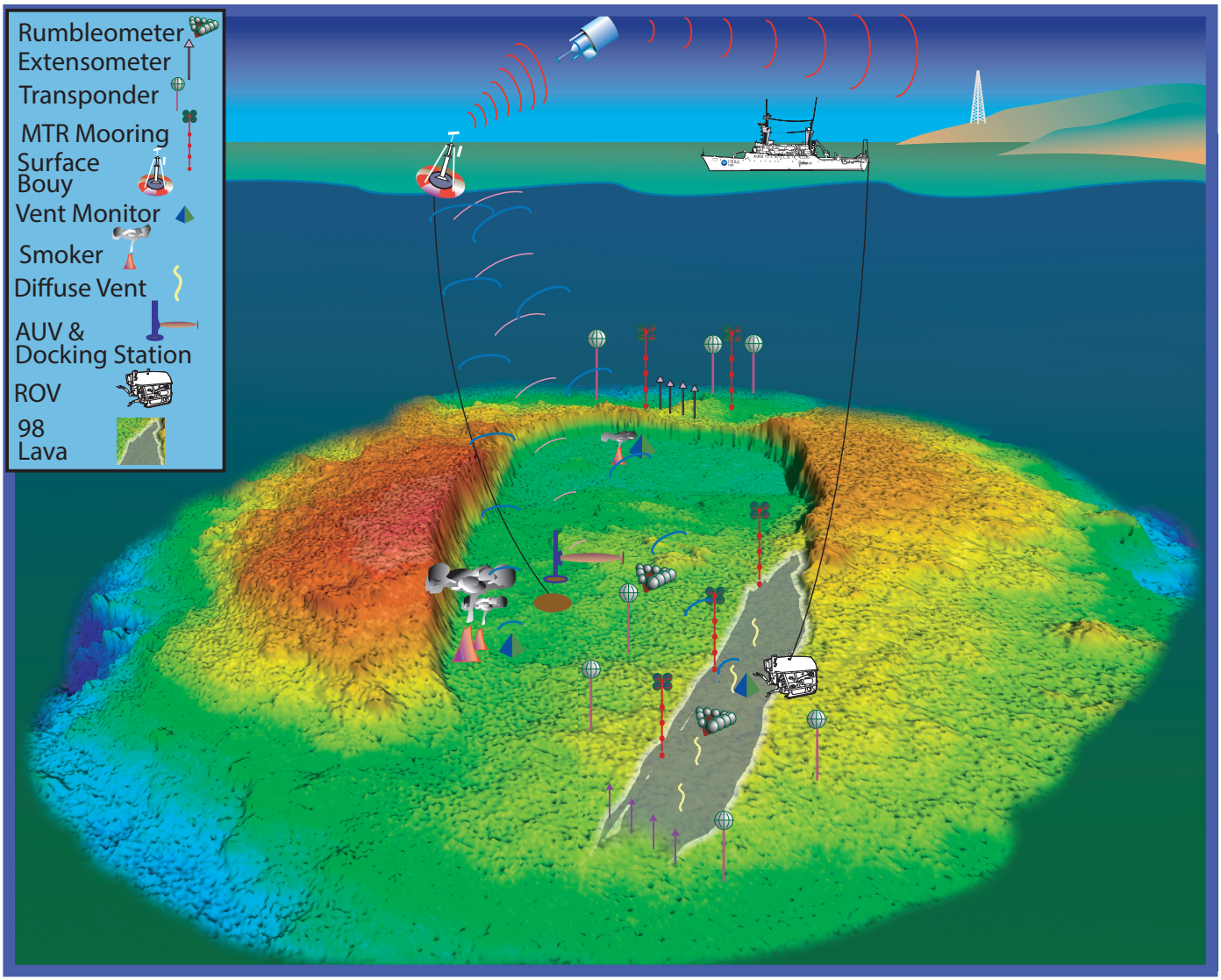
# NeMO New Millennium Observatory
# Axial Volcano
# Juan de Fuca Ridge

# Cruise Report
# Vents Leg 2b
# August 25 - September 20, 1998
# Newport, Oregon - Victoria, British Columbia

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Cruise Report compiled by Susan G. Merle, Robert W. Embley and William W. Chadwick Jr.

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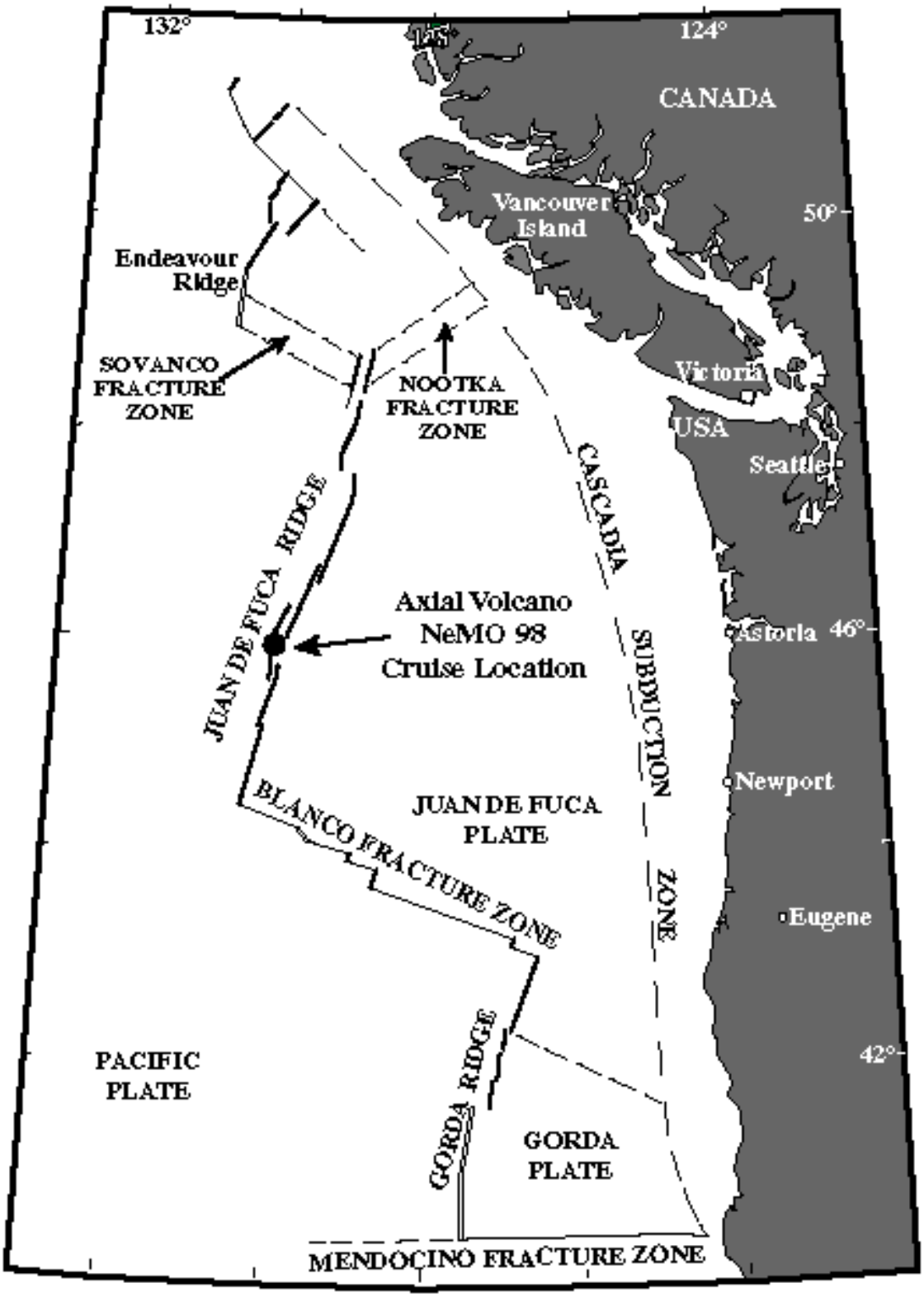
132°
125°
124°
CANADA
Vancouver Island
50°
Endeavour Ridge
SOVANCO FRACTURE ZONE
NOOTKA FRACTURE ZONE
Victoria
USA
Seattle
CASCADIA SUBDUCTION ZONE
JUAN DE FUCA RIDGE
Axial Volcano
NeMO 98
Cruise Location
Astoria
46°
Newport
JUAN DE FUCA PLATE
BLANCO FRACTURE ZONE
Eugene
PACIFIC PLATE
GORDA RIDGE
GORDA PLATE
42°
MENDOCINO FRACTURE ZONE

Figure 1

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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.

### 1.0.2 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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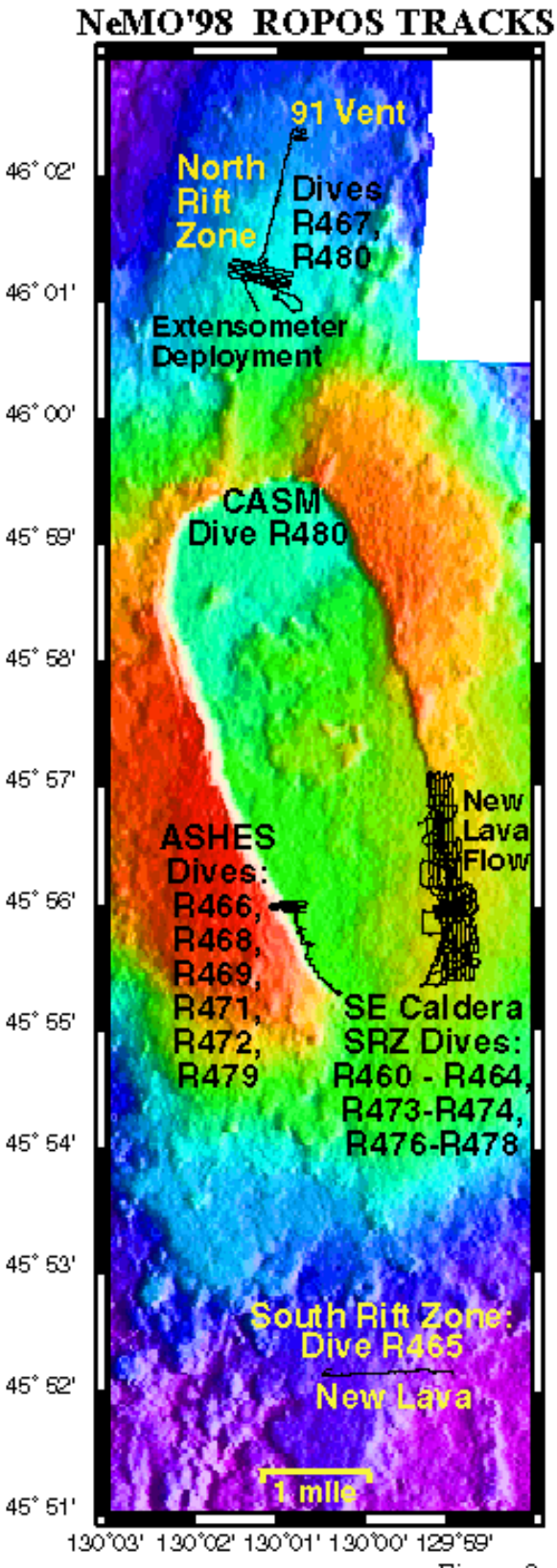

NeMO'98 ROPOS TRACKS
91 Vent
North Rift Zone
Dives R467, R480
Extensometer Deployment
CASM Dive R480
New Lava Flow
ASHES Dives: R466, R468, R469, R471, R472, R479
SE Caldera SRZ Dives: R460 - R464, R473-R474, R476-R478
South Rift Zone: Dive R465
New Lava
1 mile
46° 02'
46° 01'
46° 00'
45° 59'
45° 58'
45° 57'
45° 56'
45° 55'
45° 54'
45° 53'
45° 52'
45° 51'
130°03' 130°02' 130°01' 130°00' 129°59'

Figure 2

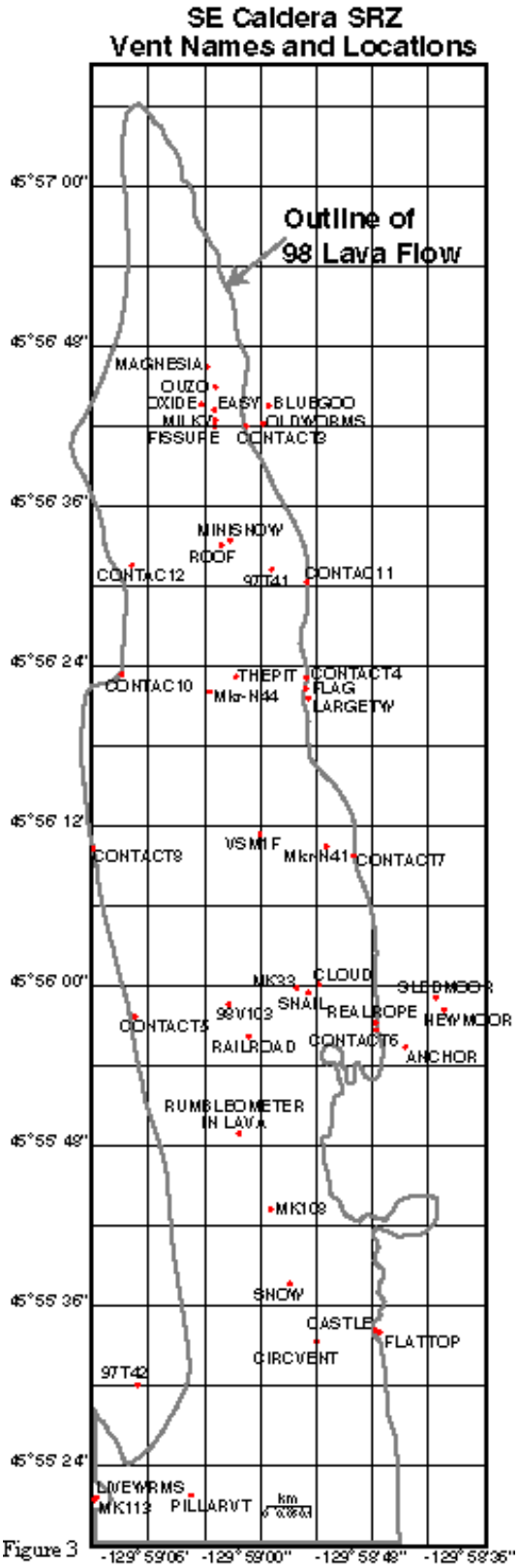

SE Caldera SRZ
Vent Names and Locations
Outline of
98 Lava Flow
45°57'00"
45°56'48"
45°56'36"
45°56'24"
45°56'12"
45°56'00"
45°55'48"
45°55'36"
45°55'24"
MAGNESIA
OUZO
OXIDE
EASY
BLUBGOO
MILKY
OLDWORMS
FISSURE
CONTACT3
MINISNOW
ROOF
CONTAC12
97T41
CONTAC11
CONTAC10
THEPIT
Mkr-N44
CONTACT4
FLAG
LARGETW
CONTACT8
VSMIF
Mkr-N41
CONTACT7
MK33
CLOUD
SLEDMOOR
SNAIL
98V103
REALROPE
NEWMOOR
CONTACT5
RAILROAD
CONTACT6
ANCHOR
RUMBLEOMETER
IN LAVA
MK103
SNOW
CASTLE
FLATTOP
CIRCVENT
97T42
LIVEWRMS
MK113
PILLARVT
km
-129°59'06"
-129°59'00"
-129°58'48"
-129°58'36"

Figure 3

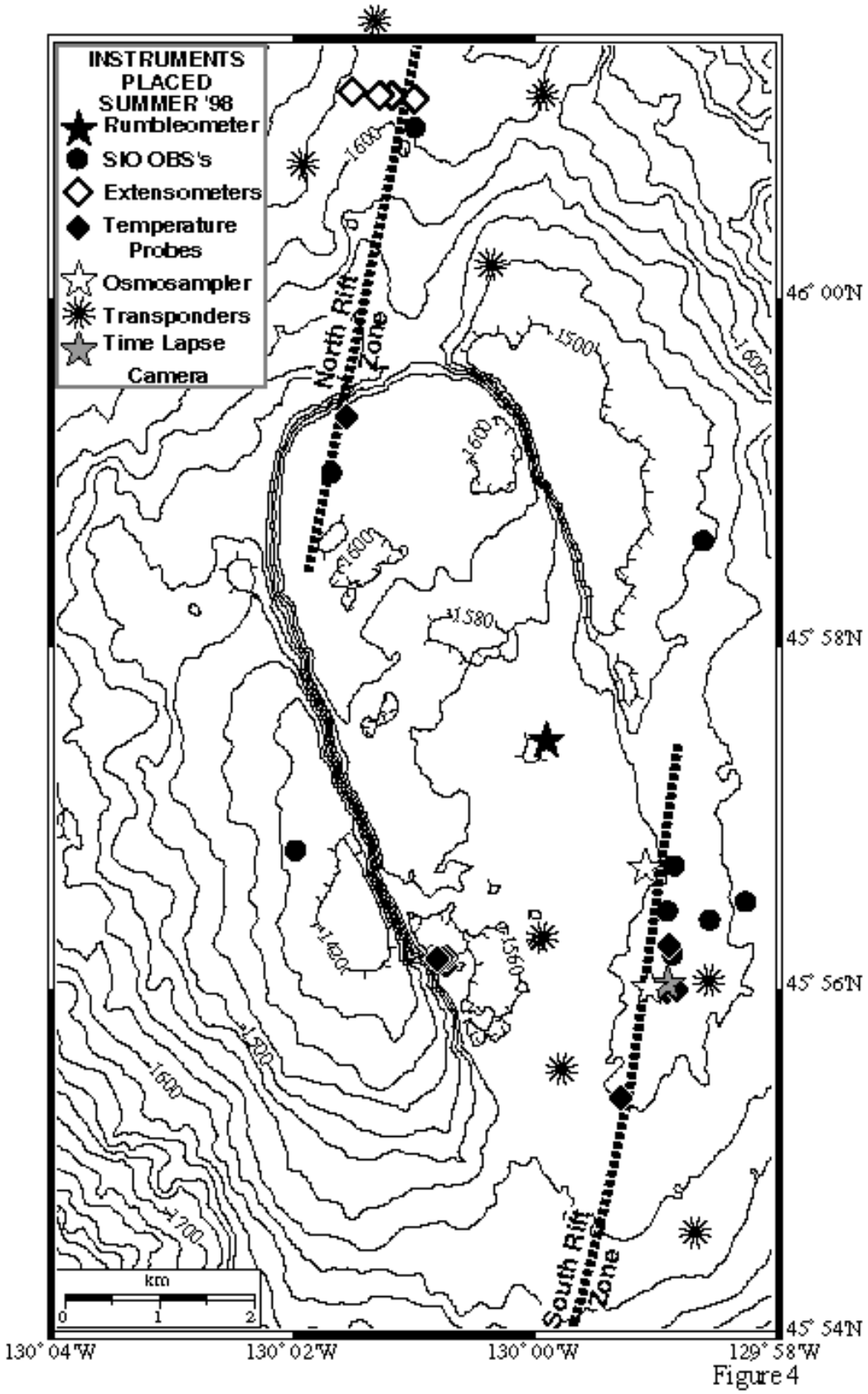
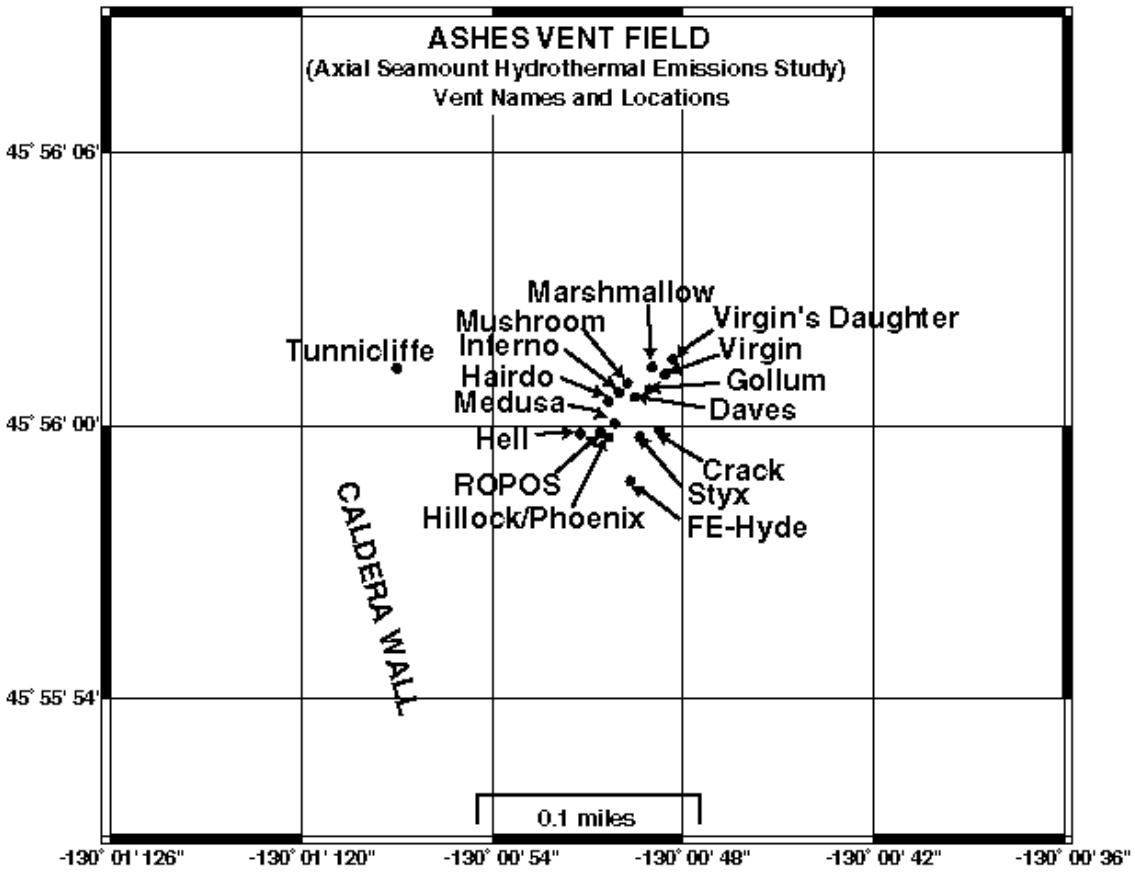

INSTRUMENTS PLACED SUMMER '98
Rumbleometer
SIO OBS's
Extensometers
Temperature Probes
Osmosampler
Transponders
Time Lapse Camera
North Rift Zone
South Rift Zone
1600
1500
1580
1620
1560
1700
km
0
1
2
46° 00'N
45° 58'N
45° 56'N
45° 54'N
130° 04'W
130° 02'W
130° 00'W
129° 58'W

Figure 4




**Depths range from 1405 at top of caldera wall to 1552 northwest of ASHES Vent Field**

Figure 5

## 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 45°55.3' and 45°57.2' (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 45°52.0'/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 45°54.5' to 45°55.0'. 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 45°54.8'.

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 45°52' and 45°55' 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 46°01.2'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 °C | Tave °C | $H_2S$ µM | Mn µM | Fe µM | $H_2S$/Q nM/J | Mn/Q nM/J | Fe/Q 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 |
| R461-20 @ Cirque Vent and hole in basalt with Fe floc cover | 6.5 | 6.5 | 87 | 3.0 | 57 | 6.2 | 0.2 | 3.5 |
| R461-21 @ Castle Vent@ base of Hi-T vent | 90 | 60 | 1400 | 18 | 71 | 6.1 | 0.1 | 0.3 |
| R461-22 @ Castle Ventprobe in tubes @ base | 5.3 | 5.0 | 132 | BDL | BDL | 13.0 | - | - |
| R461-23 @ Castle Vent and MKR N5, @ healthy tube worms | 21 | 19 | 200 | 6 | 19 | 3.0 | 0.1 0.3 | |
| R478-1 @ MKR 33 | 17 | | | | | | | |
| R478-2 MKR 33 Near OSMO Sampler and MTR | 42.2 | | | | | | | |
| R478-4 20 m SW of MKR 33 at crack venting floc | 13.0 | | | | | | | |
| 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 within big tube worms | 16.3 | 16.1 | | | | | | |
| **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 roots were | 14.8 | 13.5 | 180 | 15 | 10 | 4.1 | 0.3 | 0.2 |
| **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 worm community | 20.3 | 16 | 177 | 40.5 | 86 | 3.3 | 0.8 | 1.6 |
| **91 Vent (N. Rift)** in most intense flow near worms, clams | 4.5 | 4 | 124 | 5 | 2 | 14 | 0.8 | 0.3 |

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 μm) and particle-attached (>3μm) 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 μm) 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 Samples

A 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 (-80 C) 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 4 C, 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 50°C 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) http://newport.pmel.noaa.gov/nemo_cruise98/

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 27$^{th}$ (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 | 45°55.977 | 129°59.056 | 423694 | 5087067 |
| ANCHOR | 45°55.923 | 129°58.741 | 424099.8 | 5086961.7 |
| BLUEGOO | 45°56.725 | 129°58.985 | 423803.2 | 5088450.7 |
| CASTLE | 45°55.568 | 129°58.794 | 424022.7 | 5086305.8 |
| CIRCVENT | 45°55.555 | 129°58.899 | 423887 | 5086283 |
| CLOUD | 45°56.001 | 129°58.894 | 423903.5 | 5087108.6 |
| CONTAC10 | 45°56.389 | 129°59.248 | 423455.7 | 5087832.8 |
| CONTAC11 | 45°56.505 | 129°58.917 | 423885.6 | 5088041.9 |
| CONTAC12 | 45°56.525 | 129°59.230 | 423482.1 | 5088085.7 |
| CONTACT1 | 45°55.622 | 129°58.790 | 424029.2 | 5086406.5 |
| CONTACT2 | 45°55.727 | 129°58.686 | 424166 | 5086599 |
| CONTACT3 | 45°56.700 | 129°59.025 | 423750.1 | 5088405 |
| CONTACT4 | 45°56.385 | 129°58.918 | 423881.8 | 5087820.2 |
| CONTACT5 | 45°55.961 | 129°59.224 | 423476.3 | 5087040.6 |
| CONTACT6 | 45°55.944 | 129°58.793 | 424033.5 | 5087002.2 |
| CONTACT7 | 45°56.162 | 129°58.834 | 423985.6 | 5087406.7 |
| CONTACT8 | 45°56.171 | 129°59.298 | 423385.3 | 5087430.2 |
| CONTACT9 | 45°56.322 | 129°59.314 | 423368.5 | 5087711.1 |
| CRACK | 45°55.998 | 130° .813 | 421424 | 5087135 |
| DAVES | 45°56.011 | 130° .826 | 421408.3 | 5087158.6 |
| DYING | 45°55.011 | 129°59.511 | 423083.7 | 5085286.4 |
| EASY | 45°56.720 | 129°59.083 | 423676.5 | 5088443.2 |
| Fe-HYDE | 45°55.979 | 130° .827 | 421406 | 5087099.7 |
| FISSURE | 45°56.698 | 129°59.082 | 423677.6 | 5088403.5 |
| FLAG | 45°56.372 | 129°58.920 | 423879.1 | 5087796.4 |
| FLATTOP | 45°55.566 | 129°58.787 | 424032.8 | 5086301.9 |
| GOLLUM | 45°56.015 | 130° .815 | 421422 | 5087166.1 |
| HAIRDO | 45°56.010 | 130° .839 | 421390.7 | 5087156.8 |
| HELL | 45°55.998 | 130° .854 | 421372 | 5087135 |
| HILLOCK | 45°55.997 | 130° .842 | 421387 | 5087132.7 |
| HILPHNX | 45°55.995 | 130° .839 | 421390.9 | 5087130.4 |
| INFERNO | 45°56.013 | 130° .834 | 421397.2 | 5087162.2 |
| LARGETW | 45°56.359 | 129°58.915 | 423885.2 | 5087772.1 |
| LIVEWRMS | 45°55.359 | 129°59.293 | 423374 | 5085927 |
| MAGNESIA | 45°56.774 | 129°59.096 | 423660.7 | 5088544.7 |
| MARSHMALLOW | 45°56.022 | 130° .817 | 421420.4 | 5087179 |
| MEDUSA | 45°56.001 | 130° .836 | 421394.7 | 5087141.1 |
| MILKY | 45°56.707 | 129°59.080 | 423679.4 | 5088419.7 |
| MINISNOW | 45°56.557 | 129°59.053 | 423711 | 5088141 |
| Mkr-I | 45°56.022 | 130°00.820 | 421416 | 5087180 |
| Mkr-108 Vent | 45°55.719 | 129°58.982 | 423784 | 5086589 |
| Mkr-113 Vent | 45°55.356 | 129°59.296 | 423370 | 5085922 |
| Mkr-2 | 45°55.998 | 130°00.838 | 421392 | 5087136 |
| Mkr-21 | 45°56.016 | 130°00.815 | 421422 | 5087168 |
| Mkr-33 Vent | 45°55.996 | 129°58.935 | 423850.3 | 5087101.1 |
| Mkr-D | 45°55.995 | 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 **corrected 2014** | 4555.566 | 129° 58.776 | 424043 | 5086306 |
| 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 | 45°59.394 | 130° 1.601 | 420486.4 | 5093373.6 |
| SOCASM | 45°59.322 | 130° 1.575 | 420518.6 | 5093304.6 |

## South Rift Zone Transponder Net

| | | | | |
|---|---|---|---|---|
| ANOM | 45°52.151 | 129°59.131 | 423509.6 | 5079985.2 |
| CTD1 | 45°55.205 | 129°59.030 | 423710.6 | 5085638.9 |
| S CONTACT2 | 45°52.142 | 130° 0.464 | 421785.7 | 5079989.9 |
| TOPLAVA | 45°52.188 | 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<br>Aug 28-29 | SE Caldera SRZ:<br>Mkrs N3, 33; Milky, The Pit, Cloud Vents |
| R461 | JD 241-243<br>Aug 29-31 | SE Caldera SRZ:<br>Rumbleometer; Mkrs 108,33,113; Cloud, Sulfide, Castle, Circular Vents |
| R462 | JD 243 - 244<br>Aug 31 - Sept 1 | SE Caldera SRZ:<br>Mkr-33, Cloud Vent |
| R463 | JD 244 - 245<br>Sept 1 - 2 | SE Caldera SRZ:<br>Easy, Milky Vents; (+ Imagenex survey) |
| R464 | JD 245<br>Sept 2 | SE Caldera SRZ:<br>Oxide, MiniSnow, The Pit, Snail, Mkr-108, Mkr-113, Castle Vents |
| R465 | JD 246<br>Sept 3 | South Rift Zone:<br>reconnaissance survey |
| R466 | JD 247<br>Sept 4 | ASHES:<br>Hell, ROPOS, Hillock/Phoenix, Hairdo and Inferno Vents |
| R467 | JD 248 - 249<br>Sept 5 - 6 | North Rift Zone:<br>Extensometers; Bob Vent: (+Imagenex survey) |
| R468 | JD 250<br>Sept 7 | ASHES:<br>Gollum, Hell, ROPOS, Hillock/Phoenix, Crack Vents |
| R469 | JD 250 - 251<br>Sept 7 - 8 | ASHES:<br>Medusa, Mushroom, Marshmallow, Gollum, Daves Styx and Fe-Hyde Vents; (+Imagenex survey) |
| R470 | JD 251<br>Sept 8 | North Rift Zone:<br>Extensometers |
| R471 | JD 252<br>Sept 9 | ASHES:<br>Gollum, Mushroom, White, Inferno, Hell Vents |
| R472 | JD 252<br>Sept 9 | ASHES:<br>Steve Mound, Hell, Phoenix, Medusa, Inferno Vents |
| R473 | JD 253 - 254<br>Sept 10 - 11 | SE Caldera SRZ:<br>Easy, Milky, Roof, The Pit, Snowblower, Mkr-33, Mkr-108, Cloud, Castle Vents; (+Imagenex survey) |
| R474 | JD 255<br>Sept 12 | SE Caldera SRZ:<br>The Pit, Milky Vents; Rumbleometer; Lava Flow Mapping Traverses |
| R475 | | Dive aborted |
| R476 | JD 256 - 257<br>Sept 13 - 14 | SE Caldera SRZ: **north of 98 flow**<br>Magnesia, Easy, Old Worms, Milky Vents;<br>Lava flow traverses; (+ Imagenex survey) |
| R477 | JD 258<br>Sept 15 | SE Caldera SRZ:<br>Rumbleometer; Mkr-33 Vent |
| R478 | JD 258<br>Sept 15 | SE Caldera SRZ:<br>Mkr-33, Mkr-n4, Cloud, Nascent Vents |

| | | |
|---|---|---|
| R479 | JD 259 - 260<br>Sept 16 - 17 | Northern traverse along caldera wall:<br>ASHES:<br>Hell, Virgin, Mushroom, Medusa, Inferno Vents; (+Imagenex survey) |
| R480 | JD 261 - 262<br>Sept 18 - 19 | North Rift Zone and Northern Caldera Wall:<br>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<br>North of The Pit | R460 | | |
| HOBO (borrowed from U. Washington) | Near Cloud Vent and Mkr-33 | Alvin dive 3247<br>7/18/98 | R460 | |
| Mkr-N6 | Cloud Vent | R460 | | |
| Bacteria Traps<br>#5,6,7,8 | Mkr-33 Vent | R461 | R462 Retrieved #7,8<br>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<br>#1,2 | Cloud Vent | R461 | R462 | |
| VEMCO | Mkr-113 Vent | Alvin dive 3245<br>7/15/98 | Moved R461 | Relocated to bottom of pillar (from top) during Dive R461 |
| Bacteria Traps<br>#3,4 | Mkr-113 Vent | R461 | R464 Retrieved #3 | Bacteria Trap #4<br>Not retrieved |
| Mkr-N5 | Castle Vent | R461 | | |
| osmosampler | Mkr33 | R462 | R477 | Had HOBO probe |
| Bacteria Traps<br>#9,10,11,12 | Mkr-33 | R462 | R477 Retrieved #10,11 | Bacteria Traps<br>#9,12 Not retrieved |
| Bacteria Trap<br>#14 | Mkr-N4 | R462 | | Bacteria Trap #14<br>Not retrieved |
| Bacteria Traps<br>#16,18 | Milky Vent<br>Mkr-N2 | R463 | R474 Retrieved #16,18 | |
| Bacteria Trap<br>#17 | Easy Vent | R463 | | Bacteria Trap #17<br>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<br>#19,20,21 | Mkr-113 Vent | R464 | | Bacteria Traps<br>#19,20,21<br>Not retrieved |
| Bacteria Traps<br>#22,23,24 | Castle Vent | R464 | | Bacteria Traps<br>#22,23,24<br>Not retrieved |
| HOBO | Hell Vent (spire) | R466 | R479? | Part of osmosampler package |
| osmosampler | Hell Vent (spire) | R466 | R479 | |
| Bacteria Traps<br>#25,26 | Hillock/Phoenix Vent | R466 | | Bacteria Traps<br>#25,26<br>Not retrieved |
| Bacteria Traps<br>#27,28 | ROPOS Vent | R466 | | Bacteria Traps<br>#27,28<br>Not retrieved |
| Mkr-D | east of Hillock/Phoenix Vent | R468 | | |
| MTR | Gollum Vent | R471 | | |
| Bacteria Traps<br>#??? (3 traps) | Gollum Vent | R471 | | Bacteria Traps<br>#??? Not retrieved |
| Bacteria trap<br>#? (1 trap) | Mushroom Vent | R471 | | Bacteria Trap<br>#? Not retrieved |
| Mkr-1 | White Vent | R471 | | |

| MKRS/EXPERIMENTS | AREA | DEPLOYED (Dive) | RECOVERED (Dive) | COMMENTS |
|---|---|---|---|---|
| Mkr-N41 | south of The Pit Vent north of rumbleometer | R474 | | |
| MTR 4126 | Mkr-N41 | R474 | | |
| Mkr-N44 | west of The Pit Vent | R474 | | |
| osmosampler | Mkr-N2 (Milky Vent) | R474 | | |
| Bacteria Trap #35 | Mkr-N2 | R476 | | Bacteria Trap #35 Not retrieved |
| osmosampler (long-term) | Mkr-33 | R477 | | |
| Time-Lapse Camera (long-term) | Mkr-33 | R478 | | |
| 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) diffuse flow area | Alvin 3246 | | |
| HOBO 129 | Virgin Mound | Alvin 3246 | | |
| VEMCO | near Crack Vent | Alvin 3246 | | |

## 10.3 Sample Types (Total and per Dive)

**57 SUAVE scans**
**53 HFS samples**
**21 gastight bottles**
**7 niskins**
**2 misc.fluid samples**

**13 macrobiological samples**
**12 microbiological samples**
**(microbial traps)**
**17 hard samples (geo)**

**47 Suction Samples:**
**19 microbiological**
**8 macrobiological**
**9 macro&microbiological**
**11 fluid**

**R460**
4 SUAVE
2 geo
2 fluid

**R461**
18 SUAVE
2 gastights
2 macro
3 geo

**R462**
4 micro (bactraps)
1 micro (bag creature)
1 niskin
2 gastights
1 geo
6 suction samples
(3-micro&macro/2-micro/1-fluid)

**R463**
1 gastight
1 suction sample (fluid)

**R464**
1 micro (bactrap)
2 macro
1 geo
1 niskin
2 gastights
8 suction samples
(2-micro&macro/3-micro/1-fluid)

**R465**
2 geo

**R466**
21 SUAVE
2 macro
2 gastights
1 niskin

**R467**
1 geo
2 SUAVE
1 micro&macro

**R468**
7 HFS
1 SUAVE
1 niskin
1 geo

**R469**
16 HFS
1 SUAVE
1 gastight
1 geo

**R471**
2 macro
2 gastights
1 niskin
3 suction samples
(2-fluid/1-micro&geo)

**R472**
1 macro
1macro&geo
1 gastight
1 niskin
1 geo
8 suction samples
(2-micro/2-fluid/4-macro)

**R473**
18 HFS
2 gastights
1 niskin
1 geo
8 suction samples
(1-micro&macro)/4-micro/2-macro/1-fluid)

**R474**
2 micro (bactraps)
1 macro
5 suction samples
(4-micro/1-micro&macro)

**R475**
No samples

**R476**
1 geo
1 geo&micro
5 suction samples
(3-micro/2-fluid)

**R477**
4 micro (bactraps)

**R478**
8 SUAVE
2 gastights
5 suction samples
(1-micro/2-macro/1-micro&macro/1-fluid)

**R479**
11 HFS
2 gastights
5 suction samples
(1-micro/2-macro/1-micro&macro/1-fluid)

**R480**
2 SUAVE
2 gastights
2 geo
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

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|---|---|---|---|---|
| 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

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|---|---|---|---|---|
| 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 | |

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|---|---|---|---|---|
| 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 | 45°52.16' 129°59.17' | basalt, wedge/trapezoid shape, orange stripe inner surface, step in side, port biobox | J.Chadwick/ M. Perfit | |
| R465-2 | 45°52.17' 129°59.182' | flow structure, in port biobox, long, bonelike, glass, yellow stuff | J. Chadwick/ Mike Perfit | |

.**Dive R466** ASHES

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|---|---|---|---|---|
| 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 | |

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|---|---|---|---|---|
| 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/ 2.5 Moyer | √ |

**Dive R468** ASHES

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|---|---|---|---|---|---|
| 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 = 40°C. 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 = 170°C. 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 = 2.5°C | 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 | |

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|---|---|---|---|---|---|
| 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

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|---|---|---|---|---|---|
| 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/ McLaughlin | Roe/Guenther |

**Dive R473** SE Caldera SRZ

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|---|---|---|---|---|---|
| R473-1 | 1805 | 423679/5088458 | Fluid Sample at Easy Vent; Bag #2 with filter | Butterfield | filter lost durin dive |
| R473-2 | 1815 | "/" | Fluid Sample at Easy Vent; Filter #1 Sterivex filter only | Moyer | |

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|---|---|---|---|---|---|
| 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/ Evans | M.Lilley/ Butterfield |
| R473-6 | 1932 | 423674/5088454 | Suction Sample at Easy Vent; Jar #6 with 64 µm mesh; polynoids and white mat | Tunnicliffe/ Marcus/ Juniper | 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/ Kaye/Huber | McLaughlin |
| 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 Mkr-33 | Butterfield | McLaughlin/ 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 bag 24 | Butterfield | filter lost 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) bag sample with a filter, number 23 | Butterfield | McLaughlin/ 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 bio worms | Tunnicliffe/ Marcus/ Juniper | Juniper |
| R473-22 | 0840 | 423786/5086593 | HFS samples at Marker-108 Piston 12 ~12 degrees C | Butterfield | McLaughlin/ 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 |

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| 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 (note: sample number not in time order) | Evans | |

**Dive R474** SE Caldera SRZ

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|---|---|---|---|---|---|
| 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/ Guenther/ McLaughlin |
| R476-8 | 1817 | 423661/5088545 | Gas tight sample at Magnesia Vent; bottle #5, port side; Hdg 255 | Evans | 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

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|---|---|---|---|---|---|
| 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 = 16°C | 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/ Juniper | |
| R479-2 | 0928 | 421590/5086597 | HFS Bag sample #7 with a filter, $T_{ave}$ = ~19 deg C at intake, south of ASHES | Butterfield | Guenther/ Gendron/ McLaughlin |
| R479-3 | 1131 | 421373/5087132 | Piston #10, $T_{max}$ =26 deg C, at Porkchop<br>1139 Probe tip drifted out of hot fluid.<br>1142 Replaced in hot water new $T_{max}$ = 51 deg C. | Butterfield | Kaye/Huber/ Guenther/ McLaughlin |
| R479-4 | 1150 | "/" | Filter #16, Porkchop, same place as above, $T_{ave}$=30°C, about 1L, 8cycles | Huber | |
| R479-5 | 1202 | "/" | Sample Bag/Filter combo #6, Porkchop, same location as above, $T_{ave}$ =?°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, $T_{max}$ = 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, $T_{max}$ = 294°C, T2 58°C, | Butterfield | Kaye/ Hubert/ Guenther/ Gendron |
| R479-9 | 1340 | "/" | Gastight sample, portside GTB #5, Hell, same location at R479-8, $T_{max}$ = 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 $T_{max}$ = 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 179°C | 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<br>1604 | 421368/5087137 and 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:

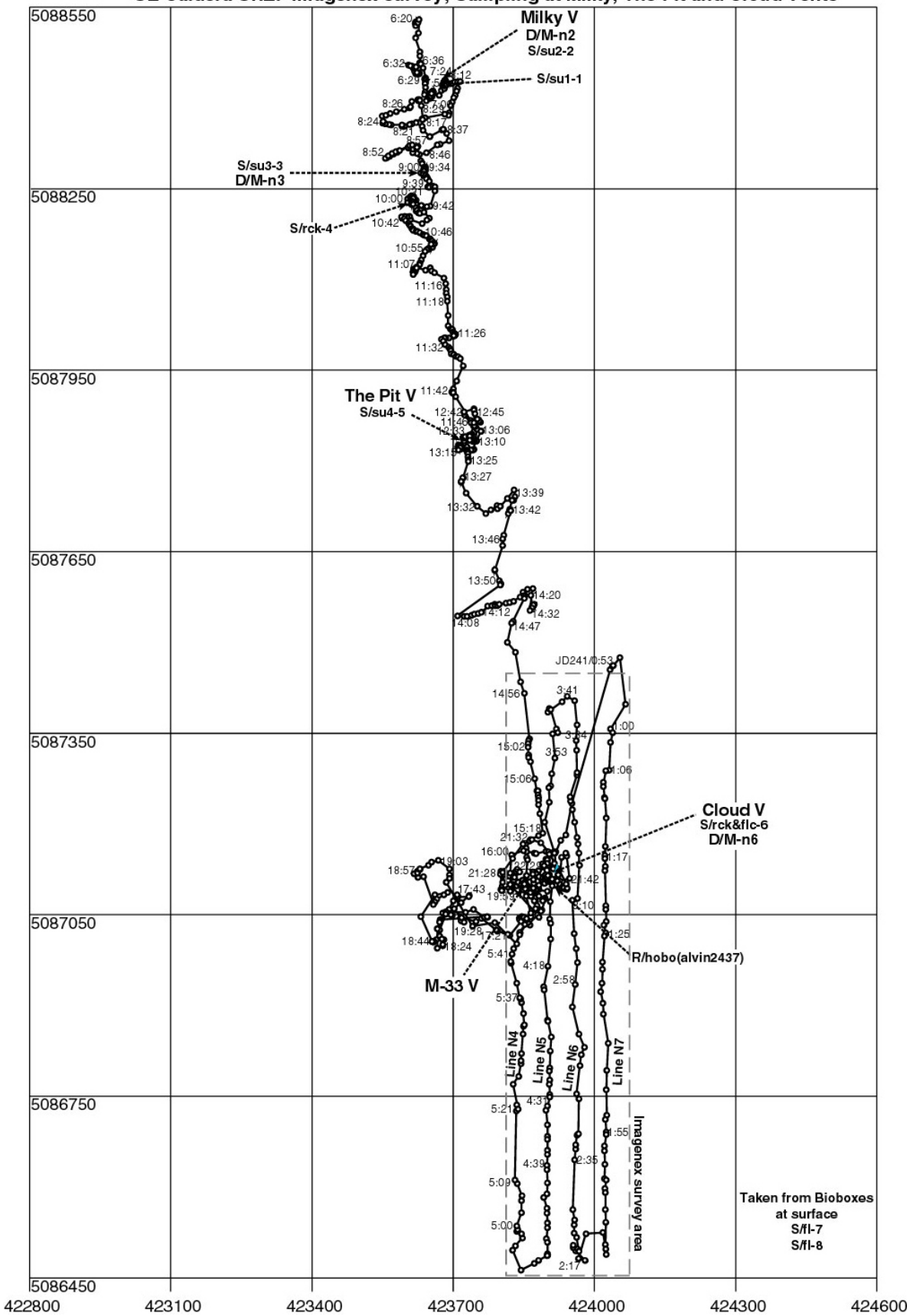
| | |
|---|---|
| ss | Suction Sample |
| su | SUAVE |
| hfs | Hot Fluid Sampler |
| niskin | Niskin bottle |
| gtb | Gas Tight Bottle |
| bactrp | Bacteria Trap |

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 - 419°C) |
| MTR | temperature probe (2 - 34°C) |
| VEMCO | temperature probe (0 - 50°C) |
| TLC | time lapse camera |

# Dive R460 (JD 240-241)

## SE Caldera SRZ: Imagenex survey; Sampling at Milky, The Pit and Cloud Vents



## 10.6 ROPOS DIVE LOGS, Dives R460 - R480

### Dive R460

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<br><br>Southeast side of caldera | Date (PDT):<br>August 27, 1998<br><br>Date (UTM):<br>August 28, 1998<br><br>Julian Day 240<br><br>Time off deck:<br>(1) 0334 aborted<br>(2) 0440<br><br>Time on bottom:<br>0607 | Date (PDT):<br>August 29, 1998<br><br>Date (UTM):<br>August 29, 1998<br><br>Julian Day 241<br><br>Time off bottom:<br>0639<br><br>Time on deck:<br>0743<br><br>Total dive time:<br>27 hr 03 min<br><br>Total bottom time:<br>24 hr 32 min | Reconnaissance survey of ~5 km along the east side of the caldera in the vicinity of known hydrothermal vents.<br><br>Test of digital still camera with onboard Jazz drive recorder<br><br>Test of Imagenex scanning sonar mapper<br><br>SUAVE analyses of vents<br><br>Deploy markers<br><br>Look for moorings deployed 1997<br><br>Sampling as appropriate |

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 UTM | Depth m | X-pos m | Y-pos m | Comments Dive 460 | Frame grab, photos and samples |
|---|---|---|---|---|---|
| 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<br>Frame grab 3 is no good | FG R460-003<br>FG R460-004<br>FG R460-005<br>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 $H_2S$. T = 2.6°C (anomaly of 0.1) | FG R460-008 |
| 0713 | | 423648 | 5088456 | Ended SUAVE<br>(camera counter 15) site where we used the SUAVE | Photo-7 |
| 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 0.5°C<br>Photo (#16 on counter) = some yellow mat, T anomaly of 2.5°C | FG R460-010<br>R460-011<br><br>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**<br>$H_2S$ 175 µM, Mn 10 µM, Fe >100 µM, T anomaly of 5.5°C | **SUAVE** 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 #).<br>Deployed at 0758<br>Photo of the marker(#18 on counter). | FG R460-012<br>FG R460-013<br>Photo-10 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments Dive 460 | Frame grab, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photo -15 (#24 on counter) is of water coming out of holes in and around pillows.<br>SUAVE #3 Mn/heat = 1.8, T anomaly 1°C,<br>Photo -16 (#25 on counter) at diffuse vent site. turned on highlight tape | FG R460-015<br>FG R460-016<br>FG R460-017<br>Photo-14<br>Photo-15<br>Photo-16 |
| 0912 | 1528 | 423640 | 5088279 | SUAVE in a hole, SUAVE problems, High temperature at 9.5°C when we lost communication. Recycled power. | **SUAVE**<br>R460-003<br>FG R460-018 |
| 0915 | 1528 | 423638 | 5088297 | Stopped highlight tape<br>SUAVE max at 13.5°C, Mn 40 µm, $H_2S$ 200 µm, Fe 40 µm, ave temp of 11.5°C, polynoid | FGR460-019<br>FG R460-020<br>(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<br>FG R460-022<br>Photo 26 |
| 0929 | 1528 | 423637 | 5088278 | Deploying **Mkr-N3** triangle marker with black letters and numbers | FG R460-023<br>FG R460-024<br>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<br>(0953) |
| 0955 | 1525 | 423608 | 5088237 | Lots of white mat, lots of floc, glassy basalt , polynoid | FGR460-027<br>Photo-28<br>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**<br>R460-4<br>FGR460-028<br>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<br>through<br>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<br>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.<br>skipped notes on Photo-37 | Photo-38 |
| 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<br>**SUAVE**<br>R460-5 |
| 1203 | | 423811 | 5087824 | SUAVE maximum T = 14°C | |
| 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<br>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<br>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<br>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<br>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<br>FG R460-051<br>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<br>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<br>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<br>FG R460-062<br>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<br>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<br>Photo-66 |
| 2052 | 1523 | 423851 | 5087102 | Good fix | |
| 2103 | | | | **Hobo probe** placed in the port side of biobox | |
| 2105 | | | | | FG R460-066<br>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<br>Photo-70 |
| 2226 | | | | Bacterial filament (?), highlight tapes on | FG R460-070<br>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<br>FG R460-074<br>FG R460-075<br>FG R460-076<br>FG R460-077<br>FG R460-078 |

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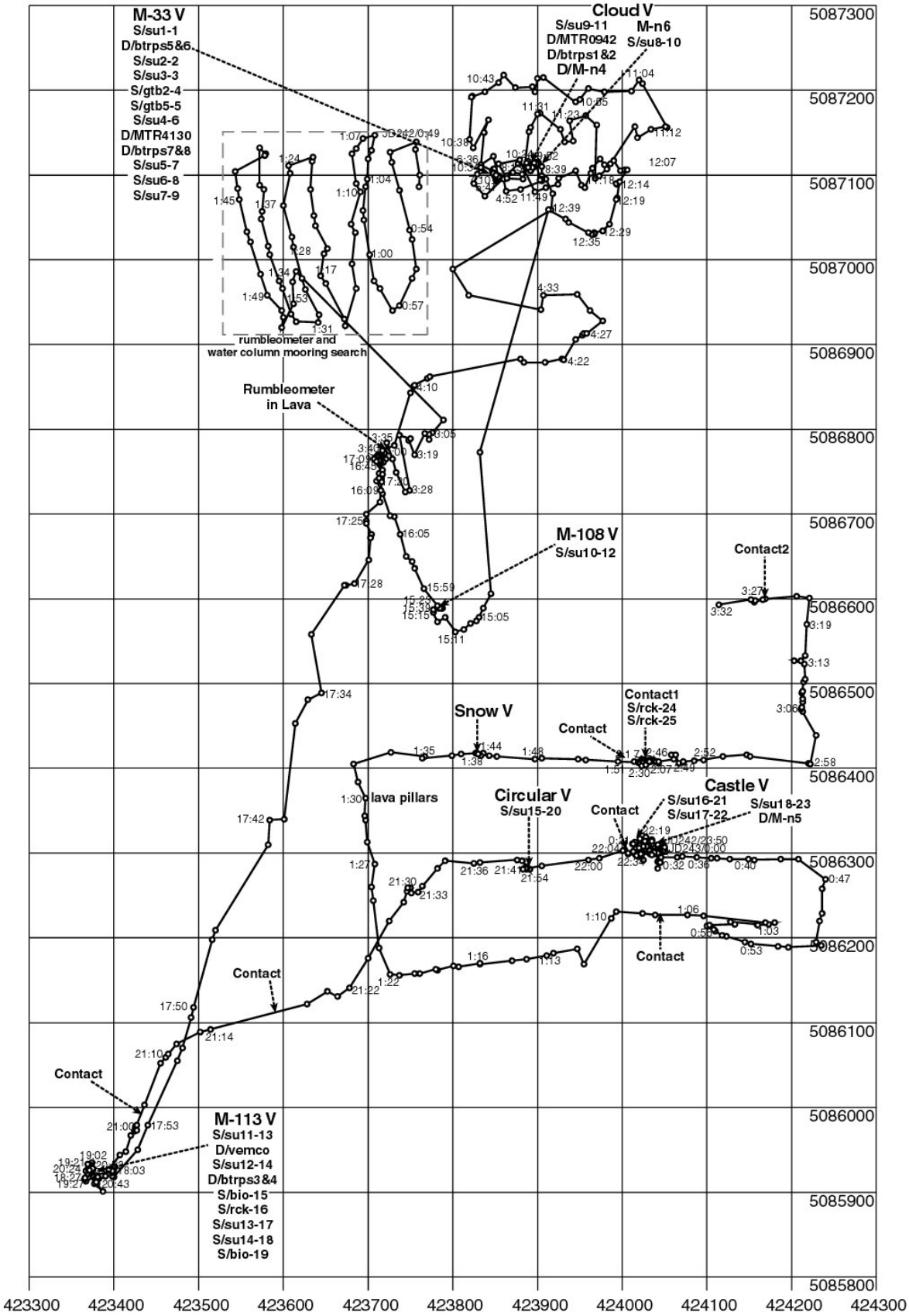
|---|---|---|---|---|---|
| 2301 | 1524 | 423897 | 5087114 | **Cloud Vent** vigorous flow, trying to get a rock sample, lots of debris in water because disturbed by ROV | Photo-76 |
| 2317 | 1526 | 423900 | 5087110 | Good fix, still trying to get sample | |
| 2323 | | | | Got sample in Pacman | |
| 2326 | | | | | 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**<br>R460-6<br>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<br>R460-080 |
| 2353 | | | | Heading back to cage | |
| 2357 | 1494 | 423874 | 5087165 | Ditto | |
| 0013<br>JD 241 | | 423918 | 5087154 | Ship heading to new watch circle to begin Imagenex survey | |
| 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 | "<br>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 | "<br>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.<br>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 R460 | |

# Dive R461 (JD241 - 243)

**SE Caldera SRZ: Rumbleometer Search; M-108, M-33, M-113, Cloud, Sulfide, Castle and Circular Vents**



**Dive R461**

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<br><br>Vent field on east side of caldera | Date (PDT): August 29, 1998<br><br>Date (UTM): August 29, 1998<br><br>Julian Day 241<br><br>Time off deck: 2255 (UTM)<br><br>Time at midwater search: 0003, August 30<br><br>Time on bottom: 0303 | Date (PDT): August 30, 1998<br><br>Date (UTM): August 31, 1998<br><br>Julian Day 243<br><br>Time off bottom: 0340<br><br>Time on deck: 0440<br><br>Total dive time: 29 hrs 45 min<br><br>Total bottom time: 27 hrs 43 min | Systematic E-W bottom reconnaissance traverses in vicinity of vents near 45°56'N 128°58.8'W<br><br>Reconnaissance southward from line of vents to known targets: Mrk-108, Sulfide, Mrk 113, and Axial Gardens<br><br>SUAVE analyses of vents<br><br>Deploy Mkrs<br><br>Systematic search for moorings deployed 1997<br><br>Sampling as appropriate |

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 UTM | Depth m | X-pos m | Y-pos m | CommentsDive R46`1 | FGs, photos and samples |
|---|---|---|---|---|---|
| 2255 | | | | Start dive, ROPOS in water; ship launch position 45°56'N, 129°58.9'W | |
| JD241 2355 | | | | Entering plume, around 1300 depth | |
| JD242 0003 | 1490 | | | Sitting at 1490, checking gauges, making sure ROPOS is ok | |
| 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 JD 242 | 1521 | | | On bottom, jumbled sheet flow<br>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<br>FG R461-002<br>Photo-78 |
| 0346 | 1523 | 423712 | 5086767 | Still looking at rumbleometer | |
| 0347 | 1522 | 423713 | 5086766 | " | |
| 0352 | 1521 | | | Still looking at rumbleometer, highlight tape on.<br><br>FGs and photos of rumbleometer.<br><br>Highlight video 0353-0357. | FG R461-003<br>FG R461-004<br>FG R461-005<br>FG R461-006<br>Photo-79<br>Photo-80 |
| 0352 | | | | Moving to NE to cross easternmost line of venting, continued sheet and lobate lava, lava lakes, lightly sedimented | |

| Time UTM | Depth m | X-pos m | Y-pos m | CommentsDive R46`1 | FGs, photos and samples |
|---|---|---|---|---|---|
| 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<br>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<br><br>Lots of lava lakes in this area | Photo-87<br>Photo-88<br>Photo-89<br>Photo-90<br>Photo-91<br>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<br>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<br>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 5-13°C | Photo-102<br>Photo-103 |

| | | | | | |
|---|---|---|---|---|---|
| 0458 | | | | SUAVE #1. Betacam started (0458-0503) | **SUAVE**<br>R461-1 |
| 0501 | | | | changed archive tapes | |
| 0507 | | | | Photo of SUAVE probe in venting crack | Photo-104 |
| 0511 | | | | SUAVE #1 ended, T = 3-15°, $H_2S$ 470 µmol, Fe 47 µmol,<br>Mn 2 µmol | |
| 0514 - 0540 | | | | Scale worms (paralvinellids) grazing on bacteria, palm worms<br><br>Highlights video 0512-0546 | FG R461-007<br>FG R461-008<br>FG R461-009<br>FG R461-010<br>FG R461-011<br>FG R461-012<br>FG R461-013<br>FG R416-014<br>FG R461-015<br>FG R461-016<br>FG R461-017<br>FG R461-018<br>FG R461-019<br>Photo-105<br>Photo-106 |
| 0545 | | | | Deployed glass wool bacteria traps #5 and #6 in venting crack | FG R461-020<br>Photo-107 |
| 0555 | | | | SUAVE #2 of bacterial mat at **Mkr-33** site<br>T = 11°C (constant), $H_2S$ ~10 µmol,<br>Fe <5 µmol,<br>Mn below detection (5 µmol) | **SUAVE**<br>R461-2<br>FG R461-021<br>FG R461-022<br>FG R461-023 |
| 0607 | | | | SUAVE #3 in through hole in bacterial mat right beside SUAVE #2<br>T = 3.9°C, $H_2S$ 15 µmol, Fe & Mn below detection | **SUAVE**<br>R461-3<br>FG R461-024<br>FG R461-025<br>FG R461-026 |
| 0611-0616 | | | | Highlights video of **Mkr-33** operations | |
| 0633 | 1523 | | | Gas tight bottle #2 in venting crack at<br>**Mkr-33**, T = 36-37°C<br>Gas tight bottle #5 near GTB #2 location, T = 20-27°C<br>SUAVE #4 a few cm south of **Mkr-33**<br>T = 37°C max, $H_2S$ 1000 µmol, Fe 40 µmol, Mn 18 µmol | **Gas Tight**<br>R461-4<br>R461-5<br>**SUAVE**<br>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 = 7°C) & #7 (T = 7.5°C) in venting crack at **Mkr-33**. | |
| 0657 | | | | | FG R461-027<br>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<br>Photo-110 |
| 0707 | | | | SUAVE #5 at the mat left of the bag creature. Temperature max at 6.6°C | **SUAVE**<br>R461-7 |
| 0713 | | | | Temperature went to 17°C in the white mat. This mat is 30 cm left of the big bag creature. Sub is heading at 127degrees. $H_2S$ 700 µmol , Mn 2 µmol, Fe 5 µmol | |
| 0722 | | | | SUAVE #6 in the big section of the bag creature<br>Temperature of 2.95°C. $H_2S$ 75 µmol, little Mn and Fe.<br>Worm on bag creature, beta-cam highlights on at 0724 until end of tape. | **SUAVE**<br>R461-8<br>Photo-111<br>FG R461-028 |
| 0736 | | | | Bag creature with bacterial mat and a worm | Photo-112<br>FG R461-029 |
| 0738 | | | | Photo of bag creature<br>FG of bag creature | Photo-113<br>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)<br>Temperature 3.05°C, $H_2S$ 40 µmol. Heading 121 | **SUAVE**<br>R461-9<br>FG R461-031<br>FG R461-032 |
| 0757 | | | | Stopped SUAVE and starting to move<br>towards **Cloud Vent** | |
| 0800 | | | | Liftoff heading towards cloud vent, sheet flows with long (10 m) crack, heading 90 following cracks | Photo-114<br>Photo-115 |
| 0802 | 1520 | | | Pillows; clear and distinct boundary from the sheets to the pillows | Photo-116<br>Photo-117 |
| 0804 | | | | Boulders with lots of flying mat, at the **Cloud Vent**,<br>**Mkr-N6** is just to the left of the sub at 57 degrees | Photo-118 |
| 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 |

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| 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<br>**Mkr-N6** is forward of us | Photo-125<br>Photo-126<br>Photo-127<br>Photo-128 |
| 0839 | | | | Moved up close to the Mkr. 22°C at the height of **Mkr-N6**.Temperatures up to 27°C in the pit | |
| 0844 | | | | SUAVE # 8 in the **Cloud Vent** about 50 cm from **Mkr-N6**, heading 346. $H_2S$ 750 µmol, Fe 62 µmol, Mn 2 µmol | **SUAVE**<br>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 4-5°C | Photo-131<br>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<br>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 24°C<br>Fe 55 µmol, $H_2S$ 750 µmol, Mn 2 µmol. We are 10 m west of **Mkr-N6**heading 24 | **SUAVE**<br>R461-11<br>Photo-133<br>FG R461-035 |
| 0936 | | | | Deploy **MTR0942** yellow handle MTR without the tape | |
| 0951 | 1523 | 423888 | 5087111 | Deployed the MTR<br>Deployed glass wool bacteria trap #1<br>Deployed glass wool bacteria trap # 2<br>Deployed **Mkr-N4** (triangle)<br>The GWT and MTR are in a little hole The Mkr is located 0.3 m to the left of the hole heading 30 | FG R461-036<br>Photo-134<br>FG R461-037<br>Photo-135<br>Photo-136<br>Photo-137<br>Photo-138<br>FG R461-038 |
| 1010 | | | | Moving, looking at the site | Photo-139<br>Photo-140 |

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| 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<br>Pillows covered with mat, broken sheets,<br>pillows and sheets, drained lava lake 1042 | Photo-143 |
| 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<br>Photo-145<br>Photo-146<br>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,<br>heading 92 | Photo-149<br>Photo-150<br>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 | 3.2°C 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 µmol | |
| 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 | |

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| 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 dribble over older lava | Photo-162<br>Photo-163 |
| 1229 | 1520 | | | Lobate flows | Photo-164<br>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<br>Photo-176<br>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 | |

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| 1345 | 1518 | | | Contact of newer and older lavas | Photo-183<br>FG R461-40<br>Photo-184 |
| 1347 | 1517 | | | Stirred up floc, pillow lavas | |
| 1348 | 1517 | | | Purple sponge on pillow lava | Photo-185<br>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<br>FG R461-041 |
| 1415 | 1525 | | | Drain back features on pillars, lava lake drainout | Photo-193<br>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<br>Photo-198<br>FG R461-042<br>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 (0.2°C) with iron and manganese anomaly, but small $H_2S$ 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<br>Photo-200 |
| 1511 | 1521 | 423803 | 5086561 | | |
| 1514 | 1517 | | | Found **Mkr-108**. 0.2°C 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 |

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| 1521 | 1520 | | | SUAVE #10 at **Mkr-108**. Max temp of 8.1°C, average of 6.0°C, drifting a lot due to probe position. $H_2S$ 230 µmol, Mn 45 µmol, Fe 25 µmol. | Photo-201<br>FG R461-045<br>**SUAVE**<br>R461-12<br>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.<br>Rumbleometer leg wedged in rock. Hydroclastics on rumbleometer suggest turbulent area. | Photo-202<br>Photo-203<br>Photo-204<br>Photo-205 |
| 1616 | 1521 | | | Started highlights video. Trying to wedge rumbleometer free. | Photo-206<br>FG R461-049<br>Photo-207<br>Photo-208<br>Photo-209<br>FG R461-050<br>Photo-210<br>Photo-211<br>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<br>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<br>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. 0.5°C 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<br>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 12°C. $H_2S$ 237 µmol, Mn BDL, Fe 7 µmol | **SUAVE**<br>R461-13<br>FG R461-054<br>Photo-218<br>Photo-219<br>FG R461-055<br>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 |

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| 1904 | | | | As above | FG R461-057 |
| 1911 | | | | SUAVE temp probe T 10.5°C 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.<br>T = 10.5 deg°C, $H_2S$ 237 µmol, Mn BDL, Fe 7 µmol | **SUAVE**<br>R461-014 |
| 1928 | | | | Trying to find a few good worms | |
| 1931 | | | | Biobox | FG R461-060<br>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<br>**Biosample**<br>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<br>FG R461-062 |
| 1956 | | | | VEMCO location photo (tube worms) | Photo-224 |
| 1956 | | | | As above | Photo-225<br>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<br>**Basalt**<br>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<br>FG R461-066 |
| 2012 | | | | Highlight tapes on | |
| 2020 | | | | Suave #13 at bacterial trap #4. Max T=23.5°C, $H_2S$ 500 µmol, Fe 9 µmol, Mn BDL. | **SUAVE**<br>R461-17<br>FG R461-067<br>FG R461-068<br>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=5.8°C max | **SUAVE**<br>R461-018<br>FG R461-072<br>FG R461-073 |
| 2036 | | | | As above | Photo-230<br>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<br>FG R461-076 |
| 2047 | | | | Pacman sample, clump of dead tube worms | **Biosample**<br>R461-020 |
| 2051 | | | | Rat tail sighted. Move northeast toward **Sulfide Vent** | |
| 2051 | | | | Rat tail fish | FG R461-077<br>FG R461-078 |
| 2052 | | | | Drained lava lake | FG R461-079 |
| 2054 | 1523 | 433404 | 5085944 | Sheet flow and crab | |

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|---|---|---|---|---|---|
| 2055 | | | | Lobate flows | |
| 2100 | 1522 | 423423 | 5085972 | Murky water | |
| 2103 | | | | Sea fan, sponges | Photo-233<br>FG R461-080 |
| 2103 | | | | Golfball sponges, brittle stars & sea cucumbers | |
| 2103 | | | | Deep sea fauna | Photo-234 |
| 2105 | | | | Starfish, jumbled sheet flow contact lobate flow, new lavas 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 | | | | Crossed contact 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<br>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<br>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**<br>R461-20<br>Photo-242<br>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 = 7.1°C, $H_2S$ 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<br>Photo-244<br>Photo-245<br>Photo-246<br>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<br>Photo-248<br>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<br>Photo-250<br>FG R461-087<br>Photo-251<br>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.<br>This site was from the Sonne camera tow | |
| 2214 | | | | Some low temperature venting next to the sulfide deposit | Photo-254 |

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| 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 60°C. Very small orifice | **SUAVE**<br>R461-021 |
| 2222 | 1520 | 424026 | 5086305 | Probe is up to 71°C. SUAVE #16 started, hdg 53 on the SW side of the deposit, highlights are off 2224, maxed out at 90°C, $H_2S$ >>1500 µmol, Fe 65 µmol, Mn 75 µmol. Looks like phase separated fluids | Photo-255<br>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, (shrimp?), smoke is clear, light gray, not black | FG R461-089 |
| 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**<br>R461-22<br>FG R461-091 |
| 2251 | 1520 | | | Start beta cam (2254) | FG R461-092 |
| 2301 | 1520 | | | T max 5.3°C, $H_2S$ ~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<br>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<br>FG R461-096 |
| 2312 | | | | Unknown red tube-like structure on chimney in background - shrimp?, top of structure is 8.5-9 m | Photo-256<br>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<br>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<br>Start highlights tape, stopped at 2357 | **SUAVE**<br>R461-23<br>FG R461-099<br>Photo 258 |
| 2359 | | | | SUAVE stopped. T max=20°C, $H_2S$ ~200 µmol, Mn ~6 µmol, Fe ~19 µmol | |
| 0003<br>JD 243 | | 424043 | 5086304 | Mkr-N5 deployed at SUAVE #18 site. Later dives reveal this to be a separate vent, distinct from **Castle**. Called **Mkr-N5**. | |
| 0006 | | | | At structure near **Castle Vent** (is **Mkr-N5** site) limpets, alvinellids, tube worms, protozoan mats | Photo-259<br>Photo-260<br>FG R461-100 |
| 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 | |

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| 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?, bag creature | Photo-267 |
| 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<br>Photo-270<br>Photo-271<br>Photo-272 |
| 0201 | | | | Grabbed a piece of the older lava, put in port side of biobox, beta cam stopped | **Basalt**<br>R461-25 |

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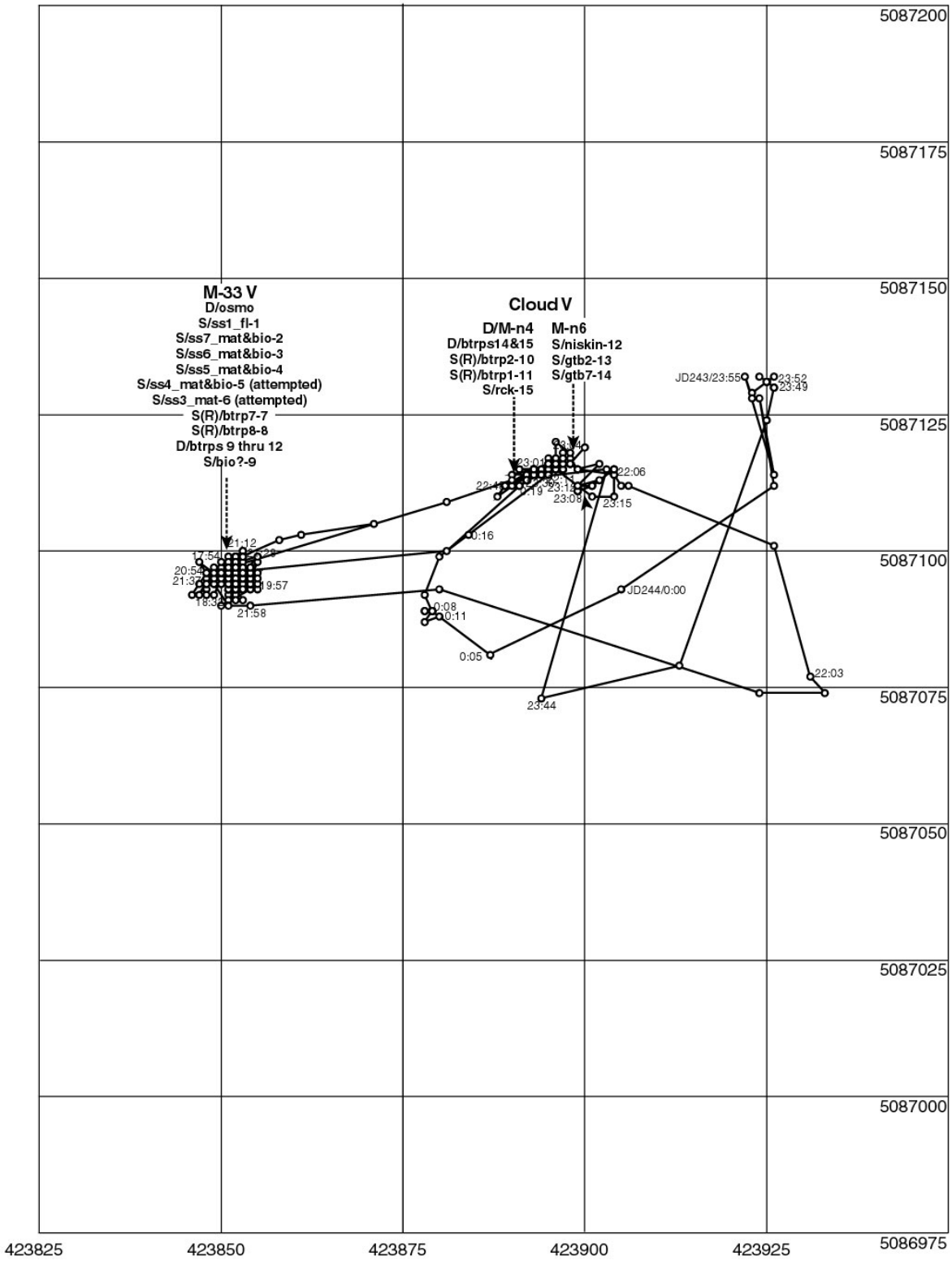
| 0206 | | 424043 | 5086406 | Trying to get piece of new lava in claw, black glassy lava very crumbly so have to try for another piece | |
| 0220 | 1522 | 424033 | 5086409 | Got it- trying to put it in port side of biobox | |
| 0233 | | | | Rock too big, trying to break it into a smaller piece | |
| 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<br>Photo-275<br>Photo-276<br>FG R461- 101<br>Photo-277 |
| 0331 | | | | Dive terminated, low oil pressure in cage reservoir | |
| 0440 | | | | **ROPOS on deck. End of dive 461** | |

# Dive R462 (JD 243 - 244)

## SE Caldera SRZ: M-33 and Cloud Vents



## Dive R462

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<br><br>Vent field on east side of caldera | Date (PDT):<br>August 31, 1998<br><br>Date (UTM):<br>August 31, 1998<br><br>Julian Day 243<br><br>Time off deck:<br>1630<br><br>Time on bottom:<br>1750 | Date (PDT):<br>August 31, 1998<br><br>Date (UTM):<br>Sept 1, 1998<br><br>Julian Day 244<br><br>Time off bottom:<br>0021<br><br>Time on deck:<br>0131<br><br>Total dive time:<br>9 hrs 01 min<br><br>Total bottom time:<br>6 hrs 31 min | Mkr-33 Vent for deploying osmosampler, bacterial traps, and collecting animals, bacterial mat, traps, and water<br><br>Cloud Vent for deploying bacterial traps and collecting animals, bacterial mat, traps, and water. |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R462 | FGs and samples |
|---|---|---|---|---|---|
| 1630 | | | | ROPOS entered water at **Mkr-33**. | |
| 1705 | 727 | | | ROPOS left cage for remainder of descent | |
| 1741 | 1394 | | | Entering plume fluids | |

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| 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<br>FG R462-002<br>FG R462-003<br>FG R462-004<br>Photo-1 |
| 1808 | 1523 | | | Still trying to get nozzle in crack | FG R462-005<br>FG R462-006 |
| 1814 | 1524 | | | Got nozzle in crack | Photo-2<br>FG R462-007<br>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**<br>R462-1<br>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**<br>R462-2<br>FG R462-010<br>FG R462-011<br>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**<br>R462-3<br>FG R462-015 |
| 1939 | | | | Slurping as above | FG R462-016 |
| 1946 | | | | Slurping as above | FG R462-017<br>FG R462-018<br>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**<br>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<br>Two *Paralvinella dela* | FG R462-022<br>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<br>FG R462-025a |

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| 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<br>Visible indications of bacterial growth | Photo-7<br>**Bac Traps**<br>R462-7<br>R462-8<br>FG R462-028 |
| 2105 | | | | Deploy bacterial traps #9, #10, #11 & #12 | FG R462-029<br>FG R462-030<br>FG R462-031<br>FG R462-032<br>Photo-8 |
| 2135 | | | | Looking down on **Mkr-33 Crack Vent** with bacteria traps | Photo-9<br>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**. | |

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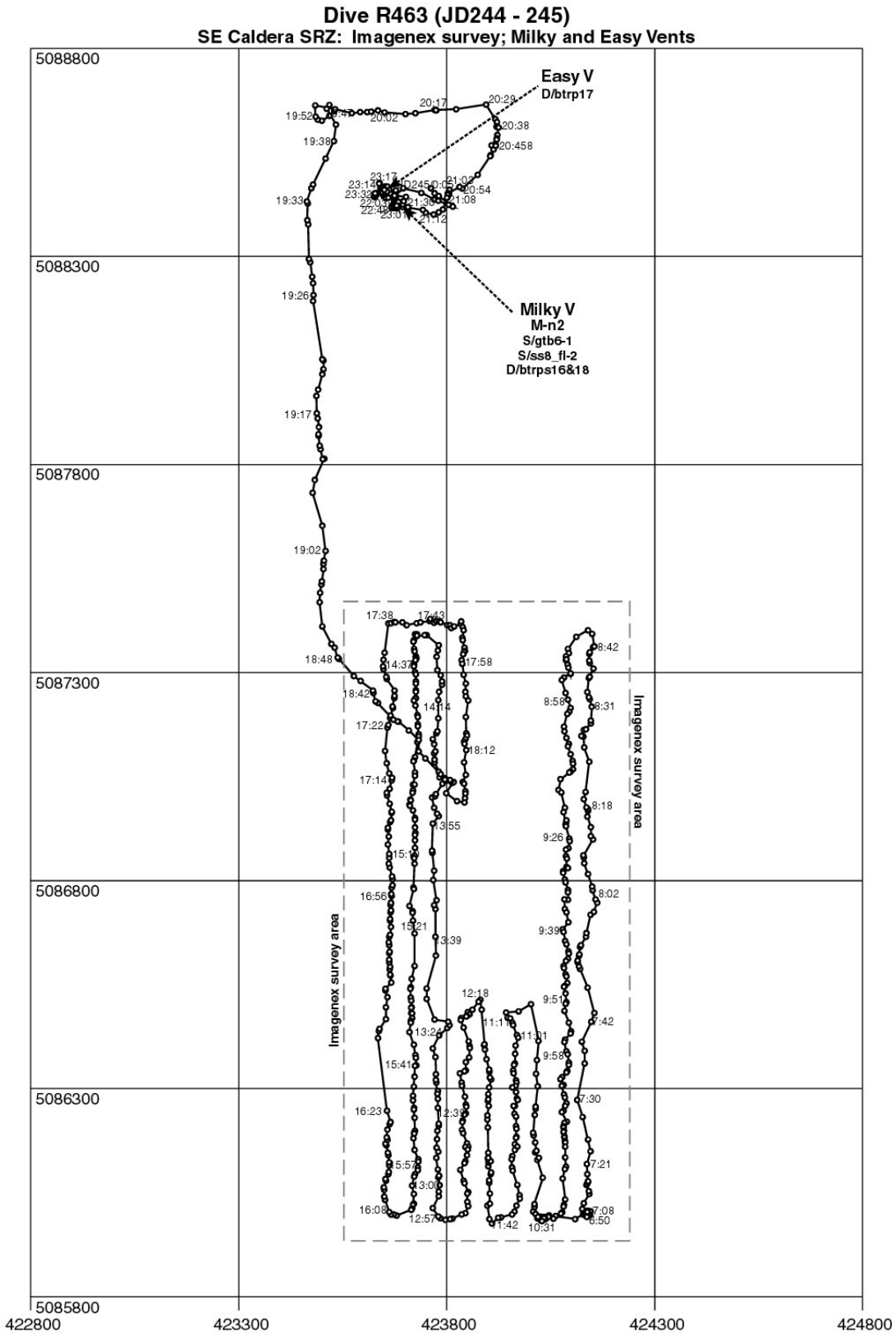
| 2254 | 1523 | | | Recovering bacteria trap #1 from **Mkr-N4** at **Cloud Vent**. | **Bac Traps**<br>R462-11<br>FG R462-034 |
| 2259 | 1523 | | | Debate about nature of **Cloud Vent**- alternating ejections of fluid that is clear then floc? Or is ROPOS just making a mess? | |
| 2301 | 1524 | 423893 | 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<br>R462-12 |
| 2310 | 1526 | | | Filled both gas tight bottles (#2 and #7) with fluid from high flow at **Mkr-N6** | **Gas Tight**<br>R462-13<br>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**<br>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**<br>R462-16<br>FG R462-034<br>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 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 | Photo-16<br>FG R462-035<br>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<br>Photo-20<br>FG R462-037<br>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<br>Photo-23<br>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. End of Dive R462. | |


Dive R463 (JD244 - 245)
SE Caldera SRZ: Imagenex survey; Milky and Easy Vents
Easy V
D/btrp17
Milky V
M-n2
S/gtb6-1
S/ss8_fl-2
D/btrps16&18
Imagenex survey area
Imagenex survey area
5088800
5088300
5087800
5087300
5086800
5086300
5085800
422800
423300
423800
424300
424800

# Dive R463

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<br><br>East side of caldera in southern area | Date (PDT):<br>August 31, 1998<br><br>Date (UTM):<br>Sept. 1, 1998<br><br>Julian Day 244<br><br>Time off deck: 0533<br><br>Time on bottom:<br>1946 | Date (PDT):<br>Sept. 1, 1998<br><br>Date (UTM):<br>Sept 2, 1998<br><br>Julian Day 245<br><br>Time off bottom:<br>0006<br><br>Time on deck:<br>0210<br><br>Total dive time:<br>20 hr, 37 min<br><br>Total bottom time:<br>17 hr, 6 min | Continue Imagenex sonar mapping further to the west started on Dive R460<br><br>Search for the missing tube worms north of Milky Vent<br><br>Sample biology at Milky Vent<br><br>Sample biology and sulfides at The Castle |

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 UTM | Depth m | X-pos m | Y-pos m | Comments Dive R463 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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.<br>Problem with imaging system | |
| 0704 | 1504 | 424134 | 5086002 | Moving ship north long Line N9 | |
| 0710 | | | | Commencing Imagenex survey<br>Proceeding north on Line N9 | |
| 0724 | 1504 | 424146 | 5086156 | " | |

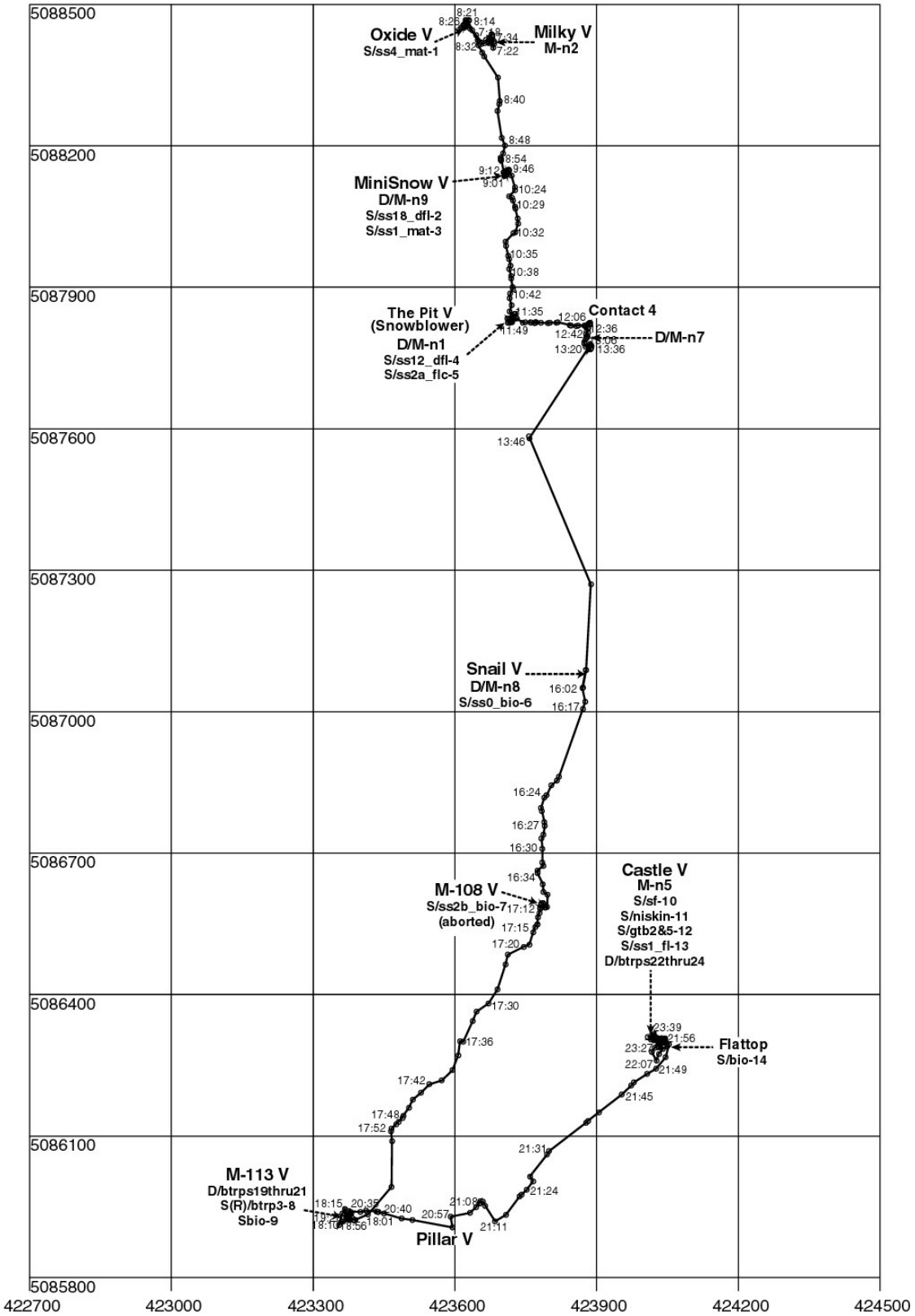
| | | | | | |
|---|---|---|---|---|---|
| 0734 | 1503 | 424142 | 5086298 | " | |
| 0745 | 1504 | 424144 | 5086500 | " | |
| 0755 | 1499 | 424123 | 5086645 | " | |
| 0805 | 1500 | 424140 | 5086816 | " | |
| 0816 | 1492 | 424142 | 5086970 | " | |
| 0826 | 1498 | 424131 | 5087120 | " | |
| 0835 | 1499 | 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<br>FG R463-002<br>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<br>FG R463-006<br>FG R463-007<br>FG R463-008<br>FG R463-009<br>FG R463-010<br>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<br>**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**<br>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<br>Photo-47<br>FG R462-12<br>Photo-48<br>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**<br>(Easy in nav), hdg 352 | FG R463-014<br>Photo-49 |
| 2350 | 1533 | 423675 | 5088444 | Positioning to deploy Craig's bacterial trap #17, polynoid (new type), trap deployed | |
| 2355 | | | | Tether management | |
| 0006<br>JD245 | | | | 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 | |
| 0210 | | | | ROPOS on deck for repairs | |

# Dive R464 (JD 245)

## SE Caldera SRZ: Oxide, MiniSnow, The Pit, Snail, M-108, M-113 and Castle Vents



## Dive R464

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

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 UTM | Depth m | X-pos m | Y-pos m | Comments Dive R464 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photo-1<br>Photo-2 (no flash)<br>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<br>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<br>Photo-9, Photo-10**Suction Sample**<br>R464-1 |
| 0814 | | | | Sucking working, finished at 0820. | FG R464-004<br>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<br>Photo-12<br>Photo-13<br>Photo-14<br>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<br>FG R464-006<br>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<br>Photo-19,<br>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<br>FG R464-007<br>FG R464-008<br>Photo-22 |
| 0903 | | | | Beta cam on - thinking of sampling<br>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),<br>moving into position to suck, filling big jar #18 for water sample, #18 has no filter, stopped at 0925. | FG R464-009<br>FG R464-010<br>FG R464-011<br>FG R464-012<br>FG R464-013<br>**Suction Sample**<br>R464-2 |
| 0925 | | | | Suction jar #1 short jar, getting white stuff from the same place that we got water for jar #18. | **Suction Sample**<br>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<br>Photo-23<br>Photo-24 |
| 1023 | | | | Pillow basalt with oxide deposits in cracks, rat tail. | Photo-25<br>Photo-26<br>Photo-27<br>FG R464-016<br>Photo-28<br>FG R464-017<br>Photo-29 |
| 1026 | | | | Driving south 180 pillows with yellow sediment in cracks. | Photo-30 |
| 1028 | 1521 | 423724 | 5088081 | More sediment , especially in holes,<br>pillow lavas. | Photo-31<br>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,<br>drained lava features (about 3 m deep). | Photo-32 |
| 1041 | 1515 | 423720 | 5087891 | Heading 180, more of the above<br>big lava lake, more whit patches on the other side with less yellow sediment. | Photo-33<br>FG R464-019<br>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<br>collapse features. | Photo-36<br>FG R464-020<br>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<br>FG R464-021 |
| 1059 | 1518 | 423719 | 5087835 | Marker in front, **Snow Blower Vent** to the side of the marker. | FG R464-022<br>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<br>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**<br>R464-4<br>FG R464-025<br>Photo-40 |
| 1108 | 1519 | 423724<br>423720 | 5087840<br>5087830 | White floc is coming out along the roof and out the hole, lots of white mat in jar. | FG R464-026 |
| 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**<br>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<br>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<br>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 |

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|---|---|---|---|---|---|
| 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<br>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<br>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<br>See Orange flag, broken off not attached to anything **Flag.** | Photo-55<br>Photo-56<br>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<br>lots of white mat. | Photo-57<br>Photo-58<br>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. | |

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|---|---|---|---|---|---|
| 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<br>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**<br>R464-6<br>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<br>FG R464-041<br>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<br>**Suction Sample**<br>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<br>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<br>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<br>Photo-75<br>Photo-76<br>Photo-77<br>Photo-78<br>FG R464-046<br>Photo-79<br>Photo-80<br>FG R464-047<br>Photo-81<br>Photo-82<br>Photo-83<br>Photo-84<br>FG R464-048<br>Photo-85<br>Photo-86<br>Photo-87<br>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<br>Photo-90<br>Photo-91<br>Photo-92<br>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<br>Photo-94<br>Photo-95<br>Photo-96<br>Photo-97<br>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<br>Photo-100 |

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| 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<br>FG R464-050<br>Photo-102<br>Photo-103<br>Photo-104<br>Photo-105<br>FG R464-051<br>Photo-106<br>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<br>Photo-109<br>FG R464-052<br>Photo-110<br>Photo-111<br>Photo-112<br>Photo-113<br>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<br>Photo-116<br>Photo-117<br>Photo-118<br>FG R464-053<br>Photo-119<br>Photo-120<br>Photo-121<br>Photo-122<br>FG R464-054<br>Photo-123<br>Photo-124<br>Photo-125<br>Photo-126<br>FG R464-055<br>FG R464-056<br>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**<br>R464-8 |
| 1917 | | | | Move to tube worms<br>new venting at site | Photo-128<br>Photo-129<br>Photo-130<br>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<br>Photo-132<br>Photo-133<br>FG R464-060 |
| 1928 | 1524 | 423377 | 5085935 | | |
| 1938 | | 423377 | 5085935 | Collect a batch dead or dying tube worms into port side biobox | **Bio sample**<br>R464-9 |
| 1951 | | | | Moved bacterial trap #3 port to starboard | |
| 2008 | | | | Vent fish sighting<br>more tube worms | FG R464-061<br>Photo-134 |
| 2010 | | 423378 | 5085937 | MORE tube worms into port biobox | FG R464-062<br>Photo-135 |
| 2023 | | | | Nine anemones counted | FG R464-063<br>Photo-136 |
| 2030 | | | | Head to **Castle Vent** Hdg 90 | |
| 2032 | 1524 | 423391 | 508593 | Tube worm clumps, spider crabs | |
| 2033 | | | | Collapsed pits | Photo-137<br>Photo-138 |
| 2034 | | | | Pillars in the large lava lake, some venting, questionable lava age identification | Photo-139 |

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| 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<br>Photo-145 |
| 2048 | | | | Jumbled sheet flow. thick orange sedimentwith "papillae" not characteristic of pelagic sediment | Photo-146<br>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<br>hollow lobe of lava | Photo-151<br>FG R464-064<br>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 | |

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|---|---|---|---|---|---|
| 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<br>FG R464-065<br>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<br>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<br>FG R464-068<br>**Sulfide spire**<br>R464-10 |
| 2334 | | 424032 | 5086297 | Niskin buoyant/exiting plume sample but not from rising plume, just nearby sea water | **Niskin**<br>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<br>**Gas-tights**<br>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**<br>R464-13 |
| 2302 | 1519 | 424023 | 5086297 | Deploying Craig's bacteria trap #22 in high flow zone, hdg 69; one trap is broken | |

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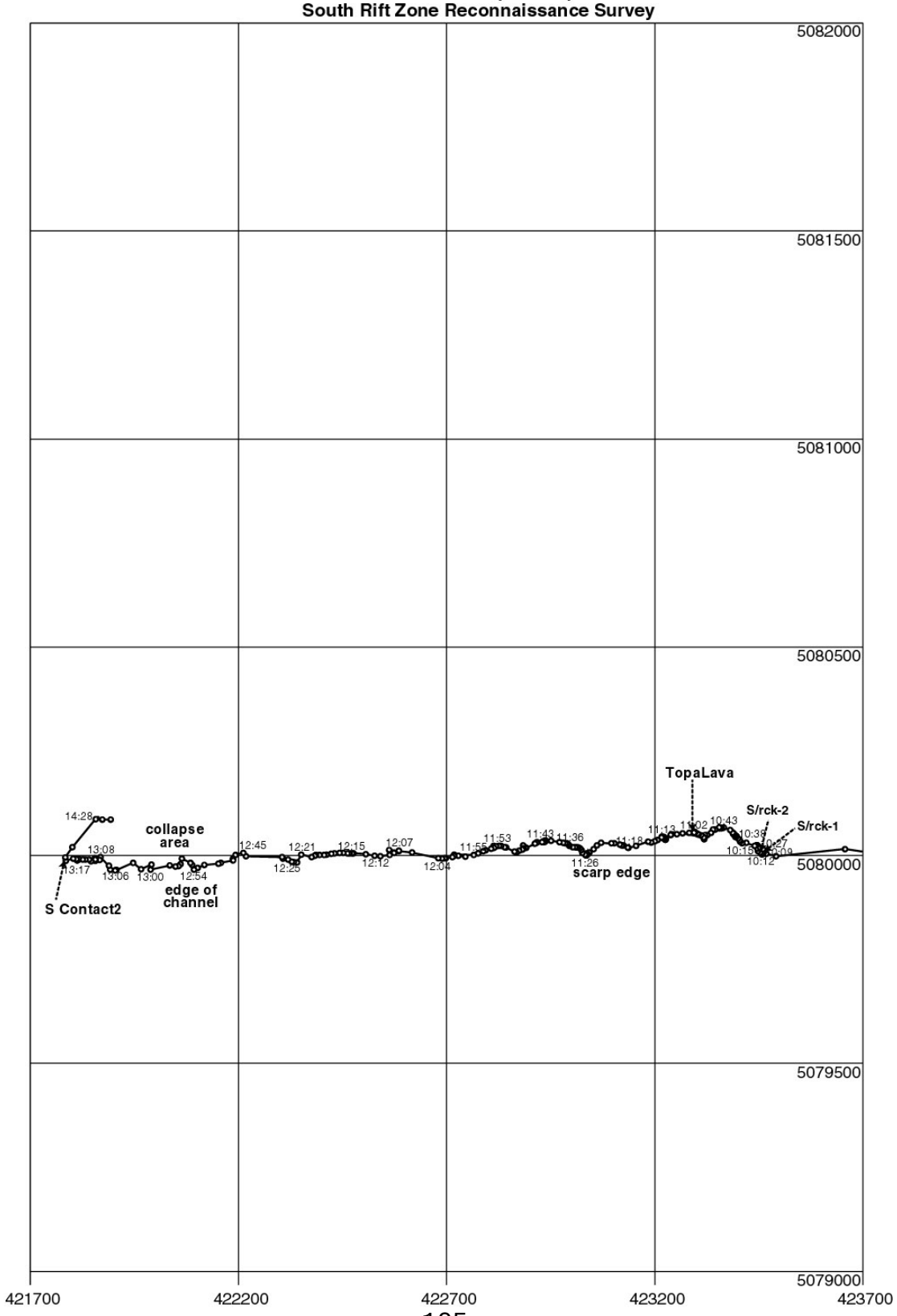
| 2311 | 1519 | | | Deploying bacteria traps #24 and #23 (the top is pried off one cylinder of #23), same location as above; #22 looks like a hole has melted through the bottom | FG R464-071 |
| 2316 | | | | One of Maia's tube worms is out of it's tube flapping in the water | FG R464-072 |
| 2321 | 1519 | 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<br>Photo-164<br>FG R464-073 |
| 2334 | 1516 | 424041 | 5086304 | Taking sample from directly behind **Mkr-N5**, hdg 197; tube worm sample in stbd biobox | **Bio sample**<br>R464-14 |
| 2337 | | | | Hydraulic line burst to 5-function arm, dive terminated, ROPOS ascending to surface | |
| 0045<br>JD246 | | | | ROPOS on deck | |

## Dive R465 (JD246)
### South Rift Zone Reconnaissance Survey



## Dive R465

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<br><br>3 n. mi. south of the caldera along the rift axis | Date (PDT):<br>Sept. 3, 1998<br><br>Date (UTM):<br>Sept. 3, 1998<br><br>Julian Day 246<br><br>Time off deck:<br>0741<br><br>Time on bottom:<br>0925 | Date (PDT):<br>Sept. 3, 1998<br><br>Date (UTM):<br>Sept. 3, 1998<br><br>Julian Day 246<br><br>Time off bottom:<br>1456<br><br>Time on deck:<br>1623<br><br>Total dive time:<br>8 hr 42 min<br><br>Total bottom time:<br>5 hr 31 min | Bottom reconnaissance traverses over the 1998 volcanic eruption in the upper south rift zone.<br><br>SUAVE any vents discovered. |

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

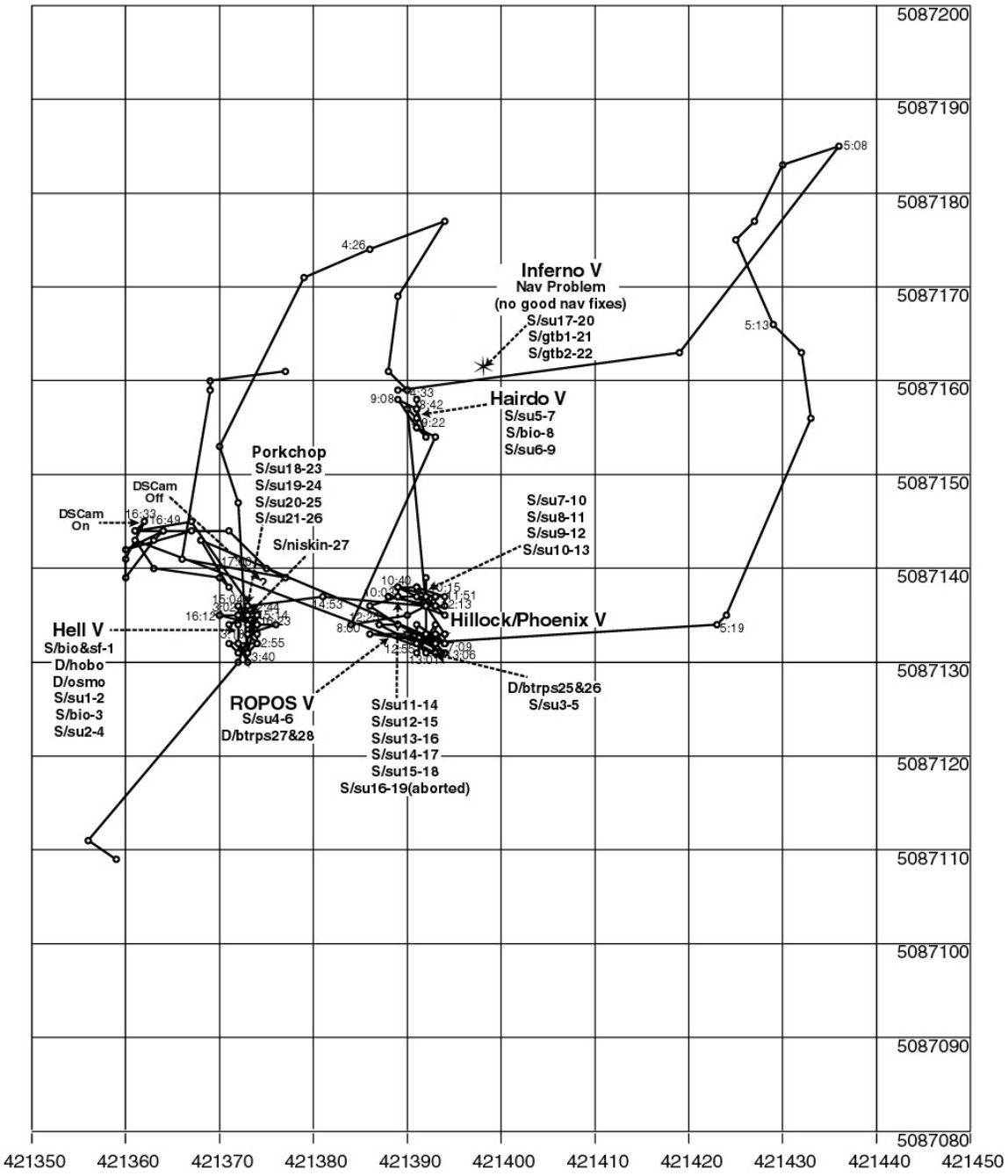
| Time UTM | Depth m | X-pos Longitude | Y-pos Latitude | Comments – Dive R465 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 0741 | | | | ROPOS launched | |
| 0925 | 1816 | | | Contact bottom, abundant sediment cover in topo lows, bad fixes (due to incorrect delay for transponders), ship driving 0.5 knot, sheet flow visible, heading west | |
| 0934 | | | | Breccia | Photo-1 |
| 0937 | | 129°59.18' | 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<br>Photo-5<br>Photo-6<br>Photo-7<br>Photo-8<br>Photo-9<br>Photo-10<br>Photo-11 |
| 0957 | | | | Have come up 5 m from base | FG R465-001<br>FG R465-002<br>FG R465-003<br>Photo-12 |
| 0958 | | | | Pillows | Photo-13 |
| 1002 | | | | Pillows, 20 m from contact | Photo-14<br>Photo-15 |
| 1005 | | 59.14' | 52.18' | | FG R465-004<br>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<br>FG R465-007<br>**Basalt**<br>R465-1 |
| 1014 | 1782 | 59.175' | 52.163' | Top flow front, drip structures, must be on slope, plenty of yellow (Fe) stuff | Photo-17<br>FG R465-008<br>Photo-18 |
| 1019 | 1784 | | | Grabbing flow structure, in port BioBox, long, bonelike, glass, yellow stuff | **Basalt?**<br>R465-2<br>FG R465-009<br>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<br>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<br>Photo-23 |

| Time UTM | Depth m | X-pos Longitude | Y-pos Latitude | Comments – Dive R465 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photo-24<br>FG R465-012<br>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<br>Photo-28 |
| 1100 | 1780 | | | Temperature check in bag creatures (bag sniffing) no thermal anomaly | FG R465-013<br>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<br>FG R465-014<br>Photo-31<br>FG R465-015 |
| 1112 | 1781 | | | Little crevasse, color change (white) along crack, orange further out, no thermal anomaly | Photo-32<br>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<br>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<br>Photo-37<br>Photo-38<br>Photo-39<br>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<br>Photo-44<br>Photo-45<br>Photo-46<br>Photo-47 |
| 1153 | 1760 | | | Tube-like pillows, some broken, very little seds | Photo-48<br>Photo-49<br>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<br>Photo-55 |

| Time UTM | Depth m | X-pos Longitude | Y-pos Latitude | Comments – Dive R465 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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. End of Dive R465. | |

# Dive R466 (JD 247)

## ASHES: Hell, ROPOS, Hillock/Phoenix, Hairdo and Inferno Vents



## Dive R466

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

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R466 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>FG R466-003 |

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|---|---|---|---|---|---|
| 0244 | 1545 | 421372 | 5087130 | Hdg 283, looking at **Hell Vent**. Sulfide worms hanging out in their tubes in between live *Ridgeia*.. | FG R466-004<br>FG R466-005 |
| 0248 | 1547 | 421374 | 5087134 | Shimmering water under a flange, highlights tape on. | FG R466-006<br>FG R466-007<br>FG R466-008<br>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<br>FG R466-011<br>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<br>FG R466-016<br>FG R466-017<br>FG R466-018<br>FG R466-019<br>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<br>**Biosample**<br>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<br>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<br>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<br>FG R466-035 |

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|---|---|---|---|---|---|
| 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<br>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.<br>Max. T = 5°C, no chemical anomalies. | FG R466-039<br>FG R466-040<br>FG R466-041<br>**SUAVE** R466-2<br>FG R466-042 |
| 0622 | | | | SUAVE #1 completed. | |
| 0624 | | | | Taking entire clump of tube worms. In port BioBox. Hdg 220.<br>Changed archive tapes at 0631. | FG R466-043<br>**Biosample**<br>R466-3<br>FG R466-044 |
| 0635 | | | | SUAVE #2 in hole left by sampling tube worm bush. Hdg 220.<br>Max. T = 6°C, $H_2S$ ~1 µmol, Mn = 4 µmol, Fe = below detection. | FG R466-045<br>**SUAVE**<br>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<br>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 =16°C, $H_2S$ = 135 µmol, Mn = 7.5 µmol, Fe = 5 µmol. | **SUAVE**<br>R466-5<br>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<br>2.8-3.0°C, with maximum of about 3.5°C. The little spire on the top of **ROPOS Vent** is dead. | FG R466-050<br>FG R466-051<br>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**,<br>heading 165, scanning with temperature up to 17C. Started a SUAVE at 0759. SUAVE #4 stopped at 0806.<br>T= 29°C, $H_2S$ 340 µmol, Mn 40 µmol, Fe 80 µmol. | **SUAVE**<br>R466-6<br>FG R466-053 |
| 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<br>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 = 14°C, $H_2S$ 138 µmol, Mn 12.5 µmol, Fe 8 µmol, temp average about 12.5°C. | FG R466-056<br>**SUAVE**<br>R466-7 |

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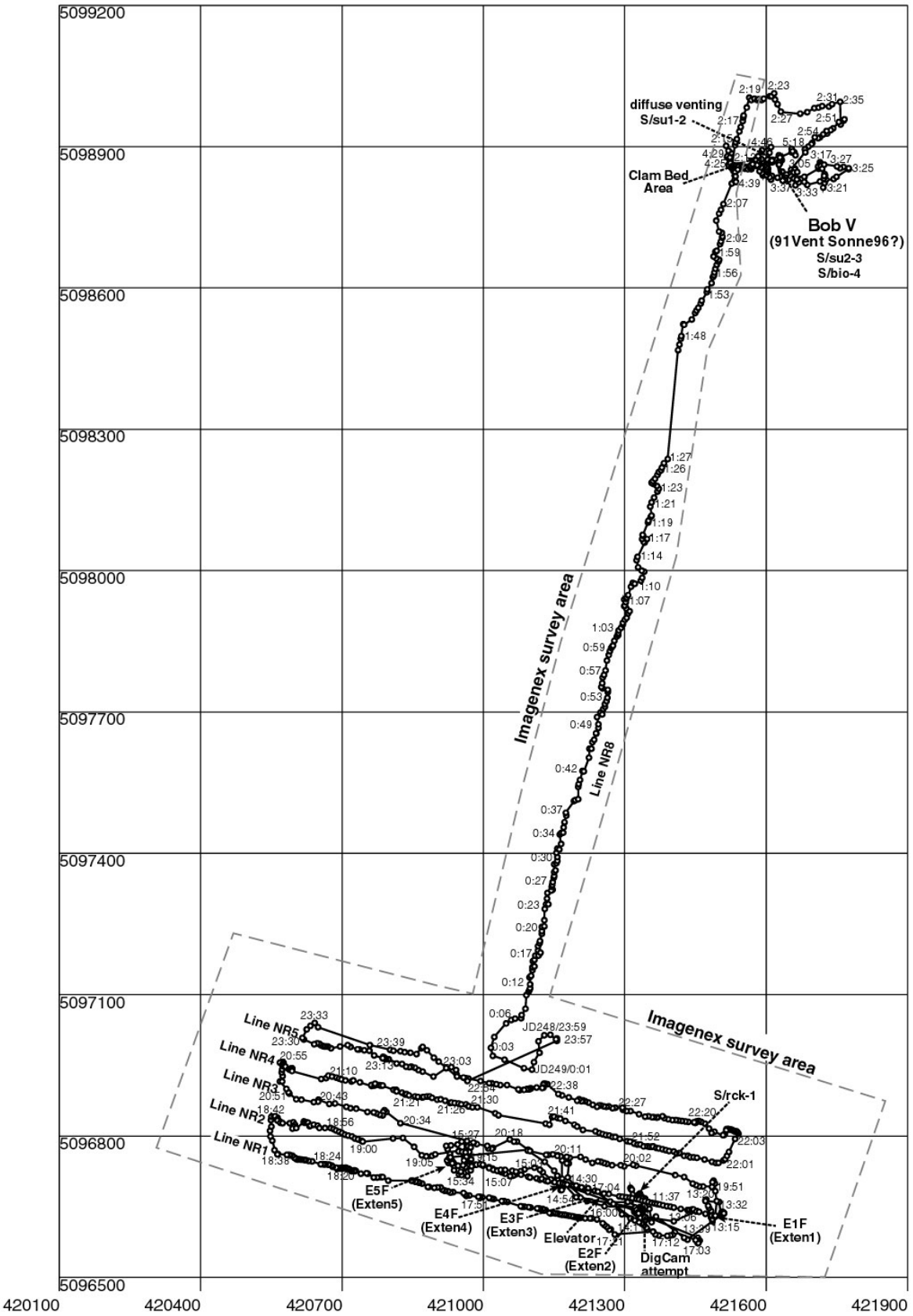
|---|---|---|---|---|---|
| 0833 | 1546 | 421391 | 5087156 | Good fix for **Hairdo Vent**. | FG R466-057 |
| 0838 | | | | Highlights are on. | |
| 0840 | 1546 | 421391 | 5087156 | Good fix for **Hairdo Vent**. Suave stopped at 0841. Another good fix 1391 and 7157. | |
| 0842 | | 421391 | 5087156 | Grabbing "hairdo" for collection and will put it in the starboard side of the BioBox. Stuffing the pile into the box and counted millions and millions of organisms. Done with the collection at 0900. | FG R466-058<br>**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 14.8°C, $H_2S$ 200 µmol, Mn 15 µmol, Fe 10 µmol, average temp of 13.5°C, stopped at 0913. | **SUAVE**<br>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.**<br>Highlight video is on; watching the battle of the worms. | FG R466-061 |
| 1000 | | 421392 | 5087136 | SUAVE #7, started, below the worms. Trying to get a good spot at **Phoenix Vent.** Starting at 1008. Max. T=20°C. | **SUAVE**<br>R466-10 |
| 1024 | | | | SUAVE #8 started and now at the worms themselves, ended at 1039.<br>Max. T=15°C. | **SUAVE**<br>R466-11<br>FG R466-062 |
| 1033 | | | | | FG R466-063 |
| 1044 | | | | SUAVE #9 at the "frisky boys". Max. T=6°C. | **SUAVE**<br>R 466-12<br>FG R466-064 |
| 1057 | | | | SUAVE #10 slightly higher up in Community II; Hdg. 145. Max. T=8°C. | **SUAVE**<br>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=4.2°C. | **SUAVE**<br>R466-14 |
| 1205 | | 421388 | 5087135 | Finished SUAVE and prepping to SUAVE again--#12 on two sulfide worms. Started at 1209. | **SUAVE**<br>R466-15 |
| 1218 | | | | Terminating SUAVE. Max.. T=6.1°C. | |
| 1221 | | | | Resetting Science STS. | |
| 1225 | 1545 | | | Found another spot to SUAVE. | |
| 1230 | | | | Video taping sulfide worms. Community I. | FG R466-065<br>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**<br>R466-16 |
| 1258 | | | | End SUAVE #13, Max.. T=80°C. | |
| 1300 | 1545 | | | Moving arm into position for next SUAVE. | |
| 1303 | | 421388 | 5087135 | Starting SUAVE #14. | **SUAVE**<br>R466-17 |
| 1312 | | | | End SUAVE #14. Max. T=24°C. | |
| 1314 | | | | Moving arm into position for SUAVE #15. Begin SUAVE #15 at 1316. | **SUAVE**<br>R466-18 |
| 1326 | | 421388 | 5087135 | End SUAVE #15. Max. T=3°C. Moving probe to next spot. Begin SUAVE #16 at 1329. | **SUAVE**<br>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**<br>R466-20 |
| 1425 | | | | End of SUAVE #17. Max. T=5.5°C. | |
| 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**<br>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**<br>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**<br>R466-23<br>FG R466-069<br>FG R466-070<br>FG R466-071 |
| 1517 | 1546 | 421373 | 5087136 | SUAVE #18 complete. Max T=16°C, $H_2S$ 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**<br>R466-24 |
| 1535 | 1546 | | | SUAVE #19 complete. Max T=19°C, $H_2S$ 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**<br>R466-25 |
| 1557 | 1546 | | | SUAVE #20 complete. Max T=19°C, $H_2S$ 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**<br>R466-26 |
| 1615 | 1546 | | | SUAVE #21 complete. Max T=20°C, $H_2S$ 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**<br>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. End of Dive R466 | |

# Dive R467 (JD 248 - 249)

**North Rift Zone: Extensometers Placed in Elevator; Imagenex Survey of North Rift Area; Sampled Bob Vent**



## Dive R467

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

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R467 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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. | |

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|---|---|---|---|---|---|
| 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<br>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. | |

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|---|---|---|---|---|---|
| 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<br>jumbled sheet flow, sponges on sheet flow. | Photo-4<br>Photo-5<br>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<br>Photo-10<br>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<br>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<br>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. | |
| 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. | |

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|---|---|---|---|---|---|
| 1535 | 1590 | 420934 | 5096742 | Found E5, calling actual drop position, **E5F**. Hdg 263. | Photo-17<br>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<br>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**<br>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<br>FG R467-007 |
| 0241 | | | | Same general constructional feature. | Photo-24 |
| 0243 | | | | Sponge sightings. | |
| 0244 | | | | Enteropneust sighting, NOT on sediment!!!. | |
| 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. | |

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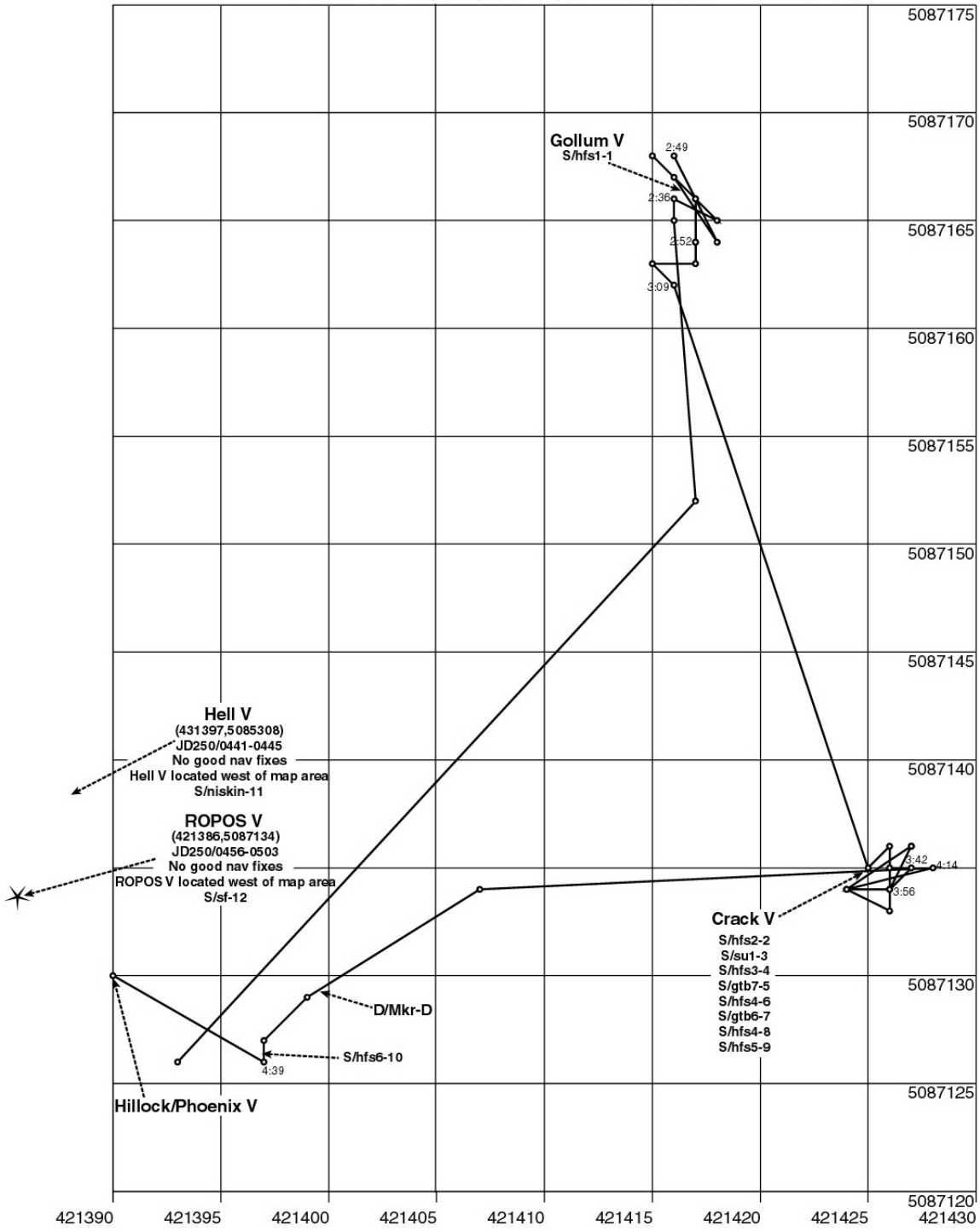
|---|---|---|---|---|---|
| 0314 | 1711 | 421711 | 5098855 | Basalt rubble, hdg East. | |
| 0326 | 1634 | 428854 | 5091634 | No joy in finding vent, proceeding West towards rift zone. | Photo-29 |
| 0327 | 1750 | | | ~2 m drop strike N-S, large blocks of basalt in otherwise basalt rubble. | Photo -30 |
| 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 (+0.03°C). | |
| 0341 | 1636 | | | Small clams, crabs. Going down and stopping to see animals up close, warm water (+0.02°C).<br>A few bacteria covered tube worms, clams, gastropods (*Provanna* and *Lepetodrilus*); very weak venting. | Photo-34<br>Photo-35<br>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 $H_2S$.<br>SUAVE #1. | Photo-37<br>Photo-38<br>**SUAVE**<br>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<br>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<br>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<br>FG R467-011 |
| 0500 | 1639 | 421629 | 5098870 | SUAVE #2 of this site. Decided to call it "**Bob Vent**". | **SUAVE**<br>R467-3<br>FG R467-012 |
| 0511 | 1640 | 421629 | 5098870 | FG-12 of orange mat.<br>FG-13 of tube worms and orange mat.<br>Fix at 0509.<br>SUAVE #2 finished: Max T = 4.5°C, $H_2S$ 124 µm, Fe 2 µm, Mn 5µM.<br>Biosample in port BioBox.<br>Photo of tether. | FG R467-013<br>FG R467-014<br>**Biosample**<br>R467-4<br>Photo-62 |
| 0517 | | | | Returning to cage. Sea state rising.<br>Archive tapes stopped. | |
| 0634 | | | | ROPOS on deck. End of Dive R467. | |

# Dive R468 (JD 250)

## ASHES: Gollum, Hell, ROPOS, Hillock/Phoenix and Crack Vents



## Dive R468

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 |
|---|---|---|---|
| Axial Seamount<br><br>ASHES vent field | Date (PDT):<br>Sept 6, 1998<br><br>Date (UTM):<br>Sept 7, 1998<br><br>Julian Day 250<br><br>Time off deck:<br>0101<br><br>Time on bottom:<br>0224 | Date (PDT):<br>Sept. 6, 1998<br><br>Date (UTM):<br>Sept.7, 1998<br><br>Julian Day 250<br><br>Time off bottom:<br>0503<br><br>Time on deck:<br>0525<br><br>Total dive time:<br><br>4 hr 24 min<br><br>Total bottom time:<br>2 hr 39 min | Diffuse flow water sampling with the 'Hot Fluid Sampler'<br><br>SUAVE diffuse flow vents<br><br>One marker (D) to deploy at a sampling site<br><br>One Niskin bottle<br><br>Pacman for grab of an oxide chimney, SUAVE it first |

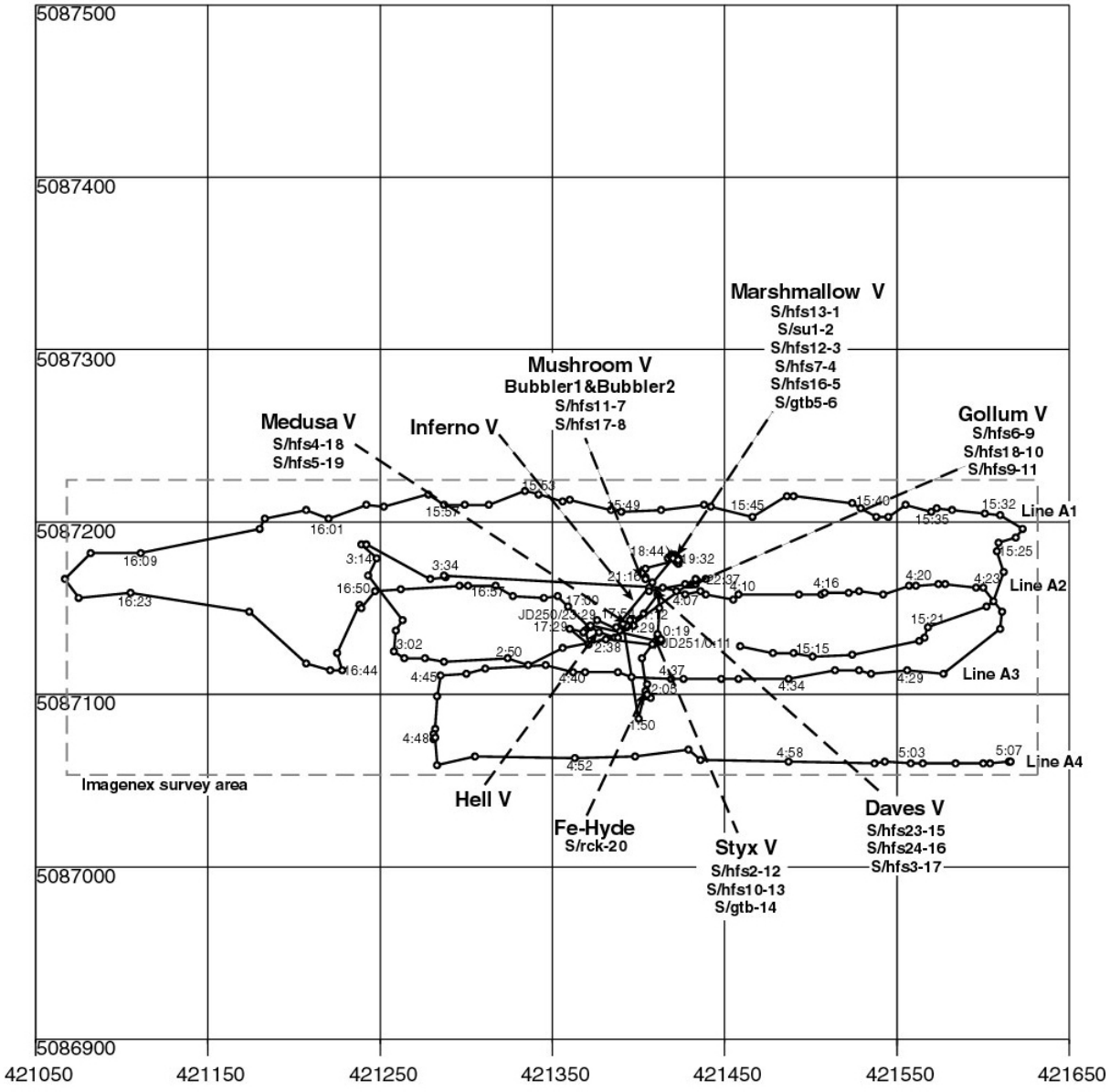
ROPOS configuration:
- Digital still camera mounted lower forward on port bumper
- Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)
- Hot Fluid Sampler (HFS) mounted lower center work area
- Photosea 1000A 35 mm camera and strobe mounted side-by-side on upper 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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R468 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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=26°C and T2=16.6°C; 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 = 21°C, T2 = 13°C | |
| 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 = 25°C. HFS-2<br>Sampler #8 - piston, gas-tight fittings<br>T1 = 35°C, T2 = 21°C, SUAVE T = 48°C<br>SUAVE at same place | **HFS** R468-2<br>**SUAVE** R468-3 |
| 0342 | | | | HFS-2 finished, ~200 ml<br>SUAVE-1 start at same place | |
| 0344 | 1545 | 421426 | 5087135 | HFS-3 at same place. T1=45°C, T2=25°C. 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=40°C. At same place. SUAVE-1 continuing, Max T=73°C. | **HFS** R468-4<br>**GTB** R468-5<br>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 = 170°C<br>GTB #6 port side. T = 170°C. At same place | **HFS** R468-6<br>**GTB** R468-7 |
| 0404 | | | | SUAVE-1 finished<br>T ave = ~70°C, $H_2S$ 500µM, Mn ~62 µm, Fe 12 µm | |
| 0405 | | 421426 | 5087135 | HFS-4 #12 piston sample at same place<br>T1 max = 70°C, T2 ave = 28°C | **HFS** 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 = 135°C, 350 ml | |
| 0419 | | | | Lost P-code on bridge | |
| 0424 | | | | Going to Hillock/Phoenix Vent. | |
| 0426 | 1546 | | | Arrived at **Hillock/Phoenix**<br>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<br>FG 468-001 |
| 0436 | | | | HFS-6 Bag #3. Background water sample without filter between Hillock/Phoenix and Hell Vents. T = 2.5°C | **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<br>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 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R468 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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 (JD 250 - 251)

**ASHES: Imagenex Survey; Medusa, Mushroom, Marshmallow, Gollum, Daves, Styx and Fe-Hyde Vents**



## Dive R469

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):<br>Sept. 7, 1998<br><br>Date (UTM):<br>Sept. 7, 1998<br><br>Julian Day 250<br><br>Time off deck:<br>1338<br><br>Time on bottom:<br>1503 | Date (PDT):<br>Sept. 7, 1998<br><br>Date (UTM):<br>Sept. 8, 1998<br><br>Julian Day 251<br><br>Time off bottom:<br>0506<br><br>Time on deck:<br>0626<br><br>Total dive time:<br>16 hr 48 min<br><br>Total bottom time:<br>14 hr 03 min | Vent fluid samples and SUAVE scans of low-temperature vents<br><br>Gas tight water samples at vents to be selected<br><br>Niskin sample at vent to be selected<br><br>Pacman sample of iron oxide south of ASHES to be selected |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R469 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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 | |
| 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 | |
| 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 $T_1$=67℃, $T_2$ =35℃Starting SUAVE, hdg 50 on all samples<br>T= 65℃, $H_2S$ ?? µmol, Fe ??µmol, Mn ??µmol | **HFS**<br>R469-1<br>**SUAVE** #1<br>R469-2 |
| 1836 | 1546 | " | " | Filling piston #12-abort, not filling<br>Filled at 1925 (see below) | **HFS**<br>R469-3 |
| 1843 | 1546 | " | " | Dave is fiddling | |
| 1849 | 1546 | " | " | Trying Bag #7-looks like its working, we can see the exhaust | **HFS**<br>R469-4 |
| 1900 | 1546 | " | " | Sampling #16 Filters only (2) at same site | **HFS**<br>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)<br>R469-1 |
| 1916 | 1546 | " | " | Starboard gas tight bottle at same site | **GTB**<br>R469-6 |
| 1920 | 1546 | " | " | "Isn't this thrilling?"-Dave Still filling #13 | |
| 1921 | 1546 | 421422 | 5087178 | Trying Piston #12 again | HFS (same)<br>R469-3 |
| 1925 | | | | Piston #12 is moving, slowly and intermittently | |

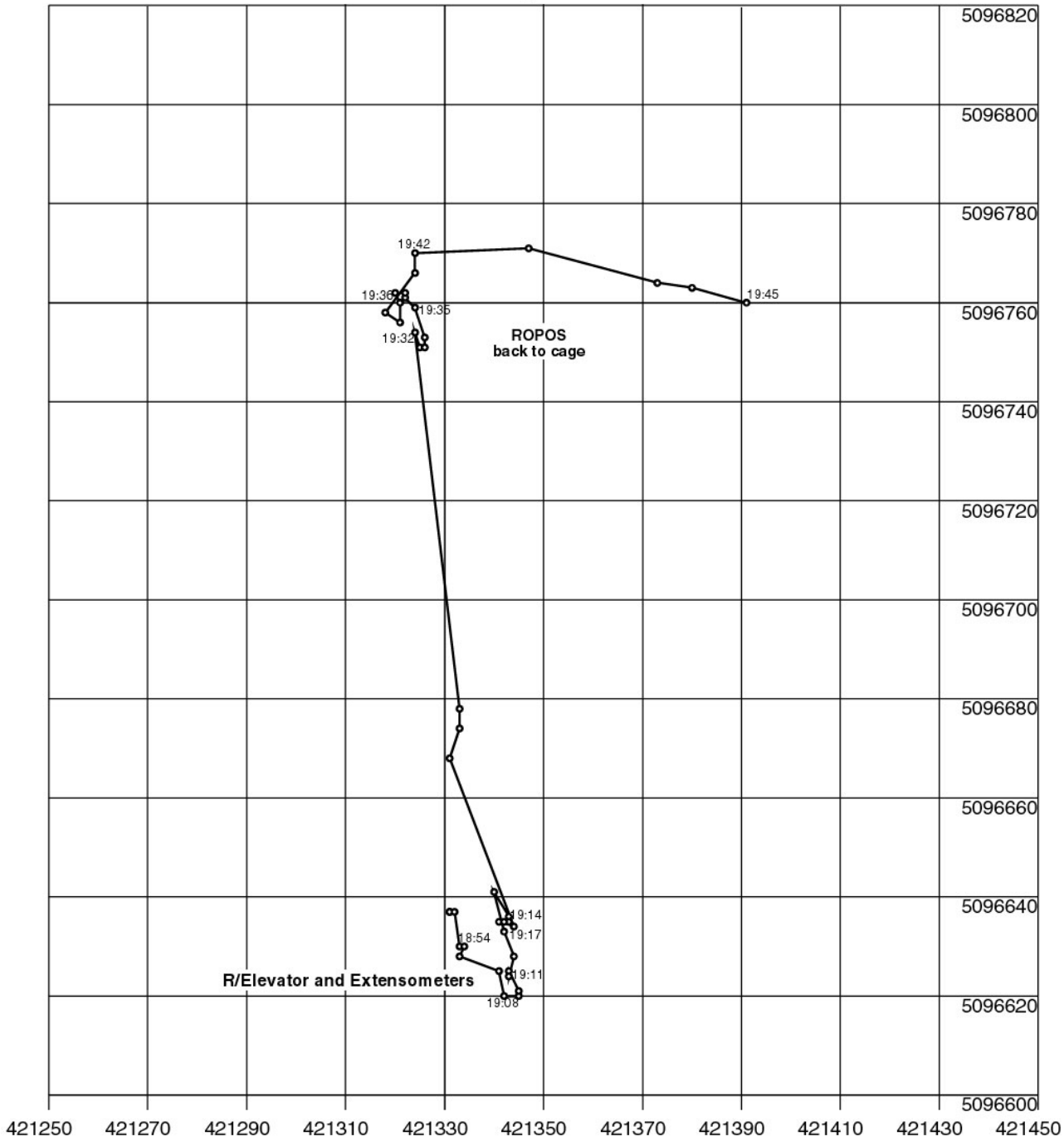
| | | | | | |
|---|---|---|---|---|---|
| 1929 | | 421422 | 5087178 | Piston #12 sampling complete; piston is half-filled | |
| 1929 | | | | Off to Gollum we go | |
| 1930 | | | | But first, a photo of **Marshmallow Vent** | FG R469-001 |
| 1933 | | | | Heading to Gollum | |
| 1938 | | | | Tether management 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<br>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<br>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 = 48.7°C at **Bubbler #2** | |
| 2114 | | | | Bubbles emerging from this mini-vent also (**Bubbler #2**) (here with a max T of 70°C) | |
| 2115 | | 421408 | 5087165 | Highlights rolling again; Probe is bigger than vent spout | FG R469-003 |
| 2116 | | | | HFS Piston #11 | **HFS**<br>R469-7<br>FG R469-004 |
| 2122 | | | | T1=70°C, T2=32°C 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=50°C, T2=17°C | **HFS**<br>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<br>Photo-4<br>Photo-5<br>Photo-6 |
| 2155 | | | | **Bubbling Mushroom chimney!** | FG R469-005<br>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 | |
| 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= 7.5°C on avg above ambient (Pump goes on and off a few times), T2 = 6.1°C on avg, probably ~500 ml sample | **HFS** R469-9 |
| 2245 | | | | Bio filter #18, T1 = 7°C, T2 = 6.2°C. 800 to 900 milliliters | **HFS** R469-10 |
| 2248 | | 421427 | 5087165 | **Gollum** being sampled | FG R469-007 |
| 2254 | | | | Gas piston #9, T1 = 7°C | **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=23°C, T2=9°C, collected 350ml of fluid; pump off, then on again, location named **Styx vent** | **HFS** R469-12 |
| 0000 JD25 1 | | 421412 | 5087132 | Bag sample #2 finished, piston sample# 10 starting at same location | **HFS** R469-13 |
| 0013 | | | | Port gas tight taken, T=14°C | **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 16°C, decide to take sample | |
| 0033 | | 421409 | 5087159 | Bag sample #23 start, temp. fluctuating between 10-20°C, 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-35.8°C | 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 421396 | 5087144 5087139 | Found a good diffuse vent around 15-20 m south of Inferno, probing for temperature, Tmax 6.9°C at base of tube worms; lots of palm worms and mat, few tube worms; called **Medusa Vent;** temp varying between 14-18°C | Photo-12 FG R469-009 |

| | | | | | |
|---|---|---|---|---|---|
| 0115 | | | | HFS bag #4 (with filter) starting, hdg 223, probe looks like it's behind the mound of worms, temperatures from 12.5-19°C | FG R469-010<br>**HFS**<br>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<br>FG R469-011<br>FG R469-012<br>**HFS**<br>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<br>FG R469-013<br>**Oxide**<br>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<br>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. Still camera not working | FG R469-015 |
| 0310 | 1544 | | | Lava contact. Camera working again | Photo-21 |
| 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<br>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. End of dive R469. | |

# Dive R470 (JD 251)

## North Rift Zone: Recovery of Elevator and Extensometers



## Dive R470

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):<br>Sept 10, 98<br><br>Date (UTM):<br>Sept 10, 98<br><br>Julian Day 251<br><br>Time off deck:<br>1700<br><br>Time on bottom:<br>1838h | Date (PDT):<br><br>Date (UTM):<br><br>Julian Day 251<br><br>Time off bottom:<br>1901<br><br>Time on deck:<br>2043<br><br>Total dive time:<br>3 hr 43 min<br><br>Total bottom time: 23 minutes. | Recover the elevator and liberate it from bottom. |

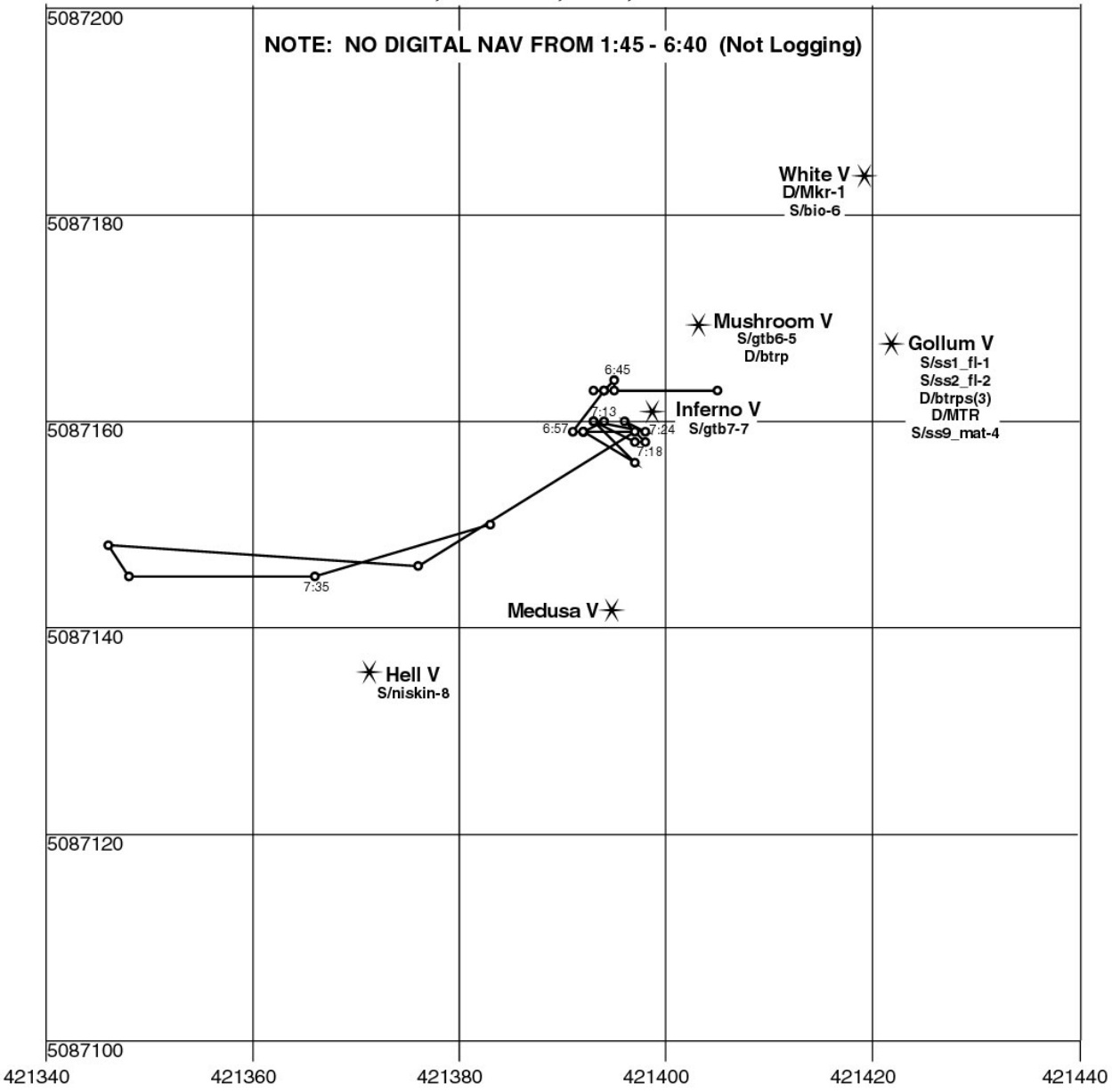
ROPOS configuration:

- 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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R470 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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!!<br>Position 46°01.1' N 130°01.0'W | FG R470-002 |
| 1901 | | | | BACK TO CAGE | |
| | | | | ROPOS and cage on deck. End of Dive R470. | |

# Dive R471 (JD252)

## ASHES: Gollum, Mushroom, White, Inferno and Hell Vents



## Dive R471

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<br><br>ASHES vent field | Date (PDT):<br>Sept. 8, 1998<br><br>Date (UTM):<br>Sept. 9, 1998<br><br>Julian Day 252<br><br>Time off deck:<br>0019<br><br>Time on bottom:<br>0145 | Date (PDT):<br>Sept. 9, 1998<br><br>Date (UTM):<br>Sept. 9, 1998<br><br>Julian Day 252<br><br>Time off bottom:<br>0737<br><br>Time on deck:<br>0900<br><br>Total dive time:<br>0718<br><br>Total bottom time:<br>0552 | Bacterial trap deployment/recovery<br><br>One MTR deployment<br><br>Three worm clump samples at Gollum, Medusa and area north of Virgin<br><br>Suction samples of chimney sites<br><br>Imagenex/DSC of ASHES<br><br>Sulfide sampling |

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

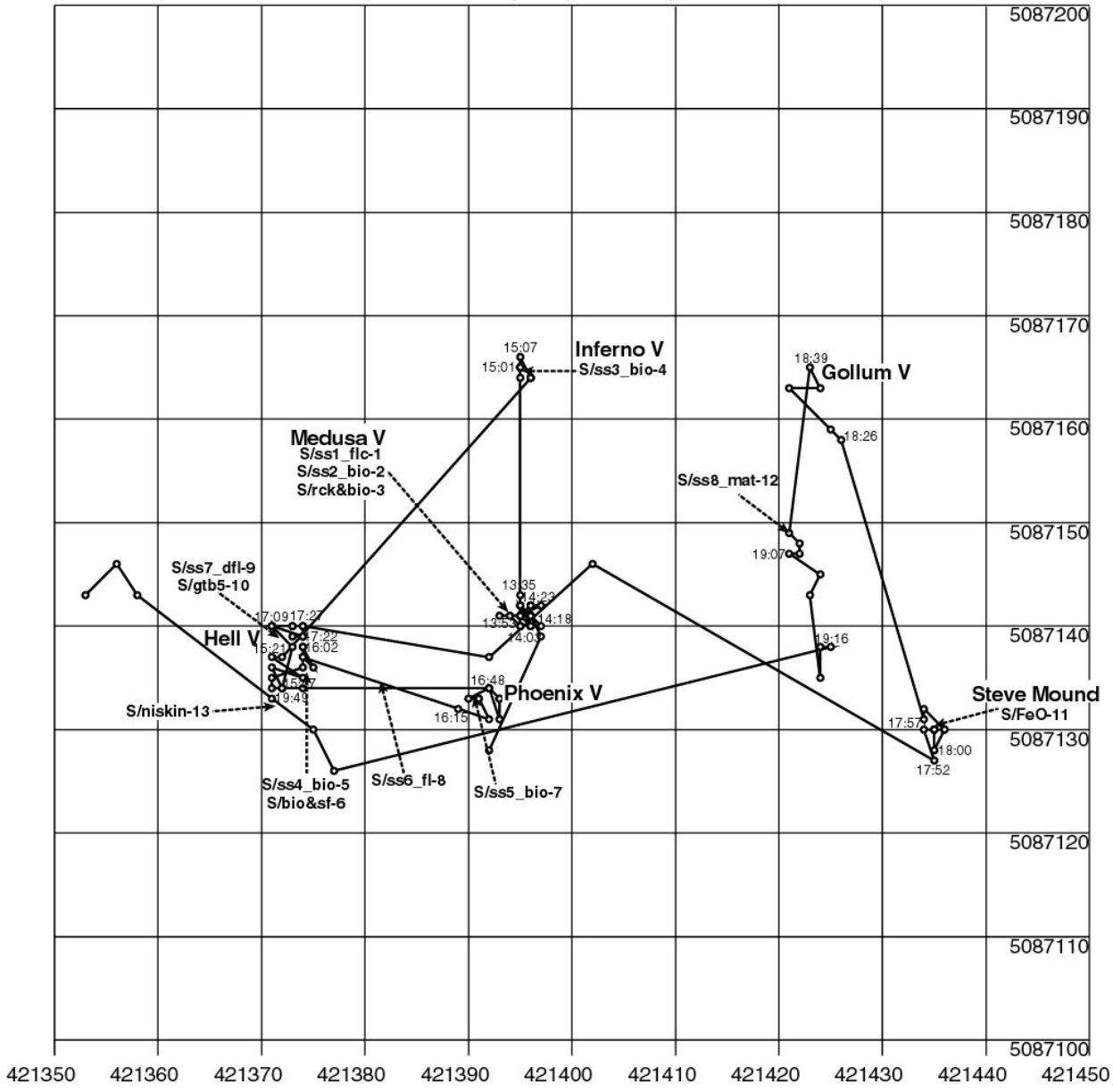
| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R471 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 0019 | | | | ROPOS launched | |
| 0141 | | | | Cage depth 1489 m | |
| 0145 | | | | On the bottom; clams, tube worms | |
| 0147 | | 421386 | 5087108 | Approx. 30m south of Hillock | |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R471 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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 Best | 5087166 fix | 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<br>Photo-2<br>Photo-3 |
| 0258 | | 421422 | 5087168 | Taking a water suction sample into jar #1 Hdg 309 | **Suction sample**<br>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**.<br>Frame grabs 002-006 not recorded | **Suction sample**<br>R471-2<br>FG R471-001 |
| 0326 | | | | Suction sample finished | |
| 0346 | | | | Changed archive tapes | |
| 0359 | | 421422 | 5087168 | Sampled tube worms at same place. In port BioBox. | **Biosample**<br>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**<br>R471-4<br>FG R471-003<br>Photo-4 |
| 0515 | | | | Proceeding W to Mushroom Vent | |
| 0517 | | | | Arrived at top of **Mushroom Vent**<br><br>FGs hdg 298 | Photos-5<br>Photo-6<br>FG R471-004<br>FG R471-005 |
| 0524 | | | | GTB sample in bottle #6 after knocking over small chimney | **GTB**<br>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<br>Changed archive video tapes | FG R471-007 |
| 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**<br>R471-6 |
| 0635 | | | | Returning to the cage | |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R471 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 0638 | 1543 | 421395 | 5087163 | Arrived at top of **Inferno Vent**<br>Hdg 001 | Photos-8<br>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**<br>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**<br>R471-8 |
| 0737 | | | | Video off, coming up | |
| 0900 | | | | ROPOS on deck | |

# Dive R472 (JD252)

## ASHES: Steve Mound, Hell, Phoenix, Medusa and Inferno Vents



## Dive R472

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):<br>Sept. 9 1998<br><br>Date (UTM):<br>Sept. 9 1998<br><br>Julian Day 252<br><br>Time off deck:<br>1206<br><br>Time on bottom<br>1322 | Date (PDT):<br>Sept. 9, 1998<br><br>Date (UTM):<br>Sept. 9, 1998<br><br>Julian Day 252<br><br>Time off bottom:<br>2000<br><br>Time on deck:<br>2137<br><br>Total dive time:<br>09 hr 31min<br><br>Total bottom time:<br>06 hr 38 min | Suction sample tube worms at:<br>Medusa<br>Inferno<br>Hell<br>Phoenix<br><br>Gas tight water samples at vents to be selected<br><br>2 Niskin sample at vent to be selected<br><br>Sample biology and sulfides at SteveMnd |

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

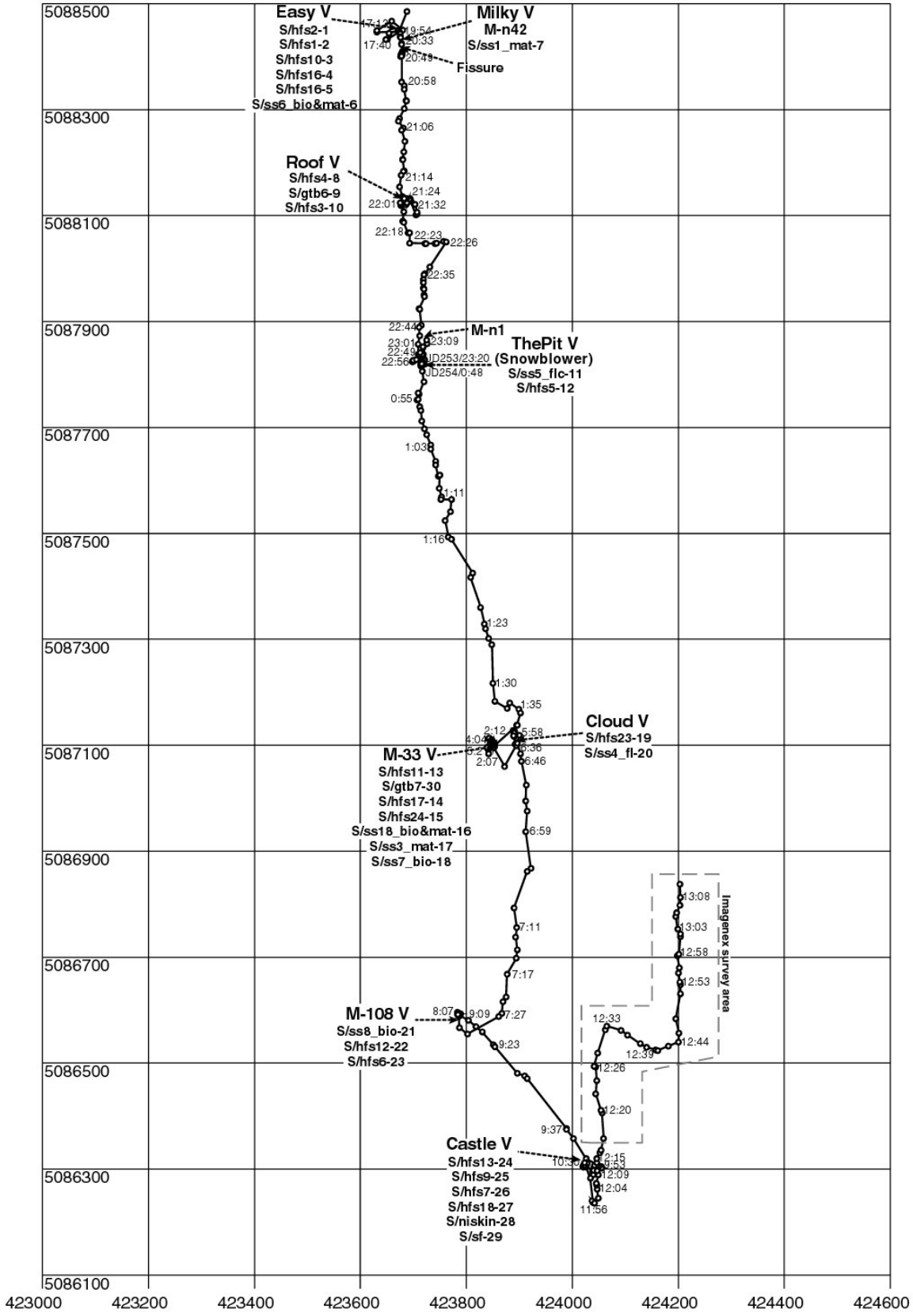
| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R472 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 1206 | 0 | 421395 | 5087140 | ROPOS launched | |
| 1322 | | | | Reach bottom | |
| 1326 | | | | Near Phoenix, white mat, looking for Medusa | |
| 1327 | | 421392 | 5087128 | 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**<br>R472-1<br>FG R472-001 |
| 1400 | 1546 | | | Still filming and sucking | |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R472 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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; preparing to sample sulfide worms that were scanned on an earlier dive | Photo-005 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 **Phoenix Vent** | FG R472-005 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 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R472 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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. End of Dive R472. | |

# Dive R473 (JD 253-254)

**SE Caldera SRZ: Imagenex Survey; Easy, Milky, Roof, The Pit, Snowblower, M-33, M-108, Cloud and Castle Vents**



## Dive R473

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 274ºC!!

Times are UTM (local PDT +7 hours)

| Region, Field, Site | Dive Begin | Dive End | Tasks |
|---|---|---|---|
| Axial Seamount<br><br>Vent fields on east side of caldera | Date (PDT):<br>Sept. 10, 1998<br><br>Date (UTM):<br>Sept. 10, 1998<br><br>Julian Day 253<br><br>Time off deck:<br>1545<br><br>Time on bottom:<br>1706 | Date (PDT):<br>Sept. 11, 1998<br><br>Date (UTM):<br>Sept. 11, 199<br>Julian Day 254<br><br>Time off bottom:<br>1314<br><br>Time on deck:<br>1449<br><br>Total dive time:<br>23 hr 04 min<br><br>Total bottom time:<br>20 hr 08 min | Fluid sampling with High Temperature Fluid Sampler.<br><br>Imagenex along contact from Castle and 600 m North. (This didn't happen)<br><br>Suctioning bacterial mats and polynoid polychaetes at low temperature vents. |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>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 | |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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 10°C; 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 (3 µm and .22 µm Sterivex); more worms different from Mkr-33 | **HFS** 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 6°C | 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 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photo-29<br>FG R473-003<br>FG R473-004<br>FG R473-005<br>Photo-30<br>Photo-31 |
| 2054 | 1530 | 423677<br>423676 | 5088366<br>5088361 | Jumbled flow; giant pit sinkhole thing; slabs of basalts; some milky venting; lava cave; jumbled up | Photo-32<br>Photo-33<br>Photo-34<br>Photo-35<br>Photo-36<br>Photo-37<br>Photo-38<br>Photo-39<br>Photo-40<br>Photo-41 |
| 2059 | 1529 | 423686 | 5088317 | Sheet flows; hdg 180; lava highway; flat sheet flow with greenish looking sediment; | Photo-42<br>Photo-43<br>Photo-44<br>Photo-45 |
| 2102 | 1528 | | | Thrust fault; on a ridge with flat sheet flows down below; large drainback feature; | Photo-46<br>Photo-47<br>Photo-48<br>Photo-49 |
| 2104 | 1526 | 423674 | 5088283 | New looking lava flows | Photo-50<br>Photo-51<br>Photo-52 |
| 2107 | 1525 | 423684 | 5088240 | Large crack; pit; large crack between two ridges; looks like a Grand Canyon | Photo-53<br>Photo-54<br>Photo-55<br>Photo-56<br>Photo-57<br>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<br>Photo-60<br>Photo-61<br>FG R473-006<br>FG R473-007<br>Photo-62<br>Photo-63<br>Photo-64 |
| 2112 | 1523 | 423682 | 5088193 | Still looking over this giant fissure with thick mat cover | Photo-65<br>Photo-66<br>Photo-67<br>Photo-68<br>Photo-69 |
| 2114 | 1523 | | | Still over the fissure; pieces of fallen blocks of lava in fissure | Photo-70<br>Photo-71<br>Photo-72<br>Photo-73<br>Photo-74<br>Photo-75 |
| 2116 | 1523 | 423677 | 5088140 | Some diffuse flow visible in fissure; some venting holes with diffuse flow coming out | Photo-76<br>Photo-77<br>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 | |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 2143 | 1523 | 423677 | 5088120 | Sampling water from crack; finicky fluid sampler acting up again; Tmax 14.6°C; Fluid sample; Bag #4; T1=10.7°C | **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<br>Photo-85<br>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 |
| 2233 | | 423723 | 5087991 | More drained out area | |
| 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<br>Photo-96<br>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<br>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<br>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 | |

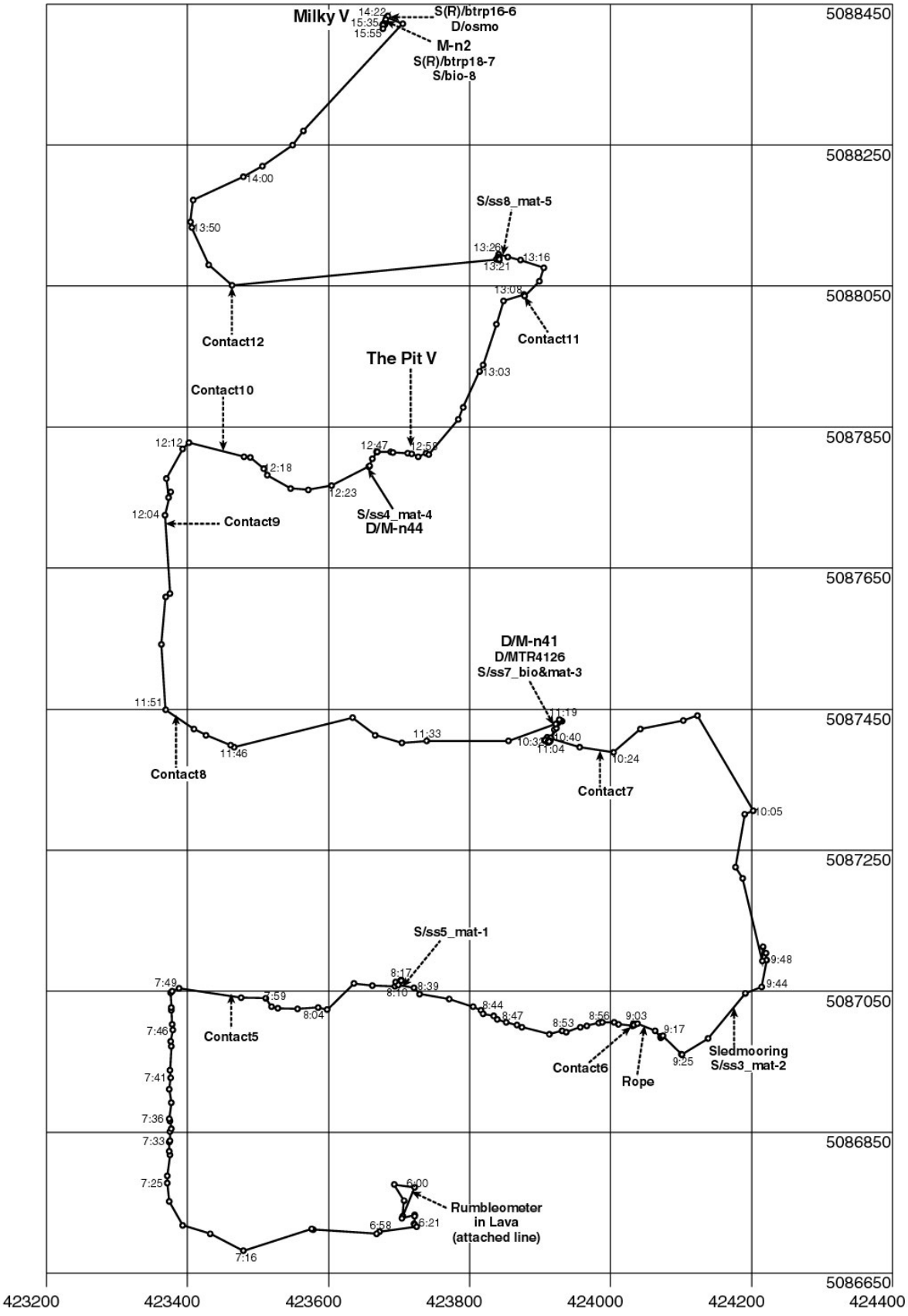
| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 2347 | " | " | " | At hole; positioning for sample; temp max 11.3°C; fluid sample; Bag #5 | **HFS** R473-12 |
| 0007 JD254 | " | " | " | Going to look for white floc | Photo-106 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=27°C, not good enough, moving around to find a better spot | R473-17 |
| 0256 | | | | At a new spot in the crack, temp max=30°C, start taking a water sample (0259), piston #11. T dropped so turned off pump, moved inlet slightly and continued sampling. T max = 37°C. | **HFS** R473-13 |
| 0311 | | | | Still sampling (hfs). GTB sample #7 at T = 34°C.<br>NOTE: GTB sample not sequential because was not originally given a sample number (missed it) | FG R473-018 **GTB** R473-30 |
| 0316 | | | | HFS finished. Changed archive videos | |
| 0317 | 1522 | 423851 | 5087098 | Taking filter sample set #17. T1 max = 54°C, T2 = 22°C. Hdg 237 | **HFS** R473-14 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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 = 40°C, ~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 |
| 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**<br>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=20°C. Fix not high quality because ROPOS is in a hole. | **HFS** R473-19 |
| 0633 | | | | HFS finished. | |
| | | | | Suction sample of 20°C 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 13°C, HFS Piston 12 at **Mkr-108** | **HFS** R473-22 FG R473-022 |

| Time UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R473 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 0855 | 1522 | | | HFS bag #6 filter, same site as above<br>done at 0904 | **HFS**<br>R473-23<br>Photo-140 |
| 0905 | | | | Off to castle vent at a depth of 1516,<br>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<br>Highlights (Steve), crab | Photo-141 |
| 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<br>Photo-143<br>Photo-144<br>Photo-145<br>Photo-146<br>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<br>Photo-151<br>FG on sit<br>R473-023<br>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 268°C max | |
| 1038 | 1520 | | | HFS sampler, Piston sample #13 at about 260°C done at 1049;<br>Gas Piston Sample #9 at same site start time 1050 and ended at 1052 | **HFS**<br>R473-24R473-25 |
| 1053 | 1520 | | | HFS sampler, Bag Sample #7 same place, stopped at 1059 | HFS<br>R473-26 |
| 1100 | 1520 | | | HFS sampler, Filter #18, same place<br>stopped at 1115 | **HFS**<br>R473-27 |
| 1116 | 1520 | | | Temp. probe stuck in hole at castle vent,<br>probe around to find highest temp, 274°C was highest temp. | FG R462-025 |
| 1129 | 1518 | | | Niskin Sample at 1518 above **Castle Vent** | **Niskin**<br>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**<br>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 (JD 255)

**SE Caldera SRZ: Attach line to Rumbleometer; E-W Lava Flow Mapping Traverses; The Pit and Milky Vents**



## Dive R474

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 |
|---|---|---|---|
| Axial Seamount<br><br>East side of Caldera | Date (PDT):<br>Sept. 11, 1998<br><br>Date (UTM):<br>Sept. 12, 1998<br><br>Julian Day 255<br><br>Time off deck:<br>0400<br><br>Time on bottom:<br>0535 | Date (PDT):<br>Sept. 12, 1998<br><br>Date (UTM):<br>Sept. 12, 1998<br><br>Julian Day 255<br><br>Time off bottom:<br>1555<br><br>Time on deck:<br>1730<br><br>Total dive time:<br>13 hr 30 min.<br><br>Total bottom time:<br>10 hr 20 min. | ● Deploy weight and attach line to Rumbleometer for stage 1 of recovery attempt<br>● E-W mapping traverses to north end of eastern vent field. Suction and rock samples along track.<br>● Suction sample of mat at The Pit Vent<br>● Deploy OSMO sampler and recover bacterial traps.<br>● Imagenex survey at north end, east side of caldera (~12 hours). |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R474 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>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<br>Photo-5<br>Photo-6 |
| 0637 | | 423708 | 5086783 | Surveying basalt columns. Photo of broken lava at rumbleometer. | Photo-7 |
| 0645 | | | | FGs of rumbleometer<br>Photos of ~1 m basalt column | FG R474-003<br>FG R474-004<br>FG R474-005<br>FG R474-006<br>Photo-8<br>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<br>Photo-11<br>Photo-12<br>Photo-13<br>Photo-14<br>Photo-15<br>Photo-16<br>FG R474-007<br>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<br>Photo-19<br>Photo-20 |
| 0715 | 1520 | 423479 | 5086682 | Contact ?????? keep going, collapse on a young flow, looking like old rock | Photo-21<br>Photo-22<br>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<br>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<br>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<br>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<br>Photo-33<br>Photo-34<br>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,<br>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) | Photo-36<br>**Suction sample**<br>R474-1<br>FG R474-011<br>FG R474-012<br>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<br>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,<br>FG #15 of new basalt over the old basalt<br>highlights are on (TARGET CONTACT #6) | Photo-40<br>FG R474-014<br>FG R474-015<br>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<br>Photo-43<br>Photo-44<br>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<br>Photo-46<br>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**<br>R474-2<br>FG R474-020<br>FG R474-021 |
| 0942<br>0948 | 1521 | 424212 | 5087114 | Sled mooring sighted (**Sledmoor** target)<br>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<br>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<br>Photo-53<br>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,**<br>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 . | FG R474-024 |
| 1054 | | | | Vent fish, new baby tube worms | Photo-57<br>FG R474-025 |
| | | | | New tube worms on new lava, trying to sample these worms | Photo-58<br>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**<br>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<br>Photo-60<br>Photo-61<br>Photo-62 |
| 1123 | 1520 | | | Put **Mkr-N4**1 back out on rock by the **MTR4126**. | Photo-63<br>Photo-64<br>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<br>Lobate flows, lots of roof collapses | Photo-67<br>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<br>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 |

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|---|---|---|---|---|---|
| 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<br>Photo-75<br>FG R474-029<br>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.<br>**Contact #9** | Photo-77 |
| 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<br>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<br>Photo-80<br>Photo-81<br>FG R474-031<br>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.<br>Lava at this marker is completely covered with the yellow/orange mat. | FG R474-033<br>**Suction sample**<br>R474-4<br>Photo-82<br>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<br>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<br>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<br>Photo-96 |
| 1317 | 1521 | | | Pillar, collapse and red stuff. | Photo-97<br>Photo-98 |
| 1320 | 1521 | 423837 | 5088089 | Slurping into jar #8. Slurping red material on new lava. | **Suction sample**<br>R474-5 |
| 1327 | 1521 | | | collapsed area with pillars | Photo-99 |

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|---|---|---|---|---|---|
| 1330 | | 423378 | 5088107 | thick new mat on lava flow | Photo-100 |
| 1332 | 1519 | | | back to really thin mat, Venting!! Floc,<br>Lots of diffuse venting and floc in the water. | Photo-101<br>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<br>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<br>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**<br>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<br>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**<br>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

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)

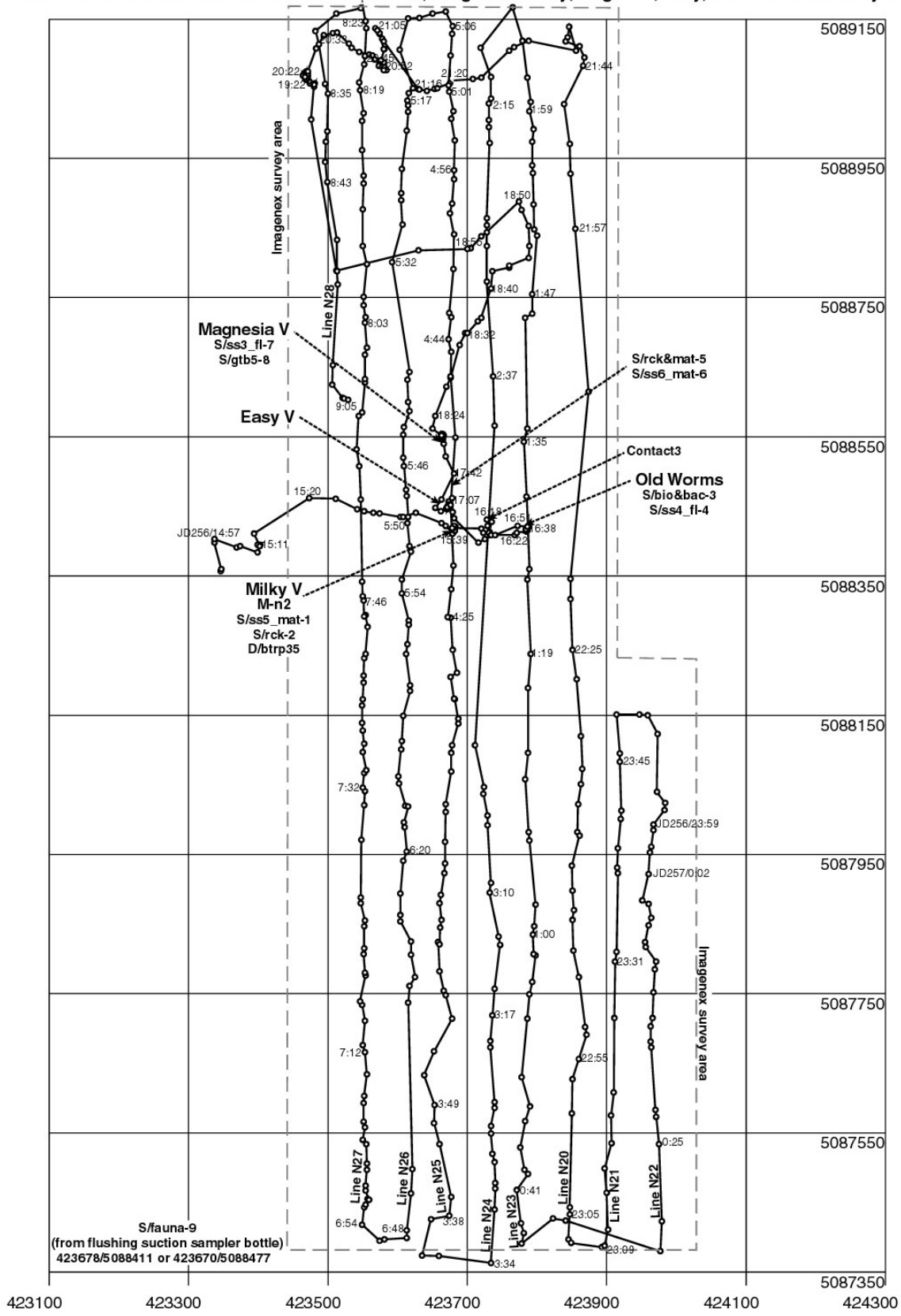
| Region, Field, Site | Dive Begin | Dive End | Tasks |
|---|---|---|---|
| East side of Caldera | Date (PDT):<br>Sept. 12, 1998<br><br>Date (UTM):<br>Sept. 13, 1998<br><br>Julian Day 256<br><br>Time off deck:<br>0245<br><br>Time on bottom:<br>0406 | Date (PDT):<br>Sept. 13, 1998<br><br>Date (UTM):<br>Sept. 14, 1998<br><br>Julian Day 256<br><br>Time off bottom:<br>0425 (aborted)<br><br>Time on deck:<br>0530<br><br>Total dive time:<br>2 hr 45 min<br><br>Total bottom time:<br>0 hr 19 min | Finish E-W transects from R474.<br><br>Deploy a bacteria trap at Milky vent.<br><br>Try to get tube worm samples from old and new lava.<br><br>Imagenex survey of the North end of the East side of the caldera. |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R475 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>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 (JD 256 - 257)

**SE Caldera SRZ: Finish E-W Lava Flow Traverses; Imagenex Survey; Magnesia, Easy, Old Worms and Milky Vents**



## Dive R476

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<br><br>East side of Caldera | Date (PDT):<br>Sept. 13, 1998<br><br>Date (UTM):<br>Sept. 13, 1998<br><br>Julian Day 256<br><br>Time off deck:<br>1333<br><br>Time on bottom:<br>1454 | Date (PDT):<br>Sept. 14, 1998<br><br>Date (UTM):<br>Sept. 14, 1998<br><br>Julian Day 257<br><br>Time off bottom:<br>9005<br><br>Time on deck:<br>1029<br><br>Total dive time:<br>20 hr 56 min<br><br>Total bottom time:<br>18 hours 11 mins. | Redo of aborted Dive 475:<br><br>Finish E-W transects from R474.<br><br>Deploy a bacteria trap at Milky Vent.<br><br>Get tube worm samples from old and new lava.<br><br>Imagenex survey of the North end of the East side of the caldera. |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R476 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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** | |

| | | | | | |
|---|---|---|---|---|---|
| 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<br>Photo-5<br>FG<br>R476-002 |
| 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<br>FG<br>R476-004<br>**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<br>Photo-13<br>FG<br>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<br>FGs R476-006<br>R476-007 |
| 1610 | 1532 | | | Heading East to **Old Worms** | |
| 1614 | 1537 | 423712 | 5088416 | Lava pillar; old lavas | |
| 1618 | 1527 | 423725 | 5088426 | At **Contact 3** | Photo-16<br>Photo-17<br>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<br>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<br>**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 | |
| 1739 | 1528 | 423663 | 5088460 | Thick mat on jumbled sheet flow | |
| 1739 | 1525 | 423681 | 5088497 | Found new Milky-type vent | Photo-28<br>Photo-29<br>Photo-30 |

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|---|---|---|---|---|---|
| 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<br>More new lava | Photo-51<br>Photo-52 |
| 1913 | | 423486 | 5088904 | Mixed old and new lava<br>Sponge, Okie-roids | Photo-53<br>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<br>Grab of the SIT camera (some problems with the still photo stuff) | FG R476-013<br>R476-014 |
| 1929 | | 423481 | 5081529 | Turn West after stopping a while | |

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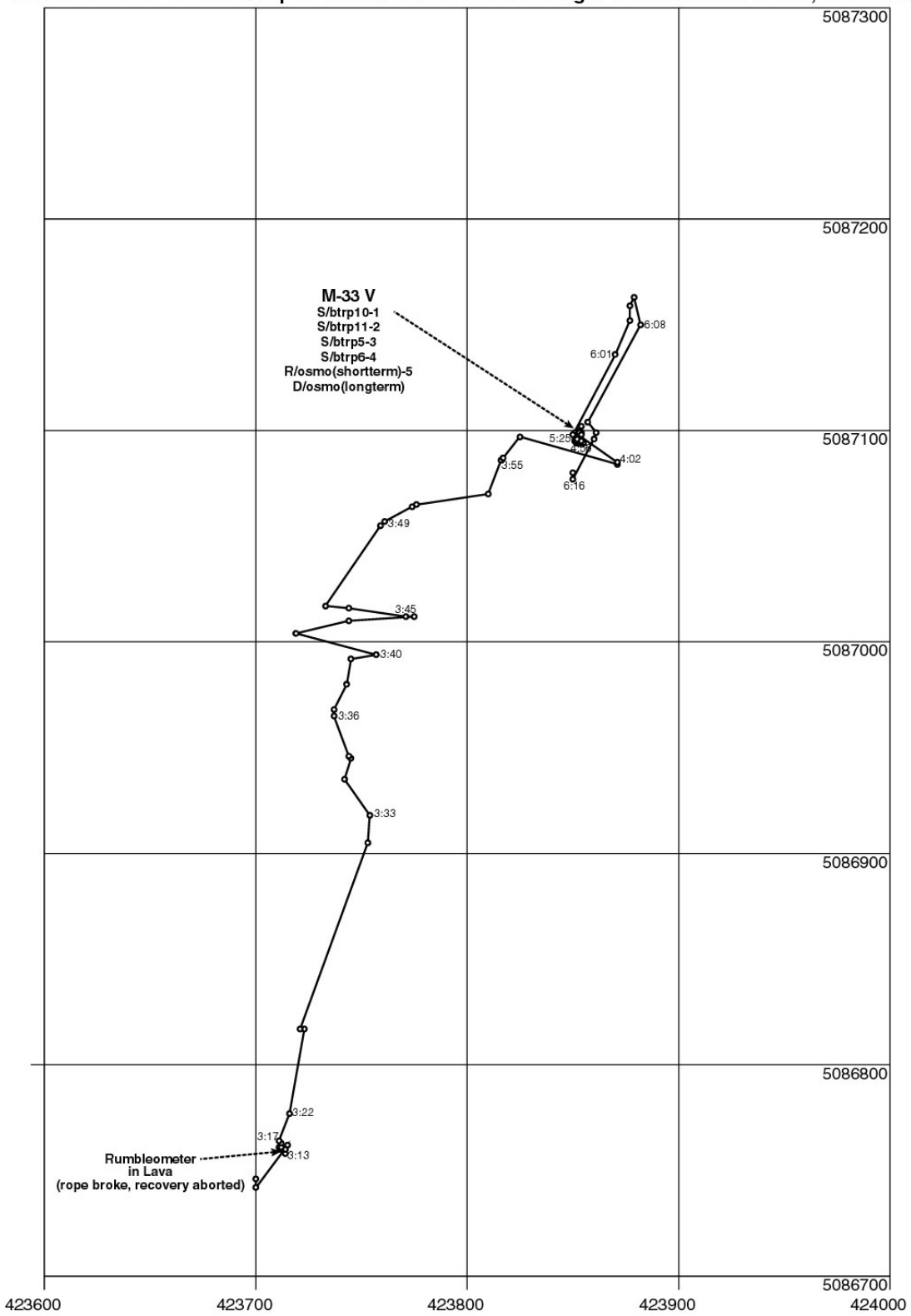
| 1933 | | | | Some problems with RGB camera displays (Lawrence Welk reruns keep coming on). We're looking at a new, glassy lobate flow where it is headed down into an older collapse area. Facing west (280). In background see a lower level of the new flow around the top of the older roof. Impression 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 | |
| 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 (JD 258)**

**SE Caldera SRZ: Failed attempt to locate water column mooring or recover rumbleometer; M-33 Vent**



# Dive R477

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):<br>Sept. 14, 1998<br><br>Date (UTM):<br>Sept. 15, 1998<br><br>Julian Day 258<br><br>Time off deck:<br>0058<br><br>Time on bottom:<br>0237 | Date (PDT):<br>Sept. 14, 1998<br><br>Date (UTM):<br>Sept. 15, 1998<br><br>Julian Day 258<br><br>Time off bottom:<br>0557<br><br>Time on deck:<br>0715<br><br>Total dive time:<br>6 hr 17 min<br><br>Total bottom time:<br>3 hr 20 min | Recover rumbleometer<br><br>Tube worm grab of new worms<br><br>Intercalibration of SUAVE with Osmosampler<br><br>SUAVE sample across the eastern contact - document transition<br><br>At Mkr 33:<br>Recover short term osmosampler and bacterial traps<br><br>Deploy long term osmosampler |

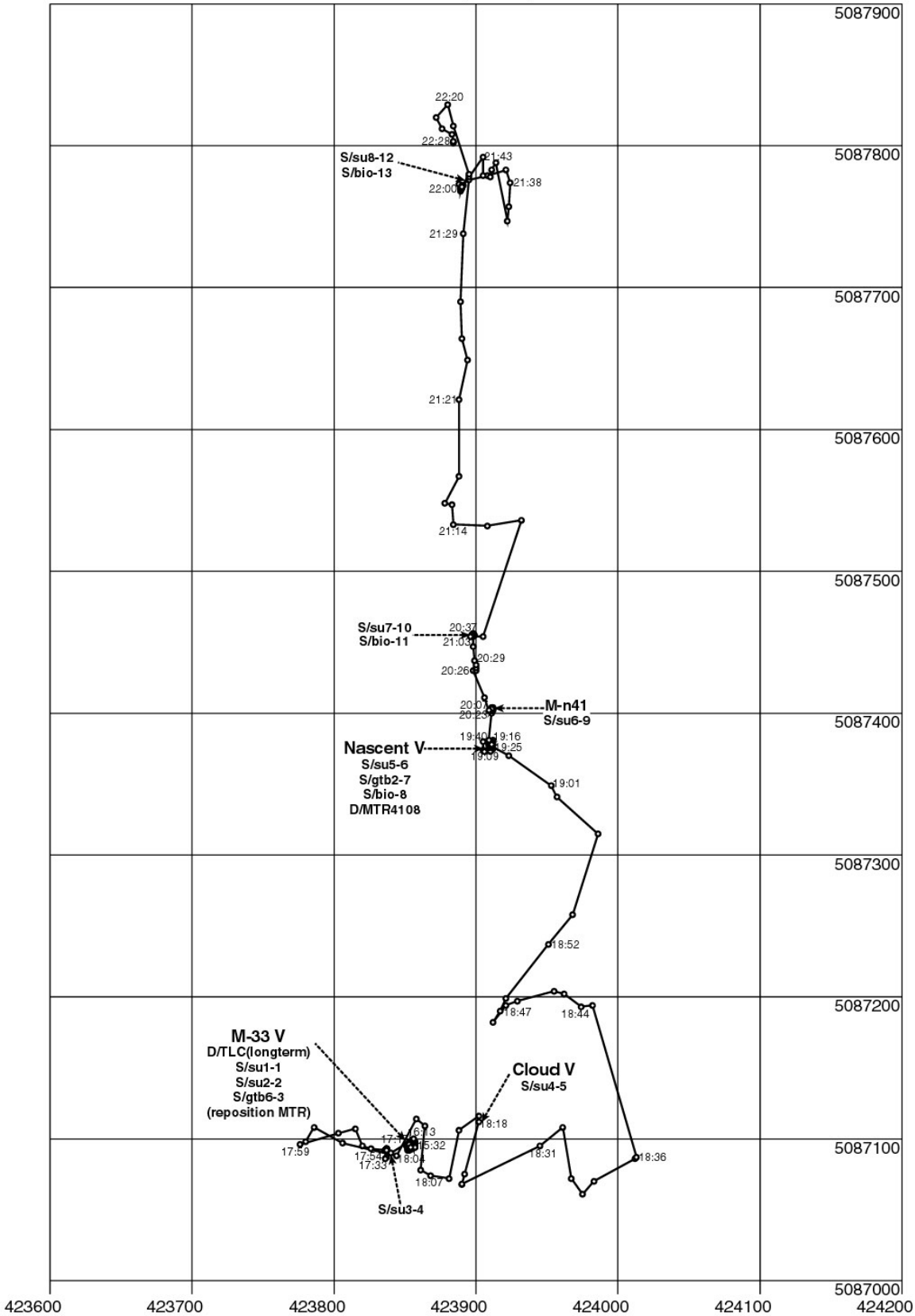
ROPOS configuration:
- Digital still camera mounted lower forward on port bumper
- Imagenex scanning sonar mounted lower inside of port bumper (~6" port of center line of sub)
- Photosea 2000S 28mm camera and strobe mounted side-by-side on upper center of bumper
- Biobox mounted lower center work area
- 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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R477 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photos 2-4<br>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<br>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**<br>R477-1 to 4 |
| 0514 | | | | Surveying site for deployment of time-lapse camera. | Photo-10<br>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**<br>R477-5 |
| 0557 | | | | Left bottom with short term OSMO sampler in the stbd claw. | |
| 0559 | | | | Stopped archive tapes | |
| | | | | ROPOS on deck. End of Dive R477. | |

# Dive R478 (JD 258)

## SE Caldera SRZ: M-33, M-n41, Cloud and Nascent Vents



## Dive R478

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):<br>Sept. 15, 1998<br><br>Date (UTM):<br>Sept 15, 1998<br><br>Julian Day 258<br><br>Time off deck:<br>1402<br><br>Time on bottom<br>1511 | Date (PDT):<br>Sept 15. 1998<br><br>Date (UTM):<br>Sept. 15, 1998<br><br>Julian Day 258<br><br>Time off bottom:<br>2240<br><br>Time on deck:<br>2351<br><br>Total dive time:<br>9 hr 49 min<br><br>Total bottom time:<br>7 hrs. 29 mins. | Deploy time lapse camera at Mkr-33<br><br>SUAVE traverses: From West of Mkr-33 East to Contact and then North along Contact to "Large Tube Worms" target.<br><br>Biosample vents at contact areas<br><br>Cook a potato in vent fluid |

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 UTM | Depth m | X-pos m | Y-pos m | Comments | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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<br>Photo-4 |
| 1605 | | | | TLC in position | Photo-5<br>FG R478-001 |
| 1617 | | | | Still fiddling with TLC; frame grab view with lasers; done with TLC | FG R478-002<br>Photo-6<br>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 17°C; photo 11 looking north along fracture | Photo-8<br>Photo-9<br>**SUAVE**<br>R478-1<br>Photo-10<br>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 42.2°C; fired gastight bottle starboard #6 | **SUAVE**<br>R478-2<br>**GTB**<br>R478-3 |
| 1713 | | | | SUAVE #2 done; repositioning MTR; max temp 3C | FG R478-004<br>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**<br>R478-4 |
| 1750 | | | | Fixed video problem by fiddling; problem again; stopped SUAVE #3; max Temp 13°C; | |
| 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<br>Photo-18<br>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**<br>R478-5 |
| 1823 | | | | SUAVE #4 done; max Temp 18.6°C | |
| 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<br>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<br><br>flatter lava, collapse | Photo-25<br>Photo-26<br>Photo-27<br>Photo-28<br>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<br>Photo-32a<br>Photo-32b |
| 1859 | 1519 | 423949 | 5087222 | Old and new lava, Hdg 14 | Photo-33<br>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,<br>**Nascent Vent**<br>Hdg 46 | Photo-36<br>Photo-37<br>FG R478-005 |
| 1910 | | | | Highlights on for 4 minutes | |
| 1915 | | | | Pullback shot of the scene<br>Sit cam Frame grab | Photo-38<br>FG R478-006 |
| 1917 | | 423910 | 5087380 | View from the other side for SUAVE #5<br>T = 24°C | FG R478-007<br>Photo-39<br>**SUAVE**<br>R478-6<br>FG R478-008 |
| 1924 | | | | GTB #2 port tripped at 24°C | **GTB**<br>R478-7 |
| 1942 | | | | Tube worm grab into starboard BioBox | **Biosample**<br>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<br>Photo-41<br>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<br>Hdg 51, we are a couple of meters east of the marker | Photo-44<br>FG R478-009<br>**SUAVE**<br>R478-9 |
| 2024 | | | | Going North...~300 meters | |
| 2026 | | | | Light and cheesy orange deposit | Photo-45 |
| 2027 | 1518 | 423902 | 5087431 | Hdg 356 | |

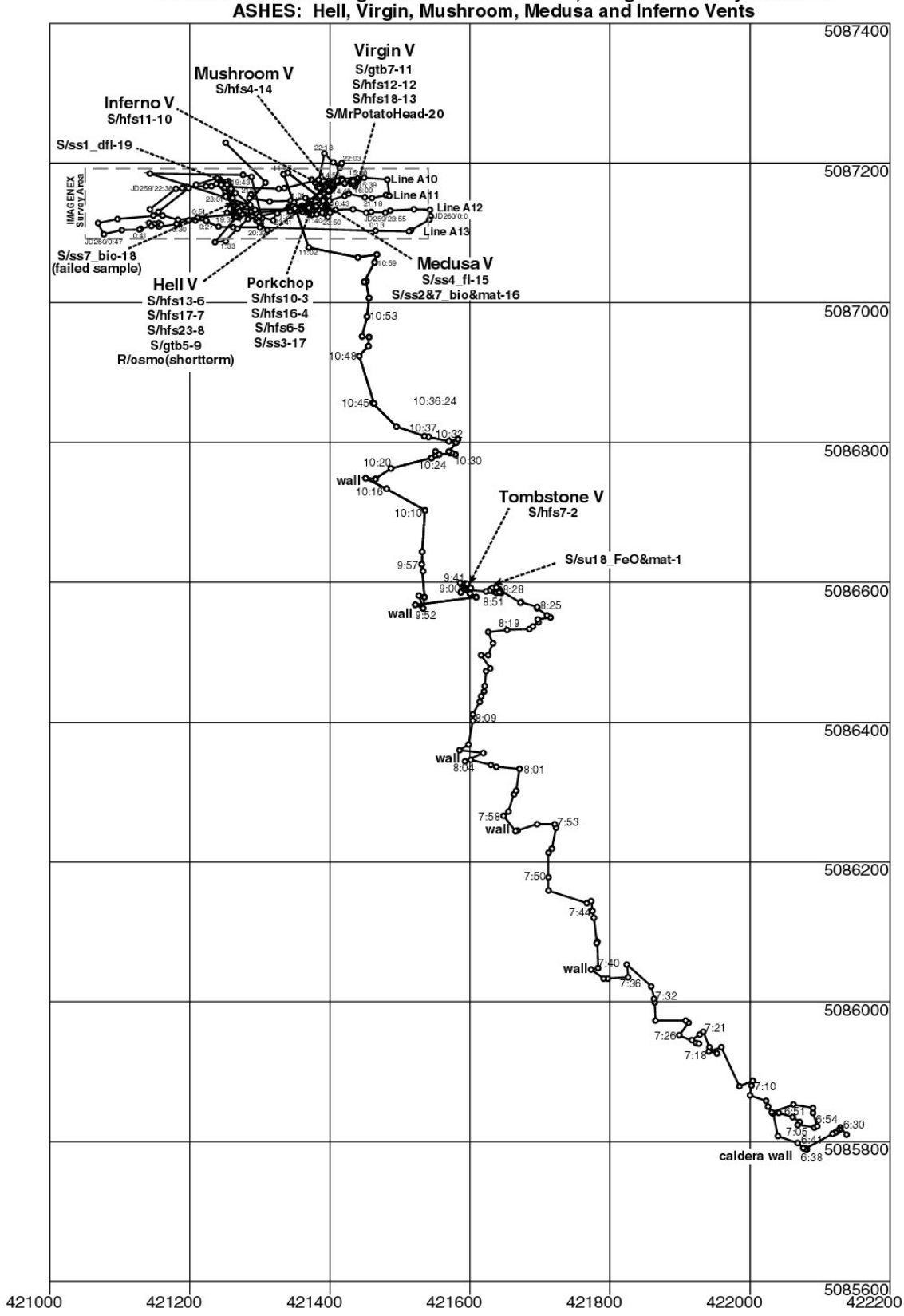
| | | | | | |
|---|---|---|---|---|---|
| 2031 | 1519 | 423898 | 5087447 | More worms | Photo-46<br>Photo-47<br>Photo-48 |
| 2036 | 1520 | 423897 | 5087455 | SUAVE #7 scan at hole near old tube worms at old flow ~50 meters North of **Mkr-N41** Hdg 285, tons of limpets, Max Temp = 9.5 deg C in the hole | **SUAVE**<br>R 478-10<br>Photo-49<br>FG R478-010 |
| 2052 | | | | Tube worm grab from next to the SUAVE hole to port BioBox | **Biosample**<br>R478-11 |
| 2058 | | | | Crab, *Munidopsis alvisca* | FG R478-011<br>FG R478-012 |
| 2100 | | | | 2 more crabs while looking around<br>to scan the area | Photo-50<br>Photo-51<br>Photo-52<br>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????<br>Contact | Photo-57<br>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<br>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<br>Photo-65 |
| 2132 | | | | **Mkr-N7** sighted, surprise surprise surprise | Photo-66 |
| 2134 | | | | Collapsed pit | Photo-67<br>Photo-68<br>Photo-69<br>Photo-70<br>Photo-71<br>Photo-72<br>Photo-73<br>Photo-74 |
| 2138 | 1518 | 423921 | 5087775 | Hdg 188. The canyon | FG R478-013 |
| 2141 | | | | Starfish | |
| 2146 | | | | Big mess of tube worms | Photo-75<br>Photo-76 |
| 2149 | | | | Very close to **Mkr-N7**, SUAVE #8 at big tube worm site max T = 16°C | **SUAVE**<br>R478-12<br>FG R478-014<br>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**<br>R478-13 |
| 2211 | | | | Hdg North, tube worm clumps | Photo-77 |

| | | | | | |
|---|---|---|---|---|---|
| 2212 | | | | Older lavas and tube worm clumps | Photo-78<br>Photo-79<br>Photo-80 |
| 2213 | | | | Older lobate lavas | |
| 2214 | | | | Clams and a few tube worms | Photo-81<br>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<br>Photo-84<br>Photo-85<br>Photo-86<br>Photo-87 |
| 2221 | | | | FG of contact | FG R478-017 |
| 2224 | | | | Lots of clams and small tube worm clumps, crab eating the clams | Photo-88<br>Photo-89<br>Photo-90<br>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<br>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<br>FG R478-020 |
| 1651 | | | | ROPOS on deck | |

# Dive R479 (JD 259 - 260)

## Northern Traverse along Caldera Wall to ASHES; Imagenex Survey at ASHES

## ASHES: Hell, Virgin, Mushroom, Medusa and Inferno Vents



## Dive R479

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 |
|---|---|---|---|
| Axial Seamount<br><br>ASHES Vent field, the Wall, and South of ASHES | Date (PDT):<br>Sept. 16, 1998<br><br>Date (UTM):<br>Sept. 16, 1998<br><br>Julian Day 259<br><br>Time off deck:<br>0454<br><br>Time on bottom:<br>0624 | Date (PDT):<br>Sept. 16, 1998<br><br>Date (UTM):<br>Sept. 17, 1998<br><br>Julian Day 260<br><br>Time off bottom:<br>0124<br><br>Time on deck:<br>0300<br><br>Total dive time:<br>21 hr 54 min<br><br>Total bottom time:<br>19 hrs 00 min | Exploration south of ASHES<br><br>HFS of high temperature vents at ASHES<br><br>Imagenex survey of ASHES locale<br><br>Recover Osmosampler |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R479 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 0454 | | | | ROPOS launched<br>Tested HFS just below the surface | |
| 0612 | 1468 | 422153 | 5085852 | Strong particulate plume | |
| 0624 | 1543 | | | On bottom; not moving<br>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<br>Photo-2 |
| 0639 | | | | Proceeding hdg 288 along wall; lava lapping up against wall | Photo-3<br>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 (cf Staurocalyptus) | FG R478-001 |
| 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<br>Photo-12<br>Photo-13 |
| 0711 | 1542 | 422007 | 5085897 | Lobate flow with little sediment cover;<br>sponges on the rocks. These are small sponges only a couple of cm high. | Photo-14<br>Photo-15 |
| 0716 | 1543 | 421959 | 5085935 | More sediment; some orange-yellow sediment between cracks, more floc in water, small sponges on the bottom,<br>nice pillows | Photo-16<br>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<br>Photo-20 |
| 0738 | 1544 | | | More sediment, lots around the base of lobes, sediments are hydrothermal in origin | Photo-21<br>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<br>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<br>Photo-26<br>Photo-27 |
| 0752 | 1545 | 421720 | 5086206 | More red staining near the edge of a collapse, pillows | Photo-28<br>Photo-29 |
| 0753 | 1546 | 421721 | 5086254 | Sheet flow, with lots of sediment coverage (~ 60%) | Photo-30<br>Photo-31<br>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<br>Photo-34<br>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<br>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<br>Photo-41<br>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<br>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<br>Photo-47<br>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<br>Photo-50<br>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 24°C and T2 was 13°C, 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<br>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<br>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<br>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<br>Photo-62<br>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<br>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<br>Photo-70<br>Photo-71<br>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 | |

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|---|---|---|---|---|---|
| 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<br>FG R479-005<br>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, $T_{max}$ = 48°C | |
| 1131 | | 421373 | 5087132 | Piston Sample #10, $T_{max}$ = 26°C, at **Porkchop** | **HFS**<br>R479-3 |
| 1139 | | | | Sample tip out of hot water | |
| 1142 | | | | Sampling again, same location,<br>$T_{max}$ = 51°C | |
| 1150 | | | | Filter #16, same location as above, $T_{ave}$ = 30 deg C, about 1L, 8 cycles | **HFS**<br>R479-4 |
| 1202 | | | | Sample Bag/Filter combo #6, $T_{ave}$= 23°C but varying greatly, same location as above | **HFS**<br>R479-5 |
| 1210 | | | | End fluid sampling, begin temp sampling for Juniper | |
| 1212 | | | | $T_{max}$ = 12.5°C, the middle of the colony | |
| 1214 | | | | $T_{max}$ = 17.5°C, leading edge of the colony | |
| 1216 | | | | Moving a few meters north, 2m | |
| 1220 | | | | Tube worm colonies, some diffuse flow | |
| 1225 | 1546 | 421370 | 5087141 | $T_{max}$ = 4.7°C, 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<br>FG R479-009 |
| 1234 | | | | Temp sampling top of **Hell** vent; $T_{max}$ =134°C | |
| 1238 | | | | Reposition sample tip. $T_{max}$ = 225°C | |
| 1246 | | | | Still at top of smoker at top of **Hell**; $T_{max}$=137°C, temp varying due to narrow stream of vigorous flow. | FG R479-010<br>FG R479-011 |
| 1253 | 1542 | 421368 | 5087137 | Sampling temp from smoker, chalcopyrite; $T_{max}$ = 270°C | |
| | | | | | |
| 1305 | | | | Piston #13, $T_{max}$ = 270°C, 42°C on the back probe. Top of Hell. Sample fluid smoker out of red chalcopyrite. Sample appears to be cloudy. | **HFS**<br>R479-6 |
| 1315 | | | | Filter #17, same place as above, $T_{max}$ =270°C, about 400mL, 3 cycles | **HFS**<br>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, $T_{max}$ = 294°C, T2 58°C, Hell vent, Hdg 085, slightly lower on chimney, west side | **HFS**<br>R479-8 |
| 1340 | | | | Gastight sample, portside, GTB #5; $T_{max}$ = 293°C, same location at R479-8 | **GTB**<br>R479-9 |
| 1353 | | | | Add one more cycle to filter #17 | |

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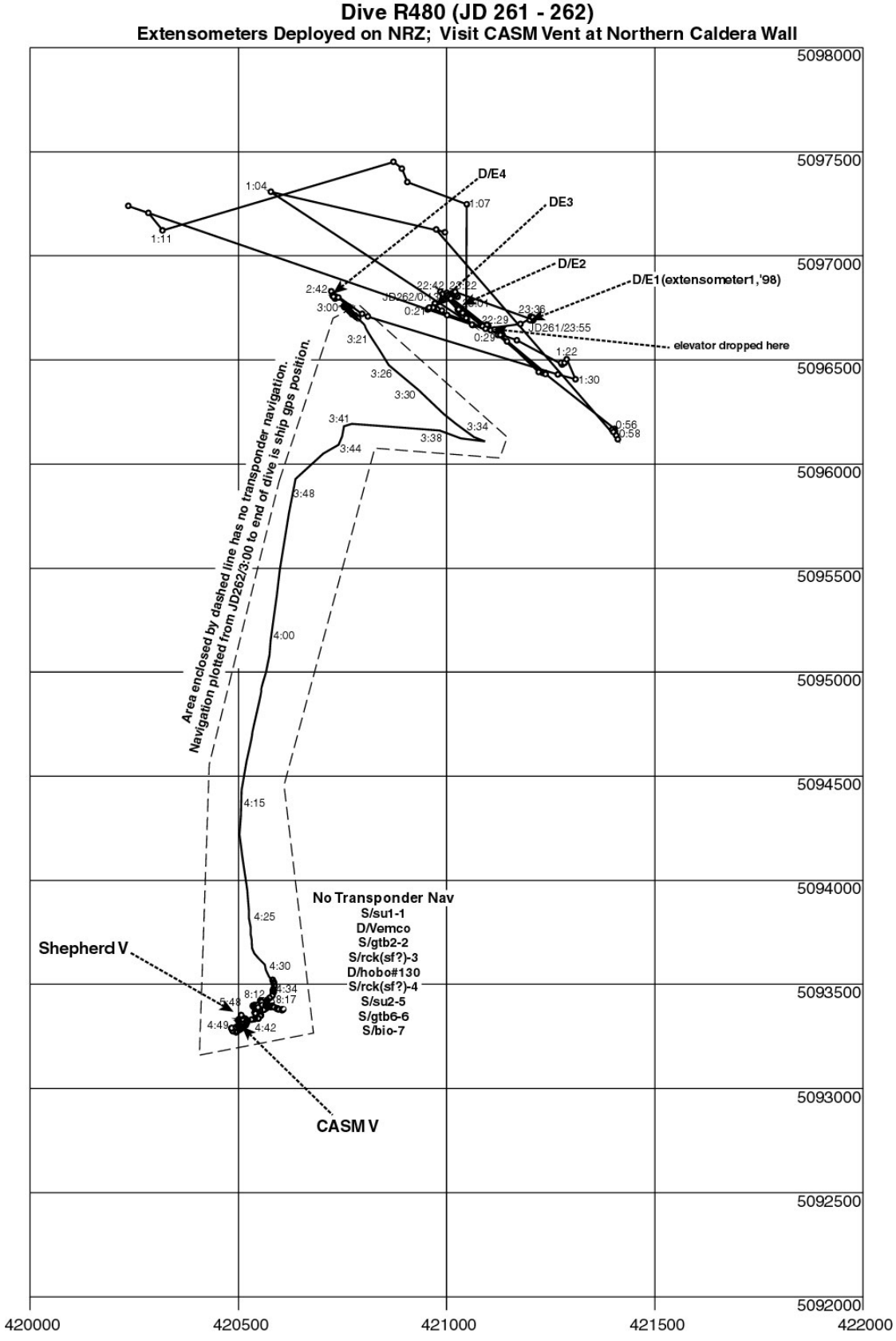
|---|---|---|---|---|---|
| 1353 | | | | Mr. Potato Head, probe and chimney | FG R479-013<br>FG R479-014<br>FG R479-015 |
| 1358 | | | | Heading to **Inferno**, hdg 067 | |
| 1359 | | 421388 | 5087163 | **Inferno**, see hobo temp probe | |
| 1402 | | | | Vigorous flow | Photo-78 |
| 1410 | | 421393 | 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) $T_{max}$ = 291°C | |
| 1425 | 1543 | | | Mr. Potato Head at **Inferno**. | FG R479-016 |
| 1439 | 1543 | | | Piston #11, Inferno, Hdg 246, near top, facing SW max. $T_{max}$ = 291°C, 13 deg on the back probe (T2). | **HFS**<br>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<br>Photo-80 |
| 1535 | 1546 | " | " | Knocked over chimney of **Virgin Mound**! Still probing Temp; Max Temp 261°C; Firing Starboard GTB #7; Filling Piston #12 | FG R479-018<br>**GTB**<br>R479-11<br>**HFS**<br>R479-12<br>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<br>Photo-82<br>Photo-83 |
| 1613 | 1546 | | | Taking background ASHES filter set #18 as we move about | FG R479-020<br>**HFS**<br>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 179°C; knocked off chimney structure | **HFS**<br>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<br>Photo-89<br>Photo-90<br>Photo-91 |
| 1657 | 1545 | | | Rattail fish; camera stopped- battery died probably | Photo-92 |
| 1700 | 1546 | | | Still looking | Photo-93<br>Photo-94 |
| 1702 | 1546 | 421394 | 5087138 | At **Medusa**; positioning for suction sampling; suction sample bottle #4 diffuse flow at **Medusa** | Photo-95<br>**Suction sample**<br>R479-15 |
| 1710 | 1546 | " | " | Suction sample bottle #2 and #7 of sulfide and palm worms and white mat | **Suction**<br>R479-16 |
| 1808 | 1547 | 421375 | 5087135 | At **Hell** to sample sulfide worms from **Porkchop**; Suction Bottles #3 | **Suction sample**<br>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<br>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<br>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<br>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<br>JD 260 | 1525 | 421362 | 5087107 | Positioning to start A13 | |
| 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 (JD 261 - 262)
Extensometers Deployed on NRZ; Visit CASM Vent at Northern Caldera Wall
D/E4
DE3
D/E2
D/E1(extensometer1,'98)
elevator dropped here
JD261/23:55
Area enclosed by dashed line has no transponder navigation.
Navigation plotted from JD262/3:00 to end of dive is ship gps position.
No Transponder Nav
S/su1-1
D/Vemco
S/gtb2-2
S/rck(sf?)-3
D/hobo#130
S/rck(sf?)-4
S/su2-5
S/gtb6-6
S/bio-7
Shepherd V
CASM V
5098000
5097500
5097000
5096500
5096000
5095500
5095000
5094500
5094000
5093500
5093000
5092500
5092000
420000
420500
421000
421500
422000

# Dive R480

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 |
|---|---|---|---|
| Axial Seamount<br><br>North rift | Date (PDT):<br>Sept. 18, 1998<br><br>Date (UTM):<br>Sept. 18, 1998<br><br>Julian Day 261<br><br>Time off deck:<br>2111<br><br>Time on bottom:<br>2230 | Date (PDT):<br>Sept. 19, 1998<br><br>Date (UTM):<br>Sept. 19, 1998<br><br>Julian Day 262<br><br>Time off bottom:<br>0815<br><br>Time on deck:<br>0930<br><br>Total dive time:<br>12 hr 19 min<br><br>Total bottom time:<br>9 hrs. 45 mins. | Deploy extensometers across north rift<br><br>Imagenex survey of the deployment area<br><br>Reconnaissance survey of CASM site (discovered August 1983) |

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 UTM | Depth m | X-pos m | Y-pos m | Comments – Dive R480 | Frame grabs, photos and samples |
|---|---|---|---|---|---|
| 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. | |

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|---|---|---|---|---|---|
| 2235 | 1585 | 421094 | 5096669 | Good ROPOS fix; getting ready to take Extensometers out of elevator. E2 | FG R480-001<br>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<br>FG R480-002<br>FG R480-003 |
| 2259 | 1592 | 421026 | 5096739 | **Deployed E2 -** in jumbled flow, hdg 353 | Photo-4<br>Photo-5<br>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<br>Photo-7<br>Photo-8<br>FG R480-008<br>FG R480-009 |
| 2353 | 1574 | | | Heading back to the elevator | |
| 2357 | | | | At the elevator, pulling out E3, hdg 299 to E3 deployment site | |
| 0001 Julian day 262 | 1580 | | | Momentarily lost E3, dropped it when we were ~10m above floor | |
| 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<br>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<br>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<br>Photo-10<br>FG R480-14<br>FG R480-15 |
| 0254 | | | | Heading back to the cage | |
| 0258 | | NO NAV FOR REST OF DIVE | | Cage and ROPOS moving up to 1400 in order to traverse to CASM | |
| 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.<br><br>Max. T on SUAVE of 7°C but sensor not right into the dense cluster of palm worms. | Photo 17-21<br>FGs<br>R480-016<br>R480-017<br>R480-018<br>R480-019<br>R480-020<br>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<br>FG R480-022 |
| 0548 | 1573 | | | Back to bottom. | |
| 0552 | 1575 | | | Active sulfide chimneys. Palm worms, a few tube worms, bag creature. Named **T & S Spires** (after Keith Shepherd's children Trevor and Sarah) | Photos 34-39<br>FGs<br>R480-023<br>R480-024<br>R480-025 |
| 0603 | 1585 | | | SUAVE #1 Max T = 42°C<br>$H_2S$ 232 µm, Mn 73 µm, Fe >91 µm<br><br>Port side gas tight bottle #2<br><br>Hdg 301 | FGs<br>R480-026<br>R480-027<br>R480-028<br>R480-029<br>Photo-40<br>**SUAVE**<br>R480-1<br>**GTB**<br>R480-2 |
| 0611 | | | | SUAVE scan finished | |

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| 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.<br>Hdg 301 | FGs<br>R480-030<br>R480-031 |
| 0628 | 1582 | | | Surveying **T & S** Spires<br><br>FG 480-033 of sampled chimney. It is ~3m high.<br><br>Attempted to sample large active chimney on **T & S**. Most didn't make it into the BioBox. | Photo 41-51<br>FG<br>R480-032<br>R480-033<br>R480-034<br>**Sulfide**<br>R480-3 |
| 0630 | | | | Changed archive tapes | |
| 0658 | | | | Deployed HOBO #130 temperature recorder into stump of active chimney.<br>Hdg 301 | Photos 52-55<br>FGs<br>R480-035<br>R480-036<br>R480-037 |
| 0701 | | | | Photos of VEMCO and HOBO probes | Photos 56-58<br>FG<br>R480-038<br>R480-039 |
| 0703 | 1585 | | | Chimney sample almost filled the port side of the bio box (silica rich) | **Sulfide**<br>R480-4<br>Photo 59 |
| 0708 | | | | Moving down the lane through the little canyon, crabs, lots of worms, | Photo 60-63<br>FG<br>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<br>R480-041 |
| 0727 | 1583 | | | Suave the tube worms<br>Stop the highlights | **Suave**<br>R480-5<br>FG<br>R480-042<br>Photo-71-73 |
| 0732 | 1583 | | | Starboard gas tight #6<br>Highlight tape on.<br>Still SUAVEing, stopped at 0738<br>max Temp 20.3ºC, H2S 177 uM, Mn 40.5 uM, Fe 86 uM;<br>Stop highlights | **Gas Tight**<br>R480-6<br>FG R480-043<br>FGR480-044 |
| 0739 | 1583 | | | Collecting tube worms from the site that was just scanned, bubbles in the water,<br>Highlights on and off, | **Tube worms**<br>R480-7 |
| 0740 | | | | Bubbles | FG<br>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 |

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| 0756 | | | | Done sampling the worms.<br>Highlights of the bubbles.<br>Taking more worms from the same place and putting them in the starboard side of the bio box. Same sample as the previous one.<br>Sample finished at 0803 | Photo-75 |
| 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<br>FG R480-046FG<br>R480-047 |
| 0814 | | | | At marker and an active chimney, heading 0 (North), more chimneys but mostly dead. | Photo 80-8?, lots of photos<br>FG R480-048 |
| 0815 | | | | Now we are off the bottom, to the cage. | |
| 0930 | | | | ROPOS on deck for final time | |