129 58.790	424029.2	5086406.5
CONTACT2	4555.727	129 58.686	424166	5086599
CONTACT3	4556.700	129 59.025	423750.1	5088405
CONTACT4	4556.385	129 58.918	423881.8	5087820.2
CONTACT5	4555.961	129 59.224	423476.3	5087040.6
CONTACT6	4555.944	129 58.793	424033.5	5087002.2
CONTACT7	4556.162	129 58.834	423985.6	5087406.7
CONTACT8	4556.171	129 59.298	423385.3	5087430.2
CONTACT9	4556.322	129 59.314	423368.5	5087711.1
CRACK	4555.998	130 .813	421424	5087135
DAVES	4556.011	130 .826	421408.3	5087158.6
DYING	4555.011	129 59.511	423083.7	5085286.4
EASY	4556.720	129 59.083	423676.5	5088443.2
Fe-HYDE	4555.979	130 .827	421406	5087099.7
FISSURE	4556.698	129 59.082	423677.6	5088403.5
FLAG	4556.372	129 58.920	423879.1	5087796.4
FLATTOP	4555.566	129 58.787	424032.8	5086301.9
GOLLUM	4556.015	130 .815	421422	5087166.1
HAIRDO	4556.010	130 .839	421390.7	5087156.8
HELL	4555.998	130 .854	421372	5087135
HILLOCK	4555.997	130 .842	421387	5087132.7
HILPHNX	4555.995	130 .839	421390.9	5087130.4
INFERNO	4556.013	130 .834	421397.2	5087162.2
LARGETW	4556.359	129 58.915	423885.2	5087772.1
LIVEWRMS	4555.359	129 59.293	423374	5085927
MAGNESIA	4556.774	129 59.096	423660.7	5088544.7
MARSHMALLOW	4556.022	130 .817	421420.4	5087179
MEDUSA	4556.001	130 .836	421394.7	5087141.1
MILKY	4556.707	129 59.080	423679.4	5088419.7
MINISNOW	4556.557	129 59.053	423711	5088141
Mkr-1	4556.022	130 00.820	421416	5087180
Mkr-108 Vent	4555.719	129 58.982	423784	5086589
Mkr-113 Vent	4555.356	129 59.296	423370	5085922
Mkr-2	4555.998	130 00.838	421392	5087136
Mkr-21	4556.016	130 00.815	421422	5087168
Mkr-33	4555.996	129 58.935	423850.3	5087101.1
Mkr-D	4555.995	130 0.836	421399	5087129
Mkr-L	4556.000	130 00.859	421365	5087140
Mkr-N1	4556.388	129 59.045	423718	5087828

Mkr-N2	4556.707	129 59.082	423679.4	5088419.7
Mkr-N3	4556.628	129 59.112	423637	5088278
Mkr-N4	4556.002	129 58.906	423888	5087111
Mkr-N41	4556.173	129 58.883	423922.4	5087428.2
Mkr-N44	4556.368	129 59.090	423658	5087792
Mkr-N5	4555.627	129 51.047	434035	5086301
Mkr-N6	4556.002	129 58.896	423901	5087111
Mkr-N7	4556.358	129 58.914	423886	5087774
Mkr-N8	4555.992	129 58.914	423877	5087088
Mkr-N9	4556.556	129 59.054	423710	5088141
MUSHROOM	4556.016	130 .828	421405.3	5087167.9
NASCENT	4556.146	129 58.891	423911	5087378
NEWMOOR	4555.970	129 58.671	424191.2	5087047.5
OLDWORMS	4556.703	129 58.996	423788.8	5088410.1
OUZO	4556.749	129 59.081	423679.6	5088496.8
OXIDE	4556.727	129 59.105	423647.9	5088456.4
PILLARVENT	4555.362	129 59.125	423591	5085929.1
PIT	4556.385	129 59.045	423718	5087823
PORKCHOP	4555.999	130 0.853	421373	5087136
RAILROAD	4555.936	129 59.022	423737.3	5086990.7
REALROPE	4555.953	129 58.794	424032.4	5087018.6
ROOF	4556.550	129 59.069	423689.8	5088129.1
ROPOS	4555.997	130 .843	421386.1	5087134.1
RUMBLE	4555.814	129 59.038	423713	5086766
SLEDMOOR	4555.985	129 58.685	424173.1	5087075.8
SNAIL	4555.990	129 58.913	423878.6	5087089.7
SNOW	4555.627	129 58.947	423827	5086417
SNOWBLOWER	4556.392	129 59.044	423719	5087835
STEVEMOUND	4555.995	130 .805	421434.8	5087128.6
STRTEX	4556.504	129 59.070	423688	5088043
STYX	4555.997	130 .822	421412.2	5087132.2
SULFIDE	4555.570	129 58.796	424021	5086309
THEPIT	4556.385	129 59.045	423718.2	5087823.2
TOMBSTONE	4555.769	130 0.680	421590	5086597
TUNNICLIFF	4556.020	130 .949	421248.7	5087178
VIRGDAUT	4556.025	130 .804	421436	5087184
VIRGIN	4556.019	130 .809	421430	5087174
VSM1F	4556.188	129 59.001	423770.2	5087457.8
WHITE	4556.024	130 .818	421419	5087182.9

North Rift Zone Transponder Net

91VENT	46 2.316	130 0.745	421661.4	5098834.3
98 E1	46 1.156	130 1.059	421228	5096691
98 E2	46 1.181	130 1.215	421027.9	5096739.8

98 E3	46 1.188	130 1.283	420940	5096755
98 E4	46. 1.211	130 1.462	420710	5096800
BOB	46 2.335	130 0.770	421629.2	5098870.2
CLAMBED	46 2.331	130 0.801	421581.7	5098862.6
CLAMMAX	46 2.336	130 0.783	421612.9	5098871.7
RIFT1	46 1.177	130 1.228	421010.5	5096833.2
SHEPHERD	4559.394	130 1.601	420486.4	5093373.6
SOCASM	4559.322	130 1.575	420518.6	5093304.6

South Rift Zone Transponder Net

ANOM	4552.151	129 59.131	423509.6	5079985.2
CTD1	4555.205	129 59.030	423710.6	5085638.9
S CONTACT2	4552.142	130 0.464	421785.7	5079989.9
TOPLAVA	4552.188	129 59.298	423294.4	5080055.9

9.4 NeMO Observatory Instruments in Place September '98

-129.9842 45.9329 98V103 Mooring

-129.9830 45.9420 97T41 Mooring

-129.9870 45.9250 97T42 Mooring

-129.9821 45.9332 Temperature Probe

-129.9818 45.9334 Temperature Probe

-129.9882 45.9227 Temperature Probe

-129.9815 45.9360 Temperature Probe

-130.0136 45.9333 Temperature Probe

-130.0136 45.9336 Temperature Probe

-130.0135 45.9337 Temperature Probe

-130.0140 45.9336 Temperature Probe

-130.0263 45.9887 Temperature Probe

-129.9847 45.9451 Osmosampler

-129.9822 45.9332 Osmosampler

-129.9822 45.9332 Time Lapse Camera

-129.9834 45.9365 Rumbleometer Deployed 98

-130.0000 45.9567 Rumbleometer Recovered 98

-129.9840 45.9302 Rumbleometer Stuck in 98 Lava Flow

-129.9550 45.8850 OBS6

-130.2283 45.9067 OBS7

-130.1250 45.8500 OBS8

-129.9167 45.9333 OBS9

-129.8150 45.8950 OBS10

-130.0333 45.9467 OBS11

-130.1283 45.9517 OBS12

-130.0167 46.0167 OBS13

-130.0283 45.9833 OBS14

-129.9767 45.9767 OBS15

-129.9850 46.0750 OBS16

-129.9167 46.0300 OBS17

-130.0617 46.0500 OBS18

-130.9133 46.1200 OBS19

-130.1850 46.0667 OBS20

-129.8200 46.0267 OBS21

-130.0383 45.8917 OBS22

-129.9967 45.8183 OBS23

-130.0133 46.1283 OBS24

-129.9807 45.9452 OBH1

-129.9758 45.9400 OBH2

-129.9817 45.9408 OBH3

-129.9708 45.9417 OBH4

-129.9825 45.9363 OBH5

10.0 NeMO'98 OPERATIONS - ROPOS DIVES R460 - R480

10.1 ROPOS Dive Locations and Dates

Dive #	Date	Location
R460	JD 240-241	SE Caldera SRZ:
	Aug 28-29	Mkrs N3, 33; Milky, The Pit, Cloud Vents
R461	JD 241-243	SE Caldera SRZ:
	Aug 29-31	Rumbleometer; Mkrs 108,33,113; Cloud, Sulfide, Castle, Circular Vents
R462	JD 243 - 244	SE Caldera SRZ:
	Aug 31 - Sept 1	Mkr-33, Cloud Vent
R463	JD 244 - 245	SE Caldera SRZ:
	Sept 1 - 2	Easy, Milky Vents; (+ Imagenex survey)

R464	JD 245	SE Caldera SRZ:
	Sept 2	Oxide, MiniSnow, The Pit, Snail, Mkr-108, Mkr-113, Castle Vents
R465	JD 246	South Rift Zone:
	Sept 3	reconnaissance survey
R466	JD 247	ASHES:
	Sept 4	Hell, ROPOS, Hillock/Phoenix, Hairdo and Inferno Vents
R467	JD 248 - 249	North Rift Zone:
	Sept 5 - 6	Extensometers; Bob Vent: (+Imagenex survey)
R468	JD 250	ASHES:
	Sept 7	Gollum, Hell, ROPOS, Hillock/Phoenix, Crack Vents
R469	JD 250 - 251	ASHES:
	Sept 7 - 8	Medusa, Mushroom, Marshmallow, Gollum, Daves Styx and Fe-Hyde Vents; (+Imagenex survey)
R470	JD 251	North Rift Zone:
	Sept 8	Extensometers
R471	JD 252	ASHES:
	Sept 9	Gollum, Mushroom, White, Inferno, Hell Vents
R472	JD 252	ASHES:
	Sept 9	Steve Mound, Hell, Phoenix, Medusa, Inferno Vents
R473	JD 253 - 254	SE Caldera SRZ:
	Sept 10 - 11	Easy, Milky, Roof, The Pit, Snowblower, Mkr-33, Mkr-108, Cloud, Castle Vents; (+Imagenex survey)
R474	JD 255	SE Caldera SRZ:
	Sept 12	The Pit, Milky Vents; Rumbleometer; Lava Flow Mapping Traverses
R475		Dive aborted
R476	JD 256 - 257	SE Caldera SRZ:
	Sept 13 - 14	Magnesia, Easy, Old Worms, Milky Vents;
		Lava flow traverses; (+ Imagenex survey)
R477	JD 258	SE Caldera SRZ:
	Sept 15	Rumbleometer; Mkr-33 Vent
R478	JD 258	SE Caldera SRZ:
	Sept 15	Mkr-33, Mkr-n4, Cloud, Nascent Vents
R479	JD 259 - 260	Northern traverse along caldera wall:

Sept 16 - 17 ASHES:

Hell, Virgin, Mushroom, Medusa, Inferno Vents; (+Imagenex survey)

R480 JD 261 - 262 North Rift Zone and Northern Caldera Wall:

Sept 18 - 19 Extensometers; CASM (Shepherd?) Vent

10.2 NeMO'98 Markers/Experiments Deployed and Recovered

(also includes ALVIN 3245-3247 deployments)

MKRS/EXPERIMENTS	AREA	DEPLOYED (Dive)	RECOVERED (Dive)	COMMENTS
Mkr-N2	Milky Vent	R460		
Mkr-N3	South of Milky Vent	R460		
HOBO (borrowed from U. Washington)	North of The Pit Near Cloud Vent and Mkr-33	Alvin dive 3247 7/18/98	R460	
Mkr-N6	Cloud Vent	R460		
Bacteria Traps #5,6,7,8	Mkr-33 Vent	R461	R462 Retrieved #7,8 R477 Retrieved #5,6	
MTR 4130	Mkr-33 Vent	R461	Moved R478	Relocated at Mkr-33 (R478)
MTR 0942	Cloud Vent	R461		
Mkr-N4	Cloud Vent	R461		
Bacteria Traps #1,2	Cloud Vent	R461	R462	
VEMCO	Mkr-113 Vent	Alvin dive 3245 7/15/98	Moved R461	Relocated to bottom of pillar (from top) during Dive R461
Bacteria Traps #3,4	Mkr-113 Vent	R461	R464 Retrieved #3	Bacteria Trap #4 Not retrieved
Mkr-N5	Castle Vent	R461		
osmosampler	Mkr33	R462	R477	Had HOBO probe
Bacteria Traps #9,10,11,12	Mkr-33	R462	R477 Retrieved #10,11	Bacteria Traps #9,12 Not retrieved
Bacteria Trap #14	Mkr-N4	R462		Bacteria Trap #14 Not retrieved

Bacteria Traps	Milky Vent	R463	R474 Retrieved #16,18	
#16,18	Mkr-N2			
Bacteria Trap	Easy Vent	R463		Bacteria Trap #17
#17				Not retrieved
Mkr-N9	MiniSnow Vent	R464		
Mkr-N1	SnowBlower Vent	R464		
Mkr-N7	east of The Pit Vent	R464		
Mkr-N8	Snail Vent	R464		
Bacteria Traps	Mkr-113 Vent	R464		Bacteria Traps
#19,20,21				#19,20,21
				Not retrieved
Bacteria Traps	Castle Vent	R464		Bacteria Traps
#22,23,24				#22,23,24
				Not retrieved
HOBO	Hell Vent (spire)	R466	R479?	Part of osmosampler package
osmosampler	Hell Vent (spire)	R466	R479	
Bacteria Traps	Hillock/Phoenix Vent	R466		Bacteria Traps
#25,26				#25,26
				Not retrieved
Bacteria Traps	ROPOS Vent	R466		Bacteria Traps
#27,28				#27,28
				Not retrieved
Mkr-D	east of Hillock/Phoenix Vent	R468		
MTR	Gollum Vent	R471		
Bacteria Traps	Gollum Vent	R471		Bacteria Traps
#??? (3 traps)				#??? Not retrieved
Bacteria trap	Mushroom Vent	R471		Bacteria Trap
#? (1 trap)				#? Not retrieved
Mkr-1	White Vent	R471		
Mkr-N41	south of The Pit Vent	R474		
	north of rumbleometer			
MTR 4126	Mkr-N41	R474		
Mkr-N44	west of The Pit Vent	R474		
osmosampler	Mkr-N2 (Milky Vent)	R474		
Bacteria Trap	Mkr-N2	R476		Bacteria Trap #35
#35				Not retrieved
osmosampler	Mkr-33	R477		

(long-term) Time-Lapse Camera	Mkr-33	R478
(long-term) MTR 4108	Nascent Vent	R478
VEMCO 98-1113-214	Shepherd Vent (CASM area)	R480
HOBO 130	T&S Spires (CASM area)	R480
HOBO 137	Inferno Vent (top)	Alvin 3246
VEMCO 98-223	Inferno Vent (base)	Alvin 3246
HOBO 129	diffuse flow area Virgin Mound	Alvin 3246
VEMCO	near Crack Vent	Alvin 3246

10.3 Sample Types (Total and per Dive)

57 SUAVE scans 13 macrobiological samples 47 Suction Samples:

53 HFS samples 12 microbiological samples 19 microbiological

21 gastight bottles (microbial traps) 8 macrobiological

7 niskins 17 hard samples (geo) 9 macro&microbiological

2 misc.fluid samples 11 fluid

R460 R461 R462

4 SUAVE 18 SUAVE 4 micro (bactraps)

2 geo 2 gastights 1 micro (bag creature)

2 fluid 2 macro 1 niskin

3 geo 2 gastights

1 geo

6 suction samples

(3-micro&macro/2-micro/1-fluid)

R463 R464 R465

1 gastight 1 micro (bactrap) 2 geo

1 suction sample (fluid) 2 macro

1 geo

1 niskin

2 gastights

8 suction samples

(2-micro&macro/3-micro/1-fluid)

R466 R467 R468

21 SUAVE 1 geo 7 HFS

2 macro 2 SUAVE 1 SUAVE

2 gastights 1 micro&macro 1 niskin

1 niskin 1 geo

R469 R471 R472

16 HFS 2 macro 1 macro

1 SUAVE 2 gastights 1macro&geo

1 gastight 1 niskin 1 gastight

1 geo 3 suction samples 1 niskin

(2-fluid/1-micro&geo) 1 geo

8 suction samples

(2-micro/2-fluid/4-macro)

R473 R474 R475

18 HFS 2 micro (bactraps) No samples

2 gastights 1 macro

1 niskin 5 suction samples

1 geo (4-micro/1-micro&macro)

8 suction samples

(1-micro&macro)/4-micro/2-macro/1-fluid)

R476 R477 R478

1 geo 4 micro (bactraps) 8 SUAVE

1 geo&micro 2 gastights

5 suction samples 5 suction samples

(3-micro/2-fluid) ` (1-micro/2-macro/1-micro&macro/1-fluid)

R479 R480

11 HFS 2 SUAVE

2 gastights 2 gastights

5 suction samples 2 geo

(1-micro/2-macro/1-micro&macro/1-fluid) 1 macro

10.4 ROPOS SAMPLES DIVES R460 - R480

Dive R460 SE Caldera, SRZ

SAMPLE NUMBER	LOCATION	SAMPLE DESCRIPTION	PRINCIPAL INVESTIGATOR
R460-1	423648/5088456	SUAVE-1 Iron bacterial floc	Massoth
R460-2	423682/5088425	SUAVE-2 Milky Vent at Mkr-N2	Massoth
R460-3	423637/5088274	SUAVE-3 Vent at Mkr-N3	Massoth
R460-4	423615/5088226	Basalt glass	J. Chapman
R460-5	423717/5087830	SUAVE-4 The Pit Vent	Massoth

R460-6	423902/5087111	Basalt	J. Chapman	Scott: Chips with attached bacteria in 3% gluteraldehyde (for G. Ferris)
R460-7		Water from port Biobox	Tsurumi	
R460-8		Water from stbd Biobox	Tsurumi	

Dive R461 SE Caldera, SRZ

R461-1	423860/5087096	SUAVE -1 at Mkr-33 Vent site	Massoth	
R461-2	"	SUAVE-2 at Mkr-33 Vent site	Massoth	
R461-3	"	SUAVE -3 at Mkr-33 Vent site	Massoth	
R461-4	"	Gas tight bottle #2 in venting crack at Mkr-33	Evans	Geunther & Butterfield: compromised water samples Lilley: half of gas ampoules
R461-5	"	Gas tight bottle #5 in venting crack at Mkr-33	Evans	Geunther & Butterfield: compromised water samples Lilley: half of gas ampoules
R461-6	"	SUAVE -4 at GTB location	Massoth	
R461-7	"	SUAVE -5 at mat 30 cm from the bag creature	Massoth	
R461-8	"	SUAVE -6 at bag creature	Massoth	
R461-9	"	SUAVE -7 at little bag creature further from the sub than little bag creature	Massoth	
R461-10	423901/5087111	SUAVE -8 in cloud vent at Mkr-N6	Massoth	
R461-11	423888/5087110	SUAVE-9 10 m west of Mkr-N6, at Mkr-N4	Massoth	
R461-12	423783/5086590	SUAVE-10 at Mkr-108	Massoth	
R461-13	423374/5085927	SUAVE-11 at Mkr-113, Axial Gardens, at top of pillar	Massoth	
R461-14	423374/5085927	SUAVE -12 at Mkr-113, where VEMCO was	Massoth	
R461-15	423374/5085927	Biosample, tube worms at Mkr-113 (where SUAVE #12 was), starboard side of biobox - a bit in port side	Tunnicliffe	
R461-16	423374/5085927	Rock sample at Mkr-113 - fell accidentally into biobox when tube worms sampled (R461-15)	J. Chadwick	Scott: chips of glass with biofilm for G. Ferris/ Kaye
R461-17	423374/5085927	SUAVE-13 at base of Mkr-113 lava pillar, place where Moyer's traps #3 & 4 deployed	Massoth	
R461-18	423382/5085916	SUAVE-14, Mkr-113	Massoth	
R461-19	"	Sample of dying tube worms at Mkr-113, kept in Pacman until surface	Tsurumi	
R461-20	423887/5086283	SUAVE-15 - Circular Vent	Massoth	

R461-21	424026/5086305	SUAVE-16 - at base of Sulfide Vent	Massoth	
R461-22	424030/5086304	SUAVE-17 - in tubeworms at sulphide deposit	Massoth	
R461-23	424048/5086303	SUAVE-18 - in tubeworms at Castle Vent	Massoth	
R461-24	424033/5086409	Older lava sample from "contact" point (#1), in port side of biobox	J. Chadwick	Scott: scrapings and chips of glass with biofilm for G. Ferris
R461-25	no fixes but nearby R461-24	Younger lava sample from "contact" point (#1), in port side of biobox	J. Chadwick	

Dive R462 SE Caldera, SRZ

R462-1	423858/5087102	Suction Sampler, Bottle #1, fluid from Mkr-33	Butterfield	Huber and Kaye
R462-2	"	Suction Sampler, Bottle #7, mat and worms from Mkr-33	Juniper/ Moyer	√
R462-3	"	Suction Sampler, Bottle #6, mat and worms from Mkr-33	Juniper/ Moyer	√
R462-4	"	Suction Sampler, Bottle #5, white mat and polynoids	Juniper	√
R462-5	"	ATTEMPTED Suction Sampler, Bottle #4, white mat and "bag creature"	Juniper	
R462-6	423852/5087098	ATTEMPTED suction sampler, bottle #3, white mat NEAR bag creature	Juniper	
R462-7	"	Bacteria trap #7 from Mkr-33 to port bio box. Trap was deployed for 48 hours.	Moyer	√
R462-8	"	Bacteria trap #8 to Mkr-33 port bio box. Trap was deployed for 48 hours.	Moyer	√
R462-9	423852/5087098	Bag creatures sampled with pac man, most of them floated off and did not end up in the bio box, but some small pieces may still be there.		
R462-10	423897/5087117	Bacteria trap sample #2 from Cloud Vent, Mkr-N4, down in hole with gray smoke. Trap was in vent for 48 hours.	Moyer	√
R462-11	"	Bacteria trap sample #1 from Cloud Vent, Mkr-N4, down in hole with gray smoke. Trap was in vent for 48 hours.	Moyer	√
R462-12	423899/5087110	Niskin bottle at Cloud Vent, Mkr-N6, in area of super high gray smokey flow.	Kaye /Huber Butterfield/ Gendron	
R462-13	"	Gas tight bottle #2 filled with fluid from high flow at Mkr-N6.	Evans	
R462-14	"	Gas tight bottle #7 filled with fluid from high flow at Mkr-N6	Evans	
R462-15	423890/5087111	Basalt sample from Cloud Vent, Mkr-N4	J. Chadwick	

Dive R463 SE Caldera, SRZ

R463-1	423678/5088420	Milk vent, Gas tight sample taken in bottle #6 on stbd arm	Evans

R463-2	423678/5088420	Milk vent, Suction sample of water, into bottle #8	Butterfield/ Kaye/Huber	

Dive R464 SE Caldera, SRZ

R464-1	423628/5088455	Suction sample, small bottle #4, at Oxide Vent??- orange and white material	Moyer/Juniper	√
R464-2	423706/5088143	Suction sample, large bottle #18, at Mini Snow, Mkr-N9 -diffuse flow with white flocs	Butterfield/ Kaye/Huber/ Moyer	√
R464-3	423706/5088143	Suction sample, small bottle #1, at Mini Snow, Mkr-N9 - white bacterial mat	Moyer/Juniper	√
R464-4	423722/5087835	Suction sample, large bottle #12, at Snow Blower Vent near Mkr-N1 - diffuse flow with white flocs	Butterfield/ Kaye/Huber/ Moyer	Gendron √
R464-5	423722/5087835	Suction sample, small bottle #2A, at Snow Blower Vent near Mkr-N1- white flocs	Juniper/Moyer	√
R464-6	423878/5087086	Suction sample, small bottle #0, at Snail- snails and bacterial mat	Juniper	
R464-7	423784/5086592	Suction sample, small bottle #2B, at Mkr-108 - scale worms and bacterial mat, aborted - NO SAMPLE		
R464-8	423373/5085933	Bacteria trap#3 at Mkr-113, in starboard side of biobox	Moyer	√
R464-9	423377/5085935	dead or dying tube worms, Mkr-113 area into port bio box	Tsurumi	
R464-10	424032/5086297	base of Castle Vent spire	Scott	Kaye,/ Moyer √
R464-11	424032/5086297	Niskin sample of seawater adjacent to buoyant plume above Castle Vent spire	McLaughlin-West/Kaye/ Huber/ Butterfield	
R464-12	424032/5086297	2 gas tights, one in fluid from the decapitated base of Castle Vent, (port, GTB #5) one in seawater about 17" away (stbd, GTB#2)	Evans	
R464-13	424032/5086297	Suction sample, large canister #1	Butterfield/ Huber/Kaye	Kaye
R464-14	424041/5086304	Biosample, tube worm grab with claw from Flat Top at Mkr-N5	Tsurumi	

Dive R465 SRZ Reconnaissance Survey

R465-1	4552.16' 12959.17'	basalt, wedge/trapezoid shape, orange stripe inner surface, step in side, port biobox	J.Chadwick/ M. Perfit
R465-2	4552.17' 12959.182'	flow structure, in port biobox, long, bonelike, glass, yellow stuff	J. Chadwick/ Mike Perfit

.**Dive R466** ASHES

R466-1	421373/5087130	Sulfide worms and sulfide from top of spire at Hell Vent.	Juniper	Kaye
R466-2	421367/5087140	SUAVE #1 at top of clump of tube worms 1 m north of Hell Vent.	Massoth/ Tunnicliffe	
R466-3	421367/5087140	Entire clump of tube worms and associated biota at Hell Vent.	Tunnicliffe/ Marcus	Kaye/ Levesque
R466-4	421367/5087140	SUAVE #2 scan of hole left by sampling tube worm bush	Massoth	
R466-5	421393/5087132	SUAVE #3 at Phoenix Vent where glass wool traps were deployed.	Massoth/ Moyer	
R466-6	421386/5087134	SUAVE #4 ROPOS Vent where glass wool traps were deployed.	Massoth/ Moyer	
R466-7	421391/5087156	SUAVE #5 in worms at the top of Hairdo Vent.	Massoth/ Tunnicliffe	
R466-8	421391/5087156	Biosample of a clump of worms at Hairdo Vent.	Tunnicliffe/ Marcus	Kaye/ Levesque
R466-9	421391/5087156	SUAVE #6 at base of Hairdo Vent after the clump of organisms were removed.	Massoth/ Juniper	
R466-10	421389/5087137	SUAVE #7 at the base of Phoenix below the worms. Site #1.	Massoth/ Juniper	
R466-11	421389/5087137	SUAVE #8 at the base of Phoenix on sulfide worms. Site #1.	Massoth/ Juniper	
R466-12	421389/5087137	SUAVE #9 slightly higher up on the same piece of sulfide as above. Site #1.	Massoth/ Juniper	
R466-13	421389/5087137	SUAVE #10 at the base of Phoenix on sulfide worms. Site #1.	Massoth/ Juniper	
R466-14	421388/5087135	SUAVE #11 at base of Phoenix. In area of no fauna. Site #2.	Massoth/ Juniper	
R466-15	421388/5087135	SUAVE #12. On two sulfide worms at base of Phoenix. Site #2.	Massoth/ Juniper	
R466-16	421388/5087135	SUAVE #13 of sulfide worms at base of Phoenix. Site #3.	Massoth/ Juniper	
R466-17	421388/5087135	SUAVE #14. Same.	Massoth/ Juniper	
R466-18	421388/5087135	SUAVE #15. Same.	Massoth/ Juniper	

R466-19	421388/5087135	SUAVE #16. Same. Aborted midway through because of power failure to ROPOS.	Massoth/ Juniper
R466-20	Bad fix	SUAVE #17 at Inferno Vent.	Massoth/ Juniper
R466-21	Bad fix	Gas Tight #6 at Inferno Vent at top of black beehive spire on south side, hdg 350, near VEMCO.	Lupton/ Evans
R466-22	421395/5087162	Gas Tight #7 at Inferno Vent at top of black beehive spire on south side, hdg 350, near VEMCO.	Lupton/ Evans
R466-23	421373/5087136	SUAVE #18 at Hell Vent of sulfide worms.	Massoth/ Juniper
R466-24	421373/5087136	SUAVE #19 at Hell at back of Porkchop near sulfide worms again.	Massoth/ Juniper
R466-25	421373/5087136	SUAVE #20 at Hell at bone of Porkchop near sulfide and palm worms.	Massoth/ Juniper
R466-26	421373/5087136	SUAVE #21 at Hell in group of palm worms.	Massoth/ Juniper
R466-27	421375/5087135	Niskin at Hell in buoyant plume at top of triple chimney, top of chimney at 1542 m.	McLaughlin-West/ Gendron/ Kaye/ Butterfield

Dive R467 NRZ

SAMPLE NUMBER	TIME	LOCATION	SAMPLE DESCRIPTION	PRINCIPAL INVESTIGATOR	SUB-SAMP
R467-1	1629	421330/5096637	Old basalts for dating from elevator drop site.	J.Chadwick/ M. Perfit	
R467-2	0357	421602/5098870	SUAVE-1 at vent with no visible flow. Some bacterial mats, a few scraggly tube worms, some gastropods. First vent we found.	Massoth	
R467-3	0500	421629/5098870	SUAVE #2 at low flow vent with orange and white bacterial mats, tube worms, lots of gastropods, and some polynoids. Considered to be the same as 91 Vent from Sonne cruise, now called "Bob Vent".	Massoth/ Tunnicliffe	
R467-4	0517	421629/5098870	Biosample of mat, tube worms, bacteria at SUAVE #2 site - Bob Vent.	Tunnicliffe/ J. Chadwick/ E Moyer	√

Dive R468 ASHES

R468-1	0252	421417/5087167	HFS-1 at Gollum 2 #10 piston	Butterfield	Kaye
R468-2	0334	421426/5087135	HFS-2 at Crack Vent piston #8 for gas	Butterfield	Evans
R468-3	0342	421426/5087135	SUAVE-1 at Crack Vent	Massoth	
R468-4	0344	421426/5087135	HFS-3 at Crack Vent. Filter #16 only.	Huber	
R468-5	0350	421426/5087135	GTB #7 (stbd side) T = 40C. Crack Vent	Evans	
R468-6	0401	421426/5087135	HFS-4 Bag sample #7. High-T sample. No filter. Crack Vent	Butterfield	Kaye
R468-7	0403	421426/5087135	GTB #6. T = 170C. At Crack Vent.	Evans	
R468-8	0405	421426/5087135	HFS-4 #12 piston sample. Crack Vent.	Butterfield	Kaye
R468-9	0414	421426/5087135	HFS-5 #13 piston sample. Crack Vent.	Butterfield	
R468-10	0436	421397/5087127	HFS-6 Bag #3. Background water sample without filter between Hillock/Phoenix and Hell Vents. T = 2.5C	Kaye/Huber	
R468-11	0444	No fixes	Niskin sample taken ~1 m above active Hell Vent in plume	Gendron	
R468-12	0458	No fixes	Stump and base of active vent at ROPOS	Jonnasson	Scott

Dive R469 ASHES

R469-1	1831	421422/5087178	Fluid Sampler Piston #13, diffuse flow-aborted Worked at later time Marshmallow Vent	Butterfield	Kaye
R469-2	1546	421422/5087178	SUAVE #1 at fluid sampler collection site Marshmallow Vent	Massoth	
R469-3	1836	421422/5087178	Fluid Sampler Piston #12, diffuse flow-aborted Marshmallow Vent	Butterfield	Kaye
R469-4	1849	421422/5087178	Fluid sampler Bag #7, diffuse flow, Marshmallow Vent	Butterfield	Kaye
R469-5	1900	421422/5087178	Fluid sampler #16 Filters only, diffuse flow, Marshmallow Vent	Huber	
R469-6	1546	421422/5087178	Starboard gas tight bottle #5, diffuse flow Marshmallow Vent	Evans	
R469-7	1546	421404/5087167	Fluid sampler #11, Bubbler #2 diffuse flow, W face of Mushroom Vent	Butterfield	Kaye
R469-8	2132	421404/5087167	Fluid Sampler #17, filter set, Bubbler #2 diffuse flow, W face of Mushroom	Huber	
R469-9	2232	421427/5087165	Fluid Sampler Bag #6 (filtered) at Gollum Vent in the worms.	Butterfield	
R469-10	2245	421427/5087165	Fluid Sampler #18 Filter set, Gollum Vent	Huber	
R469-11	2254	421427/5087165	Fluid Sampler #9, Gas piston, T1 = 7 Gollum Vent	Evans	
R469-12	2352	421412/5087132	Fluid sampler bag #2 at Styx Vent	Butterfield	
R469-13	JD251 0000	421412/5087132	Fluid piston sampler #10 at Styx Vent	Butterfield	Kaye
R469-14	0013	421412/5087132	Port side gas tight at Styx Vent	Evans	
R469-15	0033	421409/5087159	Fluid sample bag # 23 at Daves Vent	Butterfield	
R469-16	0048	421409/5087159	Fluid sample bag # 24 at Daves Vent	Butterfield	
R469-17	0051	421409/5087159	Fluid sample bag #3 at Daves Vent	Butterfield	Kaye
R469-18	0115	421394/5087141	Fluid sample bag #4 at Medusa Vent	Butterfield	

R469-19	0132	421394/5087141	Fluid sample bag#5 at Medusa Vent		Butterfield
R469-20	0155	421406/5087100	Iron oxyhydroxide from Fe-Hyde site on the south fringe of ASHES		Juniper/ Scott

Dive R470 No Samples

Dive R471 ASHES

R471-1	0258	421422/5087168	Suction sample of water from Gollum into jar #1	Juniper	Juniper
R471-2	0318	"	Suction sample of water from Gollum into jar #2	Juniper	Juniper
R471-3	0359	"	Tube worm clump from Gollum into port side of biobox	Tsurumi/ Marcus	Juniper/ J.Chadwick
R471-4	0456	421420/5087166	Suction sample of white mat on rock ~1 m from trap deployment into jar #8. Also chips of basalt glass.	Moyer	J. Chadwick/ Tunnicliffe
R471-5	0616	421402/5087168	Gastight sampler # 6 Mushroom Vent	Evans	M. Lilley/ D. Butterfield
R471-6	0616	421416/5087180	Tube worms at mkr I ~1 m west of White Vent	Marcus/ Tsurumi	√
R471-7	0650	421395/5087163	Gastight sampler #7 Inferno Vent	Evans	M.Lilley/ D. Butterfield
R471-8	0733	421376/5087146	Niskin sample on port side about 5 m above Hell Vent	Gendron	D. Butterfield

Dive R472 ASHES

R472-1	1349	421395/5087142	Suction Sample Jar #1; particulate organic matter	Juniper	Juniper
R472-2	1411	421395/5087142	Suction Sample Jar #2; sulfide worms	Juniper	Juniper
R472-3	1424	421397/5087141	Using pacman to grab rock and animal sample Port side of bio box	Tunnicliffe	Juniper/Kaye/ J. Chadwick
R472-4	1451	421395/5087165	Suction Sample Jar #3; sulfide worms at base of Inferno Vent	Juniper	Tunnicliffe/ Juniper
R472-5	1517	421374/5087135	Suction Sampler Jar #4; sulfide worms at southwest base of Hell Vent	Juniper	Juniper/Kaye
R472-6	1606	421374/5087138	Worms and flange from Hell into starboard biobox	Juniper	Tunnicliffe/

					Juniper/
					Moyer/
					Kaye
R472-7	1636	421390/5087134	Suction Sample Jar #5; sulfide worms at Phoenix Vent	Juniper	Tunnicliffe/
					Juniper
R472-8	1652	421382/5087135	Suction Sample Jar #6; background seawater near Phoenix Vent, about 1 m off floor	Kaye/Huber	
R472-9	1707	421373/5087138	Suction Sample Jar #7; diffuse flow from clump of tube worms just north of Hell Vent	Kaye/Huber	Butterfield
R472-10	1732	421373/5087138	Gas tight bottle #5; starboard side at same site for suction	Evans	M. Lilley/
					Butterfield
R472-11	1759	421375/5087130	Pacman grab of iron oxide mound at Steve Mound, near Crack Vent	Scott	
R472-12	1857	421421/508714	Suction Sampler #8; orange yellow mat; oxide mounds just south of Gollum (202 Nytex)	Moyer	Scott
R472-13	1948	421371/5087133	5 liter, right side Niskin bottle meters above Hell Vent	Gendron/	Roe/Guenther
				McLaughlin	

Dive R473 SE Caldera SRZ

R473-1	1805	423679/5088458	Fluid Sample at Easy Vent; Bag #2 with filter	Butterfield	filter lost during dive
R473-2	1815	"/"	Fluid Sample at Easy Vent; Filter #1 Sterivex filter only	Moyer	
R473-3	1841	"/"	Fluid Sample at Easy Vent; Piston #10	Butterfield	McLaughlin/
					Kaye/
					Huber
R473-4	1900	"/"	Fluid Sample at Easy Vent; Filter Set #16 (3 µm and .22 µm Sterivex)	Huber	
R473-5	1912	"/"	Fluid Sample at Easy Vent; Gas Piston #8	Butterfield/	M.Lilley/
				Evans	Butterfield
R473-6	1932	423674/5088454	Suction Sample at Easy Vent; Jar #6 with 64 µm mesh; polynoids and white mat	Tunnicliffe/	Juniper
				Marcus/	
				Juniper	
R473-7	2026	423686/5088421	Suction Sample at Milky Vent; Jar #1 with 20 µm mesh; white bacterial mat	Moyer	
R473-8	2153	423677/5088120	Fluid Sample at Roof Vent; Bag #4 with filter	Butterfield	Guenther
					filter B4 to Gendron
R473-9	2201	"/"	Gas tight bottle #6 at Roof Vent	Evans	M.Lilley/
					Butterfield
R473-10	2203	"/"	Fluid Sample at Roof Vent; Bag #3 without filter	Butterfield/	McLaughlin

					Kaye/Huber	
R473-11	2340	423718,5087823	Suction sample of floc from Snowblower Vent (at the Pit), into bottle #5	Moyer		
R473-12	0001	423718/5087823	Fluid Sample; Snowblower Vent; Bag #5 with filter, ~700ml	Butterfield	McLaughlin/	
					Guenther	
					filter B3 to Gendron	
R473-13	0256	423852/5087097	HFS sample at Mkr 33, piston #11 at	Butterfield	McLaughlin/	
			Mkr-33		Kaye/Huber	
R473-14	0317	"	HFS filter sample set #17 at Mkr-33	Huber		
R473-15	0345?	"	HFS filtered water sample at same place as -14	Butterfield	filter lost	
			bag 24		during dive	
R473-16	0429	423851/5087104	Suction sample of bag creatures and white mat ~1 m NE from -13 to -15; bottle #18	Juniper	Juniper	
R473-17	0448	423854/5087099	White mat from within the Mkr-33 Vent with the suction sampler	Moyer		
R473-18	0513	"	Suction sample of scale worms and polychaetes at Mkr-33 Vent ; bottle #7	Marcus	Juniper	
R473-19	0627	423903/5087108	HFS water sample at Cloud Vent (Mkr-N4)	Butterfield	McLaughlin/	
			bag sample with a filter, number 23		filter B7 to Gendron	
R473-20	0633	423903/5087108	Suction Sample at Cloud Vent, jar 4	Moyer		
R473-21	0755	423786/5086590	Suction Sample at Marker-108 jar 8	Tunnicliffe/	Juniper	
			bio worms	Marcus/		
				Juniper		
R473-22	0840	423786/5086593	HFS samples at Marker-108	Butterfield	McLaughlin/	
			Piston 12 ~12 degrees C		Huber/Kaye	
R473-23	0855	"	HFS bag with filter #6, Mkr-108	Butterfield	filter lost	
R473-24	1038	424022/5086306	HFS sampler, Piston sample #13 at about 260 at Castle Vent	Butterfield	Huber/Kaye	
R473-25	1050	"	HFS sampler, Gas Piston Sample #9 at same site	Butterfield	Evans/Lilley	
					Butterfield	
R473-26	1053	"	HFS sampler, Bag Sample #7, same place	Butterfield	Huber/Kaye/	
					Guenther	
R473-27	1100	"	HFS sampler, Filter #18, same place	Huber		
R473-28	1129	"	Niskin, 1518, about 3 meters above	Gendron	Roe/	
					Guenther	
R473-29	1131	"	Mature sulfide spire, in Pacman claw	Scott	Kaye	
R473-30	0311	423852/5087097	Gas tight bottle sample taken at Mkr-33	Evans		
			(note: sample number not in time order)			

Dive R474 SE Caldera SRZ

R474-1	0823	423703/5087066	Slurp Bottle #5, shit trails, some yellow mat	Juniper	No Sub-sample info.
R474-2	0933	424177/5087075	Slurp Jar #3, background sediment	Juniper	
R474-3	1111	423922/5087428	Slurp jar #7, new baby tube worms and mat near Mkr-N41. Stopped and flushed tube worms out of sample tube into the flushing jar. Returned to jar #7 and sample some mat	Juniper/ Tsurumi	
R474-4	1234	423659/5087792	Slurp jar #4. Slurping 10-12 cm patch of yellow/orange mat. West-southwest (50-60 meters) of Pit. Hdg 075. Deploying Mkr-N44.	Juniper	
R474-5	1320	423837/5088089	Slurping into jar #8. Slurping red material on new lava.	Juniper	
R474-6	1435	423682/5088431	Found Moyer's glass trap #16. Placing it in starboard side of the biobox	Moyer	
R474-7	1515	423679/5088420	Recovered glass trap #18. Placing it in starboard side of the biobox	Moyer	
R474-8	1435-1515	423679/5088420	Polynoid (1) that swam into port side biobox, Mkr-N2	Marcus	

Dive R475 Aborted

Dive R476 SE Caldera SRZ

R476-1	1537	423678/5088411	White bacterial mat; suction sampling in jar # 5; close to Milky Vent	Juniper	
R476-2	1553	423678/5088411	Rock sample from Milky Vent; 7-function arm; in port side of biobox		
R476-3	1628	423785/5088416	Old tube worms with extensive filamentous bacteria growing on the tubes; into starboard side of biobox; at Old Worm, Hdg 111	Tsurumi/ Tunnicliffe	
R476-4	1638	423785/5088416	Low flow water sample at Old Worms; suction sampler (jar # 4); Hdg 108. Slurping at low speed for 6 min.	Butterfield	Huber/Kaye/ McLaughlin/ Guenther
R476-5	1703	423670/5088477	Flat piece of mat-covered basalt, north of Milky/Easy Vents; sampled with 7-function arm into port side of biobox; Hdg 342		
R476-6	1717	423670/5088477	Suction sample of orange mat; in jar # 6; slurped for 13 min; North of Milky/Easy Vents; Hdg 342	Moyer	Juniper
R476-7	1810	423661/5088545	Suction sample of water at Magnesia Vent; slowly pumping into sample jar # 3	Butterfield	Huber/Kaye/

R476-8	1817	423661/5088545	Gas tight sample at Magnesia Vent; bottle #5, port side; Hdg 255	Evans	Guenther/ McLaughlin M. Lilley/ Butterfield	
R476-9	1537 & 1717	423678/5088411 or 423670/5088477	Fauna from flushing bottle from suction sampler	Tunnicliffe		

Dive R477 SE Caldera SRZ

R477-1	0514	423853,5087097	Bacteria trap #10 at Mkr-33	Moyer	no sub-sampling info
R477-2	"	"	Bacteria trap #11 at Mkr-33	Moyer	
R477-3	"	"	Bacteria trap #5 at Mkr-33	Moyer	
R477-4	"	"	Bacteria trap #6 at Mkr-33	Moyer	
R477-5	0544	"	OSMO sampler (short term)	Wheat	

Dive R478 SE Caldera SRZ

R478-1	1627	423856/5087095	SUAVE #1 at Mkr-33 near MTR	Massoth	no sub-sample info
R478-2	1659	423852/5087095	SUAVE #2 at Mkr-33 near osmosampler	Massoth	
R478-3	1710	423852/5087095	Starboard gas tight bottle #6	Evans	
R478-4	1736	423836/5087092	SUAVE #3 southwest of Mkr-33 at crack	Massoth	
R478-5	1813	423901/5087115	SUAVE #4 at edge of Cloud Vent	Massoth	
R478-6	1917	423910/5087380	SUAVE #5 at tube worm clump, Nascent	Massoth	
R478-7	1923	423910/5087380	Gastight bottle #2 (port) tripped at\ Nascent Vent	Evans	
R478-8	1942	423910/5087380	Tube worm grab to starboard side bio box at Nascnt Vent	Tunnicliffe	
R478-9	2009	423913/5087406	SUAVE #6 at Mkr-N41 where tube worms were collected	Massoth	
R478-10	2036	423897/5087455	SUAVE #7 at hole next to old tube worm clump just North of Mkr-N41	Massoth	
R478-11	2052	423897/5087455	Tube worm grab to port bio box	Tunnicliffe	
R478-12	2149	423890/5087771	SUAVE #8 at big tube worm site max T = 16C	Massoth	

R478-13	2209	423890/5087771	Tube worm grab where SUAVE #8 was, in port claw, will stay there for the ride up		Tunnicliffe

Dive R479 Traverse north along caldera wall to ASHES

R479-1	0838	421634/5086592	Suction Sampler jar 18 of iron oxide little chimneys with white bacterial mat	Scott/	
R479-2	0928	421590/5086597	HFS Bag sample #7 with a filter, Tave = ~19 deg C at intake, south of ASHES	Juniper Butterfield	Guenther/ Gendron/ McLaughlin
R479-3	1131	421373/5087132	Piston #10, Tmax =26 deg C, at Porkchop	Butterfield	Kaye/Huber/
			1139 Probe tip drifted out of hot fluid.		Guenther/
			1142 Replaced in hot water new Tmax = 51 deg C.		McLaughlin
R479-4	1150	"/"	Filter #16, Porkchop, same place as above, Tave=30 C, about 1L, 8cycles	Huber	
R479-5	1202	"/"	Sample Bag/Filter combo #6, Porkchop, same location as above, Tave =?C, temp varying greatly	Butterfield	Gendron/ Guenther
R479-6	1305	421368/5087137	Piston #13, Top of Hell, max T 270, 42 on the back probe. Sample fluid smoking out of red chalcopyrite. Sample appears to be cloudy.	Butterfield	Kaye/ Huber/ Guenther/ McLaughlin
R479-7	1315	"/"	Filter #17, Hell , same place as above, Tmax = 270 C, about 400mL, 3 cycles. At 1353, filtered an additional 100mL (one cycle)	Huber	
R479-8	1340	"/"	Sample Bag/Filter combo #23, Hell Vent, another chimney, hdg 085, Tmax = 294 C, T2 58C,	Butterfield	Kaye/ Hubert/ Guenther/ Gendron
R479-9	1340	"/"	Gastight sample, portside GTB #5, Hell, same location at R479-8, Tmax = 293 deg C, same location at R479-8	Evans	M.Lilley/ Butterfield
R479-10	1439	421393/5087163	Piston #11, Inferno, Hdg 246, near top, facing SW Tmax = 291 deg, 22 on the back probe (T2).	Butterfield	Kaye/ Huber/ Guenther/ McLaughlin
R479-11	1542	421432/5087175	Gas tight bottle, starboard side GTB #7 at Virgin; Max T 258 C	Evans	M.Lilley/ Butterfield
R479-12	1542	"/"	Piston #12 at Virgin; Max T 261 C	Butterfield	
R479-13	1613	variable	Filter Set # 18; background seawater in ASHES	Huber	
R479-14	1631	421403/5087167	Bag #4 with filter; at Mushroom; Max T 179C	Butterfield	Gendron/ Guenther/ McLaughlin

R479-15	1707	421394/5087138	Suction Sample Bottle #4 at Medusa; Diffuse flow from rock	Kaye/Huber/ Butterfield	
R479-16	1723	"/"	Suction Sample Bottle #2 of sulfide and palm worms and mat at Medusa; and begin suctioning bottle #7 at Medusa	Juniper	Kaye
R479-17	1808	421375/5087135	Suction Sample Bottles #3 of sulfide worms at Porkchop of Hell	Juniper	Tunnicliffe
R479-18	1908	421267/5087140	Suction Sample Bottle #7 and bottle no # (flushing bottle) of clams near Caldera Wall=FAILED SAMPLE	Tunnicliffe	
R479-19	1943	421257/5087167	Suction Sample Bottle #1 near Caldera Wall; diffuse flow in crevice	Kaye/Huber/ Butterfield	Moyer
R479-20	1328 and 1604	421368/5087137 421432/5087175	Mr. Potatohead. Cooked at Hell Vent first, then cooked some more at Virgin Vent. umm	Tunnicliffe	

Dive R480 NRZ and CASM

R480-1	0603	At CASM: no nav	SUAVE #1 at base of large sulfide chimney in CASM fissure	Massoth	
R480-2	0603	"	Gas tight- port side #2 same place as SUAVE	Evans/ Lupton	M.Lilley/ Butterfield
R480-3	0628	"	Grab of active chimney on top of T & S Spires. Several small pieces.	Scott	Juniper/ Kaye
R480-4	0703	"	Chimney - not active. Huge piece that almost filled the port side of the biobox	Scott	Juniper/ Kaye
R480-5	0729	"	SUAVE of the tube worms at T&S Spires	Massoth	
R480-6	0732	"	Gas Tight #6 on the starboard side	Evans	M.Lilley/ Butterfield
R480-7	0739	"	Tube worms	Tunnicliffe	Scott: rock/ Moyer

10.5 Dive Map Nomenclature

The dive maps depict all Vents and Markers visited, samples collected on each dive, in addition all instruments deployed and recovered are also cited.

V = Vent M = Marker

Nomenclature Example: S/ss12_dfl-4

The first letter could be:

S Sample

D Deploy

R Recover

The letters (possibly followed by a number) following the backslash indicate the sample type:

ss12 indicates that it was suction sample in bottle #12.

The letters following the underscore give more information about the sample:

_dlf indicates that the sample was diffuse flow.

The number following the hyphen designates the dive sample number.

-4 indicates that it was sample number 4 for the dive.

Sample type abbreviations:

ss Suction Sample

su SUAVE

hfs Hot Fluid Sampler

niskin Niskin bottle

gtb Gas Tight Bottle

bactrp Bacteria Trap

More sample information:

mat bacterial mat

dfl diffuse flow

flc bacterial floc

bio biological sample

sf sulfide

rck rock

FeO iron oxide

osmo osmo sampler/analyzer

hobo temperature probe (152 - 419C)

MTR temperature probe (2 - 34C)

VEMCO temperature probe (0 - 50C)

TLC time lapse camera

10.6 ROPOS DIVE LOGS, Dives R460 - R480

Dive R460


Dive Map

Dive Summary:

Dive R460 conducted a reconnaissance along the southeastern side of the caldera at Axial Seamount taking SUAVE scans and samples as appropriate and conducting mapping surveys with the Imagenex sonar and digital still camera. ROPOS passed through a particulate plume on descent and landed near a low temperature vent. Such vents, harboring bacterial mat, scale worms, palm worms and other organisms, occur intermittently along one or more lines of narrow fissures. Low viscosity basalt flows predominate: lava forms include several styles of sheet flows (smoothy, ropey, curtain drape), less abundant lobate and relatively minor pillow flows. Drained lava lakes, some with a partially intact roof and basalt pillars are common. No hydrothermal chimneys or mounds were seen but yellow sediment and popcorn size balls of floc, probably fallout from plumes, are wide-spread.

Three vent sites were worked (Milk Vent, The Pit and Cloud Vent), although SUAVE was disabled at The Pit when the 7 function arm to which the sensor was attached went berserk. The Imagenex survey was run along four N-S lines south of the Mkr-33 and Cloud Vent sites. The digital still camera survey was run in the vicinity of Mkr-33. A mooring and "rumbleometer" (seismometers with current meter) were looked for but not found. Basalt glass, one with bacteria attached, was sampled at two sites.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
Axial Seamount	Date (PDT):	Date (PDT):	Reconnaissance survey of ~5 km along the east side of the caldera in the vicinity of known hydrothermal vents.
	August 27, 1998	August 29, 1998	
Southeast side of caldera			Test of digital still camera with onboard Jazz drive recorder
	Date (UTM):	Date (UTM):	Test of Imagenex scanning sonar mapper
	August 28, 1998	August 29, 1998	
			SUAVE analyses of vents
	Julian Day 240	Julian Day 241	
			Deploy markers

Time off deck: (1) 0334 aborted (2) 0440	Time off bottom: 0639	Look for moorings deployed 1997 Sampling as appropriate
Time on bottom: 0607	Time on deck: 0743	
	Total dive time: 27 hr 03 min	
	Total bottom time: 24 hr 32 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

BioBox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Markers in BioBox. Top to bottom: Port N3, N2, N1, D; Stbd N6, N5, N4, G

SUAVE mounted port side interior; sensor on starboard (7 function) arm

Low temperature Vemcos in BioBox

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grab, photos and samples
UTM	m	m	m		
0334		423631	5088521	ROPOS off deck and into the water. There are 21 observers in the lab.	
0343				ROPOS too heavy -- returning to surface	
0354				ROPOS back on deck to add syntactic foam	
0440		423635	5088504	ROPOS back in the water	
0556				Recording video in plume detected by light attenuation on SUAVE	
0607	1520			Bottom sighted (basalt pillar) through heavy floc	
0620	1517	423620	5088519	ROPOS 10 meters above	
0621	1524			Lobate flow, dense floc	
0624	1524			Basalt pillar in lava lake; lobate lava; appears old	
0625	1524	423628	5088457	Sheet flow, 10% sediment cover	
0628	1524			Sheet flow with floc	Photo-1
0632	1526			Bacteria patches on basalt	
0633		423650	5088449		
0634	1529			Lobate flow, drained depressions, yellow bacteria	
0638	1531	423636	5088449	Sheet flow, Hdg 180	
0639	1532			Sheet flow	Photo-2
0640	1533	423640	5088433	Sheet lava	FG R460-001
					Photo
0645	1529			Yellow iron-rich bacterial sediment covering talus; slight T anomaly; Hdg 181 (missed Photo-4)	FG R460-002
					Photo-5
0648	1530			Ditto; ROPOS not moving	Photo-6
0650	1530	423652	5088408		
0655	1530			Ditto	FG R460-003
				Frame grab 3 is no good	FG R460-004
					FG R460-005
					R460-00006
0659	1530			Ditto	FG R460-007
0700					**SUAVE**
					R460-1

0708	1530			SUAVE tip in yellow fluff. About 2 to 3 µM Fe. Some H2S. T = 2.6C (anomaly of 0.1)	FG
					R460-008
0713		423648	5088456	Ended SUAVE	Photo-7
				(camera counter 15) site where we used the SUAVE	
0717				Started to move. wide angle of lots of mat. moving to the east and then will cross back to the west	FG R460-009
0721	1529	423642	5088419	Moving east. some mat. more floc in the water, more white mat	
0724	1532	423682	5088425	White smoke from a diffuse vent. polynoids = scale worm -- lots of them (tens), lots of white floc coming out of vent, T anomaly of 0.5C	FG R460-010
				Photo (#16 on counter) = some yellow mat, T anomaly of 2.5C	R460-011
					Photo-8
0729	1532	423683	5088425	Hanging out trying to get the SUAVE into the flow. Water coming out of a hole with a diameter of 0.5 m	
0733	1532	423682	5088425	Conducting a SUAVE measurement in the hole that is spewing bacteria. **MILKY VENT**	**SUAVE**
				H2S 175 µM, Mn 10 µM, Fe >100 µM, T anomaly of 5.5C	R460-2
0740	1531	423684	5088425	**Milky Vent**, Scanner done	Photo 9
				Mistake	FGR460-012
0754	1532	423682	5088425	Deploying **Mkr-N2** (marker is a triangle with black letters and #). Deployed at 0758	FG R460-012
				Photo of the marker(#18 on counter).	FG R460-013
					Photo-10
0802				Moving looking around the area, Polynoids (photo #19 on counter), lots of white material around the rocks (a potential source of floc?) polynoid swam by the camera, (0805) colonial ciliate (protozoan)?	Photo-11
0806	1528			Leaving general area heading to the east to resume our transect. ropy sheet flow with some sediment cover	
0808	1528	423691	5088423	Heading to the east (saw a fish), ground	
0811				Heading SW. first real pillow lavas (0813)	
0814	1529	423682	5088373	Heading west, broken slabs, shallow lava lake?, sheet flows, ropy sheet flows	
0818	1529	423634	5088365	Sheet flows with ropy texture, brittle flows with lots of broken chunks	
0822	1529	4235	5088360	Starting to head towards the N Sonne site, ship is moving. we are going to move E with the ROV. ship is moving to the south. ropy lava, whirls of basalt	
0826	1528	423612	5088394	Ropy broken up lava , pillow lavas some of which are hollow. Moving due south. lava flow with a cave below.	
0833	1528	423658	5088336	heading east to begin east -west hunt for North Sonne. sheet flows, rattail and crab. Photo is #20 on counter.	Photo-12
0835	1528	423679	5088348	heading south, ropy sheet flows, linear features	
0840	1527			moving to the west. Photo is #21 on counter, crab, area of hydrothermal sediment (yellow and orange in color)	Photo-13
0844	1527	423666	5088322	Photo is #22 on counter. basaltic spire maybe 1 m high, pillow lavas with yellow material in cracks, bacterial mats around pillows, small vents (0846),	Photo 14
0851	1532	423565	5088303	Heading E, bacterial mats around pillow flows. shimmering water, polynoids (6)	
0902	1528	423637	5088275	Photo -14 (#23 on counter) is hole with water venting out	FG R460-015

				Photo -15 (#24 on counter) is of water coming out of holes in and around pillows.	FG R460-016
				SUAVE #3 Mn/heat = 1.8, T anomaly 1C,	FG R460-017
				Photo -16 (#25 on counter) at diffuse vent site. turned on highlight tape	
					Photo-14
					Photo-15
					Photo-16
0912	1528	423640	5088279	SUAVE in a hole, SUAVE problems, High temperature at 9.5C when we lost communication. Recycled power.	**SUAVE**
					R460-003
					FG R460-018
0915	1528	423638	5088297	Stopped highlight tape	FGR460-019
				SUAVE max at 13.5C, Mn 40 µm, H2S 200 µm, Fe 40 m, ave temp of 11.5C, polynoid	FG R460-020
					(at 0919)
0920	1528	423637	5088274	Ended SUAVE, more polynoids (tens), frame grab of the hole that was SUAVE'd, polynoids are coming out of the hole with large flocs of bacteria,	FGR460-021
					FG R460-022
					Photo 26
0929	1528	423637	5088278	Deploying **Mkr-N3** triangle marker with black letters and numbers	FG R460-023
					FG R460-024
					Photo-27
0932	1528	423637	5088278	Leaving site	FGR460-025
0934				Moving south, drained lava lake, spotty areas of bacterial mat	
0940	1526	423657	5088251		
0948	1525			Ship moving 100 m to the south, ROV moving, bacterial mats (white)	FGR460-026
					(0953)
0955	1525	423608	5088237	Lots of white mat, lots of floc, glassy basalt , polynoid	FGR460-027
					Photo-28
					Photo-29
1004	1529	423615	5088226	Picking up a rock , but only got some small pieces of glass. Not much sample. Put in port biobox. Frame grabs of actual site where sample was collected	**Basalt**
					R460-4
					FGR460-

						028
						FG R460-029
1015	1529	423613	5088231			Photo-31
1016					Good zoom images, furry polynoids cleaning the rock & eating bacteria, two different species of polynoids	FG R460-030
						through
						R460-042
1026					Heading south, more mats	
1028	1527	423621	5088213		Lots of white mat between pillows that are covered with a yellow sediment	
1034	1526	423634	5088192		Lava drain out of the white mats, yellow between rocks, looks like a younger lava that overlies an older one	Photo-32
1037					Pillows, no mat	
1039	1526	423609	5088199		Pillows with yellowish sediment	
1046	1526	423621	5088179		Hdg 140, younger lava flow, pillows, lots of yellow sediment with some white floc., a skylight	Photo-33
						Photo-34
1052	1523	423656	5088153		Hdg 225, pillows	
1101	1525	423616	5088114		Moving ship	
1106	1525	423618	5088115		New ship position, ROPOS Hdg 133	
1109	1522				Traversing SE, murky water, poor visibility, extensive sediment ponding, iron coloration	Photo-35
1111	1523	423651	5088119		Sulphide mats, diffuse flow, white pockets, dense iron cover, Hdg 130, water venting, yellow/whitish mat, bright white spots	
1114	1518				Lava lake, turning south	Photo-36
1117					Hdg 188, sulfide rich area, white pockets, similar to the area that we saw to the north, a lot of mat and black glass material showing through	
1120	1522				Driving along edges of lava shelf , glassy material.	Photo-38
					skipped notes on Photo-37	
1121	1518	423679	5088022		Lots of white mat between pillows	
1123	1518	423697	5088018		South of target, not as dense as before, getting out of lava	
1125	1520	423702	508811			
1128					Lots of yellow material, white mat in lava cracks	
1129	1517	423681	5088003		Hdg 176	
1131					Spotty white mats, yellow material covering rocks	
1132					Lots of yellow material cover	
1135					Turning to head south west, Hdg 220	
1138	1519	423707	5087932		White mat, slight amount, still transiting, starting to see sulfide mat	
1140					Fissure	
1142	1520	423699	5087912		Lots of white floc, change Hdg to 160	
1144					Old age lava, spotty white mat, pillow lava	
1146					Small amount of sulfide venting, now very flat, go back to try to follow venting, rattail fish	
1150					Rattail fish, murky water.	Photo-39

1153	1516	423794	5087819	Basalt pillars (~1.5 - 2 m), lava lake, moving west, Hdg 271	
1154	1518	423723	5087820	Lava lake, pockets of white mat, sulfide rich water coming up, then sulfide rich area, polychaete worms	
1156				Big pit, a lot of venting fluid coming out, one of the more intense areas	Photo-40
1200				Putting arm into diffuse flow get temp	
1201				Begin SUAVE scan #4: on edge of a 1m deep collapse pit reaching down over edge only a little way - seems like extensive flow in area and volume	FG R460-043
					SUAVE
					R460-5
1203		423811	5087824	SUAVE maximum T = 14C	
1203	1520	423717	5087830	SUAVEing **The Pit**	
1215				Starboard (7 function) arm out of control. **Mkr-N1** fell out of claw onto seafloor before it was unfurled.	
1243				Claw control!! Back to cage to try things.	
1313				Finishing claw control - rotate function stuck and SUAVE cable broken; power down to immobilize hydraulics to arm.	
1309	1519	423749	5087833	Resume survey of area, 7 function arm is disabled	
1313				Yellow cover with patchy white material	
1315	1520	423380	5087132	Pit, same as the one scanned?, shimmering water, yellow covering with white mat in cracks, Hdg175	
1319	1519			Hdg 211, very murky lots of bright yellow material, flow	FG R460-044
					Photo-42
1321	1520			Point source emitting milky fluid.	Photo-43
1323	1520	423718	5087794	Hdg 229, still very milky flow, continuing to south	FG R460-045
					Photo-44
1326				Rattail fish, out of flow, Hdg 184	
1329	1520	423717	5087765	Much flatter terrain with yellow cover, Continuing south, coming to edge of structure	
1331	1519	423727	5087747	Looking out to lava lake with lava pillars, spires a couple of meters deep	
1333	1520	423769	5087713	Pillars in lava lake	FG R460-046
					Photo-46
1335	1520			Drips (stalactite) on underside of top of lava tube	
1337	1520	423815	5087738	Hdg 128, turning to come southwest, ropy lavas covered with yellow material, some is collapsed roof lava	FG R460-047
					Photo-47
1342				Laminations on a lava pillar	Photo-48
1345				Ropy lava covered with yellow material and white patches	
1347	1522	423788	5087619	Waiting for nav	
1409	1522	423723	5087543	Hdg 093, looking for floc	
1411					Photo-49
1413	1521	423798	5087563	Macrooregonia crab (female)	FG R460-048

1418				Awaiting nav	
1421	1520	423868	5087561		
1431		423872	5087563		
1433	1518			Collapsed pit, photo counter inoperable	Photo-51
1435				Pillars	Photo-52
1439	1518	423805	5087522	Nav back, Hdg 248	
1443				Moving ship to new watch circle, south to **VSMHELP** ("rumblometer"), seeing old sediment-covered lava tubes	
1458	1518			Rattail fish, skylight to lava tube,	
1459	1516	423863	5087343	Hdg 182 pillow lava	Photo53-misfired
1504	1517			Fish, pillow lava covered with yellow sediment (iron oxide), spots of white	
1507	1520			Patches of white stuff growing in cracks	
1510	1519			More white material mixed in with orange covering on pillow lavas	
1513	1519			Collapsed lava pool	
1516	1519	423944	5087191	Diffuse flow, greenish-orange and white material in cracks and over pillow lavas	
1519	1518	423881	5087181	Diffuse flow and white material in pockets	Photo-54
1520	1518			More white material on pillow lavas	
1521	1516			shimmering lava lake	Photo-55
1521	1517			Fairly cloudy water, extensive white mats	
1523	1519	423857	5087158		
1526	1517			Pillar of basalts	
1527	1518	423856	5087148		
1528	1520			Large collapsed pits, white in pockets, bad visibility, Hdg 183	
1530	1519	423871	5087113		
1530	1522			Lobate flow with white material, flatter area	Photo-56
1533	1514			test photo, counter test	Photo-57
1534	1522			Lobate flow with white and orange material	FG R460-049
1535	1522			Diffuse flow over flat pillow lavas	FG R460-050
					FG R460-051
					Photo-58
1535	1521	423846	5087107		
1535	1521			Diffuse flow venting	Photo-59
1541	1521	423836	5087125		
1544	1522			At **VSMHELP** location but instrument not seen	
1544	1523			White material on pillow lavas	Photo-60
1545	1522	423828	5087106		
1558	1520	423817	5087107		

1552	1523			Pillow lavas covered with orange floculent material	
1553	1521	423818	5087111		
1555	1522			Flat lineated sheet flow surface, floor of collapsed area, looking for rumbleometer	
1556	1522			Lateral-ing left and right (panning)	
1556	1522	423838	5087123		
1559	1521			Lava folded up in coils	
1559	1521	423812	5087158		
1600	1522	423824	5087149		
1600	1519			Pillar sticking up out of floor, out of lineated flow into collapsed area	FG R460-052
1601	1518			Lots of pillars, app. 3 meters in height	FG R460-053
1602	1519			Scale worms? on bacterial mats	
1603	1520			Diffuse venting, scale worms on pillars, thin coating of white material (mats?)	
1604	1519			Intact roof of collapsed area, lobate surface	
1605	1518			Diffuse venting	
1605	1518			Back into collapsed area	
1605	1518	423886	5087151		
1606	1521			Rat tail fish	
1607	1519			Lava bridge	FG R460-055
					FG R460-056
1606	1516	423902	5087155		
1608	1518			Going south, then west	
1609	1521			In floor of collapsed area, large pillars	
1610	1520			Bright red with yellow polychaete swimming (scale worm?)	FG R460-057
1611	1520	423890	5087121		
1611	1521			Pockets of possible bacterial mats (white material) in cracks and on sides of pillars, top of pillar covered with scale worms, some swimming	FG R460-058
					FG R460-059
1613	1517	423876	5087111		
1614	1518			Remnant of roof of lobate flow before collapse	
1615	1522			Heading back into flat sheet flow area	
1617				Turned port lights on high, blew a fuse, no lights	
1618	1512	423841	5087116		
1618	1520			Got lights back	
1619	1521			Lava whirl	
1622	1521			Lost lights again	
1622	1522	423835	5087106		

1622	1522			Got lights back!	
1622	1522			Not as much light as before, moving west, Hdg 273	
1625	1523			Step down into collapsed area about 1 m	
1626	1524			Fiddling with lights and camera image	
1627	1524	423822	5087090		
1628	1523	423821	5087089		
1628	1521			Going back north and west	
1630	1520			Very flat surface, not as much white material, mostly greenish	
1630	1521	423804	5087104		
1631	1522			At same latitude as target, moving west	
1632	1523			Sea cucumber, very flat surface	
1633	1523	423799	5087120		
1634	1522			Lateraling south	
1635	1521	423791	5087113		
1637	1523			Turning east, back towards **Mkr-33** target, in flat part, more white material	
1640	1520			Some diffuse flow/shimmering water, red polychaetes, white material abundant around flow	
1641	1521			Step down about 1 meter into sheet flow	
1644	1521	423882	5087088		
1645	1522	423899	5087082		
1648	1523			Flat area with long straight crack	FG R460-060
1648	1523	423887	5087065		
1652	1521			Cloudy water, still looking for **Mkr-33**	
1654	1522			Swirl feature in lava, bacterial mat heavy	
1657	1521	423898	5087092		
1657	1521			Moving out of flat area into more jumbled up area, more floc, bacterial mats	
1701	1521			Back into flat area, still looking for **Mkr-33**	
1701	1521	423888	5087058		
1702	1521			Thick sediments, pillars, poor visibility	
1704	1516	423861	5087035		
1705	1519			Big lava pillar	FG R460-061
					FG R460-062
					Photo-61
1707	1517			Large collapsed lava pit, having trouble finding **Mkr-33**	
1714	1510	423856	5087044		
1716				Stopping video	
1719	15088	423789	5087009		

1721	15088	423787	5087032			
1727	15088	423715	5087046	Starting the search for mooring **98V103**		
1733				Starting video		
1735	1515	423723	5087037			
1742	1514			Rat tail fish		
1743	1515	423699	5087073			
1750	1515	423683	5087052			
1754	1515			Stopping video, going back to cage, moving ship to the north of mooring target and look again		
1755	1515	423696	5087054			
1801	1485	423770	5087048			
1804	1483			At cage, going to search for **98V103** again		
1811	1490			Hdg 267, still looking, 35 m off bottom		
1819	1490			Looking south, Hdg 180		
1825	1490			Coming up to 1400 meters to look for **98V103**'s glass balls with sonar		
1833	1400			Cage is 508 m north of drop position of mooring		
1838	1399	423668	5087012	Blue		
1852	1412	423665	5087074	Blue		
1941	1417			Using Alvin calibrated positions for western transponders (only 2 down during the Alvin dives)		
1946	1488			27 m above bottom ready to descend		
1958	1516			On bottom. restart video archive		
1956	1522			Heading east toward target (mooring)		
2005	1523			Lateral back and forth (in and out), still moving east toward target (**Mkr-33**)		
2010	1522	423867	5087094	Good fix		
2013	1521			**Mkr-33** in sight, lots of flow from vent		
2018	1520					Photo-62
2019	1523	423890	5087075	Looking west, good fix		Photo-63
2020	1523			Back to ROPOS transponder		FG R460-063
2031	1523			Scale worm grazing on bag creature		FG R460-064
						FG R460-065
2033	1523			Betacam and S-VHS highlights recording		
2039	1523			Betacam off & SVHS off		
2058	1523			Hobo temp probe from Alvin dive 3247		Photo-65
						Photo-66
2052	1523	423851	5087102	Good fix		
2103				**Hobo probe** placed in the port side of biobox		
2105						FG R460-066
						Photo-67

2108					All highlights tapes on	
2109					Polynoids on bag creature	FG R460-067
2114					Highlight stopped	FG R460-068
2117					Pull back see colony and vent	FG R460-069
2121					Traveling east to **Sonne** field (for tube worms)	
2123	1522					
2133	1518				Rollin' rollin' rollin'	
2142	1516				Travel west generally with North/South lateral along that path	
2144	1517	423939	5087152		Good fix	
2147	1519				Lava bridge	Photo-68
2158	1516				Under the ship	
2203	1520	423882	5087092		Good fix	
2209	15080				Flying high in search of tubeworms	
2220	1525	423906	5087109		Several areas of high fluid flow of cloudy gray effluent, white bacterial mat on broken lavas , large broken sheet flow blocks, good fix	Photo-69
						Photo-70
2226					Bacterial filament (?), highlight tapes on	FG R460-070
						Photo-71
2229					Bacterial filaments	FG R460-071
2231					Bacterial filaments	Photo-72
2234					Grey smoke (camels I think)	Photo-73
2237					*Paralvinella dela*, close zoom on worm down in crack in high flow	FG R460-072
2242					Side view of site	Photo-74
2244					Same stuff, different angle	Photo-75
2248					Highlight tapes off, blue chunks	
2258					More *P. dela*	FG R460-073
						FG R460-074
						FG R460-075
						FG R460-076
						FG R460-077
						FG R460-078
2301	1524	423897	5087114		**Cloud Vent** vigorous flow, trying to get a rock sample, lots of debris in water because disturbed by ROV	Photo-76
2317	1526	423900	5087110		Good fix, still trying to get sample	

2323				Got sample in Pacman	
2326					FG R460-079
2330	1526	423902	5087111	Photo of sample site (**Cloud Vent**), a few 'furry' rocks (bacterial cover?) sampled, sample in starboard compartment of biobox	**Basalt** R460-6 Photo-77
2337	1525	423900	5087111		
2345	1525	423901	5087111	**Mkr-N6** deployed at **Cloud Vent**, Hdg 284, facing west, pit just north of marker	
2347				Frame grab of **Mkr-N6** (**Cloud Vent**)	FG R460-080
2353				Heading back to cage	
2357	1494	423874	5087165	Ditto	
0013		423918	5087154	Ship heading to new watch circle to begin Imagenex survey	
JD 241					
0016				Video tape #8 ended, stop taping	
0046				Ship in watch circle	
0051	1486	424033	5087455	Start to record **Imagenex ** (pencil beam sonar)	
0053	1489	424038	5087461		
0055		424054	5087475	Hdg 180, first N-S transect = N7 (900 m long)	
0100	1495	424034	5087357	Going along N7 transect heading pretty much due South	
0104	1496	424033	5087300	Heading south	
0111	1495	424027	5087225	"	
0114	1496	424024	5087162	"	
0120	1496	424026	5087054	"	
0131	1496	424019	5086927	"	
0142	1496	424024	5086860	"	
0151	1495	424025	5086751	"	
0203	1493	424023	5086563	"	
0204	1498			Down 5m	
0208	1497	424023	5086499	End of transect N7	
0212				Positioning for next transect, N6	
0216	1497	423972	5086502	"	
0222		423955	5086497	"	
0224	1497	423968	5086495	Start of second transect N6, going north	
0235	1482	423958	5086645	Moving slightly northeast along N6	
0238				Down 10 m	
0246	1491	423969	5086801	Begin to move up 5m	
0251				Down 5m	

0257	1495	423956	5086946	Heading north along N6
0302	1495	423964	5086971	"
0313	1495	423969	5087103	"
0322	1495	423963	5087178	"
0327	1495	423958	5087247	"
0332	1495	423960	5087302	"
0338	1495	423963	5087373	"
0341	1495	423951	5087407	"
0342	1495			End of line N6. Moving ship west to start of line N5.
0347	1496	423904	5087399	Maneuvering to start of line N5
0348	1495			ROPOS moving south along line N5
0358	1495	423904	5087236	"
0407	1495	423900	5087098	"
				Lots of floc
0412	1495	423905	5087043	"
0415	1495	423907	5087010	"
0420	1495	423839	5086921	"
0423	1495	423900	5086876	"
0427	1495	423905	5086810	"
0431	1495	423905	5086753	"
0436	1495	423900	5086679	"
0440	1495	423908	5086592	"
0444	1495	423899	5086557	"
0448	1495	423900	5086490	Ship moving to line N4
0452	1495	423881	5086479	
0456	1495	423843	5086498	ROPOS start line N4 heading north
0500	1495	423835	5086536	"
0505	1495	423821	5086553	"
0508	1490	423845	5086578	"
				ROPOS dropped 5 m deeper
0510	1500	423831	5086616	Ship went to wrong line (N3). Correcting.
0518	1500	423837	5086714	"
0523	1500	423831	5087241	"
0530	1500	423850	5086849	"
0538	1500	423835	5086937	"
0544	1500	423851	5087029	ROPOS moving NNE to mooring area
0547	1500	423884	5087050	"
0550				End of line N4. End of survey.

0605	1509	423937	5087093	Commence survey with digital camera at 8 to 10 meters above. Running short lines in the vicinity of **Mkr-33**, worm target area and plume site.
0606				ROPOS has been on the bottom for 24 hours
0609	1510	423978	5087114	Moving east
0610				Changing from 10 to 8 meters above.
0614	1517	423896	5087110	"
0615				Turning to east
0620	1510	423942	5087094	Changing from 8 to 10 meters above
0622				END OF DIVE

Dive R461

Dive R461

Dive Map

Dive Summary:

Found rumbleometer, couldn't wedge it out.

Marker 33 uplifted slab of sheet flow streaming warm water

Marker N6, N8, 108

Axial Gardens

Sulfide Vent => Castle Vent

Lots of SUAVE

Cloud vent

Deployed bacterial traps

Biology- tube worms, etc

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
Axial Seamount	Date (PDT): August 30, 1998	Date (PDT):	Systematic E-W bottom reconnaissance traverses in vicinity of vents near 4556'N 12858.8'W

Vent field on east side of caldera	August 29, 1998	Date (UTM): August 31, 1998	Reconnaissance southward from line of vents to known targets: Mrk-108, Sulfide, Mrk 113, and Axial Gardens
	Date (UTM): August 29, 1998	Julian Day 243	SUAVE analyses of vents
	Julian Day 241	Time off bottom: 0340	Deploy Mkrs
	Time off deck: 2255 (UTM)	Time on deck: 0440	Systematic search for moorings deployed 1997
			Sampling as appropriate
	Time at midwater search: 0003, August 30	Total dive time: 29 hrs 45 min	
	Time on bottom: 0303	Total bottom time: 27 hrs 43 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port off center line of sub)

BioBox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper.

First frame is #78

Mkrs in BioBox

SUAVE mounted port side interior; sensor on starboard arm

2 gas tight water sampling bottles -- #2 red tape on termination on starboard, #5 on port

2 MTR (low temperature recorder) in port Biobox (4127 no tape on rope loop & 4130 black tape on rope loop)

Glass wool bacteria traps -- 1-4 in port Biobox and 5-8 in starboard

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Lasers on RGB camera are 10 cm apart

Time	Depth	X-pos	Y-pos	Comments	FGs, photos and samples
UTM	**m**	**m**	**m**		
2255				Start dive, ROPOS in water; ship launch position 4556'N, 12958.9'W	
JD241				Entering plume, around 1300 depth	
2355					
JD242	1490			Sitting at 1490, checking gauges, making sure ROPOS is ok	
0003					
0020	1480			No good fixes yet	
0023	1480			Cage motor off to try to get better fixes	
0024	1480	423860	5086962	ROPOS just south of watch circle, starting to search for mooring **97V103**.	
0030	1480	423790	5087110	"	
0033	1480			", lots of white particulate in water column	
0037	1478	423780	5086968	Searching...	
0040	1480	423843	5086972	"	
0044	1480	423781	5086992	"	
0047	1480	423763	5087076	"	
0055	1480	423757	5086989	"	
0101	1480	423697	5087020	"	
0111	1480	423680	5087042	"	
0124	1479	423606	5087111	Smokey, particulates in water column, looks like a plume waft	
0135	1480	423584	5087006	Searching con't	
0148	1480	423565	5087008	"	
0151				Finished searching (end of tether), didn't find mooring	

0156	1447				Lots of smoke surrounding cage, looks like another plume	
0204					Pinging from the cage located the rumbleometer within 310 m but direction unknown	
0213					Looking for rumbleometer, no fixes on ROPOS yet	
0221	1469				"	
0238					Moving watch circle to the south because ranges are getting better	
0253	1480				Still searching for rumbleometer, trying to get better positions by adjusting cage - lowering cage to 1490	
0303	1521				On bottom, jumbled sheet flow	
JD 242					Search pattern for rumbleometer	
0304					Started archive tapes	
0307	1523	426769	5086795		Searching for rumbleometer	
0326	1522	423719	5086790		"	
0334	1520				Spider crab, big rat tail, basalt columns	
0338	1521	423716	5086771		Rumbleometer sighted. About half of NW side instrument package is buried in sheet flow. SE side is standing on its legs. Appears to have broken through a drained lava area. Basalt columns just in view ~20 m to west. Highlight video 0339-0342	FG R461-001 FG R461-002 Photo-78
0346	1523	423712	5086767		Still looking at rumbleometer	
0347	1522	423713	5086766		"	
0352	1521				Still looking at rumbleometer, highlight tape on.	FG R461-003 FG R461-004
					FGs and photos of rumbleometer.	FG R461-005 FG R461-006 Photo-79
					Highlight video 0353-0357.	Photo-80
0352					Moving to NE to cross easternmost line of venting, continued sheet and lobate lava, lava lakes, lightly sedimented	
0411	1521	423756	5086853		lightly sedimented lobate	
0414	1523				"	Photo-81
0415						Photo-82
0416	1521				older more heavily sedimented lava, lots of "popcorn" (= floc on seafloor)	
0417	1521				lava column	Photo-83
0418	1520				lava spires common, thick floc, small mat	Photo-84
0421	1517	423929	5086883		thick floc	
0423	1518				pillow lava	
0427	1517				Turning N to **Mkr-33**, old looking lobate lava with yellow sediment in interstices, considerable floc and popcorn	Photo-85 Photo-86
0431	1513				Up 5 meters over a lava mound	
0432	1518				Deep hole with floc coming out of it	

0433	1521	423907	5086598	We have come down other side of lava mound, low temperature hydrothermal products	
0435 - 0437				Photos of lava forms, basalt columns, lava lakes, partial roofs	Photo-87
					Photo-88
				Lots of lava lakes in this area	Photo-89
					Photo-90
					Photo-91
					Photo-92
0439	1518	423842	5086981	yellow stain on lava lobes	Photo-93
0440	1519			Continuing lava lakes, lobate lava with thicker yellow sediment (30% cover)	
0442	1517	423786	5087056	Turning east about 100 m south of **Mkr-33**	Photo-94
0444	1521			Small bacteria mat	
0446	1518			White bacteria mats, no shimmering water seen, turning to north towards **Mkr-33**	Photo-95
					Photo-96
0448	1519	423926	5087081	Bacterial mats very abundant, rugged terrain still	Photo-97
0449	1521			Abundant yellow hydrothermal sediment, bacterial mat	Photo-98
0450				"	Photo-99
0552	1524			Sheet flow, ugly lump fish	Photo-100
					Photo-101
0454	1522	423860	5087096	Arrived at **Mkr-33** site = uplifted slab of sheet flow streaming warm water and covered with white mat	
0457	1523			Sitting in one spot. Juniper highlight tape is on. T in fracture 5-13C	Photo-102
					Photo-103
0458				SUAVE #1. Betacam started (0458-0503)	**SUAVE**
					R461-1
0501				changed archive tapes	
0507				Photo of SUAVE probe in venting crack	Photo-104
0511				SUAVE #1 ended, T = 3-15, H2S 470 µmol, Fe 47 µmol,	
				Mn 2 µmol	
0514 -				Scale worms (paralvinellids) grazing on bacteria, palm worms	FG R461-007
0540					FG R461-008
					FG R461-009
				Highlights video 0512-0546	FG R461-010
					FG R461-011
					FG R461-012
					FG R461-013

			FG R416-014
			FG R461-015
			FG R461-016
			FG R461-017
			FG R461-018
			FG R461-019
			Photo-105
			Photo-106
0545		Deployed glass wool bacteria traps #5 and #6 in venting crack	FG R461-020
			Photo-107
0555		SUAVE #2 of bacterial mat at **Mkr-33** site	**SUAVE**
		T = 11C (constant), H2S ~10 µmol,	R461-2
		Fe <5 µmol,	FG R461-021
		Mn below detection (5 µmol)	FG R461-022
			FG R461-023
0607		SUAVE #3 in through hole in bacterial mat right beside SUAVE #2	**SUAVE**
		T = 3.9 C, H2S 15 µmol, Fe & Mn below detection	R461-3
			FG R461-024
			FG R461-025 FG R461-026
0611-0616		Highlights video of **Mkr-33** operations	
0633	1523	Gas tight bottle #2 in venting crack at	**Gas Tight**
		Mkr-33, T = 36-37C	R461-4
		Gas tight bottle #5 near GTB #2 location, T = 20-27 C	R461-5
		SUAVE #4 a few cm south of **Mkr-33**	**SUAVE**
		T = 37C max, H2S 1000 µmol, Fe 40 µmol, Mn 18 µmol	R461-6
0642	1522	Deployed **MTR4130** (black tape on rope) into venting crack at SUAVE #4 location (**Mkr-33**)	
0650		Deployed glass wool bacteria trap #8 (T = 7C) & #7 (T = 7.5C) in venting crack at **Mkr-33**.	
0657			FG R461-027
			Photo-108
0704	1522	Vent at **Mkr-33** with glass wool samplers and MTR4130 moving around to look at bag creature. We are facing the bag creature - the basalt look like a series of ropes going forward from the sub. The sub is facing 127 degrees. The crack with the glass wool samplers and the MTR is about 2 m to the right.	Photo-109 Photo-110
0707		SUAVE #5 at the mat left of the bag creature. Temperature max at 6.6C	**SUAVE**

						R461-7
0713					Temperature went to 17C in the white mat. This mat is 30 cm left of the big bag creature. Sub is heading at 127degrees. H2S 700 µmol , Mn 2 µmol, Fe 5 µmol	
0722					SUAVE #6 in the big section of the bag creature	**SUAVE**
					Temperature of 2.95C. H2S 75 mol, little Mn and Fe.	R461-8
					Worm on bag creature, beta-cam highlights on at 0724 until end of tape.	Photo-111
						FG R461-028
0736					Bag creature with bacterial mat and a worm	Photo-112
						FG R461-029
0738					Photo of bag creature	Photo-113
					FG of bag creature	FG R461-030
0749					SAUVE #7 in little section of a bag creature just cm further away from the sub (ie. big bag creature is closer to the sub and the little guy is just a little further away)	**SUAVE**
						R461-9
					Temperature 3.05C, H2S 40 µmol. Heading 121	
						FG R461-031
						FG R461-032
0757					Stopped SUAVE and starting to move	
					towards **Cloud Vent**	
0800					Liftoff heading towards cloud vent, sheet flows with long (10 m) crack, heading 90 following cracks	Photo-114
						Photo-115
0802	1520				Pillows; clear and distinct boundary from the sheets to the pillows	Photo-116
						Photo-117
0804					Boulders with lots of flying mat, at the **Cloud Vent**,	Photo-118
					Mkr-N6 is just to the left of the sub at 57 degrees	
0806					Getting organized at **Cloud Vent**, sheets of basalt on scarp face, drained lava lake	Photo-119
0812		423859	5087103		Turning around to get a better seat at the vent, sheets with long grooves	Photo-120
0816					White floc looks like snow	Photo-121
0819		423897	5087111		At **Cloud Vent** but above it and trying to get near the Mkr	
0822	1523	423901	5087116			
0824					At a vent with lots of water	Photo-122
0829					Still looking	Photo-123
0830	1520	423905	5087095		Drained lava lake with steep sided wall	Photo-124
0835	1524				Come in from the south heading north to get to the vent	Photo-125
					Mkr-N6 is forward of us	Photo-126
						Photo-127
						Photo-128
0839					Moved up close to the Mkr. 22C at the height of **Mkr-N6**.Temperatures up to 27C in the pit	

0844				SUAVE # 8 in the **Cloud Vent** about 50 cm from **Mkr-N6**, heading 346. H2S 750 µmol, Fe 62 µmol, Mn 2 µmol	**SUAVE**
					R461-10
0849				Stopped SUAVE; moving to deploy glass wool trap and MTR	
0853				Moving, moved about a meter from the last spot which was **Mkr-N6** (moved NNW 340), bad visibility.	Photo-129
				Lots of mat with some black basalt (?). We are sitting on an edge with lots of water coming out of a hole.	Photo-130
0900				Vent near the **Cloud Vent** but it was cool only 4-5C	Photo-131
					FG R461-033
0904				Moving back into **Cloud Vent**	
0906				Nice wall- lots of broken basalt all covered with a thin film of white mat. some pillows	
0908				Lots of snow and lots of bag creatures on the edge of the rock "cliffs"	
0911	1523	423903	5087100	Back on top of ridge around the **Cloud Vent**, heading 49	Photo-132
					FG R461-034
0920				On the move to do some East-West lines along the bottom with ROPOS. We want to go about 100 m from this site and will look for worms and do some geology	
0923	1522	423888	5087110	Doing Suave #9, Temperature 24C	**SUAVE**
				Fe 55 µmol, H2S 750 µmol, Mn 2 µmol. We are 10 m west of **Mkr-N6**heading 24	R461-11
					Photo-133
					FG R461-035
0936				Deploy **MTR0942** yellow handle MTR without the tape	
0951	1523	423888	5087111	Deployed the MTR	FG R461-036
				Deployed glass wool bacteria trap #1	Photo-134
				Deployed glass wool bacteria trap # 2	FG R461-037
				Deployed **Mkr-N4** (triangle)	Photo-135
				The GWT and MTR are in a little hole The Mkr is located 0.3 m to the left of the hole heading 30	Photo-136
					Photo-137
					Photo-138
					FG R461-038
1010				Moving, looking at the site	Photo-139
					Photo-140
1012	1523			On the move to do some East -West lines along the bottom with ROPOS. We want to go about 100 m from this site and we will be looking for worms and mapping geology	
1016				Ship is moving	
1021	1518			Heading to NW to get to the start of a transect line	
1024				At **Mkr-N4**, heading 311, basalt pillar (drained lava lake), snow	
1026	1522			Sheet flow with some bacterial mat in linear features	Photo-141
1029		423844	5087144	Pillars and drained lava lake	Photo-142

1033		423841	5087148	Sheet flows with floc in the water	
1038	1516	423823	5087193	Sheet flows with some pillows and broken sheet flows	
1039	1519			Starting transect heading 90	Photo-143
				Pillows covered with mat, broken sheets,	
				pillows and sheets, drained lava lake 1042	
1042		423849	5087203	While going east the sub will lateral north south, see some older lava. There is lots of black lava near areas of white mat. No visible venting but lots of white mat	Photo-144
					Photo-145
					Photo-146
					Photo-147
1045				Pillows with lots of white mat around the borders of the pillows. Diffuse flow. Heading 90. Wide spread diffuse venting but not much in the water	Photo-148
1047		423904	5087214	Smoking pit- 3.5 to 4 m deep, lots of bag creatures,	Photo-149
				heading 92	Photo-150
					Photo-151
1049				Starting a lateral move. Another smoking pit. Moving a little south but always facing east. Drained lava lake	
1052	1518			Pillows that are mostly covered with brown sediment	Photo-152
1054	1519	423945	5087186	Pillow flows with sediment cover- really nice pillows. Yellow sediment still heading 90	
1100	1521	423997	5087200	More pillows with yellow cover. Holothurians visible	
1101	1521			More holothurians and brittle stars	Photo-153
1103	1521	424024	5087210	More sediment between lobes	
1106				Heavy lobate flows with ponding sediments	
1107	1519			Water quite turbid, now turning south	
1108	1519			Drain back features	
1109	1521	424055	5087156	Lava pillar seen	
1111	1519			Collapse pits, pillow flows	
1112	1521	424034	5087154	Jumbled sheet flows	
1114	1521			Back in pillow lavas, quite cloudy	
1116	1520			Jumbled sheet flows, water more turbid	
1116	1520			Tether in sight	
1118	1518			Tether still in sight on the sit cam	
1119	1520	423907	5087158	Hdg 278	
1121	1520	423956	5087157	Pillow lavas, rat tail fish, cloudy, hdg 283	
1123	1520	423954	5087164	Hdg 280	
1124	1520			Drain-out of pillow lava, surveying for worm patch	
1126	1519			Considerable sediment cover of pillow lavas	
1128	1519			Last fix was within 20 meters of worm field	
1129	1522			Some floc in water	

1130	1520			Drain back features, lava pillars	Photo-154
1133	1519	423896	5087165	3.2C on SUAVE, bacterial mats	
1134	1520			Bacterial mats	Photo-155
1135	1520			Jumbled sheet flows	
1136	1519			Bacterial mats hdg 272	
1137	1517			Over pit, bacterial mats within view, within 6 m of worms	
1138	1520	423886	5087099	Over pit, hdg 271, laterally S for 60m, sulfide>30 mol	
1143	1520	423864	5087096	Bacterial mats with crevices, SUAVE shutting down, hdg changed to 90 degrees	
1144	1519			Drain back pit, hdg 92, fissures 5 meters across	Photo-156
1146	1520			Lava pillar on sit cam	
1146	1520	423876	5087125	Hdg 87	
1148	1521			Drain back features, on sit cam	Photo-157
1149	1518			Increase in floc, should be near **Cloud Vent**	
1150	1520			Jumbled sheet flow	
1151	1523	423898	5087106	Bacterial mats in cracks	
1153	1521	423911	5087097	Lava pillar on sit cam	
1155	1520	423923	5087090	Directly south of the worm site by 30 m	
1156	1519			Rat tail fish	Photo-158
1158	1520			Pillow lava area	
1158	1519	423945	5087105	Hdg 94	
1200	1519	423952	5087088	Drained out pillow lavas	
1204	1521	423975	5087120	Hdg 95, pillow lavas, rat tail on sit cam	
1207	1520	423990	5087117	Pillow lavas, hdg 90	
1209	1520			Looking back at gauges	
1209	1521	423998	5087105	Same coordinates as N3	
1213	1521			Pillow lavas, lump fish, lava contact	Photo-159
1215	1522	423994	5087089	Close up of lump fish	FG R461-039
1217	1521			Looking at contact between lavas	
1218	1522			Bag creature sighted	
1219	1520			Sitting still and changing heading 283	
1222	1521			Hdg 270, pillow lavas	
1224	1521			Crab seen	
1225	1518	423985	5087045	Passed transition in lava	Photo-160
1226	1518			Lobate flows, looks like contact	Photo-161
1228	1519			Again looking at contact, looks like a	Photo-162
				dribble over older lava	Photo-163
1229	1520			Lobate flows	Photo-164
					Photo-165
1230	1521	423967	5087032	Grabbing rock with pac-man	

1233	1521			Still looking for glassy rock and moving pac-man	
1234	1520			Gave up on sampling attempt, hdg 267	
1235	1519			Going to Mkr-N4, hdg 263	Photo-166
1236	1518	423945	5087044	Miss fired on photo	Photo-167
1237	1518			Drainback feature, bacterial mat	Photo-168
1238	1519			Lava pillar, drainback feature	Photo-169
1240	1522			Coming up on wall	
1241	1520			Drain out features, lava pillars, crab on pillar	Photo-170
1242	1519			Drain out lava pit	Photo-171
1244	1522			Milky water, in bottom of pit, hdg 271	Photo-172
1245	1521			Picture of spire	Photo-173
1246	1519			Picture of spire as ROPOS rose, drain back features	Photo-174
1247	1518			Lava pillars with drainback features, hdg 270	
1249	1519			Lava spires with drainback features, hdg 267	
1251	1519			Drained out lava pit, jumbled sheet flow, hdg 271	
1253	1519			Again looking down into drained out lava pit	
1254	1519			Changing hdg to 212 to SSW	
1256	1515			Rose to move SSW and to get better nav fix, hdg 360	
1258	1506			ROPOS is heading back to cage	
1302	1497			Hdg 276	
1307	1488			Heading back down	
1307	1503			SUAVE started, no nav since 1236	
1309	1518			On bottom again, view of lava pillar, hdg 201, target	
				Mkr-108	
1310	1519			Moving south at half a knot, last view was of a lava pillar with drainback features	
1312	1522			Bottom in view, hdg 186	
1313	1524			Sheet flow with some sediment cover and bacterial mat in cracks	
1317	1523			Jumbled sheet flow, hdg 171	
1320	1522			Broken pillow lavas	
1321	1524			Hdg 192, going to **Mkr-108**, lobate lavas, filled with Fe oxide	Photo-175
					Photo-176
					Photo-177
1324	1521			Bacterial mats, fluffy floc, pillow lavas	
1325	1520			Drained out pillow lavas, yellow hydrothermal sediment	Photo-178
1326	1519			Yellow sediment and white bacterial mat between lobes	Photo-179
1328	1516			Picture of pillow lavas	Photo-180
1330	1516			Pillow lavas with striations	
1330	1512	423940	5086987	Cage fix, attempting to stop ship	

1332	1517	423942	5086976	Cage fix, stalked and sessile organisms, first in awhile, hdg 180	Photo-181
1340	1515	423966	5086888	Hdg 179, cage fix, break in observations because of problems with extending computer field	
1341	1517			Sessile organisms, rat tail fish	Photo-182
1344	1513			Hdg 179, pillow lavas	
1345	1518			Contact of newer and older lavas	Photo-183
					FG R461-40
					Photo-184
1347	1517			Stirred up floc, pillow lavas	
1348	1517			Purple sponge on pillow lava	Photo-185
					Photo-186
1351	1513			Near caldera ridge hdg 176	
1352	1514	423942	5086787	Cage fix, hdg 177, pillow lavas	
1354	1516			Starfish, rat tail, lobate flows	Photo-187
1356	1516			Hdg 189, jumbled sheet flow	
1358	1517			Hdg 180, jumbled sheet flow	
1359	1517			Rat tail in view, jumbled sheet flow	
1401	1517			Jumbled sheet flow, quite broken up, hdg 209	
1405	1518			Touched bottom and stirred up sediment, sheet flow area	
1406	1514			Gauge picture	
1406	1518			Broken sheet flow, hdg 213, last good fix on ROPOS at 1236	
1407	1519			Going over ridge, pillow lavas	
1409	1520			Holothurians in cracks between pillow lavas	Photo-188
1410	1519			Large collapse pit, holothurians have removed some sediment, no temperature anomaly	Photo-189
1411	1519			Collapse pit photo, once again milky water	Photo-190
1412	1520			Yellow hydrothermal sediment in cracks of lobate flows, collapsed pit	Photo-191
1414	1519			Lava spire with drainback feature	Photo-192
					FG R461-041
1415	1525			Drain back features on pillars, lava lake drainout	Photo-193
					Photo-194
1417	1519			Drained out lava lake, hdg 211	Photo-195
1420	1524			Yellow hydrothermal sediment in cracks, sheet flow	
1421	1524			Sheet flow, hdg 213	
1423	1524			Ship stopped, jumbled sheet flow with yellow hydrothermal sediment ponded in depressions	
1425	1521			Lava pillar on sit cam, hdg 234, stirred up sediment	

1426	1514			Off bottom, hdg 232, no view	
1431	1508			Off bottom since 1426, hdg 206, no view	
1433	1488			Particles in water, no bottom view, hdg 212	
1436	1486			Back at cage, no view	
1440	1479	423846	5086597	ROPOS visible in cage cam, cage fix	
1444	1504	423844	5086602	Cage fix	
1445	1521	423824	5086598	Bottom in view, cage fix	
1446	1519			Spire seen in sit cam	Photo-196
1448	1520			Sedimented sheet flow, hdg 243	
1455	1523			Lots of lava spires/pillars, looking for **Mkr-108** on top of pillar	Photo-197
					Photo-198
					FG R461-042
					FG R461-043
1502	1519	423853	5086604		
1503	1521	423841	5086599		
1504	1522			Drained out area of intense floc	
1505	1523	423831	5086578		
1505	1523			Passed through temperature anomaly (0.2C) with iron and manganese anomaly, but small H2S signal	
1506	1517	423821	5086571		
1508	1521	423813	5086564		
1511	1521			More lava pillars, some bacterial mats, high floc, in right area for Mkr	Photo-199
					Photo-200
1511	1521	423803	5086561		
1514	1517			Found **Mkr-108**. 0.2C temperature anomaly	
1514	1519	423777	5086584	**Mkr-108**	
1516	1521			White bacterial mats, scale worms	
1517	1521	423787	5086589		
1518	1521			White bacterial mats, scale worms, some flow	FG R461-044
1521	1520			SUAVE #10 at **Mkr-108**. Max temp of 8.1C, average of 6.0C, drifting a lot due to probe position. H2S 230 µmol, Mn 45 µmol, Fe 25 µmol.	Photo-201
					FG R461-045
					SUAVE
					R461-12
					FG R461-046
1531	1521	423783	5086590		
1534	1521			Flow looks significantly less than July 20	FG R461-047
1545	1520			Looking around **Mkr-108**, lots of white floc, thick bacterial mat in cracks, bag creatures, crack ejecting large amount of white floc. Highlights video 1549-1553.	FG R461-048

1548	1523	423793	5086172		
1552	1514			Going to shake the rumbleometer, hdg 7	
1602	1514	423755	5086636		
1603	1514	423738	5086667	Stopped archive video	
1610	1522			Started archive video. Rat tail fish	
1611	1522	423710	5086739		
1613	1521	423713	5086764	Found rumbleometer, moving ship NW.	Photo-202
				Rumbleometer leg wedged in rock. Hydroclastics on rumbleometer suggest turbulent area.	Photo-203
					Photo-204
					Photo-205
1616	1521			Started highlights video. Trying to wedge rumbleometer free.	Photo-206
					FG R461-049
					Photo-207
					Photo-208
					Photo-209
					FG R461-050
					Photo-210
					Photo-211
					FG R461-051
1620	1522	423715	5086767	Rumbleometer	
1650	1522			Still trying to free rumbleometer. Stopped SUAVE logging.	Photo-212
1713	1521			Rumbleometer not moving. Heading south to **Mkr-113** in Axial Gardens area	
1718	1520			Stopped highlights video	
1719	1522	423711	5086739		
1720	1521	423714	5086732		
1724	1519	423698	5086692		
1731	1516	423626	5086669		
1738	1517	423605	5086445	Rat tail fish	
1742	1515	423584	5086339		
1745	1514	423525	5086218	NOTE: From 1731 - 1737 crossed a couple contacts	
1754	1524	423428	5085950	Approaching **Mkr-113**, Axial Gardens. Want to scan and find tube worms.	
1757	1521	423400	5085918		
1759	1525			Picture of lava pillar with dead tube worms on top of pillar. Highlights on at 1759. No temperature anomaly apparent.	Photo-213
					FG R461-052
1803	1523	423400	5085928		

1807	1524			Group of tube worms, no inside animal visible. Region is visibly devoid of Fe-floc relative to Sonne N.	Photo-214
					FG R461-053
1815	1524	423398	5085926	Exploring tube worms with probe. No thermal or chemical anomaly detected. Moving closer to **Mkr-113**.	Photo-215
1822	1522			Another group of dead looking tube worms on top of lava spire.	
1823	1524	423379	5085920	Large clumps of white bacterial mat in crevices of basalts.	
1824	1521	423373	5085925	At **Mkr-113**. Small temperature anomaly over bacterial mats with flow. 0.5C temperature anomaly. Tube worms right below Mkr with flow.	
1826	1524	423371	5085922	Tube worms down side of pillar in flow. Bag creatures down side as well. Tube, scale worms, paralvinellids in flow. Everything looks alive	Photo-216
					Photo-217
1832	1524	423374	5085927	SUAVE #11 at **Mkr-113** at top of pillar with flow and worms. Mid-water SUAVE holding on with Pacman. Temperature max at 12C. H2S 237 µmol, Mn BDL, Fe 7 µmol	**SUAVE**
					R461-13
					FG R461-054
					Photo-218
					Photo-219
					FG R461-055
					R461-056
1846	1523			Surveying area for deploying bacterial traps. Lots of floc.	
1854				Trying to reposition VEMCO [temp probe] which was dislodged. The probe looks distorted due to weight on the side	
1856				VEMCO redeployed near top of pillar, in worm clump (~20 cm higher on the pillar from where it was)	
1857				Redeployed temp probe	Photo-220
1904				As above	FG R461-057
1911				SUAVE temp probe T 10.5C near tip of VEMCO probe	
1912				Tube worms and temp probe area	FG R461-058
1915				Zoom on SUAVE parked at another spot near VEMCO	FG R461-059
1917				VEMCO slid downhill again	
1919				Suave #12 scanning at tip of VEMCO.	**SUAVE**
				T = 10.5 degC, H2S 237 µmol, Mn BDL, Fe 7 µmol	R461-014
1928				Trying to find a few good worms	
1931				Biobox	FG R461-060 Photo-221
1941				Tube worms being mangled, delivered to starboard bio box (a few in port bio box) Collected close to SUAVE #12	Photo-222
					Biosample
					R461-15
1942				As above	FG R461-061
1945				Looking for dying worms and a place to put bacterial traps	
1951				Re-re deploy VEMCO temperature probe (to the left and down the pillar), observed polynoids and limpets and paralvinellids	
1953				As above	Photo-223

					FG R461-062
1956				VEMCO location photo (tube worms)	Photo-224
1956				As above	Photo-225
					FG R461-063
2001	1525	423385	5085904	Base of pillar near shimmering water for bacteria traps (have to move a rock first)	
2004		423368	5085934	Good fix; rock goes from port to starboard of biobox (this fell in accidentally during tube worm sample #15)	Photo-226
					Basalt
					R461-016
2005				Bacterial trap #4 deployed on shimmering water with tube worm, polynoids, limpets, and gastropods	Photo-227
2007				As above	Photo-228
2010				SUAVE and bacterial traps	FG R461-064
2011				Zooms of above	FG R461-065
					FG R461-066
2012				Highlight tapes on	
2020				Suave #13 at bacterial trap #4. Max T=23.5C, H2S 500 µmol, Fe 9 µmol, Mn BDL.	**SUAVE**
					R461-17
					FG R461-067
					FG R461-068
					FG R461-069
2022				Bacteria trap #3 deployed on top of where SUAVE scanned, right next to trap #4	
2024				Highlight tapes stopped,	
2028				FG of bacterial traps #3 deployment	FG R461-070
2029				Trying to pick up detritus from Biosample R461-15 (biobox - redundant with tube worm sample)	Photo-229
2031				Dead worms with bacterial sediment	
2032	1524	423382	5085916	As above	FG R461-071
2035				Clump of dead tube worms shimmering water SUAVE #14 T=5.8C max	**SUAVE**
					R461-018
					FG R461-072
					FG R461-073
2036				As above	Photo-230 Photo-231
2037				As above	FG R461-074
2039	1523	423382	5085917		
2044				Stopped SUAVE	
2045				Dead tube worms again	Photo-232
2047				As above	FG R461-075

						FG R461-076
2047					Pacman sample, clump of dead tube worms	**Biosample**
						R461-020
2051					Rat tail sighted. Move northeast toward **Sulfide Vent**	
2051					Rat tail fish	FG R461-077
						FG R461-078
2052					Drained lava lake	FG R461-079
2054	1523	433404	5085944		Sheet flow and crab	
2055					Lobate flows	
2100	1522	423423	5085972		Murky water	
2103					Sea fan, sponges	Photo-233
						FG R461-080
2103					Golfball sponges, brittle stars & sea cucumbers	
2103					Deep sea fauna	Photo-234
2105					Starfish, jumbled sheet flow <u>contact lobate</u> flow, <u>new lavas</u> at base of a drainback feature (into older)	
2104		423436	5086000			
2106		423450	5086033			
2110					Pillar	Photo-235
2110					Sea cucumber	
2111					As above	
2112					Sea cucumber and starfish	
2114	1522	423502	5086092		2 cucumbers	
2115					Some bacterial mat, pillow flows, starfish	
2116					Spider crab	
2117					<u>Crossed contact</u> between older and newer lava (into younger)	
2118		423601	5086115			
2120					Yellow sediment	
2121					As above	Photo-236
2122		423678	5086141		Sheet flow	
2122						Photo-237
						FG R461-081
2125					Yellow stained basalt sheets, heading 45	
2126	1522	423725	5086220		Heading 35, linear features in sheet flows, going from left to right with some cracks going in the same direction as we are heading. Increase in white floc.	Photo-238
2129	1522	423747	5086252		Warmer area, holding stations temperature anomaly being picked up by scanner	
2132	1512	423751	5086254		Hanging out getting ready to do scanner, waiting for ship	
2126	1523	423825	5086288		Coming back down to the bottom, bacterial floc, jumbled sheet flows, fish, white bacterial mats in cracks of sheet flows and yellow staining	
2137					Lots of mat around sheet cracks and yellow staining. Lobate flows and drained lava lake	Photo-239

					Photo-240
2139		423906	5086291	Lobate flows with white mat and yellow film	FG R461-082
2140				Lobate in bottom of a pit with white in the cracks and yellow on top	Photo-241
2144	1523	423887	5086283	SUAVE #15, hdg 211, **Circular Vent**	**SUAVE**
					R461-20
					Photo-242
					FG R461-083
2152	1523	423887	5086283	Little white blobs - hundreds of snails covered with bacterial mat, next to few scale worms. Vent surrounded by yellow bacterial mats	FG R461-084
2156				Temp = 7.1C, H2S 87 µmol, Mn 2.5 µmol, Fe 38 µmol. Doing an east west profile. We were on top of a collapse, and we are now going east, hdg 88	
2202	1519	424003	5086304	Collapse feature, some white bacterial mat in cracks of pillow flows. Contact of older flow with younger. Older has sponges.	Photo-243
					Photo-244
					Photo-245
					Photo-246
					FG R461-085
2203		424008	5086300	Pillow flows with snails and sponges, new basalt has bacterial mat whereas the old basalt has snails and sponges.	Photo-247
					Photo-248
					FG R461-086
2206		424008	5086303	Going up over ridge with pillows, some of them hollow. Scarp between the new flow and the older flow is about 3 meters. The contact is not continuous along strike, could be circular	
2209		424025	5086307	Sulfide chimneys, highlights are on	Photo-249
					Photo-250
					FG R461-087
					Photo-251
					Photo-252
2211	1513	424021	5086309	At the top of an old massive sulfide deposit. Target **Sulfide**. This is the largest sulfide feature in Axial. We are at the top and we are 10 m off the bottom. Worms and bacteria on the side of the sulfide.	Photo-253
2212				The sulfide deposits is around pillows.	
				This site was from the Sonne camera tow	
2214				Some low temperature venting next to the sulfide deposit	Photo-254
2214	1520	424025	5086306	Almost a black smoker but is a white smoker	
2219				SUAVE #16 at **Sulfide Vent** at a small vent at the base of a little castle. Temperature varies a lot and has gotten up to 60C. Very small orifice	**SUAVE**
					R461-021
2222	1520	424026	5086305	Probe is up to 71C. SUAVE #16 started, hdg 53 on the SW side of the deposit, highlights are off 2224, maxed out at 90C, H2S >>1500 µmol, Fe 65 µmol, Mn 75 µmol. Looks like phase separated fluids	Photo-255
					FG R461-088
2234	1520	424024	5086306	Using camera to do fine scale scanning of sulfide deposit. FG of the top of the little vent,	FG R461-089

				(shrimp?), smoke is clear, light gray, not black	
2237	1520			Using the camera to check things out	
2240				Backing out hdg 75, going around the sulfide deposits to the left (east), looks like the deposit two years ago	
2243				Looking at the vent top and the smoke (not black), looks like inferno going around the deposit, looking at the tube worms	FG R461-090
				Close up look at tube worm clump. The sub is heading at 307, and the vent is about 2 m in front of the worms	
2248	1520	424030	5086304	SUAVE #17 of the tube worms about 2 m from the chimney that we just looked at. These tube worms are not looking healthy, they are not bright red, more of a light gray pink	**SUAVE**
					R461-22
					FG R461-091
2251	1520			Start beta cam (2254)	FG R461-092
2301	1520			T max 5.3C, H2S ~132 µmol (may be high), hdg 295, sample of sulfide just below tube worm grab, want to come back for it and worms, FG 094 of tube worm clump (sample we want to come back for)	FG R461-093
					FG R461-094
2305				Looking around for clump of tube worms just SUAVE'd, lots of floc, anhydrite chimney to west (hdg 356) of worms - high flow, in the background main sulfide spire	
2308				Tips of old chimneys that are now inactive	
2309	1515	424021	5086307	Thick bacterial mat over sulfides, some sulfide sediment, looking at organ pipes on top of structure in SIT cam	FG R461-095
					FG R461-096
2312				Unknown red tube-like structure on chimney in background - shrimp?, top of structure is 8.5-9 m	Photo-256
					FG R461-097
2315				Pillow lavas, hdg 106, ophuroid	
2316	1518	424021	5086314	Heading east	
2319				Small spire sitting in pillow lavas, hdg 69	Photo-257
					FG R461-098
2320				Pillow mound at base of chimney, great pillow lavas, nice striations on the pillows.	
2322				Hdg 158, on the NW side of chimney, Tube worms, protozoan mats, marker obscuring color camera, fine now	
2326	1517	424047	5086306	Big clump of healthy tube worms, large protozoan and bacterial mats covering tube worms	
2330	1515	424043	5086306	Positioning SUAVE in tube worm clump, limpets covering *Ridgeia* tubes, decide to call "**Sulphide Vent**" "**Castle Vent**" now.	
2335	1514	424043	5086306	Hdg 142 on NW side of chimney, a few tube worms and lots of alvinellids, limpets and other fauna	
2349	1516	424048	5086303	Start to scan, SUAVE #18	**SUAVE**
				Start highlights tape, stopped at 2357	R461-23
					FG R461-099
					Photo 258
2359				SUAVE stopped. T max=20C, H2S ~200 µmol, Mn ~6 µmol, Fe ~19 µmol	
0003		424043	5086304	Mkr-N5 deployed at SUAVE #18 site. Later dives reveal this to be a separate vent, distinct from **Castle**. Called **Mkr-N5**.	
JD 243					
0006				At structure near **Castle Vent** (is **Mkr-N5** site) limpets, alvinellids, tube worms, protozoan mats	Photo-259
					Photo-260

0008				Digital camera turned on, flashes every 15 secs, lots of floc	
				Looking at a new chimney, hdg 180, very near to last site, but we don't know exactly where, lots and lots of biology - tube worms, protozoan mats, alvinellids	
0012				Large spire with sulfide	
0016	1509	424035	5086302	Turning around, hdg 271, trying to figure out location of the sulfide chimney (**Castle**) in relation to the new chimney	
0022				Hdg 100, lots of floc in the water, taking digital pics from top of sulfide chimney	
0023				Directly over sulfide chimney, passed it	
0025				Moving ship to start E-W transects of area just to the south of Sulfide	
0028				Pillow lavas, hdg 10, spider crab	
0030	1520	424035	5086298	A few tube worms on top of pillow lavas, old broken up lavas, heading east from the castle chimney	
0035				Collapsed area, jumbled and ropey sheet flow, some staining at bottom of collapse, striated sheet flow, pelagic sediment, tube worms --look yellow and dying	Photo-261
0036		424098	5086294	Striated sheet flow with some tube worm clumps in cracks	
0038	1527	424113	5086291		
0039				Lots of hexactinellids (glass sponges) and	
				ophuroid (brittle star)	
0041	1529	424156	5086293	Jumbled lavas, some sediment cover	
0044				Crab, more jumbled lavas, asteroid, sea cucumbers	
0046				Heading south, starting a grid pattern to examine area, old jumbled flows at bottom of collapsed area, some ophuroids	
0047	1532	424237	5086258	Still heading south, striated sheet flow, few white globs of floc.	Photo-262
0051		424231	5086202	At end point of south transect, heading west now, hdg 274, brittle stars, sea cucumbers, pop can, sea stars, jumbled lava, ridge with striated sheet flow to left	
0053		424195	5086195	Visibility is decreasing, sediment cover is increasing	
0057	1525	424103	5086212	Spider crab	
0101	1516	442160	5086215	Ship moving, ROPOS moved out of position a bit to the east because tether was caught	
0104				Spider crab, moving west again, hdg 272,	
				striated sheet flow, asteroid,	
0107	1520	424039	5086227	Pillow lavas, start to move a little further south, hdg 225, coming off of the roof, back into collapsed area with pillars, lobate flow, back down into collapsed (contact around here)	
0111				Bacterial cover, increase in orange gelatinous stuff, all between the lobes - probably contact between older lobate lava on roof and new jumbled lavas on the floor that we're seeing now	Photo-263
0113	1524	423870	5086173	Jumbled lavas	
0117	1528	423805	5086166	More jumbled lavas, no deep sea fauna observed, thus the vote is for new lava, lots of orange gelatinous stuff between the cracks in the jumbled	Photo-264
0122	1526	423943	5086056	Turning north, hdg 359, move from jumbled lava to striated sheet flows, lava whirl, lots of orange stuff on lavas (in depressions)	
0124	1524	423717	5086188	Sheet flows	
0126				Rat tail, still heading north	
0130	1518	423697	5086383	Lava pillars,	
0132	1517	423730	5086378	Turning east, hdg 90, water very smokey, low vis, lavas still coated with orange stuff, not pelagic sediment some kind of bacteria?, photo of pressure ridge	Photo-265
0135	1524			3 m from floor of collapse to roof, white bacterial mats on pillars/in crevices, orange stuff still everywhere, increasing bacterial white mats	Photo-266
0137	1523	423827	5086418	New vent! **Snow Vent**, lots of floc coming out of it (two sources?), shimmering water, not as much orange coating right next to vent, lots of polynoids, a couple small tube worms?,	Photo-267

					bag creature	
0144	1524	423828	5086416		Still looking at **Snow Vent**	
0145					Moving east again, coming out of collapsed area up onto the lobate roof	
0146					Roof collapsed again, back into pillars, more bacterial stuff (orange) on pillars	Photo-268
0148					Back on lobate flow roof, sulfide, more orange stuff, jumbled flow with white and orange bacterial stuff	
0150	1524	423985	5086408		Thick orange mat, iron rich mounds, lobate flows,	
0152					Lava drips, contact between old and new lava, starfish	
0153	1520	424039	5086404		Turning back to look at contact more closely	
0155	1521	424038	5086412		Found contact, ophuroid, holothurians, discussing getting samples of the old and new lava	Photo-269
						Photo-270
						Photo-271
						Photo-272
0201					Grabbed a piece of the older lava, put in port side of biobox, beta cam stopped	**Basalt**
						R461-25
0206		424043	5086406		Trying to get piece of new lava in claw, black glassy lava very crumbly so have to try for another piece	
0220	1522	424033	5086409		Got it- trying to put it in port side of biobox	
0233					Rock too big, trying to break it into a smaller piece	
0240					Got a small piece	
0243					Put new lava piece in port side of biobox	**Basalt**
						R461-26
0245					Continue traverse that was interrupted by contact discovery, moving east, hdg 93, jumbled flow	
0248	1504	424063	5086416		Tether adjustments	
0250	1517				Back on bottom, pillow lavas, hdg 90, jumbled flow	
0253	1530	424135	5086413		Lots of pelagic sediment, older lavas, rat tail	
0256					Rat tail, old lava still, hydroids and corals, holothurians	
0258					Collapsed floor, jumbled sheet flows, spider crab	
0259	1527	424275	5086408		Hdg 1, north - starting a new traverse, jumbled sheet flows	
0304	1530	424212	5086468		Hdg 2, push-up blocks, light sed draping, accumulations are in interstices; small sponges	
0308	1530	424214	5086488		Jumbled flow, holothurians, branching hydroids, hydrozoans? corals?	Photo-273
0312	1530				Push-up jumbled flow with a transition to a whorly sheet flow, ophuroids and holothurians	
0314	1531	424211	5086527		Jumbled flow, lots of deep sea fauna, uplifted sheet flow, striated sheet flow, asteroids	
0320					Lineated sheet flow with sediments in depressions	
0323					Flat striated sheet flows with heavier sediment cover, crab on ropey sheet flow, asteroids, holothurians,	
0326	1530	424170	5086602		New lava! Another contact point (**CONTACT 2**) probably '98 lava, striations on new pillow lavas, highlights tape on, some ophuroids, vis decreasing	Photo-274
						Photo-275
						Photo-276

FG R461- 101

Photo-277

0331	Dive terminated, low oil pressure in cage reservoir
0440	ROPOS on deck

Dive R462

Dive Map

Dive Summary:

Dive 462 started at Mkr-33 Vent. The Osmosampler was deployed at Mkr-33. Suction samples of diffuse flow, bacterial mat, bag creatures and polynoids were sampled. Bacteria traps were deployed and others recovered at Mkr-33. The digital still camera was also utilized. After a few hours at Mkr-33 Vent ROPOS headed for Mkr-N4 at Cloud Vent where bacteria traps were deployed and other traps were recovered. Niskins and Gas Tight Bottles were also collected. ROPOS continued on traversing the area of the old SONNE wormfield. No live worms were seen. An orangish/whitish mat covered the lobate lava. When the mat was brushed off the lava the basalt underneath it appeared very shiny and young.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT):	Date (PDT):	Mkr-33 Vent for deploying osmosampler, bacterial traps, and collecting animals, bacterial mat, traps, and water
	August 31, 1998	August 31, 1998	
Vent field on east side of caldera			Cloud Vent for deploying bacterial traps and collecting animals, bacterial mat, traps, and water.
	Date (UTM):	Date (UTM):	
	August 31,	Sept 1, 1998	

1998

Julian Day
244

Julian Day
243

Time off bottom:

Time off deck:

0021

1630

Time on deck:

Time on bottom:

0131

1750

Total dive time:

9 hrs 01 min

Total bottom time:

6 hrs 31 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port off center line of sub)

BioBox mounted lower center work area, starboard side divided in half

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper.

First frame is #1

Suction sampler with 8 large bottles. #1 and #8 have 200 µm on intake, all others have 200 µm on outflow

Osmosampler in BioBox and standard jaw

5 L Niskin bottle mounted upper forward on starboard bumper bar

2 gas tight water sampling bottles-- #2 port, #7 starboard

Glass wool bacteria traps in BioBox-- #9-12 in port and #14, 15 in starboard

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Lasers on RGB camera are 10 cm apart

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**FGs and samples**
UTM	**m**	**m**	**m**		
1630				ROPOS entered water at **Mkr-33**.	
1705	727			ROPOS left cage for remainder of descent	
1741	1394			Entering plume fluids	
1746	1472			In plume	
1748	1490			Cage stopped	
1750	1522			ROPOS on the bottom	
1751	1519			Wall covered with orange bacterial mat, hdg west to **Mkr-33**. Linear features with white bacterial mat, sheet flows with mat in cracks. Found **Mkr-33**.	
1753	1522	423858	5087102	Want to deploy osmosampler and analyzer in front of **Mkr-33** near large crack.	
1755	1523			Deployed osmosampler unit next to crack, trying to remove nozzle from biobox and put in crack next to marker	FG R462-001 FG R462-002 FG R462-003 FG R462-004 Photo-1
1808	1523			Still trying to get nozzle in crack	FG R462-005 FG R462-006
1814	1524			Got nozzle in crack	Photo-2

			FG R462-007
			FG R462-008
1817	1523	**Mkr-33** with osmosampler	Photo-3
1818	1524	Suction sampler, Bottle #1, to collect fluid. Placing nozzle right into crack. Bacterial traps already have growth on lines.	**Suction Sample**
			R462-1
			FG R462-009
1824	1524	Filling Bottle #1 with diffuse fluid at slow speed, flushed for about 5-10 minutes.	
1832	1523	Flushing between sample bottles	
1834	1524	Suction sampler, Bottle #7, to collect bacterial mat and worms on the sides of the crack. Sucking at medium speed in order not to homogenize mat. Suck and stop, suck and stop, got lots of polynoids	**Suction Sample**
			R462-2
			FG R462-010
			FG R462-011
			FG R462-012
1906		Scale worms	FG R462-013
1912		Suction sampler slurping	FG R462-014
1916		Photo of slurp	Photo-4
1930		Finished with slurp #7	
1933		Start slurp gun #6, same sample goal as #7	**Suction Sample**
			R462-3
			FG R462-015
1939		Slurping as above	FG R462-016
1946		Slurping as above	FG R462-017
			FG R462-018
			FG R462-019
1950		Bacterial trap	FG R462-020
1953		Will sample patch of white mat and polynoids SUAVEd yesterday; into Slurp bottle #5	**Suction Sample**
			R462-4
2000		Patch of polynoids	FG R462-021
2003		Slurping mat and worms in circular fashion to obtain semi-quantitative sample	
2006		Chasing down the worms that try to escape	
2011		Sampled area; exposed basalt	FG R462-022
		Two *Paralvinella dela*	R462-023 R462-024

2013				Trying to slurp *P.dela* but he's hanging on; ultimately wasn't sampled	
2014				Sampled area	Phot
2015				Polynoid patch; just outside of sampled area for density estimation	FG R462-025 FG R462-025a
2016				Polynoid patch with bacterial traps in background	FG R462-026
2021				Animals in slurp bottle #5	FG R462-027
2024				Attempted Slurp bottle #4 of mat and "bag creature," vacuum cleaner got clogged, we'll return to this bottle later	**Suction Sample** R462-5
2025	1523	423852	5087098	Good fix; moved 2 m to "bag creature"	
2039				Trouble with the slurp pump, reversing flow to spit out a rock	Photo-6
2042				Pump is clear	
2044				Attempted Slurp bottle #3, bacterial mat around bag creature, but it still doesn't work	**Suction Sample** R462-6
2059				Recovery of bacterial traps #7 & #8	Photo-7
				Visible indications of bacterial growth	**Bac Traps** R462-7 R462-8 FG R462-028
2105				Deploy bacterial traps #9, #10, #11 & #12	FG R462-029 FG R462-030 FG R462-031 FG R462-032 Photo-8
2135				Looking down on **Mkr-33 Crack Vent** with bacteria traps	Photo-9 Photo-10
2138				Getting in position to collect bag creatures	
2141				Scooped up bag creatures with Pacman and put in port side bio box on top of bacteria trap #8; first section floated out and got away, but possibly a smaller piece stayed in the box.	**Biosample** R462-9
2148				Looking at bacterial traps again	FG R462-033
2150				Heading 222 looking at the uplifted side of the sheet flow slab at Mkr-33. Zones of venting are clearly marked by white staining.	Photo-11
2151				Leaving site and surveying	Photo-12
2152					Photo-13
2153				Overhead view of vent site, which is an uplifted section.	Photo-14
2155				Running digital still camera, rep rate 15sec, starting at altitude of 5 meters	
2157				Continuing DSC run, at 8-9 meters	
2158		423854	5087090	Now heading east (070) toward **Cloud Vent**. DSC on, alt 5 meters	

2202				Video of water column and ROPOS gauges.	
2203	1515	423930	5087077		
2204	1520	423918	5087111	Still in transit to **Cloud Vent**	
2204				First visual of gray smoke of Cloud Vent. Much smoke venting from rubble in an apparent collapse area.	
2210				At **Mkr-N4** in **Cloud Vent** area, looking at bacteria traps.	
2211				Positioning for recovery of bacteria traps	
2216				Moved suction sampler intake to port arm for deployment of bacteria traps. Bacteria trap #14 deployed at **Mkr-N4**.	
2223				Deploying bacteria trap #15, down in hole next to N4, top of rope barely visible for recovery.	
2229	1523	423897	5087117	Recovering bacteria trap #2 from **Mkr-N4** at **Cloud Vent**. Heading 120.	**Bac Trap**
					R462-10
2239				Bacteria trap #2 is now in the starboard biobox.	
2247	1520			Deploying bacterial trap #14 in crack at **Cloud Vent**.	
2254	1523			Recovering bacteria trap #1 from **Mkr-N4** at **Cloud Vent**.	**Bac Traps**
					R462-11
					FG R462-034
2259	1523			Debate about nature of **Cloud Vent**- alternating ejections of fluid that is clear then floc? Or is ROPOS just making a mess?	
2301	1524	423893	5087115	Looking for a spot with high flow to collect water for gas tights and Niskin bottles around **Mkr-N6**	
2306	1525	423899	5087110	Really high flow of gray smoke and chunks. Filling Niskin bottle right over **Mkr-N6** in super high flow.	Niskin
					R462-12
2310	1526			Filled both gas tight bottles (#2 and #7) with fluid from high flow at **Mkr-N6**	**Gas Tight**
					R462-13
					R462-14
2312	1525	423901	5087106	Heading back towards **Mkr-N4** looking for rocks with worms and bacteria	
2319	1523	423897	5087117	At **Mkr-N4**, hdg 271, not enough polynoids to sample so collecting a basalt sample with Pacman instead	
2328	1523	423890	5087111	Rock sample into starboard biobox	**Basalt**
					R462-15
2332				Heading back to Mkr-33, hdg 270	
2333				At **Mkr-33**, sampling bag creatures with pac man	
2338				Bag creatures in pac man, will remain there until surface	**Biosample**
					R462-16
					FG R462-034
					Photo-15
2339				Hdg 85, towards worm site, digital still camera turned on for the transect from **Mkr-33** over **Cloud Vent** to the worm site, flying at an altitude of 8m for digital stills	
2342				Over **Cloud Vent**	
2343	1519	423903	5087115	Dropping down 5 m to find worm site, couple meters east of **Cloud**	
2346	1517	423922	5087131	Turned off digital still; right over 'worm site', heavy yellow/orange coating on lobate lava	Photo-16

				flows; polynoid; orange stuff in cracks; sitting at the site of the Sonne fix for the worm field, scraping off coating to look at basalt, looks very black and glassy	FG R462-035
					FG R462-036
2357				Question as to what the coating is, looks fluffy, zoom on coating. Photo of the uncovered basalt	Photo-17
2358				Hdg 230, towards other worm site, the shifted fix for the Sonne worm field	
0002	1522	423892	5087063	Traversing area where we think the worm field was in '97 - have they all disappeared?	
0004	1519	423900	5087065	Tall, thin lava pillar	Photo-18
0006	1524	423879	5087089	Pushed up feature with some hydrothermal activity, thick white bacterial mat, looks like lots of *Depressigyra*, named **Snail**.	Photo-19
					Photo-20
					FG R462-037
					FG R462-038
0012				Moving around a few meters, pushed up sheet flows, bacterial mats, looking to see if there are any remnants of the '97 worm field	Photo-21
0013				Dense patch of polynoids, *Harmothoe*?	FG R462-039
0014				Layers of sheet flow - very distinct, polynoids all over, moving up a pillar, top of collapsed flow into lobate flows	Photo-22
					Photo-23
					FG R462-040
0017		423892	5087115	Hdg 62, towards Cloud, flying over a collapsed pit, pillar, NW of Cloud now	
0019				Stopped and looking around, lots of white bacteria on jumbled flow in collapsed pit	
0021				Off bottom, back to cage	
0131				ROPOS on deck	

Dive R463

Dive Map

Dive Summary:

Dive R463 consisted of approximately 12 hours of Imagenex survey along the South Rift Zone in the eastern caldera area. The survey was followed by a trip to Milky Vent (Mkr-N2) where the suction sampler and gas tight bottle sampled fluids. Bacteria traps were deployed and recovered at Milky Vent. Easy Vent was discovered and bacteria traps were deployed there also. ROPOS had to come to the surface because of tether problems and repairs.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT): August 31, 1998	Date (PDT): Sept. 1, 1998	Continue Imagenex sonar mapping further to the west started on Dive R460
East side of caldera in southern area	Date (UTM): Sept. 1, 1998	Date (UTM): Sept 2, 1998	Search for the missing tube worms north of Milky Vent Sample biology at Milky Vent
	Julian Day 244	Julian Day 245	Sample biology and sulfides at The Castle
	Time off deck: 0533	Time off bottom: 0006	
	Time on bottom: 1946	Time on deck:	

0210

Total dive time:

20 hr, 37 min

Total bottom time:

17 hr, 6 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

BioBox mounted lower center work area

Photosea 1000A 28 mm camera and strobe mounted side-by-side on upper center of bumper (note: the first photo of this dive will be photo-37 because film continued from R462)

Markers in BioBox: N9 in stbd side

Slurp gun with hose attached to port arm

3 sets of glass wool bacteria traps in each side of the Biobox

Pacman sampler on port (5 function) arm

Standard claw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
0533				ROPOS off deck	
0637	1467	424157	5085986	Gauge at designated depth with ROPOS	
0640	1467			ROPOS out of cage	

0650	1504			ROPOS at designated depth for Imagenex survey at 25 meters above. Problem with imaging system
0704	1504	424134	5086002	Moving ship north long Line N9
0710				Commencing Imagenex survey
				Proceeding north on Line N9
0724	1504	424146	5086156	"
0734	1503	424142	5086298	"
0745	1504	424144	5086500	"
0755	1499	424123	5086645	"
0805	1500	424140	5086816	"
0816	1492	424142	5086970	"
0826	1498	424131	5087120	"
0835	1499	424137	5087268	"
0842				Turning around and heading south
0846	1496	424113	5087386	"
0856		424078	5087277	"
0907		424098	5087104	"
0921	1493	424086	5086943	"
0936	1493	424082	5086740	"
0951	1497	424096	5086514	"
0959		424094	5086370	"
1007	1501	424084	5086255	"
1019	1501	424079	5086084	"
1023	1501	424075	5086000	Turning around and heading north
1031	1501	424018	5085989	"
1043	1502	424013	5086140	"
1052	1502	424016	5086261	"
1103	1502	424015	5086441	"
1105				End of line turning around
1108		423973	5086486	Hdg 180
1140		423965	5086009	
1143		423903	5085987	Hdg 011
1216		423884	5086490	
1220		423852	5086484	Hdg 179
1254		423808	5085957	Hdg 272
1306		423776	5086158	Hdg 012
1425		423777	5087404	
1426		423758	5087392	Hdg 269
1430		423729	5087389	Hdg 176

1455		423724	5087060	Hdg 189	
1553		423725	5086157		
1559		423717	5086067		
1603		423715	5086009	End of line	
1608		423664	5086002	Starting line, Hdg13	
1632		423631	5086414	Hdg 10	
1636		423640	5081499	Hdg 6	
1641		423656	5086545		
1717		423656	5087100	Hdg 12	
1738		423660	5087418	End of line, hdg east 91	
1750		423841	5087402	Starting line, hdg 181	
1819		423844	5086998	End of line	
1821		423806	5087002	Starting new line, hdg 320	
1844		423594	5087280	Hdg 339	
1910	1494	423499	5087792	Transit to **Milky Vent**	
1912	1494	423497	5087845		
1921	1502	423501	5088053		
1925	1504	423481	5088190		
1940	1506	423512	5088655		
1946		423530	5088649	Back on the bottom, spider crab	
1948				Lobate flows	
1951				Archive tapes on	
1952	1530	423481	5088662	No yellow sediment, pelagic (?)	
1954	1531	423532	5088654	Young sheet flow, small push ups, jumbled flows	
1955				White floc, lava lake, 1 meter high pillar	
1957	1528			Drained out area, relatively fresh lava (photo 37 = photo #1 for this dive, film continued from previous dive R462)	Photo-37
2000				Hydroid (photo), lava lake, floc increase, Hdg 94	Photo-38
1959		423619	5088648		
2004		423593	5088540	Fe rich sediments, drips (stalactites)	
2009				Hold while navigation is repaired	
2011		423701	5088642	Back on bottom, nav has been repaired	
2012				Fecal trails, more oxide	
2021		423798	5088651	This whole east west traverse has been old lava (Bill C)	FG R463-001
					FG R463-002
					FG R463-003
2024				Increase in sediment (patch)	
2025				Spider crab, rat tail fish	

2027				Spider crab	
2028		423869	5088657		
2030				Turning southwest, Hdg 216	
2032		423917	5088630	Starfish	
2036				Waiting for the ship to catch up	
2040				Sediment ponding - lobates and jumbled flow - no signs of hydrothermal activity	
2042		423922	5088591		
2046		423907	5088547		
2048				Hdg 243 toward **Milky Vent**	
2051				Spider crab, rat tail fish	
2052				Crossed NE/SW feature near drained out area, (possible indicator of tectonic control on geological features)	
2054	1518	423838	5088467	Hdg 273, golfball sponges on rocks	
2056		423806	5088453	**Tube worms** sighting gastropods and thick bacterial coating on tubes	FG R463-004
2101				Tube worms	Photo-39
2103				Polynoids, blue coating on rocks, filament, ~100 meters East milky vent, tube worms are alive with top cm of tubes translucent compared to brown below	FG R463-005
					FG R463-006
					FG R463-007
					FG R463-008
					FG R463-009
					FG R463-010
					FG R463-011
2108		423801	5088441	Moving Hdg 210, more blue stuff, more tube worms	Photo-40
2109				Going over old flows with a lot of sponges on them	
2110		423791	5088413	Old worms site, large white worms in a collapsed pit on a wall	Photo-41
2113				In transit still Hdg 314	Photo-42
2113				Crossing contact between old and younger lavas	
2114				Heavy oxide deposit	Photo-43
				Approaching **Milky Vent**	Photo-44
2118	1530	423682	5088435	Gray smoke	
2121				**Mkr-N2** spotted, spinning polynoid	
2126	1532			Positioning to collect water sample with suction sampler	
2151	1531			Still positioning to collect water sample.	
2155	1532	423680	508420	In position for water sample collection with suction sampler	
2204	1532	423678	5088420	Sampler with stbd gas tight (bottle #6)	Photo-45
					Gas tight R463-1
2227	1532			Moving slightly forward to reach vent with suction sampler nozzle	

2238	1531				Sampling with suction bottle #8 (first large container), just water	**Suction Sample**
						R463-2
2244					Sampling completed. Sampling location about 1m up on ledge from previous SUAVE scan location. Just next to **Mkr-N2**.	
2249	1531	423679	598420		Deploying bacterial traps at sampling site, Traps #18, #16. Good fix.	Photo-46
						Photo-47
						FG R462-12
						Photo-48
						FG R463-013
2307	1526				Moving off to **Oxide Vent,** hdg ~270	
2313	1529	423652	5088439		Turning north towards **Oxide Vent**, hdg 350, floc in water, light oxide covering	
2316	1533	423645	5088471		Hdg 132, turning south trying to find **Oxide Vent**	
2325	1529	423632	5088450		In vicinity of **Oxide Vent**, lots of orange oxides in depressions of lava, trying to locate position which was scanned in R460	
2330	1530	423627	5088444		ROPOS stopped, hdg 305, trying to decide if we are on target, decided we are off by at least 20m	
2332					Looking for original scan location, moving due east ~20m, then south	
2338					Still looking, orange fluffy floc all over the basalts	
2340					Found some white bacterial mat, hdg ~50; polynoid	
2344	1533	423677	5088444		New vent, named **Easy Vent** (Easy in nav), hdg 352	FG R463-014
						Photo-49
2350	1533	423675	5088444		Positioning to deploy Craig's bacterial trap #17, polynoid (new type), trap deployed	
2355					Tether management	
0006					Coming back up to the surface because of problem with level winding, bringing cage on deck and try to fix it while ROPOS still in water	
JD245						
0210					ROPOS on deck for repairs	

Dive R464

Dive Map

Dive Summary: Dive R464 began at Milky Vent where bacteria traps were repositioned. The suction sampler was utilized near Milky, MiniSnow, The Pit, Snail, and Castle Vents. Several markers were placed or repositioned on this dive. Mkr-N2 was repositioned at Milky Vent. Mkr-N9 was deployed at MiniSnow Vent. Mkr-N1 was moved to SnowBlower Vent. Mkr-N7 was placed south of Contact 4. Mkr-N9 was deployed at Snail Vent. Bacteria traps were deployed at Mkr-113 and retrieved in the same area. Gastight and niskin samples were taken near Castle Vent, as well as tubeworms and sulfide samples..

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT):	Date (PDT):	Continuation of aborted Dive 463
	Sept. 1, 1998	Sept. 2, 1998	
Eastern side of caldera in south region			Suction sample microbial mats at: Oxide Vent
	Date (UTM):	Date (UTM):	Mkr-33
	Sept. 2, 1998	Sept. 3, 1998	Floc on basalts
			Cirque vent
			Mkr 108 or 133
	Julian Day 245	Julian Day 246	
	Time off deck:	Time off bottom:	Gas tight water samples at vents to be selected
	0545	2337	
			Niskin sample at vent to be selected
	Time on bottom:	Time on deck:	
	0712	0045	Sample biology and sulfides at The Castle
		Total dive time:	
		19 hr 00 min.	
		Total bottom time:	
		16 hr 25 min.	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Biobox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Markers in biobox: N7,?

Suction sampler with hose attached to port arm

Glass wool bacteria traps in each side of the Biobox

5 liter Niskin bottle

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**Frame grabs, photos and samples**
UTM	**m**	**m**	**m**		
0545				ROPOS launched in cage.	
0707	1481			Out of cage.	
0712	1523	423685	5988444	On bottom heading 310, heading to oxide vent but came across a milk -like vent.	
0717	1528	423678	5088437	Another milky vent off to look for oxide, heading 282.	
0720				Rat tail.	
0721	1526	423683	5088416	Some diffuse venting.	
0723	1526	423689	5088413	More venting, lots of cloudy water.	
0725	1532	423679	5088420	Bacterial traps **Mkr-N2**, **Milky Vent** best approach is 042 THIS APPROACH IS IDEAL FOR THIS VENT**.** Repositioning bacterial traps. Bacteria on the lines of the glass wool traps 16 and 18.	FG R464-001
0739				Off the bottom and on the move to oxide vent, one of the traps is in a hole - looks like a drained pillow, lots of white coming out.	FG R464-002
					Photo-1
					Photo-2 (no flash)
					Photo-3
0744				Overhead shot of **Milky Vent**.	Photo-4
0745	1528	423668	5088421	Heading to **Oxide Vent** heading 313	

0748				Yellow sediment with a mixture sheet flows and pillows, ropy lava, looking for a broad pillar that is flat on top.	
0752				Ropy lava - (a ridge of it).	
0753	1531	423630	5088438	Good fix, milky water all around.	
0754	1528			This may be it, some small chimneys	Photo-5
0757		423628	5088466	On the top of the feature - some pillows, we are going to the edge and coming back at a heading of 180.	Photo-6
					Photo-7
0800	1522	423628	5088455	Good fix.	
0802	1529	423622	5088454	Collecting a suction sampler #4 (short jar), some shimmering water.	Photo-8
0804		423628	5088455	Sucking the stuff on top - whiter the better, having a hard time reaching, having a difficult time getting a sample with the suction sampler connected to Pacman.	FG R464-003
					Photo-9, Photo-10**Suction Sample**
					R464-1
0814				Sucking working, finished at 0820.	FG R464-004
					FG R464-005
0821				Getting ready to take off and go to **Pit Vent**.	
0825	1529			Moving ship.	
0829				Off the ground moving heading 171, sheet flow lavas, ropy, little sediment with white balls.	
0831	1532	423637	5088445	Low viscosity lava, orange material still with us as we go, rattail fish, some floc in the water.	
0834	1529	423662	5088390	Now into pillow flows, contact from sheets to pillows, pillow mound.	
0836	1527			Back into sheets very ropy heading 171, channel flow lavas climbing so probably going up stream.	
0838				Stopped for a moment, sheet flow, going down hill at 0839.	
0840	1526	423691	5088301	Orange floc sediment, glassy dark red mottling, lots of yellow sediment.	Photo-11
					Photo-12
					Photo-13
					Photo-14
					Photo-15
0843				Large pillows with pelagic sediment, no orange sediment coating, nice contact from a black lava and one coated with yellow stain.	Photo-16
					FG R464-006
					Photo-17
0846	1523	423706	5088201	Brittle star and lots of snails and sponges, pillows, rat tail, looking for a contact between big pillows with small pillows between.	
0849				Heading south, pillows with lots of yellow mat between the pillows, collapse pillow with several cm of orange sediment.	Photo-18
					Photo-19,
					Photo-20
0853	1523			White mats with orange stuff covering the mats - looks like loihi, stopped, no shimmering water, unknown branchy thing.	
0857	1522			Moving south, thick covering of yellow sediment, hollow pillow with lots of yellow sediment.	

0859	1521	423706	5088142	More white floc, some white mat, white floc out of vent - stopped.	Photo-21
					FG R464-007
					FG R464-008
					Photo-22
0903				Beta cam on - thinking of sampling	
				orange oxide mat with white stuff coming out, beta cam off 0904.	
0909				One of the sample inlets for the gas tight samplers was broken . Thus must trigger both to get the sample.	
0911	1522	423706	5088143	Good fix, beta cam on, beta off (0914),	FG R464-009
				moving into position to suck, filling big jar #18 for water sample, #18 has no filter, stopped at 0925.	FG R464-010
					FG R464-011
					FG R464-012
					FG R464-013
					Suction Sample R464-2
0925				Suction jar #1 short jar, getting white stuff from the same place that we got water for jar #18.	**Suction Sample**
					R464-3
0935				Still getting white stuff, shifting to get white stuff from another vent, keeping the same jar.	
0948				Still sucking.	FG R464-014
1005		423710	5088141	Finished sucking, deploying **Mkr-N9** rectangle-**Mini Snow.**	
1019				Leaving site, heading south to **Pit Vent**, heading 176.	FG R464-015
					Photo-23
					Photo-24
1023				Pillow basalt with oxide deposits in cracks, rat tail.	Photo-25
					Photo-26
					Photo-27
					FG R464-016
					Photo-28
					FG R464-017
					Photo-29
1026				Driving south 180 pillows with yellow sediment in cracks.	Photo-30
1028	1521	423724	5088081	More sediment , especially in holes,	Photo-31
				pillow lavas.	FG R464-018
1032	1517	423733	5088017	Heading 180, pillows with more sediment covering everything, drained lava lake, pillows, lots of open pillows and a big drain feature.	

1034	1515			Lava drain back feature.	
1035	1515	423713	5087967	Cloudy water with pillows and drain. features.	
1038	1519	423719	5087924	Much more yellow sediment cover,	Photo-32
				drained lava features (about 3 m deep).	
1041	1515	423720	5087891	Heading 180, more of the above	Photo-33
				big lava lake, more whit patches on the other side with less yellow sediment.	FG R464-019
					Photo-34
1043	1518	423723	5087835	Shimmering water with scale worms, new lava - pillows, diffuse venting FRESH LAVAS???	Photo-35
1045	1516	423711	5087834	Black lava with white between pillows	Photo-36
				collapse features.	FG R464-020
					Photo-37
1048				At the **Pit Vent**?, or at least the **Mkr-N1**	
1054	1517	423728	5087838	Looking for the vent, realize that we had problems with the manipulator last time, the marker is on the rim of a hollow pillow, dimension 3 m x 4 m.	Photo-38
					FG R464-021
1059	1518	423719	5087835	Marker in front, **Snow Blower Vent** to the side of the marker.	FG R464-022
					Photo-39
1101	1519	423721	5087834	**Snow blower Pit**. Lots of whit stuff coming out of a hole with a diameter 10 cm. Below is a hollow sheet, highlights still on.	FG R464-023
					FG R464-024
1103	1519	423722	5087835	Suction sample, large jar #12, no filter for water, about 3-4 m away, marker is to left of sub, sub heading at 312, marker on edge of the pit not in the pit.	**Suction Sample** R464-4
					FG R464-025
					Photo-40
1108	1519	423724	5087840	White floc is coming out along the roof and out the hole, lots of white mat in jar.	FG R464-026
		423720	5087830		
1111	1519	423722	5087835	Suction new jar #2A little jar for white floc, coming out in pulses not much now, the snow blower vent died then more came out, very sporadic venting.	**Suction Sample** R464-5
1124				Facing 310, the pit is behind, the marker should be back and on the starboard side, looking into hole and see shimmering water and scale worm coming out of hole.	FG R464-027
1128				Still looking into hole, another scale worm, hdg 311.	Photo-41
					Photo-42
1131				Hdg 032, looking for marker.	
1133				Shimmering water, see pit.	
1134				The hole is NW of pit and the marker is due north of the pit.	
1135				Picking up **Mkr-N1** and moving it to the **Snowblower Vent**.	Photo-43
					FG R464-028
1137	1519			Snow blower vents seems to have lost steam. Marker just SW of snow blower vent.	
1145				Begin lines, raising sub to ~5 m above bottom.	FG R464-029

1147	1514	423718	5087828	6 METERS ABOVE, directly above **Mkr-N1**, hdg 350, turning on digital camera.	
1150				Ship moving 600m due east, looking for burnt tube worms, leaving new lava, moving into old.	Photo-44
					Photo-45
1151	1518	423739	5087825	Lobate lavas with extensive orange mat.	Photo-46
1154	1520			Orange mat still cover everything, floor still collapsed.	
1155	1520	423769	5087825	Sheet flow on bottom of collapsed, orange mat completely covered, looks like white mat covered with orange.	FG R464-030
1156	1519			Coming into rubble, edge of collapse, wall with pillars.	
1159	1518	423801	5087825	Back to pillars.	
1200	1519	423815	5087825	Collapse appears to be 2m deep, pillars.	
1201	1517	423822	5087823	Pillars holding up some of the roof in the collapse area.	Photo-47
1202	1518	423832	5087825	More collapsed floor.	Photo-48
1205	1519	423846	5087819	More orange colored lava.	
1208				Lava with orange and white mat.	
1209	1519	423883	5087820	Clam shells and tube worms in old lava, our position is at or near contact and old/new lava. **Contact 4.**	Photo-49
1215	1519			Sipunculid worm.	
1217	1519			Tube worm remains, clam shells.	
1218	1519	423881	5087821	Blue gelatinous form "Blue Blob".	FG R464-031
1221	1519	423882	5087822	Dead tube worms in old lava.	
1223	1519			Turning 180 to head due West to look for contact, in old lava, see new lava.	
1223	1519	423878	5087815	At edge of new lava, highlights on.	FG R464-032
					FG R464-033
1228	1519			Crab on new lava.	
1229	1519			Tube worms at edge of old lava and new lava, highlights on.	
1232	1519	423883	5087818	looking at tube worms, clam shells.	FG R464-034
1234	1518			moving to look at tube worm remain, going south along the contact.	Photo-50
1236	1519			Along contact, clams and worms.	Photo-51
1237	1517			Along contact.	Photo-52
1238	1518	423879	5087808	Contact, new lava, seeing pockets of venting.	Photo-53
1239	1519	423878	5087804	Into old lava, orange sediment covered.	Photo-54
1240	1518	423879	5077795	On edge of old and new lava	Photo-55
				See Orange flag, broken off not attached to anything **Flag.**	Photo-56
					FG R464-035
1242	1519			Crab, dead tube worms and clams, facing south.	
1244				Hdg west, on edge of old/new, see live crab and dead tube worms.	
1246	1519	423879	5087793	Zooming in on live tube worms,.	
1249	1519	423877	5087790	Looking for contact again, hdg 222.	
1250	1518	423874	5087781	Hdg 213 following new lava.	
1253	1517	423886	5087780	Live tube worms, right on contact	Photo-57
				lots of white mat.	

					Photo-58
					Photo-59
1257	1519	423889	5087783	Video quality dropped due to telemetry. **Large TW.**	
1300	1520	423878	5087773	Placing marker	Photo-60
1306	1520	423886	5087774	**Mkr-N7** placed.	Photo-61
1308	1520	423885	5087774	Straightening out marker.	
1310				Having problem with cage camera.	
1313	1519	423887	5087772	Tube worms, still working with cage camera, iris on camera is tired, switched to different camera.	Photo-62
1319	1520			Iris on cage camera is tired, switched to different monitor.	
1321	1519	423888	427771	Looking for spot to deploy glass wool traps - abort trap deployment.	Photo-63
1322	1520			Exploded pillow lava.	FG R464-036
1329	1520			Tube worms, diffuse flow, palm worms, right on contact, colony appears to be between old (right) and new (to the left of the worms) lava lobes, clams on old lava highlights on.	
1336	1520			Contact, very visible.	Photo-64
1338	1514			Marker N7.	Photo-65
1340	1477			Moving to **Snail.**	
1454	1523			Lost GPS due to fire alarm.	
1517	1524	423831	5087074	Driving slowly NW, got nav back, but it seems ROPOS is stuck, moving east over sheet flow covered with oxides and fractures.	
1520	1524	423854	5087083	Good ROPOS fix, hdg towards target.	
1521	1524	423878	5087088	Lots of thick chunky white bacterial mat with flow, lots of snails.	FG R464-037
					FG R464-038
1528	1524			Trying to position to suck snails and the white mat they're nibbling on.	Photo-66
1531	1523	423878	5087086	Getting ready to suck snails, then mat, into small jar #0.	**Suction Sample**
					R464-6
					FG R464-039
1548	1524	423878	5087086	Still sucking mat now.	FG R464-040
1556	1524	423883	5087074	Still sucking.	
1559	1524	423877	5087088	Deploying **Mkr-N8** at **Snail**, hdg to Mkr-108 Vent, Digital still camera on for a couple of pictures.	Photo-67
					FG R464-041
					FG R464-042
1620	1515	423826	5086869	Hdg 225.	
1634	1523	42377	5086643	Closing on **Mkr-108**, hdg 179.	
1636	1519			Looking for **Mkr-108**, lots of floc and mat, drained lava lake.	
1642	1519	423787	5086586	**Mkr-108 Vent**, scale worm, white mat.	Photo-68
1645	1524			Lots of scale worms, some bag creatures, white mat.	FG R464-043
1649	1524	423784	5086592	Suction small bottle #2B of scale worms and mat, having problems with sucking, giving up on sucking.	FG R464-044
					Suction

					Sample
					R464-7
1715	1519			Hdg to **Mkr-113 Vent**, Axial Gardens.	Photo-69
1718	1522			Proceeding south, rat tail fish, collapsed area with yellow material, possibly new lava with covering, black glassy rock poking through yellow, white floc.	Photo-70
1723	1520			Brown and white floc, jumbled sheet flow, rat tail fish.	Photo-71
					FG R464-045
1726	1520	423707	5086464	Leaving jumbled sheet flow into flatter area, drained out lava, spires, pillars, not very glassy, no sessile organisms.	Photo-72
					Photo-73
1731	1520	423646	5086364	Hdg 210, nothing active yet, lobate lavas, no sessile organisms.	
1734	1521	423572	5086218	Lobate lavas with some shallow drained out areas, two rat tail fish, really glassy area on edges of flow, star fish, some sediment, can't tell if old or new, see contact. Collapsed pit with glassy at edges on top of pit. Rat tail, several sea cucumbers. Shallow drained out areas. Possible area of new sheet/lobate flow over old. Fronts of lobate looks glassy, hard to tell age. Coming into collapsed area, roof collapse, shrimp. Glassy smooth lobes, some sediment, confusion! Spire, drained out area/lava lake, sea stars and cucumbers on tops of area. Two spider crabs.	Photo-74
					Photo-75
					Photo-76
					Photo-77
					Photo-78
					FG R464-046
					Photo-79
					Photo-80
					FG R464-047
					Photo-81
					Photo-82
					Photo-83
					Photo-84
					FG R464-048
					Photo-85
					Photo-86
					Photo-87
					Photo-88
1747	1521	423476	5086125	Still heading towards Mkr-113, flatter glassier area, same surface, sea star, cucumbers, rat tail, sponges, brittle stars- lots on surface.	Photo-89
					Photo-90
					Photo-91
					Photo-92

					FG R464-049
1751	1521			Lobate lavas, age? Rat tail, cucumbers, some collapsed area, on surface again. Brittle stars, sea stars, sponges. Areas with increased sediment- correlate with new surface? Down in a hole then into young? lobate flow with orange/ yellowish sediment on it. Traversing between old and new flow	Photo-93
					Photo-94
					Photo-95
					Photo-96
					Photo-97
					Photo-98
1801	1523	423416	5085934	At **Mkr-113 Vent**- found tube worms- don't look alive. Scattered about. Group of tube worms that look like they've fallen off the top of a pillar!	Photo-99
					Photo-100
1804	1524	423390	5085922	Clumps of dead worms that look fallen. Seismic activity? Garden of Destruction. More tube worms on top of surface. Looking for mkr. Thick white bacterial mat, almost filamentous looking.	Photo-101
					FG R464-050
					Photo-102
					Photo-103
					Photo-104
					Photo-105
					FG R464-051
					Photo-106
					Photo-107
1809	1523	423367	5085919	Spider crab, looking for mkr, lots of dead tube worms! Some live worms among the dead ones.	Photo-108
					Photo-109
					FG R464-052
					Photo-110
					Photo-111
					Photo-112
					Photo-113
					Photo-114
1816	1524	423372	5085927	Hdg 164, looking south, **Mkr-113 Vent** is on east lip of a collapse. On edges, lots of bacterial mat, bag creatures, polynoids, looks fresh. Alvinellids, palm worms, that are alive. Thick bacterial mat. Found Craig's traps. Polynoids (at least 2 types). Traps look coated, worms on trap. Recent alive tube worms.	Photo-115
					Photo-116
					Photo-117
					Photo-118

					FG R464-053
					Photo-119
					Photo-120
					Photo-121
					Photo-122
					FG R464-054
					Photo-123
					Photo-124
					Photo-125
					Photo-126
					FG R464-055
					FG R464-056
					FG R464-057
1836	1524			Deploying bacterial traps #20 and #21 in crack at top of pillar (north side) with lots of biology (tube worms, alvinellids), hdg 170	
1843				Little red shrimp swimming by	
1844		423370	5085922	Photo of traps and **Mkr-113 Vent**	Photo-127
1856		423373	5085933	Retrieving bacterial trap #3, in port side of biobox; deploying new bacterial trap #19 at same site, CAGE CAMERA IS DOWN	**Bacteria trap**
					R464-8
1917				Move to tube worms	Photo-128
				new venting at site	Photo-129
					Photo-130
					FG R464-058
1920	1524	423376	5085939	Patch of dead tube worms, Hdg 035	FG R464-059
1926		423376	5085939	More pictures of tube worms	Photo-131
					Photo-132
					Photo-133
					FG R464-060
1928	1524	423377	5085935		
1938		423377	5085935	Collect a batch dead or dying tube worms into port side biobox	**Bio sample**
					R464-9
1951				Moved bacterial trap #3 port to starboard	
2008				Vent fish sighting	FG R464-061
				more tube worms	Photo-134

2010		423378	5085937	MORE tube worms into port biobox	FG R464-062
					Photo-135
2023				Nine anemones counted	FG R464-063
					Photo-136
2030				Head to **Castle Vent** Hdg 90	
2032	1524	423391	508593	Tube worm clumps, spider crabs	
2033				Collapsed pits	Photo-137
					Photo-138
2034				Pillars in the large lava lake, some venting, questionable lava age identification	Photo-139
2036				Cruddy pillows	Photo-140
2040				Jumbled sheet flows	Photo-141
2041				Pillar	Photo-142
2043				Sediment covered lobate lava	Photo-143
2044				Orange deposit under side of lobate, staining between pillows, black specks, "craters" apparent in sediment	
2044				Large lava lake, orange sediment cover	Photo-144
					Photo-145
2048				Jumbled sheet flow. thick orange sedimentwith "papillae" not characteristic of pelagic sediment	Photo-146
					Photo-147
2051				Low venting, shimmering water bag creatures, polynoids, bacterial mats	Photo-148
2052	1524	423576	5085921	Mats	Photo-149
2055				White mat and/or grout, polychaetes, bag creatures	
2056	1521	423591	5085927	Emerged from lava lake (VT), **Pillar Vent** discovered, more vents	
2058	1522	423611	5085932	Into pit, slime	Photo-150
2059				Hdg 99	Photo-151
				hollow lobe of lava	FG R464-064
					Photo-152
2101				Out of venting area	
2103	1521	423645	5085949	Hdg 45, heading change to castle	
2105				Pillows	Photo-153
2107	1522	423654	5085962		
2108				Bluish	
2111				Cage in view (tether management)	
2118		422117	5085933	Back on the bottom, jumbled sheet flows, same sediment, whirly sheet flow	
2121				Basalt substrate with some sediment	Photo-154
2122				Basalt substrate with some sediment	Photo-155
2122	1527	423737	5085972		
2124				Crossing sheet flow with striations; "elephant tracks" in the sediment	
2124				Sheet flow looks the same but losing linear features	

2126				Ugly Lumpfish	Photo-156
2127				Jumbled sheet flow; sediment cover increasing	
2128				Rattail fish; jumbled sheet flows	
2130				Passed over oxide mound similar to previous dive	
2131				Jumbled sheet flows, moderate sediment cover	
2132				Murky water; nearby hydrothermal venting? Broken up lava with orange floc sediment in interstices	
2132				Orange floc is stringy; sheet flow that is heavily sedimented; visibility compromised; prawn	
2133				White mat with orange oxide--center of low temperature venting? Back into jumbled surface with pockets of white mat with less sediment; ratio of mat to orange sediment increasing	
2134				New vent site with white mat and broken sheet flow lavas; video overlay pause; most lavas appear to be folded like a curtain	
2135				Video overlay back on; basalt glass fragment sitting on seafloor--hydroclastics	
2137				Orange floc is dense, less white mat, glass shards still present (or are they just bare spots?) Some bare spots are shiny.	
2140	1525	423870	5086122		
2141	1524	423878	5086128		
2141				Looking for contact with pillow lavas at **Castle Vent**; looking for a miracle	
2142				Up and over a big rock	
2143				Less sediment cover; little white mat--popcorn texture; now onto lobate flows; fat rattail fish; moved from one rock jumble to the next; now a drained lava lake	
2143	1523	423925	5086168		
2143				Large lava lake structure; pillar; more orange floc; part of one large drainback structure; fat rattail fish; lots of orange flow--indicative of venting just after the flow flowed	
2145				Arrived at another lava lake with some tube in it; back to striated sheet flows, coming to folded curtain-drape textures; another spire; some parts of roof there	
2146	1520	423973	5086207		
2147				Lobate lavas with orange floc in interstices; popcorn white mat	
2148				Glassy surface on one lava; lots of orange floc; no white mat; 50 m SW Castle Vent	
2150	1521	434937	5086254		
2151				Lobate flows; more pillows; white mate; 15 from Castle Vent; a depression about 5 m deep or so	
2152				Arrived at structure with tube worms and diffuse flow; polynoid swimming	
2154				We may have missed contact while going over drop; sulfide talus around tubeworms	
2155				Abundant tubeworms; **Mkr-N5**; structure is 8-10m high and partially caved in; we have arrived at **Castle Vent**	
2155	1510	434035	5086301		
2157				Highlight tape rolling	
2158				Big rattail and dead tube worms; "There a whole lot of scavenging going on" says Kim	
2159				Back to the cage for tether management; cage camera has failed	
2203				Cool ctenophore	
2205				We must surface soon so can only do quick sampling	
2209	1519	434017	5086279		
2210				Lobate flows, now more pillows	

2211				Tube worms, white mat	
2211	1517	434032	5086297		
2214				This vent does not appear to be Castle Vent, but this is were Marker N5 is; there are 2 sulfide structures	
2217				Tube worms growing out of heavily sedimented lavas; all of this appears to be in a depression	
2218	1514	434041	5086296	Arrived at Flattop again; there are 2-3 sulfide structures here and a basalt pillar with some sulfide and worms	
2221				Spider crab	
2222				Another spider crab	
2222				Castle vent; rocks covered with white mat; the vent is a thin spire with black	Photo-157
					FG R464-065
					Photo-158
2224				Kim's highlight tape still running	
2225				Will sample with Pacman; spire is likely anhydrite; will try to sample top of spire	Photo-159
2228				Spire broke off and fell behind stump	Photo-160
					FG R464-066
2231				Has some sulfide in Pacman; there is white anhydrite; "A sulfide in the claw is worth two in the tubeworm bush" --Dave & Jon	
2233		424032	5086297	Re-sampling stump with Pacman	FG R464-067
					FG R464-068
					Sulfide spire
					R464-10
2334		424032	5086297	Niskin buoyant/exiting plume sample but not from rising plume, just nearby sea water	**Niskin**
					R464-11
2240				Crushed a dead spire with the claw; organic pipes with anhydrite tops; Dave saw chalcopyrite inside the spire	
2241		424032	5086297	Setting up to fire gas tights at Castle Vent stump; fluid is quite clear; both gas tights fired, one port in plume (GTB#5) and the other about 17" away in sea water (GTB#2)	Photo-161
					Gas-tights
					R464-12
2246				Searching for tubeworms for Tsurumi, those with Massoth's second (#18?); FG tubeworms and lasers	FG R464-069
2247					Photo-162
					FG R464-070
2255				Positioning slurp sampler to get the nice, clear fluid from the stump of Castle Vent	
2257				Trying to determine if slurp sample is actually getting fluid	
2258		424032	5086297	Slurp pump is broken so we're letting fluid rise into suction canister #1; sample is likely highly compromised	**Suction sample**
					R464-13
2302	1519	424023	5086297	Deploying Craig's bacteria trap #22 in high flow zone, hdg 69; one trap is broken	
2311	1519			Deploying bacteria traps #24 and #23 (the top is pried off one cylinder of #23), same location as above; #22 looks like a hole has melted through the bottom	FG R464-071
2316				One of Maia's tube worms is out of it's tube flapping in the water	FG R464-072

2321	1519	424026	5086303	Heading to sulfide chimney with **Mkr-N5**, hdg 90	
2324				Lots of mat, found chimney (**Flat Top**) with **Mkr-N5**, hdg 125;	
2330				Trying to determine where SUAVE #18 was taken exactly, so Maia can get tube worm sample from same site; vent fish sitting by tube worms and alvinellids	Photo-163 Photo-164 FG R464-073
2334	1516	424041	5086304	Taking sample from directly behind **Mkr-N5**, hdg 197; tube worm sample in stbd biobox	**Bio sample** R464-14
2337				Hydraulic line burst to 5-function arm, dive terminated, ROPOS ascending to surface	
0045				ROPOS on deck	

JD246

Dive R465

Dive Map

Dive Summary:

Dive 465 was a bottom reconnaissance survey of an area south of the caldera where a comparison of SeaBeam surveys taken in 1981 and 1998 revealed bathymetric anomalies probably resulting from new lava flows. Navigation of ROPOS was bad because of incorrect delays for the transponders so positions recorded are those of the ship in P-GPS.

The eastern contact of the older partially sedimented sheet flow and new lava was encountered. The new lava appears to be dominated by pillows but there are also lobate and sheet flows. Yellow staining and floc were encountered in places. Animals ("bag creatures") and white bacterial mats are sparse to non-existent on the surface of the new flow. A 6 m high scarp strikes N-S.

Two samples were taken at the flow front; one was a branching drip structure. The dive was terminated prematurely due to failure of the 3-chip video camera.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
Axial Seamount	Date (PDT):	Date (PDT):	Bottom reconnaissance traverses over the 1998 volcanic eruption in the upper south rift zone.

3 n. mi. south of the caldera along the rift axis	Sept. 3, 1998	Sept. 3, 1998	SUAVE any vents discovered.

Date (UTM):	Date (UTM):
Sept. 3, 1998	Sept. 3, 1998
Julian Day 246	Julian Day 246
Time off deck:	Time off bottom:
0741	1456
Time on bottom:	Time on deck:
0925	1623
	Total dive time:
	8 hr 42 min
	Total bottom time:

5 hr 31 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

BioBox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Markers in BioBox

SUAVE mounted port side interior; sensor on port 5 function arm

2 gas tight bottles with intake on stbd arm

5 liter Niskin bottle

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**Frame grabs, photos and samples**
UTM	**m**	**Longitude**	**Latitude**		
0741				ROPOS launched	
0925	1816			Contact bottom, abundant sediment cover in topo lows, bad fixes (due to incorrect delay for transponders), ship driving 0.5 knot, sheet flow visible, heading west	
0934				Breccia	Photo-1
0937		12959.18'	45 52.18'	Ship position; still bad fixes, heading due west	
0942				Crinoid, pelagic sed cover about 50%	Photo-2
0943				Jumbled sheet flows	
0945				pillows, sed cover	Photo-3
0951				Jumbled sheet flow, edge of cliff/fault scarp?	
0955				CONTACT-new lava! Yellow material at base of flow and in cracks, denotes new lava, pillows	Photo-4
					Photo-5
					Photo-6
					Photo-7
					Photo-8

					Photo-9
					Photo-10
					Photo-11
0957				Have come up 5 m from base	FG R465-001
					FG R465-002
					FG R465-003
					Photo-12
0958				Pillows	Photo-13
1002				Pillows, 20 m from contact	Photo-14
					Photo-15
1005		59.14'	52.18'		FG R465-004
					Photo-16
1008					FG R465-005
1010	1785			Grabbed chunk, wedge/trapezoid shape, orange stripe inner surface, step in side, port BioBox	FG R465-006
					FG R465-007
					Basalt
					R465-1
1014	1782	59.175'	52.163'	Top flow front, drip structures, must be on slope, plenty of yellow (Fe) stuff	Photo-17
					FG R465-008
					Photo-18
1019	1784			Grabbing flow structure, in port BioBox, long, bonelike, glass, yellow stuff	**Basalt?**
					R465-2
					FG R465-009
					FG R465-010
1024	1781	59.18'	52.17'	Tether caught, back to cage	
1029	1782	59.19'	52.17'	Pillows, up about 15 m from contact	Photo-19
1032	1780			Evidence of flow from bottom of pillows, broader lobes, more fluid morphologies, BIG rattail!, lobate flows, no pillows	Photo-20
					Photo-21
1034	1781	59.22'	52.18'	Seds in crevasses, yellow or white? looks white, about 10-20% cover	
1039	1781			Linear feature, broken sheet, broad lobes on top of flow different from front, no collapse, fluid looking flows, upper crust broken up	Photo-22
					Photo-23
1042	1780	59.24'	52.19'	Crevasses , no flow seen, looks like iron bacteria and bag creatures and mats, possible poop identified, fluffy material	FG R465-011
					Photo-24
					FG R465-012
					Photo-25

1048	1780	59.27'	52.19'	Back into broad flat pillows, flow texture seen, yellow/orange material in cracks, near center of sonar anomaly (Bill Chadwick)	Photo-26
1059	1781	59.30'	52.19'	75% bacterial/bag creature cover, yellowish	Photo-27
					Photo-28
1100	1780			Temperature check in bag creatures (bag sniffing) no thermal anomaly	FG R465-013
					Photo-29
1102	1780	59.30'	52.19'	TopaLava Target	
1106	1780	59.35'	52.18'	Broken sheet flows, ropy lavas, a little less orange mat, images of orange goo	Photo-30
					FG R465-014
					Photo-31
					FG R465-015
1112	1781			Little crevasse, color change (white) along crack, orange further out, no thermal anomaly	Photo-32
					FG R465-016
1114	1781	59.38'	52.17'	Broad, massive lobes, flat regional topo, crab, less mat, getting more pillows	
1117	1781	59.42'	52.17'	Pillows	Photo-33
1121	1774			Gaining elevation, crab, little mat, pillows, staining on underside of rocks,	FG R465-017
					Photo-34
1124	1773			Morphology matches slope: steep=pillows, flat=more sheets	Photo-35
1125	1773	59.49'	52.16'	BIG DROP OFF, scarp about 6 m, oriented about N-S, brecciated face of scarp, collapse pit? NICE stratigraphic column in wall, hollow pillow at top	Photo-36
					Photo-37
					Photo-38
					Photo-39
					Photo-40
1132	1772	59.52'	52.17'	Along collapse, rubbly bottom, broken pillows in bottom	Photo-41
1137	1778			Glassy lobate pillows, varying orange mat thickness	Photo-42
1145	1772	59.63'	52.16'	Large pillows (1-2 m), 2 crabs, going upslope, reddish staining undersides, thermal/water altering stains	Photo-43
					Photo-44
					Photo-45
					Photo-46
					Photo-47
1153	1760			Tube-like pillows, some broken, very little seds	Photo-48
					Photo-49
					Photo-50
1200	1749	59.74'	52.15'	Pillows, upslope, rattail	Photo-51
1205	1735	59.77'	52.15'	Pillows, sediment increase in the interstices	
1208	1732			Cracks with white coating; broken up glass in pockets; looks like we're getting to the top of the main rift zone	Photo-52

1209	1734			Stopped on broken pieces of rock, yellowish-white coating on broken surfaces	Photo-53
1210	1733			Continuing on, ~15 from center of rift zone; ~100 m away from plateau of rift zone; no animals so it looks like same flow	
1211	1733	59.86'	52.16'	Spider crab	
1212	1732	59.88'	52.15'	Smaller pillows, no striations, light sediment cover	
1213	1732			Flattening out a bit, still in pillows; no animals	
1214	1730			Fish; thicker coating of tan material in pockets; glassy lobes	Photo-54
					Photo-55
1215	1727	59.95'	52.15'	Very glassy lobes in these pillows, tubular pillows broken off	Photo-56
1216	1725			Striated pillows	
1217	1723			Pillows, tan material in interstices; larger pillows	Photo-57
1218	1719			Getting close to top; tubular pillows; smooth surfaces, glassy	
1220	1720			Small glassy lobes; similar to pillows we've seen at other sites on the ridge; stopping to catch up with tether	
1222	1720			Continuing west; flatter here, slightly flatter lobes; collapse	
1223	1719	1300.03'	52.14'	Brecciated sheet flow; fish; ropes	Photo-58
1224	1720			Jumbled sheet flow	Photo-59
1225				Glassy surfaces; jumbled flow	Photo-60
1227				Squatty mounds/spires in jumbled flow; tether management - going back to cage	
1322		0.046'	52.14'	S. Contact 2	
1456				Looks like a fried 3 color camera cable, coming back on deck.	
1513				1230 wire out	
1623				ROPOS on deck	

Dive R466


Dive Map

Dive Summary: Dive R466 took place at ASHES Vent Field. A HOBO temperature probe and Osmosampler were deployed at Hell Vent. Twenty-one SUAVE samples were taken at various vent sites. Bacteria traps were deployed at Hillock/Phoenix Vent and ROPOS Vent. A huge clump of tubeworms and biota were sampled at Hairdo Vent. Time was spent observing sulfide worm behavior at several vents. The dive concluded with a Digital Still Camera session.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
Axial Seamount	Date (PDT):	Date (PDT):	Short-term Osmo deployment at Hell Vent
	Sept. 3, 1998	Sept. 4, 1998	
			Survey of field, check chimney locations
ASHES site			
	Date (UTM):	Date (UTM):	
	Sept. 4, 1998	Sept. 4, 1998	Check HOBO probe deployments
			Low temp diffuse flow scans (SUAVE)
	Julian Day: 247	Julian Day 247	
			Worm samples at the same spots as SUAVE
	Time off deck:	Time off bottom:	
	0102	1711	
			SUAVE scans and video mapping of sites on chimneys
	Time on bottom:	Time on deck:	
	0230	1829	Must be back on deck by noon for air drop of electronic board by C140
		Total dive time:	
		17 hr 27 min	
		Total bottom time:	
		14 hr 41 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Biobox mounted lower center work area

Markers in Biobox: 2, 11, J1, L

SUAVE mounted port side interior; sensor on 7 function arm

Osmosampler for deployment

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Gas Tight #6 on port side (black tape on peek tube near end

Gas Tight # 7 starboard

Niskin bottle (5 L)

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**Frame grabs, photos and samples**
UTM	**m**	**m**	**m**		
0102				ROPOS launched.	
0105				ROPOS leaving cage.	
0218				Entered plume.	
0230				Sighted bottom, ropy sheet flow, lots of floc in water, orange oxide clumps/mounds in cracks.	FG R466-001
0233	1546	421358	5087086	South of ASHES, mores oxides, glass sponges, about 40m south of **Hell**.	
0236	1545	421354	5087107	Heading North, jumbled flow, lots of sponges, high density of suspension feeders.	
0239				Floc increasing as we head into ASHES, lots of oxides, sighted **Hell**.	
0240				At **Hell**, lots of tube worms, zooming in on base, lots of snails (*Provanna*), little anemone, coming around south side of **Hell.**	FG R466-002
					FG R466-003
0244	1545	421372	5087130	Hdg 283, looking at **Hell Vent**. Sulfide worms hanging out in their tubes in between live *Ridgeia*..	FG R466-004
					FG R466-005
0248	1547	421374	5087134	Shimmering water under a flange, highlights tape on.	FG R466-006
					FG R466-007

					FG R466-008
					FG R466-009
0252		421378	5087134	Highlights tape off, moving up **Hell**, hdg 290. Highlights back on.	
0254				At top of **Hell**, multiple spires, can see 4 smoking spires so far, lots of tube worms, sulfide and palm worms. Looking for a place to deploy the Osmosampler.	FG R466-010
					FG R466-011
					FG R466-012
0301		421374	5087136	Highlights tape off, still looking at **Hell Vent.**	
0308		421371	5087129		FG R466-013
0311					FG R466-014
0312	1544	421375	5087129	Spire with sulfide worms, beautiful smoking top.	FG R466-015
					FG R466-016
					FG R466-017
					FG R466-018
					FG R466-019
					FG R466-020
0323		421373	5087130	Sampled spire with sulfide worms, top of spire broke off, sample will stay in Pacman; highlights tape off.	FG R466-021
					Biosample
					R466-1
0326				Deploying a high temperature Hobo probe into the spire just sampled (for Osmosampler), hdg 312. Getting pulled off site a bit.	
0350	1544	421374	5087128	Beehive where attempting to deploy Hobo.	FG R466-022
0356				Hobo dropped and recovered (0400).	
0406	1544	"	"	Hobo successfully deployed, ~same hdg.	FG R466-023
0415	1544	"	"	Osmosampler probe successfully deployed.	FG R466-024
0420	1546			Moving NE to **Inferno**, sheet and lobate, popcorn, dense floc in water column and on lavas.	
0426	1547	421401	5087178	See clams 4 cm long, first time seen in this vent field.	FG R466-025
0428	1547			Continuing transit, see tube worms, arrived at **Mushroom Vent**. Has grown in thickness and height since 1986.	
0430		421389	5087162	**Inferno Vent**. "Flame" (2 phase separation) in chimney on top. Hobo deployed by Alvin in July has coating of bacteria. Marker 19 (flag marker from 1986) now unreadable because of bio-coating. Highlights video from 0431-0433.	FG R466-026
					FG R466-027
0439	1547	421390	5087159	Palm worms on base of chimney on south side, hdg 351	FG R466-028
0443				palm and sulfide worms	FG R466-029
0445				Hdg E to Virgin Vent, doing tether management	
0447	1542			**Mushroom Vent**	
0450				Problem with cage camera. Image broken up.	
0451	1545			Heavy coating of floc on lobate lavas, tube worms, anemones, white mat, limpets. Awaiting ship to move.	
0457	1545	421420	5081763	Chuck Fisher's markers dropped out of Alvin's basket. Just beyond is a new low temperature vent field named **Gollum Vent.** Good biological gradient: white mat, limpets, anemone, scale worms, gastropods (*Provanna*)	
0504	1546	421431	5087173	Hdg 72 **Virgin Vent**. Hobo deployed in July. Anhydrite spire has grown since July. Seems darker (sulfide) at its base.	FG R466-030

					FG R466-031
0507				Heading North to look for more Virgin-like vents.	
0508	1545			Hdg 000, **Virgin's Daughter** being colonized by *Provanna*, paralvinellids, and polynoids. Tube worms to North on sheet flow.	FG R466-032
0513				Hdg 180 over bacterial mats, clams, anemone, iron oxide floc and mini-mounds over sheet flows looking for **Crack Vent**.	
0515	1547	421440	5087132	Marker 117, **Crack Vent**. Installation from July Alvin dive for filtering diffuse flow from a small crack. Leaking vent water on NE corner. Not in a good position.	FG R466-033
0522	1547	421426	5087134	Hdg 168, see several anhydrite mounds of **Crack Vent**, some with small (30 cm) spires.	FG R466-034
					FG R466-035
0526				Moving West to look for **Phoenix Vent**.	
0527	1547			**Phoenix Vent**. Solitary chimney ~4 m high. Only diffuse flow. Marker 2 at hdg 142.	
0532	1544	421391	5087132	Hdg 143 looking at **Phoenix Vent**.	FG R466-036
					FG R466-037
0535				Moving to NW looking for **ROPOS Vent**.	
0536	1548			Hdg 254, at **ROPOS Vent**. Fat pancake- shaped mound ~2 m diameter with small spire on top. Diffuse venting. Lots of animals. No fixes.	FG R466-038
0545				Moving SE to **Hillock Vent**, intact and broken sheet flows. Possible that **Hillock** and **Phoenix** are one and the same (bad navigation previously).	
0551				Heading for **Hell Vent** over lobate flows.	
0604				Lost overlay for 3 minutes.	
0607	1547	421368	5087140	At **Hell Vent** facing south.	
0614		421367	5087140	Start SUAVE #1 in clump of mostly dead tube worms in diffuse flow about 1m North of Hell Vent. Same location as 0607. Tickling the tips of the worms.	FG R466-039
					FG R466-040
				Max. T = 5C, no chemical anomalies.	
					FG R466-041
					SUAVE R466-2
					FG R466-042
0622				SUAVE #1 completed.	
0624				Taking entire clump of tube worms. In port BioBox. Hdg 220.	FG R466-043
				Changed archive tapes at 0631.	**Biosample**
					R466-3
					FG R466-044
0635				SUAVE #2 in hole left by sampling tube worm bush. Hdg 220.	FG R466-045
				Max. T = 6C, H2S ~1 µmol, Mn = 4 µmol, Fe = below detection.	**SUAVE**
					R466-4
0640		421365	5087140	End SUAVE #2. First fix in a long time. Dropping **Mkr-L** (eyeball) beside hole left by sampling hat-like tube worm bush.	
0648				Moving over lobate lavas to **ROPOS Vent**.	
0701		421387	5087132	At **Phoenix Vent**. Small Fe oxide mound? Or oxidized sulfide chimney?	FG R466-046
					FG R466-047

0710		421393	5087132	Deploying glass wool bacteria traps #26 and #25 in shimmering water at **Phoenix Vent**.	FG R466-048
0718	1547			SUAVE #3 in-between bacterial glass wool samplers - started at 0719 then restarted at 0723 and ended at 0728; Max. T =16C, H2S = 135 mol, Mn = 7.5 µmol, Fe = 5 µmol.	**SUAVE** R466-5
					FG R466-049
0732				**ROPOS Vent**.	
0733	1547	421390	5087135	In transit to **ROPOS Vent**.	
0737				Arrived at **ROPOS Vent**. Thinking about deploying two glass wool traps. First checked temperatures which are around	FG R466-050
				2.8-3.0 C, with maximum of about 3.5C. The little spire on the top of **ROPOS Vent** is dead.	FG R466-051
					FG R466-052
0752				Moved around to the other side with a heading of 76 degrees. measuring the temperature at 3.6-4 C with the hottest in the "blue" stuff.	
0752	1547	421385	5087131	Moving around again at **ROPOS Vent**,	**SUAVE**
				heading 165, scanning with temperature up to 17C. Started a SUAVE at 0759. SUAVE #4 stopped at 0806.	R466-6
					FG R466-053
				T= 29C, H2S 340 mol, Mn 40 mol, Fe 80 mol.	
0807	1547			Deploying glass wool bacteria traps #26 and #27 on **ROPOS Vent** at site that we just scanned with SUAVE.	
0810	1547	421386	5087134	Best fix for **ROPOS Vent** to date.	
				Still deploying Moyer glass wool traps number #28 and #27 finished deploying traps 0819.	FG R466-054
					FG R466-055
0820				Moving to collect worms going through pillows with little mat and some yellow staining.	
0827	1546	421389	5087154	We are going to SUAVE a pile of organisms with tube worms and the rest. **Hairdo Vent** SUAVE #5. T = 14C, H2S 138 mol, Mn 12.5 mol, Fe 8 µmol, temp average about 12.5C.	FG R466-056
					SUAVE R466-7
0833	1546	421391	5087156	Good fix for **Hairdo Vent**.	FG R466-057
0838				Highlights are on.	
0840	1546	421391	5087156	Good fix for **Hairdo Vent**. Suave stopped at 0841. Another good fix 1391 and 7157.	
0842		421391	5087156	Grabbing "hairdo" for collection and will put it in the starboard side of the BioBox.	FG R466-058
				Stuffing the pile into the box and counted millions and millions of organisms. Done with the collection at 0900.	**Biosample** R466-8
0900		421391	5087156	Going back to the hole where the "hairdo" was taken and doing another SUAVE. SUAVE #6 started at 0904. T 14.8C, H2S 200 µmol, Mn 15 µmol, Fe 10 µmol, average temp of 13.5C, stopped at 0913.	**SUAVE** R466-9
0914				Attempting to stuff the rest of the worms into the BioBox.	
0922	1547	421392	5087136	Moving to **Phoenix**, at **Phoenix Vent** 0924. We are on the NW side and facing SE (127).	
0931				Removing one worm from the basket because it is blocking the view. Frame grab with the sit camera.	FG R466-059
0934				We are going to remove a few more worms so that we can see in front of us.	
					FG R466-060
0939				Just hanging out watching biology in action at the base of **Phoenix.**	FG R466-061

				Highlight video is on; watching the battle of the worms.	
1000		421392	5087136	SUAVE #7, started, below the worms. Trying to get a good spot at **Phoenix Vent.** Starting at 1008. Max. T=20C.	**SUAVE**
					R466-10
1024				SUAVE #8 started and now at the worms	**SUAVE**
				themselves, ended at 1039.	R466-11
				Max. T=15C.	FG R466-062
1033					FG R466-063
1044				SUAVE #9 at the "frisky boys". Max. T=6C.	**SUAVE**
					R 466-12
					FG R466-064
1057				SUAVE #10 slightly higher up in Community II; Hdg. 145. Max. T=8C.	**SUAVE**
					R466-13
1107	1546			Finished SUAVE and now	
				taking temperature measurements on different sulfide worms.	
1133	1546	421388	5087135	Video of new site just to the left of where SUAVE #10 was. To the left of **Mkr-2**.	
1155	1546	421388	5087135	Hdg 210. Can see Marker 2 in background. Starting first SUAVE #11 (first SUAVE at this second site). No fauna here (Community 0). Max.. T=4.2C.	**SUAVE**
					R466-14
1205		421388	5087135	Finished SUAVE and prepping to SUAVE again--#12 on two sulfide worms. Started at 1209.	**SUAVE**
					R466-15
1218				Terminating SUAVE. Max.. T=6.1C.	
1221				Resetting Science STS.	
1225	1545			Found another spot to SUAVE.	
1230				Video taping sulfide worms. Community I.	FG R466-065
					FG R466-066
1238	1545				FG R466-067
1244	1545			Finished video of sulfide worms. Positioning arm for next SUAVE.	
1246		421388	5087135	Beginning SUAVE #13, 2 m stbd. of Marker 2, hdg. 089.	**SUAVE**
					R466-16
1258				End SUAVE #13, Max.. T=80C.	
1300	1545			Moving arm into position for next SUAVE.	
1303		421388	5087135	Starting SUAVE #14.	**SUAVE**
					R466-17
1312				End SUAVE #14. Max. T=24C.	
1314				Moving arm into position for SUAVE #15. Begin SUAVE #15 at 1316.	**SUAVE**
					R466-18
1326		421388	5087135	End SUAVE #15. Max. T=3C. Moving probe to next spot. Begin SUAVE #16 at 1329.	**SUAVE**

						R466-19
1332					Power cable was kicked out of the transformer and we lost power to everything on sub/cage.	
1337	1500				SUAVE back on line. But, SUAVE #16 was essentially aborted.	
1343					Back on bottom, anhydride mound, heading NE to **Inferno Vent**	
1344					Passing starboard side of **Phoenix**	
1347					At **Inferno**, see Hobo.	
1356	1546				Reconnaissance	
1406	1545				Videoing sulfide worms at **Inferno**.	
1417		Bad fix			SUAVE #17 at South side of **Inferno** on palm worms.	**SUAVE**
						R466-20
1425					End of SUAVE #17. Max. T=5.5C.	
1442	1546				Trying to get a gas tight sample at little onion bulb to the right and below the Embley VEMCO.	
1445		Bad fix			Gas tight #6 port at **Inferno Vent** at top of black beehive spire on south side, hdg 350, near VEMCO	**Gas Tight**
						R466-21
1446		421395	5087162		Gas tight #7 starboard side at **Inferno Vent** at top of black beehive spire on south side, hdg 350, near VEMCO	**Gas Tight**
						R466-22
1454	1545	421392	5087136		Looking for Hell Vent	
1455	1545	421373	5087136		At **Hell Vent** to scan sulfide worms	
1505	1546	421373	5087136		SUAVE #18 at **Hell Vent** at leading edge of **Porkchop** near sulfide worms near diffuse flow, hdg 355.	**SUAVE**
						R466-23
						FG R466-069
						FG R466-070
						FG R466-071
1517	1546	421373	5087136		SUAVE #18 complete. Max T=16C, H2S 1.18 mol, Mn 70 µmol, Fe 90 µmol	
1523	1546	421373	5087136		SUAVE #19 at **Hell Vent** at back of **Porkchop** near sulfide worms again. Watching worms fight.	**SUAVE**
						R466-24
1535	1546				SUAVE #19 complete. Max T=19C, H2S 470 µmol, Mn 60 µmol, Fe 87 µmol.	
1545	1546	421373	5087136		SUAVE #20 at **Hell Vent** at bone of **Porkchop** near sulfide and palm worms.	**SUAVE**
						R466-25
1557	1546				SUAVE #20 complete. Max T=19C, H2S 470 µmol, Mn 45 µmol, Fe 85 µmol.	FG R466-072
1605	1546	421373	5087136		SUAVE #21 at **Hell Vent** in group of palm worms.	**SUAVE**
						R466-26
1615	1546				SUAVE #21 complete. Max T=20C, H2S 650 µmol, Mn 75 µmol, Fe 90 µmol.	
1619	1546	421375	5087135		Surveying **Hell Vent** for Niskin deployment.	
1623	1542				Closing Niskin at **Hell Vent** in buoyant plume at top of triple chimney, top of chimney at 1542 m.	**Niskin**
						R466-27

1626	1544	421374	5087135	Setting up to begin line for Imagenex and Digital Still Camera.
1629	1538	421374	5087150	
1631	1538	421367	5087145	
1632	1546	421362	5087145	Hdg 93, turning on Digital Still Camera, going up by 1 m from 1546, taking picture(s) each meter every 15 seconds to 1536 m.
1639	1536	421366	5087143	Stopped recording video, holding position and changing exposure of DSC to 75, going down by 1 m from 1536 taking picture(s) each meter every 15-30 seconds to bottom.
1646	1544	421358	5087145	Holding position and changing exposure of DSC to 100, same as before but seems to take longer between shots, up from 1544.
1658	1536	421375	5087140	Holding position and changing exposure of DSC to 50 - having trouble firing- got it. Taking pictures every 15 seconds, now going down water column - more trouble.
1709	1541	421381	5087164?	Fiddling with DSC - forget it.
1711	1540			ROPOS going back to cage.
1739	920			Playing with DSC on way up.
1801	500			ROPOS into cage.
1830				ROPOS on deck.

Dive R467


Dive Map

Dive Summary: Dive R467 began with a search for the elevator that was deployed before the dive. The elevator was located and next the search was on for the extensometers deployed on the North Rift Zone. They were located remarkably quickly and all five extensometers were loaded into the tubes on the elevator. An Imagenex survey of the extensometer deployment area was conducted, followed by a search for the 91 Vent. What was believed to be the 91 Vent was located over 50 meters to the west of the original target. The site was named Bob Vent. Suave and biology samples were collected at Bob Vent.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT): Sept. 5, 1998	Date (PDT): Sept. 5, 1998	Deploy elevator Recover extensometers at North Rift
North Rift			

Zone

Date (UTM):	Date (UTM):	Imagenex survey of North Rift area 1 - 2 nautical miles North of the caldera.
Sept. 5, 1998	Sept. 6, 1998	
Julian Day 248	Julian Day 249	Search for "91 Vent" found by camera tow in 1991 and seen again in 1996
Time off deck:	Time off bottom:	
0943	0517	
Time on bottom:	Time on deck:	
1110	0634	
	Total dive time:	
	20 hr 51 min	
	Total bottom time:	
	18 hr 07 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper

Biobox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper on stbd

SUAVE mounted port side interior; sensor on stbd arm

5 liter Niskin bottle mounted on upper stbd bumper bar

2 gas tight bottles with intake on stbd arm: #5 on port ,black tape, #2 on stbd

Claw on port (5 function) arm

Claw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
0820		421200	5096700	Elevator launched.	
0943		421650	5096600	ROPOS launched.	
1015		421189	5096647	Elevator fix.	
1057	1266			Jellyfish.	
1105	1416			Another jellyfish.	
1110	1500			Hdg 200, first task is to find elevator	
1116	1578			Gauge check, SUAVE calibration started at 1115.	
1117	1575			ROPOS out of cage.	
1118	1574			Tether visible.	
1119	1589			Bottom visible, hdg 183.	
1122	1589			Bottom in view again, crab seen on sheet flow, lots of floc in water.	
1124	1587			Elevator 150 m to east.	
1126	1587	421250	5096633	ROPOS fix.	
1127	1588			Jumbled sheet flow, unsedimented.	
1129	1588	421277	5096663	ROPOS fix.	
1132	1586			Strobe on elevator is visible!	
1133	1586			Photos of elevator.	Photo-1
					Photo-2
1143	1586	421230	5096635	Elevator fix; ROPOS next to it.	
1135	1585			Elevator photo.	Photo-3
1136	1589	421325	5096637	ROPOS fix; hdg 130, moving North	FG R467-001
1137	1588	421323	5096641	Elevator fix; photo of elevator anchor	FG R467-002
1140	1588	421313	5096663	ROPOS fix, bad visibility, digital still camera energized.	
1145	1588	421326	5096671	Jumbled sheet flow with rat tail fish in view, ROPOS fix.	
1151	1588	421318	5096691	Still working on the digital still camera.	

1158	1588			Gauge shot, waiting for digital camera to boot up.	
1159	1588			Digital camera on and functioning, sitting in same location, hdg 1.	
1205	1588			Hdg 1, jumbled sheet flow, unidentified	
				white mass, maybe animal, noted that it is best not to send "comments" on the digital camera.	
1213	1586			Changed exposure to 75 on digital camera.	
1214	1585			Digital camera locked up.	
1215	1586			6 meters elevation, can see spider crab, hdg 1.	
1217	1584			Approaching seafloor in one meter increments for digital camera, still testing.	
1221	1588			Changing exposure on digital camera, the white mass is identified as a starfish and is seen again here	
1227	1584			Digital camera locked up again, reloaded	
				then tried to send, failed again.	
1228	1584			Bottom not in view.	
1229	1583			Camera locked up again, hdg 3.	
1232	1582			Heading down seven meters towards seafloor.	
1234	1587			Bottom in view for first time since 1227.	
1235	1587	421333	5096669	In sit cam and main cam, extensometer #2 seen, ROPOS fix, target called **E2F**.	
1237	1588	421334	5096669	View of line on extensometer. Are those organisms or just a frayed line?	FG R467-003
1241	1588			Hdg 303, more views of extensometer.	FG R467-004
1242	1588			Jumbled sheet flow, view of anchor of extensometer, E2.	
1244	1591			E2 in arm, hdg 303, bearing 229 from E2 to elevator.	
1250	1587			Lights off temporarily.	
1252	1582	421339	5096619	Lights off again, SUAVE standardization off.	
1256	1582			Near elevator.	
1258	1584			Extensometer dropped into tube of elevator.	
1259	1586			Breaking to look for extensometer E1, hdg 96.	
1304	1589			In jumbled sheet flow, with sponges seen, hdg 84, no sediment, still a lot of floc in water.	
1305	1580			Bottom not in view, rising to get a good nav. fix, less than 100 m .	
1306	1584	421404	5096619	Bottom back in view, sheet flow.	
1307	1592			Jumbled sheet flow with sponges.	
1311	1591			Smoother lava surface.	
1312	1591			Jumbled sheet flow, then smooth sheet flow.	
1316	1592			Jumbled sheet flow, very little sediment, floc in water.	
1317	1592			ROPOS bumped into lava.	
1320	1591			Jumbled sheet flow.	
1321	1592	421500	5096660	Increasing floc in water.	
1323	1589	421504	5096635	Extensometer, E1 in sight.	
1324	1592			Extensometer base, a lot of biological growth on extensometer.	

1327	1594	421508	5096637	At E1 location.	
1329	1594			Pictures of extensometer 1 in place over	Photo-4
				jumbled sheet flow, sponges on sheet flow.	Photo-5
					Photo-6
1331	1594	421509	5096641	Site called **E1F**; fix is for this location.	
1334	1594			E1 in arm, next target 180m at 270 (elevator), E1 9m from drop site.	
1341	1586			Looking for strobe on elevator--lights off temporarily, hdg 305.	
1343	1585			Elevator in sight.	Photo-7
1344	1581			E1 over tube.	Photo-8
1345	1583			E1 dropped into tube at elevator.	FG R467-005
1347	1589			Fish seen over jumbled sheet flow.	
1350	1589	421302	5096662	Jumbled sheet flow, hdg 272.	
1353	1590			At extensometer 3, E3.	Photo-9
					Photo-10
					Photo-11
1354	1591	421244	5096676	Called actual drop location of extensometer, **E3F**.	
1357	1587			E3 in arm; range of 93 m, bearing 114 to elevator.	
1358	1585			Cage light in sight.	
1359	1585			Elevator in sight, preparing to drop E3 into tube.	
1400	1584			Dropped E3 into tube.	
1403	1561			Cage in site.	
1406	1573			Gauge picture, bottom out of view.	
1409	1588			Jumbled sheet flow, picture of rat tail.	Photo-12
					FG R467-006
1411	1588	421348	5096601	Lavas date at least from the mid-1980s, according to Bob Embley.	
1412	1589	421336	5096614	As with most of this dive, considerable floc in water and lavas have a glassy appearance.	
1418	1589			Spider crab and holothurian seen on jumbled sheet flow.	Photo-13
1424	1589			Approaching drop site for extensometer 4.	
1425	1590	421184	5096642	Jumbled sheet flow.	
1428	1588	421167	5096709	Large rat tail fish.	
1430	1591	421166	5096695	Again a large rat tail.	
1431	1591	421164	5096685	Jumbled broken up sheet flow.	
1432	1589			Extensometer 4 in site, smooth sheet flow.	Photo-14Photo-15
					Photo-16
1437	1588	421149	5096705	Actual drop position of extensometer called **E4F**. Extensometer in hand, hdg 116 to elevator.	
1442	1584			Lights out to find elevator. Found it!	
1445	1581			E4 down the tube at the elevator.	

1448	1583			Transiting to E5, floc in water.	
1451	1590			Blocky sheet flow, some vertical relief.	
1454	1589	421197	5096670	Jumbled sheet flow, no sediment.	
1507	1590	421039	5096723	Rat tail fish. Lots of sponges on rocks.	
1509	1592	420999	5096720	Getting close.	
1512	1590	420959	5096752		
1514	1589	420961	5096765	Looking for E5.	
1518	1596	420971	5096742		
1525	1593	420924	5096772	Still looking, sheet flow, bad visibility.	
1532	1592	420967	5096737	Good ROPOS fix, jumbled topography.	
1534	1592	420952	5096724		
1535	1590	420934	5096742	Found E5, calling actual drop position, **E5F**. Hdg 263.	Photo-17
					Photo-18
1542	1586			Taking extensometer to elevator.	
1605	1587	421321	5096667	Found elevator.	
1607	1585			Extensometer dropped into tube of elevator.	
1609	1585			Looking at elevator.	Photo-19
					Photo-20
1610	1592	421330	5096637	At bottom; looking for a basalt sample.	
1613	1592			Highlights on; trying to grab a rock with the 7-function arm.	
1617	1592			Highlights off.	
1625	1592			Still trying to grab a rock sample.	
1629	1592	421330	5096637	Basalt sample into starboard side of BioBox.	**Basalt**
					R467-1
1635				ROPOS gauge check.	
1638	1582			Looking at elevator	
1640	1582			ROPOS cage in sight; ship positioning for Imagenex.	
1645	1550			Commencing Imagenex survey.	
1701		421455	5096584	Start of Imagenex line NR1.	
1838	1571	420563	5096761	End of Imagenex line NR1.	
1846	1572	420575	5096827	Start of Imagenex line NR2.	
1945		421484	5096631	End of Imagenex line NR2.	
1950		421486	5096702	Start of Imagenex line NR3.	
2050		420589	5096890	End of Imagenex line NR3.	
2105		420594	5096941	Start of Imagenex line NR4.	
2201		421499	5096743	End of Imagenex line NR4.	
2211		421510	5096802	Start of Imagenex line NR5.	
2330	1575	420617	5097008	End of Imagenex line NR5.	

2342		420868	5096986	Moving to the beginning of NR8, which will be next Imagenex line.	
2351	1566			Ship at start of line of NR8, waiting for the cage to catch up.	
0003	1571	421045	5096962	Start of Imagenex line NR8.	
0219	1564	421564	5099004	End of Imagenex line NR8 (extended)	
0227	1635			On the bottom again.	
0229				Jumbled sheet flow.	
0232				Archive tapes on.	
0234				Emerged from collapsed part of jumbled sheet flow.	Photo-21
0238				Jumbled flow hdg 184.	Photo-22
0240				Stubby spire.	Photo-23
					FG R467-007
0241				Same general constructional feature.	Photo-24
0243				Sponge sightings.	
0244				Enteropneust sighting, NOT on sediment!!!.	
0249	1606	1764	8958		
0253				Reeling in some tether then back to bottom a few min later.	
0257				Jumbled flow again.	
0258				Lava surface.	Photo-25
0300				Sediment coating lava.	
0301	1638	421641	5098525	Basalt rubble, very rough terrain.	
0306	1659	421659	5098845	Hdg East, lateral-ing North and South.	Photo-26
0307	1659			Hydrothermal sediment in lava rubble.	Photo-27
0309	1672	421672	5098965	Holothurian on lava rubble, hdg East.	Photo-28
0312	1665			Basalt rubble, hdg 087.	
0314	1711	421711	5098855	Basalt rubble, hdg East.	
0321	1634	421724	5098823		
0326	1634	428854	5091634	No joy in finding vent, proceeding West towards rift zone.	Photo-29
0327	1750			~2 m drop strike N-S, large blocks of basalt in otherwise basalt rubble.	Photo -30
0330	1635	421724	5098842	Basalt ridge, seem to be regularly spaced.	Photo-31
0332	1638			Basalt spires and ridges.	Photo-32
0334	1639			Small patch of Fe sediment, N-S ridges and valleys continue, still hdg West.	
0335	1666			10-15 m South of targeted vent, hdg West.	
0337	1640	421640	5098829	rubbly lava, N-S valleys, hdg West.Photo of crab.	Photo-33
0339	1624	421612	5088838	Lots of crabs, more floc, water slightly warmer (+0.03C).	
0341	1636			Small clams, crabs. Going down and stopping to see animals up close, warm water (+0.02C).	Photo-34
				A few bacteria covered tube worms, clams, gastropods (*Provanna* and *Lepetodrilus*); very weak venting.	Photo-35 FG R467-008
0353	1640	421601	5098849	Sitting at very weak diffuse flow, hdg 274.	Photo-36
0357	1636	421602	5098870	Came off bottom, lots of crabs, clam bed in depression in basalt rubble, 3 µm Mn, no Fe or H2S. SUAVE #1.	Photo-37

					Photo-38
					SUAVE
					R467-2
0403	1640			Motoring around, bacteria fringe on weak vent under crust of basalt--baby tube worms?	
0405	1640	421602	5098856	Testing temperature, rise of only a few millidegrees. Photo of crab	Photo-39
0409	1638			Photos of clam bed in depression in lava. Clams are sitting on thin sediment. Holothurian.	Photos 40-45
0412	1638	421581	5098863	Hovering over clam bed area.	
0418	1639			Small vent = granular white patch on basalt.	Photos 46 & 47
0422				Twisted basalt spire (hornito), proceeding West.	Photos 48 & 49
0423	1638	421532	5098859	Hdg West, 6 m deep depression at 0424.	
0427	1646			Tongue of young glassy lava over older lobate, proceeding South.	Photos 50-54
					FG R467-009
0430	1645			Steep slope of glassy lava, oriented 010¡, proceeding South.	FG R467-010
0436	1639			Succession of depressions, proceeding South.	
0438				Basalt structures (hornitos?); proceeding South.	Photo-55
					Photo-56
0443	1639			Tether caught under a rock.	Photo-57
0450	1634	421571	5098863	Proceeding SE across rift; mid-water following tether back.	
0449	1638			Back to bottom at clam bed, surface wind up to 25 knots. Archive tapes changed.	
0450	1633	421613	5098872	Clams, crabs, tube worms, orange mat, looking for diffuse venting. Find what is thought to be **91Vent**, quite a bit (~50+m) West of **91 Vent** target from Sonne 1996 cruise.	Photos 58-60
0455	1633			Checking out a very slow flowing vent within animal cluster, dominant animal is limpet, some tube worms, polynoids, orange and white and pink mat, hdg 180.	Photo-61
					FG R467-011
0500	1639	421629	5098870	SUAVE #2 of this site. Decided to call it "**Bob Vent**".	**SUAVE**
					R467-3
					FG R467-012
0511	1640	421629	5098870	FG-12 of orange mat.	FG R467-013
				FG-13 of tube worms and orange mat.	FG R467-014
				Fix at 0509.	**Biosample**
				SUAVE #2 finished: Max T = 4.5C, H2S 124 µm, Fe 2 µm, Mn 5µM.	R467-4
				Biosample in port BioBox.	Photo-62
				Photo of tether.	
0517				Returning to cage. Sea state rising.	
				Archive tapes stopped.	
0634				ROPOS on deck.	

Dive R468

 **Dive Map**

Dive Summary:

Dive 468 intended to do simultaneous sampling by HFS and SUAVE of a number of vents in the ASHES field for water chemistry and microbiology. A number of simultaneous samples were taken at Crack Vent, a Niskin sample in a vigorous plume at Hell Vent and a sulfide sample of a small spire at ROPOS Vent. The dive was aborted because of a malfunction in the 7 function arm which made it impossible to manipulate the water sample intakes.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
	Date (PDT):	Date (PDT):	Diffuse flow water sampling with the 'Hot Fluid Sampler'
Axial Seamount	Sept 6, 1998	Sept. 6, 1998	
			SUAVE diffuse flow vents
ASHES vent field	Date (UTM):	Date (UTM):	
	Sept 7, 1998	Sept.7, 1998	One marker (D) to deploy at a sampling site
	Julian Day 250	Julian Day 250	One Niskin bottle
	Time off deck:	Time off bottom:	Pacman for grab of an oxide chimney, SUAVE it first
	0101	0503	
	Time on	Time on deck:	

bottom: 0525

0224

Total dive time:

4 hr 24 min

Total bottom time:

2 hr 39 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Hot Fluid Sampler (HFS) mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Marker D in Pacman

SUAVE mounted port side interior; sensor on 7 function arm

5 liter Niskin bottle mounted on upper port bumper bar

2 gas tight bottles, #6 on port/#7 on stbd arm

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**Frame grabs, photos and samples**
UTM	**m**	**m**	**m**		

0101				ROPOS launched	
0211	1450			In the plume	
0224	1544			On the bottom, oxide mounds	
0226	1543			At **Hillock** (previously called Phoenix), heading to **Gollum**, sheet flow with a bit of diffuse venting, tube worms, clams	
0229	1544	421427	5087165	At **Gollum 2** (not exactly at originally defined Gollum Vent), visible diffuse flow	
0233				Limpets and palm worms, no tube worms at this specific flow site; betacam stopped	
0236		421417	5087167	Going in for a water sample with the HFS at Gollum (note: Gollum has two mounds). Hdg 325 for all sampling operations R468-1 to 9.	
0252		421417	5087167	Collecting HFS water: valve position #10 - a piston sampler, T1=26C and T2=16.6C; T1 is reading at sample tip, T2 is after 2 m of tubing; lost power for a few seconds, fluid sampler down, needs time to reboot; that didn't work, will try cycling power again	**HFS** R468-1
0303				Yea! Fluid sampler working again, pump on	
0306	1544	421418	5087160	Still sampling, T1 = 21C, T2 = 13C	
0308				HFS-1 finished. No SUAVE -- still standardizing.	
0311				7 function arm in uncontrollable spastic motion; several m off bottom while problem is investigated. Not repairable until back on surface. Decided to leave arm extended.	
0332				Proceeding to **Crack Vent** where bottom is smooth and less likelihood of pranging the sensor.	
0334	1545	421426	5087135	**Crack Vent**. Max T = 25C. HFS-2	**HFS**
				Sampler #8 - piston, gas-tight fittings	R468-2
				T1 = 35C, T2 = 21C, SUAVE T = 48C	**SUAVE**
				SUAVE at same place	R468-3
0342				HFS-2 finished, ~200 ml	
				SUAVE-1 start at same place	
0344	1545	421426	5087135	HFS-3 at same place. T1=45C, T2=25C. Valve position #16, filter only (no water sampled). Pumping 150 ml/min. Sample pump shut off when strobe fired. ~250 ml had been taken. Pump restarted. GTB#7 (stbd side) T=40C. At same place. SUAVE-1 continuing, Max T=73C.	**HFS** R468-4 **GTB** R468-5 Photos 1- 2
0357				HFS-3 finished, ~1 liter	
0401		421426	5087135	HFS-4 Bag sample #7. High-T sample at same place. ~115 ml, T max = 170C	**HFS**
				GTB #6 port side. T = 170C. At same place	R468-6
					GTB R468-7
0404				SUAVE-1 finished	
				T ave = ~70C, H2S 500µM, Mn ~62 µm, Fe 12 µm	
0405		421426	5087135	HFS-4 #12 piston sample at same place	**HFS**
				T1 max = 70C, T2 ave = 28C	R468-8
0408				HFS-4 finished	

0410	1545	421423	5087137	T probe overheated and maybe sensor of SUAVE melted so out of action	
0414		421426	5087135	HFS-5 #13 piston sample at same place	**HFS** R468-9
0417				HFS-5 finished. T1 = 135C, 350 ml	
0419				Lost P-code on bridge	
0424				Going to Hillock/Phoenix Vent.	
0426	1546			Arrived at **Hillock/Phoenix**	
				Changed archive tapes	
0428	1546	421399	5087129	Dropping **Mkr-D**	
0430				Maneuvering to sampling small weakly venting spire with Pacman on side of main sulfide structure. Aborted -- do Niskin sample first.	Photo-3 FG 468-001
0436				HFS-6 Bag #3. Background water sample without filter between Hillock/Phoenix and Hell Vents. T = 2.5C	**HFS** R468-10
0439	1540	421397	5087127	HFS-6 finished. ~400 ml	
0441				**Hell Vent**	Photo-4
0443				Hell Vent	Photos 5-8
0444	1541			Niskin sample taken ~1 m above active vent in plume at Hell Vent	**Niskin** R468-11 FG sit 468-002
0449	1545			**Hillock/Phoenix**. Hdg E. Cannot find a spire to sample that doesn't interfere with biology sample sites. Going to ROPOS Vent.	Photo-9
0456	1545			At **ROPOS** Vent.	Photo 10-11
0458	1546			Sampled stump and base of active vent at ROPOS. Most of spire, ~20 cm high, had fallen over.	**Sulfide** R468-12
0503				ROPOS going back to cage	
0507				Winching cage to surface	
0525				ROPOS on deck	

Dive R469

Dive Map

Dive Summary:

Dive 469 obtained a full load of vent fluid and filter samples from various sites locations taken with the HFS within the ASHES vent field: Marshmallow, Bubbler #1 and #2 (where gas bubbles were seen), Styx, Daves and Medusa vents. Although it was intended that SUAVE and HFS samples would be taken together, SUAVE malfunctioned after the first site (Mushroom) and was taken off line. An attempted 5 liter Niskin sample over Hell Vent failed because the trip line was too short.

An iron oxyhyrdoxide sample was taken with Pacman on the south fringe of ASHES at a site named Fe-Hyde.

Four E-W Imagenex survey lines were run between ASHES and the western caldera wall.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
ASHES Vent Field, Axial Caldera SW wall	Date (PDT):	Date (PDT):	
	Sept. 7, 1998	Sept. 7, 1998	Vent fluid samples and SUAVE scans of low-temperature vents
		Date (UTM):	Gas tight water samples at vents to be selected
	Date (UTM):	Sept. 8, 1998	
	Sept. 7, 1998		Niskin sample at vent to be selected
		Julian Day 251	
	Julian Day 250		Pacman sample of iron oxide south of ASHES to be selected
		Time off bottom:	
	Time off deck:	0506	
	1338		
		Time on deck:	
	Time on bottom:	0626	
	1503		

Total dive time:

16 hr 48 min

Total bottom time:

14 hr 03 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

SUAVE mounted port side interior; sensor on stbd arm

Vent fluid sampler intake on stbd arm

Vent fluid sampler on lower front

5 liter Niskin bottle mounted on upper port bumper bar

2 gas tight bottles with intake on stbd arm

Pacman sampler on port (5 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
1338				ROPOS in water over ASHES vent field	
1503	1478			ROPOS out of cage	
1504				Setting up for Imagenex Line A1, east west line at 1500 m	
1511	1523	421406	5987128	Setting up for line	

1532	1523	421612	5087210	Starting line, hdg 271	
1559	1523	421252	5087209	Hdg 269	
1604	1488	421183	5087202	Maneuvering up wall	
1609	1412			Still climbing wall	
1611	1404	421074	5087176	End of line A1	
1615	1400	421067	5087167	Starting line, hdg 90	
1624	1413	421112	5087159	Hdg 90	
1634	1468	421174	5087148	Maneuvering wall	
1645	1505	421220	5087145	Hdg 90	
1651	1536	421254	5087130	"	
1656	1523	421309	5087164	"	
1792	1523	421356	5087134	End of line A2	
1702	1523			Going down. Starting video.	
1704	1544	421345	5087133	To Gollum	
1705	1542	421368	5087135	Bad swells, just knocked computer over	
1712	1537			Locked up, SDS down and had to do a total re-power of ROV	
1718				Balancing color camera	
1722	1542	421360	5087138	Back up, on bottom; spider crab, sponges	
1730	1544	421369	5087136	At **Hell Vent**, going to Gollum	
1732	1544			Going over lobate flows with minimum venting from Phoenix, onto sheet flow	
1733				To Gollum we go... at **Inferno**	
1739	1537	421359	5087149	No comms	
1743	1544			Comms back	
1745	1545	421407	5087147	Looking for diffuse flow	
1746	1546	421414	5087148	"	
1748	1547	421387	5087142	Found some shimmering flow north of **ROPOS** (so much for Gollum)	
1750	1546	421385	5087140	Checking out some diffuse flow with fluid sampler and SUAVE, no good	
1800	1547			Going to Gollum, hdg 45, ended up at Inferno? Something's up with nav.	
1808	1545			Passing **Mushroom**, tube worms, clams, some venting (too hot)	
1813	1545	421419	5087190	North of **Virgin**, going to test some flow for temp	Photo-1
1818	1546	421422	5087178	Testing the waters	
1823	1525			Still checking temperature of flow	
1828	1546	421422	5087178	Still checking-"patience is a virtue"	
1831	1546	421420	5087179	This site shall be called **Marshmallow** Filling piston #13-abort, not filling T1=67 C, T2=35CStarting SUAVE, hdg 50 on all samples	**HFS**
				T= 65C, H2S ?? µmol, Fe ??µmol, Mn ??µmol	R469-1
					SUAVE #1
					R469-2
1836	1546	"	"	Filling piston #12-abort, not filling	**HFS**

				Filled at 1925 (see below)	R469-3
1843	1546	"	"	Dave is fiddling	
1849	1546	"	"	Trying Bag #7-looks like its working, we can see the exhaust	**HFS**
					R469-4
1900	1546	"	"	Sampling #16 Filters only (2) at same site	**HFS**
					R469-5
1902	1546	"	"	Fluid sampler shut off, back on after 20 sec	
1903	1546	"	"	Fluid sampler shut off, back on after 20 sec	
1910	1546	"	"	Trying piston #13 again-it's working!	HFS (same)
					R469-1
1916	1546	"	"	Starboard gas tight bottle at same site	**GTB**
					R469-6
1920	1546	"	"	"Isn't this thrilling?"-Dave Still filling #13	
1921	1546	421422	5087178	Trying Piston #12 again	HFS (same)
					R469-3
1925				Piston #12 is moving, slowly and intermittently	
1929		421422	5087178	Piston #12 sampling complete; piston is half-filled	
1929				Off to Gollum we go	
1930				But first, a photo of **Marshmallow Vent**	FG R469-001
1933				Heading to Gollum	
1938				Tether management problems; we're back-tracking to get the tether off the sharp, jagged lava seafloor.	
2003		421388	5087188	Good fix	
2006	1546	421384	5087169	Good fix	
2008				**Inferno**	
2018				Trying to find ourselves	
2026	1539	421404	5087173	Good fix; still trying to locate ourselves and dealing with the tether, which now appears to be wrapped around ROPOS somehow	
2030				Up in water column dealing with the tether	
2035				Back on seafloor at **Inferno**	
2042	1547	421402	5087166	Good fix near **Mushroom**, 4m W of us	
2050				Continuing to reorganize ASHES navigation net	
2054		421405	5087168	Target Mushroo2 added and then deleted	
				Decided Mushroo2 is the same as Mushroom	
2100	1548	421404	5087167	W base of **Mushroom**	
2102				Bubbles appear to be popping out of diffuse flow vent: named **Bubbler #1**	
2103				Highlights rolling of bubbles emerging from a small anhydrite (?) chimney adjacent to a sulfide chimney	FG R469-002
					Photo-2
2108				SUAVE is off line/in question; we will try to get T of fluids with Dave's Fabulous **Vent Fluid Sampler** (**HFS**)	

2110				Measuring T of vigorous diffuse flow to right of **Bubbler #1** vent: named **Bubbler #2**	
2111				T of 40¡C with HFS T1 probe; T range at T1 probe = 48.7C at **Bubbler #2**	
2114				Bubbles emerging from this mini-vent also (**Bubbler #2**) (here with a max T of 70C)	
2115		421408	5087165	Highlights rolling again; Probe is bigger than vent spout	FG R469-003
2116				HFS Piston #11	**HFS**
					R469-7
					FG R469-004
2122				T1=70C, T2=32C on HFS; piston filling slowly	
2124				Stopped filling HFS Piston #11	
2128				Looking at **Bubbler #1** again to show Big Boy Bob	
2132				HFS Line #17; filter set (3µm and 0.2µm); T1=50C, T2=17C	**HFS**
					R469-8
2134				SUAVE pulled off line by Gary	
2134				HFS Line 17 stopped after 150-200ml	
2135				ROPOS jerked off bottom and failed after losing telemetry	
2138				Trying to reboot ROPOS	
2141				Returning to Cage to assess damage	
2142	1502	421396	5087161	Good fix flying through water column	
2146				Back in business with new telemetry	
2150				We've found **Mushroom** again	
2153				Top of **Mushroom Vent**: clear fluid, no smoke coming from top. There may be some bubbles coming out; Highlights on. There are bubbles!	Photo-3
					Photo-4
					Photo-5
					Photo-6
2155				**Bubbling Mushroom chimney!**	FG R469-005
					Photo-7
2158	1546	421405	5087167	Good fix	
2159				Highlights off	
2201				Worms on Mushroom chimney	FG R469-006
2206				Continue to try to find Gollum, Hdg 143	
2209		421415	5087173		
2210		421424	5087166	Sit and look at tripod markers	
2212				White mounds, Hdg 92, some shimmering, contact with sheet flow	
2215		421435	5087163	Observe clump of worms near tripod marker. This is **Gollum Vent** and it's the best fix we could get at the time.	Photo-8
2230				The scene	Photo-9
2232				Bag sample (filtered) #6 in the worms, T1= 7.5C on avg above ambient (Pump goes on and off a few times), T2 = 6.1C on avg, probably ~500 ml sample	**HFS**
					R469-9

2245				Bio filter #18, T1 = 7C, T2 = 6.2C. 800 to 900 milliliters	**HFS**
					R469-10
2248		421427	5087165	**Gollum** being sampled	FG R469-007
2254				Gas piston #9, T1 = 7C	**HFS**
					R469-11
2302				Moving to a new site, heading SW, whimpy venting	
2307				Just south of **Inferno**, lots of floc and mat in lava depressions	
2309				Hdg 230, looking for diffuse venting, moving over pillow lavas	
2312				at **ROPOS** vent, hdg west to Hell	
2317	1542	421384	5087139	moving to Hell	
2320		421377	5087136	Positioning to trigger a Niskin 5m above the top of **Hell,** didn't work because trip line was too short	
2328	1538	421371	5087131	Continue to look for diffuse venting between Hell and Inferno	
2333		421387	5087130	South of Hillock, still looking for diffuse venting to sample	
2340		421418	5087133	Found a vent to sample, over by Crack vent; palm worms, limpets etc.	
2347		421411	5087132	Slightly better fix	
2350		421413	5087136		
2352		421418	5087132	Bag sampler #2, T1max=23C, T2=9C, collected 350ml of fluid; pump off, then on again, location named **Styx vent**	**HFS**
					R469-12
0000		421412	5087132	Bag sample #2 finished, piston sample# 10 starting at same location	**HFS**
JD251					R469-13
0013				Port gas tight taken, T=14C	**Gas tight**
					R469-14
0019		421407	5087147	Hdg north, for line between Hell and Inferno (NW of Hillock)	Photo-10
0030		421409	5087159	At a diffuse vent, probing it for temperature, up to 16C, decide to take sample	
0033		421409	5087159	Bag sample #23 start, temp. fluctuating between 10-20C, quite a strong current going west (visible with fluid sampler output), named **Daves Vent**	**HFS**
					R469-15
0038				Bag sample #23 stopped, Bag sample #24 start, didn't work worth a damn; trying again	
0043				#24 is pumping!	
0048				#24 done	**HFS**
					R469-16
0051				Bag sample #3 (no filter) start, Tmax-35.8C	Photo-11
					HFS
					R469-17
0102				Frame grabs of Dave's vent, heading ~210 to find some more diffuse venting with worms to get chemistry for a biosample later,	FG R469-008
0107		421397	5087144	Found a good diffuse vent around 15-20 m south of Inferno, probing for temperature, Tmax 6.9C at base of tube worms; lots of palm worms and mat, few tube worms; called **Medusa Vent;** temp varying between 14-18C	Photo-12
		421396	5087139		FG R469-009
0115				HFS bag #4 (with filter) starting, hdg 223, probe looks like it's behind the mound of worms, temperatures from 12.5-19C	FG R469-010

					HFS
					R469-18
0123				Bag #4 done	
0124				Start collecting bag #5 (with filter) at exactly same site (**Medusa**)	
0132		421394	5087141	Bag #5 done, last one. Looking at Medusa biology - lots of palm worms embedded in white mat, a few tube worms with limpets, snails, polynoids; one palm worm with it's buccal tentacles splayed across the mat (like it is deposit feeding?!)	Photo-13
					FG R469-011
					FG R469-012
					HFS
					R469-19
0142		421399	5087134	Looking for oxide mounds to sample, moving south of the ASHES vent field, jumbled flow with scattered patches of the oxide material but no discrete mounds	
0152				Soft ball sized oxide mounds in flow cracks, cruising down a striated sheet flow, hdg south again	
0155		421406	5087100	Over broken flow again, lots of oxides here ('orange flocy stuff'), around 30m south of Hillock, trying to get a sample of oxide mound with Pacman, called **Fe-Hyde**	Photo-14
					FG R469-013
					Oxide
					R469-20
0210				Opened and closed the Pacman to see if any oxide got in, some did, but lost some	
0212				Heading west to the **Wall** (west wall of caldera) jumbled sheet flow with sponges, asteroids; some more oxy-hydroxy mounds	
0220				Tether management	
0243				Big beautiful jellyfish, tether ok, heading back to wall	Photo-15
					FG R469-014
0245				Jumbled sheet flow with oxide mounds, sponges, pressure ridges on ropy sheet flow, older lavas	Photo-16
0248		421336	5087117	Hdg 271, shrimps	
0253		421287	5087119	Clams (shell debris?), rattail	Photo-17
0301	1542			Blocky pillow talus at the base of the west caldera wall	
0303	1543	421257	5087123	Proceeding N along caldera wall. Abundant tube worms, clams, spider crab	Photo 18-20
0306	1545	421259	7137	Young lobate lava	FG R469-015
				Still camera not working	
0310	1544			Lava contact	Photo-21
				Camera working again	
0311				Orange sediment in pillow lavas	
0312	1544	421248	5087179	Shimmering water at cliff face, orange precipitate; site named **Tunnicliff** Fix at 0314 at this same place	Photos 22-23
0315				Dyke in caldera wall	Photos 24-26
					FG R469-016
0318	1544	421239	5087187	Lobate lava at out a few 10's m from wall	
0322	1542	421849	5086630	Back to the wall	

0326	1538	421218	5087238	Old talus with reddish sediment on caldera wall
0328				End reconnaissance of west caldera wall
				Proceeding SW to cage
0343				Stopped archive video
0359		421411	5087174	Start Imagenex survey line A2 Hdg E
				Survey done 25 meters above
0424		421609	5087159	End of line
				Proceeding S to Line A3
0425		421609	5087115	Start Imagenex survey line A3 Hdg W
0444		421300	5087112	End of line
				Proceeding S to Line A4
0450	1522	421283	5087059	Start of Line A4 proceeding E
0506		421608	5087061	End of Line A4
				End of survey
				ROPOS returning to the cage
0513				Cage coming to surface
				Cage on deck

Dive R470

Dive Map

Dive Summary: Sole purpose was to release the elevator with extensometers. Acoustic release would not respond to surface triggering. Successful location and release with no time wasted. No samples were taken.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
	Date (PDT):	Date (PDT):	
	Sept 10, 98	Date (UTM):	Recover the elevator and liberate it from bottom.

Date (UTM): Julian Day 251

Sept 10, 98

Time off bottom:

Julian Day 251 1901

Time off deck: Time on deck:

1700 2043

Time on bottom: 1838h

Total dive time:

3 hr 43 min

Total bottom time: 23 minutes.

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

BioBox

Standard jaw on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time Depth X-pos Y-pos Comments **Frame grabs, photos and samples**

UTM	m	m	m		
1700				ROPOS in water	
1838	1588			On bottom	
1842	1588	421388	5086614		
1844				Begin search for elevator	
1844	1584			Elevator in sight	
1853		421333	5086630	Reaching for pull-pin to find that it was put right under cage, not atop weight.	FG
					R470-001
1856	1590			Reaching again - highlights	
				Can't quite reach - got it. Settling to back sub out....lost it.	
1859				Into ball - got it	
1900				ELEVATOR RELEASED!!	FG
				Position 4601.1' N 13001.0'W	R470-002
1901				BACK TO CAGE	
				ROPOS and cage on deck	

Dive R471

Dive Map

Dive Summary:

In the ASHES vent field, at Medusa, the portable biobox was deployed for later sampling. At Gollum, water samples for stable isotope analysis, tube worms, and white bacterial mat were collected. Bacterial traps were deployed here, as well as an MTR. A gas tight bottle was taken at Mushroom and more traps deployed. A new site, named White Vent, was labeled with Marker I for tube worm collection and later SUAVE. The suction sampler tube was then melted while collecting a gas tight bottle at Inferno vent. The last Niskin was collected at Hell, and the dive aborted to fix the suction sampler.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT): Sept. 8, 1998	Date (PDT): Sept. 9, 1998	Bacterial trap deployment/recovery

ASHES vent field			One MTR deployment
	Date (UTM):	Date (UTM):	
	Sept. 9, 1998	Sept. 9, 1998	
			Three worm clump samples at Gollum, Medusa and area north of Virgin
	Julian Day 252	Julian Day 252	
			Suction samples of chimney sites
	Time off deck:	Time off bottom:	
	0019	0737	Imagenex/DSC of ASHES
		Time on deck:	Sulfide sampling
	Time on bottom:	0900	
	0145		
		Total dive time:	
		0718	
		Total bottom time:	
		0552	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

BioBox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Marker 1 in BioBox

Suction sampler with hose attached to the starboard arm

Two 5 liter Niskin bottles mounted on upper stbd bumper bar

2 gas tight bottles with intake on stbd arm

Portable biobox in claw on port arm

Claw sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

MTR in port biobox

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	**m**	**m**	**m**		
0019				ROPOS launched	
0141				Cage depth 1489 m	
0145				On the bottom; clams, tube worms	
0147		421386	5087108	Approx. 30m south of Hillock	
0150				At **Hillock Vent**, hdg 42 to find Medusa	
0209	1545	421395	5087144	At **Medusa Vent**, hdg 221	
0215				Positioning and opening the portable BioBox	
0220				Trying to sample Medusa; abundant sulfide and palm worms, a few Ridgeia	
0228				Too difficult to sample with claw, going to deploy portable BioBox and come back later to suction sample the site	
0232				Hdg 045 to Gollum	
0235		421409	5087145		
0237				Stbd side Niskin kicked at some unknown time	
0248		421433	5087163	Still trying to find Gollum2, east of Gollum by about 10-15m	
0250		421422	5087166	At **Gollum Vent**, see marker. big blocks of anhydrite-looking stuff, is it just basalt covered with mat? "Anhydrite" stuff looks like it follows some kind of linear structure (contact?) to the NE	Photo-1
		Best	fix		Photo-2
					Photo-3
0258		421422	5087168	Taking a water suction sample into jar #1 Hdg 309	**Suction sample**

					R471-1
0308				Suction sample finished	
0318		421422	5087168	Second sample into jar # 2 at same place. Filtered (for stable isotope analysis). Sample taken at tripod **Mkr-21**.	**Suction sample**
					R471-2
				Frame grabs 002-006 not recorded	
					FG R471-001
0326				Suction sample finished	
0346				Changed archive tapes	
0359		421422	5087168	Sampled tube worms at same place. In port BioBox.	**Biosample**
					R471-3
0415				Deployed 1 of 3 glass wool bacteria traps at same place.	
0417				Deployed **MTR** at Gollum sample site in hole left by tube worm sample. T probe is at the bottom of this type of probe.	
0421				Deployed 2 bacteria traps at same place Hdg 348	
0452				FG of deployment setup	FG R471-002
0456	1544	421420	5087166	Suction sample of white mat on rock ~1 m from trap deployment into Jar #8. Also got chips of basalt glass. Hdg 027	**Suction sample**
					R471-4
					FG R471-003
					Photo-4
0515				Proceeding W to Mushroom Vent	
0517				Arrived at top of **Mushroom Vent**	Photos-5
					Photo-6
				FGs hdg 298	FG R471-004
					FG R471-005
0524				GTB sample in bottle #6 after knocking over small chimney	**GTB**
					R471-5
0527				Close-up views of top of chimney. Strong bubbling seen on Dive 469 are not visible now. Highlights tape on 0527-0531.	FG R471-006
0546	1546			Deployed bacteria trap	FG R471-007
				Changed archive video tapes	
0558	1545	421402	5087168	New position for **Mushroom Vent**	FG R471-008
0603	1544			Looking for a tube worm clump northwest of Virgin to sample for Jean Marcus/V. Tunnicliffe	
0604	1546	421427	5087184	Sitting at a diffuse flow site with tube worms	
0605				Leaving this site and looking around still	
0606	1545	421419	5087183	Mark place for future SUAVE. Named **White Vent**	Photo-7
0615				**Mkr-I** deployed ~1 m W of White Vent	
0616	1545	421416	5087180	Tube worms at **Mkr-I** into stbd BioBox. Hdg 276	**Biosample**
					R471-6
0635				Returning to the cage	

0638	1543	421395	5087163	Arrived at top of **Inferno Vent**	Photos-8
				Hdg 001	FG R471-009
0650				GTB #7 in vigorous vent at top of Inferno Vent. Small chimney to left is "flaming" (gas phase separation). Hdg N	**Gastight**
					R471-7
0655				Melted suction sampler hose connection. Chatting about what to do.	
0704				Video stopped	
0723				Video on; heading to **Hell Vent** to take a niskin bottle at about 5 m above the vent	
0728	1542	421376	5087146	At **Hell Vent** getting into position to trip the bottle. Tripped the Niskin bottle at a depth of 1536 at 07:33:30	**Niskin**
					R471-8
0737				Video off, coming up	
0900				ROPOS on deck	

Dive R472

Dive Map

Dive Summary:

Sulfide and palm worms were collected with the suction sampler at Medusa, Inferno, and Hell (previously SUAVEd sites). Additionally, tube worms were collected in the BioBox at Hell and Medusa. A Niskin, gas tight bottle, and diffuse flow were collected at Hell, and a background water sample also collected between vent sites. Orange iron oxides were collected with Pacman at a newly named site, Stevemnd, and more orange bacterial mat was collected with the suction sampler near Gollum.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
ASHES	Date (PDT):	Date (PDT):	Suction sample tube worms at:
	Sept. 9 1998	Sept. 9, 1998	Medusa
			Inferno
			Hell
	Date (UTM):	Date (UTM):	Phoenix

Sept. 9 1998	Sept. 9, 1998	
		Gas tight water samples at vents to be selected
Julian Day 252	Julian Day 252	
		2 Niskin sample at vent to be selected
Time off deck:	Time off bottom:	
1206	2000	
		Sample biology and sulfides at SteveMnd
Time on bottom	Time on deck:	
1322	2137	
	Total dive time:	
	09 hr 31min	
	Total bottom time:	
	06 hr 38 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Biobox mounted lower center work area

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Slurp gun with hose attached to the 7 function arm

(2) 5 liter Niskin bottle mounted on upper stbd bumper bar

2 gas tight bottles with intake on stbd arm

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
1206	0	421395	5087140	ROPOS launched	
1322				Reach bottom	
1326				Near Phoenix, white mat, looking for Medusa	
1327		421392	5087128	Rattail fish, floc in water, looking for Biobox	
1329				Approaching **Medusa**, moving into position, lots of tube worms, palm worms and sulfide worms	
1331		421393	5087143	Getting into position to take first sample	Photo-001
1338	1546	421395	5087141	Setting up to sample suspended particulates into jar #1	
1346	1546	421395	5087142	Begin 10 minute pumping and filming of Palm and Sulfide worms at **Medusa Vent**.	**Biosample**
					R472-1
					FG R472-001
1400	1546			Still filming and sucking	
1402	1546			Frame grab of suction tube, observing palm worm feeding on tube	FG R472-002
1404		421395	5087142	Still pumping, highlights on; viewing very long palm worms eating the tube of tube worm	
1408				Stop pumping and highlights	
1410		421395	5087142	Sucking sulfide worms into jar #2	**Biosample**
					R472-2
1419				Finish sampling sulfide worms, secure sampler	
1422				Looking for sample to grab with Pacman	
1424	1546	421397	5087141	Rock and animal sample into portside BioBox	**Biosample/**
					Rock
					R472-3
1436				Transit to Inferno, white mat	Photo-002
					Photo-003
					Photo-004
1438				Tube worms, white mat	
1444	1546	421395	5087165	Base of **Inferno Vent** on the Southeast side;	Photo-005
				preparing to sample sulfide worms that were scanned on an earlier dive	

					Photo-006
					Photo-007
1447	1546			Preparing to sample the sulfide worms into jar #3 on the suction sampler; jar #3 is in place	
1451	1546			Sucking sulfide worms into jar #3	**Biosample**
					R472-4
					FG R472-003
1502	1546	421395	5087165	Still sucking	
1510				Looking around Inferno	
1511	1545	421382	5087139	Going to Hell	Photo-008
					Photo-009
					Photo-010
					Photo-011
					Photo-012
					Photo-013
					Photo-014
1515				At **Hell Vent**	
1516	1545	421374	5087135	Positioning to suck worms; filling jar #4 at the base of Hell (cleaning off right side of **Porkchop**)	**Biosample**
					R472-5
					FG R472-004
1531	1545			Looking for a place to get water	
1535				Lost "G" in RGB; powering down and up again; photo of Porkchop	Photo-015
1546				Stopped video	
1550				Moving on to flange of Hell; started videos; got colors back, still funky	Photo-016
1554		421365	5087136	Positioning to get worms of flange	
1604		421374	5087138	Getting worms and flange from Hell into starboard BioBox	**Biosample**
					R472-6
1611	1545			Going to Phoenix; surveying Phoenix	
1614	1545	421392	5087133	Surveying worm site for sucking; got camera color completely back	FG R472-005
				Phoenix Vent	FG R472-006
1631		421389	5087133		
1636		421390	5087134	Positioning for sucking sampler; sucking sulfide worms into Jar #5	**Biosample**
					R472-7
					FG R472-007
1647	1544	421382	5087135	Collecting background water sample into Jar #6 about 1 m off floor	**Microsample**

					R472-8
1654				Going to Hell	
1656				Looking around base of **Hell Vent** for low temp diffuse flow sampling	
1703		421375	5087137	Looking north of Hell for tube worms for diffuse flow sampling	
1712	1545	421373	5087138	Collecting diffuse flow from group of tube worms just north of **Hell Vent** into Jar #7	**Microsample**
					R472-9
1725				Sucking water for 2 min hdg 303	FG R472-008
1732				Firing gas tight bottle starboard side	**GTB**
					R472-10
1736				Going to look for oxide mounds, hdg 070	
1741		421399	5087144	At Medusa; hdg 041; lots of bacterial mat	
1742		421403	5087144		
1746				Large rattail fish; looking around near mkr 114; white anhydrite mounds; following white cracks, more iron rich sediment	Photo-017
					Photo-018
1749		421435	5087127	Iron oxide mound east of Crack vent; fiddling with camera colors; no red	FG R472-009
					Photo-019
1755		421435	587130	Highlights on **Steve Mound**; lighter and darker colored materials; target	
1758		"	"	Collecting some oxide material with Pacman	**Oxide sample**
					R472-11
1800				Big crab!!!	FG R472-010
					Photo-020
1804				Lots of little oxide mounds; no hydrothermal activity visible; highlights off	Photo-021
1808				Tether wrapped around base of **Phoenix/Hillock**	Photo-022
					Photo-023
1810				Going to Gollum, hdg 40	
1816	1543	421402	5087141	Still looking	
1820				At **Gollum Vent**, looking for orange mats	
1822		421425	5087161	Problem with camera joystick	
1828		421420	5087159	Looking east for Moyer's orange stuff	
1829	1545	421428	5087149	Still looking	
1836		421415	5087148	"	
1839		421421	5087168	"	
1842		421418	5087151	"	
1849		421384	5087154	"	
1851		421402	5087152	"	
1853	1543	421415	5087156	"	
1857		421421	5087149	Suction sampler #8 of orange/yellow mat; coarse filter, **oxide mounds** just south of Gollum	**Oxide Sample**

					R472-12
1907		421421	5087148	Oxide mounds as above	FG R472-011
1912	1546	421423	5081743	Digital still camera tests as a function of depth	
1948	1538	421371	5087133	Right side Niskin closed 5 meters above **Hell Vent** in the plume	**Niskin**
					R472-13
2000				Heading home	
2137				ROPOS on deck	

Dive R473


Dive Map

Dive Summary: Dive R473 began at Easy Vent where five HFS samples were taken and a suction sample. ROPOS proceeded to Milky Vent were a suction sample of mat was taken. Continuing south to Roof Vent two HFS samples were taken and gas tight. Continuing couth to Snowblower Vent (near The Pit Vent) HFS and suction samples were taken. Mkr-33 and Cloud Vents were sampled next, followed by Mkr-108 Vent. Castle Vent was visited last where HFS recorded temperatures as high as 274C!!

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
	Date (PDT):	Date (PDT):	
Axial Seamount	Sept. 10, 1998	Sept. 11, 1998	Fluid sampling with High Temperature Fluid Sampler.
Vent fields on east side of caldera	Date (UTM): Sept. 10, 1998	Date (UTM): Sept. 11, 199 Julian Day 254	Imagenex along contact from Castle and 600 m North. (This didn't happen) Suctioning bacterial mats and polynoid polychaetes at low temperature vents.

Julian Day 253	Time off bottom: 1314
Time off deck: 1545	Time on deck: 1449
Time on bottom: 1706	Total dive time: 23 hr 04 min
	Total bottom time: 20 hr 08 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper center of bumper

Suction sampler with hose attached to the port arm; Bottles #1, #3, #4, #5-20 µm; #6-64 µm, #7-125 µm, #8 and #18 double-200 µm.

Hot fluid sampler (HFS) in lower work area with intake on stbd arm

5 liter Niskin bottle mounted on upper stbd bumper bar

2 gas tight bottles with intake on stbd arm: stbd #7, port #6

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
1545				ROPOS launched	
1706	1527			ROPOS on bottom	
1708				Looking for venting out of orange mounds near **Oxide Vent**	
1711	1532			Jumbled sheet flow, looking for **Oxide**	
1712	1526	423632	5088462	Found orange stuff, looking for flow now	
1716	1533	423642	5088460	Creepy black fish	Photo-1
1719	1532			Broken up flat cracked lava with orange stuff in the cracks; still looking for flow?	Photo-2
					Photo-3
1723	1529	423684	5088458	More orange stuff, no flow	
1726	1532			Lots of floc, pretty flat bottom, striations in lava, lots of orange gunk	Photo-4
1729	1532			Big deep cracks with orange stuff in them	
1731	1531	423651	5088433	More jumbled, still lots of orange, no flow but some kicked up floc	Photo-5
1735	1531	423602	5088428	Probing temp of orange under rock; let's reset, eh? No nav;	
1740	1532	423648	5088432	No temperature anomaly detected	
1742	1531			Unhappy pump	
1750	1531			Happy pump; giving up and going to **Easy Vent**	Photo-6
1752	1532			Fresh looking basalt with orange stuff	
1755		423681	5088455	Around **Easy Vent** area; looking for a good place to sample; shiny dark basalts; lots of scale worms and floc	
1758	1532			Temperature probe; climbing to 10C; lots of white and orange floc, hard to tell exactly the source of the venting	
1801	1531	423679	5088458	Fluid sample; hdg 207; Bag #2 with filter; app. 6-700 ml	**HFS**
					R473-1
1814	1532	"	"	Fluid sample; hdg 207; Filter #1 (.22 µm Sterivex); loss of comms, re-powering and rebooting; Dave's picky pump	**HFS**
					R473-2
					Photo-7
1822	1532	423679	5088458	Pump happy again; trying sample again while we zoom in on scale worms and some strange looking worm with eye? in the middle	
1830	1532	"	"	New big polynoid with white setae of unknown species- what a day, 2 new worms!	
1840	1532	"	"	Fluid sample; hdg 207; Piston #10	**HFS**
					R473-3
1853	"	"	"	Fluid sample; hdg 207; Filter #16	**HFS**
				(3 µm and .22 µm Sterivex); more worms different from Mkr-33	R473-4
1911	"	"	"	Fluid sample; hdg 207; Gas piston #8	**HFS**
					R473-5
1914	1532	"	"	Moving into position to get worms and mat; probing temperature near worms- max 6C	Photo-8

1932	1532	423674	5088454	Suction sample; hdg 235; Jar #6; polynoids and white bacterial mat	**Suction sample**
					R473-6
1954	1532	"	"	Trying to get mat out of hose	
1956	1533			Getting ready to move south towards **Milky**; lots of floc	Photo-9
2003	1530			Hdg 170; lots of floc; wall of pillows, drainback features; see more milky fluid; venting associated with pushed up feature; continuous milky venting; jumbled up blocks, displaced blocks of lava (recent tectonic activity?)	Photo-10
					Photo-11
					Photo-12
					Photo-13
					Photo-14
2009	1530	423675	5088437	Halfway between **Easy** and **Milky**; tons of floc; older lava; hdg 172	Photo-15
					Photo-16
2011	1529	423680	5088443	Glassy basalts; slabs on the floor;	Photo-17
					Photo-18
2013	1530	423679	5088420	At **Mkr-N2** near **Milky Vent**	Photo-19
					Photo-20
					Photo-21
2015	1532			Positioning to slurp bacterial white mat near **Mkr-N2**; see bacterial trap	Photo-22
					FG R473-001
2024	1532	423686	5088421	Suction Sample; hdg 140; Jar #1; white bacterial mat with some worms	**Suction sample**
					R473-7
					Photo-23
					FG R473-002
2038	1530	423679	5088409	Done sucking; Hdg 178 to **The Pit**; following venting line south; more milky diffuse venting along west side of ridge; The **Milky Way**	Photo-24
					Photo-25
					Photo-26
					Photo-27
2044	1531	423678	5088404	Highlights on; Target **Fissure** at this fix; suction pump was flushing for 10 min; highlights off at 2048; big new worms snuggling	Photo-28
					Photo-29
					FG R473-003
					FG R473-004
					FG R473-005
					Photo-30
					Photo-31
2054	1530	423677	5088366	Jumbled flow; giant pit sinkhole thing; slabs of basalts; some milky venting; lava cave;	Photo-32

				jumbled up	
		423676	5088361		Photo-33
					Photo-34
					Photo-35
					Photo-36
					Photo-37
					Photo-38
					Photo-39
					Photo-40
					Photo-41
2059	1529	423686	5088317	Sheet flows; hdg 180; lava highway; flat sheet flow with greenish looking sediment;	Photo-42
					Photo-43
					Photo-44
					Photo-45
2102	1528			Thrust fault; on a ridge with flat sheet flows down below; large drainback feature;	Photo-46
					Photo-47
					Photo-48
					Photo-49
2104	1526	423674	5088283	New looking lava flows	Photo-50
					Photo-51
					Photo-52
2107	1525	423684	5088240	Large crack; pit; large crack between two ridges; looks like a Grand Canyon	Photo-53
					Photo-54
					Photo-55
					Photo-56
					Photo-57
					Photo-58
2110	1526	423682	5088220	Going over this large crack with thick mat; coming to end of fissure; more continuation of fissure, just shifted over to the east	Photo-59
					Photo-60
					Photo-61
					FG R473-006

					FG R473-007
					Photo-62
					Photo-63
					Photo-64
2112	1523	423682	5088193	Still looking over this giant fissure with thick mat cover	Photo-65
					Photo-66
					Photo-67
					Photo-68
					Photo-69
2114	1523			Still over the fissure; pieces of fallen blocks of lava in fissure	Photo-70
					Photo-71
					Photo-72
					Photo-73
					Photo-74
					Photo-75
2116	1523	423677	5088140	Some diffuse flow visible in fissure; some venting holes with diffuse flow coming out	Photo-76
					Photo-77
					Photo-78
2120	1523	423690	5088129	Stopped ship; taking the temperature of a hole with shimmering water	
2124	1523	423711	5088109	Target **Roof**; going to sample on east side of fissure; white and orange mat material	Photo-79
2134	1523	423694	5088136	Good fix; looking for place to sample flow; fiddling with camera	
2143	1523	423677	5088120	Sampling water from crack; finicky fluid sampler acting up again; Tmax 14.6C; Fluid sample; Bag #4; T1=10.7C	**HFS**
					R473-8
2201	1523	"	"	Gas tight bottle sample	**GTB**
					R473-9
2202	1523	"	"	Fluid sample; Bag #3 without filter	**HFS**
					R473-10
2213				Proceeding south, Fe mat coating, drained out lava, Hdg 180	Photo-80
2214		423682	5088107	The lava scene	Photo-81
2215	1522	423679	5088094	More venting with oxide deposits	Photo-82
2217				as above	Photo-83
2218		423693	5088067	The scene; oxide between pillows	Photo-84
					Photo-85
					Photo-86
2220		423693	5088048	Lava tunnels	Photo-87

2223		423724	5088047		Photo-88
2224				Big hole	Photo-89
2225		423749	5088052	Mat covered lava, Hdg 110 (has been a side trip)	FG R473-008
2226				Lava scene	Photo-90
2227				Hdg 192, drained out young lava with mat	
2228				Drained out area	Photo-91
2229				Lobate flow to lobate pillows	Photo-92
2230		423736	5088009		
2233		423723	5087991	More drained out area	
2236					Photo-93
2237				Cracked sheet flow, N to S crack, under a pit, Ratty Fish	
2238				Lobate flows atop drained out area	
2240				Lobate flows, pillow lavas, hey there's no mat here	
2241		423711	5087910	Pit, loads of roof collapse	Photo-94
2242				TWO fish, wooooooo!	
2243		423715	5087843	Yellow mat, active venting	Photo-95
					Photo-96
					Photo-97
2246				With mat too	Photo-98
2248		423712	5087852	Side of pit with a lot of white mat	Photo-99
2249				More mat atop elevated area	Photo-100
2250				Venting	
2251		423720	5087837	Surface, some snow NOTE: "Photo-102" was logged twice and so since we do not know if these are actually the same picture, they are called a and b.	Photo-101
					Photo-102a
2253				Contrast between shades of lava	Photo-102b
2255				Venting	Photo-103
2258				A petroglyph, close in shot of mat peeling off the lava, was it from ROPOS on a previous dive?	FG R473-009
2304				Fuzzy rock, close up of mat; stopping to try and get a good fix	Photo-104
2309				Ugly fish, close up...cool	FG R473-010
2312				Hdg 180 to find Pit vent	
2314	1521	423718	5087823	At the **Pit Vent**, **Mkr-N1**	Photo-105
					FG R473-011
2322	1521	"	"	Specifically at **Snowblower Vent** (a little hole spewing floc next to the Pit); turned HFS pump on, not getting much of a signal, Temp up to 5.7ûC	
2334	1521	"	"	Decided to give **Snowblower** a nudge to increase flow - seems to have worked, more floc coming out; sucking out the goop into bottle #5, hdg 253	**Suction sample**
					R473-11
2344	"	"	"	Polynoid on the lava directly above Snowblower hole; still sucking	
2347	"	"	"	At hole; positioning for sample; temp max 11.3C; fluid sample; Bag #5	**HFS**

						R473-12
0007	"	"	"		Going to look for white floc	Photo-106
JD254						Photo-107
0017					Sucking up some more floc into the same bottle (#5-adding to R473-11); at **Pit**, just a different hole, within a meter of **Mkr-N1**, hdg 289. No polynoids.	FG R473-12
0030					Zooming in on the new species of polynoid (unknown sp. #1)...ohhh so beautiful! Tried to suck one up into bottle #5 but suction power wasn't enough	FG R473-013
						FG R473-014
0048					Pillow lavas, moving south along a line to **Mkr-33**, hdg 175	Photo-108
0052	1520	423711	5087763		Lobate lavas covered with mat-like material; drained out area	Photo-109
0054	1519	423712	5087739		Lava spires, view underneath shelves	Photo-110
0058					More lobate lavas, shallow drained out flows, mat covering	
0100	1520	423721	5087697		As above, picture of the inside of a collapsed structure	Photo-111
0104					Ropy lava, small spire; push up structure, broken-up rope flow	Photo-112
						Photo-113
0107					Jumbled flow, hackled flow; fish	
0109					Jumbled flow, a little floc in the water	
0110					Broken-up ropes again, transition to flatter ropy sheet flow	
0111					Spider crab; a lot of yellow, iron rich material on lavas, flatter area with broken-up slabs	Photo-114
						Photo-115
0115	1523	423760	5087524		Push-up structure	Photo-116
0117					Flat striated sheet flow, floc getting more intense?	Photo-117
0118					Rattail; in a drained out area	Photo-118
0120	1517	423020	7508380		Spire in drained out area, just came up out of drained-out area	Photo-119
0121					Edge of lava flow	Photo-120
0125					Ropy lineated flow, pressure ridge; floc in water	
0127					White floc on lavas, fall out from water; fallen down spires	Photo-121
						Photo-122
0131	1517	423849	5087201		Starting to see some venting, black lavas with white bacterial mat in depressions	Photo-123
						Photo-124
						Photo-125
0137	1518	423896	5087138			
0140	1523	423852	5087098		At **Mkr-33**	
0147					Looking at Moyer's bacterial traps that were deployed last week, heavily colonized!	Photo-126
						FG R473-015
						FG R473-016
0200					Lost telemetry to ROPOS	
0207					Telemetry back up, trying to find mkr 33 again	
0216					**Mkr-33** again	
0235					Positioning to take water samples, pump on, temp max=27C, not good enough, moving around to find a better spot	R473-17

0256					At a new spot in the crack, temp max=30C, start taking a water sample (0259), piston #11. T dropped so turned off pump, moved inlet slightly and continued sampling. T max = 37C.	**HFS** R473-13
0311					Still sampling (hfs)	FG R473-018
					GTB sample #7 at T = 34C	**GTB**
					NOTE: GTB sample not sequential because was not originally given a sample number (missed it)	R473-30
0316					HFS finished	
					Changed archive videos	
0317	1522	423851	5087098		Taking filter sample set #17. T1 max = 54C, T2 = 22C. Hdg 237	**HFS** R473-14
0340					Still sucking	FG R473-019
0345?					Filtering finished. Selecting bag #24 with filter to take a water sample at the same place.	**HFS** R473-15
0355					Sampling finished. T ave = 40C, ~700 ml	
0401					Dragged a bacteria trap a few cm when sub backed away from the site. Rope appears to be caught on something on the sub. Repositioned the trap.	
0410					Looking for bag creature sample site at **Mkr 33** ~1 m NE from the water sampling site	
0412	1522				Bag creature site	Photos 127-128
0418	1522	423851	5087104		", Hdg 223	FG R473-020
0429					Sampling bag creature and mat with suction sampler into bottle #18	Photo-129 **Suction sample** R473-16
0438					Still sampling	Photo-130
0440					Sampling finished	
0443					Vent at **Mkr 33**. Hdg 280	Photo-131 FG R473-021
0446	1522	423854	5087099		"	
0448					Sampling white mat from within the **Mkr-33 Vent** with the suction sampler into jar #3	**Suction sample** R473-17
0510					Sampling finished. Now going to shoot some scale worms. New species?	
0513					Suction sample of scale worms and polychaetes at **Mkr-33 Vent** into jar #7	**Suction sample** R473-18
0516					Changed archive videos.	
0533					Now have 2 worms. Proceeding E to Cloud Vent.	Photo-132
0555					Arrived at **Cloud Vent**	
					There has been a rock slide at **Mkr-N4** that has covered the vent.	
0627	1522	423890	5087117		HFS sample #23 bag sample with a filter at **Cloud Vent**. T1=20C. Fix not high quality because ROPOS is in a hole.	**HFS** R473-19
0633					HFS finished.	

					Suction sample of 20C vent fluid at same place in Cloud Vent. Jar #4	**Suction sample**
						R473-20
0645					Suction sample finished. Proceeding to **Mkr 108**.	
0700					Flying through the water with the greatest if ease, to **Marker-108**	
0714					Video stopped	
0729	1523	423861	5086588		Video on, on the bottom , Looking for **Marker 108**, moving over sheets with lots of deposits, drain feature, sheet flows	Photo-133
0732	1520	423827	5086576		Ropey flows heading 290 , broken sheet flows, crack heading 310, heading over ropey flows	Photo-134
						Photo-135
0738	1518	423787	5086567		Lava pillar about 5 m tall to the top of a sheet flow, active mat on the edge of a pit,	
0740	1522	423786	5086590		At **Marker-108**, which is on top of a pillar. heading 359 looking at the base of the pillar.	Photo-136
						Photo-137
0744	1522				At the base of the pillar looking for worms, we are facing 349 at a depth of 1522, Looking for a combination of white mat and worms.	
0747	1522				Heading 358, suction sampler Jar 8, at base of the pillar, hard time getting into position, pump on at 0755, cleaning off the rock that had worms on it. some bag creatures are at this site, sucking up worms, want to get at least 12 worms	Photo-138
						Suction sample
						R473-21
0800					Moving around to find more worms, snow storm, waiting for the snow to fade.	
0804					Moving around to look for more worms , trying the drive and suck technique. near the top of the pillar, trying to suck them up one at a time,	
0808	1520				At top of pillar, sucked up 4 worms, then 3 more, then a few more, mice pillows at the top of the pillar. Took about 14 worms, ended at 0830	Photo-139
0840	1522	423786	5086593		Temp 13C, HFS Piston 12 at **Mkr-108**	**HFS**
						R473-22
						FG R473-022
0855	1522				HFS bag #6 filter, same site as above	**HFS**
					done at 0904	R473-23
						Photo-140
0905					Off to castle vent at a depth of 1516,	
					video off	
0918	1486	423818	5086569		Swimming through the water column	
0944	1524	424060	5086294		Back on the bottom, lots of sediment, heading of 281	Photo-141
					Highlights (Steve), crab	
0947					Nice pillow	
0948	1514	424038	5086293		At the **Castle** structure, heading at 299, found a nice chimney to take later, going all the way around the structure, went about half way and then went back around the other side, blue color on rocks	Photo-142
						Photo-143
						Photo-144
						Photo-145

					Photo-146
					Photo-147
0952				Going to face NE to see venting at the base of the structure, looking for a marker and an active structure	Photo-148
0955	1517			Found marker N5 (=**Flattop**, near **Castle**), moving around tot he right, lots of white floc, looking at a depth of 1520	
1005				Going around the base of the structure, still looking for the site of vigorous venting, back to N5	Photo-149
1010				Stopped Steve's highlight tape nice pillows	
1014				Steve's Highlights at the top of the structure, taking pictures.	Photo-150
					Photo-151
					FG on sit
					R473-023
					R473-024
1018	1520	424022	5086306	GREAT NAV, At the site, the new chimney is now about 50 cm high, about 10 cm in diameter, venting water; LOST THE RED;	
				Highlights are off	
1023	1520			Highlights are back on, taking a water sample with the HFS	
1028				Chimney is no longer!!!!! Temp in hole is 268C max	
1038	1520			HFS sampler, Piston sample #13 at about 260C done at 1049;	**HFS**
				Gas Piston Sample #9 at same site start time 1050 and ended at 1052	R473-24R473-25
1053	1520			HFS sampler, Bag Sample #7 same place, stopped at 1059	HFS
					R473-26
1100	1520			HFS sampler, Filter #18, same place	**HFS**
				stopped at 1115	R473-27
1116	1520			Temp. probe stuck in hole at castle vent,	FG R462-025
				probe around to find highest temp, 274C was highest temp.	
1129	1518			Niskin Sample at 1518 above **Castle Vent**	**Niskin**
					R473-28
1132	1521			Hdg 044, SW side of the castle spire trying to grab an old piece of spire	
1147	1521			Sample grabbed, mature sulfide spire	**Sulphide**
					R473-29
1150	1521			Heading South to the start of Imagenex line C1.	
1201	1497	4052	6237	Beginning line C1. Hdg. 009.	
1232	1487	4062	6563	End line C1. Heading to C2. Hdg. 095.	
1256	1505			Halfway up C2. Heading 010.	
1310	1495	4203	6550	End of line C2. End of dive. Returning to cage for recovery.	
1449				Sub on deck.	

Dive R474


Dive Map

Dive Summary: Dive R474 started by attaching a recovery line to the rumbleometer. From there ROPOS proceeded do to E-W mapping traverses to the north end of the eastern vent field. Contacts 5 through 12 were mapped. A rope from a mooring that was in place before the NeMO98 cruise was spotted. A sled mooring of some type from and experiment? was sighted and photographed. Mkr-N41 and MTR4126 were deployed in the same spot. Mkr-N44 was also deployed. Suction samples were taken at several areas. Bacteria traps were retrieved near Mkr-N2, the osmosampler was deployed at the same site.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
	Date (PDT):	Date (PDT):	Deploy weight and attach line to Rumbleometer for stage 1 of recovery attempt
Axial Seamount	Sept. 11, 1998	Sept. 12, 1998	E-W mapping traverses to north end of eastern vent field. Suction and rock samples along track.
East side of Caldera			Suction sample of mat at The Pit Vent
	Date (UTM):	Date (UTM):	Deploy OSMO sampler and recover bacterial traps.
	Sept. 12, 1998	Sept. 12, 1998	Imagenex survey at north end, east side of caldera (~12 hours).
	Julian Day 255	Julian Day 255	
	Time off deck:	Time off bottom:	
		1555	

0400

Time on deck:

Time on bottom:

1730

0535

Total dive time:

13 hr 30 min.

Total bottom time:

10 hr 20 min.

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm camera and strobe mounted side-by-side on upper center of bumper

Suction sampler to be manipulated by the port 5 function arm

Biobox

OSMO sampler

Markers

2 of 5 liter Niskin bottle mounted on upper stbd and port bumper bars

2 gas tight bottles with intakes on port arm

Standard jaw sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Cage has anchor chain attached to it with a hydraulic release and 50 m of nylon rope.

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
0244				ROPOS launched twice and water alarms caused sub to come back up on deck.	
0400				ROPOS launched. First job is to **attach a line to the rumbleometer** for stage 1 of recovery.	
0502	1069			Descent continues. No more technical problems.	
0526	1448			Cage stopped. Problem: cannot unclamp ROPOS.	
0535	1447			ROPOS out of cage. Keith S. driving	
0541				Sonar contact with weight on end of 50m nylon rope at 17m range	
0542				Rope sighted in RGB camera. Following it down.	
0543				Weight sighted. Hard to see. Should have painted it white.	
0546				Weight on bottom	
0548				Nylon line released and falling to bottom. Archive tapes started.	
0553	1520			Arrived at rumbleometer. It is sitting close to a large area of drained lava lake with spectacular columns	
0557				Taking snap hook with line over to rumbleometer	
0603		423714	5086760	Highlight tapes on (S and beta)	
0606				Attaching ROPOS to rumbleometer with port arm	FG R474-001
0612				Chain on rumbleometer hooked by Dutchie. Wild applause! Rope is around a skid of ROPOS (not good).	Photo-1
					FG R474-002
0615				ROPOS disentangled (whew!). Entire operation from time ROPOS came out of the cage took 40 minutes. Proceeding to look at lavas in this area.	
0624	1521	423725	5086716	Exploded pillows; sheet flow broken, curtain drapes in places	
0627	1521			Sheet lava -- appears to be the same that rumbleometer is caught in. No colonization so must be young	Photo-2
0628				~1 m high pillar = thickness of flow?	Photo-3
0630	1520	3692	6732	Continuing N in drained lava lake past lots of columns. Look like ancient columns. Height of column measured with sub is ~1.5 - 2 m	Photo-4
					Photo-5
					Photo-6
0637		423708	5086783	Surveying basalt columns. Photo of broken lava at rumbleometer.	Photo-7
0645				FGs of rumbleometer	FG R474-003
				Photos of ~1 m basalt column	FG R474-004
					FG R474-005
					FG R474-006
					Photo-8
					Photo-9

0647		423777	5086754	Basalt columns are ~2 m high; partial roof remains. Photos of this structure. Could see underside of roof. Roof is 10 cm thick. Proceeding W to start of mapping Line B1.	Photo-10
					Photo-11
					Photo-12
					Photo-13
					Photo-14
					Photo-15
					Photo-16
					FG R474-007
					FG R474-008
0658				Noticed stbd Niskin bottle is gone.	
0702	1518	423668	5086706	Holes in lava, sheets, photo of the surface of the lava	Photo-17
0706	1520	423623	5086728	Pillows, lightly sedimented, turns into sheet flows (local) mixed with pillows	
0709	1520	423578	5086712	Lobate lavas, glass flows, some drain out features, question of "old looking?", crab. some glassy flow with less sedimentation, more glassy look. #19 is the contact between the glassy stuff and the "older" stuff. glassy pillows	Photo-18
					Photo-19
					Photo-20
0715	1520	423479	5086682	Contact ?????? keep going, collapse on a young flow, looking like old rock	Photo-21
					Photo-22
					Photo-23
0718	1522	423449	5086694	Keep going to see if this is a local outcrop of older material, heading 306, sheet flows, crab is in the frame grab	FG R475-009
0723	1525			Sheet flows heading 331, old crust, linear features in the basalt, we are going across the grain at a heading of 5.	
0726	1526	423370	5086782	Sheet flows, lineated, ropy, old basalt, lots of sediment, very rough surface, came across an abrupt surface, heading 5, photo between the flat and rough surfaces	Photo-24
0732	1525	423374	5086828	Small pillows, with lots of macrobiology on the basalts, old basalt given the organisms, drain features, an overhang with a pillar, the whole thing is and overhang with pits	Photo-25
					Photo-26
0741	1522	423375	5086918	Pillows, lots of animals on the basalt, crab, FG of the crab	FG R475-010
0748	1522	423377	5087023	Pillows, some sediment between pillows, the sub has turned east, heading at 92	
0754		423447	5087045	Went over a scarp, still on the old lavas	
0756	1522	423467	5087045	Contact, new vs. old, contact 5 (new target), nice new pillows, new lave have no sponges, old lavas have lots of sponges	Photo-27
					Photo-28
0800	1522			New pillow lavas in the floor of the collapse, some older pillars stick up amongst the new basalt, KEY to young versus old is the biology, thin coating of mat on the young lava	Photo-29
					Photo-30
0803	1517	423573	5087023	New lava, pillows, thinker coating of mat-sediment on lava, lobate flows, no longer see pillows, new lava filling in under an old flow	Photo-31
0807		423647	5087052	Roof is old (?) new lava is bellow, drain feature, now over an old lava (an island of old lava), new lava on top of the old roof (#34)	Photo-32
					Photo-33

					Photo-34
					Photo-35
0812				New flow must be 2-3 meters thick. we are at the site where the mooring should have been. The mooring is missing, lobate sheet low surface that is at least 2-3 m thick	
0814	1520	423703	5087066	Looking for mat, close to mooring site,	Photo-36
				Sampling material, slurp bottle #5 (start 0823 done at 0826), also sucking some yellow mat (0827), some white mat mixed in with the yellow mat, trying to avoid the white mat, done sucking at 0834, getting a frame grab of a fecal trail, which contains some glass (12 and 13 are fecal trail, 11 is a roof)	**Suction sample**
					R474-1
					FG R474-011
					FG R474-012
					FG R474-013
0837	1519	423721	5087055	Off to the east, to look for a rope that used to be on a mooring that was out here last summer. lobate flows , some drain features, all "new" lava, dead crab	Photo-37
0842	1518	423771	5086872	More mat on the basalt, pillows with drain features, lobes, draining around the bottom of the lobes, half roof and half collapse pit, lots of yellow orange mat in the pits, some pillars about 3 m tall	
0847	1517	423861	5087009	Pillars, drain features, some of the pillars are about 3-3.5 m tall, thicker yellow sediment as we go (photo), venting water out of a tilted slab, floor is old roof, the top of the roof is about 4 m above the floor, 3 m high roof, lots of drainage features	Photo-38
					Photo-39
0855	1519	423952	5086996	On the roof of the flow, still heading 78, less mat, more distance lobes, yellow mat on rocks - no white mat	
0900	1521	424035	5087000	On the contact, FG of old, new, and fish,	Photo-40
				FG #15 of new basalt over the old basalt	FG R474-014
				highlights are on (TARGET CONTACT #6)	FG R474-015
					FG R474-016
0905	1521			Contact (new-old) highlights are off, turning north to look for rope on the seafloor from an old mooring	Photo-41
0906	1521	424042	5087011	Rope from old mooring, following the rope to the new lava. the new lava has eaten the rope, (target **ROPE**) from a transponder (#17 is the rope) (chain is at the other end of the rope).	Photo-42
					Photo-43
					Photo-44
					FG R474-017
0913				Following rope	Photo-45
0916	1520	424073	5086990	Following rope, Suction sample of sediment jar 3, SAMPLE NOT TAKEN	
0923	1522	424100	5086961	Chain for a transponder that was attached to the rope that we were following, only one link (about 80 lb.)	FG R474-018
					Photo-46
					FG R474-019
0926	1523			Heading to the end of the transect , heading 45, at the end of the transect we will suck some sediment, jumbled flows	
0929	1521	424203	5087061	Found a cable, two lines in parallel with tape connecting the two.	Photo-47
0933	1524	424177	5087075	Collecting sediment (yellow stuff) in Jar #3, found the object that was attached to the cable (an electromagnetic experiment ?)	**Suction sample**

					R474-2
					FG R474-020
					FG R474-021
0942				Sled mooring sighted (**Sledmoor** target)	
0948	1521	424212	5087114	Heading north (8 degrees), in the old lava	
0951				Moving along a ridge, heading 354, FG of holothurian, drain feature, large pit a few meters deep. on top of flow moving north, dome small towers, crab	FG R474-022
0955	1522	424205	5087164	Old lava, sheets, jumbled, crab, more sediment, sediment covers about 75% of the flow, some drainage features, some towers, lobate, more drainage and pillars	Photo-48
					Photo-49
1002	1520			Old lavas still heading north along transect, lots of sediment, old lava	Photo-50
1008	1521			More drained features, about 2 m deep	Photo-51
1010	1519	424189	5087384	Fish (FG and Photos) ??? pillars may be 4 m deep in some drainage features. ship started to head west	Photo-52
					Photo-53
					FG R474-023
1016	1521			Sub is starting to head north west, moving at 0.75 knots, giant lobes, lots of pillows	Photo-54
1020	1522			Still pillows and still old	Photo-55
1026	1521	423986	5087407	Contact, old and new lavas, now we are on new lava (CONTACT 7) pillows, we are trucking at 0.75 knots, mats becoming thicker and covering just about everything.	
1029	1519	423906	5087406	Drainage feature, hot water coming out of the cracks, baby tube worms, water coming out of the base of pillows, lots of shimmering water, looking around site, baby worms. on new lava	Photo-56
1033	1519	423922	5087428	Deploying **Mkr-N41,**	FG R474-024
				Deploying **MTR4126** at the base of a pillow with lots of diffuse flow and baby tube worms. the rope is in the tube worms just about the pillows, we are heading at 286, the MTR is just south of the marker. The MTR and the Marker are about 30 cm apart. The MTR is in the closest hole next to the marker .	
1054				Vent fish, new baby tube worms	Photo-57
					FG R474-025
				New tube worms on new lava, trying to sample these worms	Photo-58
					FG R474-026
1103	1520	423922	5087428	Tall jar number 7 (Suction sampler), a few tube and scale worms? Had to scrape to free worms from lava	**Suction sample**
					R474-3
1106	1520			Still trying to scrape to free the worms.	
1108				Flushing bottle and getting tube worms out of tube	
1110	1520			Returning to jar #7 to sample some sulfide mat	
1114	1520			Highlights on. Viewing the new sulfide worms	
1120	1519			Flying over field to view new tube worms. Caught marker on ROV tether.	Photo-59
					Photo-60

					Photo-61
					Photo-62
1123	1520			Put **Mkr-N4**1 back out on rock by the **MTR4126**.	Photo-63
					Photo-64
					FG R474-027
1124	1519			Continuing west. Young lobate flows.	
1127	1520			Coming off roof into lineated sheet flow.	
1129	1523			Picture of young sheet flow.	Photo-65
1130	1523	423775	5087399	Surface of very complex flow patterns, kind of swirled around, broken up ropes	Photo-66
1132	1522			Folded ropes	
1133	1520			Spires, long thin drips under roof	Photo-67
				Lobate flows, lots of roof collapses	FG R474-028
1133	1520			Collapses about 2 meters deep. Big holes	
1135	1519	423704	5087402	Hdg 270, clumps of Fe deposits in lobate pockets	Photo-68
					Photo-69
1138	1520			Glass surface sticking out of coating. Lava 3.5-4.5 meters deep.	
1139	1519			Drained out area. Pit with pieces of roof collapse	Photo-70
1140	1520			Less mat covering lava	Photo-71
1142	1522			Ropy lavas, rattail fish, roof collapse. Seeing another level of lava in roof collapse. Spider crab.	
1144	1519			Still in new lava, lobate flows	
1146		423466	5087396	Glassy lobes	Photo-72
1147	1521			Still young stuff glassy lobes sticking and pockets of yellow material	
1149				Getting black and glassy. Seems to be older. Seeing ophuroids and sponges.	
1150	1525	423384	5087428	Move into old lavas, coming around to the north. **Contact #8**	
1153				Hdg 7. Picture of old lava. Brittle stars. Sediment has pale yellow/ gray color. White spots are probably sponges, many brittle stars.	Photo-73
1156		423373	5087620	Contact. Big young pillows. Hdg 9. Glassy lobes. Very big pillows. Some are 1 meter in diameter. May be seeing some older pillow lavas.	Photo-74
					Photo-75
					FG R474-029
					Photo-76
1200		423357	5087659	In old lava, lots of brittle stars. Yellow deposits spotting pillows. Sponges.	
1203	1525	423369	5087711	May have gone over contact, passed into young lava. Seeing fecal type matter. Glassy lobes. Pockets of yellow/orange.	Photo-77
				Contact #9	
1207	1527	423376	5087758	Attempting to take sample of glassy drip. First attempt crumbled. Second attempt failed. No luck	
1208	1526			Moving onward, hdg 2.	
1210	1528	423376	5087812	Back to old, see sponges, starting to drive NE. **Contact**	
1212				Lots of sponges, still old lava, hdg 088, brittle stars	

1214	1525	423456	5087832	**Contact #10** Hdg 110 towards Pit	
1216				Young pillows, heavily coated with mat. Local deposits on bottom of flows.	
1218	1522			Fish poking into mat. Stuff in pockets appears to be stuff that sloughed off surface of pillows.	
1220	1522	423571	5087761	Heavily covered pillow lavas, seeing some floc. A little drain out. Back to lobes and pillow.	
1223	1522	423623	5087783	Nice close-up of the lava	Photo-78
					Photo-79
1226	1522	423659	5087792	Surface of 98 lava that is covered in yellow/orange, Fe-rich mat. Frame 30 zoomed out, 31 and 32 zoomed in on mat.	FG R474-030
					Photo-80
					Photo-81
					FG R474-031
					FG R474-032
1231	1522	423658	5087792	Sampling into jar #4. Notice that when yellow/orange surface is removed another layer is revealed. Deploying **Mkr--N44** about ~2 meters from slurp spot.	FG R474-033
				Lava at this marker is completely covered with the yellow/orange mat.	**Suction sample**
					R474-4
					Photo-82
					Photo-83
1252				Begin transit again, hdg 089. Seeing floc in water, approaching Pit. Picture of yellow and white mat where the warm water is coming out between the lobes.	Photo-84
1254				Scale worms and bag creatures	Photo-85
					Photo-86
1256				Collapsed pit with warm water coming out	Photo-87
1257				Milky fluid flowing out of hole in lobe Highlights on.	Photo-88
1257				Ship hdg 093, thick mat on new lava lobes. Various forms of mat, pits and 2-3 meters deep. Collapsed section with pillars (3 meters).	Photo-89
					Photo-90
1300	1520			Red staining on top of the roof section	Photo-91
1302	1520	423791	5087878	Flying over collapse (not quite as deep) with pillars, mat not as thick	
1303	1519			Archway between two pillars	Photo-92
1305	1521	423842	5088009	Passing in and out of roof and collapsed roof (only about 1m)	
1307				Floc in water. Broad lobes of new lava flow, not as much collapsed as before, very little mat. Approaching edge of new lava.	
1308		423885	5088041	Old lava under new lava, very close to contact. At **Contact #11**	Photo-93
1309				Back to old lava. Hydroids on lava.	
1312				Older lava to the east of the new flow with burrows, heavily sedimented.	Photo-94
1315				Crossing old lava into new lava	Photo-95
					Photo-96
1317	1521			Pillar, collapse and red stuff.	Photo-97

					Photo-98
1320	1521	423837	5088089	Slurping into jar #8. Slurping red material on new lava.	**Suction sample**
					R474-5
1327	1521			collapsed area with pillars	Photo-99
1330		423378	5088107	thick new mat on lava flow	Photo-100
1332	1519			back to really thin mat, Venting!! Floc,	Photo-101
				Lots of diffuse venting and floc in the water.	Photo-102
1336	1523			Lots of heavily sedimented (yellow/orange) lobate flows. Hdg 258	
1340	1524			Mat getting a little thinner. Pillow lava intact.	
1343	1526			Turning west. pillows lavas thin coating of mat. Hdg 245	Photo-103
1345	1527			Continuing west, more of the same	
1347	1529	423463	5088051	**Contact #12.** Older flow sticking up through the new flow. Older flow has sponges	Photo-104
					Photo-105
1348	1530			Water alarm on cage is sounding, so ROPOS is now hdg toward Milky vent. Hdg 012	
1351	1532	423401	5088092	Old jumbled flow. **Contact -** New broad lobes with older stuff poking through. Lightly covered with yellow/orange mat.	Photo-106
					Photo-107
1352	1531	423408	5088172	Hdg 047. Sheet flows. Stepped down from lobate surface to floor of a collapse (~1m).	
1354				Back on top of roof, lobate morphology. Yellow mat. See older lava between new lobes. Older lava has sponges.	
1355	1531			Island of old lava.	
1357	1530			Lost blue in the camera. New lava on the old lava	Photo-108
1359	1531	423479	5088205	Going back into new jumbled lava	Photo-109
1401	1531	423549	5088250	New jumbled lava, hdg 053	
1403	1529			More new jumbled lava, very rough, heavily sedimented	Photo-110
1407	1532	423588	5088329	Ropy sheet flow, photo of contact of flat ropy sheet and jumbled flow. hdg 038	Photo-111
1410	1533			Coming up on pillar, in floor of collapsed area 1.5-2m deep. Floc. Water beginning to cloud.	
1411	1530	428386	5088386	Transitional ropy to jumbled lava.	Photo-112
1412		423652	5088416	Photo of yellow covered pillar	Photo-113
1413				Beginning to look for marker at milky vent. Water is very murky. Jumbled lava. Lots of mat .	
1418				Looking for milky vent, more of the same, lost nav.	
1420		423704	5088419	No venting yet, lots of mat, coming through a pit. See **Mkr-N2**	
1422	1531	423682	5088431	Found Moyer's glass trap #16. Placing it in starboard side of the biobox	**Bacteria trap**
					R474-6
1430	1533			Deploying Wheat's OSMO sampler, Hdg 046	
1456	1532			See Moyer's other trap, deploying OSMO nearby.	
1458	1532	423679	5088421	Still deploying...	
1500				Deployed! Frame grab of OSMO	FG R474-034
					Photo-114

1506	1532	423679	5088420	Trying to retrieve the glass wool traps.	
1515				Glass wool trap successfully recovered and placed in the starboard side of the biobox **Mkr-N2**	**Bacteria trap** R474-7
1530				Repositioning OSMO sampler	
1548				Finished repositioning OSMO sampler	Photo-115
1552	1532			Attempted to fire Niskin at Milky Vent, but it appeared to be already closed	
1554				Dive aborted due to water alarm	
1730				Cage on deck. Back in water and on deck again. ROPOS remained in water for repairs to cage tether winch.	

Dive R475

No Dive Map

Dive Summary:

Approached bottom to the west of Milky Vent on young (new) lava flow. Proceeded west at least 50 m to contact with older sheet flow. Dive aborted because of water alarm in the cage can. No samples were collected on dive R475. Only on bottom for 25 minutes. No dive chart created.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
East side of Caldera	Date (PDT): Sept. 12, 1998	Date (PDT): Sept. 13, 1998	Finish E-W transects from R474. Deploy a bacteria trap at Milky vent.
	Date (UTM): Sept. 13, 1998	Date (UTM): Sept. 14, 1998	Try to get tube worm samples from old and new lava.
	Julian Day 256	Julian Day 256	Imagenex survey of the North end of the East side of the caldera.
	Time off deck:	Time off	

0245	bottom:
	0425 (aborted)
Time on bottom:	
0406	Time on deck:
	0530
	Total dive time:
	2 hr 45 min
	Total bottom time:
	0 hr 19 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm camera and strobe mounted side-by-side on upper center of bumper

Biobox mounted lower center work area (bacteria trap in stbd side)

Slurp sampler with hose attached to the 5 function arm

two 5 liter Niskin bottle mounted on upper stbd and port bumper bar

2 gas tight bottles with intake on stbd arm (#5 port, #6 starboard)

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples

UTM	m	m	m		
0245				ROPOS launched	
0406	1529			On bottom west of Milky Vent. Lobate basalt. No animals on it .Looks like the new flow. Proceeding W looking for contact. Solitary star fish.	
0410				Started archive videos	
0415	1532			**Contact** with older sheet flow. Marker from Biobox wrapped around suction hose.	Photos 1-2 FG R475-001
0420				Proceeding E to **Milky Vent** over pillow-lobate lava	
0425				Cage water alarm on hard. Going back to cage and surface.	
0426				Archive videos stopped.	
0530				ROPOS on deck	

Dive R476


Dive Map

Dive Summary: Dive R476 began with the deployment of a bacteria trap at Milky Vent. A suction sample of bacterial mat was taken, as well as a basalt sample in the same area. Old Worms was visited where biology and bacteria were sampled at well as fluid from the area. Heading northwest more rock and mat was sampled, concluding at Magnesia Vent where more fluid was sampled with the suction sampler. A gas tight bottle was also fired at Magnesia Vent. After sampling was completed, eight Imagenex lines were surveyed in the area.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount	Date (PDT):	Date (PDT):	Redo of aborted Dive 475:
	Sept. 13, 1998	Sept. 14, 1998	
East side of Caldera			Finish E-W transects from R474.
	Date (UTM):	Date (UTM):	
	Sept. 13, 1998	Sept. 14, 1998	Deploy a bacteria trap at Milky Vent.

Julian Day 256	Julian Day 257	Get tube worm samples from old and new lava.

Time off deck:	Time off bottom:	Imagenex survey of the North end of the East side of the caldera.
1333	9005	

Time on bottom:	Time on deck:
1454	1029

Total dive time:

20 hr 56 min

Total bottom time:

18 hours 11 mins.

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm camera and strobe mounted side-by-side on upper center of bumper

Biobox mounted lower center work area (bacteria trap in stbd side)

Slurp sampler with hose attached to the 5 function arm

Two 5 liter Niskin bottle mounted on upper stbd and port bumper bar

2 gas tight bottles with intake on stbd arm (#5 port, #6 starboard)

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
1333	1525	423350	5088400	ROPOS launched	
1451				ROPOS left cage	
1454	1531			On bottom	
1455	1531	423332	5088402	Picture of contact	Photo-1
					Photo-2
					FG
					R476-001
1505	1531	423391	5088388	Sheet flow	
1507	1530	423410	5088392	Drain out feature in lobate flow	Photo-3
1512	1529			Set up of suction sampler, view of sampler	
1516	1529	423394	5088411	Bottom not in view	
1517	1527			Bottom in view, 100 m north of **Milky**	
1520	1528	423457	5088461		
1521	1529	423511	5088456	Lobate lava flow covered with thick white mat; heading to **Milky Vent**	
1526	1529	423608	5088435	Jumbled sheet flow; oxide area	Photo-4
					Photo-5
					FG
					R476-002
1528	1532	423626	5088441		
1529	1531	423663	5088422	Jumbled sheet flow	Photo-6
1531	1531	423679	5088412	Venting with white mat	Photo-7
1532	1531	423681	5088412		Photo-8
					Photo-9
					Photo-10
					FG
					R476-003
1537	1531	423678	5088411	Sampling white mat and substrate with suction sampler (jar #5)	Photo-11
					FG

					R476-004
					Suction sample R476-1
1551	1532			Flushing suction sampler hose with flushing jar	
1552	1532	423678	5088411	Sampling rock near **Milky Vent** with 7-function arm; into port side of biobox	**Basalt**
					R476-2
1559	1531	423679	5088415	At **Mkr-N2**. Looking at OSMO sampler.	Photo-12
					Photo-13
					FG
					R476-005
1602	1531	423678	5088419	Moved to other side of vent; hdg 029; still looking at OSMO sampler	
1605	1532	423678	5088419	Deploying bacterial trap #35 near OSMO sampler; hdg 027	Photo-14
					FGs R476-006
					R476-007
1610	1532			Heading East to **Old Worms**	
1613	1532				Photo-15
1614	1537	423712	5088416	Lava pillar; old lavas	
1618	1527	423725	5088426	At **Contact 3**	Photo-16
					Photo-17
					Photo-18
1621	1524			Old lava pillar	
1624	1524	423784	5088413	Tube worms; at **Old Worms**	Photo-19
					Photo-20
					Photo-21
					Photo-22
					FG R476-008
					Photo-23
1626	1526	423785	5088416	Clump of old tube worms with extensive filamentous mat growing on the tubes	Photo-24
					Photo-25
1628	1528	423785	5088416	Hdg 111; Sampling tube worms with 7-function arm; into starboard side of biobox	**Biosample**
					R476-3
1638	1528	423785	5088416	Sampling low flow water at **Old Worms** with suction sampler (jar # 4); Hdg 108	**Suction sample R476-4**
1644	1528			Stopping suction sampling	
1648	1528	423785	5088416	Trying to deploy marker 4; site will remain unmarked because marker 'escaped' to the surface!	

1651	1525			Heading west back towards **Milky Vent**	
1652	1528	423740	5081528	Contact between old and new lava	
1657	1529			Heading north towards northern tip of lava flow; jumbled flow with orange mat	Photo-26
1659	1527	423685	5088430	North of **Milky Vent**	
1701	1527	423678	5088462	North of **Easy Vent**	
1703	1527	423670	5088477	Mat covered pillar; sampling mat covered basalt (flat piece) with 7-function arm; north of **Milky/Easy Vents;** Hdg 342	Photo-27
					Basalt sample
					R476-5
1717	1527	423670	5088477	Suction sampling of orange mat at same site; jar # 6; Hdg 342	**Suction sample R476-6**
1730	1527			Done sucking; flushing suction sampler hose	
1735	1528			Heading north for East-West traverses	
1738	1521	423662	5088443		
1739	1528	423663	5088460	Thick mat on jumbled sheet flow	
1739	1525	423681	5088497	Found new Milky-type vent	Photo-28
					Photo-29
					Photo-30
1745	1530	423661	5088545	Lots of white floc in the water- 'blizzard' area; new vent: **Magnesia Vent**	Photo-31
					Photo-32
					Photo-33
					Photo-34
					Photo-35
1749	1530	423689	5088497	Looking at the hole of a new white-floc vent: **Ouzo Vent**	
1758	1530			Two sparrows on the aft deck	
1810	1529	423661	5088545	Suction sampling of fluid at **Magnesia Vent**; sample jar # 3	**Suction sample R476-7**
1815	1529			Done fluid sampling	
1817	1529			Firing gas tight bottle # 5 (port side) at **Magnesia Vent**; Hdg 255	**Gas tight**
					R476-8
1820	1529	423661	5088545	Flushing suction sampler hose	Photo-36
1823	1527	423653	5088472	Going north to northern end of lava flow; several pillars, up to 2m high	Photo-37
					Photo-38
1826	1527			Collapsed lava roof (3m diameter)	Photo-39
1827	1527			Collapsed pillars	
1828	1529	423683	5088666	Jumbled sheet flow	
1829	1529			3m-high pillar	Photo-40
1830	1529	423684	5088639	Pillars	Photo-41

					FG R476- 009
1832	1524			Pillow lobate flows	Photo-42
					FG R476- 010
1836	1519	423720	5088721	Broken sheet flow; extensive area of mat in the cracks	Photo-43
					Photo-44
1837	1520			Lots of ophuroids (brittle stars) indicating old lava - contact has been crossed	
1839	1518	423730	5088753	Older lava with ophuroid and thick layer of pelagic sediments	
1841	1517	423735	5088778	Video problems - lost red on color camera; stopping ROPOS to fix the video	
1845	1521	423767	5088801	Photo of old lava. Proceeding west	Photo-45
1848	1517			Old heavily sedimented lava, worm burrows	Photo-46
1850				Old sedimented lava. Still going west	Photo-47
1855	1518			Ridges oriented N-S	
1856	1520	423708	5088821	Old lava, rifts, drainbacks, jumbled flow	
1857				Sediment scene	Photo-48
1858		423677	5088816	Big rattail fish	
1902		423630	5088818	Jumbled sheet flow	
1908	1528	423512	5088789	Pillars, maybe newer lava, turning north	Photo-49
1909				Lobate roof of new flow	Photo-50
1911				Contact (island) between new and old lava	Photo-51
				More new lava	Photo-52
1913		423486	5088904	Mixed old and new lava	Photo-53
				Sponge, Okie-roids	Photo-54
1915				Older lava to the north	Photo-55
1916				More new lava	Photo-56
					Photo-57
1917				Rattail fish	
1918		423476	5089006	Contact area, sponges	Photo-58
1920				New lava coming out of a manhole cover	Photo-59
					Photo-60
					FG R476-011
					R476-012
1922		423480	5089053	Getting into ropey sheet flows	
1923				Starfish	
1924				Pit, old lava inside, surrounded by new stuff	FG R476-013
				Grab of the SIT camera (some problems with the still photo stuff)	R476-014
1929		423481	5081529	Turn West after stopping a while	
1933				Some problems with RGB camera displays (Lawrence Welk reruns keep coming on). We're looking at a new, glassy lobate flow where it is headed down into an older collapse area.	

				Facing west (280). In background see a lower level of the new flow around the top of the older roof. Impression is that lava moved in from SE at this spot, with enough local momentum to push the lobate flow up over a small rise. These lobates are not altered or coated with orange mat as in the central, area roof of lobate flow.	
2029				Starting toward Imagenex line N27; Still having problems with the video system; not recording	
2030	1527			Small pit in new flow	
2032	1527			Drainout in new lava ~2 m deep	
2035	1527			Video is fixed; start traverse to the east	
2037	1527	423515	5089131	Young lava drainout area; ~2 meters	
2041	1525	423545	5089103	Contact with older jumbled flow and young lobate flow; shallowing; lava appears to be flowing down wall?	
2045				Contact with the wall	FG
					R476-015
					R476-016
2048	1514			Going up the east wall of the caldera	
2054				Contact with wall and younger lava	FG R476-017
2056		423584	5089075		
2100		423580	5089088	Rattail Fish	
2102				White sediment, crab	
2103				Edge of wall (sit cam grab)	FG
					R476-018
2109		423578	5089122	Going south fast, Hdg 157, Rattail fish	
2112		423600	5089063	Starting East	
2115		423629	5089050	Fissure, ~5 meters deep x 10 meters wide	
2118	1513	423657	5089051		
2122		423719	5089092	big mess o' sediment, footprints with brittlestars (Okie-roids)	FG R476-019
					R476-020
2127	1513	423753	5089068	Lava contact (young, but not new lava)	FG R476-021
2130	1515	423776	5089119	Hdg 91, Rattail fish, starfish	
2133		423846	5089110	Double lava whirlpool, spider crab	
2136				Start up to 25 mat, preparing for Imagenex line N20	
2138	1490	423843	5089124	In the blue. Start line N20; hdg. 166	
2307	1496	423845	5087409	End line N20	
2310	1496	423903	5087400	Start line N21; hdg. 002	
2348	1496	423916	5087985	End line N21	
2349	1496	423959	5088150	Start line N22; hdg. 179	
0031	1496	423976	5087380	End line N22	
0037	1496	423778	5087391	Start line N23; hdg. 009	
0204	1496	423787	5089181	End line N23	
0208	1496	423744	5089147	Start line N24 ; hdg. 180	

0334	1496	423719	5087365	End line N24
0337	1496	423648	5087428	Start line N25 ;hdg. 002
0507		423682	5089151	End of Line N25, hdg N
0510		423608	5089148	Start of line N26, hdg S
0648		423613	5087411	End of Line N26
0655	1493	423549	5087418	Start of Line N27, hdg N
0823		423554	5089147	End of Line N27
0832		423482	5089133	Start of line N28
0855		423498	5088649	End of line N28
0905	1493			Sub starting ascent
1029				Sub on deck

Dive R477

 **Dive Map**

Dive Summary:

An attempt to pull the rumbleometer off the bottom with a rope connected to the cage by a 2000 lb weak link failed. Looked for but did not find a train wheel mooring weight from a previous cruise located about half way between the rumbleometer and Mkr-33. At the Mkr diffuse vent, recovered 4 bacteria traps and the short term OSMO sampler that had been left on a previous dive. Also, located a place to deploy a time-lapse camera and moved an MTR. No other samples were taken.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
East side of the Caldera, Axial Seamount	Date (PDT): Sept. 14, 1998	Date (PDT): Sept. 14, 1998	Recover rumbleometer Tube worm grab of new worms
	Date (UTM):	Date (UTM):	Intercalibration of SUAVE with Osmosampler

Sept. 15, 1998	Sept. 15, 1998	
		SUAVE sample across the eastern contact - document transition
Julian Day 258	Julian Day 258	
		At Mkr 33:
Time off deck: 0058	Time off bottom: 0557	Recover short term osmosampler and bacterial traps
		Deploy long term osmosampler
Time on bottom: 0237	Time on deck: 0715	
	Total dive time: 6 hr 17 min	
	Total bottom time: 3 hr 20 min	

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28mm camera and strobe mounted side-by-side on upper center of bumper

Biobox mounted lower center work area

SUAVE mounted port inside with intake attached to the 7 function arm

5 liter Niskin bottle mounted on upper stbd bumper bar

2 gas tight bottles with intake on stbd arm

Pacman sampler on port (5 function) arm

Standard jaw on starboard (7 function) arm

Snaphook in stbd jaw with 50 m of line tiewrapped to back of cage for Rumbleometer recovery

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
0058				ROPOS launched	
0235				Start recording tapes	
0237				On the bottom; start looking for the rumbleometer	
0239	1521	423727	5086774	Looking...	
0243	1522	423710	5086762	Found the **rumbleometer**!	
0244				Claw positioning to attach the rope from the cage to the rumbleometer	
0246				Highlights tape on	
0249				Attached snap hook to chain on rumbleometer, photo of attachment	Photo-1
0254				Returning to the cage to pull up rumbleometer; highlights tape stopped	
0257				Start to move the cage up; rope to rumbleometer is 50m long	
0301				Cage depth 1480m; start to see tugging on the rope	
0302				Cage depth 1475m	
0303				Cage depth 1470m, rope is taught; highlights tape started	
0306	1466			Rope broke, recovery aborted; highlights stopped	
0310	1523			Back on bottom looking for rumbleometer	
0311	1522			Rumblometer sighted, covered with 50 m of white line. It hasn't budged. Took Digital Still Camera shots.	FG R477-001 Photos 2-4 DSC
0321	1520			Proceed NE to Mkr 33 via the railroad wheel mooring. Sheet flows. SUAVE not working. Decision to do other tasks at Mkr 33 and come back up	
0333	1521			Large drained lava lake. Most of terrain is lobate with some sheet flows and drained lava lakes. Fine dusting of yellow floc.	
0339	1520	423733	5086990	At position of wheel. Looking for it.	
0346				Didn't find the wheel despite careful search. Proceeding to Mkr 33	
0349				Top blown out of lava lobe	Photo-5

					FG R477-002
0355				Young sheet flow with dense orange floc	
0357	1523	423825	5087097	Bacteria along fractures in sheet flow	Photo-6
0358				More dense bacteria	Photo-7
0400				Diffuse vent with white bacteria in sheet flow	Photo-8
0401		423865	5087090	Sheet flow. Hdg NE	
0403	1524	423853	5087097	At **Mkr 33**. Lots of ropes hanging in the water. The new scale worms are here -- 2 big ones and a small one (Mom, Dad & Jr.?). Hdg SE	Photo-9
0409				Short term OSMO sampler inlet removed from vent. Covered with bacteria. Will pick up later.	
0421				Deploying long-term OSMO sampler	FG R477-003
0426				Long term OSMO sampler taken out of Biobox for later deployment. Start recovery of bacterial traps left on an earlier dive. Kim Wallace walked in with a very sedate storm petrel.	
0435				Changed archive video tapes	
0514				Recovered bacteria traps. #10 mangled and broke apart on recovery. It had been stuck in the vent.	**Biosamples**
					R477-1 to 4
0514				Surveying site for deployment of time-lapse camera.	Photo-10
					FG R477-004
0528				Long-term OSMO sampler deployed.	
0534				Moved Embley's MTR to a different part of Mkr 33 vent.	FG R477-005
0537				Long term OSMO sampler	FG R477-006
0544				Short term OSMO sampler recovered into Biobox.	**OSMO**
					R477-5
0557				Left bottom with short term OSMO sampler in the stbd claw.	
0559				Stopped archive tapes	
				ROPOS on deck	

Dive R478

Dive Map

Dive Summary:

During dive R478 the Time Lapse Camera was deployed at Mkr-33 Vent. SUAVEs were taken at several vents: Mkr-33, Cloud, Nascent (new), Mkr-N41 and Mkr-N7. Unfortunately, SUAVE could not be calibrated so all measurements are relative. The contact between the new and older lavas was explored. Baked tube worms and broiled clams were found. Tube worms were collected at Mkr-N41. MTR4108 was deployed at Nascent Vent.

Times are UTM (local PDT +7 hours)

Region, Field, Site	Dive Begin	Dive End	Tasks
Axial Seamount, East Rift Zone	Date (PDT): Sept. 15, 1998	Date (PDT): Sept 15. 1998	Deploy time lapse camera at Mkr-33
			SUAVE traverses: From West of Mkr-33 East to Contact and then North along Contact to "Large Tube Worms" target.
	Date (UTM): Sept 15, 1998	Date (UTM): Sept. 15, 1998	Biosample vents at contact areas
	Julian Day 258	Julian Day 258	Cook a potato in vent fluid
	Time off deck: 1402	Time off bottom: 2240	
	Time on bottom 1511	Time on deck: 2351	
		Total dive time: 9 hr 49 min	

Total bottom time:

7 hrs. 29 mins.

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm stereo camera and strobe mounted side-by-side on upper center of bumper

SUAVE; intake on stbd arm

2 gas tight bottles with intake on port arm

Standard jaw on port (5 function) arm

Standard jaw on starboard (7 function) arm

MTR in biobox

Photosea 1000A 35 mm time lapse camera in time lapse stand; held by both arms

Time	**Depth**	**X-pos**	**Y-pos**	**Comments**	**Frame grabs, photos and samples**
UTM	**m**	**m**	**m**		
1402				ROPOS launched	
1407				ROPOS out of cage	
1511	1521			ROPOS at bottom	
1512				Start recording tapes	
1518		423838	5087121	Going to **Mkr-33**	
1520	1522	423843	5087110	Northwest of **Mkr-33**; sheet flows, cracks with warm water; bacterial mat	
1525	1524	423856	5087096	At **Mkr-33**; getting ready to deploy time lapse camera	
1530				Still positioning for TLC	
1532		423856	5087096	Placed TLC on seafloor near **Mkr-33**	Photo-1
1537				Releasing float on camera unit; first tie wrap broken; having problem with second tie wrap	
1543				Float released; repositioning TLC	Photo-2
1558				Still positioning TLC	Photo-3

					Photo-4
1605				TLC in position	Photo-5
					FG R478-001
1617				Still fiddling with TLC; frame grab view with lasers; done with TLC	FG R478-002
					Photo-6
					Photo-7
1626	1524	423854	5087093	Trying SUAVE #1 at **Mkr-33** near MTR; seems to be working; worms at Mkr-33; 1640 stopped SUAVE; max Temp 17C; photo 11 looking north along fracture	Photo-8
					Photo-9
					SUAVE
					R478-1
					Photo-10
					Photo-11
1644				Repositioning MTR into active area of crack; MTR was hooked on BioBox; picking it up again to position	FG R478-003
1656	1524			Setting up for SUAVE #2 at **Mkr-33**; looking for hot spot	
1659				SUAVE #2 at **Mkr-33** in crack near osmosampler intake; Max T 42.2C; fired gastight bottle starboard #6	**SUAVE**
					R478-2
					GTB
					R478-3
1713				SUAVE #2 done; repositioning MTR; max temp 3C	FG R478-004
					Photo-12
1722		423853	5087094	Still repositioning MTR	Photo-13
1729				Hdg southwest to look for more venting for SUAVE	Photo-14
1733	1524	423836	5087092	Southwest of **Mkr-33** at some venting crack with snails and lots of orange mat; bag creature; positioning for SUAVE temp; lots of white mat coming out of crack; problem with video	Photo-15
1736				Starting SUAVE #3; mat has been grazed off by animals	**SUAVE**
					R478-4
1750				Fixed video problem by fiddling; problem again; stopped SUAVE #3; max Temp 13C;	
1752		423815	5087106	Heading west to look for more vents; sheet flow; orange material, white floc coming out of crack	Photo-16
1756				Cracked sheet flow; like dusting of iron oxide sediment	
1758		423773	5087063	More lineated sheets; collapsed lake; turning around, hdg East past **Mkr-33**; fixed video problem by re-initializing camera	
1802				Crossing pressure strain cracks in the sheets	
1803				Abundant iron fluff and white bacterial mat but no evidence of flow; on top of a huge swirl of lava	Photo-17
					Photo-18
					Photo-19

1804	1522	423858	5087114	Pillar structures with white mat	Photo-20
1808	1519			Broken jumbled sheet flow; less iron fluff now; getting some temperature anomalies with SUAVE	
1809	1523	423888	5087106	At **Cloud Vent**; video problems on color camera; re-initializing camera once again	
1811	1524	423901	5087115	Positioning for SUAVE #4	Photo-21
1813	1524	423901	5087115	Starting SUAVE #4 at the edge of **Cloud Vent**; lost color camera signal; camera back after re-initializing	**SUAVE**
					R478-5
1823				SUAVE #4 done; max Temp 18.6C	
1825	1520	423914	5087115	Camera problems - re-initializing	Photo-22
1828				Large cracked pillar; no white mat, orange sediment; lobate flows; collapsed pit; large accumulation of sediment	
1832	1520			Hdg 090; Heavy sediment; no venting visible; lobate flows	
1834		423967	5087072	More sediment, no flow	
1835		423972	5087061	Rattail fish; lobate flows; contact area; glassy lobate on top;	Photo-23
					Photo-24
1838		424010	5087075	Near contact, moving east; now NW	
1839		424016	5087088	Traversing over contact, moving north towards N41; re-initializing camera; rattail fish	
1841				Hdg north; new lava flow over old sheet flow; jumbled sheet flow; star fish	
1843		423974	5087193	Heavy orange sediment in crack; some new flow over old again	Photo-25
					Photo-26
					Photo-27
					Photo-28
				flatter lava, collapse	
					Photo-29
1847		423929	5087197	Hdg 347	
1850	1517	423925	5087223	Still lobate flows with Fe oxide staining	
1852				Spider crab	
1853				Collapse	Photo-30
1854	1519	423974	5087269	Crab, we don't know why	Photo-31
					Photo-32a
					Photo-32b
1859	1519	423949	5087222	Old and new lava, Hdg 14	Photo-33
					Photo-34
1901	1519	423972	5087329	Rattail fish	
1903	1519	423915	5087382	White stuff between rocks, venting in the area of Mkr 41	Photo-35
1905	1519	423911	5087382	Tube worm sighting, polynoids and venting,	Photo-36
				Nascent Vent	Photo-37
				Hdg 46	FG R478-005
1910				Highlights on for 4 minutes	
1915				Pullback shot of the scene	Photo-38

				Sit cam Frame grab	FG R478-006
1917		423910	5087380	View from the other side for SUAVE #5	FG R478-007
				T = 24C	Photo-39
					SUAVE
					R478-6
					FG R478-008
1924				GTB #2 port tripped at 24C	**GTB**
					R478-7
1942				Tube worm grab into starboard BioBox	**Biosample**
					R478-8
1943				Little bag creatures	
1959		423911	5087378	Target for **Nascent Vent**	
2000				**MTR4108** deployed at **Nascent Vent**. We hope that this will serve as a marker for the vent because there aren't any other ones around.	
2004				Moving toward **Mkr-N41**	Photo-40
					Photo-41
					Photo-42
2005		423913	5087406	Arrival at **Mkr-N41**	Photo-43
2009				Start SUAVE #6 at **Mkr-N41** where tube worms had been collected on a previous dive. Max Temp 20 C	Photo-44
				Hdg 51, we are a couple of meters east of the marker	FG R478-009
					SUAVE
					R478-9
2024				Going North...~300 meters	
2026				Light and cheesy orange deposit	Photo-45
2027	1518	423902	5087431	Hdg 356	
2031	1519	423898	5087447	More worms	Photo-46
					Photo-47
					Photo-48
2036	1520	423897	5087455	SUAVE #7 scan at hole near old tube worms at old flow ~50 meters North of **Mkr-N41** Hdg 285, tons of limpets, Max Temp = 9.5 deg C in the hole	**SUAVE**
					R 478-10
					Photo-49
					FG R478-010
2052				Tube worm grab from next to the SUAVE hole to port BioBox	**Biosample**
					R478-11
2058				Crab, *Munidopsis alvisca*	FG R478-011

					FG R478-012
2100				2 more crabs while looking around	Photo-50
				to scan the area	Photo-51
					Photo-52
					Photo-53
2105				Sponges 15 - 20 meters west of the venting, passed through suspected new-ish lava	
2107				B & W Photo of "the red stuff"	Photo-54
2109				Oops	Photo-55
2110				Large pillows, old lavas, more sponges, ophuroid	
2113				Lesser sediment cover	Photo-56
2114	1519	423884	5087533	Hdg 355	
2116		423878	5087548	New flows maybe????	Photo-57
				Contact	Photo-58
2120	1519	423886	5087598	Starfishes ,cucumbers	
2121				Sediment increase, spider crab, Starfish, brittlestar, rattail fish	Photo-59
2123		423896	5087663	~100 m South of Large Tube Worms. FishNot really a contact (oops)	Photo-60
					Photo-61
2125				Fluids filtering between cracks in frontal lobates	
2126		423889	5087690		
2129				Dead tube worms, clams	Photo-62
2130				Very stiff fish	Photo-63
2131				Big mess of worms, venting	Photo-64
					Photo-65
2132				**Mkr-N7** sighted, surprise surprise surprise	Photo-66
2134				Collapsed pit	Photo-67
					Photo-68
					Photo-69
					Photo-70
					Photo-71
					Photo-72
					Photo-73
					Photo-74
2138	1518	423921	5087775	Hdg 188. The canyon	FG R478-013
2141				Starfish	
2146				Big mess of tube worms	Photo-75

					Photo-76
2149				Very close to **Mkr-N7**, SUAVE #8 at big tube worm site max T = 16C	**SUAVE**
					R478-12
					FG R478-014
					FG R478-015
2157				Highlights tape on for 2 minutes	
2200				Little galatheid crab sitting atop a *Ridgeia*; checking out the clump while we wait for the SUAVE to finish	FG R478-016
2204	1520	423890	5087771	SUAVE #8 finished; taking a tube worm grab with port arm, sample will stay in the claw to come up	**Biosample**
					R478-13
2211				Hdg North, tube worm clumps	Photo-77
2212				Older lavas and tube worm clumps	Photo-78
					Photo-79
					Photo-80
2213				Older lobate lavas	
2214				Clams and a few tube worms	Photo-81
					Photo-82
2215	1520	423875	5087813	At the **contact**, hdg 272; three tube worms sticking out from under a lobate flow; looking around at the contact area, pictures of the contact	Photo-83
					Photo-84
					Photo-85
					Photo-86
					Photo-87
2221				FG of contact	FG R478-017
2224				Lots of clams and small tube worm clumps, crab eating the clams	Photo-88
					Photo-89
					Photo-90
					Photo-91
2226	1520	423885	5087804	Hdg 227; At the **BBQ site**, a few tube worms sticking out from under the contact, clams too; trying to determine if the worms are alive or not; limpets and provannids on the new lava and polynoids on and around the worms	Photo-92
					Photo-93
2236				Starting a few minute video clip for the web of the contact, BBQ area	FG R478-018
2240				Dive over, coming up	
2305				On ascent to surface, can see tube worm grab flapping around in the claw. Strange gall-like thing wrapped around a tube worm with a circular spot in the middle of it. Two frame grabs of this.	FG R478-019
					FG R478-020
1651				ROPOS on deck	

Dive R479

Dive Map

Dive Summary: Dive R479 began south of ASHES vent field. ROPOS proceeded north on a reconnaissance survey of the caldera wall and surrounding area. Suave samples and a HFS sample were collected. A new vent was discovered (Tombstone Vent). ROPOS proceeded north to ASHES where Hell, Mushroom, Inferno, Virgin and Medusa Vents were visited. HFS, suction samples and gastights were collected. Mr Potato Head was cooked at Virgin Vent. The osmosampler that was deployed at Hell Vent on a previous dive was recovered..

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
	Date (PDT):	Date (PDT):	Exploration south of ASHES
Axial Seamount	Sept. 16, 1998	Sept. 16, 1998	
			HFS of high temperature vents at ASHES
ASHES Vent field, the Wall, and South of ASHES			
	Date (UTM):	Date (UTM):	
	Sept. 16, 1998	Sept. 17, 1998	
			Imagenex survey of ASHES locale
	Julian Day 259	Julian Day 260	
			Recover Osmosampler
	Time off deck:	Time off bottom:	
	0454	0124	

Time on bottom:

0624

Time on deck:

0300

Total dive time:

21 hr 54 min

Total bottom time:

19 hrs 00 min

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm camera and strobe mounted side-by-side on upper center of bumper

Hot fluid sampler (HFS) mounted lower center work area; intake attached to 7 function arm

Suction sampler with hose attached to the 5 function arm

2 gas tight bottles with intake on the HFS

Standard jaw on port (5 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
0454				ROPOS launched	
				Tested HFS just below the surface	
0612	1468	422153	5085852	Strong particulate plume	
0624	1543			On bottom; not moving	
				Archive videos started	

0627	1544	422138	5085810	Still not moving; lobate lava with small sponges, holothurian.	
0630				Proceeding W towards the caldera wall	
0643	1543	422075	5085787	At the **caldera wall**; Hdg 261	Photo-1
					Photo-2
0639				Proceeding hdg 288 along wall; lava lapping up against wall	Photo-3
					Photo-4
0642				Sediment pond; ripple marked	Photo-5
0644	1543			Old sedimented sheet lava at caldera wall	Photo-6
0647	1543	2025	5085801	Drained lava	Photo-7
0648	1543	422033	5085840	Proceeding E across lobate flows	
0653	1542	422091	5085825	Old lobate with holothurians and lily flower shaped glass sponges	FG R478-001
				(cf Staurocalyptus)	
0655				Same; proceeding N	Photo-8
0657				Sheet flow; hdg 330, lateraling W	Photo-9
0659	1543			Collapsed lava lake	Photo-10
0701				Hdg W; same lobate lava	
0706				Heading about 330 but going back and forth to cover more ground, lobate lava with little sediment cover	Photo-11
					Photo-12
					Photo-13
0711	1542	422007	5085897	Lobate flow with little sediment cover;	Photo-14
				sponges on the rocks. These are small sponges only a couple of cm high.	Photo-15
0716	1543	421959	5085935	More sediment; some orange-yellow sediment between cracks, more floc in water, small sponges on the bottom,	Photo-16
				nice pillows	Photo-17
0724	1545	421932	5085941	Lots of sediment, jumbled boulders and sheet flows	Photo-18
0730	1546	421865	5085973	Jumbled lava, lots of sediment in lows	Photo-19
					Photo-20
0738	1544			More sediment, lots around the base of lobes, sediments are hydrothermal in origin	Photo-21
					Photo-22
0739	1542	421768	5086023	At the wall and heading back; only small broken pillows on the wall, no columns of basalt on the wall; the wall is nice and vertical.	
0742				Red staining (lots of it) on the basalt next to drainage features	Photo-23
					Photo-24
0743				Flat lobates, with sediment and sponges, collapse features, more red staining, red staining is usually around the edges of a collapse	Photo-25
					Photo-26
					Photo-27
0752	1545	421720	5086206	More red staining near the edge of a collapse, pillows	Photo-28
					Photo-29
0753	1546	421721	5086254	Sheet flow, with lots of sediment coverage (~ 60%)	Photo-30

					Photo-31
					Photo-32
0757	1547	421647	5086249	Sheet flow goes to within 20 m of the wall, the wall was at 0757, between the wall and the sheet flow is a pillow flow	Photo-33
					Photo-34
					Photo-35
0801	1546	421671	5086333	More sheet flows with sediment, about 55 m from the wall - back we go towards the wall	Photo-36
0804				Slight hit on temperature, talus, at base of the wall at 0805, talus shoot, fine grain sediment on wall, reddish staining on the wall, traversing along wall	Photo-37
					Photo-38
0807	1547	421594	5086360	Leaving wall and heading back into the middle	
0809	1546	421604	5086402	More blips on the temp probe; sediment on sheet flows with small relatively flat lobate flows	Photo-39
0815	1547	421621	5086491	Pillows with some sediment, brittle stars, sponges	FG R479-002
0819	1545	421685	5086533	Same as above, but with little chimneys only a few cm high, more sediment and more floc in the water. Jumbled lava next to sheet flows, the chimneys were on the jumbled lava	Photo-40
					Photo-41
					Photo-42
0824	1545	421703	5086560	Searching the area for deposits, at the CTD site, back in the field at 0826, iron oxide deposits on broken sheets	Photo-43
0830	1545			Largest chimneys are about 25 cm across, most of them are small, some of these have texture to them and some of them have white bacterial mat covering. Highlight times 0830-0833	Photo-44
					Photo-45
0834				Destroyed mat to prove it was a mat	
0838	1545	421634	5086592	Suction sample in Jar 18 small outtake with a nytex screen	**Suction sample**
					R479-1
0849				Done sampling, going to head towards the wall; old flow, sponges, big fish, tube worms, small and scattered groups; sediments local; heading 269; some live groups, widely spaced groups of tube worms, white mat, little clams	Photo-46
					Photo-47
					Photo-48
0856	1546	421606	5086582	White mats in cracks, sheet flows, big crab, stopped to see what the temperature is at a tube worm clump (0911); temp is 5 vs a 2.5 background; not going to suck from this one; want something warmer.	Photo-49
					Photo-50
					Photo-51
0915				Moving around to look for a warmer clump of worms, little splotches of red mat, white mat, more venting	Photo-52
0919	1546	421590	5086597	**Tombstone Vent;** moving around to sample from a diffuse vent, stopped to test the temp.	
0928				Bag Sample #7 with filter, Max. Temp 24C and T2 was 13C, done at 0937	**HFS**
					R479-2
0938				Moving, looking around here for more venting, crabs, Galatheid Crab	
0945				We are in a little depression with a wall that is about 2 m tall; heading 136 and out of tube worms; checking tether, back through the field, location about 50 m from the wall	Photo-53
0947				Heading over pillows with sediment in between pillows; more sediment than average, at the wall 0950	
0952	1546	421495	5086568	At the wall, moving to the watch circle that is centered over the "animal concentration in 1980s"	Photo-54
0955				Came over a little ridge, now going down into a little smoke	

0956				Crab, pillows with sediment covering 50%, some white mats and snails	Photo-55
					Photo-56
0958	1545	421534	5086637	Tube worms, white mat, etc. around the base of pillows; clams, some nice grouping of live worms (1000) all covered with floc	Photo-57
					Photo-58
1001				Leaving the main "vent' area; the area of venting is 35 m from the wall, back in the area	
1003	1545			Human made object, a transponder, DataSonics transponder	FG R479-003
1005		421528	5086668	This is a N-S running patch (330 degrees); some white mat 1007	Photo-59
					Photo-60
1009	1544	421508	5086703	Heading back to the west, jumbled lava, sheet flows with lots of oxide deposits; some sediment jumbled flows, sponges	Photo-61
					Photo-62
					Photo-63
1012	1544	421515	5086734	Some oxide deposits that are small chimney shaped objects, out of the tube worms and into the oxides, on a big ropey sheet flow, can't see any water come out of the oxide deposits, some of them have white parts so some of them must be active	
1015	1544	421481	5086734	Lots of sponges, sheet and pillow flows, at wall 1017, wall covered with sponges	Photo-64
1022	1544	421510	5086773	Jumbled basalt, sponges, white mat, some Fe oxides in little mounds	Photo-65
1026	1545	421556	5086783	Sheet flow with sediment cover about 70%; linear features of mats are perpendicular to sheet flow, the navigation is probably off by 200 m relative to our transponders; the correct location should be 200 m south of what is plotted	Photo-66
					Photo-67
1030	1544			Heading east to see where we get out of the oxide deposit; the oxide deposit on the sheet flow continues; have to head back to west 1032; oxide deposits thinned but did not disappear	Photo-68
1033	1546	421570	5086802	Sheet flows with oxide deposits; nice crack in the sheet flows, about 10 cm deep and filled with oxides	Photo-69
					Photo-70
					Photo-71
					Photo-72
1036				Contact between sheet and pillows; wall is about 80 m to the West	Photo-73
1040	1544	421495	5086823	Jumbled basalt with some sediment, heading 308, generally heading to ASHES and going back and forth	
1044	1543	421461	5086857	Heading NW to get to ASHES, catching up to the ship, more oxide deposits	
1049	1544	421455	5086938	Little sediment, long stringy things; dead worms???	
1054	1544			Broken lava with sponges and sediment, now on sheet flows; jumbled sheets, more sheets with linear features with Fe oxide little chimneys	FG R479-004
					FG R479-005
					Photo-74
1058	1543	421449	5087030	Jumbled lava with sponges, some Fe oxide sediment	Photo-75
1103	1542			Little iron oxide mounds	FG R479-006
1107	1544	421334	5087184	Tube worms	
1111	1541	421396	5087130	At **Hillock**, rattail fish, moving to site north of Hell, looking for diffuse flow with biology	
1116	1544			Looking for diffuse vent, **Porkchop**, at base of **Hell**, found black smoker, looks like a possible sample spot	FG R479-007
1118	1545			Probing the area for temp anomalies	
1122	1545	421373	5087132	Probe in black smoker, Tmax = 48C	

1131		421373	5087132	Piston Sample #10, Tmax = 26C, at **Porkchop**	**HFS**
					R479-3
1139				Sample tip out of hot water	
1142				Sampling again, same location,	
				Tmax = 51C	
1150				Filter #16, same location as above, Tave = 30 deg C, about 1L, 8 cycles	**HFS**
					R479-4
1202				Sample Bag/Filter combo #6, Tave= 23C but varying greatly, same location as above	**HFS**
					R479-5
1210				End fluid sampling, begin temp sampling for Juniper	
1212				Tmax = 12.5C, the middle of the colony	
1214				Tmax = 17.5C, leading edge of the colony	
1216				Moving a few meters north, 2m	
1220				Tube worm colonies, some diffuse flow	
1225	1546	421370	5087141	Tmax = 4.7C, no sample	
1228				Heading to **Hell**	
1230				**Hell**. Hobo and OSMO sample, already encased in tube worms	Photo-76
1232				Photos of Hobo and OSMO sample at Hell	FG R479-008 FG R479-009
1234				Temp sampling top of **Hell** vent; Tmax =134C	
1238				Reposition sample tip. Tmax = 225 C	
1246				Still at top of smoker at top of **Hell**; Tmax=137C, temp varying due to narrow stream of vigorous flow.	FG R479-010
					FG R479-011
1253	1542	421368	5087137	Sampling temp from smoker, chalcopyrite; Tmax = 270C	
1305				Piston #13, Tmax = 270C, 42C on the back probe. Top of Hell. Sample fluid smoker out of red chalcopyrite. Sample appears to be cloudy.	**HFS**
					R479-6
1315				Filter #17, same place as above, Tmax =270C, about 400mL, 3 cycles	**HFS**
					R479-7
1324				Chimney	Photo-077
1328				Frame grab of Mr. Potato Head getting baked	FG R479-012
1340	1542			Sample Bag/Filter combo #23, Tmax = 294C, T2 58C, Hell vent, Hdg 085, slightly lower on chimney, west side	**HFS**
					R479-8
1340				Gastight sample, portside, GTB #5; Tmax = 293C, same location at R479-8	**GTB**
					R479-9
1353				Add one more cycle to filter #17	
1353				Mr. Potato Head, probe and chimney	FG R479-013
					FG R479-014

					FG R479-015
1358				Heading to **Inferno**, hdg 067	
1359		421388	5087163	**Inferno**, see hobo temp probe	
1402				Vigorous flow	Photo-78
1410		421393	5087163	Inferno, Hdg 246, near top, facing SW, trying to position HFS T probe into chimney which was thrashed by former GTB sampling (~dive 473) Tmax = 291C	
1425	1543			Mr. Potato Head at **Inferno**.	FG R479-016
1439	1543			Piston #11, Inferno, Hdg 246, near top, facing SW max. Tmax = 291C, 13 deg on the back probe (T2).	**HFS**
					R479-10
1455				At **Mushroom**	
1455	1546	421404	5087166	Going to **Virgin Mound**, jumbled sheet flows and tube worms	
1457	1544	421418	5087176	See **Virgin's Daughter**, turn to head SE	
1501	1545	421432	5087175	At **Virgin**; temperature probe; HFS got some filters knocked off	FG R479-017
1510				Fiddling with temperature probe	Photo-79
					Photo-80
1535	1546	"	"	Knocked over chimney of **Virgin Mound**! Still probing Temp; Max Temp 261C; Firing Starboard GTB #7; Filling Piston #12	FG R479-018
					GTB
					R479-11
					HFS
					R479-12
					Photo-81
1555	1546			Still sucking after pump stopped a couple of times	
1604	1546			Cooking potato at **Virgin Mound**; making a video clip of the BBQ	FG R479-019
					Photo-82
					Photo-83
1613	1546			Taking background ASHES filter set #18 as we move about	FG R479-020
					HFS
					R479-13
1613				Going to **Mushroom** to take a temp	
1619	1545	421403	5087167	At **Mushroom**, taking T	Photo-84
1630	1545	"	"	Bag #4 with filter; max T 179C; knocked off chimney structure	**HFS**
					R479-14
1641	1545	421396	5087153	Going back to cage for tether management	
1649	1545	421384	5087150	Going Northwest of **Hell** at **Inferno** -area to sample clams	Photo-85
1653	1546	421392	5087163	West of **Inferno**; found some clams	Photo-86
1654	1546	421384	5087170	Some venting, worms, clams	Photo-87
1655	1545			Big hat of tube worms; looking for large clumps of clams	Photo-88
					Photo-89

					Photo-90
					Photo-91
1657	1545			Rattail fish; camera stopped- battery died probably	Photo-92
1700	1546			Still looking	Photo-93
					Photo-94
1702	1546	421394	5087138	At **Medusa**; positioning for suction sampling; suction sample bottle #4 diffuse flow at **Medusa**	Photo-95
					Suction sample
					R479-15
1710	1546	"	"	Suction sample bottle #2 and #7 of sulfide and palm worms and white mat	**Suction**
					R479-16
1808	1547	421375	5087135	At **Hell** to sample sulfide worms from **Porkchop**; Suction Bottles #3	**Suction sample**
					R479-17
1819	1547			Going to **Hillock** for worm observation	
1822	1546	421390	5087129	At **Hillock** to observe worm colonization at **Mkr-2**	FG R479-021
					FG R479-022
1838	1545			Going to the wall for sampling; computer lock up	
1846	1487			Back in business, to the cage we go	
1854				On our way to **Caldera Wall**	
1857	1545	421272	5087134	Lots of sponges, orange mat, tube worms	
1900	1545	421267	5087140	Spotted clumps of clams with sediment	FG R479-023
					FG R479-024
1908	"	"	"	Collecting clams buried in sediment into Suction Bottle #7--failed sample	**Suction sample**
					R479-18
1926	1545	"	"	Having trouble sucking into jar #7, trying flushing jar no #; no luck--failed sample	
1937	1545			Moving north for mat and water	
1942	1546	421256	5087165	Found some diffuse venting with orange vent around; Suction Sample Jar #1 of diffuse flow	**Suction sample**
					R479-19
					FG R479-025
2011				Interruption in bottom time due to ship out of position (blown off station)	
2038				Going back to bottom	
2046				On bottom	
2048	1546	421268	5087131	hdg 299	
2054		421249	5087171	resume sucking R479-19 but maybe not at precisely the same place	
2057				Proceed with Imagenex sonar, east-west transects from wall through ASHES areas	
2108	1527	421287	5087150	SOL Imagenex Line A11	
2251		421143	5087134	Finished Line A10	
2305		421275	5087135	Beginning Line A12	

2358		421218	5087127	Finished Line A12
0016	1525	421362	5087107	Positioning to start A13
JD 260				
0021	1525	421300	5087108	Start Line A13, hdg 280
0046		421065	5087116	End of Line A13 and Imagenex survey; heading east to **Hell** to pick up the osmosampler
0115	1543			At **Hell Vent**. Positioning to recover osmosampler.
0123		421374	5087136	Osmosampler recovered.
0124				Off bottom, heading for home (deck, not cage).
0300				ROPOS on deck

Dive R480

Dive Map

Dive Summary:

Dive R480 placed 4 extensometers across the North Rift and then proceeded 3400 m south to the CASM site. There was no navigation for the CASM work but the fissure in which vents were first found in 1983 was easily located. Shepherd Vent has become a biological oasis with dense clusters of palm worms, tube worms and others. About 30 m north, a cluster of ~3 m tall sulfide spires with both diffuse and focused venting was encountered and sampled for biology and geology. Gas bubbles were streaming out of the top of a spire where sampling was done. This site is new and was named "T & S Spires". HOBO and VEMCO temperature recorders were deployed here. SUAVE scans were performed at Shepherd Vent and T & S Spires. Gas tight bottles were filled at both sites. The Lamphere Chimneys were also encountered about 20 m to the east of the fissure. They are no longer hydrothermally active. Dive R480 concluded the NeMO 98 program in high style.

Times are UTM (local PDT +7 hours)

Region, Field, Site	**Dive Begin**	**Dive End**	**Tasks**
	Date (PDT): Sept. 18, 1998	Date (PDT): Sept. 19, 1998	
Axial Seamount			Deploy extensometers across north rift
	Date (UTM): Sept. 18, 1998	Date (UTM): Sept. 19, 1998	Imagenex survey of the deployment area
North rift			

Reconnaissance survey of CASM site (discovered August 1983)

Julian Day 262

Julian Day 261

Time off bottom:

Time off deck:

0815

2111

Time on deck:

Time on bottom:

0930

2230

Total dive time:

12 hr 19 min

Total bottom time:

9 hrs. 45 mins.

ROPOS configuration:

Digital still camera mounted lower forward on port bumper

Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)

Photosea 2000S 28 mm camera and strobe mounted side-by-side on upper center of bumper

SUAVE sampler with inlet attached to the port (5 function) arm

VEMCO #214 and HOBO #130 temperature probes

2 gas tight bottles with intake on port arm

Standard jaw on port (5 function) arm

Standard jaw on starboard (7 function) arm

Time	Depth	X-pos	Y-pos	Comments	Frame grabs, photos and samples
UTM	m	m	m		
2050				Elevator launched with 4 extensometers after 39 hour wait for weather. One extensometer (E1) popped part way out of the launch tube -- could see that orange float was missing. Float slipped down the pole with the recovery line during launch (rope from crane to elevator broke with snap load).	
2111				ROPOS launched	
2226	1590	421110	5096664	Good elevator fix	
2227	1590	421098	5096664	Good elevator fix	
2230	1588			At elevator!	
2234	1585	421094	5096665	Still at elevator. ROPOS fix.	
2235	1585	421094	5096669	Good ROPOS fix; getting ready to take Extensometers out of elevator. E2	FG R480-001 Photo-1
2238	1585			Photo of Extensometer in elevator	Photo-2
2239	1585			Extensometer (E) in clay - Moving to deployment site for E2 ~93 m away at hdg. 322	
2246	1587	421049	5091587	Good ROPOS fix	
2250	1592	421034	5096723	"	
2252	1592			Positioning to deploy E2, big rattail	Photo-3 FG R480-002 FG R480-003
2259	1592	421026	5096739	**Deployed E2 -** in jumbled flow, hdg 353	Photo-4 Photo-5 FG R480-004
2301				Hdg 137 back to elevator to get another extensometer	
2308	1583			Back at elevator; preparing for on bottom extensometer repair of E1 - float has slid down the tube, need to get the claw in to pull it out; SIT FG	FG R480-005
2313	1585			Got it! E1 being pulled out of tube	FG R480-006
2316	1590			Hdg 207 to deploy E1, stopped to adjust E1, attempting to get pumpkin back to the top	
2320				Pumpkin seems snug around the bottom, unable to move it up, leaving it	FG R480-007
2326	1587			Hdg 78 to E1 deployment site, stopped to wait for a good fix (~2332)	
2336	1579	421208	5096690	Good ROPOS fix, hdg 90 30m to E1 target	
2343	1589	426676	5091592	Just SE of E1 target	
2345	1592	426708	5091203	**Deployed E1-**in jumbled flow, waiting to get a good fix for this site, can't get a great one - position of E1 is probably somewhere between this fix and the last one above.	Photo-6

						Photo-7
						Photo-8
						FG R480-008
						FG R480-009
2353	1574				Heading back to the elevator	
2357					At the elevator, pulling out E3, hdg 299 to E3 deployment site	
0001	1580				Momentarily lost E3, dropped it when we were ~10m above floor	
Julian day 262						
0003	1592				Have E3 again, hdg 299 for 179m	
0015	1589	426752	5090970			
0019	1592	426743	5091590		**Deployed E3 -** in jumbled flow; heading back to the elevator; digital still camera was turned on at some point, don't know when	FG R480-010
						FG R480-011
0023					Noticed that SIT overlay reads 481 (Dive number), changed to 480	
0027					At the elevator, pulling out the last extensometer E4 (#5 on the pumpkin, but 4 on the rope), set down E4 in order to release elevator	FG R480-012
						FG R480-013
0034					Releasing the elevator, will take 30-40 min. to reach surface, ship will pick it up	
0040	1590	421239	5096431		Elevator released	
0042					Back at E4, picked it up and heading back to the cage, will hang at the cage with E4 until elevator is picked up by ship	
0045	1460	421120	5096679		Hovering near cage, waiting...	
0114					Elevator on the surface	
0145					Elevator on deck	
0150					Ship repositioning	
0228	1466				Ship is on station, ROPOS is moving back down to the bottom to deploy E4	
0238	1591	420797	5096719		Hdg 319 to E4 deployment site	
0243	1590	420732	5096793		Stopped to try and get a good fix, got it 0246	
0248	1596	420733	5096799		Due east E4 target site by ~20m, positioning to deploy E4	
0251					**E4 deployed-** positioned in lobate flow; E1-E3 positioned in jumbled flows	Photo-9
						Photo-10
						FG R480-14
						FG R480-15
0254					Heading back to the cage	
0258		NO NAV			Cage and ROPOS moving up to 1400 in order to traverse to CASM	
		FOR REST				
		OF				

		DIVE			
0306	1400			Waiting for transponders to be turned off	
0315				On our way to CASM vent site at 1.2 kt SOG	
0340				Ship going 4 kt = too fast!!	
0444	1380			Strong concentration of particulates in the water column. Going to the bottom. Shallowest point at the top of the wall is 1485 m (re cage safety)	
0454	1466			Dense particulates	
0459				On the bottom. Sheet lava.	
0500	1578			Archive tapes restarted. Were turned off at 0305. Proceeding W	
0502				Fissure oriented N-S.	
0504	1577			Proceeding N in fissure. Hydrothermal stain on lower slope of W wall.	Photo-11
0507	1587			At dead end. Go up and over. Proceeding N. Lots of crab, clams, tube worms. Probably **Shepherd's Vent**.	Photos 12-16
1510	1584	not	moving	Hot water. Dense animals (especially palm worms). Biology considerably changed since 1983.	Photo 17-21
					FGs
					R480-016
				Max. T on SUAVE of 7C but sensor not right into the dense cluster of palm worms.	R480-017
					R480-018
					R480-019
					R480-020
					R480-021
0521				Maneuvering looking for place to SUAVE. Lost Shepherd's Vent	Photo-22
0530				Back into box canyon	Photo-23
0531				Back at Shepherd's Vent	Photos 24-29
0537	1581			Proceeding N along fissure	Photos 30-31
0539	1581			Sulfide chimneys in fissure. Back to cage for tether management. Moving ship closer to work area.	Photos 32-33
					FG R480-022
0548	1573			Back to bottom.	
0552	1575			Active sulfide chimneys. Palm worms, a few tube worms, bag creature.	Photos 34-39
				Named **T & S Spires** (after Keith Shepherd's children Trevor and Sarah)	FGs
					R480-023
					R480-024
					R480-025
0603	1585			SUAVE #1 Max T = 42C	FGs
				H2S 232 µm, Mn 73 µm, Fe >91 µm	R480-026
					R480-027

			R480-028
		Port side gas tight bottle #2	R480-029
			Photo-40
			SUAVE
		Hdg 301	R480-1
			GTB
			R480-2
0611		SUAVE scan finished	
0625		VEMCO temperature recorder deployed at SUAVE site. Hot water coming out of a tiny sulfide chimney ~2 cm high. Black sulfide released when chimney disturbed.	FGs
		Hdg 301	R480-030
			R480-031
0628	1582	Surveying **T & S** Spires	Photo 41-51
			FG
		FG 480-033 of sampled chimney. It is ~3m high.	R480-032
			R480-033
			R480-034
		Attempted to sample large active chimney on **T & S**. Most didn't make it into the BioBox.	**Sulfide**
			R480-3
0630		Changed archive tapes	
0658		Deployed HOBO #130 temperature recorder into stump of active chimney.	Photos 52-55
		Hdg 301	FGs
			R480-035
			R480-036
			R480-037
0701		Photos of VEMCO and HOBO probes	Photos 56-58
			FG
			R480-038
			R480-039
0703	1585	Chimney sample almost filled the port side of the bio box (silica rich)	**Sulfide**
			R480-4
			Photo 59
0708		Moving down the lane through the little canyon, crabs, lots of worms,	Photo 60-63

			FG
			R480-40
0711		Lots of crabs (at least 6 in view), going along the wall, going down, heading 320, looking at bottom of the canyon	Photo-64
0712		Up against a wall, heading 12, looking at a slope that might be the base of a wall, going down again, wall in front of us when we are at 300.	
0714	1580	Talus slope, crab, heading 22 wall, wall all over, might be out of venting area, turning back to the south to find the chimneys	
0718	1588	Heading 181, looking for vents, clam shells, 183 looking at a wall , worms with lots of crabs, same area that we already passed a few minutes ago--Verena thinks that this is remains of Taylor's Vent	Photo-65-66
0721	1583	More worms, heading 199, crabs, an area that is dying, but new venting at places, dead worms on silica mound	Photo-67-69
0725	1582	Found live worms, on the back side of mound where we deployed the temperature probe, back at **T&S Spires**	Photo-70
			R480-041
0727	1583	Suave the tube worms	**Suave**
		Stop the highlights	R480-5
			FG
			R480-042
			Photo-71-73
0732	1583	Starboard gas tight #6	**Gas Tight**
		Highlight tape on.	R480-6
		Still SUAVEing, stopped at 0738	FG R480-043
		max Temp 20.3C, H2S 177 uM, Mn 40.5 uM, Fe 86 uM;	FGR480-044
		Stop highlights	
0739	1583	Collecting tube worms from the site that was just scanned, bubbles in the water,	**Tube worms**
		Highlights on and off,	R480-7
0740		Bubbles	FG
			R480-045
0741		Still sampling, chimney is on box, got a subsection of the big piece, making it fit in the box, starboard side, more blood, more blood, where are the sharks???	Photo-74
0756		Done sampling the worms.	Photo-75
		Highlights of the bubbles.	
		Taking more worms from the same place and putting them in the starboard side of the bio box. Same sample as the previous one. Sample finished at 0803	
0806		Just looking at the site were we took the samples and looking for bubbles, more highlights, bubbles coming up from the back side, big bubbles	Photo-76
0810		End of dive, ROPOS off the bottom	Photo-77-79
			FG R480-046FG R480-047
0814		At marker and an active chimney, heading 0 (North), more chimneys but mostly dead.	Photo 80-8?, lots of photos

0815	Now we are off the bottom, to the cage.
0930	ROPOS on deck for final time