CHADWICK

VENTS 1991 Atlantis II/Alvin Cruise

Cruise Report
August 18 - September 6, 1991

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

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Atlantis II/ALVIN Vents 1991
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VENTS CRUISE REPORT
AII CRUISE 125-XXXI
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Overview

This cruise was a multidiscplinary dive series planned and conducted by scientists from the NOAA VENTS Program, the University of California at Santa Barbara, Florida Institute of Oceanography, the University of Florida, Oregon State University, the U.S. Geological Survey and the Geological Survey of Canada. The dives were funded by the NOAA Underwater Research Program. A series of sixteen dives were completed on the Southern Juan de Fuca Ridge. The goals of the program were: (1) geological mapping and sampling of the recent eruptive site (site of the mid-80's megaplume), (2) chemical sampling of the vent system, and (3) a study of the chemical and dynamical nature of buoyant hydrothermal plumes. A newly constructed chemical scanning system was also used for the first time on this dive series.

Summary of Scientific Results

Dives on 1980's Volcanic Eruptive Site-- (2430,2432)

Two dives were made on volcanic mounds that had been shown by repeat Sea Beam surveys to have been erupted between 1981 and 1987. The mounds consist of a uniform series of pillow lavas with glassy surfaces. Smaller, very glassy and unsedimented fingers of lava fill the spaces between pillows. No tectonic fractures were observed cutting the young flows. The only indications of hydrothermal activity on the young flows were a few clusters of dead tube worms and some thick pockets of yellow sediment (probably iron-rich low-temperature precipitates). Preliminary observations from the dives indicate that the lavas were erupted within narrow grabens that probably formed during dike injections. Mapping of the boundaries of the flows determined from the dive traverses will be used to determine the accuracy of the Sea Beam survey technique of measuring eruption volume.

High-Temperature Vents-- (2429,2433,2434,2436,2437)

In addition to detailed sampling of the Monolith vent discovered in 1990, two new high-temperature vents were discovered. The Fountain Vent lies about 600 m northeast along the same fracture system as the Monolith. Its temperature was measured at 315°C. The Organ Pipe Vent lies about 2 km south of Monolith within the (probable) eruptive fissure area of the young sheet flows. Its temperature was measured at 260°C. The high chlorinity of the vent fluids recovered from this area supports the hypothesis that the entire Cleft Segment is underlain by a phase-separated hydrothermal system. Preliminary chemical and mineralogic studies of active and inactive chimneys suggests relationships between the evolution of chimneys and the volcanic tectonic cycle of the neovolcanic zone. The Monolith Vent has recently undergone a higher temperature phase, which has resulted in a high temperature mineral assemblage (chalcopyrite) being deposited within lower temperature chimneys. One hypothesis is that this event is related to the Megaplume event.

Observations Relevant to the "Megaplume"--

Several general observations can be made that suggest some major recent changes in the hydrothermal system. First, the biologic system seems to have undergone a major change. In 1988, the system was dominated by bacterial mats and by-products. In 1991, bacterial mats were less prevalent and many of the tube worm areas were dead. Second, many of the low-temperature vents have apparently undergone a change in chemistry, with lower H_2S, higher chlorinity and higher iron than in 1988. A large area of young basalt adjacent to one of the most vigorous of the vents seen in 1988 (Tripod Vent) was covered in flocculent, iron-rich sediment. At this site, the venting had drastically slowed in 1990 and had virtually stopped in 1991. These changes may be related to adjustments in the water-rock interactions since the sea-floor spreading events took place.

Buoyant Plume Experiment--

An important component of this year's NOAA Alvin Dive Program at Cleft Segment was the Buoyant Plume Experiment. The overall objective of the experiment was to provide a complete characterization of the physical and geochemical processes governing the concentrations of hydrothermal constituents in the buoyant plume, including physical properties (temperature, salinity, density, temperature microstructure), suspended particles (concentration of such particles and their chemical composition), and dissolved constituents (dissolved Fe, Mn, etc., He, CO2, other dissolved gases). These experiments are necessary for a better understanding of the relationship between the chemistry of the vented fluids and the chemistry of the neutrally buoyant plumes that are dispersed laterally away from the vent fields. Samples of venting fluids and particulates rising in and settling from the buoyant plume at Monolith Vent were collected on six Alvin dives in 1990 and six dives in 1991. A total of 110 dissolved and particulate samples were collected during the present dive series. A major accomplishment critical to the experiment was the success of the NOAA Chemical Scanner, which provided high frequency measurement of iron and manganese during the the drive-throughs. These data will be analyzed to provide insight into the non-conservative geochemical processes occurring within the chemically dynamic region extending between the vent orifice and the neutrally-buoyant plume endmembers. The first and last dives were devoted to direct sampling of the end-member vent fluids and to extensive particle sampling in the water column; this vent fluid sampling at the beginning and end of the experiment was necessary to place constraints on the variability of fluid compositions over the course of the experiment. The core of the experiment was carried out during 4 dives during which the submersible was driven laterally through active buoyant plumes at different levels in the water column while at the same time collecting physical and chemical data and also capturing discrete water samples. During these buoyant plume "drive-throughs", the submersible was fitted with the following experiments, which collected data and samples at a variety of scales:

1) A suite of temperature and conductivity sensors mounted on a sting projecting from the front of the basket. These sensors collected data at ~16 Hz;
2) A transmissometer mounted near the sting, which measures light attenuation, thereby providing a direct measure of suspended particles
3) A microconductivity sensor used to resolve high frequency temperature fluctuations at the 1 millisecond time scale, also mounted on the sting
4) A in-situ flow injection analysis system, or Scanner, used to measure Fe and Mn continuously from water pumped through an inlet located at the end of the sting
5) A set of 4 titanium gas-tight bottles which were pre-evacuated and triggered from within

the submersible. Since these 150 ml bottles filled in much less than a second, they afforded point sampling in both space and time. The bottle inlets were also located at the end of the sting. 6) A particle collection system consisting of a filter and pump which could be started and stopped from within the submersible. The inlet projected forward from the basket. 7) A set of 4 conventional PVC Niskin bottles mounted on the side of the basket. These bottles could be triggered using the submersible arm. With the exception of items 2, 6, and 7 above, all of the sensors and sampling inlets were co-located at the end of the sting within a ~8 cm distance. An additional temperature sensor was located 1 m above the sting to provide additional information on the spatial scale of the plume temperature variations. Although some equipment difficulties were encountered during the first two plume drive-through dives, all of the systems were fully operational during the last two plume dives, and our objective was met. Although most of the buoyant plume experiment was conducted at the Monolith vent site, during dive 2441 a suite of plume drive-throughs were conducted at the Organ Pipe vent in order to provide a comparative study at a different vent. In summary, the experiment was extremely successful, although the chemical analysis of the discrete samples and the processing and analysis of the continuous physical and chemical data will occupy us for most of this next year.

Night Program

CTD and dredging operations were conducted during evening and early morning hours. The CTD tows and casts were designed to provide data on the extent of and chemical character of the neutrally buoyant plume to complement the buoyant plume experiment. Three along-axis tows, two across-axis tows and three vertical casts were completed in seven nights of operations. One of the vertical casts included a successful integration of the chemical scanner with the CTD package. Ten dredges were made, and seven of them returned samples of basalt. These form part of a data base that is being analyzed in conjunction with the submersible-collected samples in the neovolcanic zone

Operations

The Alvin operated very well throughout the sixteen dives. Integration of the scientific equipment with Alvin was accomplished without any major problem, and the changing in and out of the various instruments through the dive series was easily accomplished. A considerable amount of pre-cruise planning with the Alvin group greatly aided this effort. The only significant difficulty encountered during the dive series was with navigation, and this probably largely resulted from a problem with the NOAA transponder calibration. Two Alvin transponders were deployed to compensate for this, and they performed well. In-sub navigation performed very well for most of the dives. A MacIntosh-based program brought by the scientific party that provided post-dive edited plots of x-y and time (or depth, temp. etc.) along track proved very useful. A copy of this software was left onboard for use by other scientific parties.

Summary

Except for the two lost dives from weather, the dive series achieved nearly all of its scientific goals. The rich results from this cruise will provide data for many scientific publications.

Sept. 6, 1991

Robert Embley   Gary Massoth

Co-Chief Scientists

VENTS ATLANTIS II/ALVIN CRUISE

July/August 1991

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
18 Depart Astoria	19 Dive 2429 Monolith	20 Dive 2430 Northern New Volcanic Mounds	21 Dive 2431 Tripod Area and South CTD: TA91-01	22 Dive 2432 New Volcanic Mounds CTD: TA91-02	23 Dive 2433 Monolith	24 Dive 2434 Monolith Buoyant Plume CTD: TA91-03
25 Dive 2435 N.Monolith CTD: TA91-04	26 Dive 2436 Fountain Vent	27 weather	28 weather	29 Dive 2437 Tripod-Pipe Organ Vent	30 Dive 2438 Monolith Buoyant Plume	31 Dive 2439 Monolith Buoyant Plume
1 Dive 2440 Monolith Buoyant Plume	2 Dive 2441 Pipe Organ Buoyant Plume	3 Dive 2442 Monolith	4 Dive 2443 Cavern	5 Dive 2444 Southern Sheet Flow	6 Arrive Astoria	7

VENTS 1991
Dive Summaries

DIVE 2429

PORT OBSERVER: R. EMBLEY
STARBOARD OBSERVER: GARY MASSOTH
PILOT: PAT HICKEY

The objectives of the dive were: (1) Deploy six Miniature Temperature Recorders along an East-West line over the neovolcanic zone, (2) relocate and sample the Monolith vent, do a comprehensive video survey around it, and (3) locate and sample new vents north of the Monolith. The dive began at 1030, somewhat late because of late arrival from Astoria. Alvin reached bottom at 1210 and began deploying the MTRs at 1216. They were deployed at approximately 100 m spacing from West to East. The eastern boundary of the young lavas appeared to be displaced about 110 m east of the boundary on maps from previous data. The six MTRs were deployed by 1255 and the sub started toward the Monolith Vent (taking into account the shift in x). Insub navigation was intermittent, the 10.5 kHz transponder was being received about 80% of the time, the 14.5 kHz transponder was only occasionally picked up. The Monolith vent was reached at 1310. A careful survey with both SIT and Osprey cameras were made (on separate recorders). Three Niskins were tripped at 1,2 and 3 m above the orifice. MS1 and MS, Gas-tight 1 and the forward discrete major were tripped in 300 C water; MS1 did not fill. A sulfide chimney was also recovered from near the top of Monolith. These samples were all taken on Station 1. ALVIN then proceeded to the north to look for additional smokers reported (but not sampled or photographed) in 1990 on Dives 2260 and 2266. A major extinct field of chimneys was seen at 1444 at a water depth of about 2250 m. After proceeding south and downslope for about 50 m, an active chimney was found by the pilot at about 1458. The remainder of the samplers were tripped here at Station 2. The smoker (later christened "Fountain Vent") was venting diffuse water around an "onion-like" domewhich was covered with extensive biology. A sulfide/ biology sample was taken off this and the dive was terminated at about 1540. Marker #45 was deployed at about 100 m above this smoker. (Later recovered on dive 2436 lying 50-100m away).

DIVE 2430

PORT OBSERVER: BILL CHADWICK
PILOT (STBD OBSERVER): BOB GRIEVES
PILOT-IN-TRAINING: ROGER HUGHES

This dive was located on the north Cleft Segment, Juan de Fuca Ridge - specifically, at the northern end of "Mound 8", a large pillow ridge that is one of several new lava flows that were erupted sometime between 1981 and 1987 (documented by repeated Sea Beam surveys and camera tow data). The approximate drop site was 45° 09, -130° 09. The dive was transponder navigated (in the "Ducerland" net). The in-sub navigation was not working properly during this dive, but the surface navigation is adequate.

The objectives of the dive were to: 1) make geologic observations of the ridge (the most voluminous of the newly erupted lava flows), 2) take rock samples of the new lava and the older surrounding lava, 3) take samples of 2 kinds of hydrothermal sediment found on the new lavas, and 4) follow the new/old lava contact to the northern end of the new lava mound and examine any structures at the northern end related to the eruption.

The sub reached the bottom near the eastern contact between the old and new lavas. During the dive, the contact on the northeast side of the lava flow was mapped (a distance of about 800 m). Rock samples were taken of the new and older lavas, hydrothermal sediment was sampled on the new lavas, and bottom water was sampled. After transiting to a high point in the central part of the lava flow, additional rock and sediment samples were obtained before returning to the surface. The rock samples will be compared to other samples from the southern-most new pillow mound to determine the variability in composition of the erupted lavas.

Important observations during the dive include: 1) The lavas that make up the northern-most new lava mound are the same in morphology and sediment cover to the other new mounds to the south, supporting the conclusion that all the mounds were erupted at the same time and with a similar eruptive style. 2) Of the 2 kinds of hydrothermal sediment observed on the new lavas, the "orange globs" seem to be ubiquitous on the undersides of large pillows, whereas the fine, dusty yellow sediment seems to be only locally present, usually along the crestline of a pillow mound. 3) The first sessile organisms (crinoids?) are just starting to colonize the new lava flows, consistent with the very young age of the lavas. This is interesting because last year during Alvin dive 2262, no sessile organisms were observed living on the new lava of "Mound 1" (and dive 2432 observed the same crinoids (?) now colonizing Mound 1). 4) The north end of the new lava ridge was mapped to be about 200 m further north than that indicated by the Sea Beam depth anomally. This information will help evaluate the limits of resolution of the Sea Beam technique. The northeastern contact of the new lava flow (over a distance of at least 600 m) is defined in most places by a fault scarp, where the new lavas lap up against a 10-m high fault scarp that faces to the west, thus the outline of the lava flow is somewhat tectonically controlled. 5) The radial arrangement of pillow tubes around the high points on the ridge, and the lack of a graben or other major structure along the northern end of the flow, suggests that the lava flow was erupted from distinct eruptive centers along the ridge, as opposed to continuously along a fissure system, even though the eruption was probably ultimately fed by a dike intrusion.

DIVE 2431

PORT OBSERVER: IAN JONASSON
STARBOARD OBSERVER: JIM GENDRON
PILOT: CINDY VANDOVER

The dive commenced with a search for markers 3 and 6 at Tripod site. Despite an intensive search, the site was not located. An attempt was made to sample dead bacterial floc (ferruginous) with a scoop bag, but only a small sample was recovered (Stn. 1). It was obvious that extensive dead small worms in area were covered with by the Floc. It is likely that the absence of venting, the presence of hydrolyzed iron, and the dead worms (no H_2S) indicate a dead or dying hydrothermal system. It is also notable that the waters are very clear in the cleft (no bacterial flocs). The rest of the dive was devoted to cross-axis transects and an along-strike search for a high temperature site predicted from the plume data. An old chimney pair was found about 25 m east of the main fissure system at a contact between new and old flows. Further east there was a suggestion that new lavas reoccupied older drainback channels. Two traverses from the active cleft to the west wall crossed 700 m of a collapsed lava lake. Adjacent to the cleft, collapse is extensive, with 5 to10 m spires common. Two large patches of hydrothermal floc appear in the center of the lake. A local origin is suspected; a leaky floor was observed. The last stop on the cleft was at the only active site observed on the dive. At this location a vertical wall of thin laminar sheet flows host extensive bacterial mat colonies. Limpets are also present. Worms on the surface clustered around warm water, (8-10° C) were sampled. Also, interesting drip patterns are preserved in the sheet flows. In addition to the underside of the plates preserving "staloctite-type" drips, the top surface preserved the drip deposits. The plates were also covered with small worms of unusual nature. The dive ended after Marker 46 was placed atop the east wall of the cleft.

DIVE 2432

PORT OBSERVER: BOB EMBLEY
STARBOARD OBSERVER: BILL CHADWICK
PILOT: PAT HICKEY

This dive was located on the north Cleft Segment, Juan de Fuca Ridge - specifically, in the new volcanoes area. The dive started at the northern end of "Mound 1", and ended just south of "Mound 3", both new lava flows that were erupted sometime between 1981 and 1987 (documented by repeated Sea Beam surveys and camera tow data). The approximate drop site was 45°01', -130°12'. The dive was transponder navigated (in "Meganet"). The in-sub navigation was working most of the time during this dive (30 second cycle), although there were intervals when we were missing fixes. There is an offset between the fixes this year and in previous years. The objectives of the dive were to: 1) make geologic observations of the newly erupted lava flows and any structures adjacent to them related to their eruption, 2) take rock samples of the new lava and the older surrounding lava, 3) search for small vent communities on the new lava that had been seen in camera tows, and take samples of the biology, and 4) examine a feature that appears as a distinct young lava flow on sidescan imagery, just northeast of Mound 1.

The sub reached the bottom near the northeastern contact of Mound 1. We traversed across the northern end of Mound 1, and mapped out the northern contact. Next, we drove northeast along structures over the "sidescan target" until we encountered Mound 2. At Mound 2, we made a traverse and mapped out parts of the contact. Finally we continued driving north along structure almost as far as (but apparently short of) Mound 3. Rock samples were collected of the new and older lavas at Mounds 1 and 2. Very small pockets of tube worms were observed on Mounds 1 and 2, but were very sparse and were not sampled. No active venting was observed, although we had trouble locating the previously observed vent sites on and near Mound 2. Whatever venting once existed seems to have diminished to almost nothing. One of Ed Baker's temperature moorings was located within 1-2 m of a large fracture.

Geologic observations about the new lava flows include the following: 1) The northeast contact of Mound 1 is a ~5-m-high fault scarp - this was also observed at Mound 8 (dive 2430) therefore the tectonic control of lava flow boundaries seems to be common. 2) Sessile organisms (crinoids?) were again observed to be just starting to colonize the new lava flows. This is an interesting observation because last year during Alvin dive 2262, no sessile organisms were observed living on the new lava of "Mound 1". Therefore the time necessary for colonization can be bracketed between 4-8 years, an observation which can help in estimating the ages of other young lava flows. 3) Along the southwest contact of Mound 2, a 5-m-deep graben was observed which had walls of old lava, but was floored with new lava. The graben had a thin horst (a wall of old lava) in the middle. Further to the north the new lavas had flooded and buried the graben (a similar relationship to the graben along the south contact of Mound 1). This suggests that the Mound 2 lavas were erupted from this graben and then flowed downhill to the east. 4) The younger mound seen in sidescan imagery (its lavas cover pre-existing structure) was found to be considerably older then the new lavas erupted during the 1980's.

DIVE 2433

PORT OBSERVER: RANDY KOSKI
STARBOARD OBSERVOR: DAVE BUTTERFIELD
PILOT: BOB GRIEVES

The objective of this dive was to sample the plume, vent fluids, and sulfides at the Monolith Vent (MV) and, time permitting, to sample other vents north of MV, especially Fountain Vent. The entire dive was spent at MV. Alvin submerged at 0800 and reached bottom about 85 m east and 75 m south of MV at 0940. After crossing a series of N-S trending fissures and flat-topped ridges exposing pahoehoe and blocky lava flows, we located MV near the west wall of the inner valley. The MV has at least 12 black smoker chimneys and numerous lower temperature discharge sites on a N-S elongated, steepsided edifice with approximate dimensions of 10 m long, 7 m wide, and 6 m high. The coalesced particulate plume was more-or-less vertical above the vent during this dive.

We circled the vent area twice before commencing with the plume sampling (Station 1). Four Niskin bottle samples were taken at 3, 5, and twice at 7 m above the highest chimneys, with corresponding water depths of 2251, 2249, and 2247 m.

Next we measured temperatures of 295, 293, and 296.6°C at the top, center, and base of the "beehive" chimney on the S side of MV (Station 2, depth 2255 m). This chimney collapsed and disintegrated prior to the third T measurement which was obtained from the exposed basal orifice. One major manifold water sample and one gas-tight water sample were taken at the exposed orifice. Fragments of the collapsed sulfide chimney (mostly Zn sulfide + anhydrite) were recovered from the basket. Next we measured a maximum temperature of 309.5°C at the orifice of the anhydrite-chalcopyrite-rich chimney sampled during dive 2429.

Then we moved to Station 3, a cluster of four active sulfide chimneys on the southeast side of MV (depth 2255 m). There we filled two discrete major water samplers with fluid discharging from the site of a collapsed chimney. Fluid from that site had a Tmax of 303.4°C. Fragments (Zn-sulfide rich) from the collapsed chimney were recovered. A vigorously discharging chimney within the cluster, topped by multiple spouts, was recovered nearly intact. The channelways in this complex chimney are lined with chalcopyrite. A T of 314°C was measured at the orifice after removal of the chimney. A beehive-type chimney in the cluster yielded a T of 301°C about 5 cm below its top.

Station 4 was a large beehive-type chimney with three anhydrite-rich minichimneys projecting from the top, located at the north end of MV (2257 m depth). A T probe measurement of 309°C was obtained at the chimney top. All three of the anhydrite (+ Zn sulfide)-rich chimneys were sampled.

Then we moved to Station 5, two small black smoker chimneys on the NW side of MV (2259 m depth). There we took two major manifold samples and a gas-tight water sample from the top of one chimney. Tmax was 328°C. A temperature taken at the basal orifice after knocking the chimney down was 322°C.

At this point, we ran low on battery power and left the bottom at 1447.

DIVE 2434

PORT OBSERVER: RICHARD FEELY
STARBOARD OBSERVER: JOHN TREFRY
PILOT: CINDY VAN DOVER

Objectives:
1. Sample the buoyant plume from Monolith Vent at selected distances above the vent orifice.
2. Collect sediment samples from the base of Monolith Vent.
3. Sample low temperature fluids emanating from the base of Monolith Vent and nearby small chimney vent.
4. Collect limpets from the area.

The dive began promptly at 0800 and we reached the bottom depth of 2551 m at 0911 in close proximity to Monolith Vent. First, we took video images of the plume from several directions, noting a southwesterly flow of the plume at heights of >30m above the vent orifice. Then, we began a 3-hour sampling of the plume at the following distances above the top of Monolith Vent: 5, 10, 15, 20, 25, 30 and 35 m. Samples were collected using the PMEL in situ pump, the Florida Institute of Technology in situ pump and Niskin bottles. We managed to stay relatively well situated in the plume during the 8 to 20 minute sampling periods at each depth. Sometimes, it was necessary to temporarily stop pumping and reposition. Collectively, 10 pump samples and 4 Niskin samples were collected.

After sampling the plume at Monolith Vent, we moved to the base of the structure and collected two sediment samples using the discrete major samplers. The sediment was thickest along cracks in the basalt and both samples were taken carefully at a distance of <10m northeast of the base of the Monolith.

Low temperature fluids were first sampled from the small chimney about 15m north of Monolith Vent. Two major and one gas-tight samples were collected at temperatures of 35 to 44° at this site.

While in the area of the small chimney, a sizeable colony of limpets was observed on a sulfide deposit and the deposit with biota were placed in the basket.

Finally, we returned to the base of Monolith Vent and sampled low temperature fluids at the base of the structure. One major and one gas tight sample were obtained at 7.2°C while on a heading of 035° at Monolith Vent. Another major sampler was triggered in 28.8°C vent fluid while on a heading of 301° at the base of Monolith.

We departed from the bottom at 1524 and surfaced at 1645.

DIVE 2435

PORT OBSERVER: BOB EMBLEY
STARBOARD OBSERVER: IAN JONASSON
PILOT: PAT HICKEY

The primary objective of the dive was to conduct detailed mapping of the area north of the Monolith where high-temperature activity had been found on Dive 2429. The dive focussed on cross- and along-structural transects for several hundred meters north and south of the Fountain Vent. After a comparison of fixes between the NOAA and Alvin-placed transponders at the Fountain Vent, the Alvin-placed 9.0 and 9.5 kHz transponders were used throughout the dive and provided excellent navigation. After a video survey of the Fountain Vent, the Alvin made a transect to the top of the fault-sliced hill, turned northeast for about 60 m, and proceeded downslope to find the the dead chimney field seen on Dive 2429 (and probably sampled on Dive 2266 in 1990). After a small survey and a sample, the fracture was followed back to the southwest to the Fountain Vent, where Marker 42 was placed on the northeast side. The fault block that Fountain resided on was then followed to the south toward the Monolith Vent. Although hydrothermally derived sediments and staining were observed along this trend, no sign of active venting was seen. The traverse was terminated about 200 m southeast of Fountain Vent at a site where wall alteration was observed and sampled (Stn 4 at 1140). A short traverse was made to the southeast off the hill and then a 400 m long northeast traverse along the lava plain was conducted. After taking a basalt sample at Stn. 5, an upslope traverse was made to the northwest to intersect the active trend. After sampling a white-stained fractured basalt at Stn 6, an area of warm-water venting was intersected on the slope. A warm-water sample (12°C) was taken at Stn 7. This fracture, which appeared to be slightly offset to the west from the fracture on which the Fountain is on, was followed to the northeast until no further sign of venting was seen. An upslope slope traverse was then made across the large NE-SW trending fracture that was prominently displayed on the the SeaMarc sidescan. After crossing it onto the flatter terrain to the west, Alvin turned back to it with the intention of following it to the northeast. A small (2 m high) isolated sulfide chimney on the NE side of the fracture was sampled (Stn. 8) and the fracture was then followed to the NE for about 200 m, where it merged into a set of intersection fractures. It was at this location that a large chimney (9m high) was observed. After a video survey of this feature, a traverse was made to the SE onto the plain, then to the SW for about 100 m and then back onto the hill to the NW. The dive ended amidst a large field of dead chimneys (the Sentinals) at midslope on the hill, approximately along-strike with the venting to the south. Marker 44 was deployed at this site.

DIVE 2436

PORT OBSERVER: RANDY KOSKI
STARBOARD OBSERVER: DAVE BUTTERFIELD
PILOT: BOB GRIEVES

The objectives of this dive were to (1) sample the vent fluids and sulfides at the Fountain Vent (FV), (2) map volcanics and vent locations on a traverse northward from FV, (3) investigate a dead chimney field observed on dive 2437, and (4) sample and record the stratigraphy of lava flows. The theme song for this day was "Stormy Weather." We launched into a building sea and quickly submerged at 0812. Our landing point on the sea floor (0930) was about 100 m W and 40 m N of the target FV. The insub navigation was working well and we located FV on a range and bearing. The terrain was fissured thick flows with blocky interiors and twisted pahoehoe tops. FV has a double edifice oriented NE-SW with active chimneys branching upward from each mound. The NE edifice is taller (estimate 5 m) and larger and has a dense profusion of tubeworms around its top. The smaller SW edifice (estimated height about 3 m) also has an abundant biota. The elongate vent area has a long dimension (NE-SW) of about 7 m.

We began our sampling at 1012 at a beehive-type chimney about 2 to 3 m above the base of the NE edifice (Station 1). Our heading was 179. The Alvin probe recorded a Tmax of 311.5°C. We took four vent fluid samples from the chimney: 1 manifold major (M1, T1 = 315°C, T2 = 42°C), 1 gastight (T1 = 315°C, T2 = 67°C), and 2 discrete major samples. After water sampling was completed, the Alvin probe was used to check vent temperature. Temperatures of 304°C and 309°C were recorded. We also checked the ambient T in the tube worm thickets near this chimney, and observed T variations between 12 and 16°C. We sampled a small inactive sulfide spire (mostly Zn sulfide) 0.5 m from the beehive chimney, and then collected two samples of the lower wall of the beehive structure with the dust pan, despite some flip-flops of the manipulator.

Station 2 was located at the SW edifice where we sampled several fingerlike chimneys projecting outward from the base. During sampling our heading was 025°, X = 4012, Y = 12089. Our first task was to collect pieces of a beehive chimney with the dust pan. Then the manipulator was used to create a larger orifice for water sampling, and the Alvin probe recored a maximum T of 307°C. Two manifold samplers (M2 with T1 = 318°C and M3 with T1 = 305° and T2 = 141°C) and one gas-tight bottle (GT2, T1 = 302°C and T2 = 133°C) were filled. Many of the chimneys were fragile with a thin sulfide wall surrounding a hollow interior. Pieces of chimney walls with tube worms attached were sampled. The manipulator was used to break a more massive chimney which appeared to be pyritic. The T probe inserted into the stump of this chimney recorded a maximum T of 253°C.

At 1330 we left FV for our next target, the 12°C vent area 275 m to the north which was observed on the previous dive. We encountered numerous deep fissures and cliffs with exposures of blocky lava flows. In places, the lava had white alteration patches and bacterial growth along fractures. The low T vent area was a N-S ridge with many clusters of dead tube worms and areas of shimmering water. This site was on the east side of a deep fissure. A tube worm grab (Station 3) was placed in the bio box. We drove northward another 250 m to the site of numerous dead chimneys observed, but not sampled, on the previous dive. After observing several tall (more than 10 m?) cathedral-like chimney structures (the absence of oxidation suggests they are Zn-sulfide rich) and no indication of active venting, we were told to terminate the dive because of worsening weather conditions on the surface. We left bottom at 1428 without obtaining a sulfide sample. We surfaced under poor weather conditions at 1548.

DIVE 2437

PORT OBSERVER: BOB EMBLEY
STARBOARD OBSERVER: GARY MASSOTH
PILOT: CINDY VANDOVER

The primary objectives of this dive were to: (1) Locate, photosurvey and, if possible sample vent fluids at the Tripod Site, (2) locate and sample a high temperature vent predicted from water column chemistry located in the vicinity, and (3) make 2 E-W geologic traverses. Alvin reached bottom at 10 a. m. and proceeded east toward the edge of the young lava flow. Afte about 30 minutes, Markers #3 and #6 (left in 1988) were located. The crack in the lineated sheet flow that these markers were placed on was venting 60°C water in 1988 and 30°C water in 1990. In 1991, the area was covered with a orange-yellow fluffy sediment (also extensive in 1990) and the venting had virtually ceased. Dead tubeworms littered the area and only a few very localized spots of diffuse venting were observed. The only active vent was located within the cleft area near the " hidden vent" (so-named in 1988). This vent was pouring out large flocs of material (probably bacteria) but the site was so murky that no sampling was possible. After a survey of the tripod area, Alvin made a circuit north for about 200 m and then back to the south to box in the Tipod site. When the appropriate x-y position was reached, the markers were not in sight. After several passes through the area (which had very poor visibility from the previous visit), Alvin began moving south along the cleft. This traverse revealed extensive hydrothermal sediments draping the pillars and small areas of diffuse venting, but no chemosythetic communities. Marker #6 was observed on the sheet flow to starboard. At one point a small patch of delicate tube structures was observed and sampled (Stn. 2). This site consisted of orange-yellow sediment draping vertical tubes (old tubeworms?) that had a small amount of warm fluid emanating from them. Less than a hundred meters southwest of this site,a large high-temperature vent was discoverd. This consisted of a line of smokers about 40' to 60' in length emanating from the collapsed lava cleft in new sheet flows. The tops of several of the very delicate pipes on this edifice were up to about 10 to 12 m high. A temperature of 260°C was measured on both the upper and lower parts of the edifice. A full suite of water samples was taken on the upper portion of the structure where a " beehive" structure was broken open to increase flow. The thin pipes on the upper portion of the structure proved too fragile to sample and one of the harder chimneys broke off and fell to the base. This chimney was found at the base with black smoke was still oozing out of it. The cross-section resembled a tree trunk, with very concentric rings. Alvin then left the vent area to make a final box survey of the area. The dive was terminated when the batteries became too low for continued operation. Two major objectives of the dive were accomplished. The only major problem encountered during the dive was the navigation.

DIVE 2438

PORT OBSERVER: JOHN LUPTON
STARBOARD OBSERVER: MIKE STAPP
PILOT: PAT HICKEY

This dive was devoted almost entirely to driving through buoyant plumes in the water column at the Monolith site. The objective was to collect as much physical and chemical data as possible in the dynamic plume rising from the Monolith vent. However, the dive was flawed by several equipment failures: the NOAA Scanner system did not work during the dive, and the conductivity channel in the McDuff CTD system failed to operate. However, we collected excellent temperature and temperature microstructure data in the plume, as well as 8 discrete water samples in the plume (4 from titanium gas-tight bottles, and 4 from Niskin bottles). In summary, the dive began by visiting the Monolith vent and confirming the pressure depth of the top of the vent. Then we began a series of plume drive-through's at various heights above the vent: 2 drives at +5m, 3 drives at +10m, 3 drives at +15m, 4 drives at +20m, 2 drives at +25m, and 3 drives at +35m. Then we devoted about 45 minutes to driving a series of north-south lines in a "lawnmower" pattern to map the plume at +30m. This was then repeated at +50m. Finally, we drove a series of east-west lines at +70m to map the plume at this highest level. We then descended to the vent and took some video of Table vent, which is just 10 m or so due north of Monolith. Then we completed a short plume drive at +2m over Table vent and Monolith, and then dropped weights and began out ascent to the surface.

DIVE 2439

PORT OBSERVER: ED BAKER
STARBOARD OBSERVER: SHARON WALKER
PILOT: BOB GRIEVES

Objectives:

1. Combined hydrographic and chemical transects of buoyant hydrothermal plumes at several depths.

2. Sample buoyant hydrothermal plumes using Niskin bottles, gas-tight samplers, and in-situ filtration.

The dive began about 0815 and we reached bottom at 1021. The Monolith vent was found a few minurtes later. Several minutes were spent observing the vent for recent changes and obtaining high-quality hand-held video of the mound. Pilot Grieve noted that the "beehive" structure he had destroyed on Dive 2433 had largely rebuilt itself. At 1059 we began the first buoyant plume drive-through at a depth of 2250 m, nominally 5 m above the top of Monolith. Five drive-throughs were completed by 1117. Three additional drive-throughs were completed between 1259 and 1307. Gas-tight M1 was tripped during the first drive-through at 1100:42.

The second series of drive-throughs was at 2245 m, 10 m above vent. Five passes were made between 1122 and 1144. Niskin 1 was tripped at 1123:20 and Niskin 2 at 1131:27.

The third series was at 2240 m, 15 m above vent. Five passes were made between 1151 and 1227. Niskin 3 was tripped at 1152, Niskin 4 at 1159, gas-tight M2 at 1159. In-situ pump of John Trefry was turned on for a total of 15:05 during passes at this depth.

The plume was small in cross-section and easily observable by the pilot and on the SIT-cam during the first three series. We spent about 5 min searching for the plume at the next level, 2235 m, 20 m above vent. After locating it we made three passes between 1242 and 1253, tripping gas-tight M3 at 1249. Three more passes were made between 1328 and 1337 after briefly returning to the bottom.

At the next level, 2230 m, 25 m above vent, we made four passes between 1311 and 1326. Gas-tight M4 was tripped at 1311.

Following the last of these easily-observable drive-throughs we rose to the 2205-m level and began a systematic "lawnmower" survey to map the plume. This survey lasted about one hour, from 1407 to 1508. The plume here, about 50 m above vent, appeared more spread out, covering an area at least 50 m by 50 m. At the end of this survey we ascended to the surface.

All discrete sampling on this dive was successful. The chemical scanner system appeared to operate generally well, although some mysterious software problems caused the loss of transmissometer data early in the dive and may have affected other data channels as well. Lupton's microconductivity probe recorded during the entire dive, but data from his Sea Bird temperature and conductivity probes were lost because of computer glitches.

Dive 2440

PORT OBSERVER: JOHN TREFRY
STARBOARD OBSERVER: DAN DION
PILOT: CINDY VANDOVER

Objectives:

1. Collect video images of very recent chimney regrowth at Monolith Vent.

2. Collect continuous data at selected depths for conductivity, temperature, light transmittance, dissolved manganese and dissolved iron throughout the buoyant plume at Monolith Vent.

3. Evaluate the influence of the submersible on the shape and movement of the buoyant plume.

4. Sample the buoyant plume from Monolith Vent at selected distances above the vent orifice for helium, suspended particles and dissolved trace metals.

Narrative:

The dive began promptly at 0800 and we reached the bottom depth of 2261 m at 0932 in close proximity to Monolith Vent. First, we took color and black and white video images of recent chimney regrowth on the southeast side of Monolith Vent while at headings of about 250 to 330 . The beehive chimney that had been toppled earlier in the cruise was showing rapid regrowth.

Then, at 0955 we set up to initiate a series of passes through the buoyant plume at the following distances above Monolith vent: 55, 35, 20, 10, 5 and 45 m. The passes were carried out in the order listed above to investigate the influence of the submersible on the shape and dispersion of the plume. Numerous passes were made through the buoyant plume at each height above the vent. Continuous data were acquired for conductivity, temperature, light transmittance, dissolved manganese and dissolved iron throughout the day, including each pass through the buoyant plume. All instruments, probes and data acquisition appeared to be in working order. The scanner was calibrated three times during the dive.

The plume was moving to the northwest at 55 m; however, it was relatively well contained with a width of 20-30 m. A sharp, narrow plume was also observed at succeedingly lower depths. In contrast, upon return to 45 m later in the dive, the buoyant plume seemed much more difuse and spread over a broader area. Despite these observations, the apparent influence of the submersible on the plume is still speculative at this time. Data from duplicate traverses of the same path at other depths will help provide an additional perspective.

During the course of the plume passes, samples were collected for helium (55, 35, 10 and 45 m above the vent), suspended particles and dissolved trace metals (Niskin bottles at 55, 35, 35 and 45 m above the vent) and the FIT in situ pump was activated at 35 m above Monolith Vent.

We departed from the bottom at 1435 and surfaced at 1545.

DIVE 2441

PORT OBSERVER: JOHN LUPTON
STARBOARD OBSERVER: LANE ABRAMS
PILOT: PAT HICKEY

This dive was devoted entirely to the so-called buoyant plume experiment. In contrast to the previous buoyant plume dives, this dive was conducted at the newly-discovered Pipe Organ Vent considerably south of the Monolith site, which was the location of the previous buoyant plume studies. Dive 2441 was essentially a total success, since all of the multiple systems on the submersible functioned perfectly, as far as we were able to discern without extensive analysis of the data.

During our descent we carried out a calibration of the NOAA Scanner system, and then collected data with the Scanner and the CTD system while descending through the stable effluent layers to the seafloor. We touched bottom on the broad sheet flows to the west of the vent site. We then drove ~100 m and quite easily found the vent. We spent the next few minutes driving around the rather elongated vent edifice while taking hand-video out of the port window. During this drive-around, although we were careful not to directly disturb the plumes emanating from the vent, we managed to kick up quite a lot of flock into the water column, which was then entrained into the plumes and carried upward.

We then began a series of drives through the buoyant plume, beginning at the highest level of +50 m. We devoted over an hour to driving patterns at +50m, mainly along east-west lines. Thereafter, our plume drives were more random in nature. We completed a series of passes at +35m, at +20m, and at +10m. While at the +10m level, we interrupted the plume drives to hover for 15 minutes at this height in the plume while activating the Trefry pumping system.

Then we tackled the more difficult task of studying the plume from this distributed vent source at shallow heights of +5m or so. We used the technique of first descending to the seafloor and lining up on the vents, then rising the 5m and driving through the vent plumes. After repeating this process a few times, we then completed two drives perpendicular to the axis of the vents.

Finally, we descended to the vent system again and the pilot took more hand-held video out of the forward window. We then dropped weights, and collected Scanner and CTD data during our ascent through ~1580m depth. Then a partial Scanner calibration was carried out.

DIVE 2442

PORT OBSERVER: RICHARD FEELY
STARBOARD OBSERVER: KEVIN ROE
PILOT: BOB GRIEVES

Objectives:
1. Sample the buoyant plume from Monolith Vent at selected distances above the vent orifice.
2. Collect high temperature fluids from the base of Monolith Vent.
3. Sample extinct chimney from the base of Monolith Vent.
4. Collect basalt from the base of Monolith Vent.

The dive began promptly at 0750 and we reached the bottom depth of 2552 m at 0910 in close proximity to Monolith Vent. First, we began a 3-hour sampling of the plume at the following distances above the top of Monolith Vent: 5, 10, 15, and 20m. Samples were collected using the PMEL in situ pump, the FIT in situ pump and Niskin bottles. We managed to stay relatively well situated in the plume during the 30 minute sampling periods at each depth. Only on one occasion at 5m was it necessary to temporarily stop pumping and reposition. Collectively, 5 pump samples and 4 Niskin samples were collected.

After sampling the plume at Monolith Vent, we moved to the northwest face of the structure and collected high temperature vent fluids from the same orifice as was sampled by Butterfield and Koski during Dive 2433. Three major samples and one gas tight sample was collected at this site. We then moved to the south side of Monolith and collected one large extinct chimney and one basalt sample at the base.

After completing our rock sampling at Monolith we proceeded north to look for "New Vent." We stopped at Table Vent, at 15m to the north to get a new bearing on "New Vent." When we got to to the presecribed coordinates no vent was in sight of the sub. After the dive It was determined that Table Vent and New Vent were one in the same.

Since time and power were getting low we decided to spend the rest of the dive recovering Bob and Bill's MTR experiments, which were recovered in the order MTR4, MTR5, MTR6, MTR3, MTR2, and MTR1.

We departed from the bottom at 1510 and surfaced at 1650.

Dive 2443

PORT OBSERVER: ED BAKER
STARBOARD OBSERVER: GARY MASSOTH
PILOT: CINDY VANDOVER

The objectives of this dive were to revisit the chain of low-temperature vents along North Cleft Segment between Cavern and Marker 4 Vents to determine if there have been significant changes in the character of venting along this section of Cleft Segment and to investigate using continuous Scanner sensors the relations of Mn and Fe to heat for this low-temperature venting regime. Both objectives were fully addressed during the course of the dive, although the final conclusions await a more complete analysis of the data. Preliminary indications are, however, that the mission was satisfactorily completed.

All the target vents were located without problem using a combination of in-sphere acoustic navigation and geologic maps made from previous dives in this area. All of the low-temperature vents remained active. Based on earlier descriptions of previous flow, the volume and thermal output of the vents appears to be similar to that observed in 1988 and 1990. The most obvious change noted was a reduction in the vitality and biomass of the biological communities associated with these vents. No "healthy" white and red worms were seen at any of the sites. The common nature of the biological substrate was a brown, dingy, and meager assemblage of small tube worms and associated smaller creatures. As the dive progressed to the south, the communities displayed an increasing white bacterial mat-type appearance. With the exception of a few like tube worms observed south of Cavern Vent, the crack transect in non-vent regions was visibly void of sessile vent fauna. None of the abundant worm patches observed between the Marker 4 Vent and Tripod Vent in 1988 were observed during this dive.

Continuous sensing of dissolved Mn, Fe(II) and Fe(II+III), temperature, conductivity, and light transmission was performed with the PMEL Scanner. Measurements were made along the full dive transect. Selected close-point sensing was accomplished at all of the target vents by positioning the intake port for the Mn and Fe sensors and a temperature probe directly in the flow path of the warmest shimmering water" vents. In each case, calibration samples were collected in discrete water bottles.

Within the first half-hour of the dive transect, the ALVIN rudder became fouled by rocks. This caused the pilot to operate in "differential" thruster mode, effectively giving us only one-third the forward thrust normally available, and very slushy directional control. That the full transect was completeed along with some difficult yet successful sampling operations is testament to the tenacity and ability of the pilot to get the job done.

Dive 2444

PORT OBSERVER: MATT SMITH
PILOT (STBD OBSERVER): PAT HICKEY
PILOT-IN-TRAINING: PAUL MCCAFFREY

Objectives: The primary objectives of this dive were geologic mapping and sampling of the area in between markers 46(402581X/4978643Y)& marker1 (402262X/4977445Y).

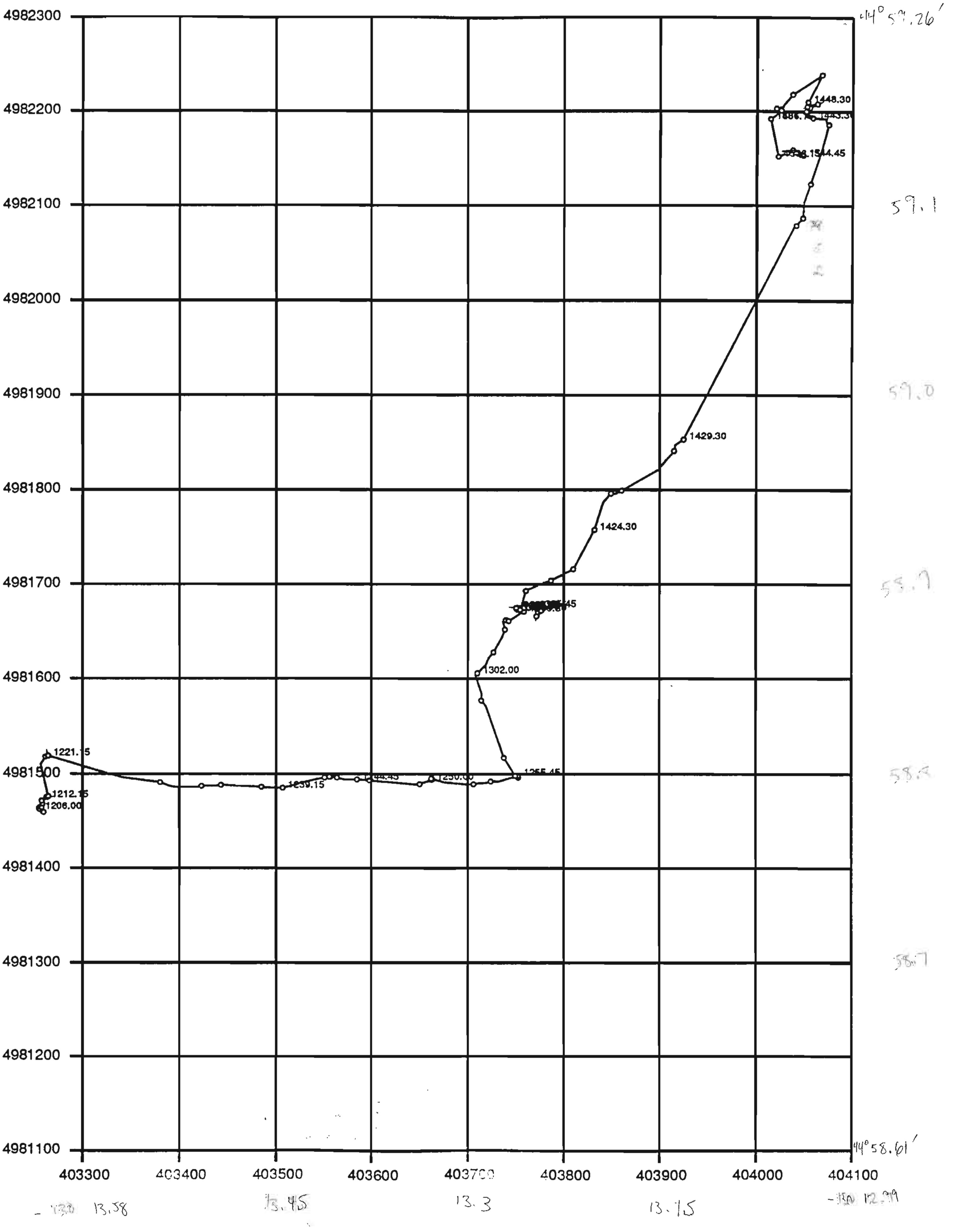
ALVIN was cleared to dive at 7:06am and reached the bottom at approximately 8:40am. We landed east of our target in an area of collapse and pillars at approx. 402535X/4978275Y). We then travelled east through the area of new volcanism and collapse into the older pillow lava terrain stopping at 402739X/4978274Y to sample the older lavas. Once this sampling was done we travelled west to the contact between the old lavas and newer lavas, following that contact southward in search of marker 46. Almost immediately we found an extensive tube worm field (apparently still thriving) that existed along the contact between the two lava flows. Most of the worms were residing on the older lavas. The time was approximately 9:05 am. This biological community was estimated by the pilot to be at least as big as a half of a football field. We con tinued to follow the contact southward, and found marker 46 at approximately 9:20 am. (302581X/4978643Y). We then sampled tube worms and basalt at a nearby site within the region of collapse. This would be station 2. Time of sampling was 9:24 at a position of 302424X/4977728Y. At that point we started doing E-W traverses that extended from the region of fissuring east of the old lava-new lava contact, across the collapse/pillar area, into the smooth sheet flows of the lava lake that is west of the collapse. We did a total of 6 traverses across the region of collapse; (E-W) each spaced about 100-200 meters apart from one another (in a north-south direction.) Movement in a southern direction on the east side of the traverses followed a system of fissures existing in the older pillow terraine. It was along this fissure system that we sampled a dead sulfide chimney (the only one seen during the dive) and a basalt. This occured at approximately 11:32; just prior to the beginning of the fifth E-W traverse. This was sampling station 3, located at 302424X/4977728Y. After sampling at that locality we did the final two E-W traverses, ending up at sampling station 4; the marker 1 site. There we found some vigorous venting of warm hydrothermal waters (19°C) and took 2 major samplers, 2 gas tight samplers, and niskin bottles. Computer aided data logging with themanifold sampler was not possible, so temperatures were logged by hand. The final basalt sample was taken there (402262X/4977445Y) before dropping the weights and surfacing at 13:31. The geologic traverses showed good general agreement with mapping done using side scan sonar and deep tow photography data.

Note on ALVIN navigation--

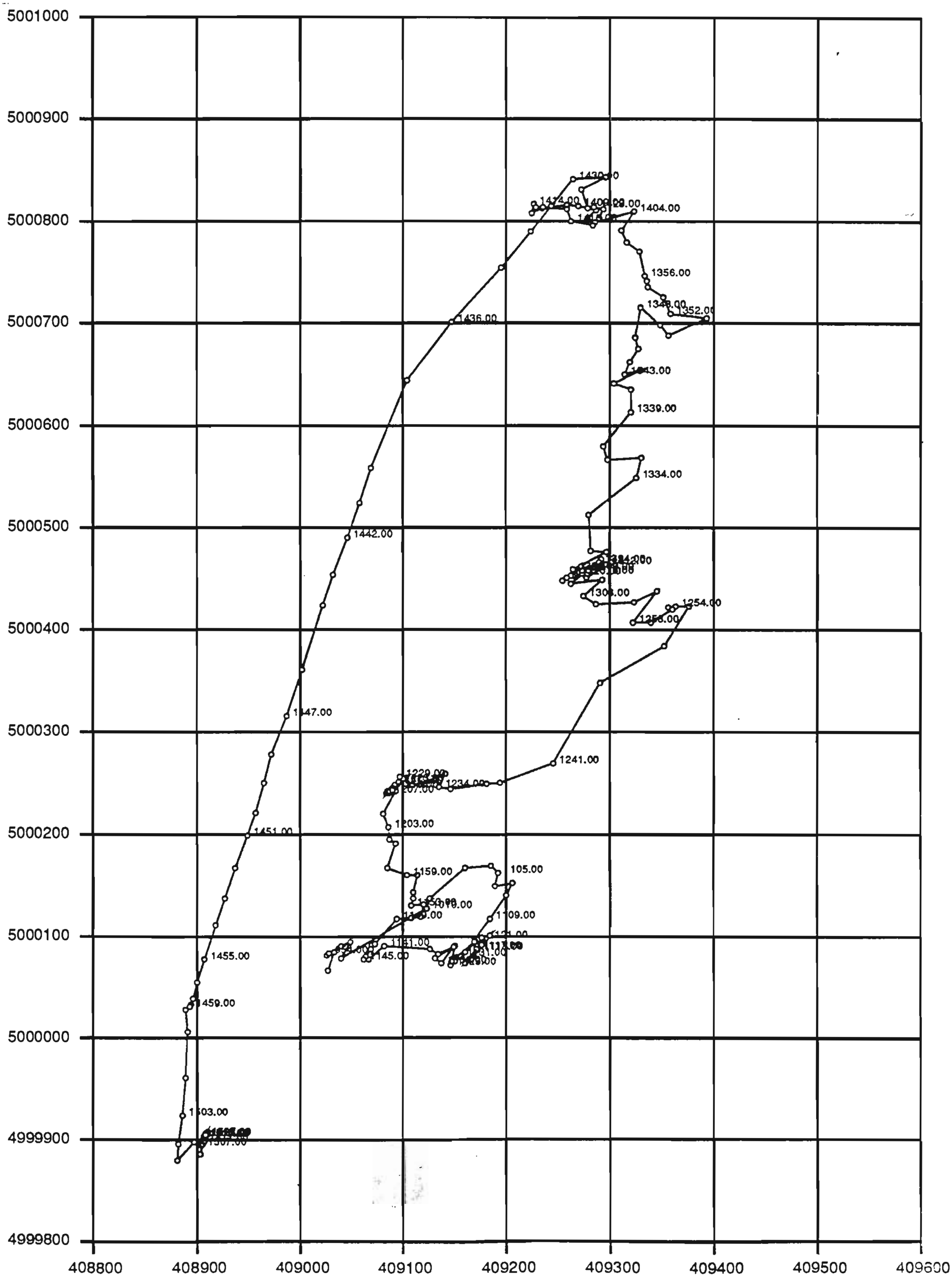
The following plots of the submarine navigation tracks incorporate the best navigation data available at "press" time. This is not the final navigation which will be available by the 1992 cruise field season or hopefully sooner. Please use the numbers indicated on the x/y grids with caution.

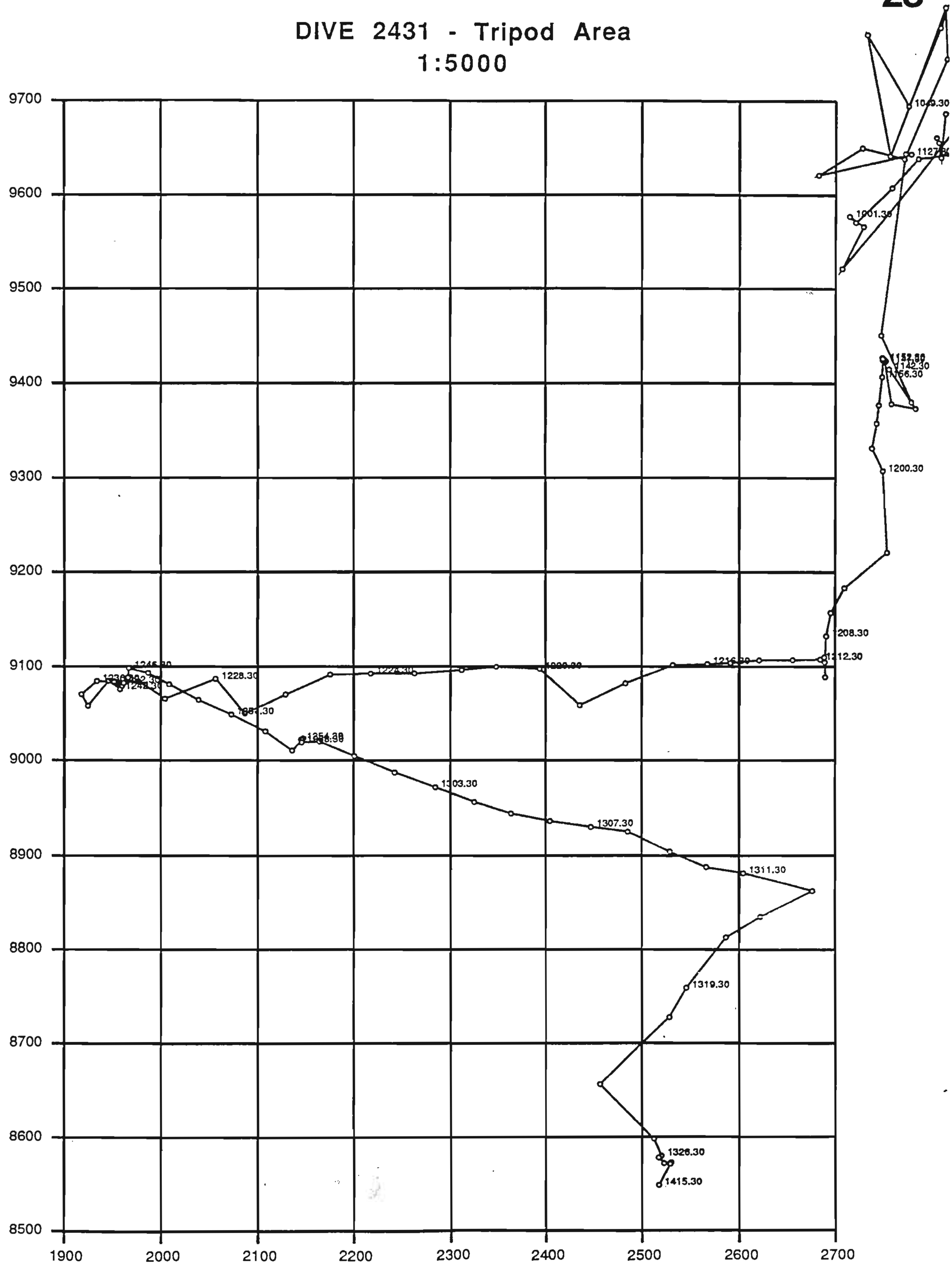
Dives 2430 and 2431 reflect surface navigation using the NOAA transponders. Dives 2429, 2432, 2437, 2443, and 2444 were in-sub navigation with the NOAA transponders. The remaining dives used the ALVIN transponders with in-sub navigation. There are navigation offsets associated between all of these different transponder nets.

DIVE 2429 - Monolith
1:5000



DIVE 2430 - N. Cleft
MOUND 8
1:5000




DIVE 2431 - Tripod Area
1:5000
9700
9600
9500
9400
9300
9200
9100
9000
8900
8800
8700
8600
8500
1900
2000
2100
2200
2300
2400
2500
2600
2700
1049.30
1001.30
1200.30
208.30
1212.30
1216.30
1224.30
1228.30
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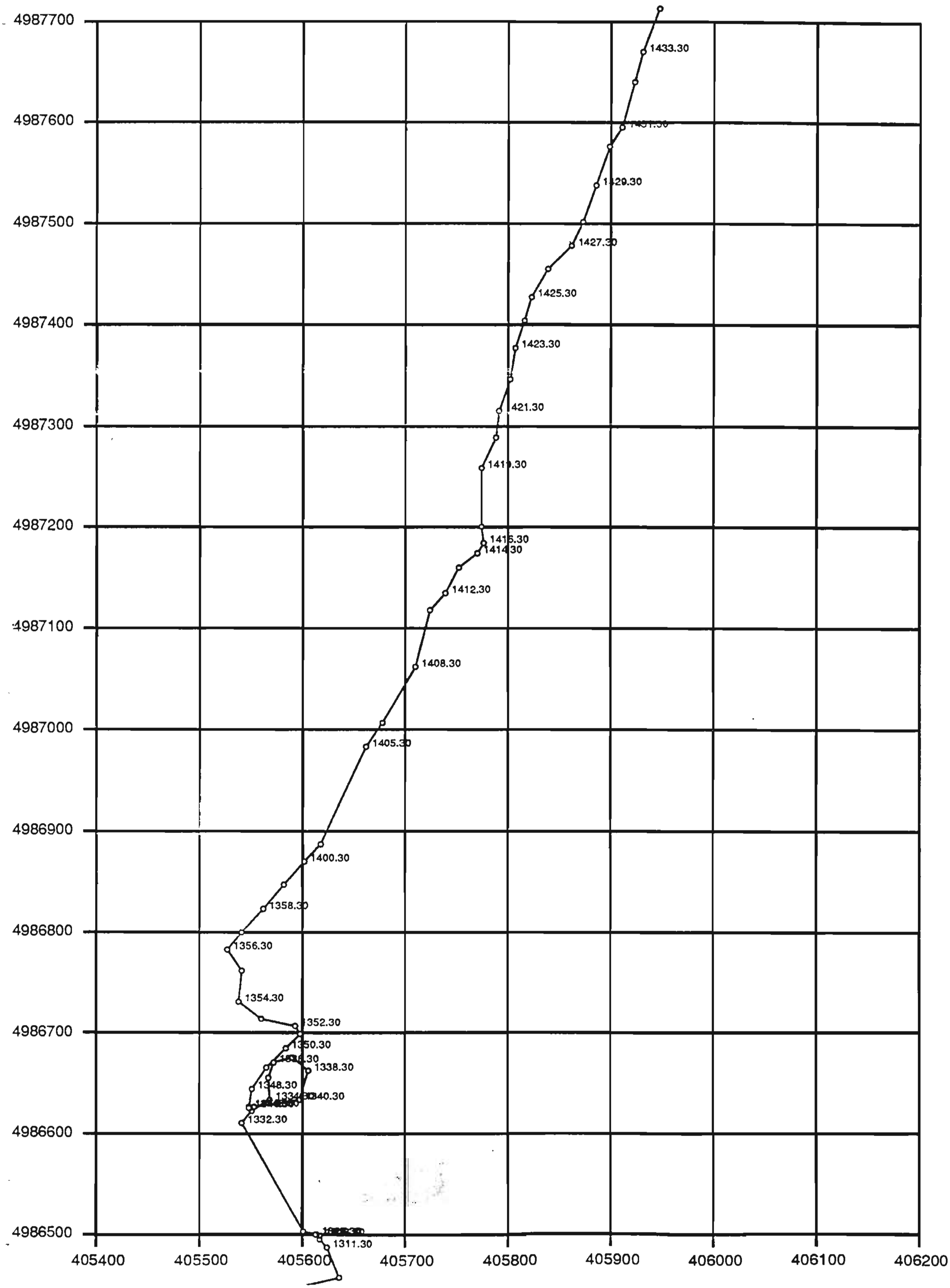
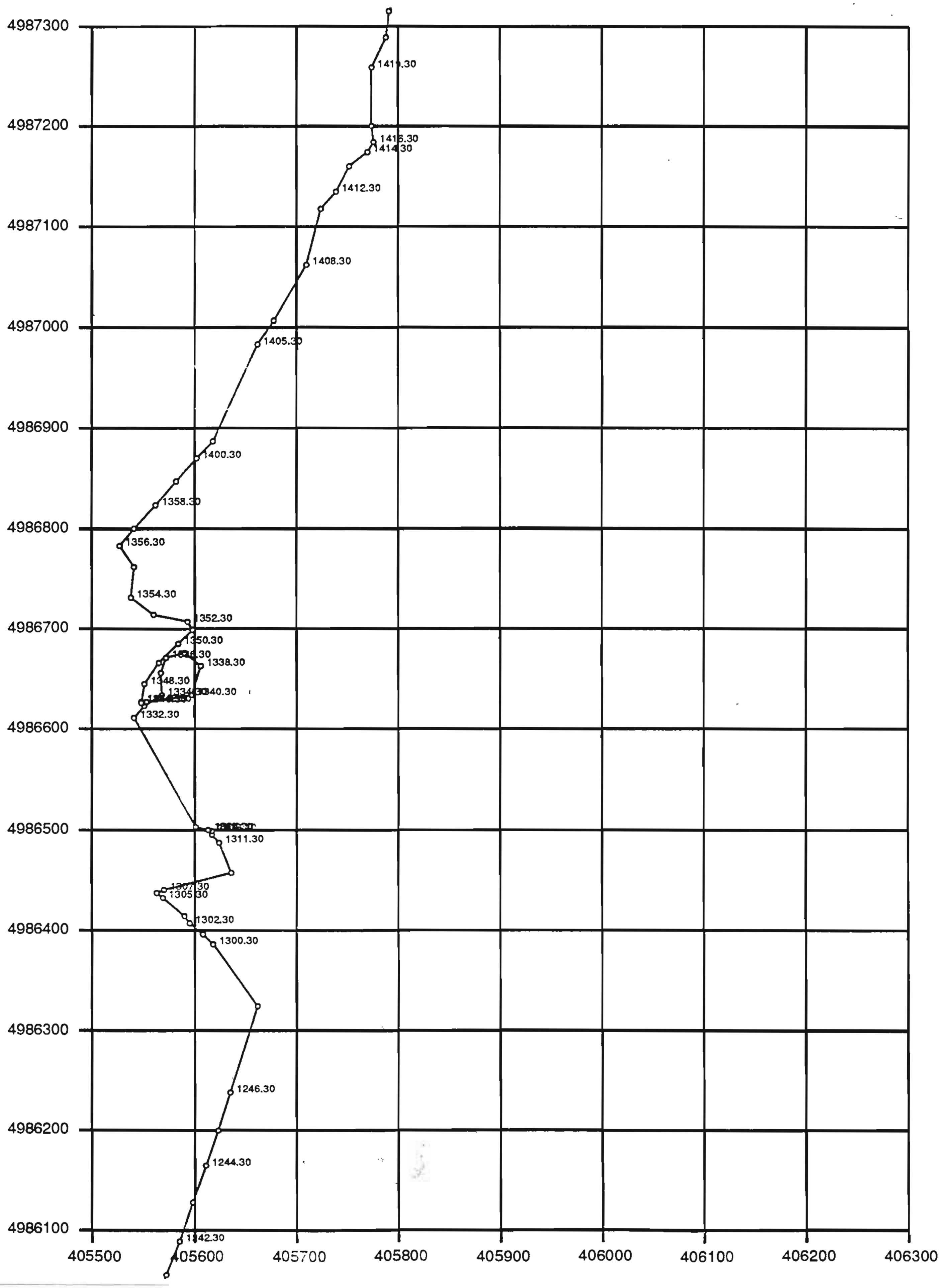
1307.30
1311.30
1319.30
1326.30
1415.30

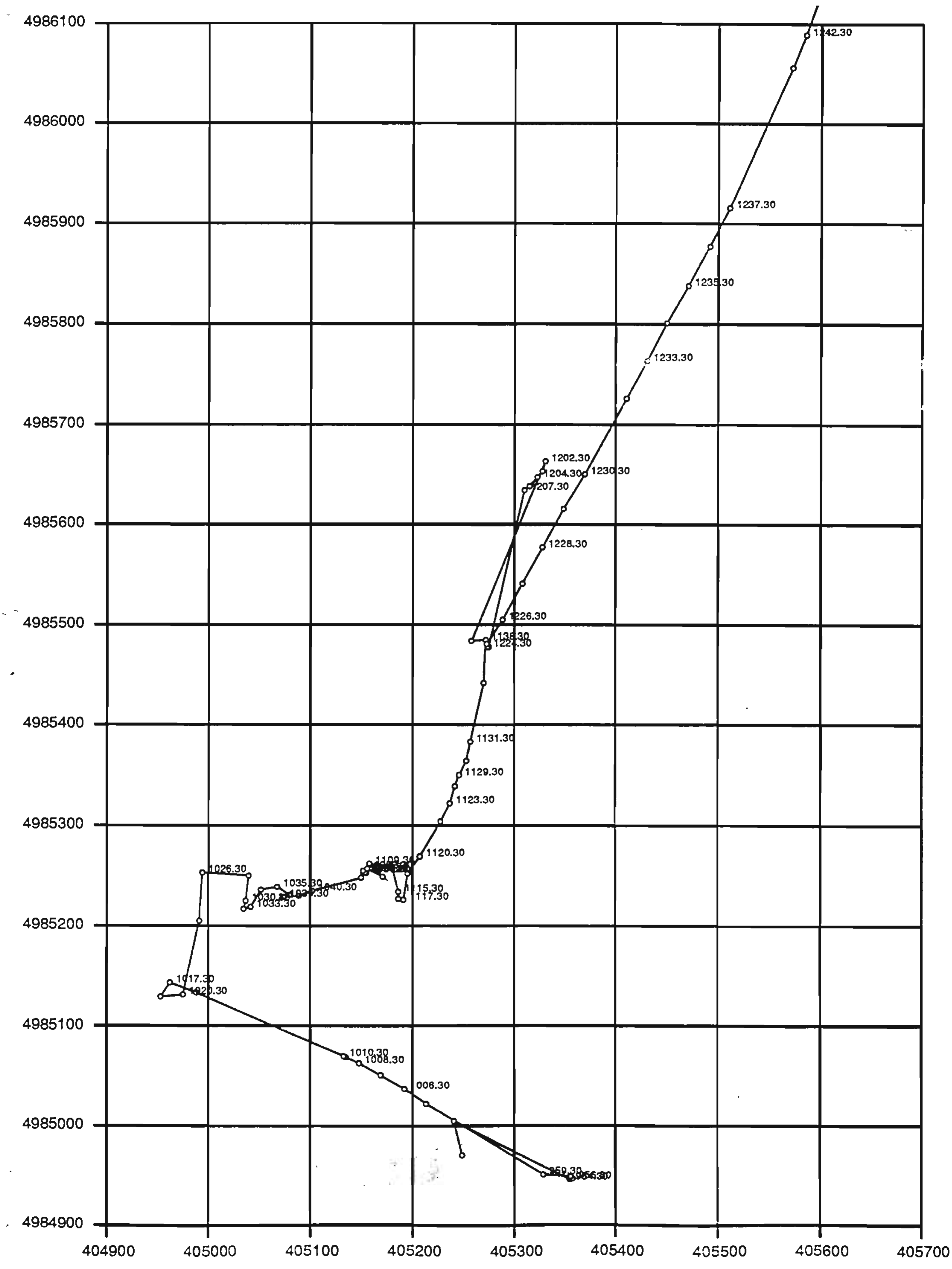
DIVE 2432 - N. Cleft MOUND 1+2
1:5000



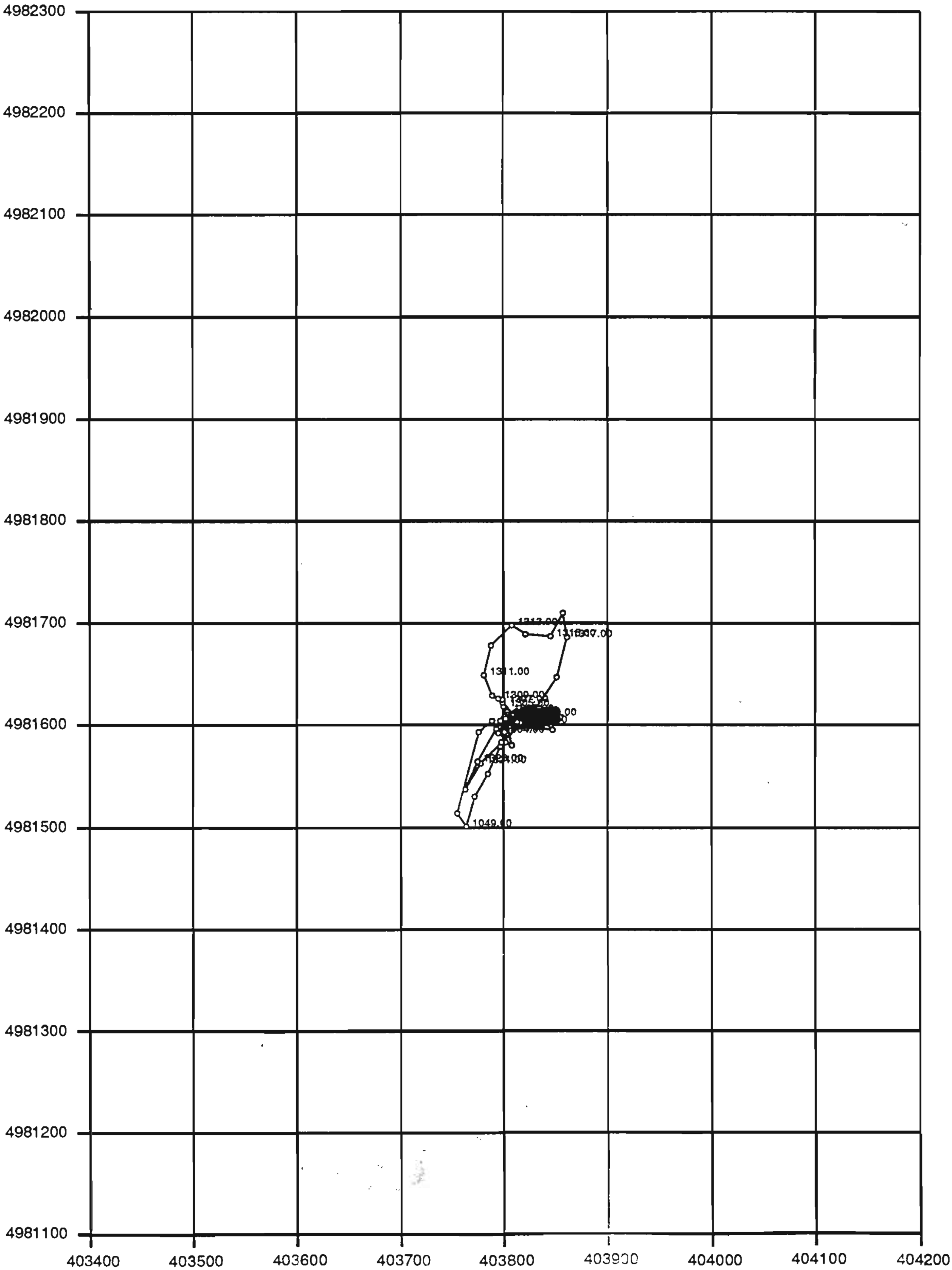
DIVE 2432 - N. Cleft
1:5000



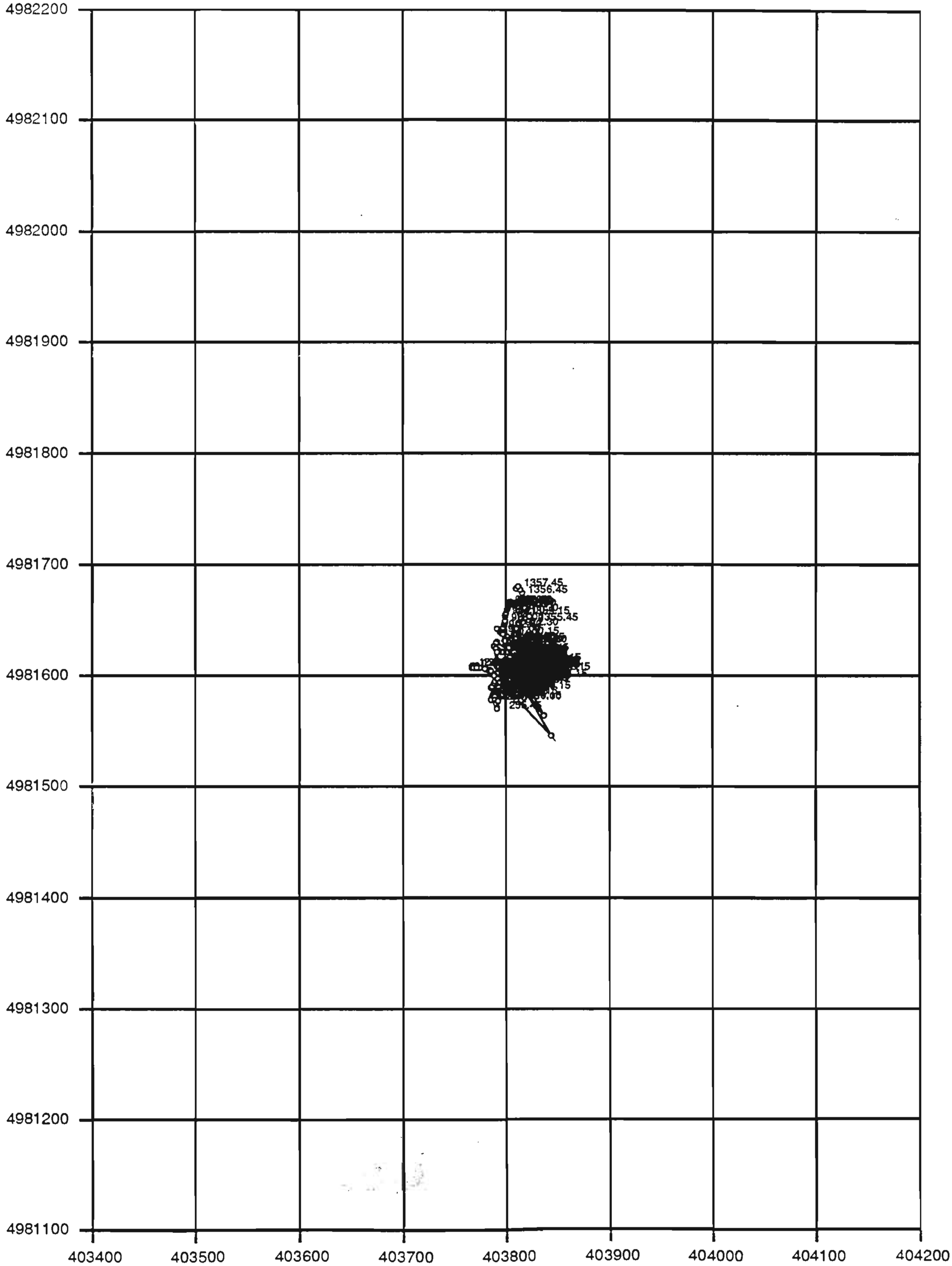
DIVE 2432 - N. Cleft
1:5000



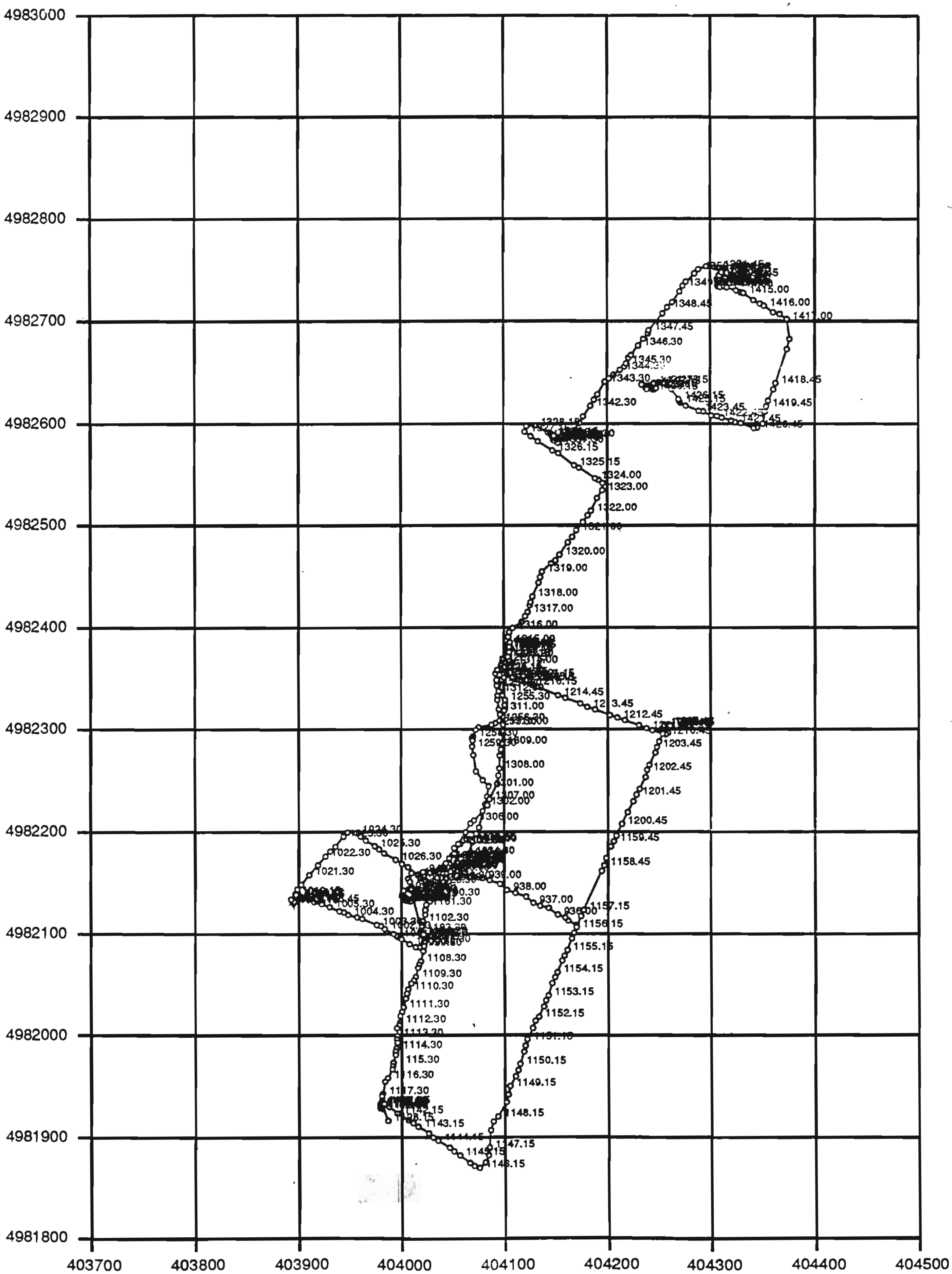
DIVE 2433 - Monolith
1:5000



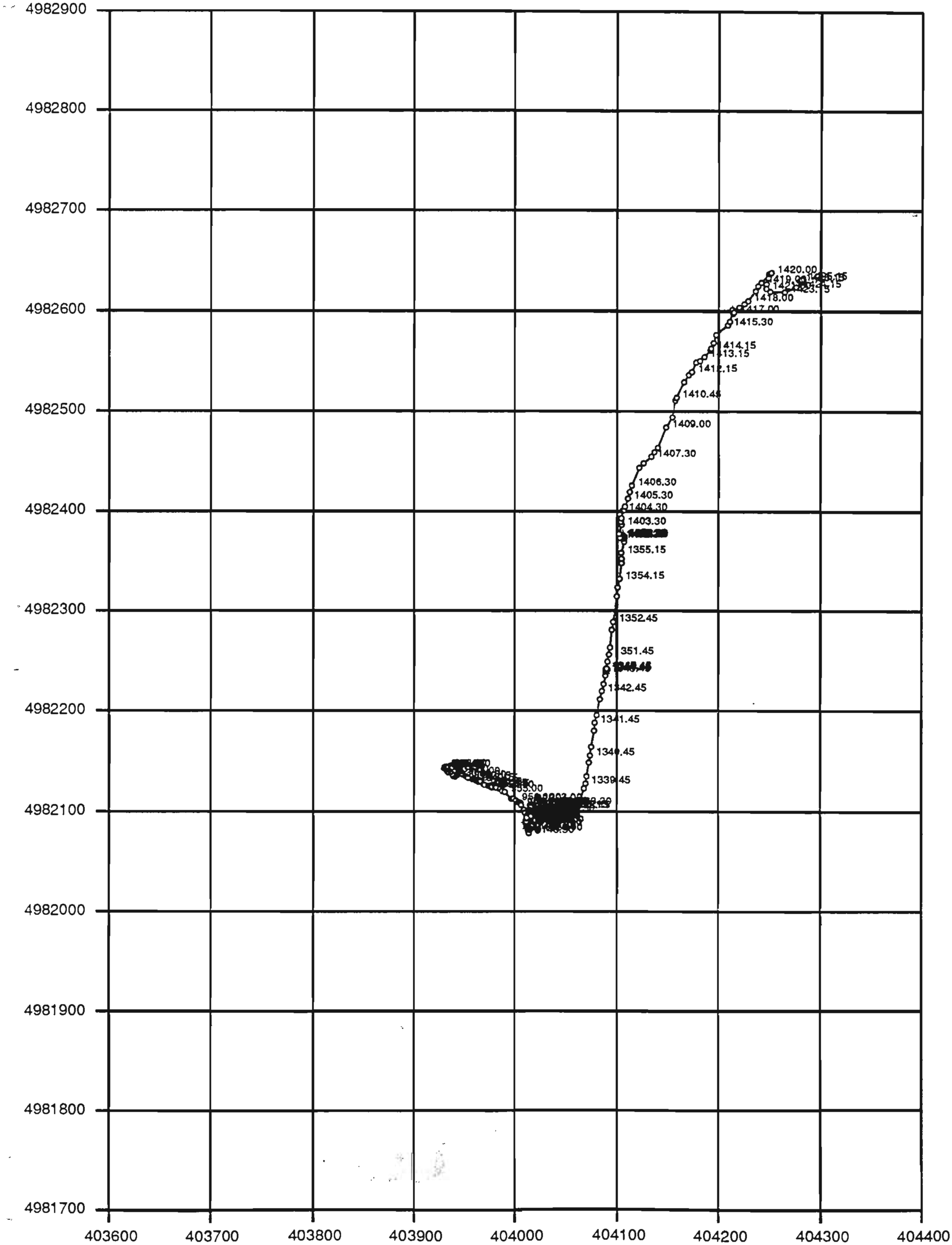
DIVE 2434 - Monolith Buoyant Plume
1:5000



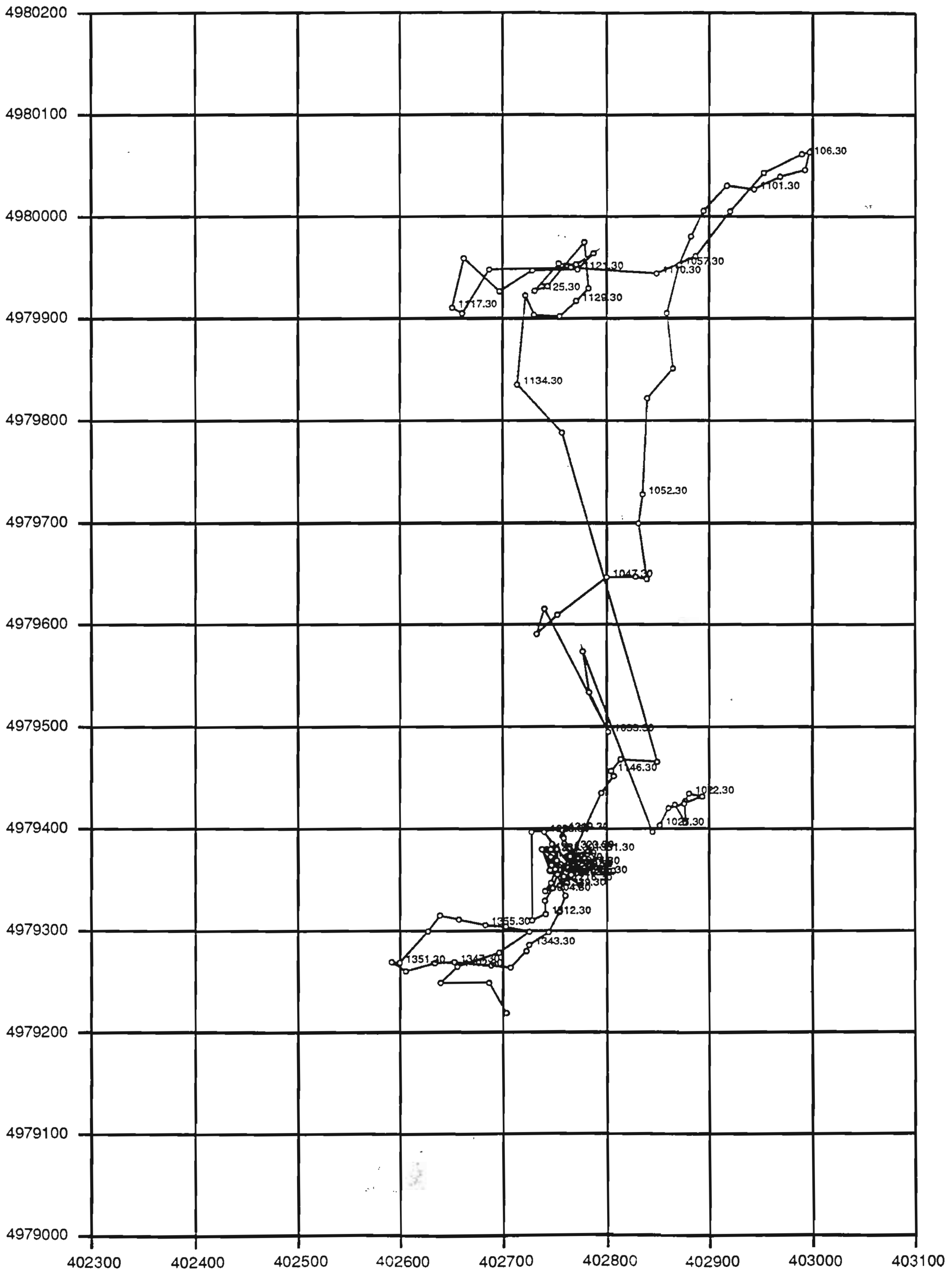
DIVE 2435 - N. Monolith
1:5000



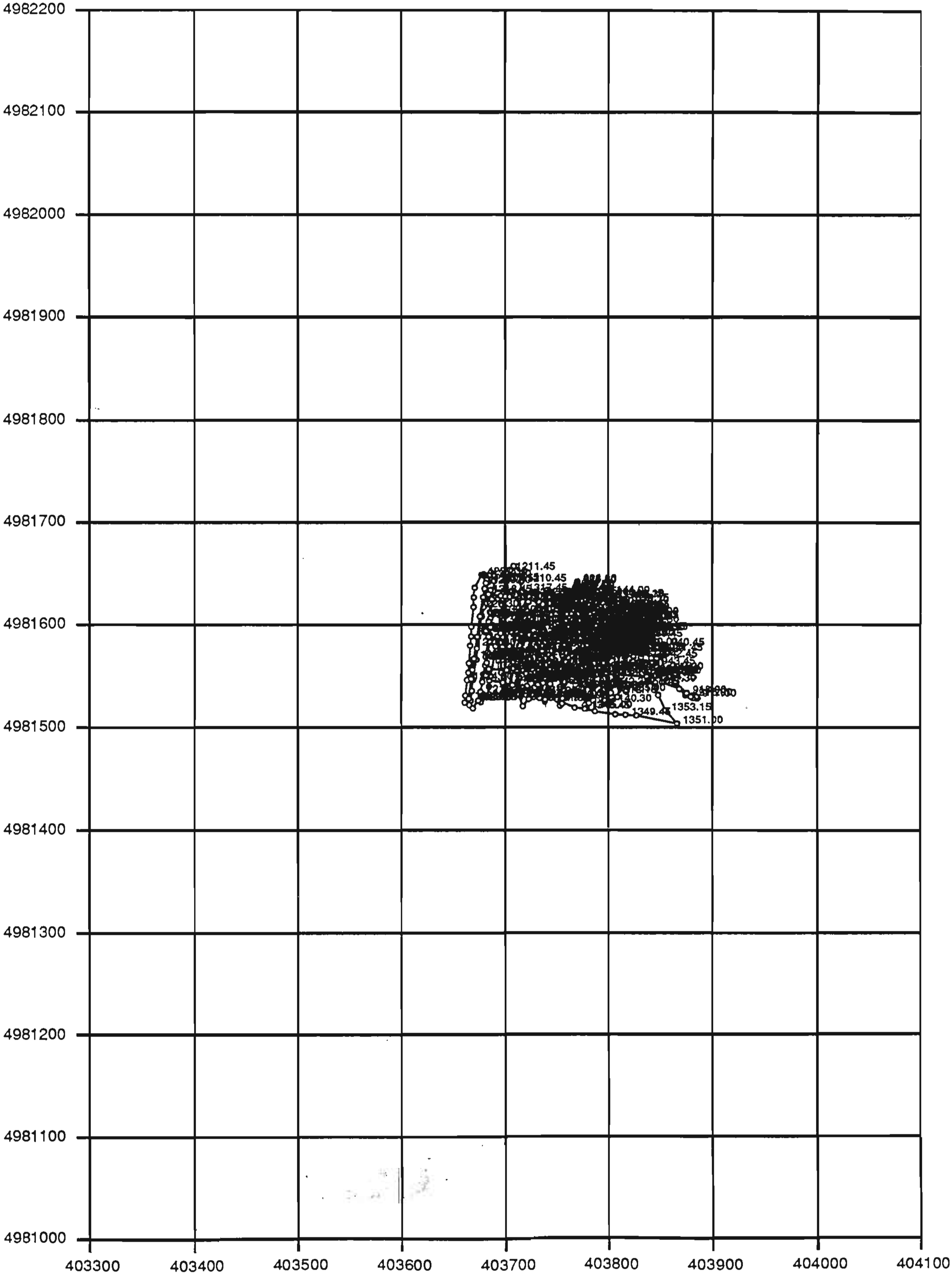
DIVE 2436 - Fountain Vent
1:5000



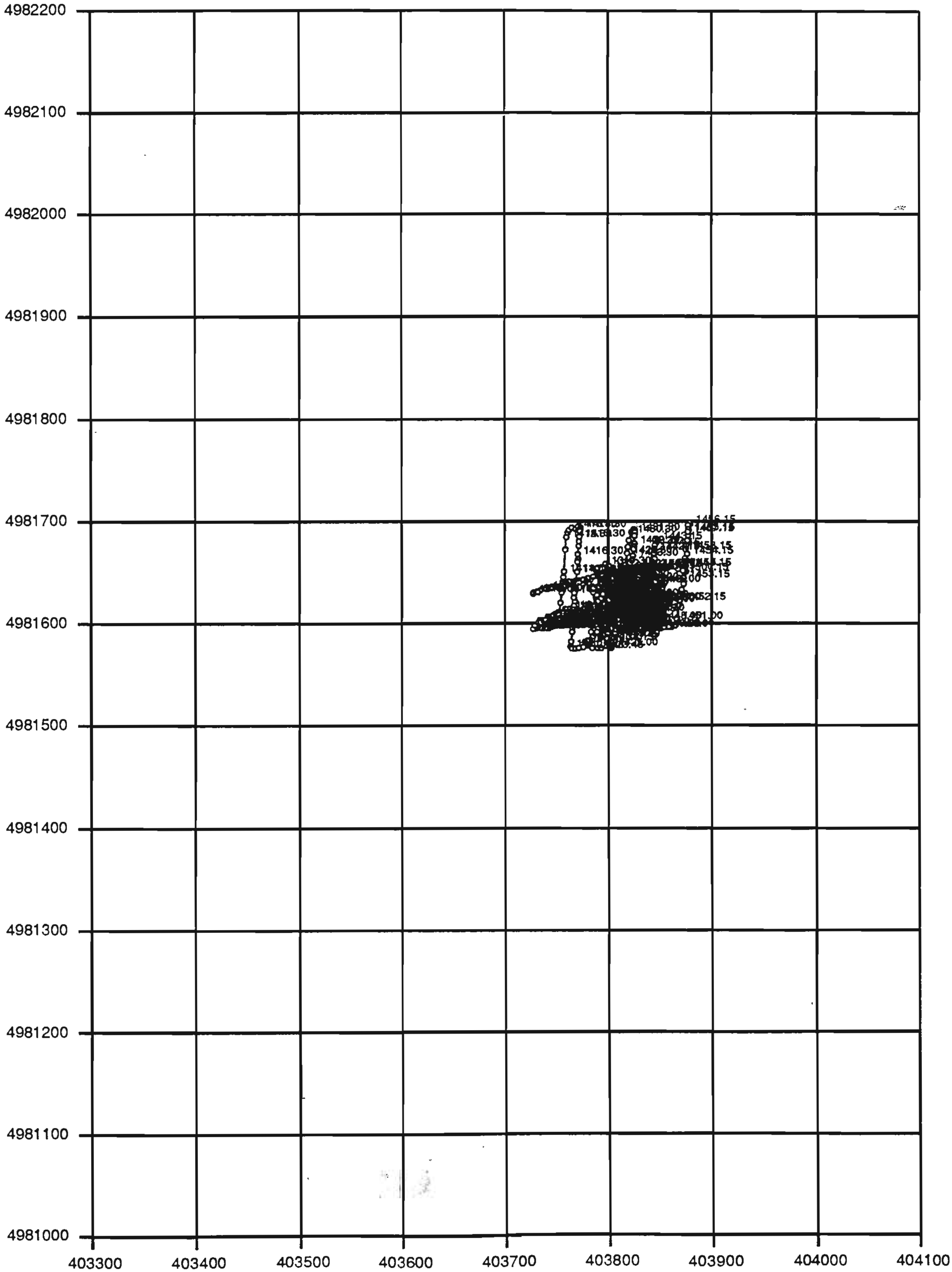
DIVE 2437 - Tripod/Pipe Organ Vent
1:5000



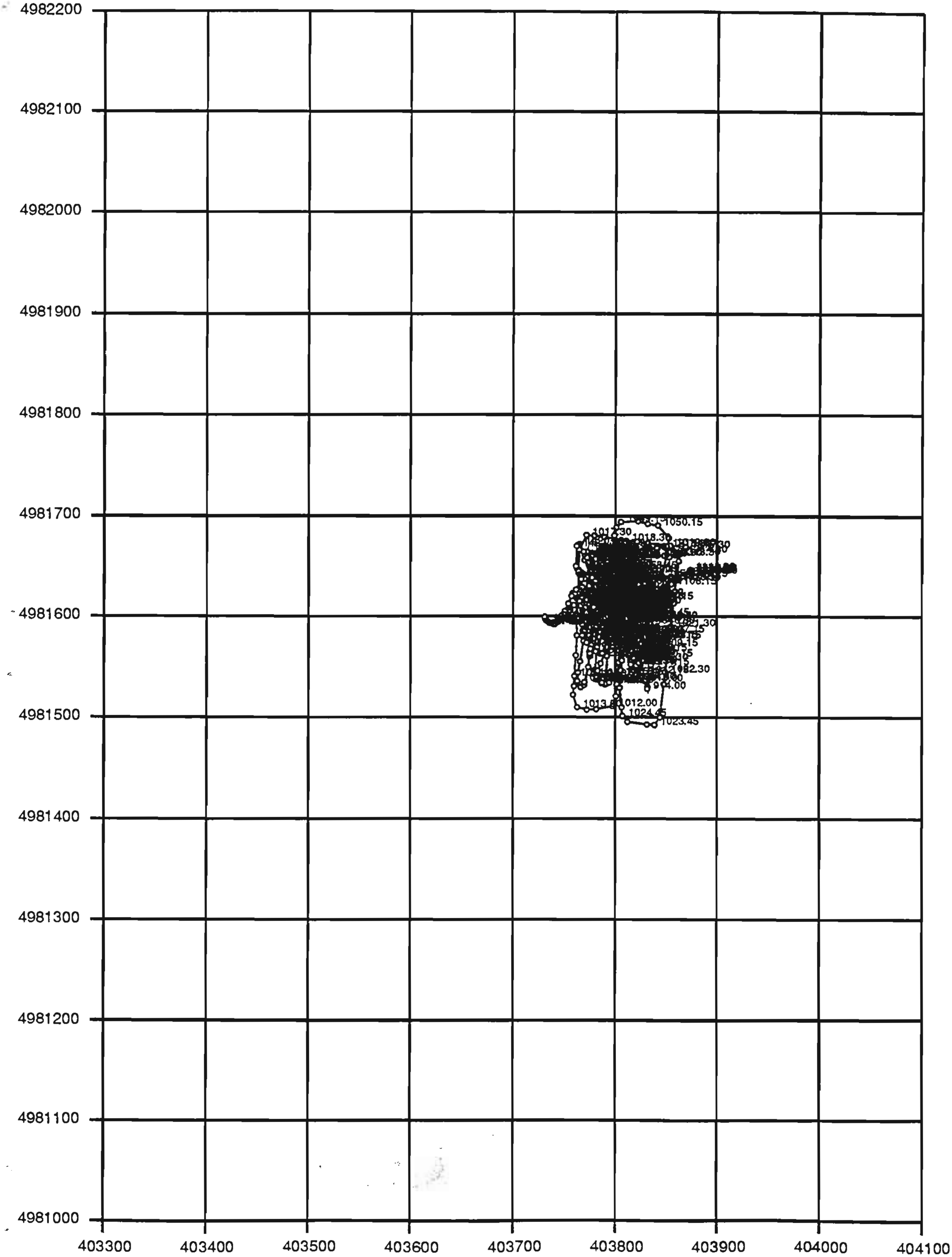
DIVE 2438 - Monolith Buoyant Plume
1:5000



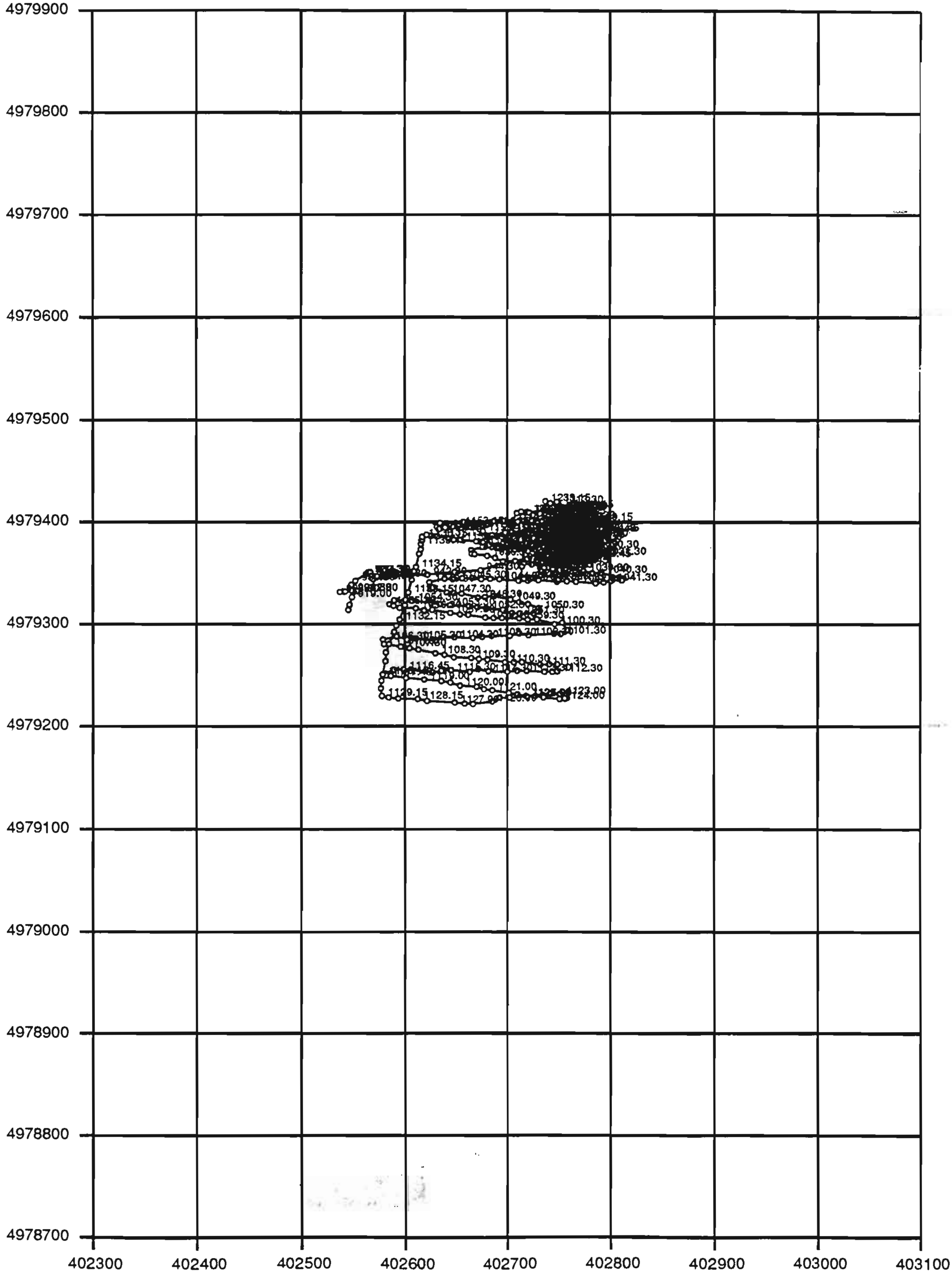
DIVE 2439 - Monolith Buoyant Plume
1:5000



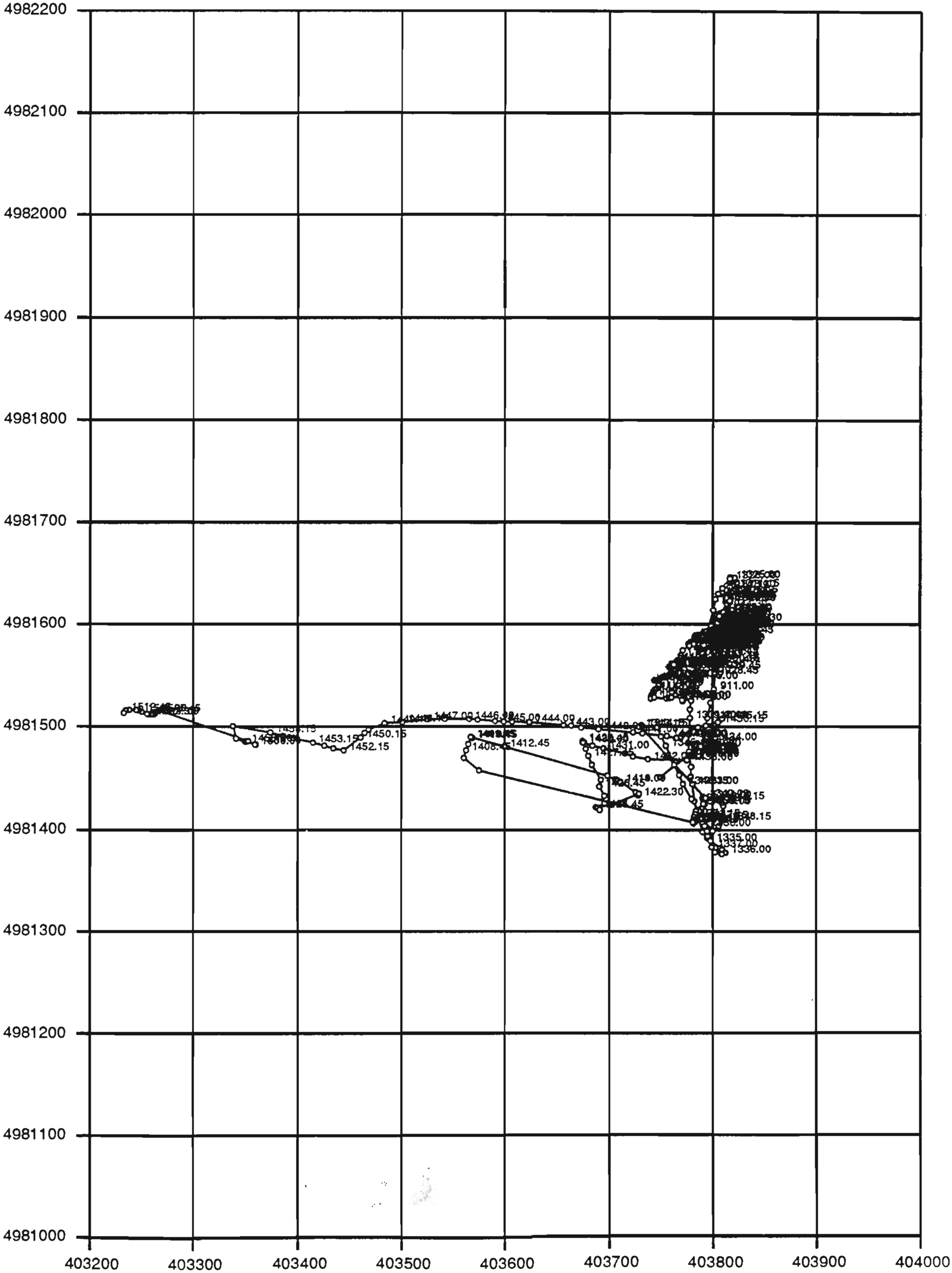
DIVE 2440 - Monolith Buoyant Plume
1:5000



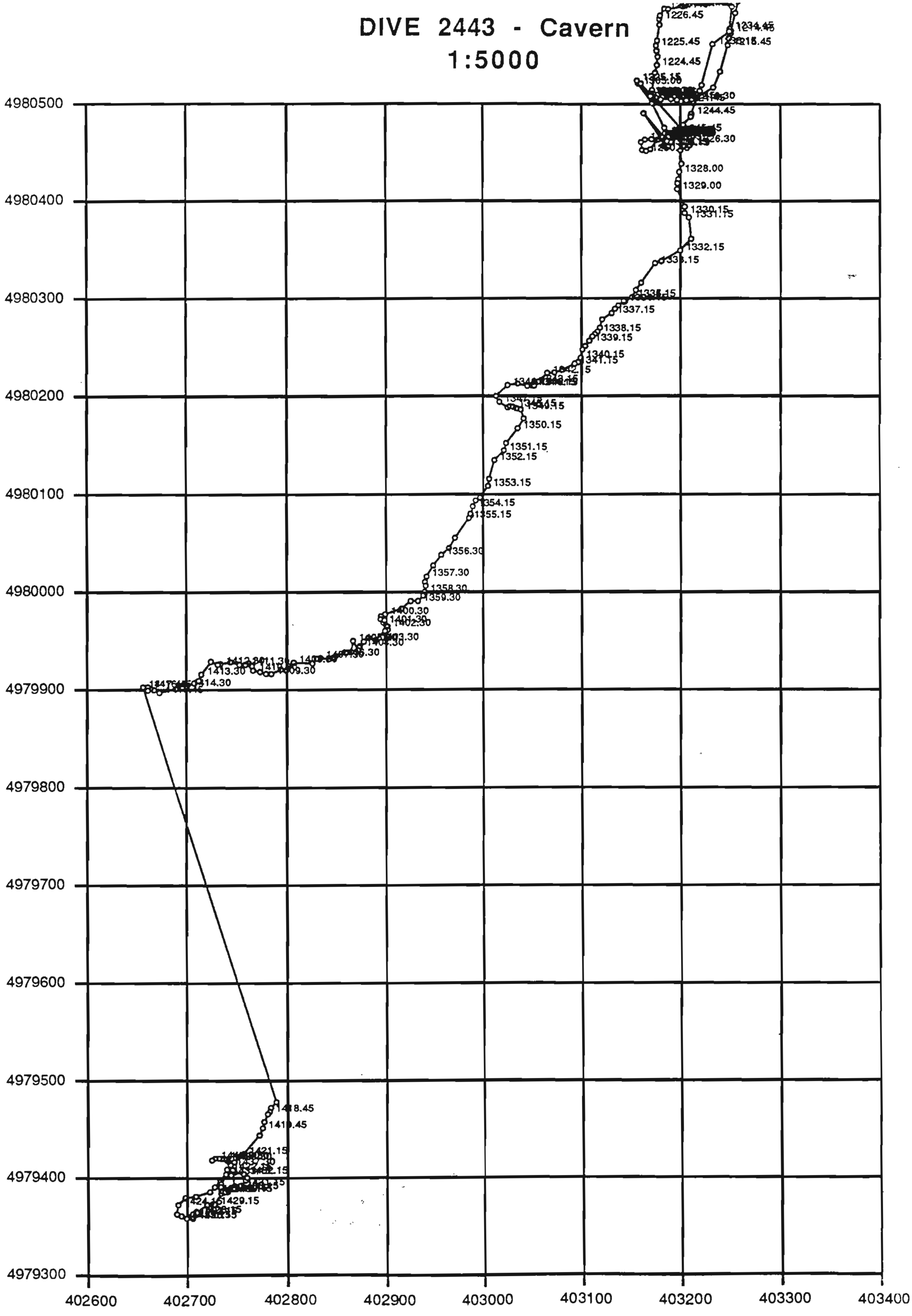
DIVE 2441 - Pipe Organ Buoyant Plume
1:5000



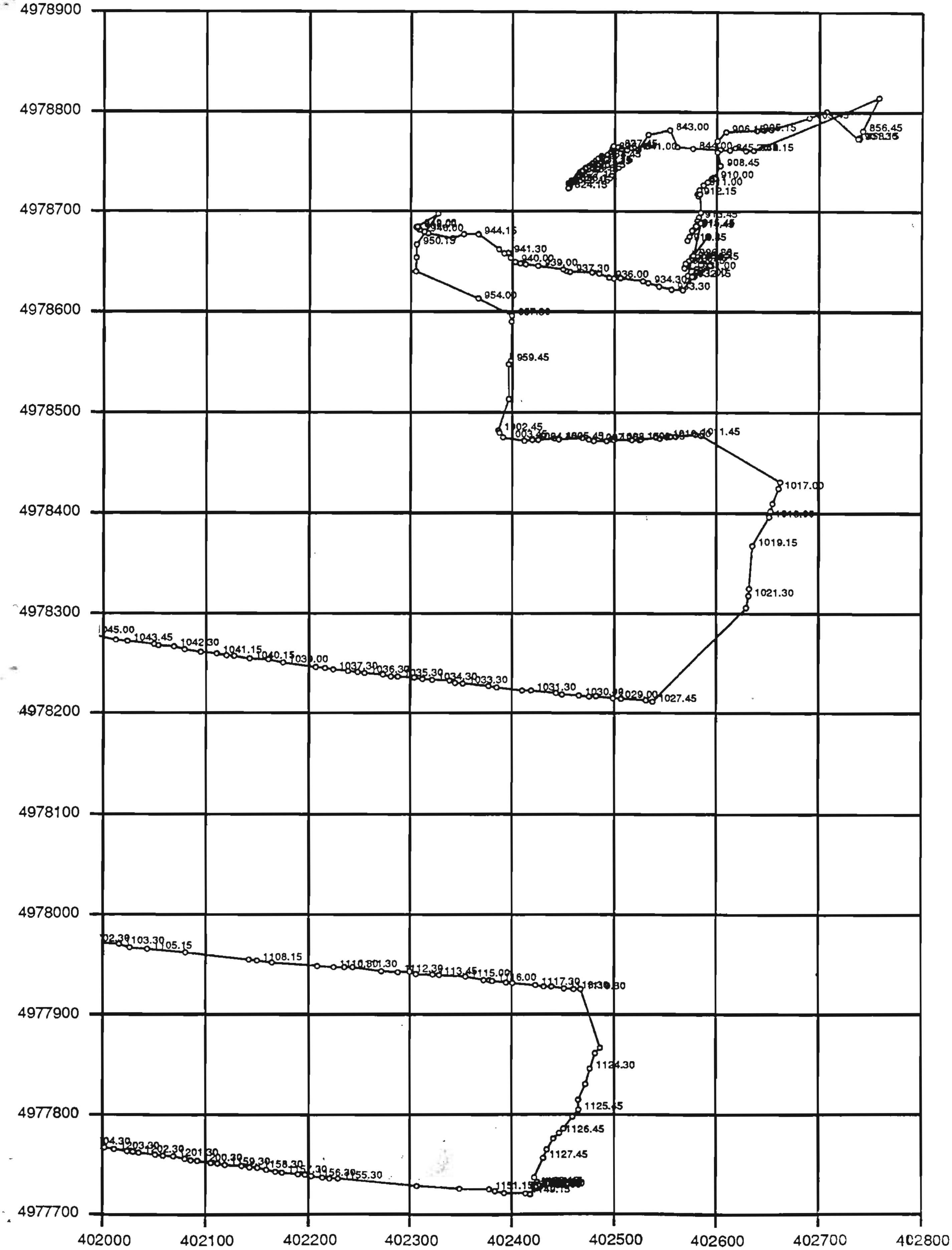
DIVE 2442 - Monolith
1:5000



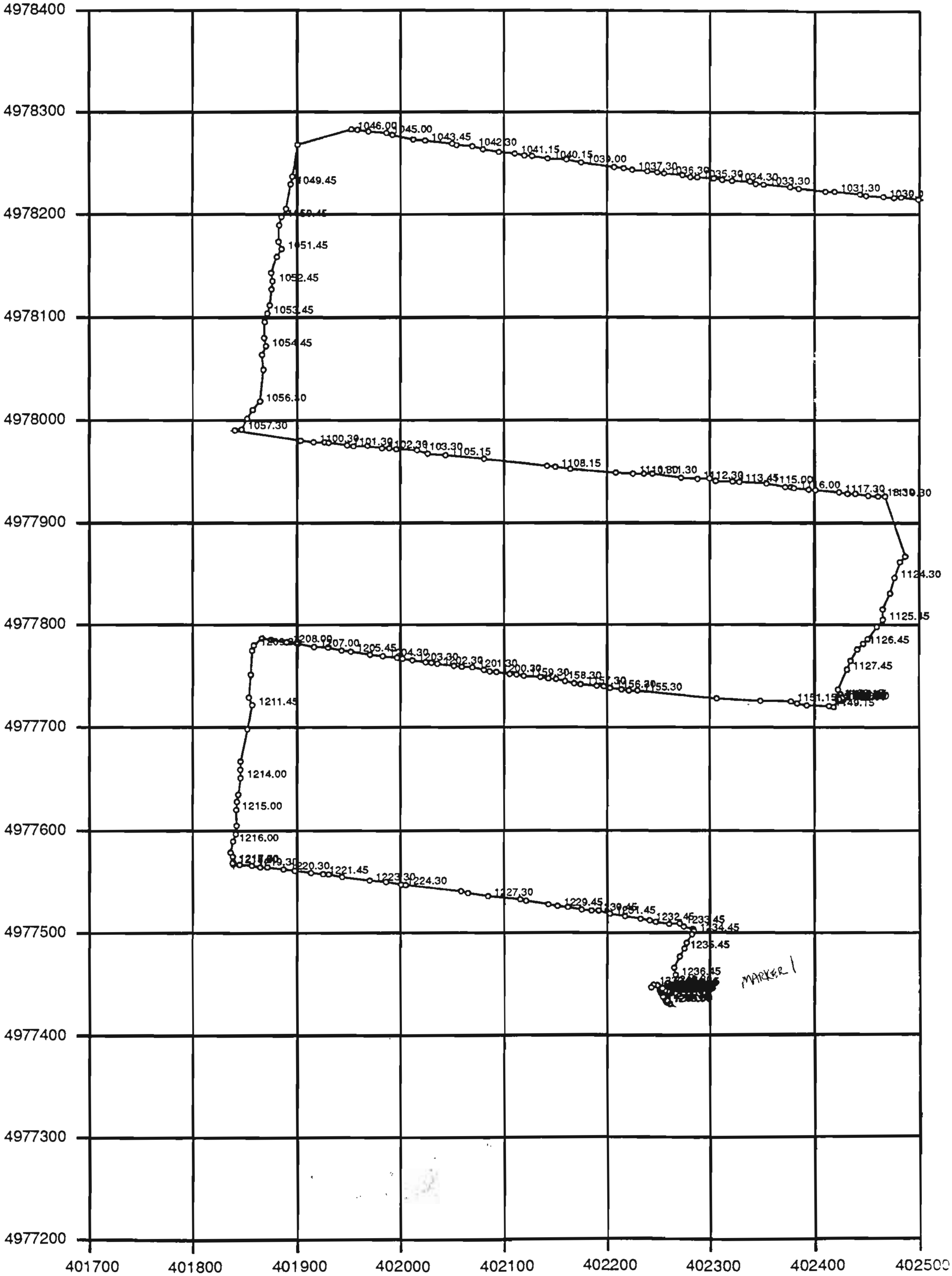
DIVE 2443 - Cavern
1:5000



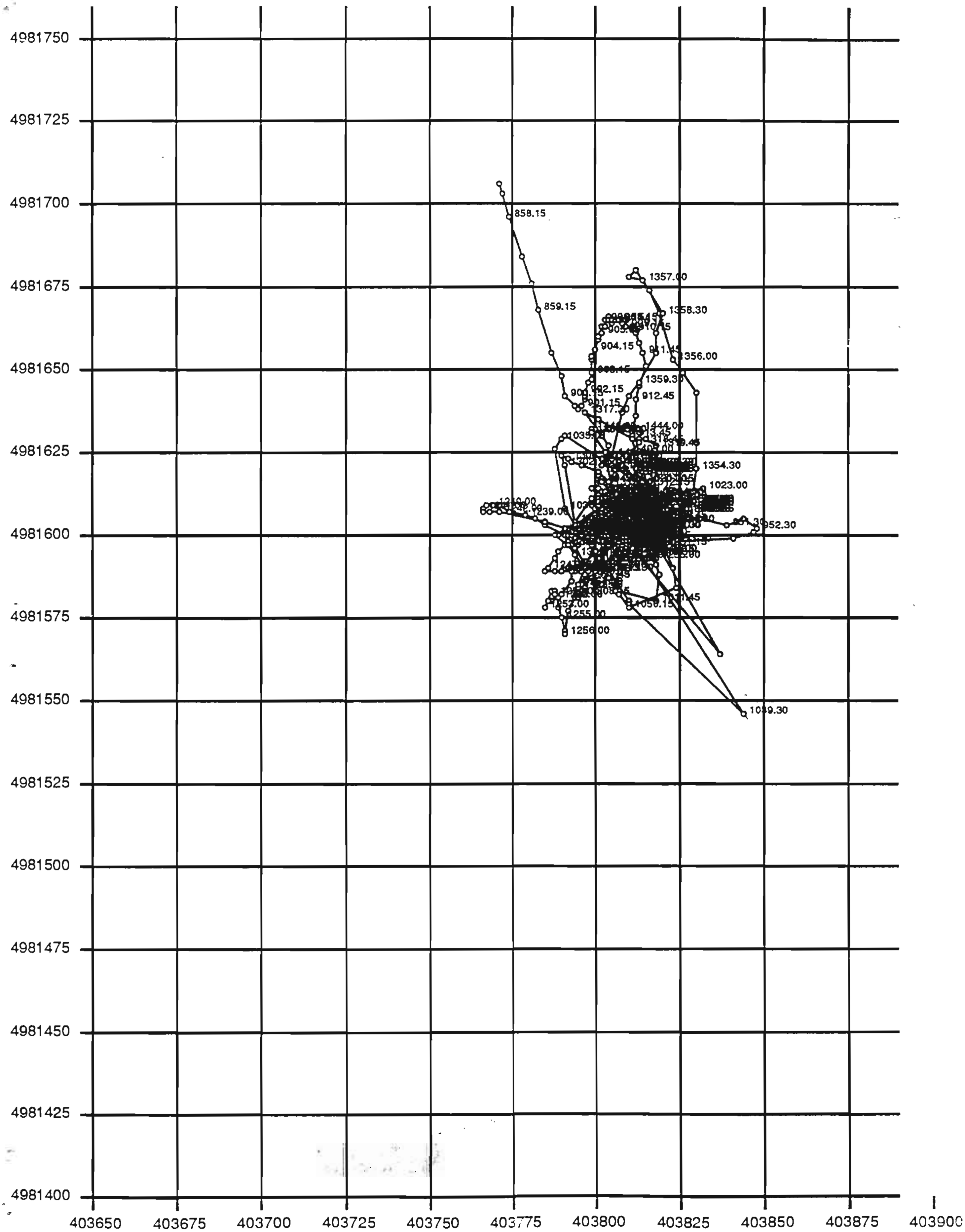
DIVE 2444 - S. Cleft
1:5000



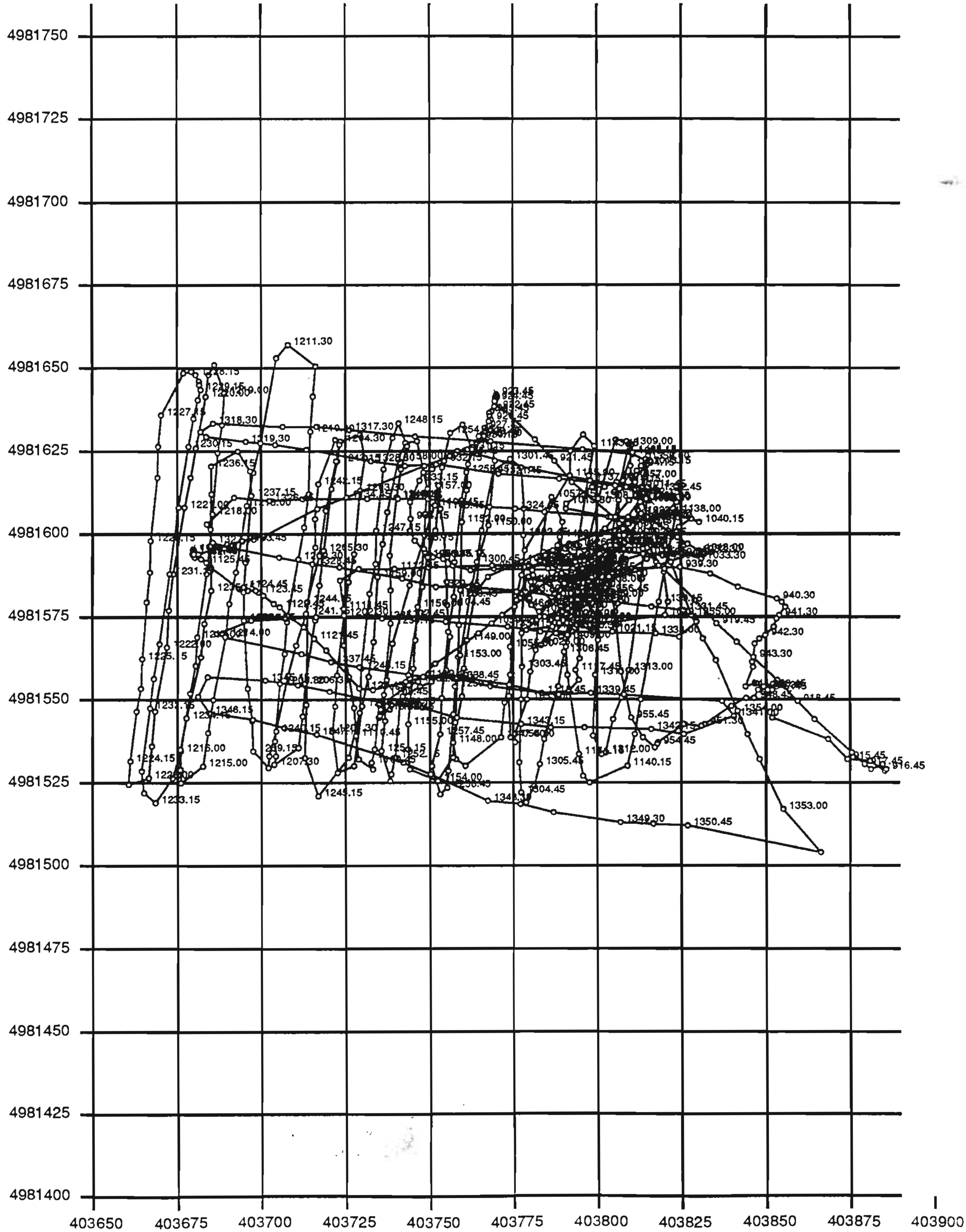
DIVE 2444 - S. Cleft
1:5000



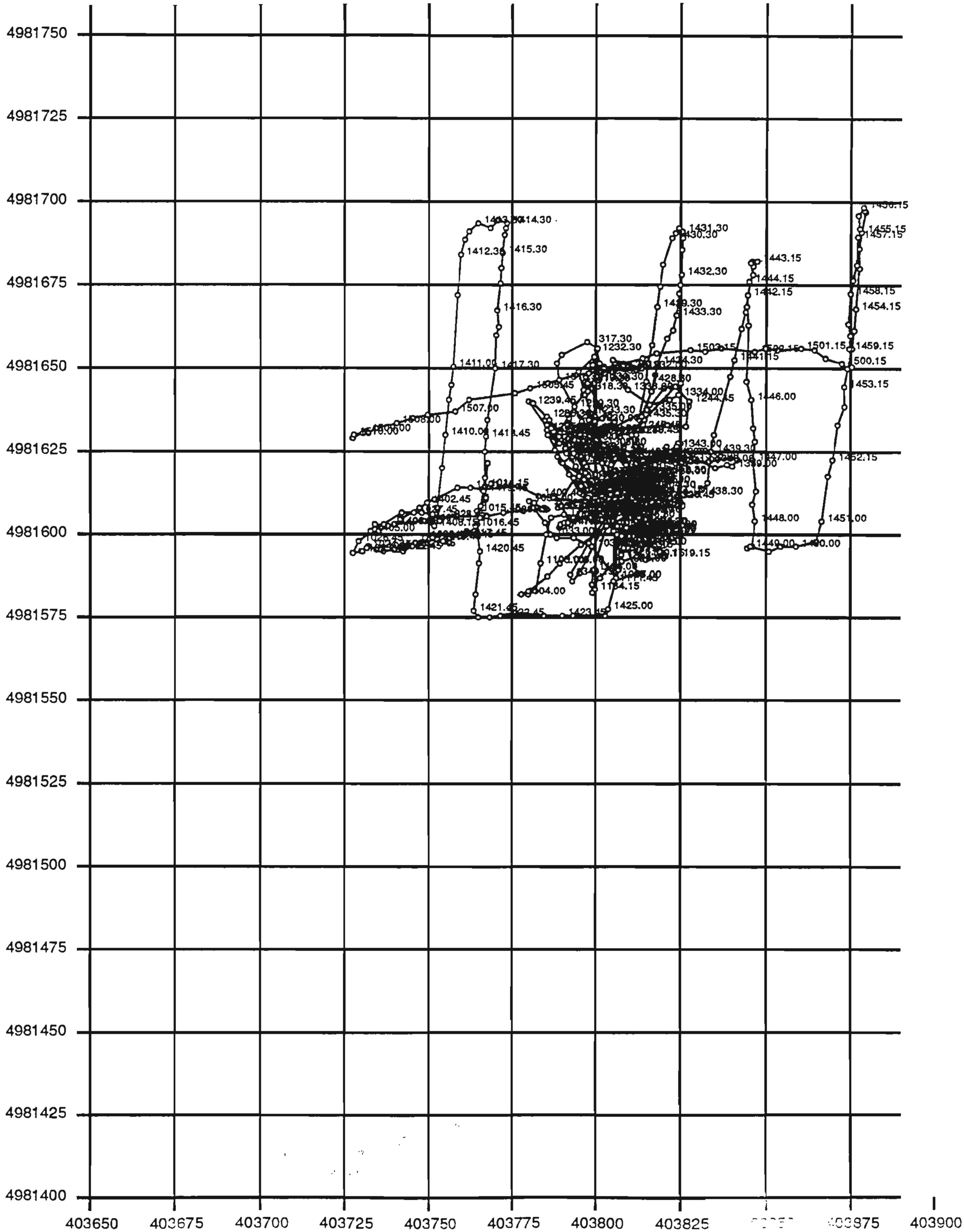
DIVE 2434 - Monolith Buoyant Plume
1:1500



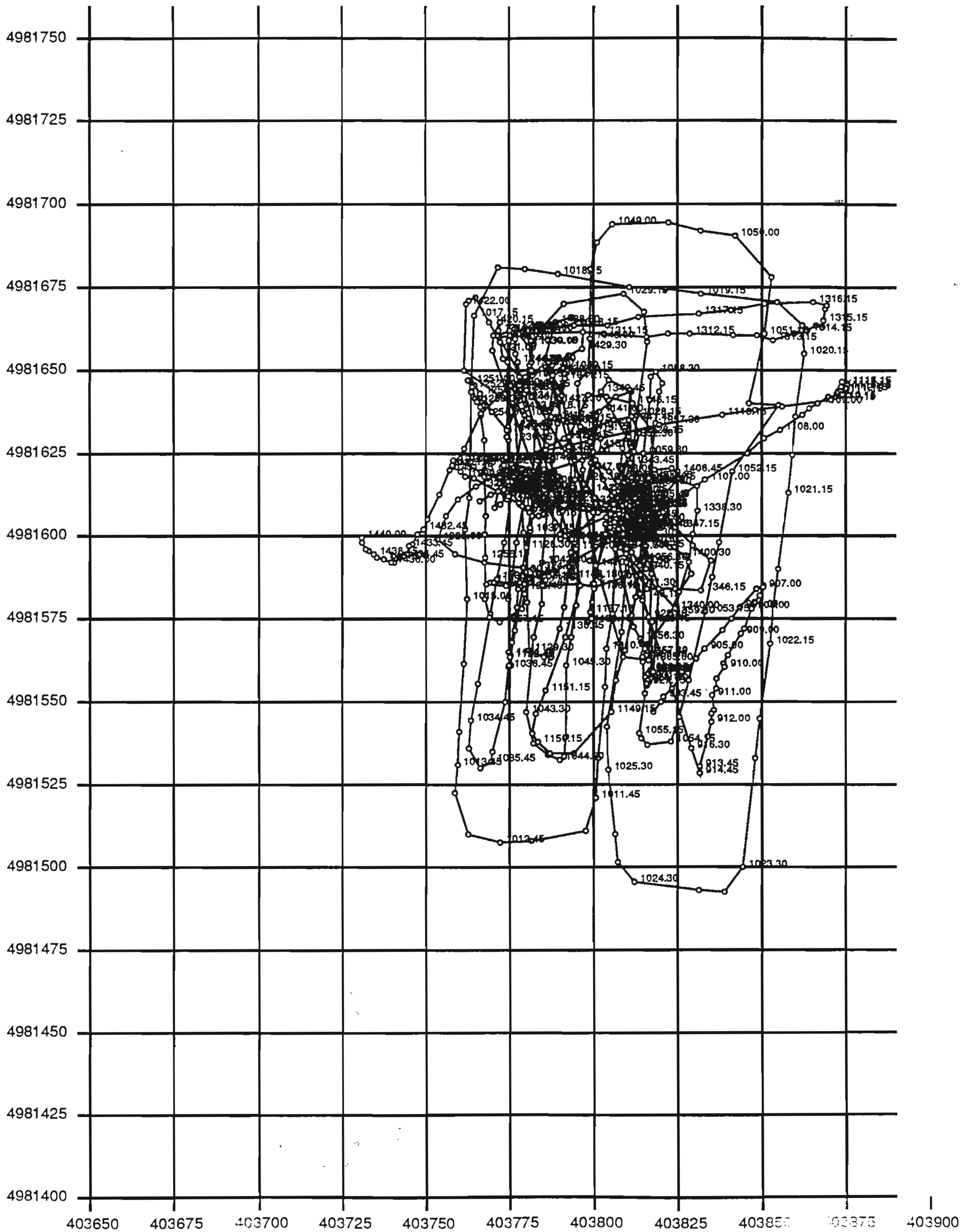
DIVE 2438 - Monolith Buoyant Plume
1:1500



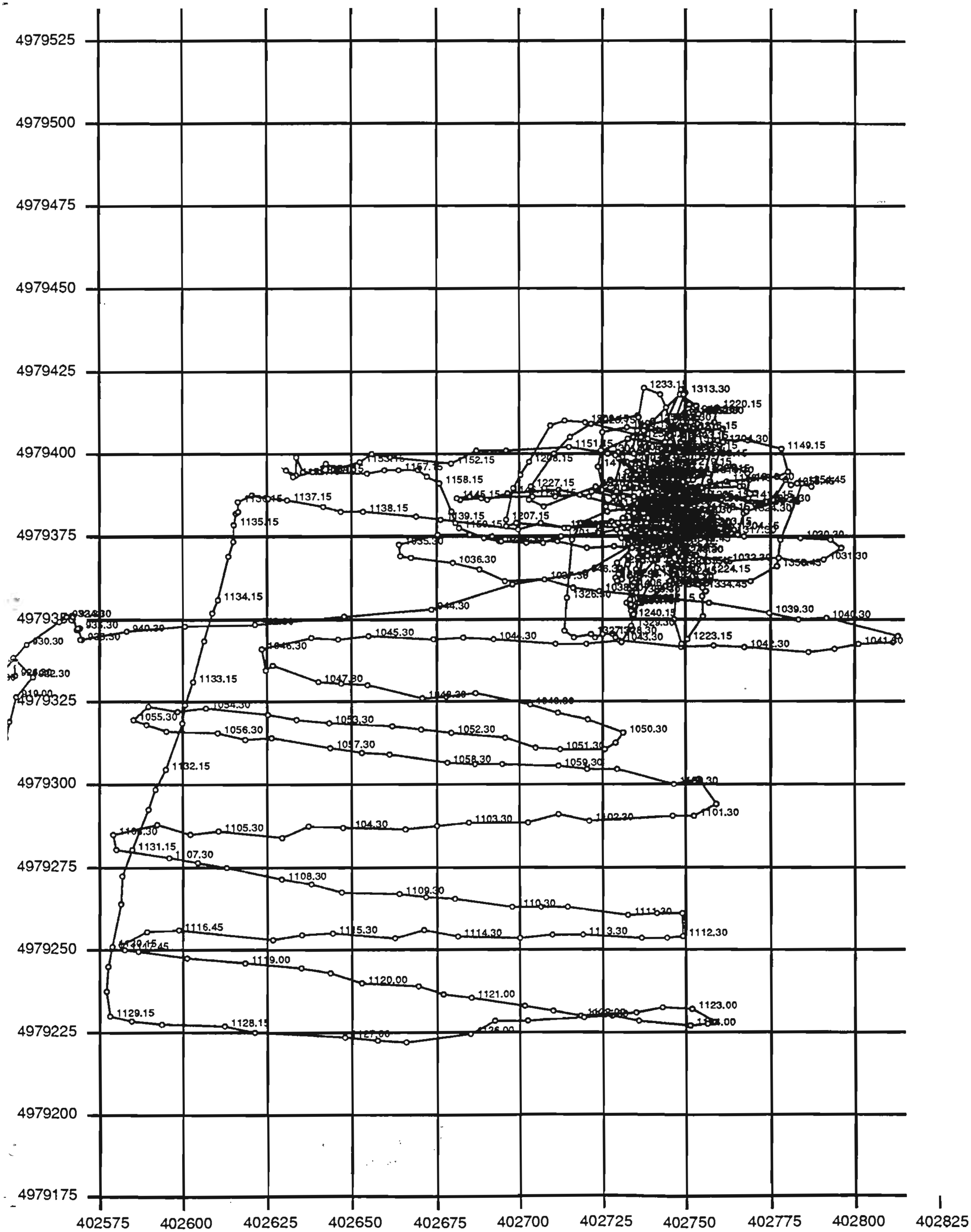
DIVE 2439 - Monolith Buoyant Plume
1:1500



DIVE 2440 - Monolith Buoyant Plume
1:1500



DIVE 2441 - Pipe Organ Buoyant Plume
1:1500



Dive Sample Summary

SAMPLE #	TYPE	TIME	POSITION	DEPTH (m)	TEMP	REMARKS
2429-1	Niskin 1,2,3	1330.00	403757X/4981670Y	2261.00	2.06,2.09,2.13	on Monolith sulfide chimney
2429-1	manifold/gas tight	1337.00	403757X/4981670Y	2261.00		
2429-1	sulfide	1347.00	403757X/4981670Y	2261.00		
2429-2	water		404014X/4982192Y	2254.00		
2429-2	biology		404014X/4982192Y	2254.00		
2429-2	sulfide	1530.00	404014X/4982192Y	2254.00		
2430-1	basalt	1040.00	409173X/5000195Y	2398.00		new lava near East contact
2430-2	basalt	1129.00	409156X/5000081Y	2385.00		old lava near contact, pillow
2430-3	sediment	1214.00	409099X/5000254Y	2400.00	1.79	attempt at orange sediment found under large pillows in new
2430-4	basalt	1312.00	409297X/5000464Y	2407.00		new lava, 3 pieces (1 with orange sed.)
2430-5	4 manifold majors	1442.00	in transit		1.78	tripped major samplers/bottom water
2430-6	blue major	1513.00	408900X/4999900Y	2343.00		attempt to sample fine yellow sediment on new lava
2431-1	sediment	1030-1050	402825X/4979775Y	2280.00		floor of lava lake, 20m w. of Cleft
2431-2	biology	1120-1128	402775X/4979645Y	2272.00		dead worms top of western edge of cavern near Cleft
2431-3A	sulfide	1131-1140	402755X/4979425Y	2270.00		2 dead chimneys about 25m E. of Cleft in mix of new/old lava
2431-3B		2241-1151		2274.00		base of sulfide stacks;evidence of sulfide interaction
2431-4	basalt	1231-1234	401965X/4979080Y	2274.00		glassy ropy lava from rubbly ridge 50m E. of W. Wall
2431-5	basalt	1254-1300	402155X/4979019Y	2278.00		glassy ropy lava from lake floor, 300m E. of W. Wall
2431-6A	3 majors/1 GT	1329-1400	402530X/4978560Y	2279.00	8.0-12.0	water from sheet flows in walls of Cleft
2431-6B	biology	1329-1420	402530X/4978560Y	2278.00	8.0-12.0	small flat worms 1-2cm cases on sheet flow interpace wal
2431-6C	basalt	1329-1420	402530X/4978560Y	2278.00		sheet flow drip stalactites under;prostrated ones welded on
2432-1	basalt	1054.00	305171X/4985249Y	2278.00		new lava of Mound 1 along north contact
2432-2	basalt	1124.00	405241X/4985339Y	2277.00		old lava north of Mound 1, along a fissure
2432-3	basalt	1314.00	405614X/4986500Y	2284.00		new lava of Mound 2
2432-4	basalt	1439.00	405947X/4987713	2290.00		old lava between Mounds 2 and 3
2433-1	Niskin	1027.00	Monolith plume	2251.00		3m above chimney tops
2433-1	Niskin	1031.00	Monolith plume	2249.00		5m above chimney tops
2433-1	Niskin	1037.00	Monolith plume	2247.00		7m above chimney tops
2433-1	Niskin	1038.00	Monolith plume	2247.00		7m above chimney tops
2433-2A	major	1133.00	s. side of MV	2255.00	270.0/170.0	base of beehive chimney after collapse
2433-2B	gas tight	1140.00	s. side of MV	2255.00		base of beehive chimney after collapse
2433-2C	sulfide	1110.00	s. side of MV	2255.00		fragments of fragile bulbous chimney with diffuse lateral v
2433-3A	discrete	1222.00	SE side	2255.00	303.40	cluster of 4 chimneys, venting dark smoke;from orifice after
2433-3B	discrete	1227.00	SE side	2255.00	303.40	same as above
2433-3C	sulfide	1237.00	SE side	2255.00		basal part of collapse chimney
2433-3D	sulfide	1242.00	SE side	2255.00	314.00	nearly complete chimney multiple spouts,chalcopyrite lining
2433-4A	sulfide	1338.00	N. side	2257.00	309.00	3 sulfate-rich minichimneys from top of beehive chimney
2433-4B	discrete	1349.00	N. side	2257.00	305.00	top of beehive chimney
2433-5A	major	1418.00	N. side	2259.00	327.2/215.0	vigourous small chimney flank of mound below & 3m from be
2433-5B	major	1419.00	N. side	2259.00	328.0/215.0	same as above
2433-5C	gas tight	1423.00	N. side	2259.00	328.00	same as above
2434-1	Feely filter	955.00	403815X/4981697Y	2251.00	1.94	
2434-2	Feely filter	1042.00	403813X/4981605Y	2250.00		

2434-3	Trefry filter	1042.00	403813X/4981605Y	2250.00		
2434-4	Niskin	1044.00	403808X/4981609Y	2249.00	2.67	
2434-5	Niskin	1055.00	403804X/4981608Y	2250.00	3.26	
2434-6	Feely filter	1101.00	403796X/4981600Y	2245.00	1.94	
2434-7	Niskin	1102.00	403796X/4981600Y	2245.00	1.94	
2434-8	Feely filter	1126.00	403801X/4981593Y	2240.00	1.91	
2434-9	Niskin	1128.00	403806X/4981596Y	2241.00	1.91	
2434-10	Feely filter	1141.00	403804X/4981601Y	2235.00	2.46	
2434-11	Feely filter	1157.00	403802X/4981601Y	2230.00	2.09	
2434-12	Feely filter	1210.00	403810X/4981608Y	2225.00	2.26	
2434-13	Feely filter	1222.00	403803X/4981600Y	2225.00	2.36	
2434-14	Feely filter	1243.00	403791X/4981602Y	2221.00	1.92	
2434-15	sediment	1323.00	403828X/4981610Y	2261.00		
2434-16	sediment	1330.00	403828X/4981610Y	2261.00		
2434-17	major	1427.00	403816X/4981620Y	2256.00	35.0/5.3	
2434-18	gas tight	1427.00	403816X/4981620Y	2256.00	35.0/5.3	
2434-19	major	1433.00	403816X/4981620Y	2256.00	43.9/4.6	
2434-20	sulfide/biology	1440.00	403808X/4981616Y	2255.00	2.30	
2434-21	major	1504.00	403807X/4981598Y	2258.00	7.2/6.0	
2434-22	gas tight	1504.00	403807X/4981598Y	2258.00	7.2/6.0	
2434-23	major	1517.00	403812X/4981600Y	2259.00	28.8/12.2	
2435-1	basalt	1010.00	403900X/4982138Y	2238.00	1.90	ropy lava
2435-2	basalt	1040.00	404055X/4982174Y	2257.00		basalt sheet flow
2435-3	sulfide	1050.00	404050X/4982164Y	2256.00	1.87	small pinnacle chimney py/sio2 from lobate flow
2435-4	basalt	1125.00	403981X/4981929Y	2254.00	1.86	altered crackle breccia in blocky sheet flow
2435-5	basalt	1204.00	404255X/4982304Y	2263.00	1.86	coarse ropy flow, fresh
2435-6	basalt	1222.00	404125X/4982348Y	2263.00		altered fractured blocky lava
2435-7	2majors/gas tight	1250.00	404104X/4982381Y	2247.00	11.1/16.3	
2435-8	sulfide	1333.00	404149X/4982484Y	2244.00	1.82	2m high py/si chimney (old)
2435-9A	sulfide	1354.00	404310X/4982750Y	2235.00		top of 12m chimney pinnacle
2435-9B	basalt	1359.00	404310X/4982750Y	2246.00		1m below base of chimney altered lobate flow py/sio2
2436-1A	major	1026.00	Fountain,N.side	2250.00	315.0/42.0	top of beehive chimney
2436-1B	gas tight	1030.00	same	2250.00	315.0/67.0	same
2436-1C	discrete	1045.00	same	2250.00	304-309.0	same
2436-1D	discrete	1110.00	same	2250.00	304-309.0	same
2436-1E	sulfide	1125.00	same	2250.00		small sulfide spire, inactive
2436-1F	sulfide	1125-1134	same	2250.00	304-309.0	fragments of beehive chimney wall near base
2436-2A	sulfide	1210.00	Fountain,S.side	2252.00		fragments of beehive-type chimney
2436-2B	discrete	1224.00	same	2253.00	307.00	orifice for beehive chimney
2436-2C	major	1229.00	same	2253.00	310.00	beehive chimney orifice after excavation my manipulator
2436-2D	major	1235.00	same	2253.00	305.0/141.0	same
2436-2E	gas tight	1243.00	same	2253.00	302.0/133.0	same
2436-2F	sulfide/biology	1255.00	same	2253.00		pieces of chimney wall with attached tube and palm worms
2436-3	biology	1245.00	404106X/4982375Y	2245.00		dead tube worms from ridge with shimmering water
2437-1	sediment	1039.00	402666X/4979891Y	2281.00		oxyhydroxide sediment
2437-2A	major/gas tight	1225.00	Organ Vent	2273.00	261.00	Organ Vent orifice
2437-2B	major	1230.00	same	2273.00	255-257.00	same orifice

2437-2C	major	1235.00	same	2273.00	254.00	same orifice
2437-2D	major/GT/discrete	1239.00	same	2273.00	255.00	same orifice
2438-1	gas tight	1016:31	Monolith			
2438-2	gas tight	1023:56	Monolith			
2438-3	gas tight	1034:50	Monolith			
2438-4	niskin	1035:16	Monolith			
2438-5	niskin	1038:02	Monolith			
2438-6	niskin	1059:24	Monolith			
2438-7	niskin	1108:24	Monolith			
2438-8	gas tight	1119:33	Monolith			
2439-1	gas tight	1100:42	403807/4981602	2251.00		
2439-2	niskin	1123:23	403805/4981605	2245.00		
2439-3	niskin	1131:27	403802/4981607	2246.00		
2439-4	niskin	1142:03	403793/4981605	2240.00		
2439-5	niskin	1159:27	403805/4981604	2241.00		
2439-6	gas tight	1159:38	403804/4981606	2241.00		
2439-7	gas tight	1249:40	403801/4981610	2235.00		
2439-8	gas tight	1311:28	403808/4981604	2230.00		
2440-1	niskin	1046:33	403797/4981620	2199.00		
2440-2	gastight	1105:42	403805/4981598	2220.00		
2440-3	niskin	1131:31	403793/4981595	2222.00		
2440-4	gas tight	1141:40	403797/4981613	2220.00		
2440-5	niskin	1205:10	403790/4981618	2221.00		
2440-6	niskin	1426:40	403789/4981627	2210.00		
2442-1	niskin	921.00	403806/4981598	2250.00		PMEL pump sampled
2442-2	niskin	1021.00	403799/4981591	2245.00		Trefry pump sampled
2442-3	niskin	1047.00	403792/4981592	2240.00		PMEL pump sampled
2442-4	niskin	1129.00	403859/4981558	2234.00		pump sampled
2442-5	2majors/gas tight	1230.00	403806/4981606	2258.00	319.00	
2442-6	major	1233.00	403806/4961606	2258.00		
2442-7	sulfide	1252.00	403812/4981601	2258.00		extinct arm of Monolith
2442-8	basalt	1254.00	403811/4981601	2258.00		basalt sample at the base of Monolith
2443-1A	basalt	<1100	near Cavern	2270.00		in rudder cage
2443-1B	major/gas tight	1100.00	403410/4980976	2270.00	22.7-27.5	Cavern Vent
2443-1C	basalt/biology	1100.00	Cavern Vent	2270.00		basalt with snails
2443-2	major/gas tight	1153.00	Marker M	2262.00	>25	
2443-3	major	1249.00	Marker 4		15.00	
2443-4A	niskin	1438.00	Pipe Organ Vent	2269.00		partly in smoke
2443-4B	niskin	1438.00	Pipe Organ Vent	2267.00		in smoke
2443-4C	basalt	1438.00	Pipe Organ Vent			
2444-1	basalt	856.00	402739/4978774	2247.00		older pillow terrain east of new lavas
2444-2	basalt	924.00	402477/4978656	2278.00		in region of collapse near marker 46
2444-3	basalt/sulfide	1132-1145	402424/4977728	2262.00		dead chimney along a fissure in older pillow terrain
2444-4	basalt	1300-1330	402262/4977445		19.00	area of diffuse venting,orange floc on rocks,little white bac

Dive Sample Description

Sample Number	Relative Age	X Coord.	Y Coord.	Time Sampled	Geologic Setting	Sample Morphology
2430-1	youngest (0)	9173.00	30195.00	10:40	n. most new mnd near E cont.	pillow breakout
2430-2	older (2)	9156.00	30081.00	11:29	old lavas near 2430-1	lg pillow frag(>20kg)
2430-4	youngest (0)	9297.00	30464.00	13:12	n. most new mound	3 sm pillow frags
2431-3B	young? (1)	2755.00	9425.00	11:41-11:51	20 m E of collapse nr sulfide	lobe-pillow
2431-4	young (1)	1965.00	9080.00	12:31-12:34	nr west wall on edge lava lak	sheet pushup frag
2431-5	young (1)	2155.00	9019.00	12:54-13:00	in lake in area ass. w/ Fe floc	glass rope
2431-6C-1	young (1)	2530.00	8560.00	13:29-14:20	e. wall of collapse area	v. thin laminar sh. fl.
2431-6C-2	young (1)	""""	""""	""""	same	lobe frag
2431-6C-3	young (1)	""""	""""	""""	same	v. thin laminar sh. fl.
2432-1	youngest (0)	5171.00	15249.00	10:54	n. contact of s.most new mou	pillow breakout
2432-2	older (2)	5241.00	15339.00	11:24	n. of s.most new mound	older pillow frag.
2432-3	youngest (0)	5614.00	16500.00	13:14	"new lava of ""mound 2"""	irregular sheet?
2432-4	??(1)??	5497.00	17713.00	14:39	btwn new mounds 2 and 3	10 kg pillow frag
2435-1	young (1)	3900.00	12138.00	10:10	100m west of fountain vent	sheet rope
2435-2	young (1)	4055.00	12174.00	10:35-10:48	50m NE of f.v. along fracture	contorted sh. flow
2435-4	older (2)	3981.00	12304.00	11:20-11:30	along frac in older massive fl	massive sheet flow
2435-5	young (1)	4255.00	12304.00	12:04	y. flow over older massive fl.	ropey sheet
2435-6	older (2)	4125.00	12348.00	12:16-12:22	floor rock; along alt. trend	massive sheet
2435-9B	older (2)	4310.00	12750.00	13:52-14:18	hoodoo remnant of a wall	thick bedded sheet
2442-8	young (1)	3812.00	11601.00	12:55	base of monolith vent	pill./lobe frag
2443-1A	young (1)	? close to 1b	? close to 1b	??	pillar top near landing site	sheet frag
2443-1B	?	3410.00	10976.00	?	nr. low T vent at Cavern site	lobe frag
2443-4	?	2740.00	9419.00	?	nr. pipe organ vent	lobe frag
2444-1	older(2)	2739.00	8774.00	08:57	in older pillows E. of collapse	ropey glass???
2444-2B	young(1?)	2576.00	8655.00	09:20-09:30	w/in coll. ass. w/ worms	lobe frag
2444-3B	older(2?)	2426.00	7728.00	11:46	E. of coll. nr. fissure	thin lobe-sheet
2444-4B	younger (1-2?)	2253.00	7443.00	12:52-13:30	at M1 site ass. w/ low T vent	thick sh.-lobe

Sample	Glass Condition	Crystallinity	Phenocrysts	Vesicularity	Mn	Weath/Alt	Comments
2430-1	7mm good fresh	meso	plag*+ol*	slightly	no	light or. stain	light orange deposits/staining in fractures
2430-2	elephant skin	meso-holo	plag±ol	moderately	up to 1mm	light or. stain	taken from a fault bounded bench;glass thin
2430-4	7mm good fresh	meso	plag*+ol*	slightly	no	no	xls occur in clots up to 5mm diam.
2431-3B	5mm ele. skin	meso	Plag±cpx?	v.few micro	no	orange floc	nearly aphyric; new lava in mixed area nr contact
2431-4	fr.4 mm ele. skin	meso	plag + cpx	non	no	no	nr. aphyric; from rubbley pushup nr talus
2431-5	good	glass	plag.*	non	no	sl.br.st.on sur	plag. sparse; taken in lava lake 320 m W of wall
2431-6C-1	fresh 1cm th	hyalo-meso	none	non	v. slight	no	taken 3m from the top of a 10m stack of thin sheets w
2431-6C-2	v. thin ele skin	meso	none	non	no	no	"some lobes on top, all in the process of collapse;"
2431-6C-3	non-vitreous?!	hyalo-meso	none	non	v. slight	no	exuding warm water; marker 46 here;good drips
							on underside of sheets and tops. Pix Taken!
2432-1	1-2.5cm th; v fr	meso	plag.*+ol.*	moderately	no	no	xls occur in clots and are abun. in glass and rock
2432-2	good	meso	plag*+cpx	moderately	v. slight	slight oran. st	plag. is abund in clots; cpx single eu. xls.; glass is mag.
2432-3	good w/ var thick	meso	plag.*+ol.*	moderately	no	grey-yell st	underside stained and molded; xls occur in clots
							Coll. near a graben that may have been the source
2432-4	1 cm f. fr	meso-holo	plag*+ol*	mod incr inw	no	y-o st + palag	coll w/in 200m of known m3 outcropping; prob older
2435-1	1.5 cm fresh	meso	plag*+ol	one pipe ves	slight(=sl)	smoke fallout	from autobrecciated hollowed shts overlying massive
2435-2	v. fr. l;.75-3cm	meso	plag*(<#1)	slightly	no	.3-.5mm smoke	taken along a fracture that focuses HT activity
2435-4	thin ele. skin	meso	plag.	micro	no	bleached to 1cm	sample covered in tan-white clay up to 1cm thick
2435-5	v. fresh(1kg gl.)	all glass	plag*	non	sl(=micrometers)		looks like y. fl. are tecton. channelled w/in older mass
2435-6	none	meso-holo	plag	non	no	weath lt brown	talc like alt along frac.; plag in sm clots
2435-9B	1cm ele skin-hackl	meso	plag± ol	micro	no	Fe-oxide stain	some sulfide on glass surface; less phyric than 2435-6
2442-8	fr. hackly	meso	plag*	v. slightly	no	Fe-oxide stain	taken right near monolith vent
2443-1A	fr. hackly	meso	plag(v. little)	non	slight	no	locality unknown but near landing site; prob. pillar top
2443-1B	thin ele. skin	meso	plag(v. little)	non	no	Fe-oxide stain	near M2; rock stained milkey white in places
2443-4	thin ele. skin	meso	plag(v. little)	non	no	lt. brn stain	underside frothy in appearance
2444-1	fr. interior	glass	plag*	non	slight	ochre stain	sample 3-5cm thick glass rind fuzzy on top; pillow fra
2444-2B	hackly ele. skin	meso	pl.*±ol±cpx	moderately	no	thin Fe oxide st.	"2 pieces v. diff. obe is ves.+xl rich, other is neither"
2444-3B	ele. skin	meso	plag.	non	on bottom	oran. st.	near extinct sulfide along fissure E. of collapse
2444-4B	v. fr. 2cm thick!!	meso	plag.(v. little)	non	v. slight	oran. st. on bott.	fr. flows inbtwn older in area of low T venting; nr M1

Dredge Summary

Sample Number	Relative Age	Ships Lat N. in S.B. Loran	Ships Lon W in S.B. Loran	Geologic Setting	Sample Morphology
DR19-1	older (off axis)	44° 58.37'	130° 22.97'	off ridge to the W. of MP over a small elongate	1.5 kg glass rope
DR19-2	older (off axis)	44° 58.37'	130° 22.97'	topographic high. Bites all at same location.	2 kg piece of ropey sheet
DR19-3	older (off axis)	44° 58.37'	130° 22.97'		older pillow frags
DR19-4	older (off axis)	44° 58.37'	130° 22.97'		older pillow frags
DR19-5	older (off axis)	44° 58.37'	130° 22.97'		older pillow frags
DR20-1	young? (1?)	45° 01.76'	130° 14.05'	along axis(neovolcanic zone?) on s. most Vance Segment	"glass and comp. ""mud cobbles"""
DR21-1	older (?)	45° 16.10'	130° 04.09'	n. extension of Cleft Seg. N and E. of new mound construc.	ropey sheet 3-3.5 cm th
DR21-2	older (?)	45° 16.10'	130° 04.09'		hackley sheet 3-3.5 cm th
DR21-3	older (?)	45° 16.10'	130° 04.09'		sheet 7-8 cm thick
DR21-4	older (?)	45° 16.10'	130° 04.09'		folded sheet 4-5 cm thick
DR21-5	older (?)	45° 16.10'	130° 04.09'		like 21-3 only v thin(1.5cm)
DR21-6	older (?)	45° 16.10'	130° 04.09'		sheet like 21-4 (4-5cm th)
DR21-7	older (?)	45° 16.10'	130° 04.09'		2 kg pillow fragment
DR21-8	older (?)	45° 16.10'	130° 04.09'		pillow/lobe fragment
DR21-9	older (?)	45° 16.10'	130° 04.09'		lobe fragment
DR22-NO RECOVERY		44° 48.36'	130° 23.87'		
DR23-1	older (just off axis)	44° 48.39'	130° 20.81'	"just west of ridge that borders the central graben, S of M	pillow breakout
DR23-2	older (just off axis)	44° 48.39'	130° 20.81'		pillow breakout
DR23-3	older (just off axis)	44° 48.39'	130° 20.81'		pillow/lobe frag.
DR23-4	older (just off axis)	44° 48.39'	130° 20.81'		pillow/lobe frag.
DR24- NO RECOVERY		44° 37.88'	130° 24.91'		
DR25-1	older (just off axis)	44° 32.50'	130° 27.79'	on ridge that borders W. side of axis; btwn S. Cleft site anc	sheet frags
DR25-2	older (just off axis)	44° 32.50'	130° 27.79'		sheet frags
DR25-3	older (just off axis)	44° 32.50'	130° 27.79'		contorted sheet
DR25-4	older (just off axis)	44° 32.50'	130° 27.79'		v. contorted sheet
DR25-5	older (just off axis)	44° 32.50'	130° 27.79'		thick sheet-lobe
DR25-6	older (just off axis)	44° 32.50'	130° 27.79'		thick sheet-lobe
DR26- NO RECOVERY		44° 55.38'	130 04.16'		
DR27-1	older (just off axis)	44° 54.40'	130° 16.95'	on ridge that borders W. side of axis; s. of MP	pillow-lobe
DR27-2	older (just off axis)	44° 54.40'	130° 16.95'		contorted ropey sheet??
DR27-3	older (just off axis)	44° 54.40'	130° 16.95'		lobe
DR27-4	older (just off axis)	44° 54.40'	130° 16.95'		lobe
DR28-1	youngest(0)	45° 08.40'	130° 07.49'	n. most new mound	glass only

Sample Number	Glass Conditi	Crystallinity	Phenocrysts *= also in glass	Vesicularity	Mn	Weath/Alt	Comments
DR19-1	all glass	all glass	aphyric	micro	th .1mm-1cm	some palag.	Fairly thick flow (8-20cm)
DR19-2	ele skin glass	meso	aphyric	micro	th .1mm-1cm	some palag.	Fairly thick flow (8-20cm)
DR19-3	no glass	meso-holo	aphyric	micro	th .1mm-1cm		py. occurs in a band coincidant w/ weath. Horizon
DR19-4	no glass	meso-holo	aphyric	micro	th .1mm-1cm	Sec. gypsum	coarse gr gypsum along fracture
DR19-5	no glass	meso-holo	aphyric	micro	th .1mm-1cm	Sec. gypsum	coarse gr gypsum along fracture
DR20-1	dirty	all glass	slight. pl. phy	non	1-7 mm thick	none	
DR21-1	v. little glass	meso	aphyric	non	no	bott. gl. pale gr	fairly well sedimented
DR21-2	no glass	meso	aphyric	non	no	bott. gl. pale gr	"hackly texture, drip structures, prob. same unit as 21-1"
DR21-3	no glass	meso	aphyric	micro	no	3-4mm weath rind	"more crystall. and ves.than 21-1,2;top&bottom scallopec
DR21-4	ele. skin (not	meso	aphyric	non	approx. .5mm	none	"younger? than 21-1,2,3; Mn pres.-is this an upper flow?"
DR21-5	no glass	meso	aphyric	non	lt. sooty coat	thin or.-yell. stain	resembles 21-3 except v. thin
DR21-6	good ele. skin	meso	aphyric	non	lt. sooty coat	none	prob. same unit as 21-4
DR21-7	ele. skin	meso	nearly aphy.(p	moderately	approx. .5mm	ferr. clays/st.	sulfides in ves.?; clays/st change from br/yell to grn w/
DR21-8	thin ele. skin	meso	aphyric	local. into ban	lt. coating	5mm weath rind	glass has a milky white surface easily rubbed off
DR21-9	entire selv. in (5mm thick)	meso	aphyric	micro	moderate	yell. Fe? staining	outermost glass layer preserved.
DR22-NO RECOVERY							
DR23-1	ele. skin	meso	aphyric	micro	thick (2mm)	along fracs.	lots of sediment inbtwn layers of elephant skin glass
DR23-2	ele. skin	meso	aphyric	micro	thick (2mm)	along fracs.	v. probably same flow as 23-1
DR23-3	ele. skin	meso-holo	plag.	micro	??	or.-brn-grn	bottom surface curvaplanar & frothy
DR23-4	ele. skin	meso-holo	plag.	micro	??	palagonite on gl.	bottom surface curvaplanar & frothy w/ greenish color
DR24- NO RECOVERY							
DR25-1	clean ele. skin	meso	aphyric	micro-non	on bottom	none	glass sample taken from a different piece(same flow?)
DR25-2	entire selvage	meso	aphyric	non	.25-.5 mm	none	good glass under Mn coating
DR25-3	hackly-ropey	meso	aphyric	non	up to .5 mm	oran. staining	v. contorted pushup? feature with some good ropes
DR25-4	highly var.	meso	aphyric	lg pipe	variable	oran.-gray st.	so contorted that the sample was spherical
DR25-5	entire selvage	meso	aphyric	non	up to .5 mm	oran. staining	"though morph is diff. looks like all same from Mn, etc."
DR25-6	ele. skin	meso	aphyric	non	up to .5 mm	oran. staining	looks more lobate; may be older (Mn on ele. skin)
DR26- NO RECOVERY							
DR27-1	dirty ele. skin	meso	aphyric	non	approx. .1mm	some palagonite	fair amt. of sed. w/in glassy selvage.
DR27-2	v. little to nor	meso	aphyric	non	approx. .1mm	weathered look	looks older; ropey w/o glass; heavily sedimented
DR27-3	v. little to nor	meso	aphyric	non	approx. .1mm	weathered look	looks sim. to 27-2 but is more clearly a sheet-lobe flow
DR27-4	entire selv. in	meso	aphyric	non	approx. .1mm	some palagonite	similar to 27-1
DR28-1	v. fresh	all glass	plag.*	non	no	none	about 3kg of good glass recovered.