CHADWICK

GEOCHEMICAL, GEOLOGIC & BIOLOGIC TIME-SERIES INVESTIGATIONS AT THE 1993 COAXIAL & THE 1980s NORTH CLEFT ERUPTION SITES JUAN DE FUCA RIDGE

ATLANTIS II / ALVIN EXPEDITION
CRUISE # 132-09
JUNE 24 - JULY 9, 1995
ASTORIA, OREGON - ASTORIA, OREGON

COMPILED BY
JULIA E. R. GETSIV &
ROBERT W. EMBLEY

TABLE OF CONTENTS

LOCATION MAP 2
CRUISE OVERVIEW 3
OPERATIONS SUMMARY 16
VENTS/MARKERS TABLE 18
I. **COAXIAL SEGMENT** 21
COMPOSITE DIVE MAPS 22
ALVIN DIVE SUMMARIES 26
SAMPLE NOMENCLATURE 37
DIVE STATIONS - SAMPLES/MARKERS 38
INDIVIDUAL DIVE PLOTS 41
II. **NORTHERN CLEFT SEGMENT** 49
COMPOSITE DIVE MAP 50
ALVIN DIVE SUMMARIES 51
DIVE STATIONS - SAMPLES/MARKERS 58
INDIVIDUAL DIVE PLOTS 60
III. **AXIAL VOLCANO** 65
DIVE MAP 66
ALVIN DIVE SUMMARY 67
DIVE STATIONS - SAMPLES/MARKERS 69
INDIVIDUAL DIVE PLOT 70
IV. **NIGHT OPERATIONS** 71
MAP OF ROCK CORE & DREDGE SITES 73

Contact Information for data inquiries:
Julia E. R. Getsiv: getsiv@pmel.noaa.gov
Robert W. Embley: embley@pmel.noaa.gov

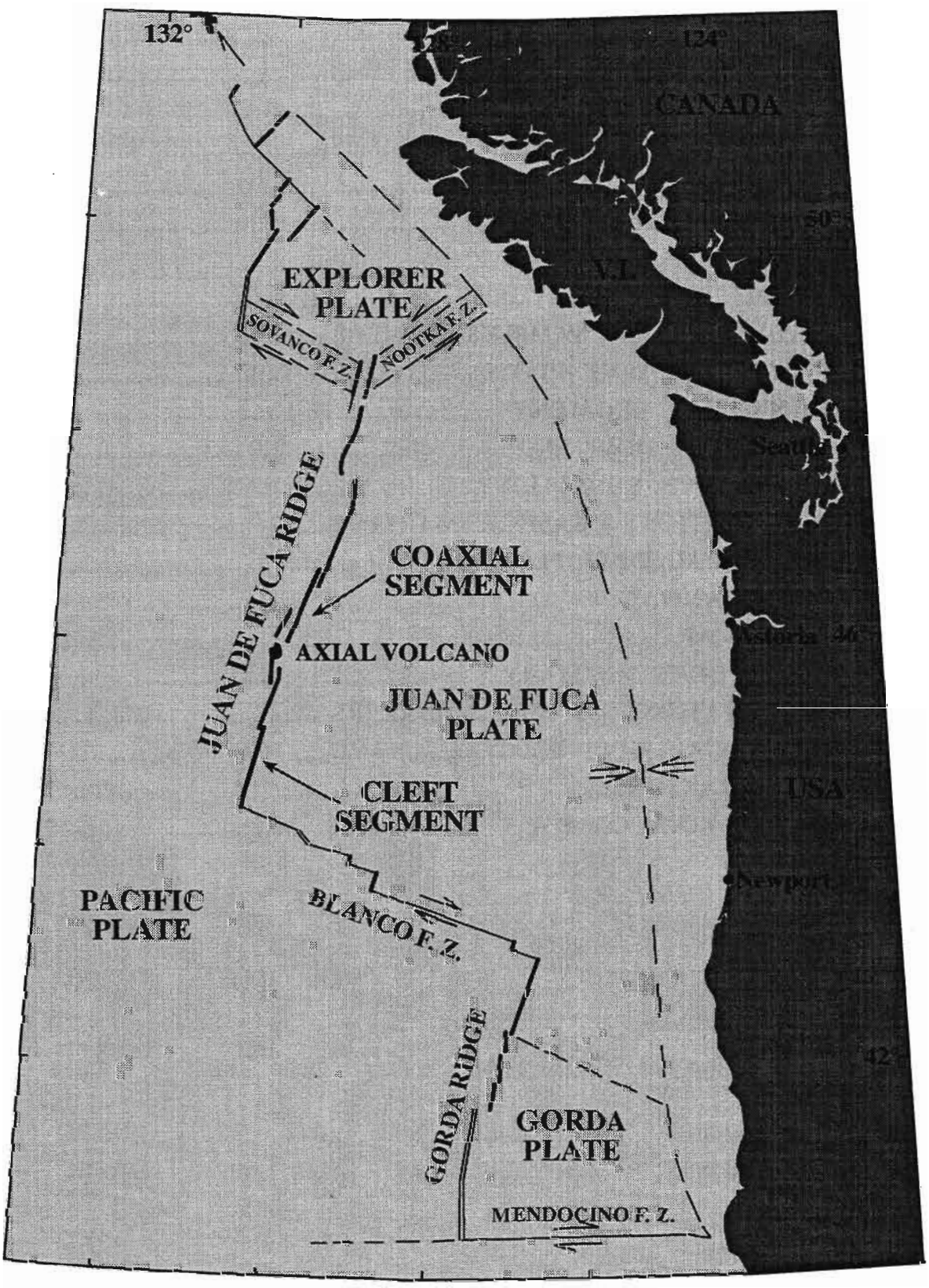

132°
124°
CANADA
50°
V.I.
EXPLORER
PLATE
SOVANCO F. Z.
NOOTKA F. Z.
JUAN DE FUCA RIDGE
COAXIAL
SEGMENT
AXIAL VOLCANO
JUAN DE FUCA
PLATE
CLEFT
SEGMENT
PACIFIC
PLATE
BLANCO F. Z.
GORDA RIDGE
GORDA
PLATE
MENDOCINO F. Z.
Seattle
Astoria
46°
USA
Newport
42°

Figure 1

A. OVERVIEW

The Atlantis II left Astoria, Oregon on June 24, 1995 and returned to Astoria, Oregon on 9 July after completing 13 Alvin dives (the 13th dive, 2952, was an engineering dive). The cruise combined 10 dives sponsored by the NOAA Undersea Research Program (with Principal Investigators from the NOAA VENTS program, the University of Florida, the Geological Survey of Canada, and the University of Washington) with 2 dives sponsored by NSF (Margaret Tivey of Woods Hole Oceanographic Institution as PI). This was the third in a series of NOAA/NSF Alvin dive programs to conduct multi-disciplinary time-series investigations at the CoAxial Segment of the Juan de Fuca Ridge where a volcanic eruption occurred in June-July of 1993. Unexpected problems with the VENTS mooring program (realized on the DISCOVERER cruise preceding the ALVIN program) diverted two dives to the northern Cleft segment. The major impact of this on the original dive program was to cancel the two dives at the East Blanco Depression. Fortunately, however, no dives were lost to weather or other problems, so that we able to accomplish all our goals at the CoAxial segment and to conduct one dive at the ASHES vent field on Axial Volcano. In summary, there were seven dives on the CoAxial Segment (Fig. 1), one dive at the ASHES vent field on Axial Volcano (Fig. 1) and four dives at the northern Cleft Segment (including the two NSF-funded dives) (Fig. 1).

B. SITE SUMMARIES

I. COAXIAL SEGMENT

Lava Flow Site--Background

The CoAxial Segment (Fig. 2) had a well-documented dike injection and eruption episode in June-July of 1993 which was detected and monitored by the NOAA/Navy real-time T-wave monitoring system. Two "event plumes" were found over the axial valley centered around 46°30'N where the T-waves had concentrated during the latter part of the episode. This site (which subsequently was known as the Flow site) became the target for dives with the Canadian remotely operated vehicle ROPOS off the NOAA R/V DISCOVERER in mid-July, 1993, during which a fresh, venting lava flow 2.5 km long was discovered, mapped and sampled (Fig 2). The lava flow was erupted on a ridge just north of an older volcano cone on the median volcanic ridge. Extensive venting was also found southward from the cone for about 4 km along a fracture system that is along an extension of the trend of the lava flow. ROPOS recovered rock samples, some water samples, and took temperature measurements. Subsequent NSF/NOAA Alvin dives in October, 1993 recovered several high quality vent fluid samples and left prominent markers at the sample sites. A magnetics and gravity survey was also conducted at the Flow site during the October dive series (P. Johnson, M. Tivey, and M. Holmes P.I.s). ALVIN dives conducted in July, 1994 by NOAA and dives with the submersible DSV TURTLE and the U.S. Navy remotely operated vehicle ATV in September, 1994 (P. Johnson, P.I.) revealed that the site had almost ceased venting. A water column survey conducted by the NOAA ship DISCOVERER in June, 1995 did not detect any hydrothermal plumes over this site. No new observations or samples were taken during the 1995 program. However, no active venting was observed on several dives made at this site in August-September, 1995 during an NSF-funded ALVIN dive program led by P. Johnson.

Lava Flow Site--1995

Dive 2940 was made to recover the NOAA Extensometer array that was deployed about 1 km south of the 1993 lava flow (Fig. 3). This array was deployed in September of 1994 from the DISCOVERER, but failed to surface during the planned recovery in May, 1995. Unfortunately, ALVIN's thruster entrained some of the line from one of the extensometer instruments during Dive 2940, and the dive had to be aborted and only two of the five instruments were recovered.

Fortunately, the ALVIN group decided to make an engineering dive on the extra day at the end of Leg IX and the rest of the package was released by ALVIN and recovered by the ATLANTIS II.

Floc Site--Background

In the latter part of the 1993 DISCOVERER cruise, ROPOS discovered large quantities of white floc (thought to be bacterial in origin) in the water column and on the seafloor centered around 46°19'N (Fig. 4). In September of 1993, a Scripps Institution of Oceanography expedition on R/V Melville conducted Deep-tow side scan and CTD operations in this area and discovered seafloor temperature anomalies at 46°18'N. Night time CTDT/chemical surveys off the AII in October of 1993 found very intense attenuation and high-methane plumes over the site and ALVIN dives discovered several zones of diffuse venting associated with high bacterial production along a fissure zone that cuts through older pillows and sheet flow lavas between approximately 46°17'N and 46°19.5'N. This area became known as the "Floc" site (Fig. 3). The biological system was, at that time, characterized entirely by prodigious bacterial productivity, including areas that emitted clouds of large-diameter floc particles that became known as "snowblower" vents. Such intense bacterial productivity had been observed previously in 1991 at 9°N on the East Pacific Rise and at the north Cleft site in the late 1980s. A time-lapse camera and temperature probe was emplaced at one of the sites (R. McDuff, PI), several vent fluid and biological samples were recovered, and markers were left at several of the vent sites.

In 1994, CTDT tows revealed continued strong attenuation anomalies at the Floc site. However, the plumes had a reduced rise height compared to 1993, suggesting a decrease in total heat flux. Dives 2789, 2791, and 2793 resurveyed and resampled about 2.5 km of the hydrothermally active fissure zone visited on the three dives made during the 1993 NSF/NOAA Event Response cruise. At that time, there were extensive bacterial mats along the fissure and floccular clouds being released. In 1994, the apparent mean temperature of the system appeared to have significantly decreased and there was a qualitative decrease in the production of floc (observed both in the plume data and on the seafloor) and venting flux along part of the system (Marker 3A and north). At the same time, the biological community over a section of the fissure had persevered and matured, with small tubeworms colonizing the walls of the fissure amongst the ubiquitous bacterial mats. A small area within an intensive diffuse venting section along the fissure south of the Marker 3A site was chosen as a site for long-term chemical and biologic time series studies. Dive 2791 carried out careful video/camera and SUAVE chemical scanner surveys at this site and left two markers (2 and 6). About 1 km north at the Marker 11 site, a U. Wash. time lapse-camera and a temperature probe package deployed in October, 1993, was recovered on the 1994 dive series.

It was clear from the plume surveys in 1993 and 1994 that venting at the Floc site extended along axis from about 46 17'N to 46 19'N. However, due to the limited number of dives available, the 1993 and 1994 dive programs only covered the northern 2 km of the zone along which the plume temperature and attenuation anomalies were at a maximum. In August, 1994, the NOAA Ship DISCOVERER conducted towed camera surveys over this area. Several additional venting sites were found along the southward extension of the active fissure swarm at the Floc site between 46°16'N and 46°18'N. Another intriguing result from the camera surveys was the discovery of a series of young pillow lava mounds along a ridge lying about 500 m west of the hydrothermally active fissure swarm. The mounds were found between 46°15.5'N and 46°21'N. A comparison of the original 1981 Sea Beam survey with the 1991 survey revealed a small but significant difference anomaly between 46°17'N and 46°18'N which correlated with the young flows seen on the camera tows. The new area of venting and the young lava flows discovered on the 1994 camera tows became high priority targets for the 1995 dives.

The Floc Site--1995

Five dives were made at the Floc site between latitudes 46°17'N and 46°19'N (2946, 2947, 2948, 2949, and 2951) (Fig. 4). Dive 2946 visited two marker sites (Markers 11 and 3A) that had been sampled in 1993 and 1994. Both of these sites revealed a significant decrease of venting. The Marker 11 site, which had been the site of a "snowblower" vent (venting large particles of bacterial debris) in 1993 and was still venting in 1994, had significantly diminished in 1995. The temperature of the venting fluid was less than a degree above ambient. Marker 3A was still venting at one spot, but the venting had ceased at the original site. The marker 10 site, which lies about 700 m southeast of Marker 3A, also had significantly reduced venting and a temperature barely above ambient.

The Floc area has two known centers of significant venting remaining. One lies about 100 m south of Marker 3A at the HDV site (Huge Diffuse Vent) where a lush biological system is now in place and diffuse vent fluids are exiting at a temperature up to about 17°C. The University of Washington time lapse temperature probe was placed at this site (for a year-long deployment). The other site lies about 2 km south of Marker 10 at 46°17.2'S. This site was found during the 1994 camera survey and was visited for the first time on Dives 2948 and 2949. Extensive bacterial mats were found coating portions of the west wall of a large fissure over several hundreds of meters. Some portions of the mat were covered with a large population of Nemertean worms (a new genus and possibly a new family of this phylum). These were first found last year at the northern Floc site and may represent one of the first macrofaunal colonizers of hydrothermal vents on the Juan de Fuca Ridge. A few small (juvenile) tubeworms were also found at this site.

In summary, the hydrothermal system at the Floc site is continuing to change. The overall impression is that the venting has contracted to two main sites separated by about 2 km distance, but this conclusion is based on very limited mapping of the site. In any case, there have been major changes in the biological system. Tubeworms have become well-established at the northern location (HDV site). On the other hand, the southern site appears to be at the stage that the northern one was last year.

Several of the young lava mounds at the Floc site were visited on Dives 2948 and 2951 (see dive summaries for details). Chemical analysis of these samples taken on these dives will be valuable in determining the relationships between the young eruptions along the CoAxial Segment.

The Source Site

There are four major vents (two of these, Beard and Church, were discovered in 1993) and a number of minor ones situated over about 100 m along a west-facing scarp at a depth of about 2262 m (Fig. 5). The scarp bisects a constructional pillow lava ridge on the west side of the narrow axial valley. Smaller chimneys occur on the slope beneath the major vents and appear to line up at oblique angles to the primary fracture system (which is at about 030°). The fluids (up to 294°C) are metal poor, almost smokeless, and are currently forming anhydrite with some polymetallic sulfides.

All the vents at the Source Site sampled to date discharge clear fluids in the 223°C to 294°C temperature range. Observations and measurements made on Dive 2946 at the Source site indicate that no apparent significant changes in chemistry have occurred at this site since its discovery in 1993.

II. CLEFT SEGMENT

1. Summary of thermocouple/thermistor array experiment, Monolith and Table Vents, Cleft Segment, Juan de Fuca Ridge

(NSF Project--M.K. Tivey and A.M. Bradley Pis, WHOI)

Two temperature monitoring instrument packages, deployed on August 6, 1994, were recovered from the Monolith and Table vent sites (northern Cleft Segment, Fig. 6) during 2 dives on June 27 and June 30, 1995. One instrument package had been placed at the B marker at the base of the northeast side of Monolith vent; a thermistor array (cluster of 20 closely spaced thermistors on a tripod stand) had been left in diffuse flow, and a stainless steel ring containing 18 closely spaced thermocouples (a TC loop) had been placed over an excavated beehive structure. The second instrument package had been left at the south side of Table vent; a TC loop had been positioned over a linear group of 280°C smokers venting clear fluid, and a thermistor array tripod had been left nearby in an area of lower temperature diffuse flow. Each instrument package consists of a datalogger with cables leading to the discrete thermocouple or thermistor modules. The year-long deployment was used both as a test of the instrument design and as an opportunity to monitor temperature every minute simultaneously at four separate spots within a vent area.

The two dataloggers and one thermistor tripod were recovered during the first dive (ALV2941), and the other thermistor tripod and TC loops were recovered during the second dive (ALV2944). The dataloggers successfully recorded information once per minute for 6 months from each of the deployed arrays. As anticipated, a smoker had grown inside the stainless steel ring and through the thermocouple array that had been left at the base of the Monolith vent. Temperatures measured during the first hours of deployment record emplacement of the chimney wall. Within 2000 minutes (33 hours) several thermocouples measured stable temperatures of 308°C, other thermocouples measured relatively stable temperatures of 275 and 170°C, and several others still recorded temperatures of <25°C. Unfortunately the thermocouples began to fail within 1200 minutes of deployment, and within about 15.7 days all of the thermocouples had failed. It is clear from looking at the recovered TC loop that there was significant corrosion of the Inconel sheathed thermocouples, particularly wherever sulfide was deposited, as well as corrosion of the stainless steel frames. Based on a quick look at the data recorded from the tripods, it appears that the thermistor arrays worked well. By the time the tripod was recovered from the base of Monolith vent, however, temperatures had become high enough (>80°C measured during recovery) that parts of the module had melted. Apparently this failure occurred after the end of January (i.e., after data had ceased to be recorded). The thermistor tripod recovered from the Table vent was intact. The thermocouple array (TC loop) recovered from Table vent exhibited less corrosion than the one recovered from the base of Monolith although some sulfide had precipitated on one portion of the array. A quick look at the data recorded indicates that some of the thermocouples failed early on in the experiment, but it appears that some of the thermocouples worked until data stopped being recorded in late January. Analysis of the 6 month long temperature records from two areas of fluid flow at Table vent and from one area of diffuse flow at the base of Monolith vent will be carried out on shore. Results of the instrument test indicate that the general instrument design worked well, but that titanium needs to be used, despite the expense, anywhere where sulfide may precipitate.

In addition to recovery of the instrument packages deployed in 1994, detailed video surveys were done of the Monolith and Table vents, fluid samples were taken at the Monolith vent, and solid samples were taken at the Monolith and Table vents, to enable comparison of structure morphology and fluid composition between the start and end of the experiment, and to supplement data sets collected previously by D. Butterfield and co-workers, and R. Koski and co-workers. Biological samples from the two dives were given to V. Tunnicliffe and J. Holden. A mesotech survey of the area north of Monolith vent, up to Fountain vent, was done at the end of dive 2944.

2. Other Dives at North Cleft--Mooring Recoveries, Time-Series Vent Fluid Sampling (NOAA VENTS Program)

Two weeks preceding the AII cruise, a serious problem developed with the NOAA VENTS current meter/temperature time series mooring program on the northern Cleft Segment (Fig. 6). The VENTS program has had a continuing program to monitor the heat and chemical flux from this site since the eruptions of the mid-1980s. Four out of ten moorings placed on the seafloor in 1994 did not release from the bottom anchor, although the signal from the acoustic releases indicated that the release had triggered. In order to recover some of the valuable equipment and year-long time-series data on the moorings, and to trouble-shoot the problem for future deployments, it was decided to devote two dives to try to recover some of the moorings. The 1995 deployments of the moorings were deferred until the second leg of the DISCOVERER in order to evaluate any information from the ATLANTIS II cruise. Dive 2942 was able to release a $30K current meter mooring loose (to be recovered by the ATLANTIS II) in less than 1 hour of bottom time and then proceeded to traverse two kilometers to the Pipe Organ vent where several vent fluid samples were taken. This sample set represents a valuable continuation of our time-series of North Cleft vent fluids (this particular vent had exhibited the greatest change in chlorinity since 1991). On dive 2942 one of two MTR moorings that hadn't released earlier in the summer was located and released. The second MTR mooring at this site (deployed in 1993) could not be located. The remainder of the dive was used to conduct geologic mapping in the southern part of the megaplume site.

Two problems have been identified with the recovered moorings: (1) a unusually high biofouling, and (2) a possible problem with the mechanics of the rotating pin on the release. Remedial steps were taken with the moorings sent out on the DISCOVERER.

III. AXIAL VOLCANO

ASHES Vent Field--1995

Dive 2950 revisited the ASHES vent field (Fig. 7), which was last sampled in 1988 during an earlier NURP-sponsored ALVIN dive series. The major finding of this dive was the discovery that the ASHES vents had significantly increased in temperature (by up to at least 20°C since 1988). The temperature of Inferno vent is now 348°C, which is precisely the critical point for seawater at this water depth. The tip of this vent orifice appeared as a spectacular "flame" structure on the 3-chip video, possibly the result of light reflecting off of a gas-rich fluid. The observers also reported that there was a widespread increase in venting throughout the vent field.

An additional finding was the culturing of two hitherto unknown hyperthermophiles from the diffuse vents on Axial Volcano (J. Holden, pers. commun.). This finding invigorates a hypothesis that has been developing over the past year as the result of our interactions with J. Holden, J. Delaney, Chris Fox and others on the renewed importance of Axial Volcano to the VENTS Program.

B. DISCIPLINE REPORTS:

I. CHEMISTRY

Scientific Goals

Although we collected samples from three different segments (North Cleft, CoAxial, and Axial Volcano), the scientific interest is to evaluate change in the chemical composition of hydrothermal fluids from each site and relate it to the volcanic/tectonic state of each segment. Both N. Cleft and CoAxial have been affected by recent volcanic activity. Our model proposes that vapor-dominated venting occurs during the high heat-flux period following a volcanic intrusion/eruption, and that compositions evolve toward cooler brine-like conditions over time.

On board chemistry

Samples were processed one at a time as soon as possible after the sub was on deck. Initial processing time was approximately 30 minutes per sample. Samplers were removed from the sub, the seawater in the top of the samplers was poured out, the spring and trigger piston were removed, and a manual screw drive attached to express the sample. A clean piece of silicone tubing was pushed over the sample outlet. 15 to 30 ml of sample were expressed to rinse the tubing, then an aliquot for H_2S was immediately taken and analyzed by the methylene blue colorimetric method in triplicate, and at multiple dilutions if necessary. Using a clean plastic 60ml syringe rinsed with sample, aliquots were removed for filtering through 0.2µm "Anotop" sterile syringe filters (30ml for organics (frozen), 25ml for nitrogen purge, 30ml for filtered). 60ml were drawn for major elements. On selected samples, 30 to 120 ml were drawn for microbiological work. In some cases, 15 ml cuts were preserved with glutaraldehyde. 60 ml were drawn into a glass syringe for pH and alkalinity. The silicone tube was removed and the remaining sample (200 to 500ml) was expressed into a 500ml bottle for trace metal analysis. Only the dead volume was left in the sampler. The samplers were checked for dregs particles when disassembled for cleaning, and those with significant particulate matter present were poured and rinsed into a bottle using distilled, de-ionized (18 megohm-cm) water.

Dissolved silica was determined on board using Mortlock's version of the standard molybdate colorimetric method. pH was measured in a constant-temperature jacket (25°C). Alkalinity was done by potentiometric titration (Gran method). Ammonia was analyzed colorimetrically (indophenol blue, Parsons et al., 1984) on samples purged with nitrogen to remove H_2S. Filtered and purged samples were diluted 100-fold in volumetric flasks for IC analysis of anions (chloride and sulfate). On the assumption that sulfate is zero in the high-temperature fluids, end members were calculated for chloride and other constituents measured on board.

Preliminary results

We successfully resampled Pipe Organ and Monolith vents and found that the temperatures were unchanged at Pipe Organ and slightly lower at Monolith. Chlorinities appear to have increased by a very small amount at both sites compared to 1994. Overall, the trend in the high-temperature vents has been toward lower chlorinities since 1990/91 (see Butterfield and Massoth, JGR 1994).

We collected 18 major samples on 4 dives at the Floc site and 7 major samples on 1 dive at the Source site. Shipboard results show no change in the end member composition for Source, once more indicating that this site was not affected by the recent volcanic activity on the CoAxial segment. High levels of H_2S were still observed at the HDV site (up to 230 micromols/liter) and at the marker 26 site further south, where we had not previously sampled vent fluids. Conclusions about the chlorinity will have to wait for high-precision analysis. While the Flow site underwent very rapid evolution and decay of heat and chemical flux, the Floc site is evolving more slowly, consistent with a larger, better insulated heat source.

On the penultimate dive, we revisited the ASHES vent field in the caldera of Axial Volcano. After observing extensive areas of diffuse venting to the south of the field, we located and sampled fluids from Virgin Mound, Inferno, Mushroom, Hell, and a small diffuse vent a few meters north of Hell. Inferno vent was at the boiling temperature (348°C), which represents an increase of 18 degrees over the previous maximum observed temperature in this field. The chemistry is still consistent with a steady-state, boiling upflow zone, with vapor preferentially shunted off to the east. Cathles (1993) hypothesis that ASHES could represent a vent field in transition from vapor- to brine-dominated venting is incorrect, and we have a clear example of a boiling hydrothermal system.

The effort to conduct time-series vent fluid sampling on the Juan de Fuca Ridge has yielded important information on how hydrothermal systems evolve, and it is worthwhile to continue these efforts,

especially at CoAxial, where fluid temperature and chemistry and the biological ecosystem are still changing rapidly.

II. GEOLOGY

Dive Observations

The only dives on which there were primary geologic goals were on Dive 2948, 2949, and 2951. The latter two visited and sampled the young lava mounds at the Floc site. Dive 2948 mapped in the southern portion of the hydrothermally active fissure system a the Floc site. Drainout features along this feature observed during dives 2948 and 2949 show that this fissure at one time served as the eruptive fissure for the extensive sheet flows found near it, thus confirming that eruptions have occurred along two parallel trends separated by less than a kilometer. (See also Site Summaries)

Sampling on Dives

Basalt samples were taken at stations of opportunity on all of the dives. Sulfide samples were recovered from the Pipe Organ, Source Site and at the ASHES vent field.

Mesotech Surveys

Microbathymetry data using the downward-looking ALVIN Mesotech scanning sonar were collected on several dives at the Monolith, Source, and Floc sites to complement earlier surveys.

Rock Coring and Dredging (Night Operations)

Night operations consisted of transponder deployments, recoveries and calibrations and basalt sampling performed using both dredge and a precision rock coring device. Sampling locations (Fig. 8) were chosen based on bathymetry, camera tow and in some cases SeaMARC I data in an effort to complement the sample suite collected by submersible. In all, 43 rock cores were taken, 35 of which recovered sample. In addition, 2 rock dredges were taken in sites farther off-axis where rock coring had limited potential for recovery. Night time rock sampling was performed along the Cleft segment west of the axis, Axial Seamount south rift zone and along the CoAxial Segment. Basalt sampling along the Cleft segment consisted of 8 rock core stations (6 successful) along the west flanking ridge of the axial graben between approximately 44°38.5' and 44°56.5' N latitude, 4 rock core stations in a transect line east of the young sheet flow at a latitude of approximately 44°55.5' N. and lastly one rock dredge (good recovery) taken on a small seamount west of the axis at an approximate latitude and longitude of 46°13.5'; 129°38'. Operations along the CoAxial segment consisted primarily of rock coring with one dredge being taken along a topographic high east of the Floc site where rock core recovery was poor. Rock core stations were taken primarily from the regions between the Flow and Floc sites and between the Floc and Source sites with some additional stations on the topographic high west of the axis also being sampled. In total, 29 rock core stations (25 successful) and 1 rock dredge (good recovery) were taken in the area of the CoAxial segment. Lastly, two successful rock cores were sampled along the southern rift zone of Axial Seamount, both of which had good recovery.

III. MICROBIOLOGY (J. Holden)

Much of the bacterial mat previously associated with the diffuse venting at the Floc site was absent this year due to diminished venting. In 1994, the sites at Marker 10 and Marker 6/2 were covered with an extensive carpet of brilliant white bacterial material. None of this material was found at either site this year where venting had ended. The mat associated with Marker 3A and nearby Marker 17 was still present and appeared grey-brown with long white strands. Extensive brilliant white mat was seen at the HDV (Huge Diffuse Vent) site (Marker 16), and at a new site approximately 2 km southwest (Marker 18). Mat samples from Marker 17, Marker 18, and the HDV were collected

with a slurp gun and either frozen or preserved in glutaraldehyde. The frozen samples will be sent to Dr. Kim Juniper from the University of Montreal for analysis. A 20 ml aliquot of Major sampler fluid was preserved in glutaraldehyde from every Major sample collected on the cruise. The bacteria in the samples will be counted onshore. Four Niskin samples (one from Source, two from Floc, and one background) were concentrated for virus counts to be made at the University of Washington.

Macrofauna, diffuse and high-temperature vent fluids, and sulfides collected from the Cleft Segment, the CoAxial Segment, and the ASHES vent site on Axial Seamount were used to enrich for thermophilic and hyperthermophilic microorganisms. The samples were incubated at 55 and 90°C. Confirmation of hyperthermophilic growth will be made onshore. Isolation and characterization of the thermophiles and hyperthermophiles will occur in the lab of Dr. John Baross at the University of Washington.

IV. MACROBIOLOGY (V. Tunnicliffe)

The NOAA ALVIN program for 1995 offered two major opportunities for vent biology studies on Juan de Fuca Ridge. The first was on CoAxial, the second on the ASHES Vent field of Axial. A revisit of the Source site on CoAxial confirmed the limited extent of venting as a source of recruits to the new vents sites some 30 km distant. Collections on Beard Vent further strengthens conjecture that the site is recently invigorated: one very abundant species (the spiders) is present mostly as recent immature juveniles. Exploration of the new vents revealed two exciting aspects: the death of some areas and the further recruitment at venting areas. Markers 11 and 2 had been investigated in 1994: a few animal species were present at that time. No temperature anomaly could be located by ALVIN at these sites but a few tubeworms remained. Scavengers such as copepods and scaleworms were abundant but the few live tubeworms had few symbionts and little red blood. An important observation is that the juveniles appear to be the last to die, apparently requiring few reserves to stay alive.

At Huge Diffuse Vent (now Marker 16 and company), the venting continued over a fairly extensive area. Bacterial mats were still abundant and only appeared grazed near the venting cracks. Many more species had recruited since July 1994 - the sequence is important in determining the colonization capability and the interdependence of these vent animals. Several species were present that were not found at Source Site suggesting that recruits came from further afield. Unlike the eruption at 9°N EPR, CoAxial is a fresh start: there was no pool of larvae from a pre-existing population, nor any survivors from the eruption. Thus it is an important test of colonization and exploitation capability. Other notable features include a shift in biomass to much smaller individuals in one of the pioneering species, increase in numbers of predators and the continued absence of certain species so common at other vents. In October 1993, no vestimentiferans were seen on CoAxial. Twenty months later, the largest tubeworm collected measured 135 cm. All recruitment stages were present.

ASHES vent field in Axial caldera remains an active site of biological production. During the submersible's 500m traverse northeast into the vent field, tubeworm colonies, clam shells, crabs and fish were seen most of the way. High water turbidity suggested extensive hydrothermal emissions. The biological boundaries of the vent field appeared to have increased. All major vents were still active; Mushroom Vent had grown considerably, no longer a tubeworm-covered mound. We see very rapid community evolution on CoAxial. Could an older vent area like ASHES also be changing or does it continue an equilibrium composition that we saw as long ago as 1986?

C. NAVIGATION

Excellent DSV ALVIN navigation aboard the ATLANTIS II results from a multi-step process involving careful planning and execution to maximize accurate navigation results. The submersible is navigated with long-baseline transponder nets. The submersible's position is monitored by surface controllers with the ACNAV program (one fix per minute) and the pilot and scientists in the sphere

with the Insub program (three fixes per minute). Position is reported in ALVIN-X/Y (meters) coordinates based on a grid whose origin is located to the south and west of the transponders and dive region for each transponder net. The ALVIN-X/Y's are converted to lat/long with the ALVIN group's Makelat program.

The initial step in establishing a transponder net is to determine where the submersible will be diving so that the most effective transponder locations may be chosen for the area. Navigation results are best when transponders are deployed at approximately one nautical mile apart on local bathymetric highs so as to avoid transmit interference by seafloor obstacles such as seamounts. For this cruise, six nets were deployed: three at the CoAxial segment, one at Axial Volcano and two at the Cleft segment.

Transponder locations are calibrated using the ALVIN group's Minotaur and GPSCal programs. Minotaur logs ship X/Y locations and transponder ranges during the survey. The most effective ship path during calibration is a diamond pattern formed by four survey points spaced one half nautical mile out from the transponder deployment site. Ship noise tends to interfere with survey data acquisition so to minimize this problem the ship drifts through each survey point for five minutes and drives at a speed of 3-4kts between points. GPSCal calculates the transponder's position by performing a best fit of all the logged ranges and position data.

Two NSF-purchased expendable transponders (4-6 year lifetime) were placed at the Floc site and will be used during P. Johnson's dive series in 1995-96. The recoverable transponders were retrieved at the end of the cruise and the UW expendables will be recovered in the summer of 1996. The transponder's release code is listed in parentheses following the transponder's frequency, unless it is an expendable transponder, designated by "X".

I. TRANSPONDER NETS:

COAXIAL SEGMENT

Flow site (Extensometer and Rescue Moorings, 1993 Flow, Graben):
Origin: 46°28.493'N, 129°37.516'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
11.5kHz (G)	2782.0	1982.5	2100.7	46°29.563'N, 129°35.343'W
9.5kHz (C)	3551.3	3779.5	2213.8	46°30.533'N, 129°34.741'W

Floc site:
Origin: 46°14.931'N, 129°47.48'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
9.5kHz (B)	6439.6	2894.8	1974.7	46°16.493'N, 129°42.47'W
8.5kHz (X)	6982.7	5085.7	2000.2	46°17.676'N, 129°42.047'W
7.5kHz (X)	7746.0	7283.6	2007.3	46°18.863'N, 129°41.453'W

Source site (Church, Beard and Mongo vents):
Origin: 46°05.718'N, 129°52.006'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
11.0kHz (E)	4530.9	5844.2	1899.4	46°08.873'N, 129°48.491'W
11.5kHz (X)	5240.8	6986.3	1967.0	46°09.489'N, 129°47.940'W

CLEFT SEGMENT

North Cleft (Vents: Monolith, Pipe Organ, Table; CM and MTR moorings)
Origin: 44°57.47'N, 130°13.79'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	SeaScape Lat/Long
13.0kHz (F)	3141.9	4098.1	2029.0	44°59.683'N,130°11.399'W
12.5kHz (E)	2548.5	2783.6	2037.0	44°58.973'N, 130°11.851'W
10.0kHz (G)	1635.2	3067.6	2045.0	44°59.126'N, 130°12.546'W

*Test calibration: 12.5E and 10.5G were deployed, surveyed and calibrated using the Seascape program on the R/V DISCOVERER earlier in the 1995 cruise season. The transponders were resurveyed and recalibrated using the ALVIN group's GPSCal program to compare these results to those obtained from Seascape. The outcome and difference in X/Y coordinates are reported below. **The Seascape positions were the ones used for navigation**, not the GPSCal positions listed below.*

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
12.5kHz (E)	2549.1	2789.5	2029.2	44°58.976'N, 130°11.852'W
	-1.0X	+5.9Y	-7.8Z	
10.5kHz (G)	1632.3	3075.0	2039.7	44°59.130'N, 130°12.549'W
	-2.9X	+7.4Y	-5.3Z	

Redeployed further south for a later dive.

13.0kHz(F)	1706.7	1689.2	2039.4	44°58.382'N, 130°12.491'W

Origin: 44°52.50'N, 130°16.00'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
10.5kHz (D)	1984.2	5849.4	2065.6	44°55.658'N, 130°14.493'W
13.5kHz (H)	1287.8	3537.4	1980.6	44°54.410'N, 130°15.022'W

AXIAL VOLCANO

ASHES (Vents: Virgin Mound, Inferno, Mushroom, Hillock, and Hell)
Origin: 45°55.00'N, 130°01.50'W

Transponder	Alvin-X	Alvin-Y	Alvin-Z	Makelat Lat/Long
13.0kHz (F)	1786.1	4506.1	1310.6	45°57.432'N, 130°00.119'W
10.0kHz (G)	3096.6	1915.4	1302.8	45°56.034'N, 129°59.105'W

II. NIT FILES (PARAMETER FILES USED FOR ACNAV)

.NIT	Net	Area	Dives	Transponder Freq.
132-09BS	CoAxial	Flow	2940	11.5G,9.5C
132-09CS	N.Cleft	Monolith	2941	13.0F,12.5E,10.0G
132-09DS	N.Cleft	Pipe Organ	2942	13.0F,12.5E,10.0G
132-09ES	N.Cleft	54' site	2943	10.5D,13.5H
132-9FS	CoAxial	Source	2945	11.0E,11.5X
132-9GS	CoAxial	Floc	2946,2947,2948 2949,2951	9.5B,8.5X,7.5X
132-9HS	Axial	Ashes	2950	13.0F,10.0G

III. DETAILED DIVE NOTES

2940
Initial file has x/y's from InSub navigation program using an origin of: 46°28.493'N, 129°37.516'W. Dive conducted using transponders 11.5G and 9.5C. Alvin was not deployed until 11:00 am (18:00 GMT) due to a problem with the A-frame. The entire dive was spent at the Extensometer site, yet ended early when Alvin's prop caught the line from the extensometer, causing a power failure.

2941
Initial file has x/y's from InSub navigation program using an origin of: 44°57.47'N, 130°13.79'W. Dive conducted using transponders 13.0F and 12.5E. Alvin landed southeast of

Monolith Vent and traversed west in search of the fissure. Alvin then followed the fissure northeast up to Monolith Vent. The Monolith target was 2279x/3601y and the actual vent was found at 2238x/3614y.

2942
Initial file has x/y's from InSub navigation program using an origin of: 44°57.47'N, 130°13.79'W. Dive conducted using transponders 13.0F and 12.5E, from 09:00 to 15:00, then the sub switched to transponders 12.5E and 10.0G for the rest of the dive. The travel times from the 13.0F were infrequent, resulting in bad fixes during the latter part of the dive. The north-south orientation of transponders 13.0F and 12.5E most likely caused a geometry problem for the sub since the dive area was south and slightly west of both transponders. The navigation was replayed using 12.5E and 10.0G for the entire dive and then the navigation was spliced together using the replayed version from 09:00 to 15:00 and the original navigation file from 15:00 to 15:30.
RENAV command: renav -f 2942.nav -n 2942.navnet -d -L 12.5 10.0 >2942.replay
NAVNET file:

```
1494.0
0.0
A     1706.7 1689.2 2039.4 12.5   13.0
B     2548.5 2783.6 2037.0 12.5   12.5
C     1635.2 3067.6 2045.0 12.5   10.0
```

2943
Initial file has x/y's from InSub navigation program using an origin of: 44°52.5'N, 130°16.0'W. Dive conducted using transponders 10.5D and 13.5H. The threshold in the sub was set too high and thus the 13.5 transponder was not being picked up, so navigation was spotty to non-existent for InSub. The surface navigation was used instead, providing, for the most part, one fix per minute.

2944
Initial file has x/y's from InSub navigation program using an origin of: 44°57.47'N, 130°13.79'W. Dive conducted using transponders 13.0F and 12.5E. Alvin once again landed southeast of Monolith Vent and traversed west in search of the fissure. Alvin then followed the fissure northeast up to Monolith Vent using the target 2238x/3614y from Alvin dive 2941.

2945
Initial file has x/y's from InSub navigation program using an origin of: 46°05.718'N, 129°52.006'W.
Dive conducted using transponders 11.0E and 11.5X.

2946
Initial file has x/y's from InSub navigation program using an origin of: 46°14.931'N, 129°47.48'. Dive conducted using transponders 8.5X and 7.5X. The data disk in the sub filled up 12:42:30 and ceased logging InSub navigation. The Surface navigation was processed for the whole dive and matches reasonably well with the portion of the InSub navigation.

2947
Initial file has x/y's from InSub navigation program using an origin of: 46°14.931'N, 129°47.48'W. Dive conducted using transponders 8.5X and 7.5X.

2948
Initial file has x/y's from InSub navigation program using an origin of: 46°14.931'N, 129°47.48'W. Dive conducted using transponders 9.5B and 8.5X. At 14:48 the InSub navigation computer ceased to make fixes, although the transponders' ranges were still good and being

logged. This end section was replayed using the program Renav.
RENAV command: renav -f 2948.nav -n 2948.navnet -d -L 9.5 8.5 >2948.replay
NAVNET file:

```
1494.0
0.0
A     6439.6 2894.8 1974.7 3.0    9.5
B     6982.7 5085.7 2000.2 3.0    8.5
C     7746.0 7283.6 2007.3 3.0    7.5
```

2949
Initial file has x/y's from InSub navigation program using an origin of: 46°14.931'N, 129°47.48'W. Dive conducted using transponders 9.5B and 8.5X.

2950
Initial file has x/y's from InSub navigation program using an origin of: 45°55.00'N, 130°01.50'W. Dive conducted using transponders 13.0F and 10.0G.

2951
Initial file has x/y's from InSub navigation program using an origin of: 46°14.931'N, 129°47.48'W. Dive conducted using transponders 7.5X and 8.5X.

D. GIS

The VENTS GIS (using ArcView software package) system was implemented as a sea-going capability for the first time on the ATLANTIS II cruise. This provided excellent access to the data base and evolved into a very efficient planning tool during the course of the dive program. Having the ability to rapidly view different aspects of a site's data base is increasingly important, particularly in a multidisciplinary program such VENTS. The GIS project has provided VENTS with a powerful analytical tool and will serve as a template for use on other deep-submergence projects, particularly those that revisit sites for temporal studies.

E. ALVIN OPERATIONS, ETC.

The ALVIN group performed at its usual high level of professionalism. The dives were very productive in terms of bottom time, sampling, etc. We are particularly grateful for the successful release of several NOAA current meter and temperature recorder moorings during the dive series. This has been critical to evaluating the release problem that has plagued the NOAA VENTS plume monitoring program the past two years.

The addition of the video editing capability and the dedicated science computers were greatly appreciated and well-utilized. The new 3-chip camera continues to be invaluable to the science party.

The science to user communication have greatly improved during the past two years.

F. ATLANTIS II

The commitment of the AII officers and crew to the science program has always been high, and it continues to be so. There are a few specific highlights from the science point of view (but not in any way to take away from the rest of the ship's personnel). The new stewards department is doing a great job (nearly everyone commented) and we also particularly appreciated the skill of the bosun and the deck force in recovering all the moorings intact. The new science computers, color printer, and the efficient e-mail capability were also very much appreciated.

Don Moller continues to provide very good pre-cruise communications with the science parties.

G. PERSONNEL:

Scientific Party:

Robert Embley	Chief Scientist	NOAA/PMEL
Margaret Tivey	Co-Chief Scientist	WHOI
Andra Bobbitt	Navigation/GIS System	Oregon State U./CIMRS
David Butterfield	Vent fluid chemistry	JISAO
William Chadwick	Geology	Oregon State U./CIMRS
John Delaney	Geology	U. Washington
Ken Feldman	SSSG Technician	WHOI
Julia Getsiv	Navigation/Cruise Data Collation	Oregon State U./CIMRS
James Holden	Microbiology	U. Washington
Ian Jonasson	Economic Geology	Geol. Surv. Canada
Geoff LeBon	Chemistry	U. Washington./JISAO
Stephen Liberatore	Electronics	WHOI
Marvin Lilley	Gas Chemistry	U. Washington
John Lupton	Gas Chemistry	NOAA/PMEL
Kevin Roe	Chemistry	U. Washington/JISAO
Kim Sapp	Petrology	U. Florida
Matt Smith	Basalt Chemistry	U. Florida
Verena Tunnicliffe	Vent Biology	U. Victoria
Dawn Wright	Geology/GIS System	Oregon State U.

ALVIN Group:

Dudley Foster	Expedition Leader
Robert Grieve	Pilot
Paul McCaffrey	Technician
David Olds	Technician
Thomas Reese	Technician

ATLANTIS II:

Paul Howland	Master
Patricia Pasanen	1st Mate
Craig Dickson	2nd Mate
Sallye Davis	3rd Mate
David Ouellette	Ele/Com
Wayne Bailey	Bosun
Emily McClure	AB
Kathleen Wilson	AB
John Cawley	AB
Paul Kay	OS
Edward Rowell	OS
Dylan Weidman	OS
Kevin Fisk	Chief Engineer
Jeffrey Little	1st Engineer
Anne Toal	2nd Engineer
Jeanne Savoie	3rd Engineer
John Kutil	Dk Engineer
Harold Bean	Oiler
Lou Fox	Oiler
John Baon	Oiler
Lawrence Jackson	Steward
Debra Querner	Cook
Robert Martin	M.A.

OPERATIONS SUMMARY

Date	Local	JD	GMT	Event	Location
6/24-25/95	12:00 to 10:30	175-76	19:00 to 17:30	In transit	From Astoria to the Juan de Fuca Ridge
	11:18 to 00:35		18:18 to 07:35	Transponder deployment/calibration	CoAxial segment - Source site
	11:18 to 15:00		18:18 to 22:00	11.0E (1912.0 m)	46° 08.865 N 129° 48.511 W
				*11.5X (1967.0 m)	46° 09.489 N 129° 47.940 W
					Floc site
	16:06 to 18:07		23:06 to 01:07	9.5B (1974.7 m)	46° 16.493 N 129° 42.470 W
					Flow site
	19:59 to 00:35		02:59 to 07:35	11.5G (2100.7 m)	46° 29.563 N 129° 35.343 W
				9.5C (2213.8 m)	46° 30.533 N 129° 34.741 W
6/26/95	10:47 to 17:40	177	17:47 to 00:40	Alvin dive **ALV2940** Divers Chadwick/Meinig	CoAxial segment - Flow site
	21:31 to 22:18		04:31 to 05:18	Deploy transponders 7.5X & 8.5X	CoAxial - Floc site
6/27/95	08:10 to 16:20	178	15:10 to 23:20	Alvin dive **ALV2941** Divers Tivey/Liberatore	Cleft segment - Monolith & Table vents
	15:54 to 16:35		22:54 to 23:35	Recover transponder 13.0F	Cleft segment - Monolith & Table vents
	17:24 to 00:00		00:24 to 07:00	Transponder deployment/calibration	Cleft segment - 54' site
				10.5D (2065.6 m)	44° 55.658 N 130° 14.493 W
				13.5H (1980.6 m)	44° 54.410 N 130° 15.022 W
					Pipe Organ
				13.0F (2039.4 m)	44° 58.382 N 130° 12.491 W
6/27-28/95	22:00 to 05:50	178-79	05:00 to 12:50	Dredge and rock coring	Cleft segment
				Dr1	45° 04.520 N 130° 32.702 W
					45° 04.950 N 130° 33.180 W
				RC1	44° 55.540 N 130° 11.020 W
				RC2	44° 55.682 N 130° 11.552 W
				RC3	44° 55.807 N 130° 12.120 W
				RC4	44° 55.843 N 130° 12.418 W
	08:20 to 17:24		15:20 to 00:24	Alvin dive **ALV2942** Divers Butterfield/PIT	Cleft segment - Pipe Organ and CM moorings
	17:19 to 18:00		00:19 to 02:00	Recover transponder 13.0F	Cleft segment - Pipe Organ
	18:00 to 20:00		01:00 to 03:00	Test calibration 12.5E &10.0G	Monolith, Cleft segment
				*12.5E	44° 58.976 N 130° 11.852 W
				*10.5G	44° 59.130 N 130° 12.549 W
					****These positions were not used****
6/29/95	02:30 to 05:30	180	09:30 to 12:30	Rock coring	Cleft segment
				RC5	44° 56.429 N 130° 14.803 W
				RC6	44° 54.579 N 130° 15.448 W
	08:28 to 16:29		15:28 to 23:29	Alvin dive **ALV2943** Divers Embley/PIT	Cleft segment - 54' site, MTR mooring
	17:30 to 19:00		00:30 to 02:00	Recover transponders 13.5H & 10.5D	Cleft segment - 54' site
6/29-30/95	21:00 to 05:55	180-81	04:00 to 12:55	Rock coring	
				RC7	44° 38.572 N 130° 24.388 W
				RC8	44° 43.090 N 130° 21.109 W
				RC9	44° 44.562 N 130° 20.614 W
				RC10	44° 47.035 N 130° 19.465 W
				RC11	44° 50.961 N 130° 17.179 W
				RC12	44° 52.909 N 130° 16.202 W
	08:08 to 17:56		15:08 to 00:56	Alvin dive **ALV2944** Divers Tivey/Liberatore Monolith	Cleft segment - Monolith & Table vents
	18:30 to 19:39		01:30 to 02:39	Recover transponders 12.5E & 10.0G	Cleft segment - Monolith & Table vents
7/1/95	08:15 to 17:03	182	15:15 to 00:03	Alvin dive **ALV2945** Divers Lupton/Jonasson	CoAxial segment - Source site
	16:47 to 17:30		23:47 to 00:30	Recover transponder 11.0E	CoAxial segment - Source site
7/1-2/95	21:54 to 00:17	182-83	04:54 to 07:17	Calibrate transponders	CoAxial segment
				Floc site: 7.5X (2007.3 m)	46° 18.863 N 129° 41.453 W
				8.5X (2000.2 m)	46° 17.676 N 129° 42.047 W

Date	Local	JD	GMT	Event	Location
7/2/95	00:30 to 05:45		07:30 to 12:45	Rock coring	CoAxial segment - Floc site
				RC13	46° 14.308 N 129° 44.231 W
				RC14	46° 15.238 N 129° 43.684 W
				RC15	46° 15.949 N 129° 43.163 W
				RC16	46° 15.431 N 129° 43.540 W
	08:09 to 17:04		15:09 to 00:04	Alvin dive **ALV2946**	CoAxial segment - Floc site
				Divers Delaney/Roe	
7/2-3/95	19:00 to 05:30	183-84	02:00 to 12:30	Dredge and rock coring	CoAxial segment - Floc site
				Dr2	46° 12.946 N 129° 36.914 W to
					46° 14.300 N 129° 58.957 W
				RC17	46° 14.077 N 129° 38.590 W
				RC18	46° 15.790 N 129° 38.852 W
				RC19	46° 17.696 N 129° 38.679 W
				RC20	46° 19.305 N 129° 38.579 W
	07:58 to 16:13		14:58 to 23:13	Alvin dive **ALV2947**	CoAxial segment - Floc site
				Divers Tunnicliffe/Holden	
7/3-4/95	19:00 to 05:50	184-85	02:00 to 12:50	Rock coring	CoAxial segment - Floc site
				RC21	46° 24.900 N 129° 40.374 W
				RC22	46° 23.117 N 129° 40.858 W
				RC23	46° 22.624 N 129° 40.098 W
				RC24	46° 22.030 N 129° 41.090 W
				RC25	46° 21.726 N 129° 40.386 W
				RC26	46° 20.931 N 129° 41.129 W
				RC27	46° 19.160 N 129° 41.653 W
				RC28	46° 19.225 N 129° 41.519 W
	08:00 to 16:59		15:00 to 23:59	Alvin dive **ALV2948**	CoAxial segment - Floc site
				Divers Chadwick/Smith	
7/4-5/95	22:00 to 06:30	185-86	05:00 to 13:30	Rock coring	CoAxial segment - Floc site
				RC29	46° 19.268 N 129° 45.709 W
				RC30	46° 20.450 N 129° 45.929 W
				RC31	46° 20.369 N 129° 45.980 W
				RC32	46° 19.510 N 129° 46.255 W
				RC33	46° 20.924 N 129° 45.103 W
				RC34	46° 22.418 N 129° 43.991 W
				RC35	46° 20.464 N 129° 45.991 W
	07:53 to 16:08		14:53 to 23:08	Alvin dive **ALV2949**	CoAxial segment -Floc site
				Divers Embley/PIT	
	21:05 to 01:46		04:05 to 08:46	Deploy/calibrate transponders	Axial Volcano
				ASHES: 13.0F (1310.6 m)	45° 57.432 N 130° 00.119 W
				10.0G (1302.8 m)	45° 56.034 N 129° 59.105 W
7/6/95	03:00 to 05:15	187	10:00 to 12:15	Rock coring	Axial Volcano
				RC36	45° 51.806 N 130° 00.399 W
				RC37	45° 50.125 N 130° 00.674 W
	08:00 to 16:39		15:00 to 23:39	Alvin dive **ALV2950**	Axial Volcano - ASHES vent field
				Divers Butterfield/Tunnicliffe	
				Recover transponders 13.0F & 10.0G	Axial Volcano - ASHES vent field
7/7/95	01:30 to 05:45	188	08:30 to 12:45	Rock coring	CoAxial segment - Floc site
				RC38	46° 12.989 N 129° 45.825 W
				RC39	46° 12.595 N 129° 46.987 W
				RC40	46° 12.089 N 129° 46.318 W
				RC41	46° 11.707 N 129° 46.650 W
	07:58 to 16:42		14:58 to 23:42	Alvin dive **ALV2951**	CoAxial segment - Floc site
				Divers Holden/Wright	
				Recover transponder 9.5B	CoAxial segment - Floc site
7/7-8/95	22:15 to 01:30	188-89	05:15 to 08:30	Rock coring	CoAxial segment - South of Floc site
				RC42	46° 11.279 N 129° 46.107 W
				RC43	46° 10.790 N 129° 47.280 W
	07:58 to 16:42		14:58 to 23:42	Alvin dive **ALV2952**	CoAxial segment - Flow site
				Diver PIT (engineering dive)	
7/8-9/95	12:30 to 11:30	189-90	19:30 to 18:30	In transit	From the Juan de Fuca Ridge to Astoria

*Transponder deployed on previous cruise

VENTS & MARKERS TABLE

(last updated January 26, 1996)

COAXIAL SEGMENT

FLOW SITE MARKERS (ORIGIN 46°28.493', 129°37.516') **Marker positions shifted to match 1995 ALVIN navigation during Johnson Leg**

Marker	Location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
3 (triangle)	On top of small constructional hill in center of fissure	1994	ALVIN	2794	~12:30	1994	ALVIN	2794	12:30:30	2449	4561	7520	46° 32.552'	129° 33.953'
13 (bucket lid)	Extensive floc/mats on new flow	1993	ALVIN	2670	14:41	1993	ALVIN	2670	14:41:00	2390	3674	5947	46° 31.703'	129° 34.646'
UW 119	West of Marker 6A	1995	ALVIN	2983	14:10	1995	ALVIN	2983	14:10:00	2392	3579	5786	46° 31.616'	129° 34.720'
UW 105	East of Marker 6A	1995	ALVIN	2983	14:34	1995	ALVIN	2983	14:30:00	2403	3591	5775	46° 31.610'	129° 34.711'
6A (square)	1993 once venting area of new flow	1993	ALVIN	2670	14:11	1995	ALVIN	2984	09:50:30	2383	3588	5773	46° 31.609'	129° 34.713'
0 (triangle)	1993 venting area area of new flow	1993	ALVIN	2670	13:07	1994	ALVIN	2788	12:48:00	2382	3485	5506	46° 31.465'	129° 34.793'
7A (square)	West of flow ridge, thick mats, yellow pptes	1993	ALVIN	2670	10:40	1994	ALVIN	2788	13:18:00	2383	3462	5480	46° 31.451'	129° 34.811'
P1	DIFFUSE VENTING area in fresh lava	1993	ROPOS	hys234	11:10	1993	ROPOS	hys234	11:10:02	2380	3470	5434	46° 31.426'	129° 34.805'
4A (square)	Old lava	1993	ALVIN	2672	10:23	1993	ALVIN	2672	10:23:00	2409	3140	5395	46° 31.405'	129° 35.063'
Y10	Sulfur-stained drainouts in new lava	1993	ROPOS	hys219	22:52	1993	ROPOS	hys219	22:51:55	2379	3511	5330	46° 31.370'	129° 34.773'
11 (bucket lid)	Extensive mats	1993	ALVIN	2672	12:30	1993	ALVIN	2672	12:31:00	2377	3397	5301	46° 31.354'	129° 34.862'
14 (bucket lid)	Minor staining	1993	ALVIN	2672	11:58	1993	ALVIN	2672	11:58:30	2395	3423	5293	46° 31.350'	129° 34.842'
UW 112	In small swale located on hydrothermally stained ridge of 93 Flow	1995	ALVIN	2993	15:28	1995	ALVIN	2993	15:28:30	2382	3171	4680	46° 31.019'	129° 35.039'
UW 111	West of the eastern contact of 93 Flow	1995	ALVIN	2993	13:25	1995	ALVIN	2993	13:22:00	2428	3468	4620	46° 30.987'	129° 34.807'
UW 110	West of Marker UW111	1995	ALVIN	2993	15:12	1995	ALVIN	2993	15:12:45	2404	3351	4617	46° 30.985'	129° 34.898'
Y2	Alterations/new fractures in fresh lava	1993	ROPOS	hys221	05:16	1993	Ship	hys221	05:15:49	2371	3017	4472	46° 30.907'	129° 35.159'
Y15	Weak venting, floc, new pillows	1993	ROPOS	hys221	04:26	1993	ROPOS	hys221	04:28:24	2358	3085	4174	46° 30.746'	129° 35.106'
UW 104	On a high block in once venting area, near Marker 5A	1995	ALVIN	2994	15:36	1995	ALVIN	2994	15:37:30	2386	2790	3870	46° 30.582'	129° 35.336'
5A (square)	Diffuse vent site, old lava, in graben	1993	ALVIN	2671	13:21	1995	ALVIN	2671	13:43:00	2384	2798	3868	46° 30.581'	129° 35.330'

FLOC SITE MARKERS (ORIGIN 46°14.931', 129°47.48')

Marker	Location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
5 (triangle)	SNOWBLOWER VENT	1993	ALVIN	2676	13:50	1995	ALVIN	*		2290	7010	8046	46° 19.274'	129° 42.026'
9 (triangle)	At high point 30m W of vent and Marker 11	1993	ALVIN	2676	11:52	1995	ALVIN	**		2226	6719	7194	46° 18.814'	129° 42.252'
11 (triangle)	Small mound in front of DIFFUSE VENT	1993	ALVIN	2676	11:40	1995	ALVIN	2946	10:38:39	2228	6749	7194	46° 18.814'	129° 42.229'
17	Diffuse venting site ~7m northeast of 3A	1995	ALVIN	2946	14:35	1995	ALVIN	2946	14:35:00	2226	6479	6698	46°18.547'	129°42.437'
3A (square)	Old pillows, extensive mats	1993	ALVIN	2673	13:53	1995	ALVIN	2946	13:08:15	2228	6463	6684	46° 18.539'	129° 42.451'
23	HDV site	1995	ALVIN	2951	11:50	1995	ALVIN	2951	11:50:00	2238	6465	6658	46° 18.525'	129° 42.450'
29	HDV site	1995	ALVIN	2951	11:42	1995	ALVIN	2951	11:42:00	2241	6399	6643	46° 18.517'	129° 42.501'
32	HDV site	1995	ALVIN	2951	11:40	1995	ALVIN	2951	11:40:00	2246	6411	6636	46° 18.513'	129° 42.492'
27	HDV site	1995	ALVIN	2951	11:34	1995	ALVIN	2951	11:34:00	2246	6452	6631	46° 18.510'	129° 42.460'
22	HDV site	1995	ALVIN	2951	11:29	1995	ALVIN	2951	11:30:00	2251	6428	6623	46° 18.506'	129° 42.479'
16	HDV site	1995	ALVIN	2951	13:59	1995	ALVIN	2951	13:59:00	2250	6458	6623	46° 18.506'	129° 42.455'
24	HDV site	1995	ALVIN	2951	11:28	1995	ALVIN	2951	11:28:00	2253	6434	6616	46° 18.502'	129° 42.474'
UW T Probe	HDV site	1995	ALVIN	2951	11:11	1995	ALVIN	2951	11:11:00	2260	6451	6614	46° 18.501'	129° 42.461'
19	HDV site: south of line of tubeworms	1995	ALVIN	2951	11:25	1995	ALVIN	2951	11:25:00	2261	6453	6612	46° 18.500'	129° 42.459'
2 (triangle)	4-5m below rim of fissure on the gently sloping talus near the fissure	1994	ALVIN	2791	13:00	1995	ALVIN	2947	12:36:00	2269	6372	6424	46° 18.399'	129° 42.522'
6 (triangle)	On the west rim of fissure above Marker 2	1994	ALVIN	2791	14:17	1995	ALVIN	2947	12:36:00	2265	6372	6424	46° 18.399'	129° 42.522'
10		1994	ALVIN	2793	10:52	1995	ALVIN	2947	13:27:30	2268	6224	6066	46° 18.205'	129° 42.637'
26	Deployed marker a few meters from west wall of fissure.	1995	ALVIN	2949	13:37	1995	ALVIN	2949	13:37:00	2245	5682	4458	46° 17.337'	129° 43.059'
18	Marker deployed on top of "fuzzy" fissure wall.	1995	ALVIN	2948	11:03:50	1995	ALVIN	2948	11:03:50	2241	5646	4180	46° 17.187'	129° 43.087'
15	Marker deployed down in fissure.	1995	ALVIN	2949	11:20	1995	ALVIN	2949	11:30:00	2243	5623	4113	46° 17.151'	129° 43.105'

* Position determined from rigid 1994 to 1995 navigation shift of +4m in X and -22m in Y

**Position determined from its relative location to Marker 11.

SOURCE SITE (ORIGIN 46°05.718', 129°52.006')

VENTS

Vent	Found Year	Found Vehicle	Found Dive #		Position determined Year	Position determined Vehicle	Position determined Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
TWIN SPIRES	1994	ALVIN	2787		1995	ALVIN	2945	12:56:00	2050	4382	6715	46° 9.343'	129° 48.606'
MONGO VENT	1994	ALVIN	2787	09:49:18	1995	ALVIN	2945	10:12:00	2045	4404	6674	46° 9.321'	129° 48.589'
CHURCH VENT	1993	ALVIN	2681	13:07	1995	ALVIN	2945	10:01:45	2062	4391	6633	46° 9.299'	129° 48.599'
BEARD VENT	1993	ALVIN	2681	11:32	1995	ALVIN	2945	09:50:45	2050	4372	6608	46° 9.285'	129° 48.614'

MARKERS

Marker	Location/ description	Deployed Year	Deployed Vehicle	Deployed Dive #		Position determined Year	Position determined Vehicle	Position determined Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
1	On a small basalt mound, 3-4m south of MONGO VENT	1994	ALVIN	2787	11:42:30	1995	ALVIN	2945	10:10:30	2048	4395	6669	46° 9.318'	129° 48.596'
8A	North side of CHURCH VENT	1993	ALVIN	2681	13:07	1995	ALVIN	2945	10:01:45	2062	4391	6633	46° 9.299'	129° 48.599'

CLEFT SEGMENT

NORTH CLEFT (ORIGIN 44°57.47', 130°13.79')

VENT POSITIONS (known active vents as of 1994)

Vent	Found Year	Found Vehicle	Found Dive #		Position determined Year	Position determined Vehicle	Position determined Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
AQUARIUS VENT	1994	ALVIN	2778		1994	ALVIN	2781	13:15:30	2260	2906	5294	45°00.328'	130°11.580'
FOUNTAIN VENT	1991	ALVIN	2429		1994	ALVIN	2781	09:47:00	2242	2476	4125	44°59.697'	130°11.907'
TABLE VENT	1990	ALVIN			1994	ALVIN	2941	11:48:00	2244	2248	3646	44°59.438'	130°12.080'
MONOLITH VENT	1990	ALVIN	2258		1994	ALVIN	2941	10:36:30	2249	2247	3631	44°59.431'	130°12.081'
CAVERN VENT	1988	ALVIN	2077		1994	ALVIN	2776	10:10:00	2262	1995	2876	44°59.023'	130°12.273'
PIPE ORGAN VENT	1991	ALVIN	2437		1994	ALVIN	2942	11:43:00	2269	1354	1399	44°58.225'	130°12.760'

MARKER POSITIONS

Marker	Location/ description	Deployed Year	Deployed Vehicle	Deployed Dive #		Position determined Year	Position determined Vehicle	Position determined Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
13 (triangle)	AQUARIUS - Single sulfide mound with diffuse venting	1994	ALVIN	2778	15:04:30	1994	ALVIN	2778	15:04:30	2259	2909	5295	45°00.329'	130°11.578'
44	At extinct sulfides northeast of FOUNTAIN	1991	ALVIN	2435	14:29:00	1991	ALVIN	2435	14:29:00	2243	2716	4656	44°59.984'	130°11.725'
42	Next to FOUNTAIN	1991	ALVIN	2435	11:02:40?	1994	ALVIN	2781	09:47:00	2242	2476	4125	44°59.697'	130°11.907'
10	MONOLITH east side	1990	ALVIN	2261	no notes	1995	ALVIN	2941	10:36:30	2249	2247	3631	44°59.431'	130°12.081'
11	MONOLITH west side	1990	ALVIN	2261	no notes	1995	ALVIN	2941	10:36:30	2249	2247	3631	44°59.431'	130°12.081'
2	On lava spire few m's west of CAVERN	1988	ALVIN	2080		1994	ALVIN	2776	09:51:30	2262	1990	2888	44°59.029'	130°12.277'
M	On DIFFUSE VENT a few m's east of main fissure	1990	ALVIN	2267	12:55:00	1991	ALVIN	2443	11:47:00	2253	1896	2769	44°58.965'	130°12.348'
8	On extinct sulfide chimney west of main fissure	1988	ALVIN	2094		1994	ALVIN	2780	11:39:45	2260	1790	2538	44°58.840'	130°12.429'
4	On DIFFUSE VENT just west of main fissure	1988	ALVIN	2077	14:53:44	1991	ALVIN	2443	13:26:00	2265	1825	2591	44°58.869'	130°12.402'
5	Collapse pit vent (between Markers 6 and 8)	1988	ALVIN	2077	11:27:00	1988	ALVIN	2077	11:27:00	2269	1519	1830	44°58.458'	130°12.635'
3	TRIPOD (extinct-1991) ~10 m north from M6 along fissure through young sheet flow	1988	ALVIN			1995	ALVIN	2942	15:30:45	2270	1382	1562	44°58.313'	130°12.739'
6	TRIPOD - On fissure at site of tripod flow monitor (deployed and recovered 1988)	1988	ALVIN			1994	ALVIN	2776	13:45:00	2272	1385	1550	44°58.307'	130°12.737'
40 (foam block)	PIPE ORGAN - 5 m east of vent	1991	ALVIN	2437	13:00:00	1995	ALVIN	2942	11:26:30	2270	1360	1401	44°58.226'	130°12.755'
46	Only lead weight, which was retrieved by ROPOS during dive	1991	ALVIN	2431	14:15:30	1991	ALVIN	2444	09:20:45	2265	1202	735	44°57.867'	130°12.876'
1	DIFFUSE VENT - Near eruptive fissure on southeastern part of young sheet flow	1988	ALVIN	2076	14:06:40	1991	ALVIN	2444	12:42:45	2266	884	-461	44°57.221'	130°13.118'
22	Diffuse vent (almost extinct 1993)	1990	ALVIN	2264	12:50:00	1990	ALVIN	2264	12:50:00	2273	-160	-4277	44° 55.161'	130° 13.912'

SOUTH CLEFT (ORIGIN 44°38', 130°24')

VENT 3 MARKER POSITIONS

Marker	Location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
.+ (circle)	Hydrothermal mound along west wall of cleft	1984	ALVIN			1994	ALVIN	2782	11:10:00	2240	3719	5562	44° 41.003'	130° 21.188'
3- (rectangle)	Valley floor east of cleft	1984	ALVIN			1984	ALVIN	USGS			3679	5186	44° 40.800'	130° 21.218'
8- (rectangle)	Small lopsided conical chimney visible from marker 1-	1987	ALVIN			1987	ALVIN	USGS			3629	5182	44° 40.798'	130° 21.256'

VENT 1 MARKER POSITIONS

Marker	Location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
7 (rectangle)	Inactive sulfide atop basalt column	1984	ALVIN			1984	ALVIN	USGS			3109	3691	44° 39.993'	130° 21.649'
? (rectangle)	Near a smoking chimney, "vik" on side of marker covered with "sline"					1994	ALVIN	2783	~13:20	2186	2857	2876	44° 39.553'	130° 21.840'
1/ (rectangle)	283°C black smoker	1984	ALVIN			1984	ALVIN	USGS			2822	2865	44° 39.547'	130° 21.866'
12 (triangle)	Two ~340°C chimneys joined at base	1994	ALVIN	2783	09:56	1994	ALVIN	2786	09:56:00	2214	2825	2841	44° 39.534'	130° 21.864'
/0 (rectangle)	Small chimneys within couple meters of base of 9m chimney	1984	ALVIN			1984	ALVIN	USGS			2780	2812	44° 39.518'	130° 21.898'
1 (circle)	Low temp vents with biology		ALVIN				ALVIN	USGS			2671	2476	44° 39.337'	130° 21.980'
.- (circle)	Sparse field of tubeworms & clam shells in hydrothermal sediment	1984	ALVIN			1994	ALVIN	2783	09:45:00	2179	2708	2465	44° 39.331'	130° 21.952'
2/	In cleft near west wall, non-vent area	1984	ALVIN			1994	ALVIN	2785	13:35:00	2224	2666	2284	44° 39.233'	130° 21.984'

PLUME MARKER POSITIONS

Marker	location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
1V (rectangle)	Inactive sulfide chimney at northern end of PLUME SITE	1984	ALVIN			1984	ALVIN	USGS			2324	1224	44° 38.661'	130° 22.243'
8X (rectangle)	Large area of active black smokers on a shelf inside the cleft	1984	ALVIN			1984	ALVIN	USGS			2219	984	44° 38.531'	130° 22.322'
1X (rectangle)	Just east of the east wall of the cleft	1984	ALVIN			1984	ALVIN	USGS			2154	754	44° 38.407'	130° 22.371'

AXIAL VOLCANO

VENT POSITIONS (ORIGIN 45°55.00', 130°01.50')

Vent	Found Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
VIRGIN MOUND	1986	PISCES IV	1720		1995	ALVIN	2950	11:35:30	1542	895	1869	45° 56.009'	130° 0.808'
MUSHROOM	1986	PISCES IV	1720		1995	ALVIN	2950	13:16:45	1543	859	1864	45° 56.006'	130° 0.835'
INFERNO	1986	PISCES IV	1720		1995	ALVIN	2950	12:30:00	1543	854	1858	45° 56.003'	130° 0.840'
HELL	1986	PISCES IV	1720		1995	ALVIN	2950	14:00:00	1542	830	1832	45° 55.989'	130° 0.858'
HILLOCK	1986	PISCES IV	1720		1995	ALVIN	2950	15:21:30	1542	850	1811	45° 55.977'	130° 0.842'

MARKERS

Marker	Location/ description	Deployed Year	Vehicle	Dive #		Position determined Year	Vehicle	Dive #	Time	Depth (m)	Alvin x	Alvin y	Latitude	Longitude
1	MUSHROOM, on seafloor	1986	PISCES IV			1995	ALVIN	2950	13:16:45	1543	859	1864	45° 56.006'	130° 0.835'
31	MUSHROOM	1986	PISCES IV			1995	ALVIN	2950	13:16:45	1543	859	1864	45° 56.006'	130° 0.835'
2	HELL	1986	PISCES IV			1995	ALVIN	2950	14:00:00	1542	830	1832	45° 55.989'	130° 0.858'
27	HELL	1986	PISCES IV			1995	ALVIN	2950	14:00:00	1542	830	1832	45° 55.989'	130° 0.858'
28	HILLOCK , on seafloor	1986	PISCES IV			1995	ALVIN	2950	15:21:30	1542	850	1811	45° 55.977'	130° 0.841'
32	HILLOCK , on side of edifice	1986	PISCES IV			1995	ALVIN	2950	15:21:30	1542	850	1811	45° 55.977'	130° 0.841'

COAXIAL SEGMENT

COAXIAL SEGMENT

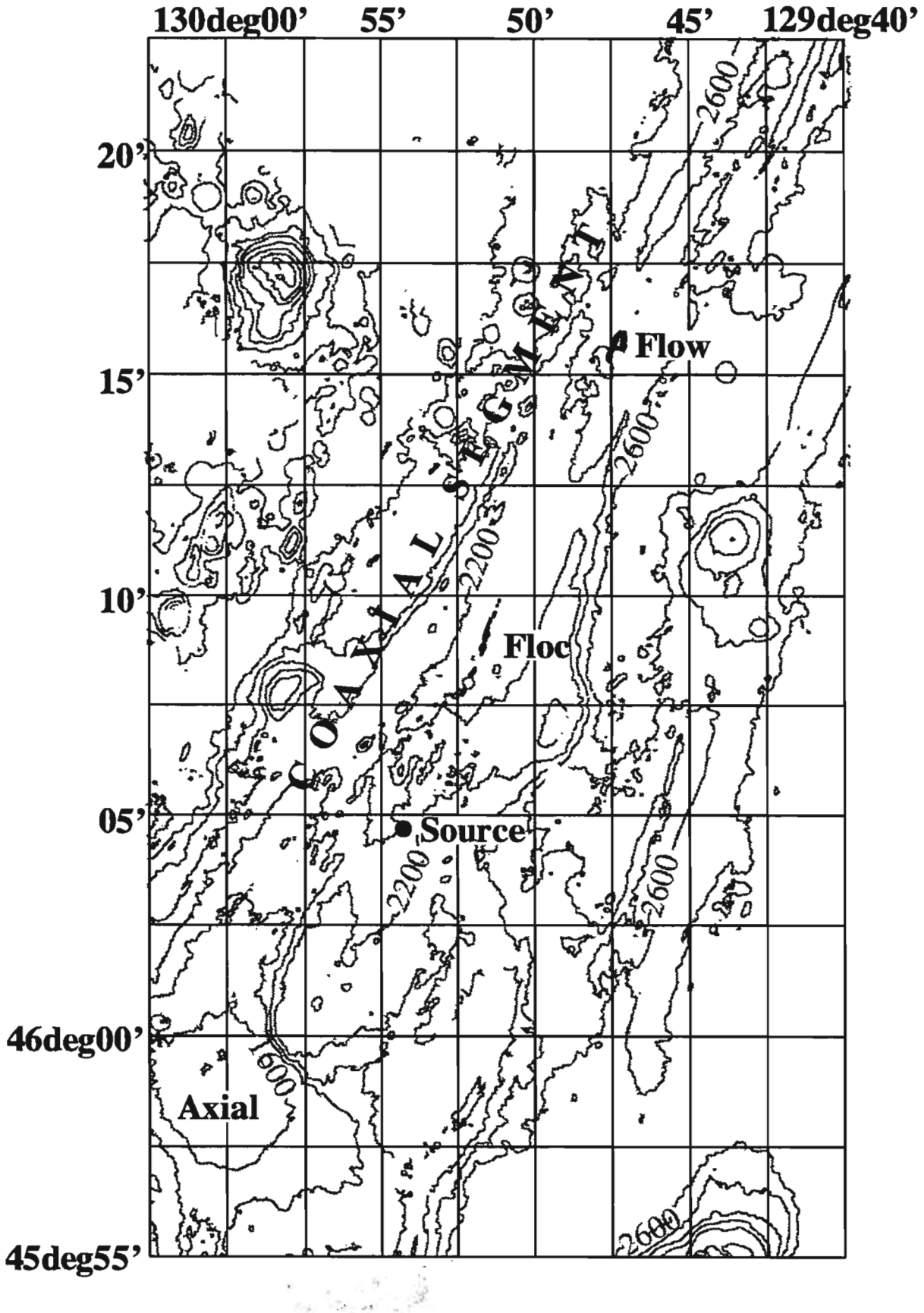


Figure 2

FLOW SITE

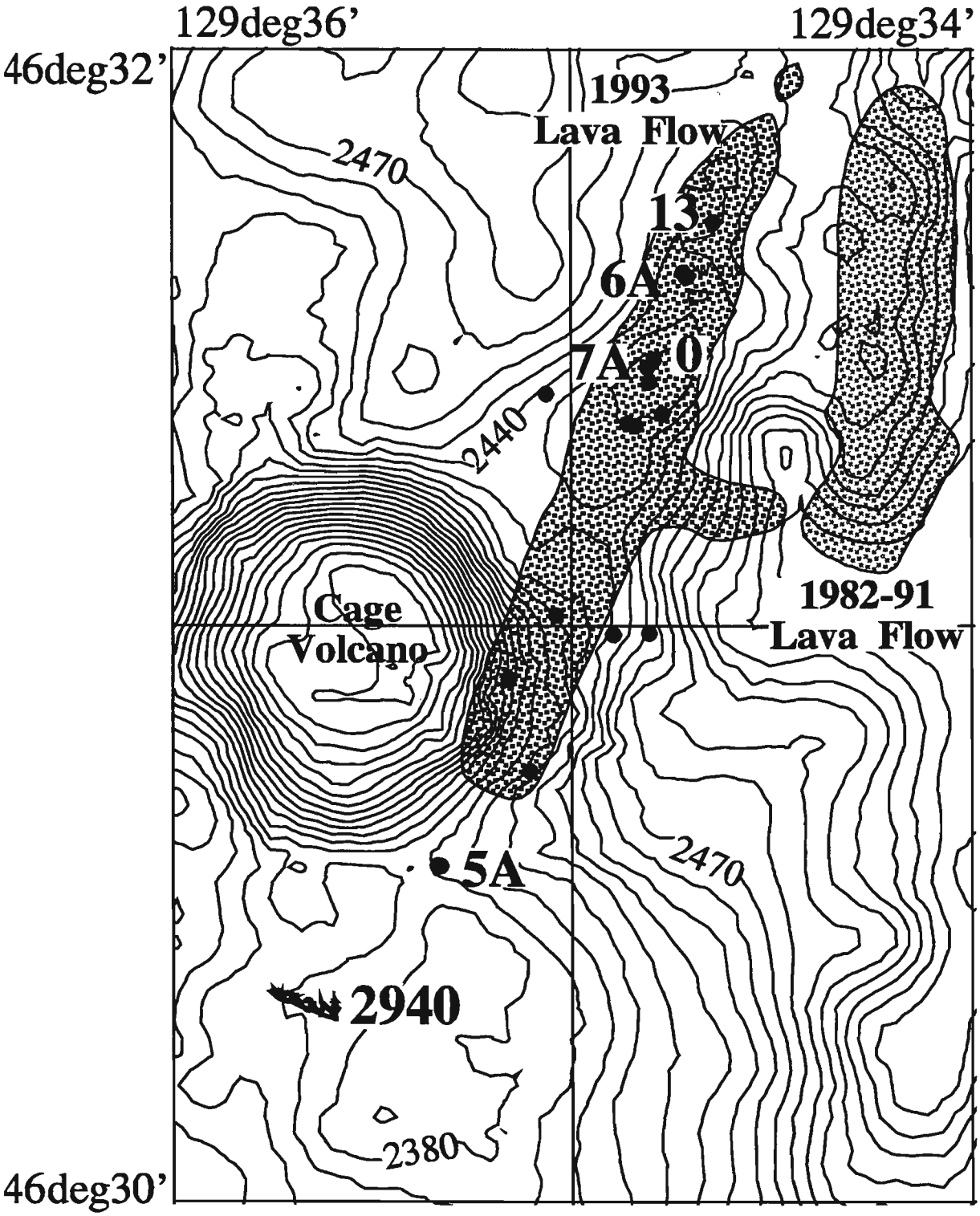


Figure 3

FLOC SITE

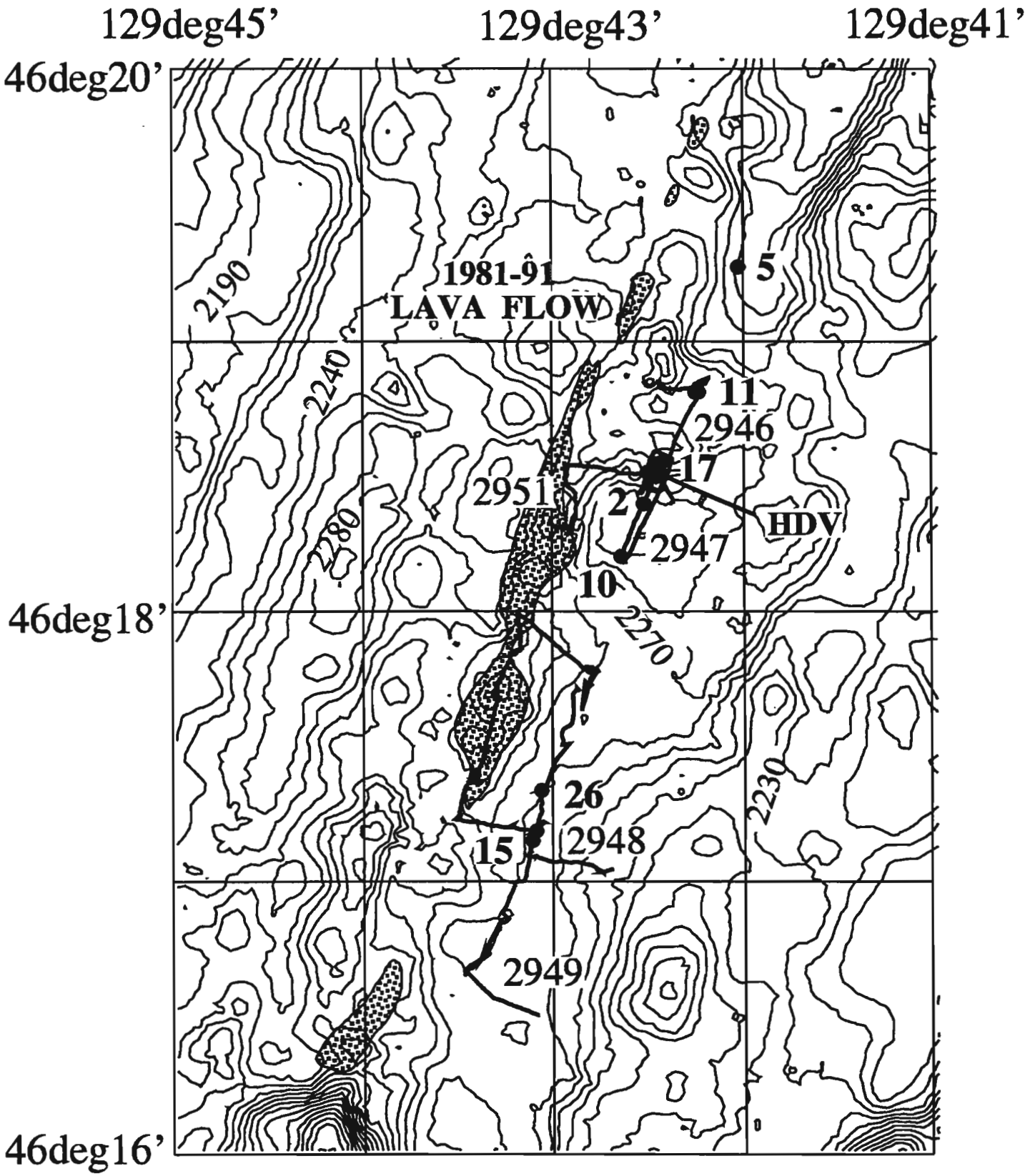


Figure 4

SOURCE SITE

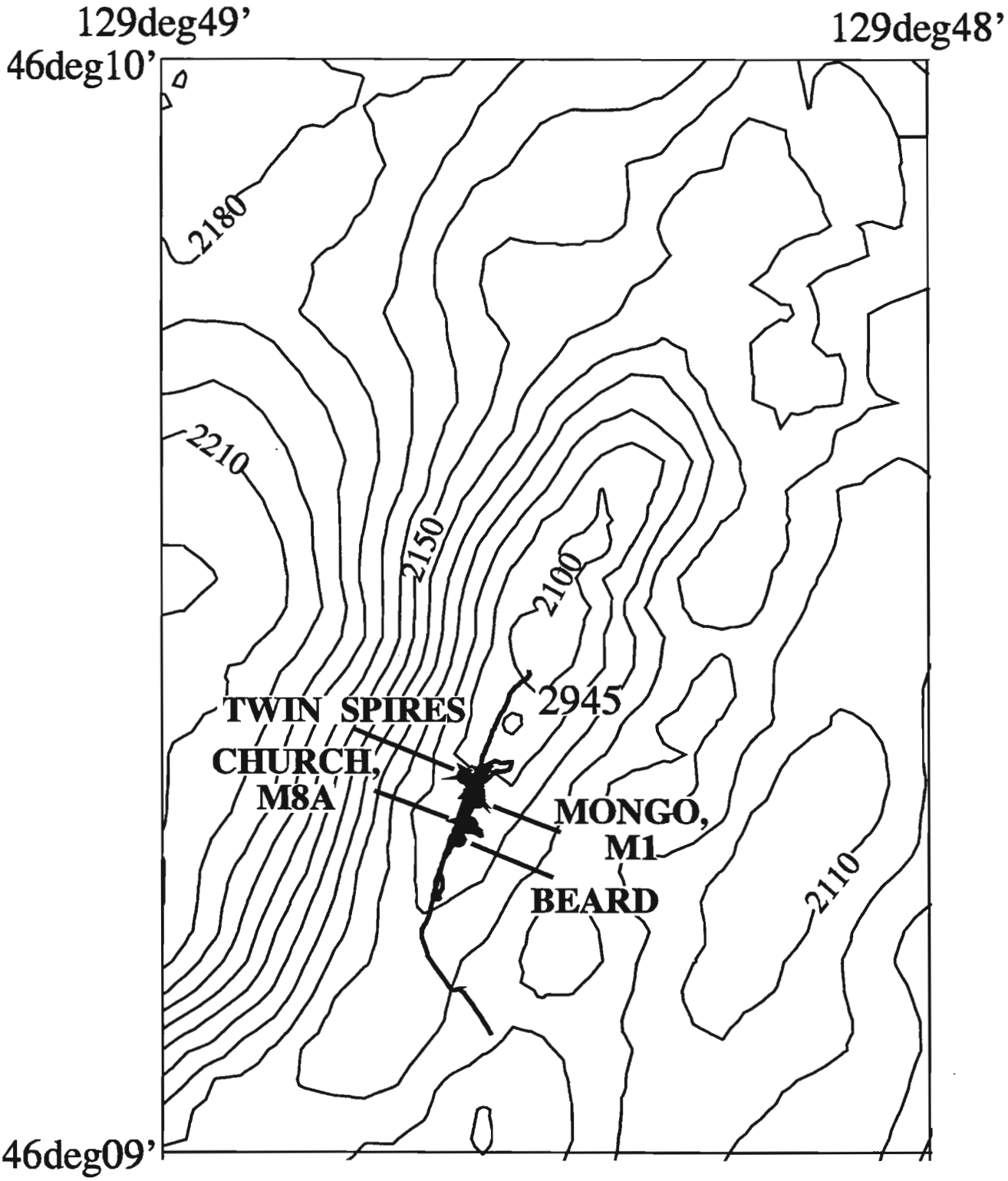


Figure 5

DIVE SUMMARIES - COAXIAL SEGMENT

Video set-up for all dives:

high 8 mm recorder #1: recorded video from the two Alvin color 1-chip cameras and the black/white down-looking sit camera.

high 8 mm recorder #2: recorded the 3-chip camera exclusively.

*All depths are TOTAL water depth, unless otherwise noted.

DIVE 2940: FLOW SITE - EXTENSOMETER

June 26, 1995
Pilot: Dudley Foster
Port Observer: Bill Chadwick (author of this summary)
Starboard Observer: Chris Meinig

Narrative:

The plan for this dive was to dive on the NOAA Extensometer mooring (just south of the 1993 CoAxial lava flow), investigate why it had not released when the DISCOVERER sent the release command in May, and hopefully to be able to release the mooring. Visiting the instruments on the bottom would also give us an opportunity to see them deployed on the seafloor and help us evaluate the effectiveness of our current surface-based deployment technique. Other goals for the dive were to conduct geologic mapping and search for venting along the graben south of the 1993 lava flow, and to collect additional Mesotech sonar data of this structure, but unfortunately the attempt to recover the extensometer mooring was ill-fated.

We dove on the mooring site and first located the "rescue" mooring and then the extensometer mooring - Alvin located both by a combination of CTFM sonar and ranging on the release transponder of the moorings. We found that the acoustic release on the extensometer mooring had indeed released the anchor and had risen about 5 m, but it was snagged on the anchor chain by a loop of polyolefin line from the mooring which was pinched around the shackle at the end of the chain because of the buoyancy of the mooring's glass balls. This came about because the mooring was apparently fouled during deployment - the thin spectra line from the mooring to the first instrument and the line from the 1st to the 2nd instruments were both fouled in the glass balls. This resulted in the 1st instrument being kept right next to the mooring and consequently left plenty of slack in the polyolefin to get fouled on the anchor.

After surveying the mooring carefully and determining that it would be easy to release with Alvin, we decided to try and locate the remaining 4 extensometer instruments in the array by following the spectra line between instruments. The spectra line was bent over about 45° in the bottom current and was somewhat difficult to follow. We found that the other instruments were at only 45 m spacing (instead of the 100 m spacing we were aiming for), suggesting either that the instruments were streaming at a steeper angle during deployment or that the anchor fell much faster than the instruments after the mooring was dropped to the seafloor.

After we reached the 5th instrument, we were ready to return to the mooring to release it, but we unknowingly sucked some spectra line into 3 of Alvin's rear thrusters. It appeared that the thrusters had stopped working and we could not proceed - so the decision was made to drop weights and return to the surface. We realized the sub was snagged when we only rose 400 m (about the length of the unfouled mooring) and stopped ascending, and our nav position was directly over the mooring. We had become part of the mooring. There were a few minutes of unhappy thoughts, but we quickly realized that adding up the negative buoyancy of the mooring

and positive buoyancy of Alvin showed that we just needed a couple hundred pounds more positive buoyancy to lift the mooring. We pumped out 250 pounds of water ballast and started rising slowly to the surface (with the entire extensometer mooring, including the anchor beneath us).

When we reached the surface (x/y=2027,3152) and Alvin started bobbing in the waves the spectra line broke between instruments 3 and 4, and the rest of the mooring fell back down to the seafloor. After Alvin was recovered we were able to haul extensometers 4 & 5 on board, because they were still attached to the tail of the sub.

The fouling problem with the extensometer mooring occurred during deployment, so we obviously need to seriously re-think how these instrument are deployed and recovered. A preferable strategy may be to install permanent benchmarks on the seafloor and place the instruments on the benchmarks by ROV or submersible.

DIVE 2945 - SOURCE SITE

Summary written by I. Jonasson with some input from J. Lupton

Port Observer: John Lupton
Starboard Observer: Ian Jonasson
Pilot: Robert Grieve

Narrative:

We reached bottom at 0920h, 2118 m depth, at the base of a large constructional mound considered to be the location of the 020 deg. striking fissure system that hosts the Source vents. We travelled upslope for the next 40 minutes over hummocky to undulating pillow lava fields. Typical morphology was 0.5 to 1 m decorated and stretched pillows and tubes with few interpillow buds. All is well-sedimented and apparently old. Locally brittle stars are abundant, with a few anemones and occasional small rat-tails. We crossed a small crest and fracture at 0940h and turned north to follow it. The fissure broadened and deepened and became higher on the east side as it traversed local mound slopes. The walls are in places, of intact pillows and tubes where sloping, and elsewhere sharply cleaved. They are lined with pink and white corals, anemones, and carry a few crabs. The abundance of filter animals increased as we neared the target at Beard Vent and the water was murkier.

Beard was reached at 0951h, 2050 m depth, and was seen to be perched on the eastern lip and upper wall. The main stack was festooned with worms and filter feeding animals, including bottle brush sponges which are common to the entire fissure system in the vicinity of vents. Church Vent and Marker 8A were reached at about 1000hrs where we discovered navigation offsets to be -10 m in X and +10 m in Y. We drove to Mongo and Marker 1 traversing considerable hydrothermal sediment cover on pillowed to lobated flows. Mongo vent had regrown its anhydrite chimney (cf. Middle Valley) to about 7 m in height since its collapse in 1994 and was perched on a constructional debris mound of anhydrite (x,y = 4395, 6669). Its base is at 2049 m depth on the eastern lip of the fissure system. We observed a line of smaller vents trending downhill WNW. These would be studied later. Some large crabs were scattered about. We next sought the location of Twin Spires and after a few mis-fires located it at the end of a broadened valley between pillow mounds but on the trend of the fissure system which seems to die out there. Its position is heralded by greatly increased abundances of bottles brush sponges on fissure walls nearby. The chimneys have tough indurated bases of anhydrite and pyrite but with flimsy white anhydrite tops (x,y = 4404, 6711).

We returned to Church vent and first collected a Niskin sample ~1 m above the vent [2945-1N1]. Then we carried out temperature measurements (278.0°C with manifold sampler) and

collected 2 water samples with the manifold Major samplers [ALV2945-1D1 and ALV2945-1D2] and 2 manifold gas-tight samples [ALV2945-1G1 and ALV2945-1G2]. We then conducted detailed video surveys of animal communities before collecting worms and spiders which were in 20-39°C water [ALV2945-1B]. A temperature measurement with the Alvin hi-T probe in the water sampling orifice yielded T=281.5°C. Church vent is located at x,y = 4387, 6632 and forms a WNW trending line of inactive vents (large) and active spires (1 m or so) over about 30 m. Church lies in a cleft between pillow mounds rather than in a sharp fissure and there is considerable low temperature activity between it and Beard to the south. A small active spire about 10 m WNW of Church was sampled [2945-2S]; it consists of anhydrite and wurtzite. Temperature was not measured.

At Mongo a Niskin water sample was taken ~1 m above the bifurcated pinnacle before it was disturbed [ALV2945-3N1]. Shortly after that the Mongo pinnacle was felled by Alvin, and further sampling was carried out from the stump itself. The water, which appeared darker after the spire was toppled, measured 292.5°C with the Alvin hi-T probe. A Major sampler pair and discrete Major were tripped in the vent [ALV2945-3D1, ALV2945-3D2, and ALV2945-3D3], as well as 2 discrete gas-tight samplers [ALV2945-3DG1 and ALV2945-3DG2]. A second Niskin sample was collected 1 m above the stump of Mongo [ALV2945-3N2]. The fallen chimney was about 0.5 m diameter except at its base where it was thinned and necked considerably by wall dissolution. The interior at the base was mineralized with 2-4 cm thick layers of chalcopyrite and wurtzite. It was sampled [ALV2945-3S1]. Mongo also has a 20 m line of secondary vents that form a WNW line marked by an anhydrite constructional razorback ridge. These are most vigorous in the steep south side and near its base where beehive and spire structures are seen. The north sloping side has innumerable small orifices steadily venting white to clear smoke. The smaller spires appear to have worm colonies (time = 1335h). Galatheid crabs are abundant.

Twin spires was relocated and the fresh anhydrite top of one spire (~1 m) was sampled [ALV2945-4S1] as well as the indurated base [ALV2945-4S2]. Water sampling was carried out in the orifice formed by the broken off spire. The Alvin hi-T probe recorded a steady temperature of 253.8°C. Two discrete Major samplers and two discrete gas-tights were triggered in the vent [ALV2945-4D1, -4D2, -4DG1, and -4DG2]. The active vents carried a few small spindley worms (Ridgia?). A nearby (1 m NW) inactive chimney (~25 cm) was collected [ALV2945-4S3]. It consists, as do the active ones, largely of pyrite and anhydrite. Dead worms were attached. A piece of pillow bud basalt was sampled about 4 m E of Twin Spires, close to a narrow cleft [ALV2945-5R1].

The last part of our dive consisted of a south to north Mesotech survey carried out at approximately 10 m elevation, with the instrument on 20 m range, some 20 m west of the line of vents, and traversed them all. The dive ended at the north waypoint of the survey at 1430h.

DIVE 2946 - FLOC SITE

July 2, 1995
Pilot: Dudley Foster
Port Observer: John Delaney
Starboard Observer: Kevin Roe
This summary prepared by R. Embley after review of video tapes

Dive Objectives:

The primary objective was to survey and sample the northern part of the Floc site, in particular Markers 11 and 3, which were put in place in October, 1993.

Narrative:

The ALVIN landed several hundred meters west of Marker 11 at 09:29. After taking a basalt sample (1B) at the landing site, a traverse toward Marker 11 was begun. The navigation was poor, so the traverse eastward was made partly above bottom. The Mesotech was used to collect microbathymetry along the way. ALVIN returned to the bottom at 09:51. After locating the fissure system that Marker 11 lies along, a search of the area was conducted, and Marker 11 was sighted at 10:22. A large octopus was seen near the marker. A view of the fissure that lies a few meters west of Marker 11 at 10:29 with the downward looking SIT camera clearly showed substantial clumps of tubeworms. The submersible could not maneuver into that site for sampling, so sampling was conducted at a site about 2 m north of Marker 11 on the east side of the fissure (there's a much large fissure to the east of Marker 11, which ALVIN presumably followed south to reach the area). The tubeworms here were mostly dead and the temperature anomaly was only about 0.5°C. above ambient. The port majors and gas-tights, tubeworms, and a basalt was collected here (STN. # 2). From here, ALVIN followed the fissure south towards Marker 3A. Along the way, a basalt sample was collected from the western lip of the fissure at 12:46 (STN. # 3). Marker # 3A was sighted. An area of diffuse venting was seen at 13:04 on the west side of the fissure. Small amounts of shimmering water was emanating from holes in the pillow lavas here. Marker 3A was found at 13:05. All of the venting found in the vicinity of Marker 3A was north of Marker 3A. After a quick survey of the site, samples were taken from one of the small vents in the basalt between 13:50 and 14:15. Good 3-chip video showed a diverse biota in the holes, consisting of tubeworms, polychaetes, and bacterial mats. The maximum temperature measured was 8.1°C. Marker 17 was deployed at this site (6479x; 6698y) at 14:35. A Niskin bottle was also tripped over this vent. After mud was stirred up, ALVIN moved to another site a few meters away and attempted to take a mat sample with a pair of discrete major samplers (the slurp pump failed). A niskin bottle was triggered over this site. ALVIN DIVE 2946 ended at 15:15.
The overall impression at site 3A is that there continues to be a reasonable heat flux at the Marker 17 site where the sampling on Dive 2946 took place.

DIVE 2947 - FLOC SITE

July 3, 1995
Pilot: Bob Grieve
Port Observer: Verena Tunnicliffe
Starboard Observer: Jim Holden (author of this summary)

Dive Objectives:

1. Locate and mark the 'Huge Diffuse Vent' (HDV) site discovered last year.
2. Resurvey the HDV, Marker 6/2, and Marker 10, and sites for temporal change in the fluid chemistries and biological community composition over the last year. The survey consisted of fluid sampling with Major and Gas Tight samplers, slurp gun sampling of bacterial mat, arm grabs of macrofauna, video surveys of the sites, and a high-definition Mesotech survey over the Marker 6/2 site.
3. Run two Mesotech survey lines between Markers 10 and 3A east and west of the main fissure running 020°.

Narrative:

The sub landed at 0910 h approximately 300 m SE of Marker 17 and proceeded up a pillow lava slope towards Marker 17. The sub crossed over a series of parallel fractures running 020° which varied in width between 1 and 6 m wide (at 0921h, 0924 h, and 0926 h; the latter fracture being the main fracture). At 0928 h, the submarine entered a region of low-level diffuse venting

with small clumps of *Ridgeia sp. tubeworms.* The pillow basalts in the region were covered with grey-brown bacterial mat with long white strands. White bacterial mat was found only in the immediate vicinity of venting. At 0931 h, the sub encountered Marker 17 (x:6473, y:6701, 2224 m, 074°). We began a biological three-chip video survey of a site 1-2 m west of the marker. Macrofauna and basalt were sampled from the site (0945 h and 0959 h, respectively) before the sub moved east towards the main fracture. The biology sample was placed into the forward compartment of the portside biobox.

At the fracture, the sub turned south and followed its western lip for approximately 50 m where the sub encountered extensive diffuse venting (1016 h). Dive weights dropped a year ago approximately 10 m east of the site confirmed the location of the HDV site. At 1034 h, Marker 16 was placed at the site next to the dive weights. (Note: Marker 16 was snagged and subsequently redeployed on dive 2951. See Markers table for final position.) Due to poor transponder signals, the sub rose 8 m to get a fix on the marker (1037 h, x:6439, y:6627, 2246m). We then descended into the HDV site to begin the on-bottom survey. The dominant features of the site were a line of densely-packed tubeworms running 345° upslope and a thick extensive carpet of white bacterial mat to the west of the worm line. At 1045 h, we began our biology video survey using the three-chip camera. At 1057 h, the sub measured 16.7°C with the low-temperature probe within the tubeworm line. The manifold arm was positioned in the line of venting at 1112 h (T_1=14.0°C and T_2=10.0°C) and the outer portside Major (#14) sampler was tripped; however, the manifold computer had locked-up and was no longer reading temperatures correctly. Therefore, the sample temperatures are uncertain. The computer was rebooted, the inner portside Major (#11) was tripped at 1129 h (T_1=13.7-14.2°C and T_2=11.8°C), and the portside Gas-Tight was tripped at 1133 h (T1=13.8-14.4°C and T2=12.4°C). A discrete Major (#6) and a discrete Gas Tight (purple) were drawn at 1138 h and 1140 h, respectively, from the same location as the manifold samples. At 1142 h, macrofauna from the tubeworm line were collected with the manipulator and placed into the starboard biobox. The University of Washington temperature probe was deployed at in the flow beneath the line of tubeworms at 1148 h, the data recorder was placed in top of a basalt pillow for relocation and retrieval. At 1155 h, a basalt was collected 1-2 m west of the tubeworm line, then the slurp gun was used to sample bacterial mat from the site at 1201 h. The sub rose from the bottom and followed the line of tubeworms and diffuse venting north which led directly to Marker 17 primarily on a heading of 020°.

The sub then lifted to an altitude of approximately 40 m and headed south to the Marker 6/2 site where Marker 6 is on the west lip of the main fracture and Marker 2 is downslope of the wall of the fracture near its at a site of intense diffuse venting in 1994. The site is bordered by a meter-wide fissure north of the field with a sheer wall north of the fissure and a talus slope south of the fissure. The venting in 1994 was north and south of the fissure. The sub descended on Marker 6 at 1235 h (x:6372, y:6427, 2266 m, 186°) and found the site was no longer actively venting. One year before, the site was covered by a carpet of white bacterial mat with numerous small clumps of tubeworms throughout the area. None of the mat was seen on this dive and only a few remnant tubeworm tubes were found. At 1244 h (x:6377, y:6413), the low-temperature probe was placed into a stained crack and the temperature measured was 1.8-1.9°C, or ambient temperature. At 1251 h, we ran a three-chip video survey from Marker 2 up to Marker 6 retracing the route taken a year ago. At 1256 h, a piece of basalt with remnant tubeworms attached was collected from a point 1 m north of Marker 2 (x:6377, y:6414, 2272 m, 333°) and placed in the aft portion of the portside biobox. A mesotech survey of the site was aborted due to the inactivity site.

At 1314 h, the sub followed the cross fissure south along a heading of approximately 200° towards Marker 10. The sub encountered the lava collapse zone at 1315 h (x:6345, y:6364, 2266 m, 206°). At 1319 h (x:6311, y:6282, 2266 m, 206°), the sub exited the collapse area and the bottom became lobate to ropey sheet flow. At 1328 h, the sub crossed a narrow fissure running 020° and found Marker 10 in a zone stained with hydrothermal sediment. There were numerous

small clumps of tubeworms in the area; however, the worms appeared to be dead or near death. A year ago, the area was covered with an extensive white bacterial mat with some small clumps of tubeworms in the area. At 1337 h, the low-temperature probe measured 2.0°C. We began a broad video survey of the area at 1342 h and were unable to find any active venting. At 1349 h (x:6229, y:6046, 2266 m, 152°), a piece of basalt was collected, then at 1401 h the sub moved east of the main fracture to run a mesotech line from the latitude of Marker 10 to the latitude of Marker 3A. We began the mesotech survey at 1408 h (x:6298, y:6056, 2242 m, 027°) which ran 17 m above the bottom. We completed the mesotech line at 1442 h (x:6505, y:6593). A power shortage prevented us from running the second Mesotech line. At 1443 h (x:6501, y:6600, 2243 m, 306°), we triggered a discrete Major (#4) 9 m above the bottom to be used as a background sample. At 1445 h, the weights were dropped and we began our ascent.

DIVE 2948 - SOUTHERN FLOC SITE

Starboard. observer: Matthew Smith (author of this summary)
Port observer: Bill Chadwick
Pilot: Dudley Foster

Narrative:

The goals of this dive were to: 1) make a cross-axis geologic traverse across the axial valley to examine the relationship between the line of fissures and active venting at the Floc site and the line of young (~10 year old) pillow lavas further to the west, 2) search for venting in the southern part of the Floc site which had previously been unexplored by Alvin but where CTD plumes and camera tows had shown evidence of venting, and 3) examine any geologic structures adjacent to the young lava flows west of the venting line.

During the descent, the magnetometer was turned on and began logging at about 08:55 and 1700 m depth. The sub reached the bottom at 09:13, approximately 500-600 meters east of the line of current venting activity (x=6102, y=3891), landing on relatively old-looking, medium-sedimented lobate flows approximately 100 m SSW of target 1. We then proceeded on a WNW heading that would intersect the interpreted line of current hydrothermal activity approximately 100 m south of target 2. At 09:26 (x=6098, y=3898, z=2212m) a basalt sample (1R) was taken from a relatively older-looking lobate flow. We then continued along our previous course, and at 09:51 crossed 2-4 m scarp and a flow contact into an area dominated by ropey to jumbled sheet flows with some collapse, that appeared slightly younger than the lobate flows that we had been flying over. At 09:55 we sat the sub down to take a sample (2R) of a jumbled sheet flow (x=5647, y=4002, z=2238). After continuing along the same heading, we encountered the main fissure at 10:00, identified by its similarity to the one with active venting seen from camera tows. It was 10-15 m deep and had lava drain-back and bath-tub-ring structures along its walls, suggesting it may have been the source of the sheet flows. Very shortly after descending into the fracture and turning NNE, we began to see indicators of active hydrothermal venting, including extensive areas covered with bacterial mats (especially along the west wall). Unable to find a focused area of venting from which to sample water, we used the slurp gun to collect some of the bacterial material (3B) at 10:20 (x=5638, y=4144, z_{sub}=2244m, z_{tot}=2247m). We then ascended up the wall to a depth of 2237m where we fired the forward niskin (4N) a few meters above the bacteria coated wall (x=5650, y=4194). After continuing further NNE along the fissure we found a large section of the west wall covered with bacteria where we saw a few sparse tube worms (x=5635, y=4175, z=2250). Despite the bacteria, we did not see any localized source of shimmering water from which to sample while inside the fissure. We tried to sample tube worms, but ended up stirring up a cloud, so we rose up the west wall to the rim, some 15m above the bottom of the fissure, and we deployed Marker 18 (station 5) at 11:03 (x=5646, y=4180, z_{sub}=2230m). We then sampled a

piece of basalt rope from a sheet flow just beyond the lip of the fissure (6R) at 11:11 (x=5643, y=4176, z_{tot}=2232).

We then proceeded along a WNW heading towards target 3. We continued to pass over areas dominated by sheet flow and gentle lobate flows until 11:34, when pillows and greater relief lobate flows began to dominate as we began to climb the constructional pillow ridge along which the young lava flows were erupted, west of the line of venting. The lavas that make up this ridge are relatively old, similar to those encountered at the landing site. We continued to climb this constructional ridge, and at 11:49, stopped to sample pillow basalt 7R (x=5107, y=4260, z_{tot}=2202). We then turned to a heading of approximately 020° exploring the terrain south of the young flow identified by the 1994 camera survey, attempting to identify any structures that may have been associated with their emplacement. At 11:55 we crossed an east-facing fault scarp down dropped ~5 m to the east. We encountered the contact with the young flow at 12:05 (x=5123, y=4520, z=2203), on the east side of the scarp, and as we continued NE, the scarp was soon buried by the young lava. The young lava is dominantly pillows, with lobate flows in some areas. It has considerable sediment on it, but is clearly distinguishable from the surrounding older lavas because it lacks sediment pockets between pillows and is darker and glassier. The young flow is totally unfissured and sessile organisms are generally absent, but a few small stalked animals (the first colonizers) were seen on it during this dive. At 12:12, shortly after entering the young flow, we stopped to sample a basalt (8R) from them (x=5133, y=4520, z_{tot}=2203). We then returned to the south contact of the flow to look for any graben structures that might be there (was there a west-facing scarp to the east of the other scarp?). After exploring and not finding a second fault scarp, we returned to our transect along the young flows at approximately 020°. The young flow appears to be quite thin in many places, because we often saw small patches of older lava surrounded by the young lava (the older lava outcrops tended to be large pillows, whereas the younger lavas were lobate and small pillow forms). The flow clearly just caps a pre-existing pillow ridge. This is consistent with the SeaBeam difference results which only show a small anomaly near the south end of the flow we traversed (between 1981 and 1991 surveys). We then continued along the same heading, continuing to climb up the constructional mound parallel to its axis, but slightly east of its crest, which is a very steep-sided ridge here (the slope rose steeply to the west and dropped off steeply to the east). The high point of the traverse was at about 12:56 (x=5381, y=5039, z=2182 m). At 13:10 we set down to take another basalt sample (9R) from the young flow (x=5405, 5213, $z=_{tot}$2194). We reached the contact with the older lava again at 13:25, and soon after crossed a 3-m-high, east-facing scarp in the old lavas. At 13:30 we sampled a basalt (10R) from the older lava at the top of the scarp (x=5501, y=5408, z_{tot}=2202). After sampling, we went east across the scarp and almost immediately found young lavas again near the base of the scarp. We looked for a paired west-facing scarp to the east, but did not find one, only young lavas going down the east slope of the ridge. Where we encountered the east-facing scarp was apparently a place where the young lava flow gets too thin and narrow to bury the scarp (which it does both to the north and south), but the flow is probably continuous through this area (east of the scarp), instead of there being 2 separate flows. We then continued along a heading of approximately 020° and started to climb another constructional slope into a thicker part of the young lavas where they were broad lobate forms (13:43). At 13:50, we took the last basalt sample (11R) in the area of young lobates (x=5526, y=5665, $z=_{tot}$2195). This was near target 4 and there was considerable hydrothermal staining on the young lavas.

From here, we changed to a SE heading and flew towards target 5, which was another site where camera tows had seen venting. We crossed the contact into older lavas at 14:14 (x=5629, y=5594). Almost immediately after descending off of the constructional feature the terrain became more fractured, and at 14:35 we crossed into a highly fissured and faulted area that was apparently along strike of the venting line. At about 14:45, the nav computer in the sub stopped giving us fixes, which made our search harder. The fissure system is clearly much more complex at this latitude that what we had observed further to the south. There are at least 5 major fissures here.

We descended into several of the fissures (some of which had sheet flow drain back and bathtub rings) in search of signs of active or past hydrothermal venting but were unable to find any. At 15:28 we ran out of power and dropped weights. We tripped the blue #10 discrete major for a background sample at approximately 90 m off of the bottom and continued on to the surface.

DIVE 2949 - SOUTHERN FLOC SITE

June 5, 1995
Port Observer: Bob Embley
Stbd. Observer: Marvin Lilley
Pilot: Bob Grieve

Note: Altimeter was inoperable during this dive because of hard ground (Mesotech was working).

Dive Objectives:

The primary objective was to survey and sample hydrothermal vents found along the fissure zone at the Floc site south of the sites discovered in 1993. Camera surveys and CTD tow-yos indicated venting in this area. This was designed as the along-axis companion to the across axis traversse made on Dive 2948.

Narrative:

ALVIN reached bottom at 09:15 east of the fissure zone and began traversing to the northwest. Fissure zone was crossed at 09:30-09:37 and then ALVIN turned NE to cross it again. Began to follow fissure zone NE at 09:49. Lots of drainout features associated with the fissure swarm. A survey of the fissure zone northward brought us to a deep and wide fissure/graben at 10:03. Started to see hydrothermal staining at 10:15 and encountered large zone of bacterial mats on the west wall of the fissure at 10:23. Maximum temperature measured at this site was only about 2.9 C (1.2 C above ambient). After taking a bacteria-coated rock sample (Station 1R) at 10:35, ALVIN continued moving northeast along the fissure. A more vigorous site of bacterial mats and obvious shimmering water was reached at 10:42. A maximum temperature of 5.5 C was measured at this site (STATION # 2). Outer and inner port majors and Port Gas Tight samplers were triggered in diffuse vents at the base of the west side of the fissure wall. Marker 15 was placed at this site at the base of the wall. Rose up west fissure wall and saw layer of glassy sheet flow with bathtub rings plastered on wall. Marker 18 (deployed on Dive 2948) was spotted on top of west wall at 11:37. Descended into fissue again at 11:37. Nice video scan of wall reveals bag creatures (bacterial product) similar to those seen at North Cleft in 1988. There are two types of mats-- on upper portion of wall, lots of strands waving in current. Deeper down, mats cling to rock. Limpets are found on bare rock. Many Nemertean worms found on deeper mat. Also observed scale worms but did not see any tube worms at this site. Measured maximum of 5.9 deg. C temperature at this site (STATION # 3). Port manifold majors and port gas-tight samples taken here. Slurp sample with Nemertean worms also taken here. Left Stn. 3 site at 12:36 and continued driving northeast along fissure. See altered basalt at 12:38 on east side of fissure and interesting juxtaposition of glassy bathtub ring lava and underlying older lava across from altered zone on west side of fissure. Sample 4R taken of younger lava here at 12:38. Older lava appears to have been thermally altered by overlying sheet flow. A sample of the altered lava on the east side of the fissure was taken at 12:48. Good 3-chip documentation of both of these sites. A cross-section traverse of fissure was made after Station 5 and it was observed that the younger sheet flows were only found on west side at this location. After meandering along fissure zone to the NE, another venting area was located at 13:07 (STATION # 6). Small tubeworms were observed here. A maximum temperature was measured here of 5.6 deg. C. Tripped discrete majors 6 and 4

and purple discrete gas tight here. Also sampled a few tube worms and imaged some more Nemertean womrs. Good video survey of biology here. Marker # 26 deployed at fracture in bottom of fissure at 13:29. Venting on both sides of fissure here. At 13:34, started heading NE along western lip of fissure. Lost fissure at 13:54-- in lava drainout area then found it again at 14:00. Saw some bacterial mat at 14:01. Still on fissure with stained rock when dive was terminated at 14:10 because of low battery.

DIVE 2951 - FLOC SITE

Friday, July 7, 1995
Pilot: Bob Grieve
Port Observer: Jim Holden
Starboard. Observer: Dawn Wright (author of this summary/transcript)

Narrative:

The objectives of Dive 2951 were to: (1) gain a better understanding of the geometry and interrelationships between geological and biological features at the Huge Diffuse Vent (HDV) site; (2) complete an additional, more detailed Mesotech survey to better define the topography of HDV; (3) complete a detailed video survey of the line of tubeworms extending off the main fissure at the edge of HDV to be used as part of a video mosaic; (4) take additional water and biological samples; and (5) explore the lava mounds directly to the west of HDV in order to determine how the lavas are erupting there and the structural relationships between the mounds are; and (6) take a sample of fresh basalt from the lava mound so that petrological comparisons could be made to samples taken further at Floc. All of these objectives were designed to tie together the discoveries made during previous dives to Floc and to thus bring some closure to our series at dives there during this cruise. Due to the complexity of our dive plan not all of our objectives were realized. This resulted in only 28 minutes being available to fulfill the geological objectives (#5 and #6) instead of the planned 2 hours. However, we learned many valuable things about doing fine-scale video surveys, the techniques of which still need to be refined. The Mesotech and video surveys, as well as the water and biological sampling, were largely successful. Scores of 35mm shots were also taken (by Jim in particular) of the line of tubeworms and the surrounding pillow lavas. And perhaps we have a clearer idea of where to go from here in terms of our time-series experiments and observations there.

We touched down on the seafloor at ~0909 in fairly sedimented, elongate pillows, got our bearings and then rose back into the water column in order to run our 3 Mesotech lines. The Mesotech survey went very smoothly for the most part, and took a little under 2 hours to run 3 250-m-long lines (from 0927 to 1041). Fixes were spotty due to the threshold on channel 1 being too low. This helped the situation but did not completely solve the problem of spotty fixes, which remains a mystery. During our center line, which went right over the HDV site, we pushed off course slightly by a westerly current. We were especially vulnerable to this because of driving up hill at a slower than normal survey speed (10 m/min as opposed to 15 m/min). This factor in addition to the spotty navigation are the sources of error in our Mesotech survey. Still, we feel as though we gathered excellent data and were able to image the main fissure trending 020° through the HDV site.

Upon completion of the survey we made our way back to the HDV sight. With the Mesotech still running we decided to take a quick reconnaissance of the area in order to get a good mental image of the area and to better assess the geometry of features. At ~1050 we ran uphill from the scarp entered the HDV area, and made our way to Marker 3A. We did not mean to go that far north and turned around to get back to the main fissure. We sighted Marker 16 and the UW temperature probe on our way back down at 1056 and prepared to deploy markers for the video survey. From ~1125 to ~1152 we deployed 7 markers (#'s 19, 24, 22, 27, 32, 29, and then 23)

which were to serve as target points for the video survey. See the chart at the end of the report for approximate xy's for these sites. We had 3 additional markers but decided to save them to mark any sampling sites. At 1200 we attempted to do the video survey, the plan being to start in the south at Marker 19 and to "mow the lawn" up the scarp, moving largely in an E-W (constant Y) direction and using a downlooking, as opposed to forward-looking, perspective. This proved to be very difficult as we had a hard time finding some of the markers that we had deployed for this purpose. At 1217 we determined to try again, this time surveying up the scarp in a constant X direction. Our difficulties continued as it was discovered that this configuration made too narrow of a swath. It was too hard to get overlapping runs. At 1218 we returned to Marker 19 and tried to work our way up the scarp again towards Marker 23. Our navigation continued to be spotty.

Time became a major factor at this point, so having given our best shot at the video survey, we determined at 1249 to set down at the Marker 16/UW temperature probe site and take some bio and diffuse water samples. The Mesotech was also turned off. A slurp sample was taken at 1253 (6452x, 6621y, depth 2253m (sub 2250m), heading 015°, altitude 3. We wanted to take manifold samples but encountered difficulties keeping the temperature probe in desired position long enough to capture the warmest water. This was partly due to a ballast problem with the sub. Unloading all those markers apparently made us quite light (each marker weighed ~7 lbs. I believe, so we unloaded ~49 lbs.). Bob was unable to take in water to make up the difference because taking in diffuse hydrothermal fluids apparently causes corrosion. We also had difficulty getting T2 on the manifold to equilibrate. Flipping between "full" and "variable" on the intake switch seemed to help, but we still ended up with a T2 that was always ~3-4° below T1. Due to the excessive amount of time being spent with the temperature probe and manifold, Bob tripped 2 Niskin bottles in the interim. Jim Holden recorded the info. on the Niskin and manifold samples while I operated the computer for the manifold. He also took some excellent closeup video of tubeworms with the 3-chip camera on the starboard. arm, deftly employing the zoom capability when appropriate.

We were starting to get really concerned about our dwindling power reserves. At 1354 we decided to make our way west to the lava mounds. We were not sure at that point whether or not we would even have enough power left to make it there. As we rose from the seafloor at 1356, Marker 16 got caught in the basket. It was redeployed at 6468, 6626. At 1402 we drove like mad to the west. We rose up as high as 60 m up in the water column. This was a judgement call. Rather than crawl over the seafloor to examine cross-axis structures we opted to fly through the water column in the hope that we would save power by not having to drive up and down over features. We were trying to stick with our original plan of examining the lava mounds in some detail.

At 1425 we set down on heavily dusted lobate pillows at 5850, 6696. There was significant sediment pocketing in between the pillows and the glassy flows that we hoped to examine and sample were nowhere in sight. We spent a couple of minutes in quick reconnaissance and then determined to head south and go as far as we could. We zig-zagged a little in search of fresh material but still headed predominantly south at 180°. In the 25 or so minutes that remained, we crossed over a terrain that was largely made up of elongate, heavily sedimented pillows, some flow breccia, and a few fissures that trended approximately 270°. This orientation came as quite a surprise as I was expecting to see features trending largely 020°. These fissures were encountered after we apparently came down off the mound. Perhaps there is some structural discontinuity or deval in between the mounds in this region. We reached the second large mound on our map at ~1445 and tried to climb to the summit. The terrain got progressively younger as the sediment pockets almost disappeared and the pillows flattened out into almost a sheet flow terrain. But alas, just as that terrain was encountered we ran out of power! So goes the life of a geologist on an interdisciplinary venture! The weights were dropped at ~1453. Many thanks to Bob Grieve for a terrific dive despite the difficulties. It was also quite a pleasure working with Jim Holden.

Marker Fixes (as they were deployed/encountered on our first S-N traverse):

19	6461, 6617
UW Temp. Probe	6459, 6618

24	6442, 6620
22	6437, 6626
27	6460, 6639
32	6416, 6641
16	6468, 6626 (new position after getting caught in *Alvin*'s basket)
29	6409, 6646
23	6474, 6662

SAMPLE NOMENCLATURE GUIDELINES

Example: ALV2940-1N2

The sample names contain four parts in the following order:

1. **Dive Number** i.e. ALV2940 (Alvin dive 2940) followed by a hyphen.
2. **Station Number** i.e. 1 (first station during dive 2940).
3. **Sample Type** i.e. N (Niskin sample)
   - **B**: Biology
   - **C**: sediment/push Core
   - **D**: Discrete major
   - **DG**: Discrete gas-tight
   - **G**: Manifold gas-tight
   - **M**: Manifold major
   - **N**: Niskin
   - **R**: Rock
   - **S**: Sulfide (includes chimney samples, talus, chimney fragments)
   - **SM**: Sulfide Miscellaneous (chips from unknown source)
   - **SL**: Slurp gun
   - **T**: Temperature measurement (listed seperately when no sample was taken.)
   - **U**: SUAVE
   - **#[number]**: Marker deployment (i.e. ALV2775-1#2; deployment of marker #2 at station one.)
4. **Sample Number** i.e. 2. Samples are numbered in the order they were taken for each sample type at a particular station.

COAXIAL DIVE STATIONS: SAMPLES/MARKERS

Alvin Dive 2945: Source site, Origin 46° 05.718' / 129° 52.006'

Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2945-1N	11:05	2051	2061	4389	6633	343	46°09.299'	129°48.601'			Niskin (blue forward)	Niskin sample taken 1m above Church vent.
ALV2945-1D1	11:23	2059	2061	4387	6632	000	46°09.298'	129°48.603'		T1=278°C, T2=221.8°C	Manifold major - port outer	Church vent.
ALV2945-1D2	11:27	2059	2061	4385	6631	019	46°09.297'	129°48.604'		T1=276°C, T2=231.4°C	Manifold major - port inner	Church vent.
ALV2945-1G1	11:31	2059	2061	4385	6631	023	46°09.297'	129°48.604'		T1=269.8°C, T2=228.8°C	Manifold gas-tight - port	Church vent.
ALV2945-1G2	11:31	2059	2061	4385	6631	023	46°09.297'	129°48.604'		T1=269.8°C, T2=228.8°C	Manifold gas-tight - stbd.	Church vent.
ALV2945-1B	11:57	2059	2061	4389	6631	330	46°09.298'	129°48.601'		20-39°C (high T probe)	Worms	Worm sample on Church vent spire. Placed in left forward Bio-box.
ALV2945-2S	12:07	2062	2067	**	**	172	**	**			Sulfide	A small active sulfide spire ~10m west-northwest of Church vent. Placed in milk crate.
ALV2945-3N1	12:16	2041	2049	4399	6677	070	46°09.322'	129°48.593'			Niskin (middle)	Niskin tripped ~1m above undisturbed Mongo vent spire.
ALV2945-3D1	12:27	2046	2049	4399	6678	088	46°09.323'	129°48.593'		292.5°C (high T probe)	1st of discrete major pair (#12)	Discrete major tripped in stump of toppled Mongo vent.
ALV2945-3D2	12:27	2046	2049	4399	6678	088	46°09.323'	129°48.593'		292.5°C (high T probe)	2nd of discrete major pair (#5)	Discrete major tripped in stump of toppled Mongo vent.
ALV2945-3D3	12:33	2046	2049	4399	6678	106	46°09.323'	129°48.593'		292.5°C (high T probe)	Discret major #10	Discrete major tripped in stump of toppled Mongo vent.
ALV2945-3DG1	12:37	2046	2049	4399	6678	102	46°09.323'	129°48.593'		292.5°C (high T probe)	Discrete gas-tight #6 (yellow)	Discrete gas-tight tripped in stump of toppled Mongo vent.
ALV2945-3DG2	12:39	2046	2049	4399	6678	101	46°09.323'	129°48.593'		292.5°C (high T probe)	Discrete gas-tight #5 (red)	Discrete gas-tight tripped in stump of toppled Mongo vent.
ALV2945-3N2	12:40	2046	2049	4399	6678	102	46°09.323'	129°48.593'			Niskin - aft	Niskin tripped ~1m above stump of toppled Mongo vent.
ALV2945-3S	13:47	2046	2049	4406	6679	265	46°09.323'	129°48.587'			Sulfide	Sample taken from base section of toppled Mongo spire.
ALV2945-4S1	12:56	2048	2050	4382	6715	021	46°09.343'	129°48.606'			Sulfide	Fresh anhydrite top of one of the spires of Twin Spires vent.
ALV2945-4S2	12:56	2048	2050	4382	6715	021	46°09.343'	129°48.606'			Sulfide	Indurated base of Twin Spires.
ALV2945-4D1	13:02	2048	2050	4382	6715	029	46°09.343'	129°48.606'		253.8°C (high T probe)	Discrete major #6	Discrete major taken in broken-off spire orifice.
ALV2945-4D2	13:05	2048	2050	4382	6715	029	46°09.343'	129°48.606'		253.8°C (high T probe)	Discrete major #4	Discrete major taken in broken-off spire orifice.
ALV2945-4DG1	13:08	2048	2050	4382	6715	028	46°09.343'	129°48.606'		253.8°C (high T probe)	Discrete gas-tight #7 (purple)	Discrete gas-tight taken in broken-off spire orifice.
ALV2945-4DG2	13:13	2048	2051	4401	6717	045	46°09.344'	129°48.591'		253.8°C (high T probe)	Discrete gas-tight #2 (black)	Discrete gas-tight taken in broken-off spire orifice.
ALV2945-4S3	13:17	2048	2051	4401	6717	016	46°09.344'	129°48.591'			Sulfide	Inactive chimney ~1m Northwest of Twin Spires.
ALV2945-5R	13:21	2048	2051	4405	6713	023	46°09.342'	129°48.588'			Basalt	Pillow bud basalt ~4m East of Twin Spires.

Alvin Dive 2946: Floc site, Origin 46° 14.931' / 129° 47.48'

Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2946-1R	9:28	2198	2202	6478	7259	039	46°18.850'	129°42.440'			Basalt	Sample taken near constructional volcanic site.
ALV2946-2M1	11:53	2227	2228	6750	7202	255	46°18.819'	129°42.228'	11	1.94°C (low T probe), 2.4°C (manifold)	Manifold major #14 - port outer	Location North of Marker 11. Ambient temperature 1.66°C.
ALV2946-2M2	11:58	2227	2228	6750	7202	254	46°18.819'	129°42.228'	11	2.5°C	Manifold major #11 - port inner	
ALV2946-2G	12:00	2227	2228	6750	7202	254	46°18.819'	129°42.228'	11	2.5°C	Manifold gas-tight #4 - port	
ALV2946-2B	12:06	2227	2228	6750	7202	255	46°18.819'	129°42.228'	11		Tubeworms	Tubeworm grab contained approximately 25 tubes, 4-5 with occupants.
ALV2946-2R	12:09	2227	2228	6750	7202	276	46°18.819'	129°42.228'	11		Basalt sample	Rock sample of pillow wedge placed in forward Bio-box.
ALV2946-3R	12:47	2225	2226	6650	6918	232	46°18.665'	129°42.307			Basalt sample	Basalt sample the size of a "hard ball" broken in three pieces. Sampled from location between Marker 11 and Marker 3A.
ALV2946-4M1	13:50 - 14:06	2225	2226	6479	6698		46°18.547'	129°42.439'		T1=8.0°C, T2=4.0°C, 8.14°C (low T probe)	Manifold major #15 - stbd outer	Sample site located 7m Northeast of Marker 3A.
ALV2946-4M2	13:50 - 14:06	2225	2226	6479	6698		46°18.547'	129°42.439'		T1=8.1°C, T2=5.9°C	Manifold major #13 - stbd inner	Sample site located 7m Northeast of Marker 3A.
ALV2946-4G	13:50 - 14:06	2225	2226	6479	6698	073	46°18.547'	129°42.439'		T1=8.1°C, T2=5.6°C	Manifold gas-tight #3	Sample site located 7m Northeast of Marker 3A.
ALV2946-4DG	14:09	2225	2226	6479	6698	073	46°18.547'	129°42.439'		T1=8.2°C, T2=5.9°C	Discrete gas-tight #7 (purple)	Sample site located 7m Northeast of Marker 3A.
ALV2946-4D1	14:15	2225	2226	6479	6698	081	46°18.547'	129°42.437'			Discrete major #4	Sample site located 7m Northeast of Marker 3A.
ALV2946-4#17	14:35	2225	2226	6479	6698		46°18.547'	129°42.437'	17		Marker deployment - #17	
ALV2946-4N	14:42	2222	2226	6473	6700		46°18.548'	129°42.444'	17		Niskin	The first Niskin tripped did not fire (broke off attached poly hood). This Niskin successfully fired directly over vent.
ALV2946-4D2	14:59	2225	2226	6475	6701		46°18.548'	129°42.442'	17		1st of double major #5	This sample was fired to simulate a slurp sample. Only the first (#5) of the two fired.
ALV2946-4D3	14:59	2225	2226	6475	6701		46°18.548'	129°42.442'	17		2nd of double major #12	This sample was taken to simulate a slurp sample. This one did not fire.
ALV2946-4D4	15:10	2225	2226	6475	6701		46°18.548'	129°42.442'	17		Discrete major #6 (yellow)	This sample was fired while scraping surface of rock to simulate a slurp sampler.

Times that time were taken from the Surface navigation.

Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2946-4D4	15:10	2225	2226	6475	6701		46°18.548'	129°42.442'	17		Discrete major #6 (yellow)	This sample was fired while scraping surface of rock to simulate a slurp sampler.

**InSub navigation ceased logging at 12:42:30 so the positions in the above table after that time were taken from the Surface navigation.

Alvin Dive 2947: Floc site, Origin 46° 14.931' / 129° 47.48'

ALV2947-1B	9:45	2223	2224	6472	6701	090	46°18.548'	129°42.444'	17		Tubeworms	Worms and other macrofauna placed in port Bio-box in forward compartment.
ALV2947-1R	9:59	2222	2223	6470	6702	054	46°18.549'	129°42.446'	17		Basalt	Rock collected from region of venting. Sample placed forward of port Bio-box.
ALV2947-2M1	11:12'	2251	2251	**	**	056	**	**	16		Marker deployment - #16	Marker deployed. **Note: Marker had been accidentally snagged and redeployed on dive 2951. See Markers table for final position.**
ALV2947-2M1	11:12	2251	2251	**	**	056	**	**	16		Manifold major - port outer	Manifold computer locked up during sampling, uncertain of the fluid temperature during sampling. File name "2947-HDV". At HDV site.
ALV2947-2M2	11:29	2251	2251	**	**	058	**	**	16		Manifold major - port inner	Manifold file name "2947-HDV2".
ALV2947-2G1	11:33	2251	2251	**	**	058	**	**	16	T1=13.8-14.4°C, T2=12.4°C; 16.7°C (low T probe)	Manifold gas-tight	
ALV2947-2D	11:38	2251	2251	**	**	058	**	**	16	16.7°C (low T probe)	Discrete major	
ALV2947-2G2	11:40	2251	2252	**	**	058	**	**	16	16.7°C (low T probe)	Dicrete gas-tight	
ALV2947-2B	11:42	2251	2252	**	**	051	**	**	16	16.7°C (low T probe)	Macrofauna	Sample placed in starboard Bio-box.
ALV2947-2T	11:48	2251	2252	**	**	332	**	**	16	16.7°C (low T probe)	Macrofauna	Sample placed in starboard Bio-box.
ALV2947-2R	11:55	2249	2251	**	**	038	**	**	16		Basalt	
ALV2947-2SL	12:01	2249	2251	**	**	038	**	**	16		Slurp gun	
ALV2947-3R	12:56	2272	2276	6377	6416	333	46°18.394'	129°42.519'	2	1.8-1.9°C (low T probe)	Basalt	Collected dead tubeworms attached to basalt.
ALV2947-3B	12:56	2272	2276	6377	6416	333	46°18.394'	129°42.519'	2	1.8-1.9°C (low T probe)	Tubeworms	Collected dead tubeworms attached to basalt.
ALV2947-4R	13:49	2267	2268	6229	6045	181	46°18.194'	129°42.634'	10	2.0°C	Basalt	
ALV2947-5D	14:43	2236	2254	6506	6593	306	46°18.490'	129°42.418'			Discrete major	Background seawater sample taken at 9m above bottom.

**No good InSub navigation from 10:41 to 12:14.

Alvin Dive 2948: Floc site, Origin 46° 14.931' / 129° 47.48'

ALV2948-1R	9:26	2212	2212	6098	3897	321	46°17.035'	129°42.737'			Basalt	Old basalt lobe. Placed between Bio-box and divider.
ALV2948-2R	9:55	2238	2239	5647	4003	023	46°17.092'	129°43.087'			Basalt	Jumbled flow (~15cm). Placed in port front region of basket.
ALV2948-3SL	10:20	2244	2246	5638	4142	283	46°17.167'	129°43.094'			Slurp gun	Bacterial slurp from area of no visible venting water, but significant amounts of bacteria.
ALV2948-4N	10:37	2236	2241	5651	4189	352	46°17.192'	129°43.083'			Niskin - forward (yellow)	Niskin fired near the top of a huge wall.
ALV2948-5#18	11:03:50	2230	2241	5646	4180	268	46°17.187'	129°43.087'	18		Marker deployed - #18	Marker deployed on top of "fuzzy" fissure wall.
ALV2948-6R	11:11	2231	2231	5640	4176	023	46°17.185'	129°43.092'			Basalt	Basalt rope sample from top of big wall near Marker 18. Sample (12 x 15cm) placed in front starboard milk crate.
ALV2948-7R	11:49	2201	2202	5107	4263	119	46°17.232'	129°43.507'			Basalt	Pillow bud from top of older pillow mound. Softball-sized sample placed between milk crate and Bio-box.
ALV2948-8R	12:12	2202	2204	**	**	078	**	**			Basalt	Pillow bud of young-looking flow. Curved pillow tube placed in left front corner.
ALV2948-9R	13:10	2193	2194	5403	5208	350	46°17.742'	129°43.276'			Basalt	Softball-sized sample of young material from newish mound. Placed in milk crate.
ALV2948-10R	13:30	2200	2202	5502	5408	281	46°17.850'	129°43.199'			Basalt	Older bud (20 x 13cm) placed in right front area behind slurp gun.
ALV2948-11R	13:58	2193	2194	5531	5682	312	46°17.998'	129°43.177'			Basalt	New lobe fragment from second 1982-91 mound traversed. Sample (~20cm diameter) placed in front center.
ALV2948-12D	15:31	2145	2235	5989	5300	193	46°17.792'	129°42.820'			Discrete major #10 (blue)	Water sample tripped ~90m above bottom.

Alvin Dive 2949: Floc site, Origin 46° 14.931' / 129° 47.48'

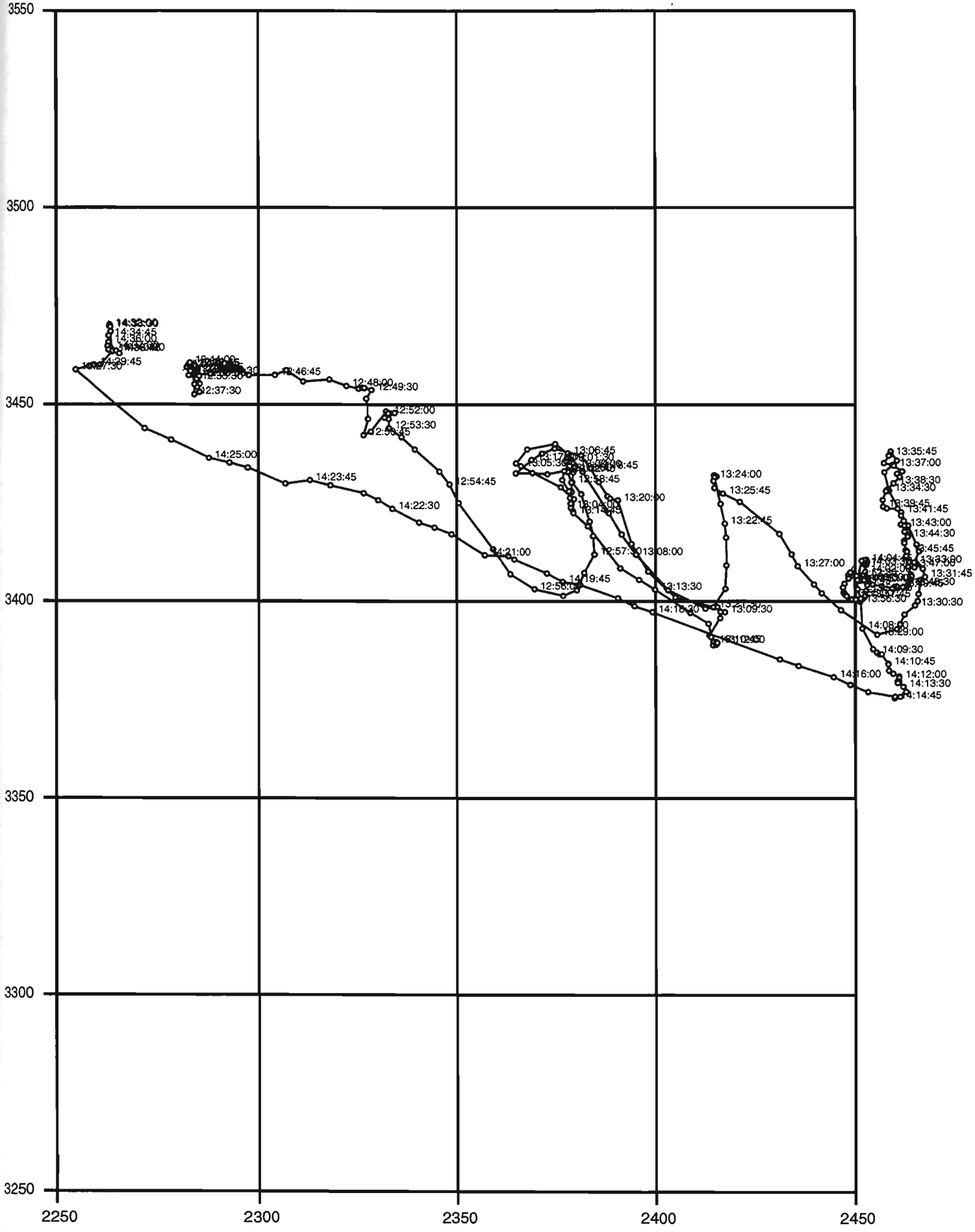
ALV2949-1R	10:35	2239		5602	4022	327	46°17.102'	129°43.121'			Basalt	Basalt with white mat coating. Recovered from base of fissure wall on west side.
ALV2949-2M1	11:07	2243		5623	4113	247	46°17.151'	129°43.105'	15	T1=5.0°C, T2=4.5°C	Manifold major - port outer	
ALV2949-2M1	11:07	2243		5623	4113	247	46°17.151'	129°43.105'	15	T1=5.0°C, T2=4.5°C	Manifold major - port inner	

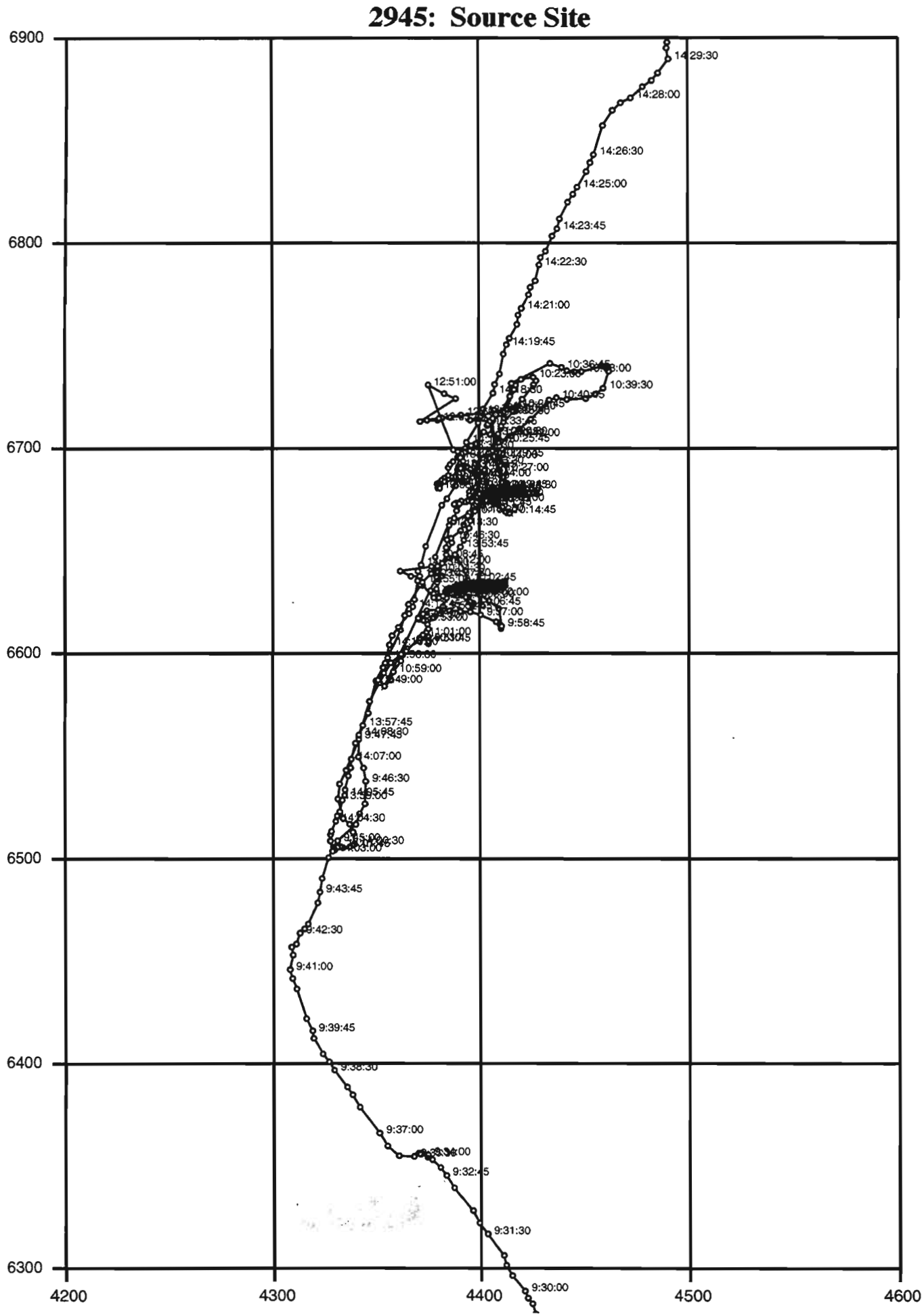
Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2949-2G	11:07	2243		5623	4113	247	46°17.151'	129°43.105'	15	T1=5.0°C, T2=4.5°C	Manifold gas-tight - port	
ALV2949-2#15	11:20	2242		5623	4113	247	46°17.151'	129°43.105'	15		Deployed Marker 15	
ALV2949-3M1	11:45	2242		5649	4186	357	46°17.190'	129°43.084'	18	5.7°C (low T probe)	Manifold major - stbd. outer	Location in fissure below Marker 18.
ALV2949-3M2	11:45	2242		5649	4186	357	46°17.190'	129°43.084'	18	5.7°C (low T probe)	Manifold major - stbd. inner	Location in fissure below Marker 18.
ALV2949-3G	12:11	2242		5649	4186	357	46°17.190'	129°43.084'	18		Manifold gas-tight - stbd.	Location in fissure below Marker 18.
ALV2949-3R	12:17	2242		5648	4185	003	46°17.190'	129°43.086'	18		Basalt	Rock from base of fissure with limpets on it. Same location as above.
ALV2949-3B	12:18	2242		5648	4185	003	46°17.190'	129°43.086'	18		Slurp sample	Slurp sample of mat with small red worms. Same location as above.
ALV2949-4R	12:42	2243		5690	4236	297	46°17.218'	129°43.053'			Basalt	Sheet flow drain back remnant on west wall of fissure. Position is that of Station 5 except ~10-20 meters due west.
ALV2949-5R	12:45	2242		5701	4236	265	46°17.217'	129°43.044'		5.6°C (low T probe)	Basalt	From altered zone on east wall of fissure. Opposite from Station 4. Position taken after station when sub rose off the bottom.
ALV2949-6D1	13:13	2248		5682	4458	332	46°17.337'	129°43.059'	26	5.6°C (low T probe)	Discrete major #6	
ALV2949-6D2	13:13	2248		5682	4458	332	46°17.337'	129°43.059'	26	5.6°C (low T probe)	Discrete major #4	
ALV2949-6DG	13:20	2248		5682	4458	332	46°17.337'	129°43.059'	26	5.6°C (low T probe)	Discrete gas-tight (purple)	
ALV2949-6B	13:29	2247		5682	4458	317	46°17.337'	129°43.059'	26		Tubeworms	Juvenile tubeworms from ~0.5m below Marker 26.
ALV2949-6#26	13:37	2244		5682	4458	038	46°17.337'	129°43.059'	26		Marker deployment - #26	Deployed marker a few meters from west wall of fissure.

Alvin Dive 2951: Floc site, Origin 46° 14.931' / 129° 47.48'

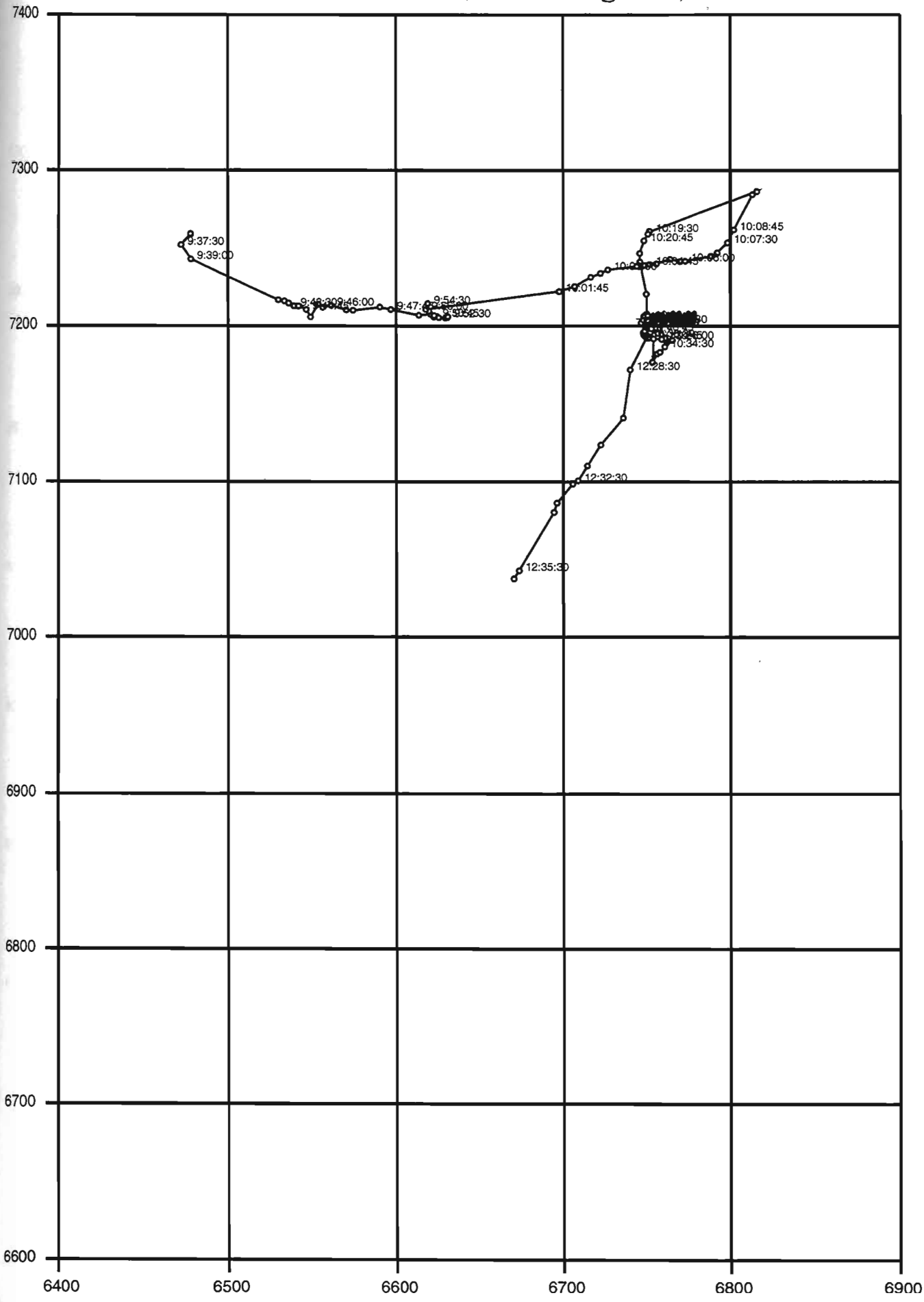
ALV2951-1#19	11:25	2254	2266	6453	6612	321	46° 18.500'	129° 42.459'	19		Marker deployment - #19	HDV site: south of line of tubeworms
ALV2951-2#24	11:28	2252	2253	6434	6616	280	46° 18.502'	129° 42.474'	24		Marker deployment - #24	HDV area.
ALV2951-3#22	11:30	2247	2251	6428	6623	016	46° 18.506'	129° 42.479'	22		Marker deployment - #22	HDV area.
ALV2951-4#27	11:34	2244	2246	6452	6631	048	46° 18.510'	129° 42.460'	27		Marker deployment - #27	HDV area.
ALV2951-5#32	11:40	2242	2246	6411	6636	276	46° 18.513'	129° 42.492'	32		Marker deployment - #32	HDV area.
ALV2951-6#29	11:42	2239	2241	6399	6643	009	46° 18.517'	129° 42.501'	29		Marker deployment - #29	HDV area.
ALV2951-7#23	11:50	2235	2238	6465	6658	018	46° 18.525'	129° 42.450'	23		Marker deployment - #23	HDV area.
ALV2951-8SL	12:52	2250	2252	6447	6620	030	46°18.504'	129°42.464'			Slurp gun	Slurped white mat west of line of tubeworms.
ALV2951-8N1	13:18	2249	2251	6448	6624	328	46°18.506'	129°42.463'		T1=10.3°C, T2=2.5°C	1st of double Niskins	Niskins tripped together.
ALV2951-8N2	13:18	2249	2251	6448	6624	328	46°18.506'	129°42.463'		T1=10.3°C, T2=2.5°C	2nd of double Niskins	Niskins tripped together.
ALV2951-8M1	13:24	2248	2250	6450	6626	328	46°18.507'	129°42.461'	*16	T1=14.2°C, T2=11.9°C	Manifold major - port outer	Sample from the HDV area *~1.5m southwest of Marker 16.
ALV2951-8M2	13:29	2248	2250	6450	6626	324	46°18.507'	129°42.462'	*16	T1=13.5°C, T2=11.5°C	Manifold major - port inner	Sample from the HDV area *~1.5m southwest of Marker 16.
ALV2951-8G1	13:39	2249	2251	6450	6626	312	46°18.507'	129°42.461'		T1=16.5°C, T2=10.5°C	Manifold gas-tight - port	HDV area.
ALV2951-8G2	13:50	2249	2250	6452	6627	312	46°18.508'	129°42.460'		T1=15.8°C, T2=12.4°C	Manifold gas-tight - stbd.	HDV area.
ALV2951-8B	13:51	2249	2250	6452	6630	327	46°18.509'	129°42.460'			Biology	HDV area.
ALV2951-9#16	13:59	2249	2251	6458	6623	304	46° 18.506'	129° 42.455'	16		Marker deployment - #16	HDV area.

2940: Flow Site - Extensometer

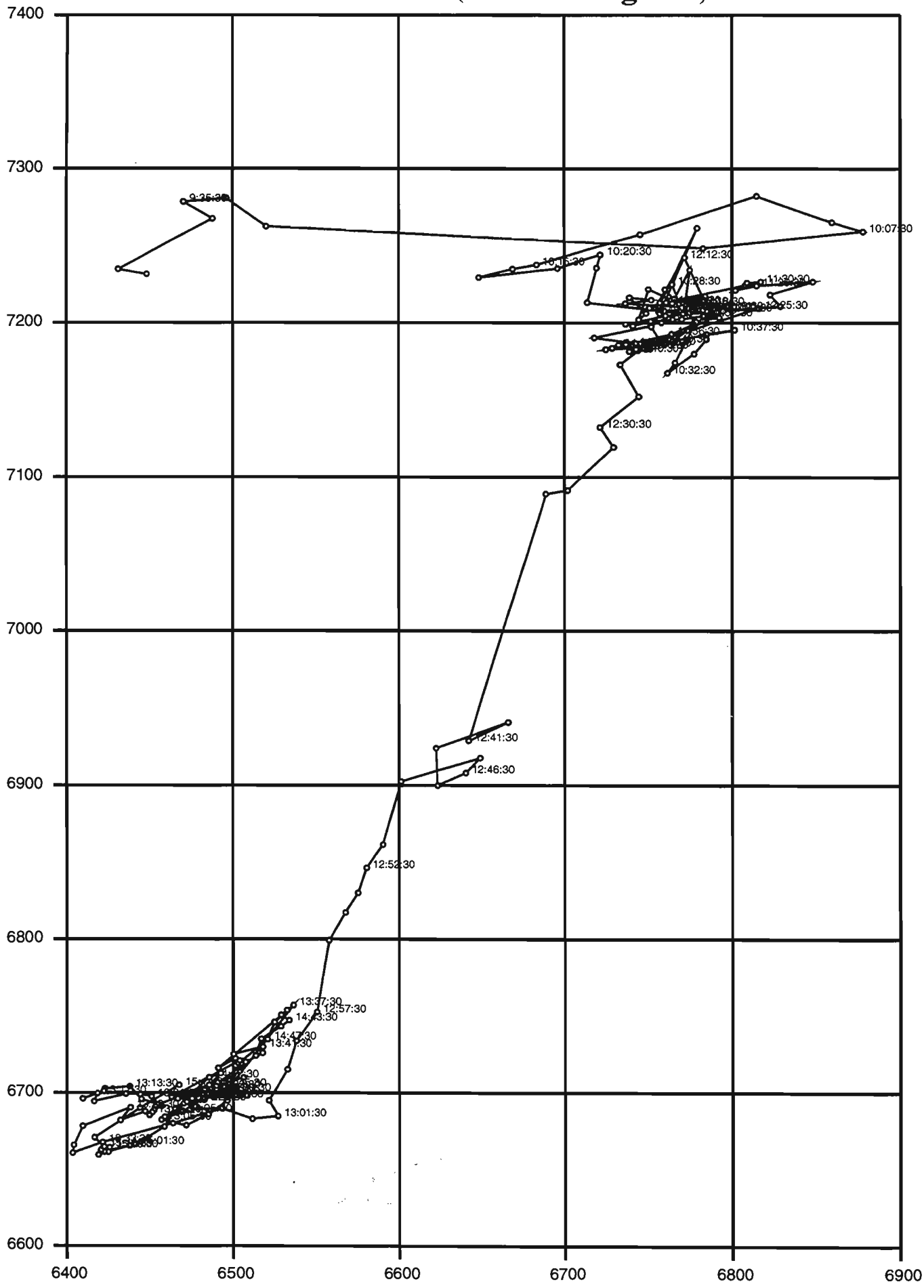



2945: Source Site
6900
6800
6700
6600
6500
6400
6300
4200
4300
4400
4500
4600
14:29:30
14:28:00
14:26:30
14:25:00
14:23:45
14:22:30
14:21:00
14:19:45
12:51:00
10:39:30
9:58:45
10:59:00
13:57:45
14:07:00
9:46:30
9:43:45
9:42:30
9:41:00
9:39:45
9:38:30
9:37:00
9:32:45
9:31:30
9:30:00

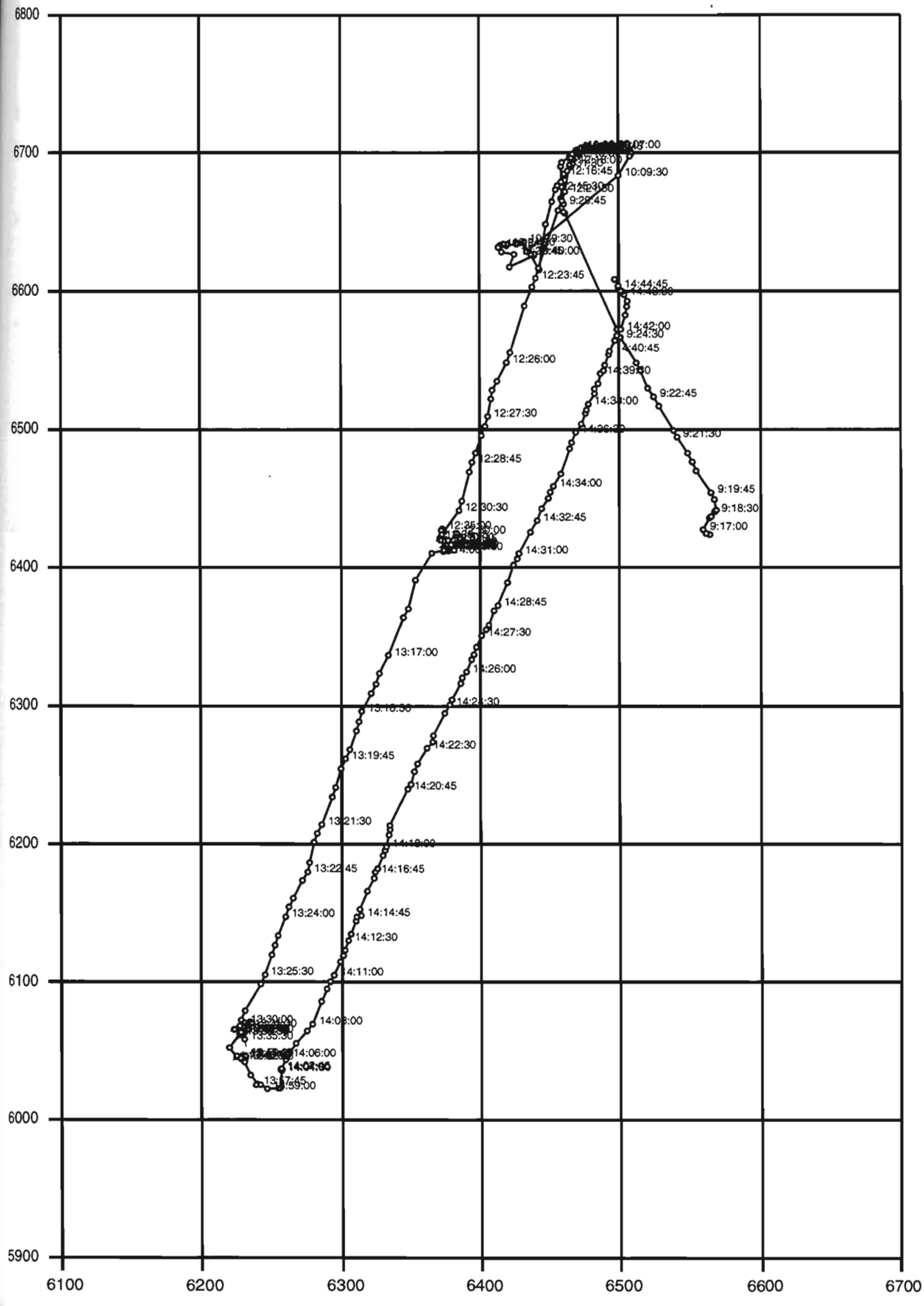
2946: Floc Site (Insub navigation)



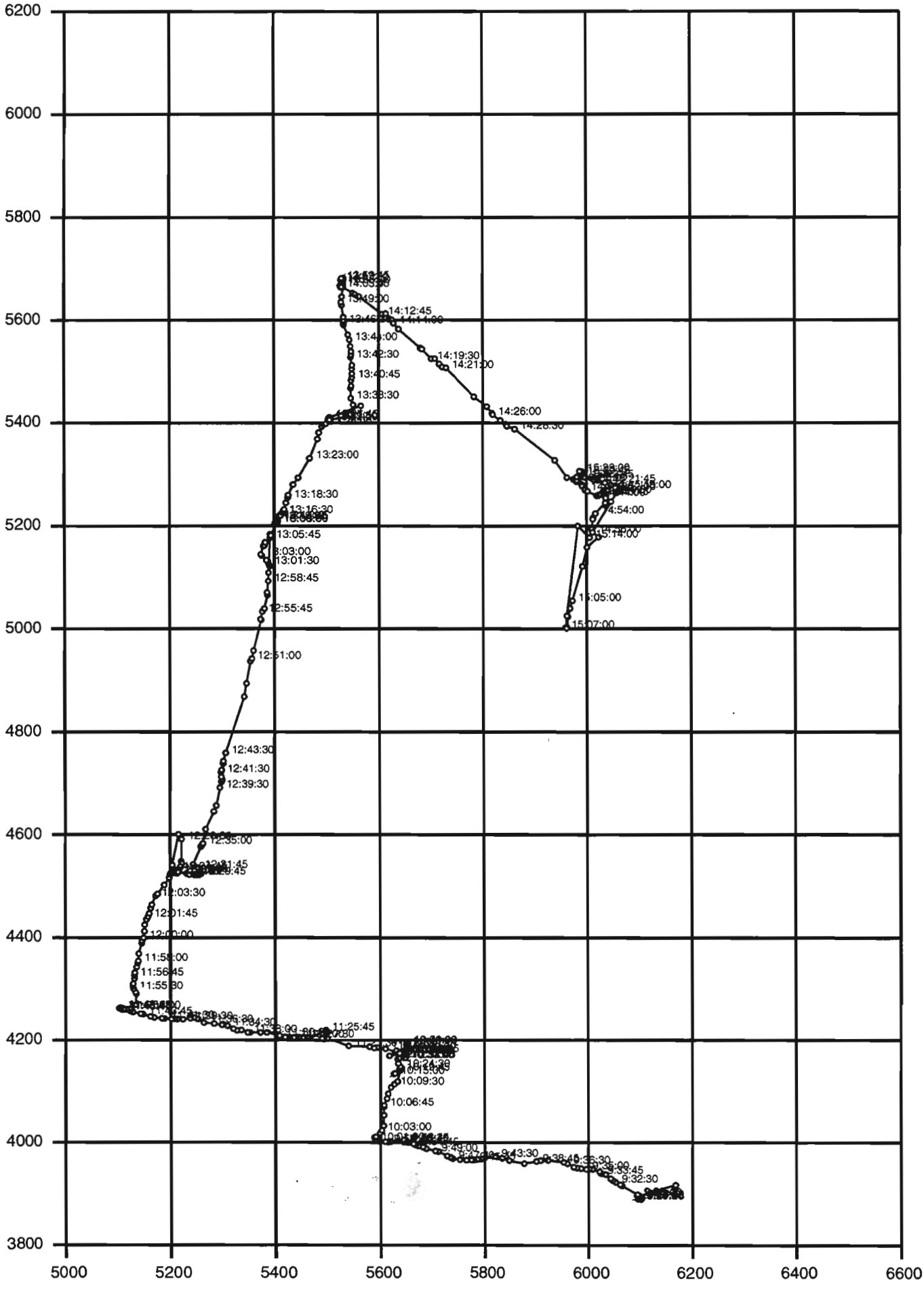
2946: Floc Site (Surface navigation)



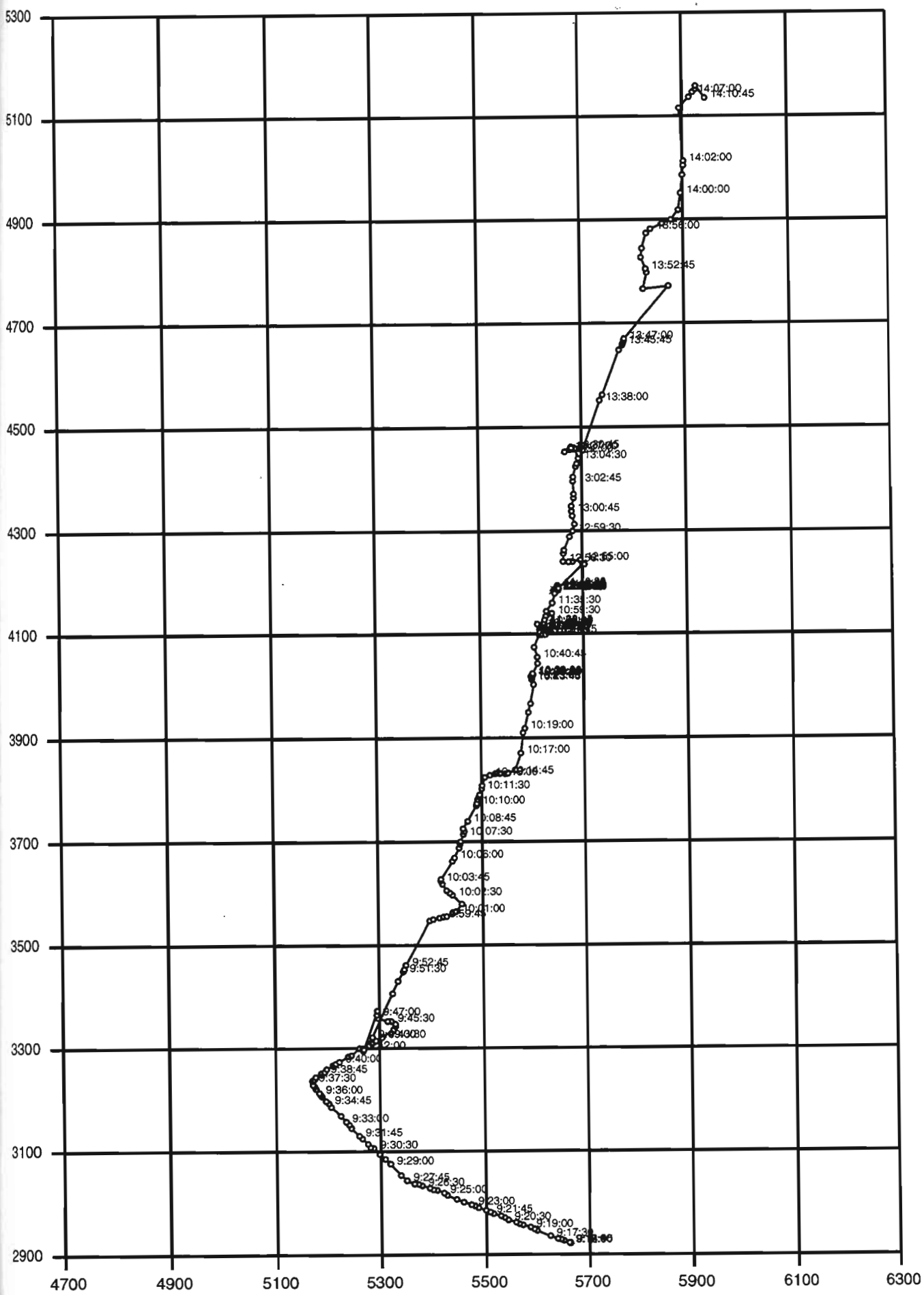
2947: Floc Site



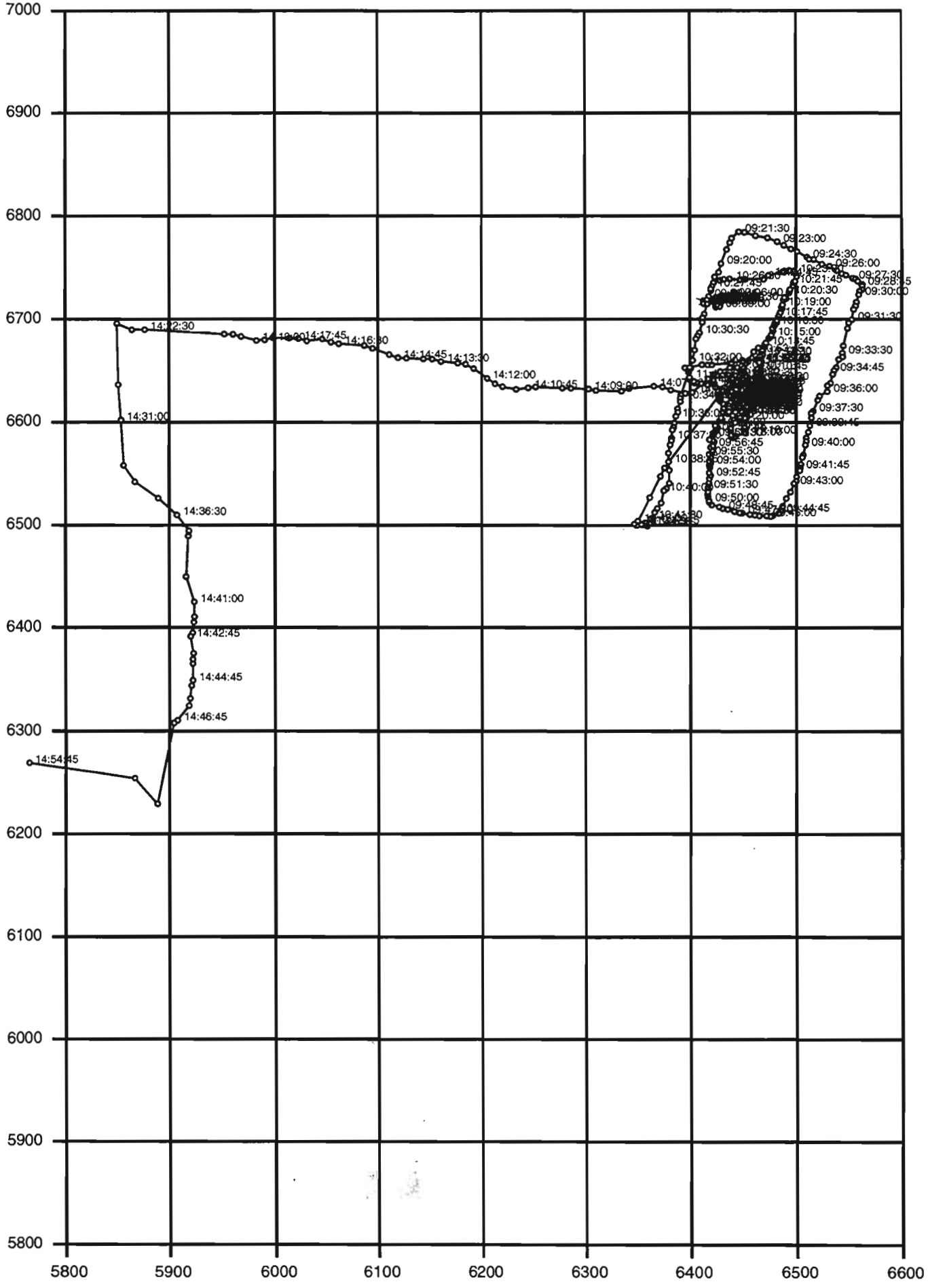
2948: Southern Floc Site



2949: Southern Floc Site



2951: Floc Site



NORTHERN CLEFT SEGMENT

NORTHERN CLEFT

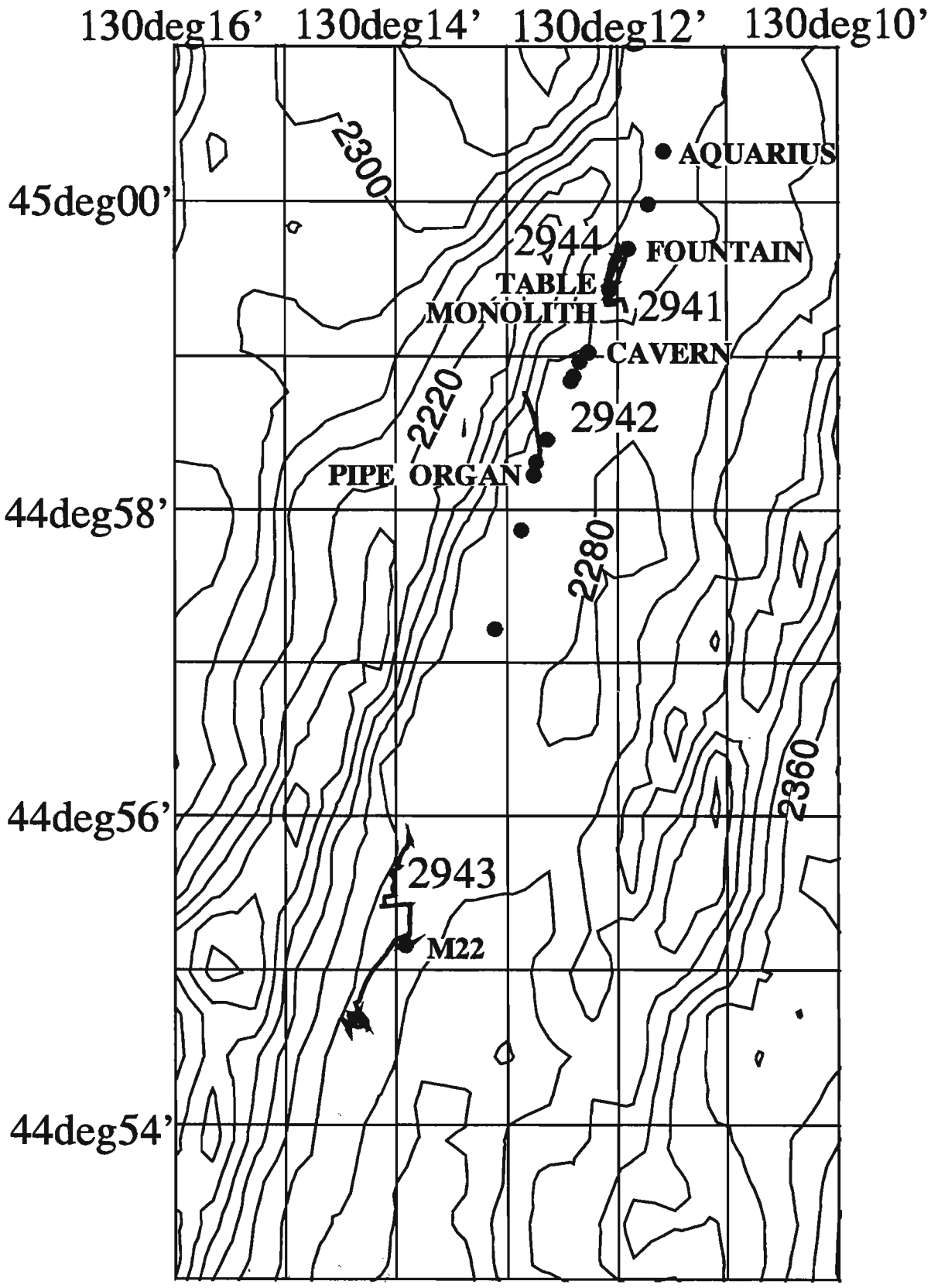


Figure 6

DIVE SUMMARIES - NORTHERN CLEFT SEGMENT

Video set-up for all dives:

high 8 mm recorder #1: recorded video from the two Alvin color 1-chip cameras and the black/white down-looking sit camera.

high 8 mm recorder #2: recorded the 3-chip camera exclusively.

*All depths are TOTAL water depth, unless otherwise noted.

DIVE 2941: DATALOGGER RECOVERY AT MONOLITH AND TABLE VENTS, PART 1

June 27, 1995
Pilot: Bob Grieve
Port Observer: Meg Tivey (author of this summary/transcript)
Starboard Observer: Steve Liberatore

Dive Objectives:

To recover 2 dataloggers and 3 thermistor tripods from Monolith and Table Vents (these were deployed August 6, 1994), to photograph and estimate sizes of any structures that grew through thermocouple loops, and to sample fluids at Monolith and/or Table using 2 major and 2 gas tight bottles.

Narrative:

All objectives accomplished except sampling fluids at Table Vent. We landed southeast of Monolith, went west to the fissure, then north to the site. We took good 3-chip video of the tripod and TC loop (which had a chimney grow through it) at the Marker B site, Monolith Vent. We then recovered the datalogger and the tripod that had been left in the crate. The ICL did not work (though it did work in a test at the surface just after we submerged). We then sampled a small 295°C smoker on the west side of Monolith for fluid (gas tight and major) and solid samples (Station 2). We then went to Table Vent where we took good 3-chip video of the deployed tripod and TC loop, and recovered the datalogger, crates, and other tripod. After adjusting the weight of the sub, we returned to Monolith, and sampled fluid at a 296°C vent (gas tight only - Station 4). We did a full 3-chip video survey of Monolith, and then of Table Vent, and did a temperature probe survey of the Table TC loop (T ranged from 2.8°C at electronics to 20 to 176°C inside loop to 266°C at a spot outside the loop). We sampled a small inactive spire near the TC loop (Station 6).

Audio Transcript:

1005h: 2260m (sub 2256m), on bottom on old sedimented pillow and lobate flows. x2449, y3361.
1006h: Port camera on at rep rate of 30 sec starting at 172. Both videos started. 2259m (sub 2258m), x2449, y3368.
1009h: Port camera off
1011h: At launch target and heading toward target 1 over lobate flows with dusting of sediment with some ponding of sediment. Hdg 340, 2260m (sub 2258m), x 2454, y 3388. Port cam on at 8 s rep rate.
1013h: Decreasing rep rate of port camera to 15 sec.

1014h: Coming to small fault scarp about 2 m high. Hdg 344, trends at 240 to 344.
1015h: Turning to head west. Dropping off about 3 m - over large fissure. 10 m wide fissure, trends N-S. Our hdg is 264.
1018h: Crossing another N-S fissure, drops 3-5 m, width 20 m - walls of fissure not as sharp as previous.
1020h: Another N-S fissure, 10 m deep, 5 m wide, in sedimented lobate flows, hdg 268
1021h: Another small fissure, 2253m (sub 2251m).
x2220, y3505, 2254m (sub 2252m), hdg 266, just crossed contact old to new flow.
1025h: At fissure, nice collapse features; pillars; turning to head north, depth 2269m (sub 2253m), x2204, y3505.
1030h: At Monolith, x2238, y3613.
1031h: First glance, a lot less activity than last year. Have found instrument package.
1035h: At Station 1, Marker B on Monolith, Hdg 211, x2249, y3630, 2250m (sub 2248m). Changing rep rate of port cam to 30 sec,
1049h: Finished good 3-chip video of TC loop (with chimney growing through it) and tripod.
1052h: Trying ICL loop, against pad at 1053h - no luck, even against tester, but DID work when first in water (Later found that it had leaked).
1102h: TC loop cable cut
1105h: TS tripod cable cut.
1108h: Finished at marker B site. Instrument ALV2941-1I recovered - datalogger/milk crate package with 1 tripod in crate (was never taken out of crate), left other tripod and TC loop to recover next dive. Going to sample high T fluids somewhere on Monolith.
1113h: Looking for smoker to sample, can see some talus that has fallen since last year - ~1 ft block is sitting against anchor of marker W10??.
1115h: Structure has changed significantly since last year. Few beehives, none robust. Mostly chimneys. Hdg 325. At an orifice just N of where Kadko's bike flag is.
1116h: Station 2, sampling small smoker, hdg 304, x2244, y3618, 2251m (sub 2247m), T 295°C.
1130h: Bottle 6 triggered (ALV2941-2D). Put in milk crate. Probably entrained seawater since came out of hole while sampling.
1134h: White (really purple) gas tight sample (ALV2941-2G) taken. One small piece of sulfide, tip of orifice, also sampled (ALV2941-2S=Rock 1).
1139h: Finished at Monolith. Hdg 351, looking for Table vent. Took 3 or 4 photos (handheld) of smoker that grew through TC loop at Station 1 out of port window. Starboard strobe not working.
1148h: At Table Vent - Station 3 - just took good 3-chip video of the deployed TS tripod, and the TC loop.
1152-1153:30h: tried ICL again - no luck.
1155h: Cutting cables - 1155:30 TC loop cable cut; Instrument ALV2941-3I recovered - crate in basket at 1157; TS tripod cable cut at 1158:52.
1204-1205h: Changed video tapes. Checked max T in tripod = 20°C.
1207h: Recovering tripod.
1211h: Left shackle w/polypro line where tripod was.
1227h: Port camera off.
1234h: Went off to west to pump water and drop one weight. Done pumping.
1236h: Port cam back on at rep rate of 30 s. Off 10 m cliff hdg 096, were at 2222m (sub 2221m), x 2189, y3679, went there to pump in relatively clean water and drop 1 weight to trim sub. Now going back to Monolith. Just reached other side of 10-15 m wide fissure.
1237h: On broken sheet flow. Old sulfide structure x2216, y3680, (sub 2226m), 2-3 spires ~2 m diameter at base and 2 to 2,5 m high, tapering to points at the top. Sitting on edge of NNE trending scarp. Now descending benched slope of talus.
1240h: Slope of broken sheet flow 3-6" to 1/2 m in size, 2236m (sub 2235m), x2236, y3671.
1243h: 2245m (sub 2244m), x2258, y3674y, over old lobate flows with sed cover and some spider crabs.

1245h: At base of slope is flat old sheet flow - fissured N-S, hdg 207 and following fissures, 1/2 m wide.
1250h: I sent us too far east - now turning back to go west to Monolith. x2289, y3611, 2256m (sub 2250m), hdg 267.
1252h: Back at Monolith.
1254h: At Station 4, at smoker higher up on Monolith than station 2. 2254m (sub 2246m), x2238, y3620.
1256h: T of vent is 296°C
1256h: Using gas tight on 296 vent, sitting 6 m up on cliff of basalt and then sulfide. Some sulfide and basalt talus. Where there used to be beehives there is now smokers.
1258:20h: Tripped yellow gas tight bottle (ALV2941-4G). Put bottle in with tripod.
1259h: Good 3-chip of 296°C smoker. No solid sample taken.
1300-1313h: Video survey of Monolith starting at top and spiraling down clockwise, 1.5 revolutions (see Alvin video for hdg info).
1319h: Measuring T on outside of small spire at Station 5; 6 to 20°C, using Hi T probe. Sample taken (ALV2941-5S) and placed in front starboard milk crate. T of flow after taking spire= 285°C. x2246, y3621.
1324h: At N side of Monolith over low lying structures with diffuse flow. Hdg to Table vent. x2246, y3627, 2251m (sub 2246m).
1343h: Just completed video survey of Table vent, clockwise.
1347h: T probe survey of Table TC loop. 2.8 at electronics, 176 at point at edge, 20°C in center, 22°C at outside (see video). Highest T 266°C at spot just outside loop.
1353h: Finished with T probe.
1356h: Sampled small inactive spire at Station 6, near TC loop, and placed it in port forward milk crate (ALV2941-6S).
1358h: Leaving Table/Monolith sites.
1405h: Transitting east to get over sheet flow Hdg 097. 2249m (sub 2246m), x2262, y3656.
1424h: Dive over 2253m (sub 2245m) 2172x, 3883y, End of dive - driving lesson over. Port camera at 725 (started at 102). 11 photos taken using port handheld.

DIVE 2942: PIPE ORGAN VENT

June 28, 1995
Pilot: Dudley Foster
PIT: Tom Reese
Observer: Dave Butterfield (author of this transcript)

Audio Transcript:

0930h: 2074m At top of mooring level, using CTFM to locate. Nav giving consistent fixes.
0950h: Video turned on. Mooring in sight.
0953h: 2186m. Descending down the mooring line. It is in the video, both 3-chip and Alvin.
time? At base of mooring. Our position in the net says we are 60 meters bearing 240° from the stated target.
1003h: Clock on 3-chip says 084720 at 100411 Alvin time, and the date is set to 06/27/95. Dudley will correct this later. We take some closeup video of the mooring release. The mooring is vertical and looks normal, no lines tangled. Release failed.
101625h: The mooring was released by giving it a slight upward tap at the base of the release.
1024h: Heading 167°, alt 10m, heading for target 2, Tripod vent area. Old pillow terrain, no tectonic features observed. Tom is driving.
1034h: 2260m. Still over pillow terrain, but we are flying too high to see bottom well. Recording down-looking sit camera.

103950h: Can see the bottom. We are now over sheet flows with collapse pits. Heading 175°, total depth 2267m. Extensive area of lobate flow with collapsed roof. Some pillars. We are too high for the 3-chip camera to pick up the bottom

1046h: Ropy sheet flow, no collapse. Dusting of sediment. Striated. Total depth 2270m, alt 4m, heading 184°. Some glassy sheen visible.

1047h: Pressure ridge of jumbled ropy flow, only a meter or two high.

1052h: Bow cameras back on at 8 seconds. They were turned off when we were too high in the water to see bottom.

1100h: Still on sheet flow, some hydrothermal sediment here. Looking for edge of sheet flow.

1105h: We see the contact of the lava lake edge. We will drive south along the edge of the lava lake and look for marker 40. We did not see any markers coming over the smooth sheet flow area in the tripod target area.

time? 1388,1498 xy current position. Pipe Organ target is 1357,1428. Tom skipped by the tripod target area, so we are pretty close. We have a discussion of how to find Pipe Organ vent by driving south on the ledge of the drainback wall of the lava lake. After some minutes we get moving along the ledge heading south. We keep driving south along the edge for about 10 minutes.

time? Dudley sees some staining or mat to starboard. Possibly some shimmering water. Tom sees the marker and drives to it.

1122h: At marker 40 with Pipe Organ on the right. We will do a video survey first, then move in for sampling. Start at heading 223°, depth 2259m at top of vent. Dudley points the 3-chip straight out. Switching between the sit and overhead color camera. Approximate x/y is 1372/1379.

1126h: Continuing the video survey. Moving south along the east side.

1131h: More video looking east. I count five or possibly six spires.

1132h: Brief closeup of biology on vent.

1133h: heading 160°, we have come nearly all the way around. At heading 180°, we look right down the line of the spires.

1135h: After circling the structure from north along the east side, around the south end and back up the west side. Depth 2264m, heading 210°, we are moving in to sample a smoker on the north end. Dudley setting up the sub.

1200h: Changed video between taking temperature and water samples. Max T was 291°C, but was not very stable. Heading 147°, depth 2264m, total 2268m.

1201h: STATION 1 We take discrete major sample #4, gas-tight #6, and major #6, all at the north end of the structure between 12:01 and 12:25. Vent orifice is about 1m from top of structure. Maximum temperature here was 291°C, and was not very stable.

1204h: Changed bow camera to 60 second rep from 15.

1228h: We move to the south end for more sampling. Biological texture covers most of the surface of the sulfide. Most areas are orange, but some appear more white and the colonization is more healthy looking.

1238h: STATION 2 Multiple orifice smoker 70cm from top of structure at south end. Setting up for more water sampling. At 12:44 we take double major (bottle numbers 10 and 11) and gas tight #2 at 12:54. Maximum temperature here was 300°C. I can see the spires out the starboard porthole, and a block of basalt at the base of the sulfide.

1243h: STATION 3. At 13:18, take double major (bottle numbers 9 and 1) on second large spire from the south end, on the east side. In stowing the samplers after using them, they fell over the back end of the basket and we're not sure if they are still on the sub or not. A few minutes later we take gas-tight number 7 in the same orifice. Maximum temperature here was 291°C.

1334h: STATION 4 Orange Niskin taken above Pipe Organ at 2261m. Blue Niskin taken at

1336h: at depth 2260m. Red Niskin taken at 13:39 at depth 2256m.

1342h: Looking for vent again. We are looking for diffuse sites to sample. Bob Embley calls down that it would be helpful to run Mesotech sonar lines over the vent.

1348h: We hear unidentified pinging lasting for about 1 minute. Still looking for the vent. We don't get good fixes very often and it takes us a while to get back to the vent.
1421h: We see the double major pair that dropped off the back of the basket. It is lodged at the base of Pipe Organ on the east side. It is out of reach of the sub's arms and we cannot recover it. Heading 262°, depth 2268m, total 2269m. Just below the second spire from the south end.
1505h: We run a Mesotech line from south to north trying to drive over Pipe Organ vent, but we did not see the vent. We were too close to the bottom to get good data.
1529h: We end the dive in the marker 2 area. There is no diffuse venting, no animals. Only some hydrothermal sediment remains in this area that was very actively venting in 1988. We see marker 3. 1382/1562 x/y. Dropped weights here.

DIVE 2943 - 44° 54'N, Inner Graben

June 29, 1995
Pilot: Bob Grieve
Port Observer: Bob Embley
Starboard Observer: Tom Reese (PIT)

Dive Objectives:

The dive had three goals. The first one was to release two Miniature Temperature Recording (MTR) moorings that failed to release. The second goal was to find the Marker 22 vent site which had been visited and sampled in 1990 by ALVIN and in 1993 by ROPOS. The third goal was to map the southernmost portion of the young sheet flow and associated structures.

Narrative:

The ALVIN reached bottom at 09:59 Local time near the drop position of the MTR moorings. In-sub navigation was poor to nonexistent for the first half of the dive and the sub had to be vectored to targets from the surface. Mooring T23 (deployed in 1994) was in sight at 10:22 and released at 10:45. It had dropped into a shallow collapse pit in older lobate lava flows. The second mooring was searched for until 12:13. The mooring did not respond to acoustic interrogation and the CTFM could not locate it. At 12:13, ALVIN began to drive towards the Marker 22 site. However, the lack of insub navigation frustrated the search for this target also. Several areas of hydrothermal sediments were observed in the vicinity but no active venting was found and the marker was never seen. At 13:28 ALVIN headed north to look for southern portion of young sheet flow. A series of northwest and northeast trending lines across a recent fissure zone were made at the end of the dive but no fresh lava was encountered. The dive ended at 14:41.

DIVE 2944: COMPLETING TC/TS INSTRUMENT RECOVERY

June 30, 1995
Pilot: Dudley Foster
Port Observer: Meg Tivey (author of this summary/transcript)
Starboard Observer: Steve Liberatore

Dive Objectives:

Recover thermocouple loops and last tripod, take water samples, collect sulfide worms, do mesotech survey north to Fountain, take video and temperature measurements at Fountain.

Narrative:

All objectives were met except for collecting water samples and doing any work at Fountain Vent. We approached Monolith by landing to the southeast, heading west, then north. We arrived at Marker B at the base of Monolith at 1005, and measured temperatures around the chimney that had grown through the TC loop, then recovered the loop (most of the chimney disintegrated during the recovery process - what little remained in the loop was protected in the basket by putting on the "cake lid"). The highest temperature measured in the orifice that had been beneath the loop was 300.4°C. We attempted to take a manifold sample, but the arm disconnected at the shoulder joint - so NO water samples were possible during this dive. Temperatures were measured in and around the tripod (max of 80°C), and the tripod was recovered. We then went to Table Vent, and recovered the TC loop which was cemented to the structure. Most of the biological organisms that were covering the loop were lost during recovery, but what few remained were protected in the basket using the second "cake lid". We returned to Monolith to take good still photos with the external cameras, and to sample a spire and smaller pieces of sulfide that were covered with sulfide worms (Samples ALV2944-3S1 and S2). The temperature at the orifice of the piece sampled, after sampling, was 298°C. We then did a mesotech survey of 3 long N-S and 2 short E-W lines north to Fountain Vent.

Audio Transcript:

0931h: 2249m, 2254m total depth, at launch target, x2331 y3484. Videos on. Turning external cameras on, port is at 81, starboard is at 3 and contains Verena's good film. Rep rate of 30.
0934h: Starting to transit, hdg 088, over fissured lobate flows with a dusting of sediment.
0940h: Starting to head west 2257m (sub 2248m), rep rate to 15 sec.
0943h: Hdg 280, just crossed fissure 5 m wide, 5 m deep. Lobate flows with dusting of sediment.
0943h: 2254m (sub 2252m), x2281, y3462.
0945h: Rep rate to 60 s. Still going west.
0947h: 2253m (sub 2252m), over fresh flow. Have not yet reached fissure but are turning to 333 to head more northerly.
0951h: Took 3 photos of new lava flow, are now over fissure. 2254m (sub 2252m), x2216, y3533.
1005h: Rep rate to 30. At instruments.
1007h: Rep rate to 15 sec
1032h: Station 1, at Marker B site at base of Monolith, using high T probe at TC loop. Outer wall of chimney up to 13°C. At orifice is 221°C. At points in loop and out of loop ~ambient.
1035h: Going to pick up loop.
1043h: Loop in basket, with 1 rock in it. Bulk of chimney disintegrated. Note: Between dive 2941 and today, the anhydrite spire disappeared, and a rock (talus from above?) was lying on the edge of the loop.
1046h: Cam rep rate to 60, at frames 301 (port) and 223 (starboard).
1049h: Turned off external cameras.
1057h: Cameras back on at 60 s rep rate.
1106h: Excellent stable T of orifice where TC loop was = 300°C.
1111h: Using manifold sampler.
1124h: Manifold arm disconnected - no samples possible.
1126h: Start 2nd videos. Checking T in tripod. Ambient at all but point near base (see video) which was up to 80°C.
1130h: Tripod recovered, hdg 220, x2244, y3632, 2251m (sub 2249m). End Station 1.
1139h: At Station 2, Table Vent, white balancing 3-chip. Hdg 322, x2252, y3644, 2248m (sub 2247m).
1145h: Recovering Table TC loop. Cameras at 30 s rep rate.

1153h: Rep rate to 60. TC loop recovered - was stuck on hard. Most of organisms dislodged during pulling.
1157h: Frames 374, 296.
1204h: Cameras off since just messing with basket.
1208h: Cameras back on at rate of 15 s. Heading back to Monolith for photos.
1214h: Positioning for still photos.
1218h: Rep rate to 8 sec., hdg 173.
1229h: Hdg 195, x2245, y3633, 2251m (sub 2248m), nice smokers!
1235h: Hdg 213, x2246, y3631, trying to sample beehive - camera off.
1240h: 10°C on outside of chimney.
1242h: Cameras on at 60 sec rate (at frames 516 and 438).
1255h: Switching rep rate on camera depending on dusting in water.
1308h: Having hard time sampling - everything crumbles.
1313h: Cameras on at 30 s rate; hdg 292, x2246, y3628, 2252m (sub 2247m), piece sampled (ALV2944-3S1; in rear of basket on tripod). More pieces pulled in afterwards (ALV2944-3S2; in front of basket). T at orifice after sampling = 298°C. T at orifice just to right = 306°C = max T at Monolith measured this year.
1329h: Cameras off at frames 608 and 530. Finished at Monolith.
1337h: Starting Mesotech line north to Fountain.
1450h: Lost nav for 5 or 10 minutes. were heading south, almost to T6. Now will head west for ~150 m. Picked up nav shortly after moving west.
1529h: 2230m, wts away. Just finished last mesotech line. 8 stills port handheld; 21 stills starboard handheld.
1650h: At surface.
1750h: Still at surface since tow line caught in screw - recovered at 1753h.

NORTH CLEFT DIVE STATIONS: SAMPLES/MARKERS

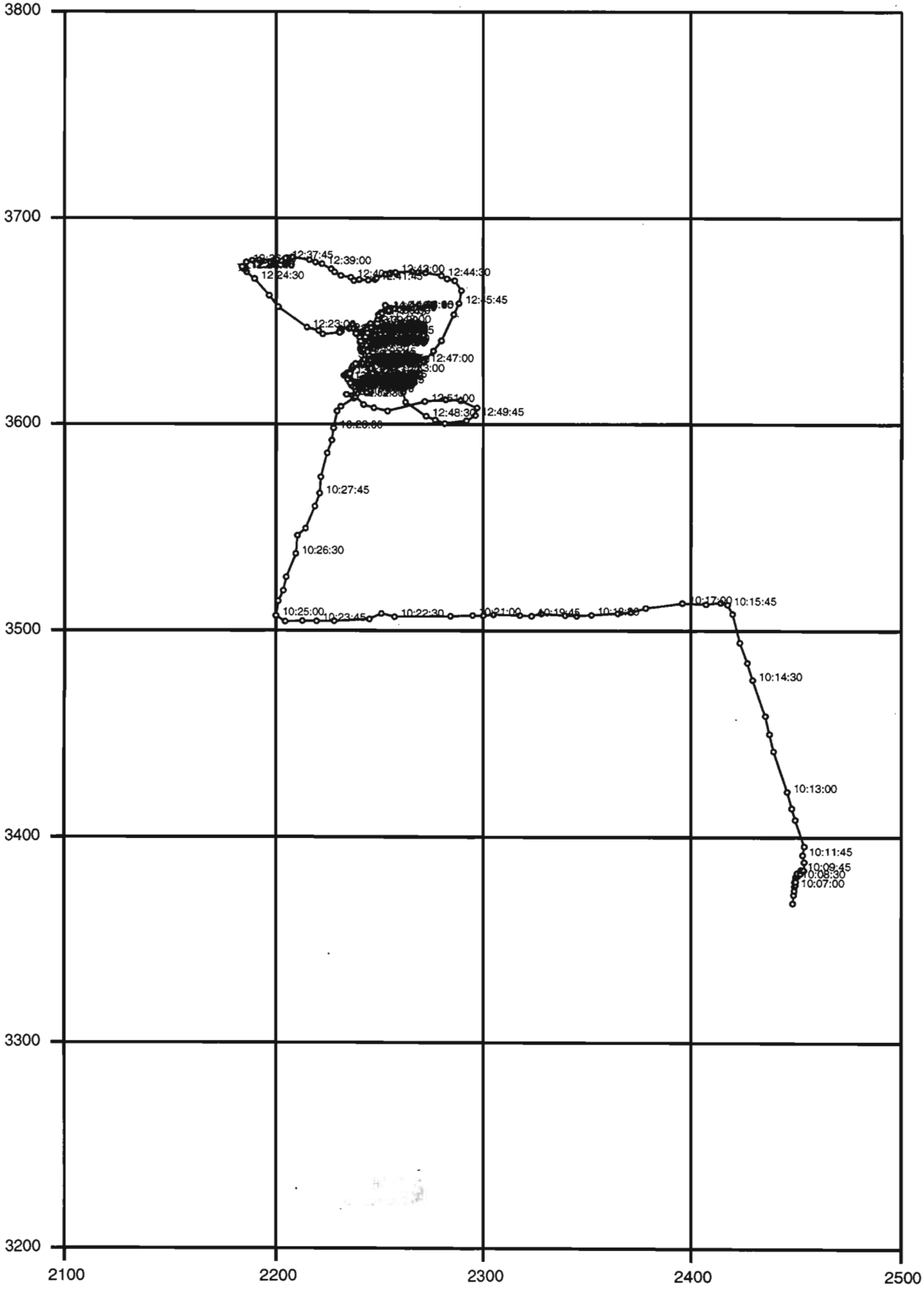
Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
Alvin Dive 2941: Monolith and Table vents, Origin 44° 57.47' / 130° 13.79'												
ALV2941-1I	11:08	2249	2250	2243	3631	211	44°59.430'	130°12.085'	13		Datalogger and one Thermistor tripod instrument recovered	Instruments recovered from Monolith vent.
ALV2941-2S	11:16	2247	2251	2243	3617	304	44°59.423'	130°12.084'			Sulfide	Sample of black smoker orifice from the Southeast side of Monolith. Very small piece of wall where bottle #6 and purple/white gas-tights were taken. "Rock #1".
ALV2941-2D	11:30	2247	2252	2245	3618	304	44°59.424'	130°12.083'		295°C (high T probe)	Discrete major #6	Sample from black smoker orifice from the southeast side of Monolith. Nozzle popped out - probably sucked in seawater.
ALV2941-2DG	11:34	2247	2251	2244	3617	304	44°59.423'	130°12.084'			Discrete gas-tight (purple)	Sample from black smoker orifice from the southeast side of Monolith. Sample should be good.
ALV2941-3I	11:55	2246	2248	2247	3647	233	44°59.439'	130°12.081'			Datalogger and two Thermistor tripod instruments recovered	Instruments recovered from Table vent.
ALV2941-4DG	12:58	2247	2255	2238	3620	061	44°59.424'	130°12.088'		296°C (high T probe)	Discrete gas-tight (yellow)	Sample taken from Southeast side of Monolith vent. Bob heard it trip - should be good.
ALV2941-5S	13:19	2247	2252	2245	3621	308	44°59.425'	130°12.083'		high T probe: 285°C inner, 6-20°C outer	Sulfide	Sample of sulfide from the east side of Monolith vent. Put in starboard front milk crate. "Rock #2".
ALV2941-6S	13:56	2247	2251	2245	3638	041	44°59.434'	130°12.083'			Sulfide	Sample of sulfide from Table vent. Put in port forward crate. "Rock #3".
Alvin Dive 2942: Pipe Organ vent, Origin 44° 57.47' / 130° 13.79'												
ALV2942-1D1	12:00-12:01	2264	2269	1358	1396	147	44°58.2234'	130°12.7572'		291°C	Discrete major #4	Northernmost spire of Pipe Organ Vent. Max temperature of 291°C not very stable. Could be higher. Heading changed to 145° for water sample. ~1m from top.
ALV2942-1DG1	12:10	2264	2269	1356	1397	147	44°58.224'	130°12.759'		291°C	Discrete gas-tight #6 (yellow)	Same vent as above. Got 286°C maximum temperature after sampling.
ALV2942-1D2	12:25	2264	2270	1357	1396	147	44°58.224'	130°12.7584'		286-291°C	Discrete major #6	Same vent as above. Bottle shimmered and looked good.
ALV2942-2D1	12:43-12:45	2263	2271	1352	1385	023	44°58.2174'	130°12.762'		300°C	1st of double major (#10)	South end of Pipe Organ Vent. Multiple orifice smoker ~1m from top.
ALV2942-2D2	12:43-12:45	2263	2271	1352	1385	023	44°58.2174'	130°12.762'		300°C	2nd of double major (#11)	South end of Pipe Organ Vent. Multiple orifice smoker ~1m from top.
ALV2942-2DG1	12:54	2264	2272	1355	1384	336	44°58.2174'	130°12.7596'		300.4°C	Discrete gas-tight #2 (2 black)	Sub swinging around to starboard during set-up. Heading 336° at time of sample.
*ALV2942-3D1	13:18	2262	2266	1360	1390	260	44°58.2204'	130°12.756'		291°C	1st of double major (#9)	The sub moved north from station #2 one or two spires. *Sampler fell off back end of basket and landed at base of vent. **Unable to recover.**
*ALV2942-3D2	13:18	2262	2266	1360	1390	260	44°58.2204'	130°12.756'		291°C	2nd of double major (#1)	The sub moved North from station #2 one or two spires. *Sampler fell off back end of basket and landed at base of vent. **Unable to recover.**
ALV2942-3DG1		2262	2266	1360	1390	260	44°58.2204'	130°12.756'		291°C	Discrete gas-tight #7 (purple)	Same vent as above.
ALV2942-4N1	13:34	2265	2272	1350	1389	116	44°58.2198'	130°12.7638'			Niskin (orange)	Niskin taken over Pipe Organ vent. Debris in water.
ALV2942-4N2	13:35	2261	2272	1352	1390	162	44°58.2204'	130°12.762'			Niskin (blue)	Niskin taken over Pipe Organ vent.
ALV2942-4N1	13:39	2257	2270	1351	1405	262	44°58.2288'	130°12.7626'			Niskin (red)	Niskin taken over Pipe Organ vent. Good sample in smoke.
Alvin Dive 2943: 54' site, Origin 44° 52.5' / 130° 16.0'												
ALV2943-1R	14:38	2268	2269	2790	6227	058	45°00.832'	130°11.668'			Basalt	Piece of older pillow basalt.
Alvin Dive 2944: Monolith and Table vents, Origin 44° 57.47' / 130° 13.79'												
ALV2944-1I1	10:43	3301	3302	2245	3637	220	44°59.434'	130°12.083'	13	high T probe: 221°C inner, 13°C outer; 300.4°C inner after recovery	Thermocouple loop recovered	TC loop - most to all of chimney that had grown through it was lost during shaking of loop during recovery. Temperature was recorded before and after recovery. Manifold did not work.
ALV2944-1S	10:43	3301	3302	2245	3637	220	44°59.434'	130°12.083'	13		Sulfide	Sample taken of a sulfide piece inside Thermocouple loop (was attached to TC array).
ALV2944-1I2	11:30	3301	3304	2244	3632	220	44°59.431'	130°12.083'	13	80°C (high T probe)	Thermocouple loop recoverd	Temperature was up to 80°C at one spot near base of Tripod vent (see video).
ALV2944-2I	11:53	3299	3300	**	**	322	**	**			Thermocouple loop recoverd	Thermocouple loop was struck hard at end. Had a sulfide sample in it when recovered (ALV2944-2S)

Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2944-2S	11:53	3299	3300	**	**	322	**	**			Sulfide	Thermocouple loop was struck hard at end. Had this sulfide sample in it when recovered.

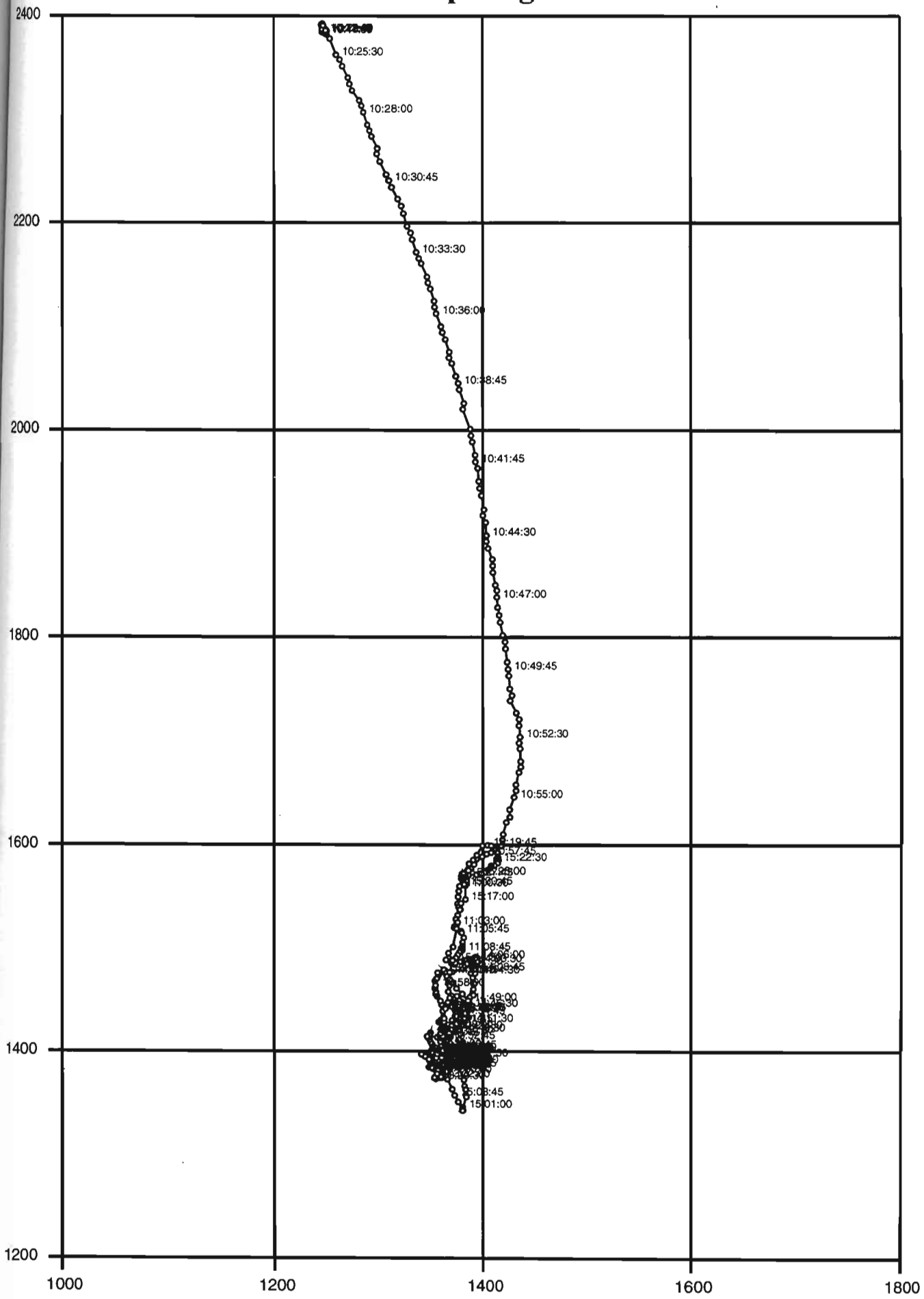
Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2944-2S	11:53	3299	3300	**	**	322	**	**			Sulfide	Thermocouple loop was struck hard at end. Had this sulfide sample in it when recovered.
ALV2944-3S1	13:13	3299	3304	2247	3627	292	44°59.428'	130°12.081'		298°C (high T probe)	Sulfide with worms	Worms attached to the sulfide are sample ALV2944-3B. Temperature taken in orifice after sample was taken. Placed in rear of basket.
ALV2944-3B	13:13	3299	3304	2247	3627	292	44°59.428'	130°12.081'			Worms from above sulfide	These worms were attached to the above sulfide.
ALV2944-3S2	13:20?	3298	3304	2247	3627	292	44°59.428'	130°12.081'		298°C (high T probe)	Sulfide with worms	Sulfide pieces from just below ALV2944-3S1 sample location. Sample in front area of basket.
ALV2944-3B2	13:20?	3298	3304	2247	3627	292	44°59.428'	130°12.081'		298°C (high T probe)	Worms from above sulfide	Worms attached to sulfide pieces from just below ALV2944-3S1 sample. Sample in front of basket.

**No navigation at this time.

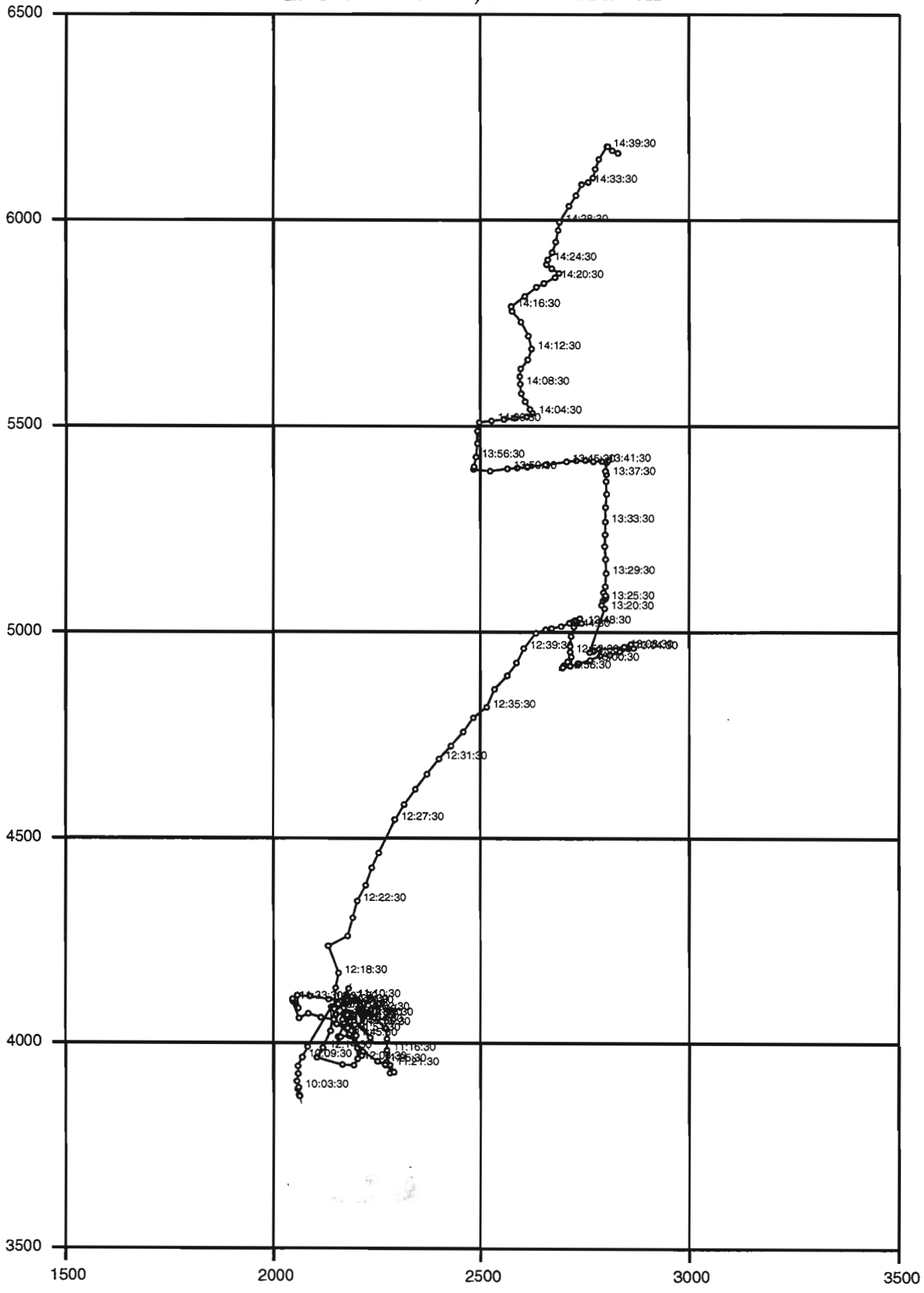
2941: Monolith/Table Vents



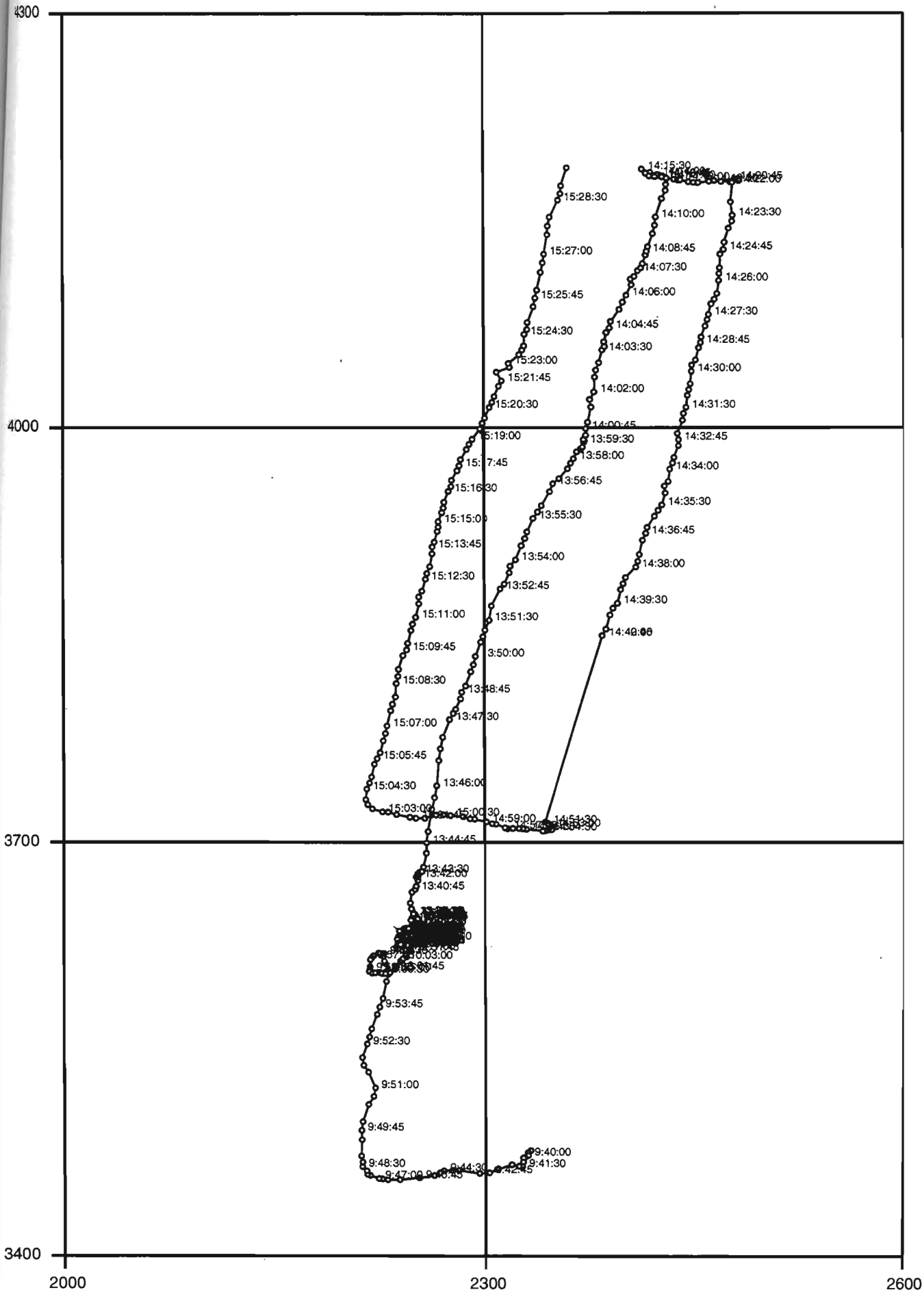
2942: Pipe Organ Vent



2943: 44° 54'N, Inner Graben

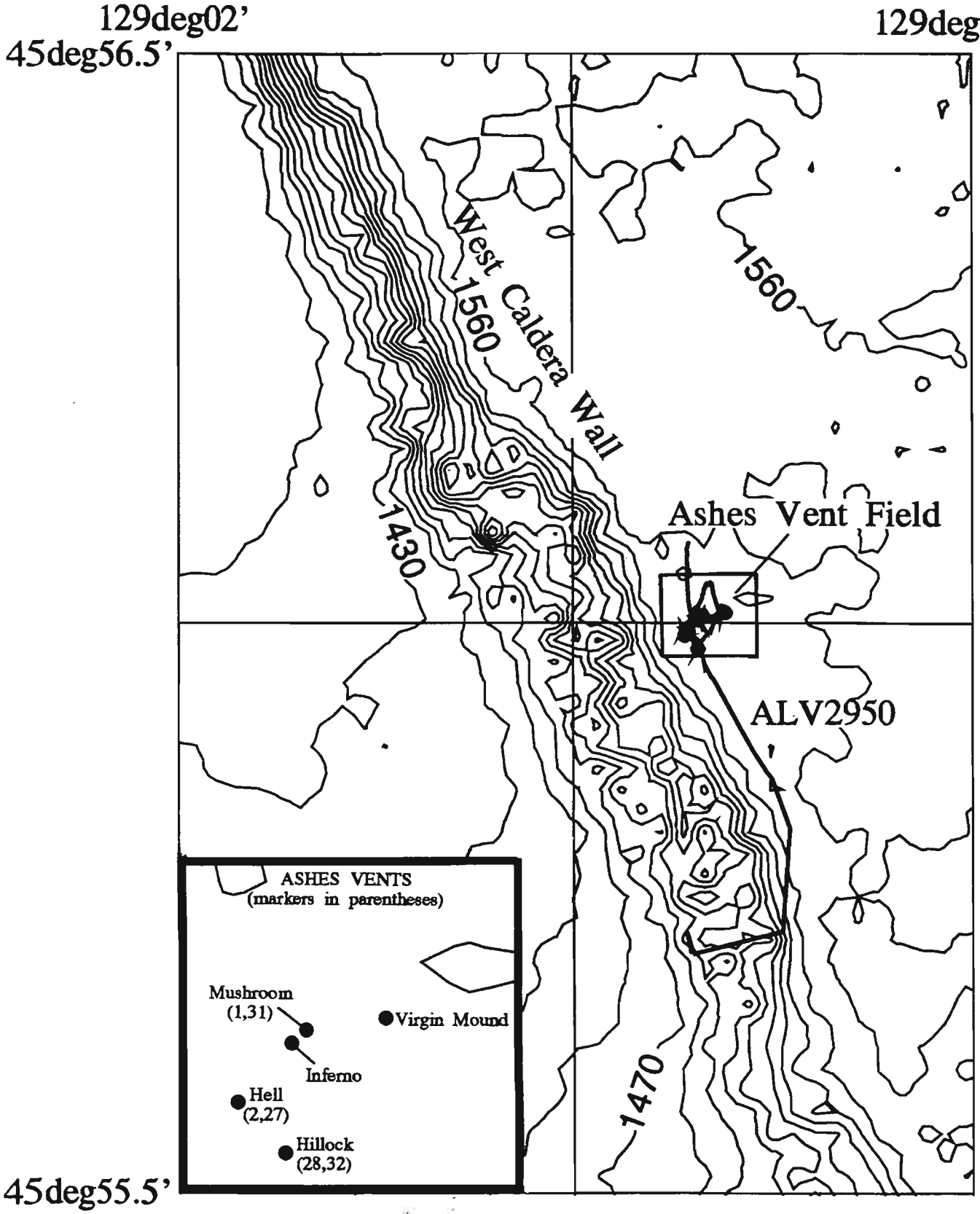


2944: Monolith/Table Vents



AXIAL VOLCANO

AXIAL VOLCANO - ASHES



DIVE SUMMARY - AXIAL VOLCANO

Video set-up for dive:

high 8 mm recorder #1: recorded video from the two Alvin color 1-chip cameras and the black/white down-looking sit camera.

high 8 mm recorder #2: recorded the 3-chip camera exclusively.

*All depths are TOTAL water depth, unless otherwise noted.

DIVE 2950 - AXIAL VOLCANO, ASHES VENT FIELD

July 6, 1995
Port: Verena Tunnicliffe
Starboard: David Butterfield (author of this transcript)
Pilot: Dudley Foster

Dive Objectives:

Revisit ASHES Vent field to resample water, monitor chimneys and biota and to assess major changes in field since 1988.

Audio Transcript:

0850h: Land on caldera wall southwest of target

0915h: Fly into caldera; extremely poor visibility, milky. (Recorders off). Land in venting; worm clumps with low-level venting.

0942h: On floor; 1544m (sub 1543m). no fixes. Iron oxide/yellow deposits and mounds; clams. Lavas vary between jumbled/smooth sheet flows and lobate flows. Most of transit to ASHES has some sign of hydrothermalism. 0953: Bad fixes, video very poor due to low visibility. Macrourids much larger than Cleft or CoAxial. Much greater density of non-vent creatures than at those sites.

1005h: Approaching vent field - anemones. Tubeworm clumps, lots of bacterial mat. 1006h: Flag Marker 23. Approach Hillock 020° (864x 1779y). About 1.5 m - does not seem to be active on south side.

1011h: Approaching Hell Vent; diffuse flow and tubeworm scattered on all sides. South side - clear black anhydrite cone part way up; top with beehives; well colonized. Double spires on top.

1020h: Traverse to Inferno but miss it on three passes. (1024h: 829x 1847y).

1034h: Back at Hell. Beehive on north side. Pass to west but find venting and worms to north of Inferno.

1050h: Turn 170 and into large worm clumps.

1054h: Virgin Mound; (885x, 1873y). Station 1 - Sample 2 majors and 2 gas-tights with manifold (temps: 316°C; high temp probe 319.6°C. Anhydrite/sulphide sample.

1145h: Moving to Inferno. approach on south side and sample on eastern pillar of Inferno - there is no smoker spigot on western pillar - big tubeworm clump there but sealed mounds are leaking lots of water.

1155h: Video of flaming smoker atop Inferno. Station 2 - Fire two discrete majors and 2 gas tights; high temp probe to 348°C. 857x 1854y.

1235h: Video survey up north side of Inferno.

1242h: At Mushroom; 1246h: looking at flange on northeast side. 1304h: measure temp under a flange lower on chimney. 313°C See "pools". 860x 1871y. Also measure temperatures

on upper side of flange among sulphide worms (26°C) then flip off marcasite crust about 1-2mm to register 47°C.

1320h: Station 3 - major discrete sample in small outlet on side of Mushroom that is mostly clear with some particulates: increases in vigor after excavation. Mushroom turns to a thin chimney on the top half. About 3 m tall.

1327h: Over worm pillars that seem to form lines on 020 strike north of Hell.

1341h: Reposition on south side of Hell to sample water. 1405h: Station 4 - fired 2 starboard majors on manifold and a discrete gas tight. Manifold temperature at 314°C. 830x 1834y.

1410h: Take 2 chimney pieces; one small tubular chimney close (~10 cm) from the water sampled orifice and one lobe (~15cm wide) which broke into several pieces. Some fluid through it initially, much more after breaking.

1418h: Station 5, grab worm pillar just north of Hell (826/1844), heading 048°- no solid internal structure. Gas tight and double major. Manifold temperature 30.5°C. 1449h: assessing other worm pillars to see if any underlying structure.

1512h: Station 6, back at Virgin mound to fire a Niskin; Vestal mound lies just to northeast of Virgin - about 4m. Follow a line of active venting south. to examine Crack Vent area. Considerably more colonization and impression is of greater areal extent of diffuse venting. Large areas of the basalt are "steaming"; find anhydrite cracks just north of iron oxides some mounds of which are colonized by worms.

1521h: Station 7 - basalt with snails from Anemone Ridge, 851x 1807y..

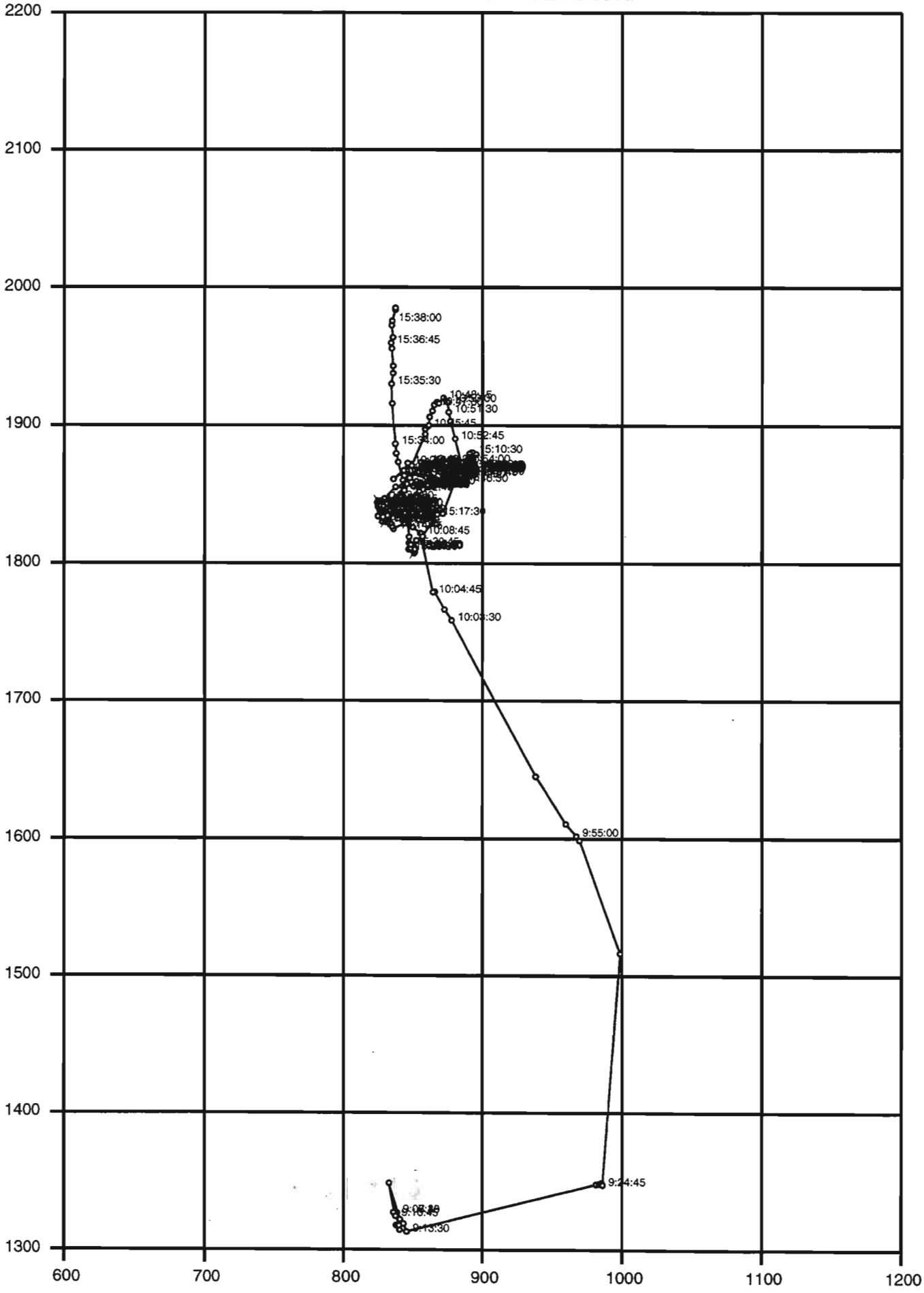
1526h: Run one Mesotech line northward over Hillock through field. Start 1532 at 846x 1831y; end 1537h at 835x 1964y.

AXIAL DIVE STATIONS: SAMPLES/MARKERS

Alvin Dive 2950: Axial Volcano, ASHES vent field, Origin 45° 55.00' / 130° 01.50'

Name	Time	Sub Z	Total Z	ALV X	ALV Y	HDG.	Lat	Long	Marker	Temp.	Sample	Comments
ALV2950-1M1	11:10	1542	1542	894	1868	013	45°56.008'	130°00.809'		T1=316°C, T2=250°C; 319.6°C (high T probe)	Manifold major - stbd. outer	Sample taken at Virgin Mound.
ALV2950-1M2	11:10	1542	1542	894	1868	013	45°56.008'	130°00.809'		T1=316°C, T2=250°C; 319.6°C (high T probe)	Manifold major - stbd. inner	Sample taken at Virgin Mound.
ALV2950-1G1	11:13	1542	1542	894	1868	013	45°56.008'	130°00.809'		T1=316°C, T2=250°C; 319.6°C (high T probe)	Manifold gas-tight - port	Sample taken at Virgin Mound.
ALV2950-1G2	11:13	1542	1542	894	1868	013	45°56.008'	130°00.809'		T1=316°C, T2=250°C; 319.6°C (high T probe)	Manifold gas-tight - stbd.	Sample taken at Virgin Mound.
ALV2950-2DG1	12:03	1540	1543	856	1856	347	45°56.002'	130°00.838'		348°C (high T probe)	Discrete gas-tight (orange)	Sample taken at Inferno vent.
ALV2950-2DG2	12:06	1540	1543	856	1856	347	45°56.002'	130°00.838'		348°C (high T probe)	Discrete gas-tight #2 (black)	Sample taken at Inferno vent.
ALV2950-2D1	12:13	1540	1543	856	1856	347	45°56.002'	130°00.838'		348°C (high T probe)	Discrete major #4	Sampled near top of Inferno vent.
ALV2950-2D2	12:15	1540	1543	856	1856	347	45°56.002'	130°00.838'		348°C (high T probe)	Discrete major #10	Sampled near top of Inferno vent.
ALV2950-2N	12:30	1536	1543	854	1858	351	45°56.003'	130°00.840'			Niskin - middle	Niskin tripped ~2m above Inferno vent.
ALV2950-3D	13:15	1542	1543	859	1864	056	45°56.006'	130°00.836'		*313°C (high T probe)	Discrete major #6	*Smoker next to 313°C flange at Mushroom vent. No temperature measured at smoker because probe broke.
ALV2950-4M1	13:55	1540	1542	830	1832	049	45°55.989'	130°00.858'		314°C (manifold)	Manifold major #13 - stbd. outer	Sample taken ~1m from top of smoker at Hell vent.
ALV2950-4M2	13:55	1540	1542	830	1832	047	45°55.989'	130°00.858'		314°C (manifold)	Manifold major #15 - stbd. inner	Sample taken ~1m from top of smoker at Hell vent.
ALV2950-4S1	14:00	1540	1542	830	1832	060	45°55.989'	130°00.858'			Sulfide	Small tubular chimney placed in right side front of basket.
ALV2950-4DG	14:05	1540	1542	830	1832	064	45°55.989'	130°00.858'			Discrete gas-tight (red)	
ALV2950-4S2	14:10	1540	1542	830	1832	060	45°55.989'	130°00.858'			Sulfide	Placed large lobe of sulfide in front area of basket. Lobe was not venting prior to sampling.
ALV2950-5B	14:28	1542	1543	826	1844	048	45°55.994'	130°00.861'		30°C (manifold)	Tubeworm pillar	Grabbed a worm pillar (no sulfide substrate) located north of Hell vent.
ALV2950-5DG	14:32	1542	1543	826	1844	048	45°55.994'	130°00.861'		30°C (manifold)	Discrete gas-tight (purple)	Sampled diffuse vent fluid from worm pillar North of Hell vent.
ALV2950-6N	15:09	1538	1541	877	1864	067	45°56.006'	130°00.822'			Niskin - forward	Niskin fired over Virgin Mound. This is the same location as Station #1.
ALV2950-7R	15:15	1542	1542	881	1862	199	45°56.005'	130°00.819'			Basalt with worms	Picked up rock with worms on it in region south of Hillock vent. Sampled placed in left half of Bio-box.
ALV2950-7B	15:15	1542	1542	881	1862	199	45°56.005'	130°00.819'			Worms on basalt	Worms from above basalt sample.

2950: ASHES Vent Field



NIGHT OPERATIONS

NIGHT OPERATIONS

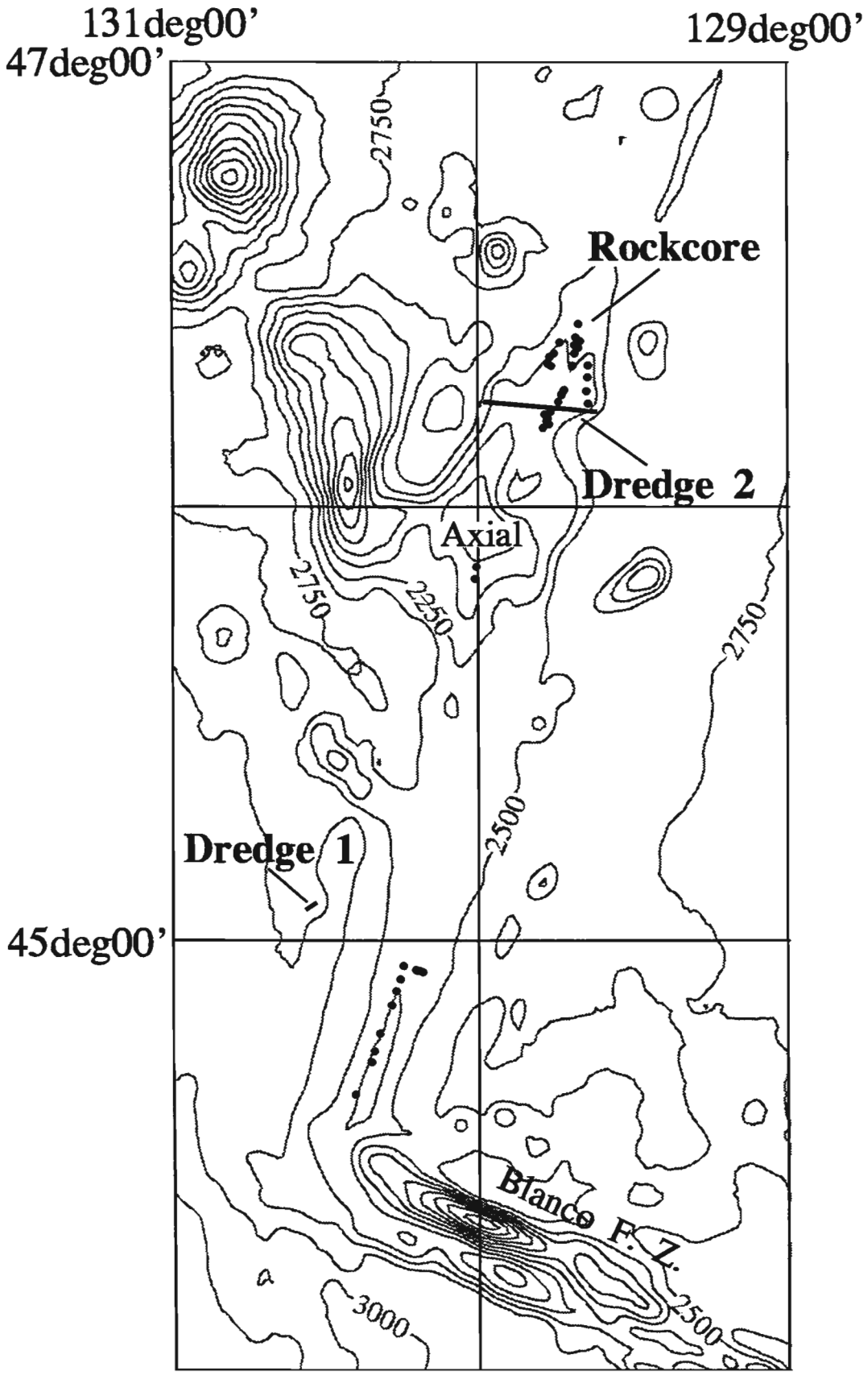


Figure 8