SOJOURN II on R/V Melville
Tahiti->Easter Island----28 Oct.->3 Dec., 1996

FINAL CRUISE REPORT

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Cruise Objectives

The principal operational goal of Sojourn II was to survey the axial zone of the ultrafast-spreading East Pacific Rise (EPR) at 17°15'-40'S using the fiber-optic, near-bottom *Argo II* optical/acoustic system and AMS/DSL-120 sonar system. The segment of the southern EPR between 17°15'-40'S (the "Spike" Segment) is a superb area for investigation of relationships between ridge axis magmatism and other axial processes. Here, along a 2nd order segment of ridge only 46 kms long, 1991 seismic data show that the axial magma chamber (AMC) changes along strike from a flat-topped body residing at relatively constant depth to a peaked cupola ("spike") that intrudes to within 0.8 km of the seafloor at 17°25'S (Detrick et al., 1993). This abrupt shallowing of the magma chamber creates the most extreme along-strike variations in thermal gradients that we know of on the global mid-ocean ridge system. Our scientific objective was to test the hypothesis that along-strike thermal gradients, resulting from a segmented, episodic pattern of magma supply to fast-spreading mid-ocean ridges, exert primary control on distribution and types of hydrothermal vents and vent biota, and on variations along-strike in fine-scale volcanic and tectonic features of the axial zone.

Axial summit troughs (calderas and graben) are sites on fast-spreading centers where most volcanic and hydrothermal venting seem to be concentrated (e.g. Haymon et al., 1991, 1993). Our secondary science goal was to investigate the nature and development of axial troughs at an ultrafast spreading center. To pursue this investigation, we carried out a secondary survey of the 100 m-deep axial summit graben located to the south of our main survey area, along the northern "Hump" Segment at 18°23'-29'S, for comparison with the smaller 12 m-deep axial summit caldera that we mapped during Sojourn II along the Spike Segment. To explore the transition between the morphologically distinct Hump and Spike Segments, we ran single, continuous *Argo II* and AMS/DSL-120 lines along the ridge axis to connect the two areas.

Our surveys of the fine-scale segmentation and distribution of hydrothermal vents, biota, and small-scale geological features along the Spike and Hump ridge segments provide excellent baseline maps that will be extremely useful for future submersible, water column, and seismic studies planned in these areas.

Acknowledgements

The chief scientists thank the WHOI DSOG shipboard technical group for their truly dedicated effort to our science mission. They gave us 150%, and did a great job! Special thanks go to Dan Fornari back at WHOI for his extra efforts on behalf of our program. We also acknowledge Andy Bowen at WHOI for his assistance with cruise planning and preparations.

We wish to thank Captain Buck and the officers and crew of the R/V Melville for their absolutely outstanding support for the science operations during Sojourn II. Our success in meeting our objectives would not have been possible without their skillful and efficient ship operations. We particularly appeciate all the assistance received with loading and set-up of the WHOI equipment in Tahiti, the expert help we got with an array of over-the-side operations, with deployments/recoveries of various instruments, with ship-driving during and between our various operations, and with communications. Everyone aboard did whatever they could to assist us, even though our towing operation was a bit like an alien invasion from...Mars? We really appreciate the friendliness and flexibility of the ship's personnel as our plans and timetables shifted in response to technical difficulties and seafloor observations. Thanks are due to Bob Seeley and Paul for all the excellent meals they served us (how

DO they keep the lettuce for so long?), and to Paul Beuren for all the delicious fresh fish!

We thank Bill Armistead and Steve Lerner for their time and assistance in Tahiti. We also thank Milene Cormier for sharing data with us from the 1993 Nautile dives in our study area. This cruise was funded by the U.S. National Science Foundation RIDGE program.

Summary of Significant Findings

During Sojourn II, we visually inspected a total area along the ridge crest of 7.6 million m^2, and acoustically imaged a total area of ~150 km^2. Our preliminary data reveal that:

1) The neovolcanic zone along the Spike segment of the EPR is very narrow (10-100 m) except in the region directly above the magma chamber spike at 17° 25'S, where it broadens to ~500 m.
2) The southern half of the Spike segment has experienced a recent eruption within the axial zone during the past 1-5 years that extends all the way to the south tip of the segment, just north of the small overlapping spreading center (OSC) at 17°41'S. A very large eruption occured not long before the Naudur submersible program in December, 1993 (Auzende et al., 1995). Eruptions have occured locally in some areas since December, 1993, but these appear to have been small in volume.
3) The ridge axis along the Spike segment is very active hydrothermally, with at least 23 high-temperature (smoker) areas distributed along the 46 km-long segment.
4) The most vigorous hydrothermal areas along the Spike segment are just slightly off-axis on the edge of the neovolcanic zone at 17°24.8'S (on top of the AMC spike) and at 17°37.2'S.
5) The largest plume anomalies along the Spike segment occur south of 17°34'S.
6) A narrow (<50 m-wide, 12 m-deep) ASC exists between 17°26'S and 17°29'S and appears to have been filled in with lava flows from 17°26'S to 17°24'S (i.e. directly above the 1991 AMC spike). North of the AMC spike and south of the ASC, the axis is often defined by a single fissure or pair of fissures. Hydrothermal vents are common along these axial fissures.
7) Mobile vent organisms (fish, octopus, crabs, dandelions) are abundant along portions of the Spike segment where high temperature vents exist. Sessile vent organisms are not well-established on the newest flows, but are abundant on slightly older

flows. Anemones grow densely on slightly older ("Age 1.5") lava flows in hydrothermally-active areas. Many of the black smoker chimneys appear biologically barren. Bacterial mats are rare.
8) Whereas the Spike segment axial zone is young and dominated by volcanism, the Hump segment is older and tectonically ripped apart by gaping fissures on the floor of a deep axial trough. A vigorous new field of black smokers, called the Sojourn Vents, was discovered along the margin of a large collapse in younger lava flows at 18° 24.3'S.

Personnel

The science party, known as "The Sojourners", included 25 people representing eight institutions (see mailing list in Appendix 1). The team was led by Profs. Rachel Haymon (Chief Scientist) and Ken Macdonald (Co-Chief Scientist), both from UCSB. Dr. Daniel Scheirer, a post-doc from Brown University, joined the team as a co-principle investigator. Dr. Scheirer previously served as one of the two chief scientists for Sojourn I. Accompanying Haymon and Macdonald on this cruise were five UCSB graduate students, two UCSB undergraduate students, and a recent UCSB graduate. Haymon and the UCSB students also were previous participants in Sojourn I. Guest scientists joining R/V Melville in Tahiti included Prof. Dawn Wright (Oregon State University), Dr. Cindy Van Dover (University of Alaska, Fairbanks) and Dr Sergei Sudarakov (VNIIOkeangeologia, St. Petersburg). Two graduate students from Woods Hole Oceanographic Inst. and Rutgers University, respectively, also came aboard in Tahiti. The Sojourn II science team was rounded out by seven members of the Deep Submergence Operations Group (DSOG) from Woods Hole Oceanographic Inst. (led by Skip Gleason), and two Scripps Inst. of Oceanography shipboard technicians.

Data Collection and Management

The following types of data were collected during Sojourn II (see Appendix 2):

1) SeaBeam 2000 multibeam bathymetry and sidescan sonar data, plus magnetometer and gravity data, acquired during transit from Tahiti to the EPR at 17.3°S

2) AMS/DSL-120 sidescan sonar and phase bathymetry data (processed at sea)

3) *Argo II* Hi-8 video data (~1300 hours of tapes from 3 cameras)

4) *Argo II* electronic still camera images (96,112 digital images)

5) *Argo II* color 35 mm still photographs (2500 photographs)

6) *Argo II* 200 kHz sidescan sonar data (unprocessed)

7) *Argo II* Imagenex sonar profiler data

8) *Argo II* telemetry data

9) *Argo II* CTD data

10) *Argo II* transmissometer data

11) *Argo II* magnetometer data

12) Navigation data for *Argo II* and AMS/DSL-120

13) MAPR (temperature and nephelometer) data from Argo II and AMS/DSL 120 lines

14) CTD and MAPR data from two Tow-Yo casts

Keeping track of so many datasets as they are acquired, and compiling the data into forms that are readily useful both at sea and post-cruise, are major challenges. The information below and in relevant appendices explains how this was done and is a useful guide for future users of the Argo system and users of the data we collected during Sojourn II.

All of the original datasets currently reside in the labs of Haymon and Macdonald at UCSB. Other Sojourn participants have copies of specific datasets as required for their research. All requests for data from this cruise should be directed to Rachel Haymon (.see contact information given in Appendix 1).

Appendix 2 is a daily summary of the data acquired and archived during the cruise. Keeping this log daily prevented physical pieces of data (tapes, plots, logsheets, etc.) from being misplaced or mislabelled, and provided us with a listing at the end of the cruise of all our data.

Appendix 3 details the ways in which various datasets (navigation, fish attitude, magnetometer, transmissometer, CTD, Imagenex sonar) were processed at sea. The Argo 200 khz sidelooking sonar data were not processed at sea, but were recorded as raw data files and archived. Watchstanders hand-logged the occurrence of significant sonar targets appearing on the speed and slant-range-corrected waterfall display in the control van, so that we could select relevant portions of this huge dataset later for processing at UCSB. We also recorded the waterfall display on videotape for later quick visual access to the 200 kHz dataset.

The AMS-120 sonar data were processed at sea and archived both as raw files and processed files of reflectance amplitude and bathymetry. Hardcopy plots of the reflectance amplitude data were generated at sea (see figures in this report). A hand-made mosaic of these plots was made at sea for the Spike survey area. Mosaics of the plots for the North Hump area and the ridge crest between the Spike and North Hump areas will be produced post-cruise at UCSB, as will corresponding plots of the processed phase bathymetry files that were generated at sea.

Digital electronic still images were filtered at sea and stored as raw, decimated, and normalized files. An example of a decimated ESC image is shown on the cover of this report. Hard copy was plotted at sea for all of the decimated images, and these are being archived at UCSB into reference notebooks. The normalized image files are useful for generation of digital ESC mosaics. Some digital mini-mosaics were generated at sea from the normalized ESC images, using MacIntosh Adobe Photoshop software. This work is being continued post-cruise at UCSB.

During our shipboard watches, we digitally logged our visual observations in a manner that parsed observed features by categories into individual files that could be merged with our navigation in a GIS to produce geographic plots of the spatial distribution of an individual category or set of categories. This kind of event logging makes it possible for us to manage and display our thousands of visual observations in a comprehensible manner (for example, we can easily check the locations all black smokers relative to the locations of all fissures by plotting these two categories on the same map). The observational categories were organized into a hierarchical tree shown in Appendix 4. This method of event logging was pioneered during the Venture III Argo survey at EPR 9°-10°N in 1989 (Haymon et al., 1991; Wright et al., 1995) and was further developed during the LUSTRE Argo-Jason survey in July-August, 1996 (see LUSTRE Final Cruise Report by Fornari et al., 1996). As a back-up to the real-time digital logging, we had a second real-time watchstander simultaneously generating a handwritten observational log that was used at sea to edit the digital log for accuracy and completeness. By the end of the cruise, we had a complete set of edited visual observation files that we used with the GIS "ArcView" software program to create feature distribution plots such as those included in this report.

Copies of the log sheets used by watchstanders to keep track of various data streams during the Argo watches are compiled in Appendix 5.

Transit Surveys: Tahiti --> East Pacific Rise at 17.3°S

We departed Papeete on October 28th at

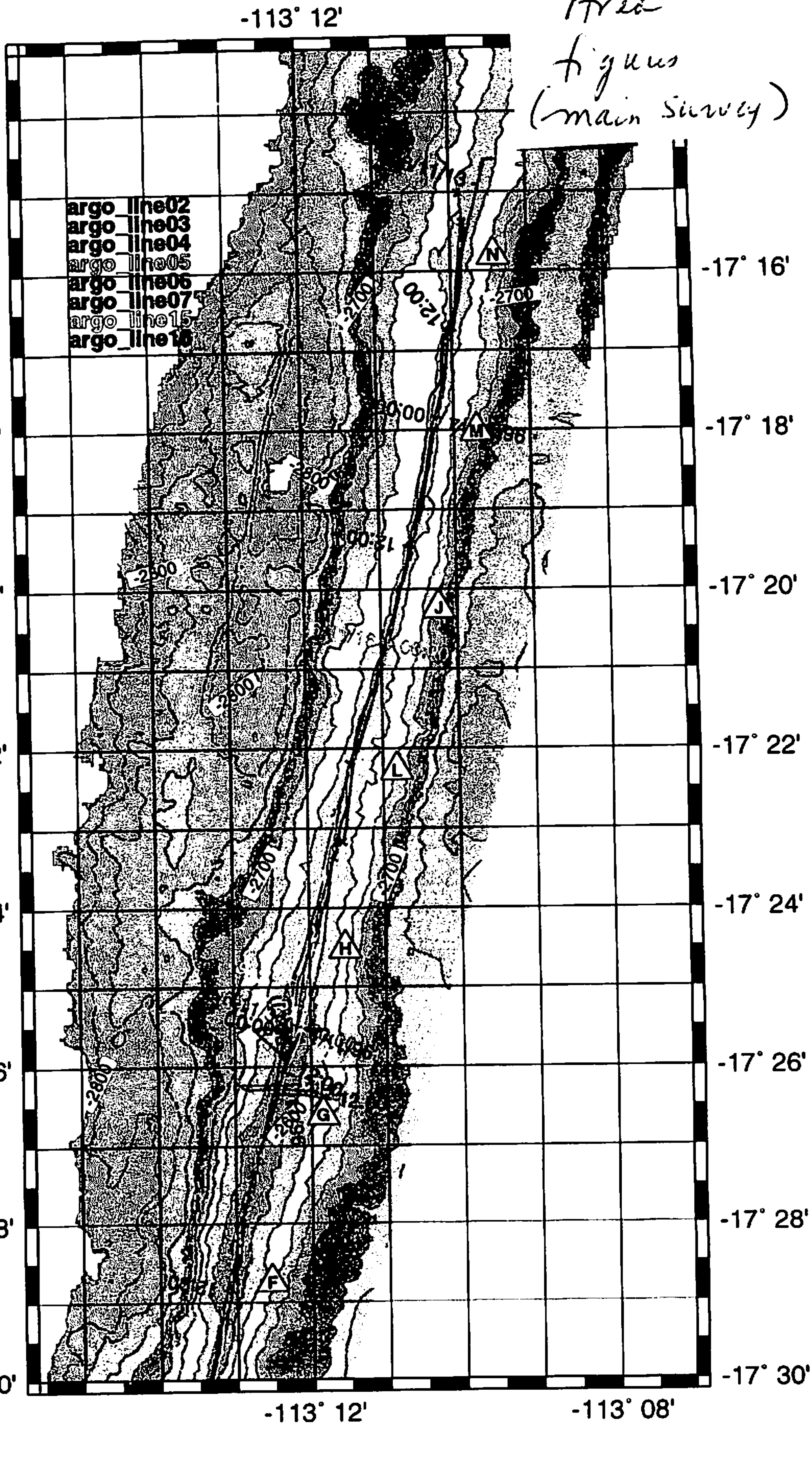
-Positive gravity lineaments are associated with seafloor that appears to be of normal age and that contains normal ridge-parallel abyssal

We found that the neovolcanic zone of the 2nd-order Spike segment, which includes several 4th-order segments, is a very narrow strip, <100 m wide in most places. Within this zone we observed contacts between young lava flows of five different relative ages, from which we estimate that at least four eruptions have occured in this area in historic times. Two of these eruptions appear to have occured within the past five years, based on visual comparison of their color, luster (glassiness), and sediment accumulation with 0-5 year-old flows we have seen on the EPR at 9-10°N (Haymon et al., 1993; Rubin et al., 1994). The most voluminous eruptions are the second-to-youngest flows. These flows emanate from the axial zone to cover a broad (~500 m wide) area at the latitude where the AMC spike was observed seismically in 1991 (17°25'S). North and south of the area affected by the magma spike, we saw that flows of the same apparent age issued from a system of eruptive fissures; in fact, the boundary between the Pacific and Nazca plates for many kilometers along the ridge axis appears to be defined by a single 0.5-10 m-wide en echelon fissure. From 17°26'-29'S, a narrow (8-50 m wide) axial summit caldera exists. North of 17° 26' there is evidence that a northward extension of this trough has been flooded by the recent eruptions above the magma spike centered at 17°25'S.

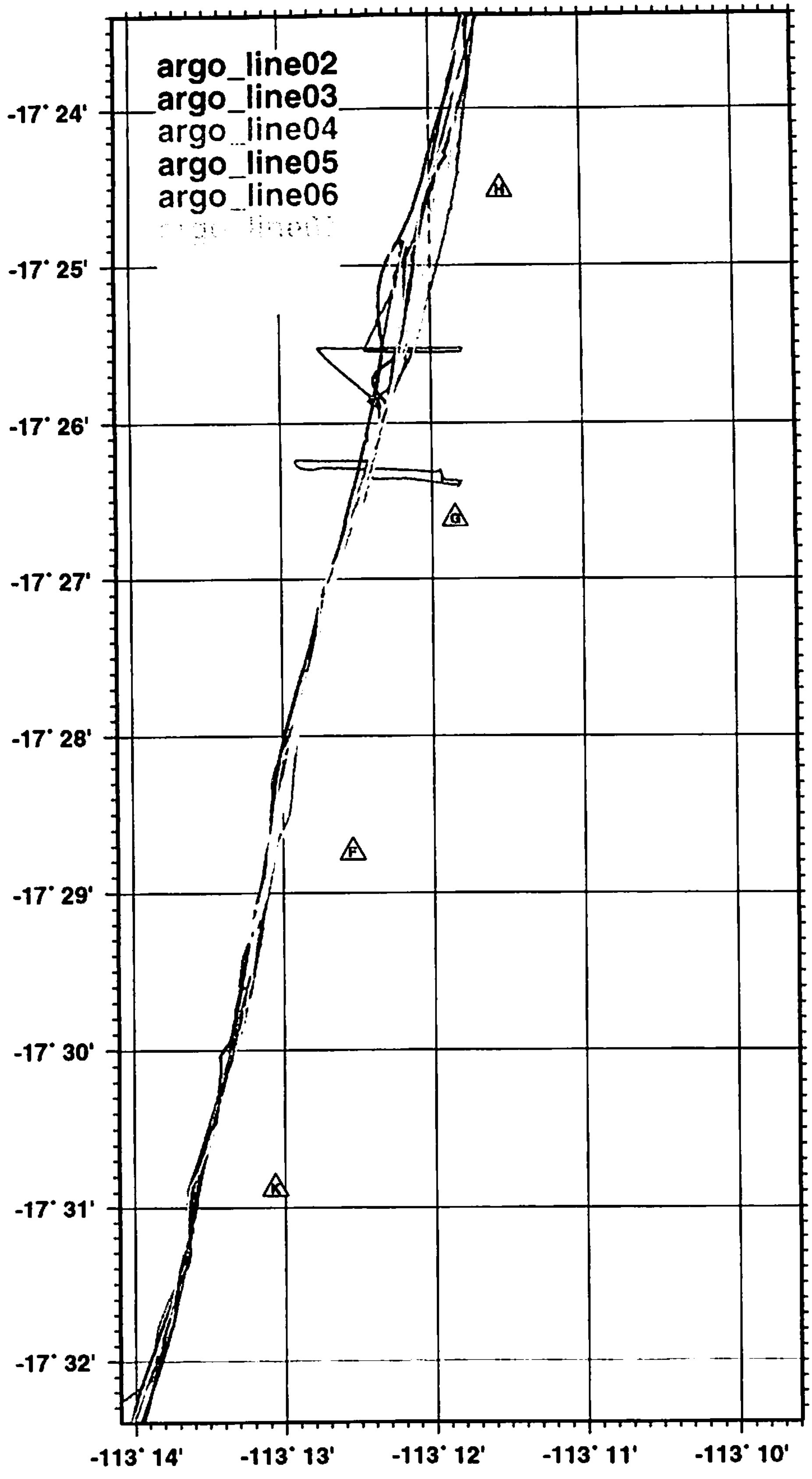
The Spike segment is extremely active hydrothermallycontains many active and inactive hydrothermal vents.

SOJN02MV -- spike_n -- AR(

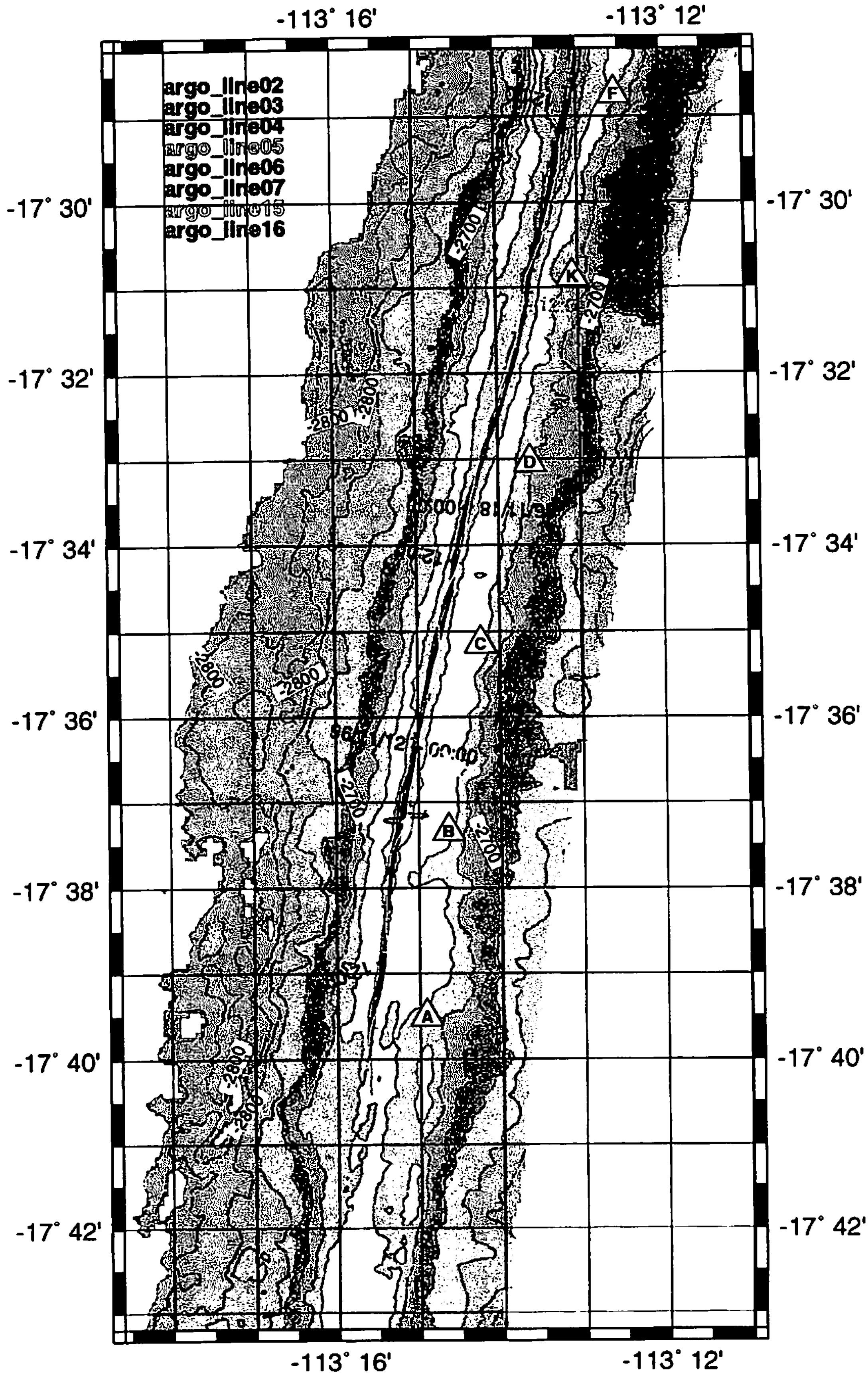
Spike Area figures (main survey)



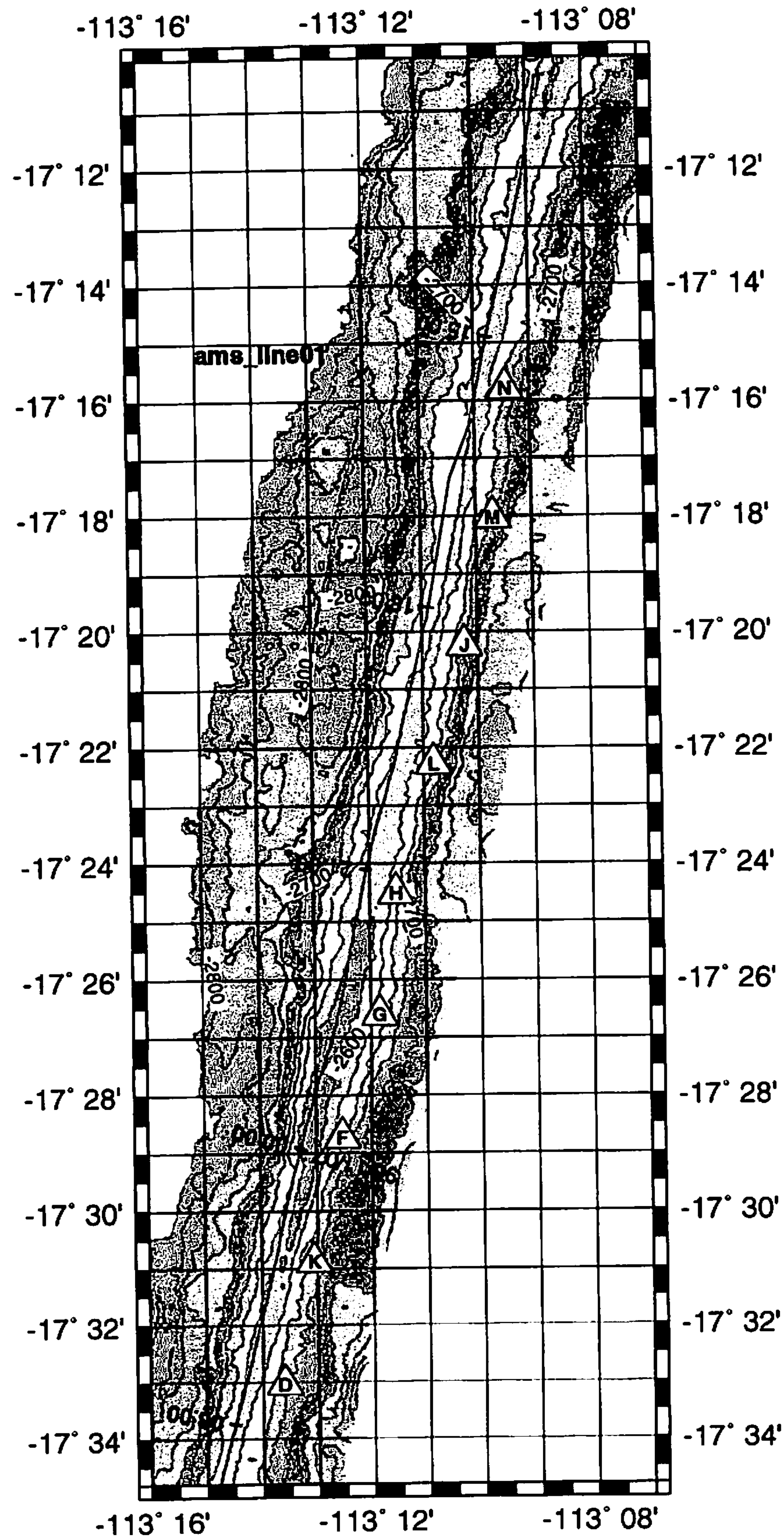
SOJN02MV -- fish nav -- spike_central



SOJN02MV -- spike_s -- ARG



SOJN02MV -- spike_n -- AMS



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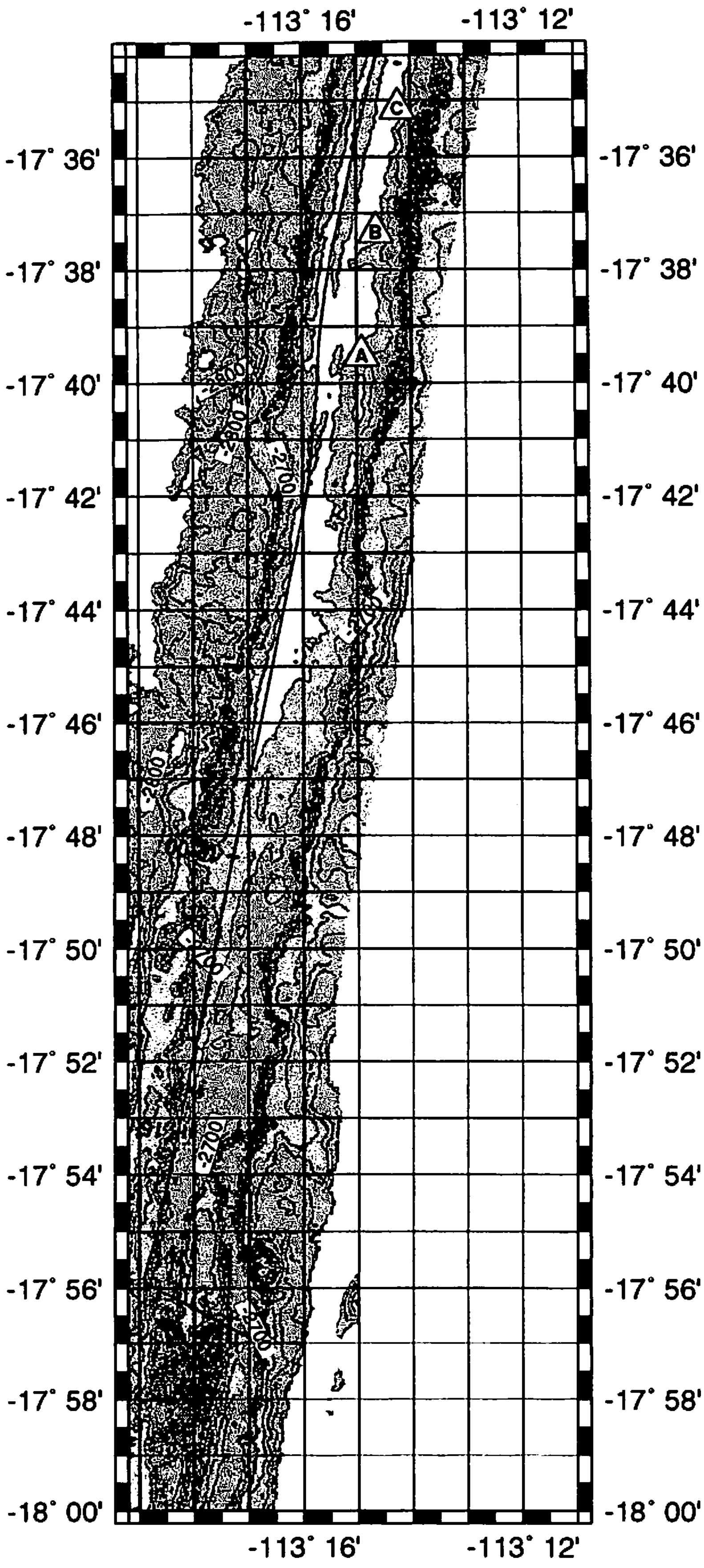
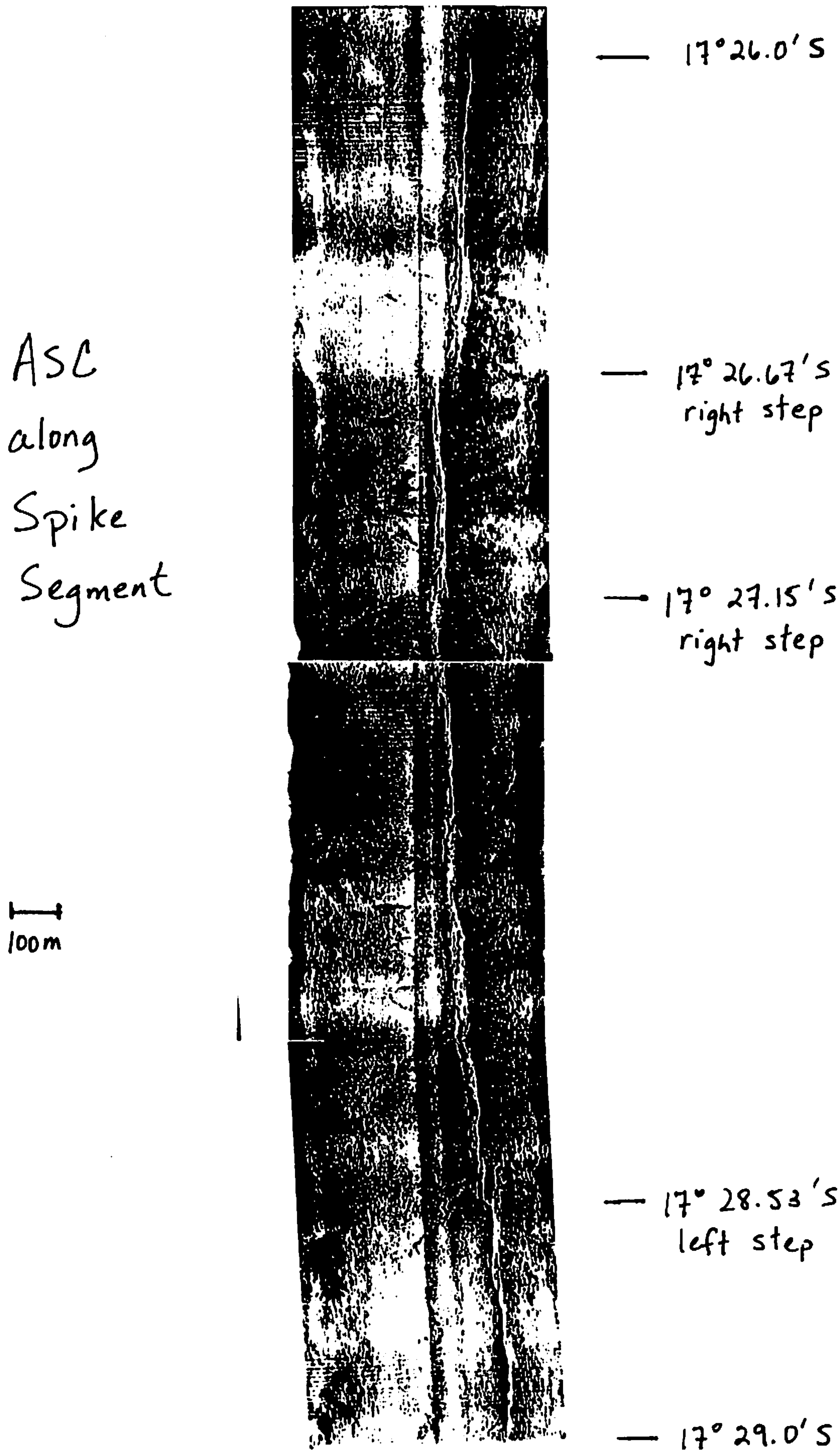
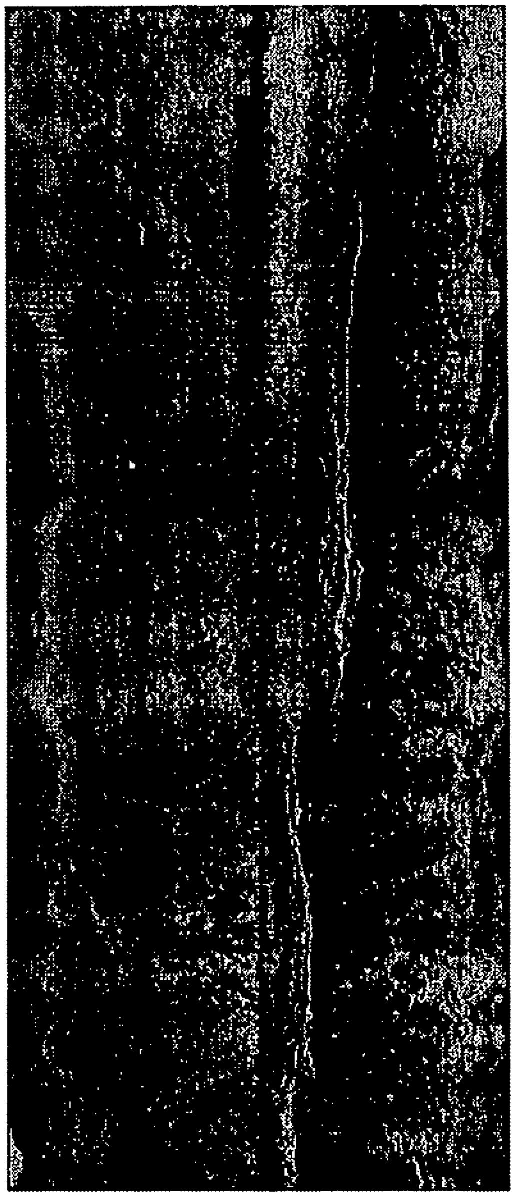



ASC along Spike Segment
100m
17°26.0'S
17° 26.67'S right step
17° 27.15'S right step
17° 28.53'S left step
17° 29.0'S

Example of DSL120 Sidescan

STBD

PORT
961106/2200z



Aldo Lake

17" 26.67' S
right step

961106/2300z

Example of DSL120 bathymetry

STBD

PORT

961106/2200z

~ 900m total bathy swath

- depths range from ~ 2550 - 2650 m

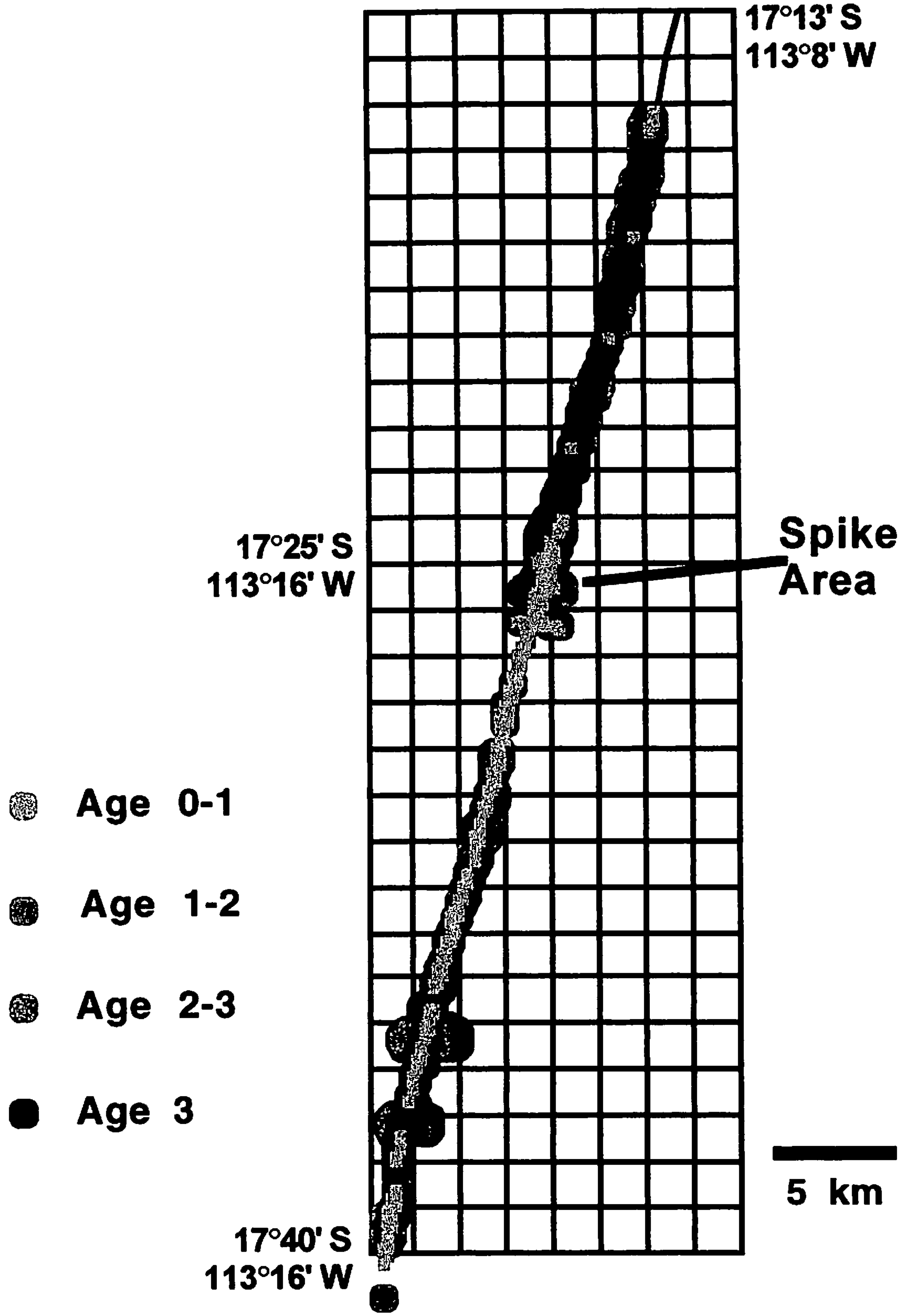
Aldo Lake

17° 26.67' S right step

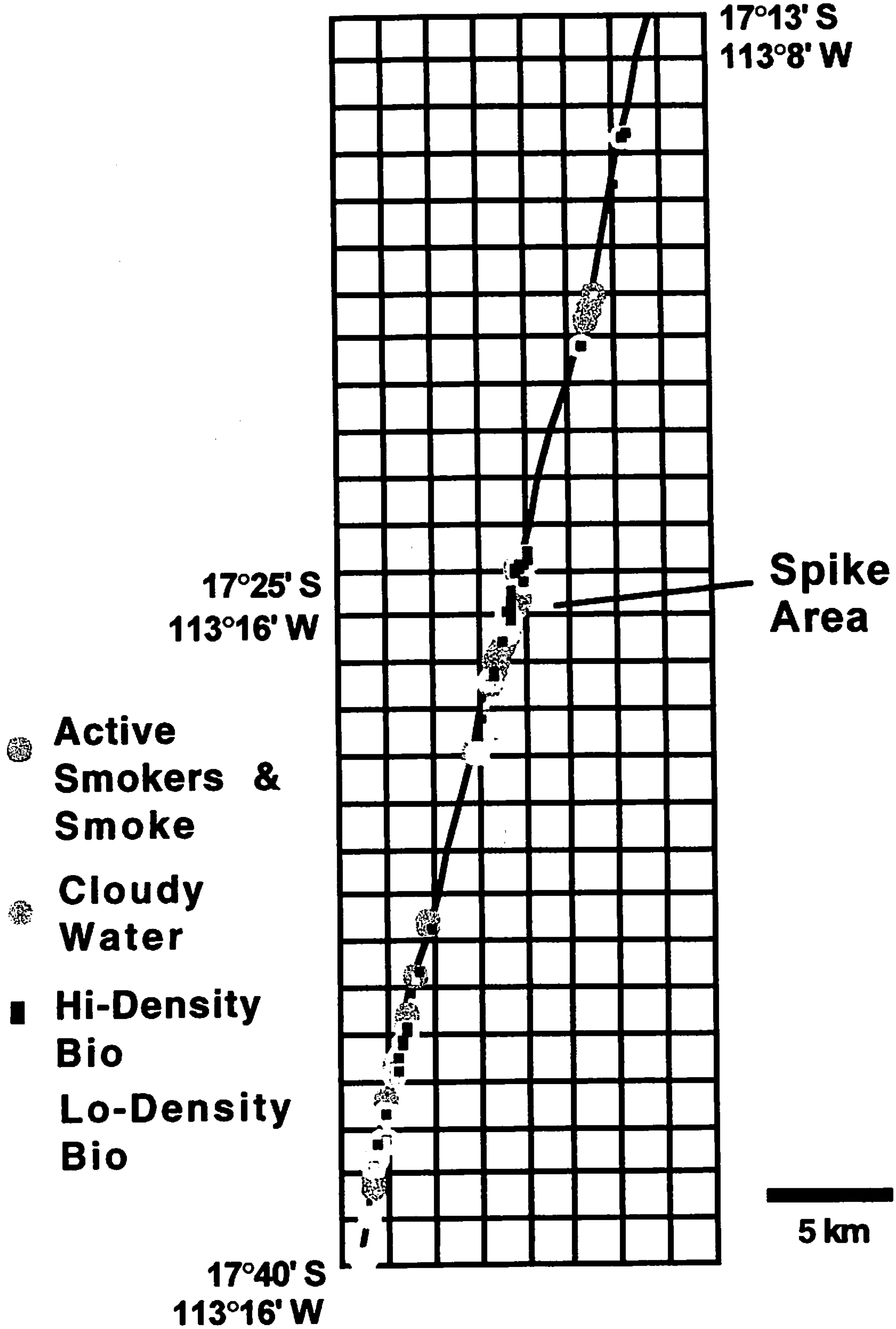
961106/2300z

Argo II Electronic Still Camera Image of
Santa Claus on a Lava Pillar, left by the French
Naudur Expedition in December 1993

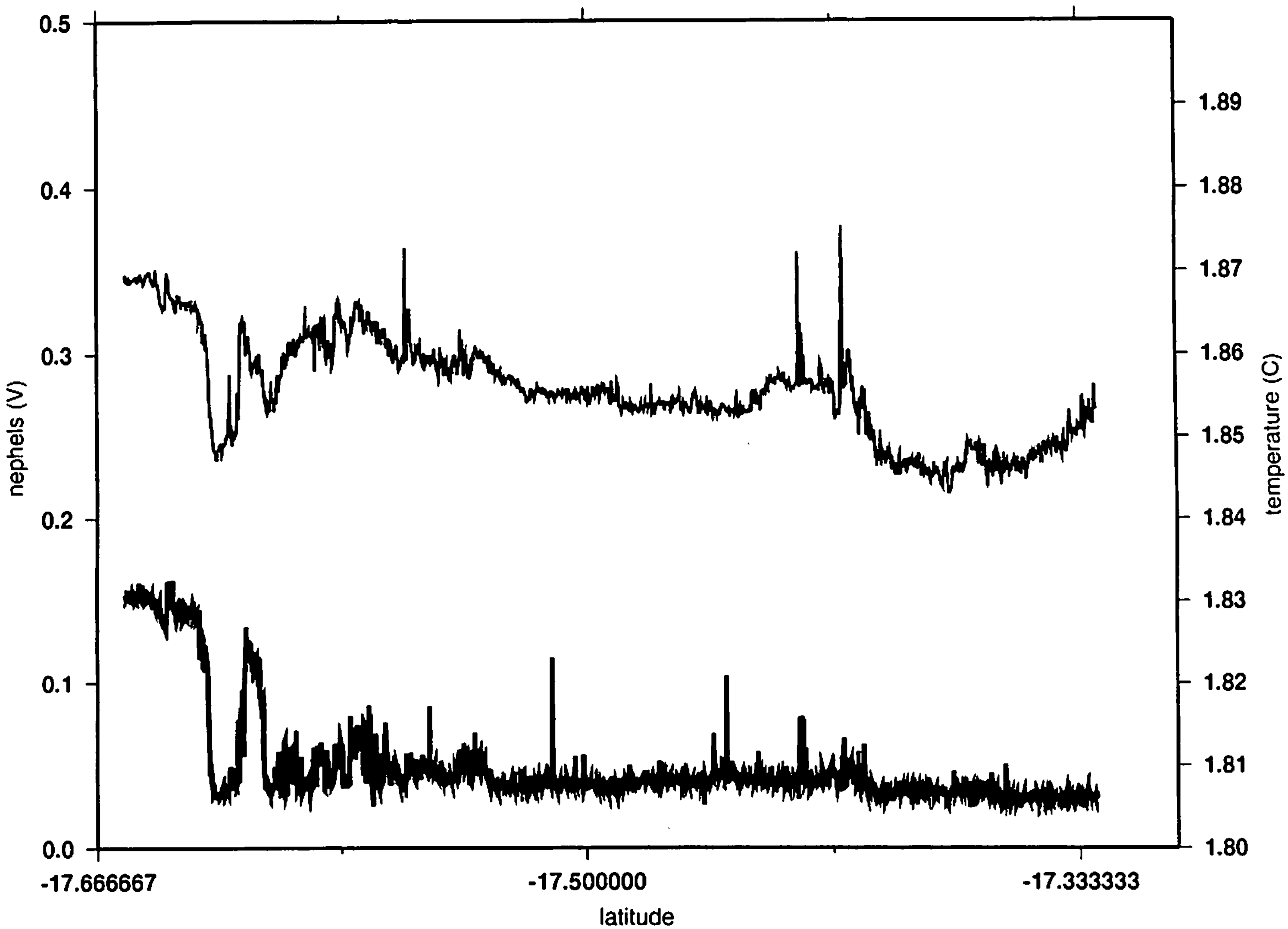
Spike Survey Relative Lava Ages (1 minute lat/long grid)



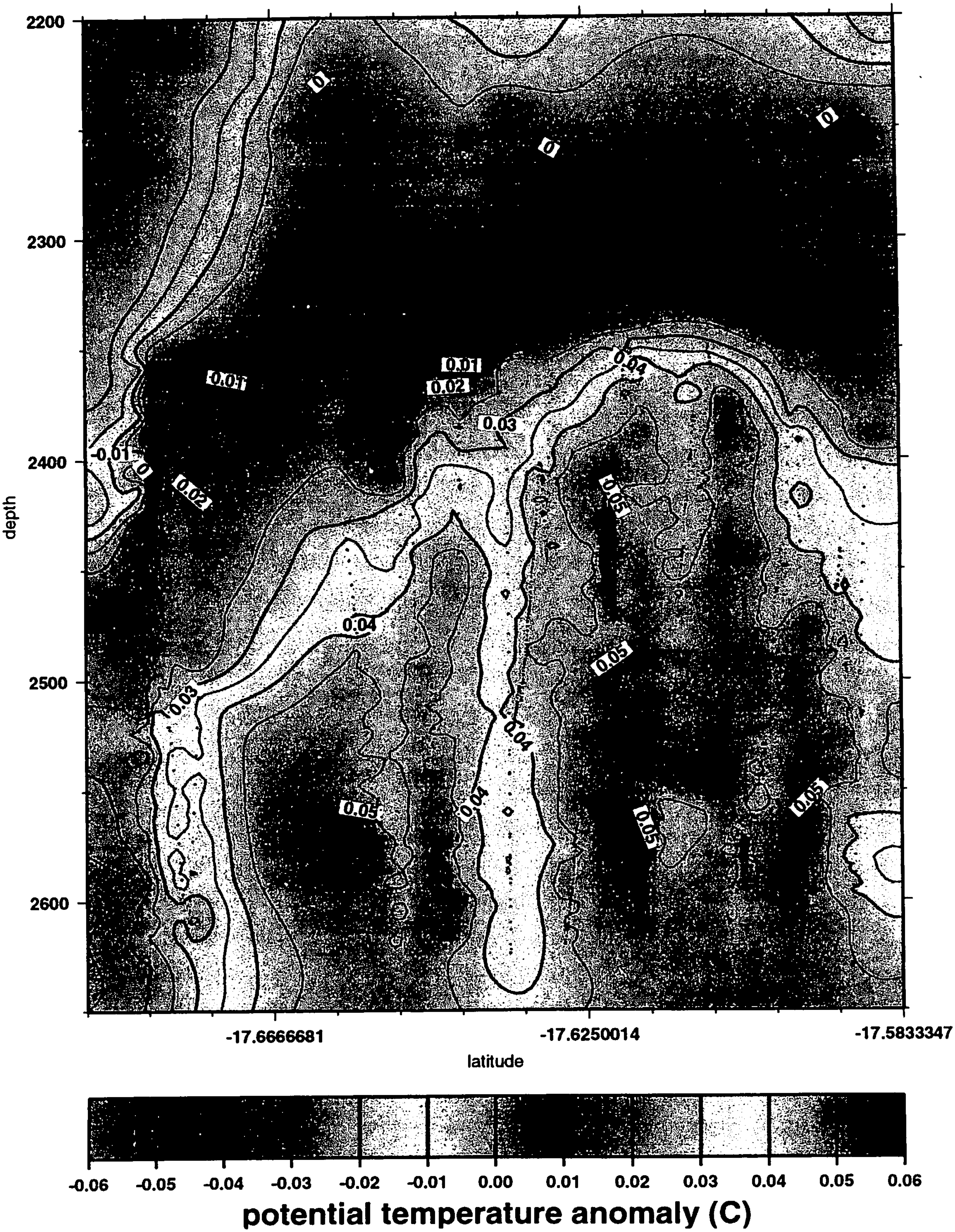
Spike Survey Smokers & Animal Communities (1 minute lat/long grid)



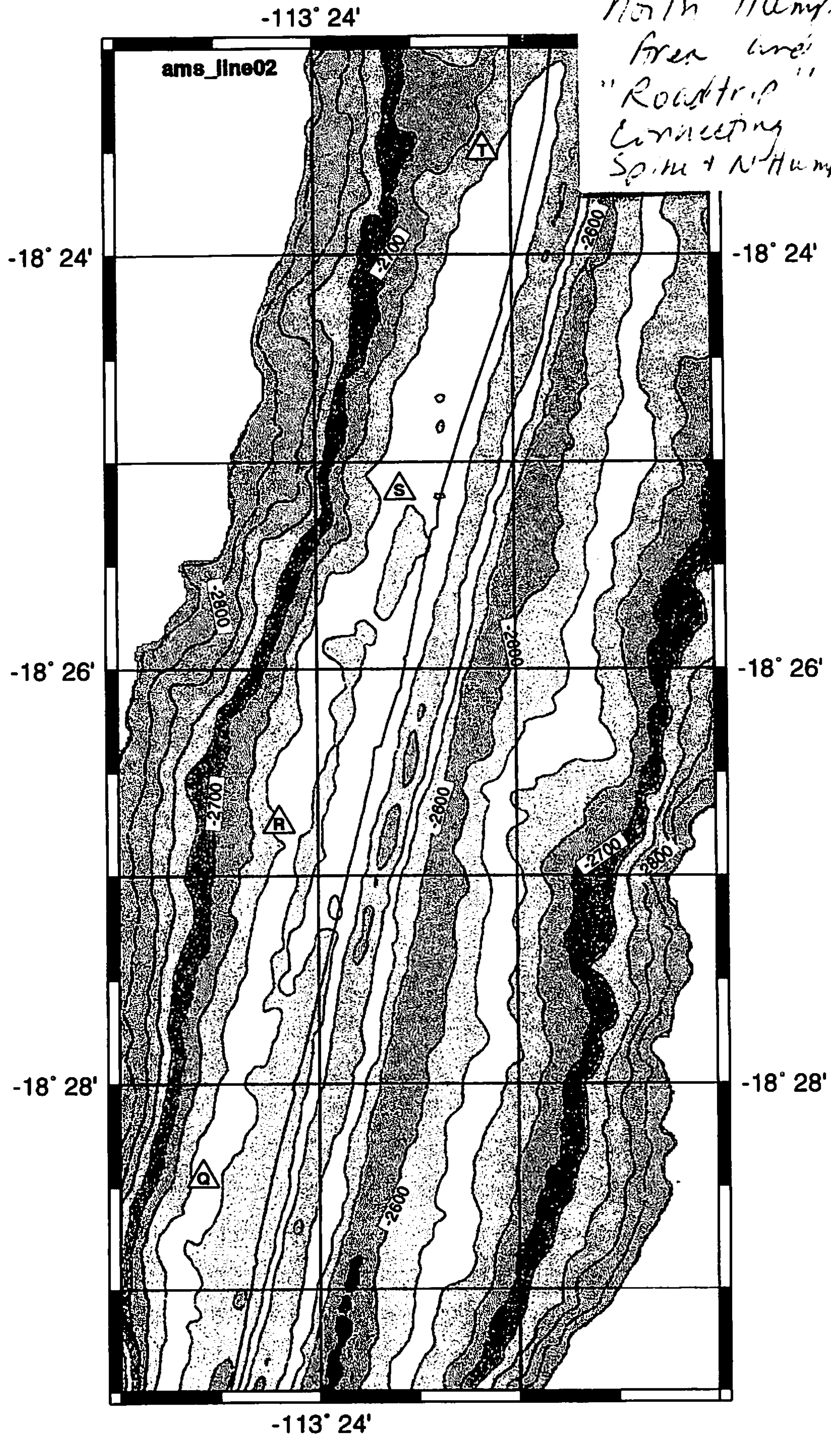
Plot of AMS01



Plot of CTDTOW1

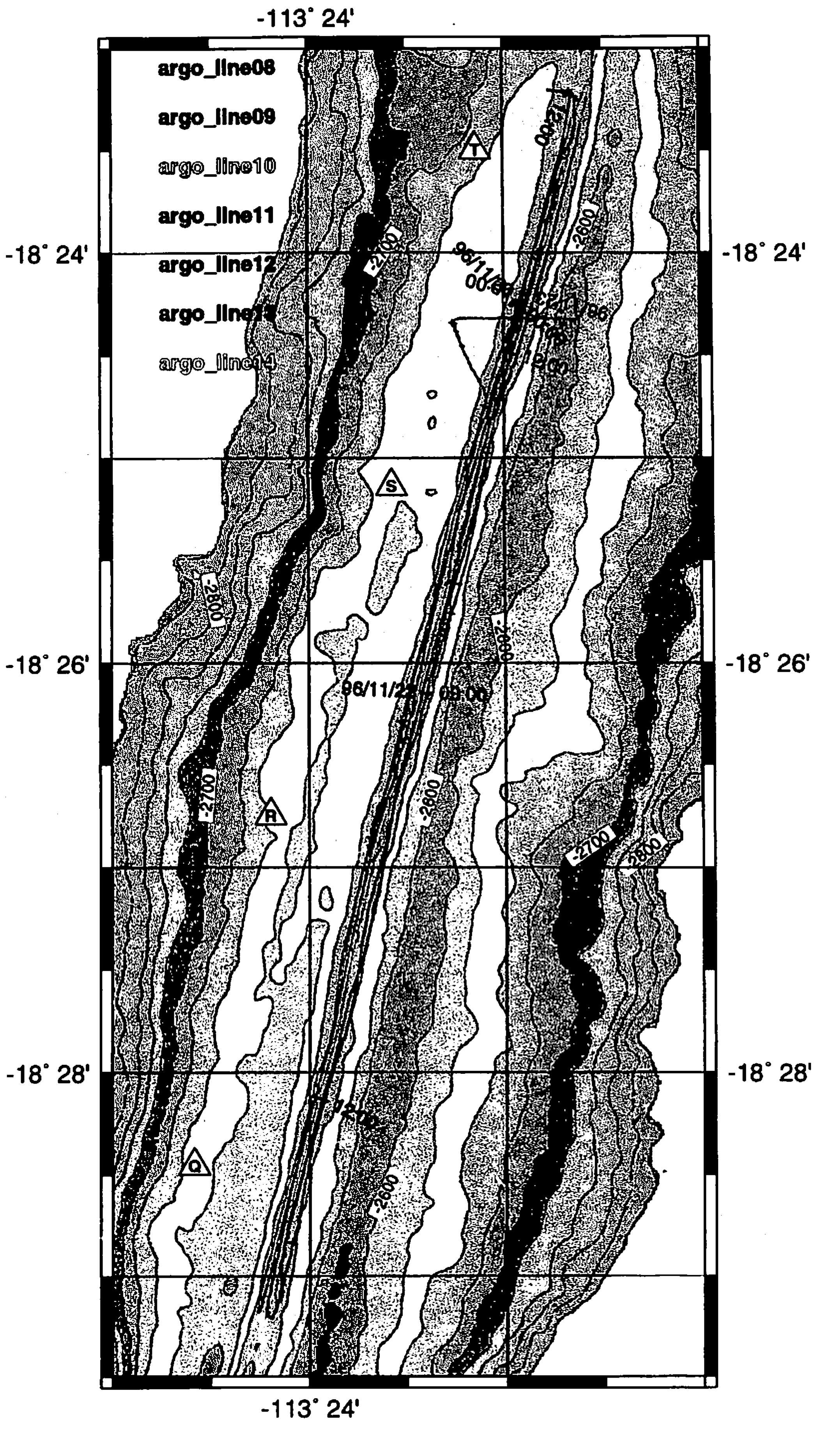


SOJN02MV -- north-hump -- AMS

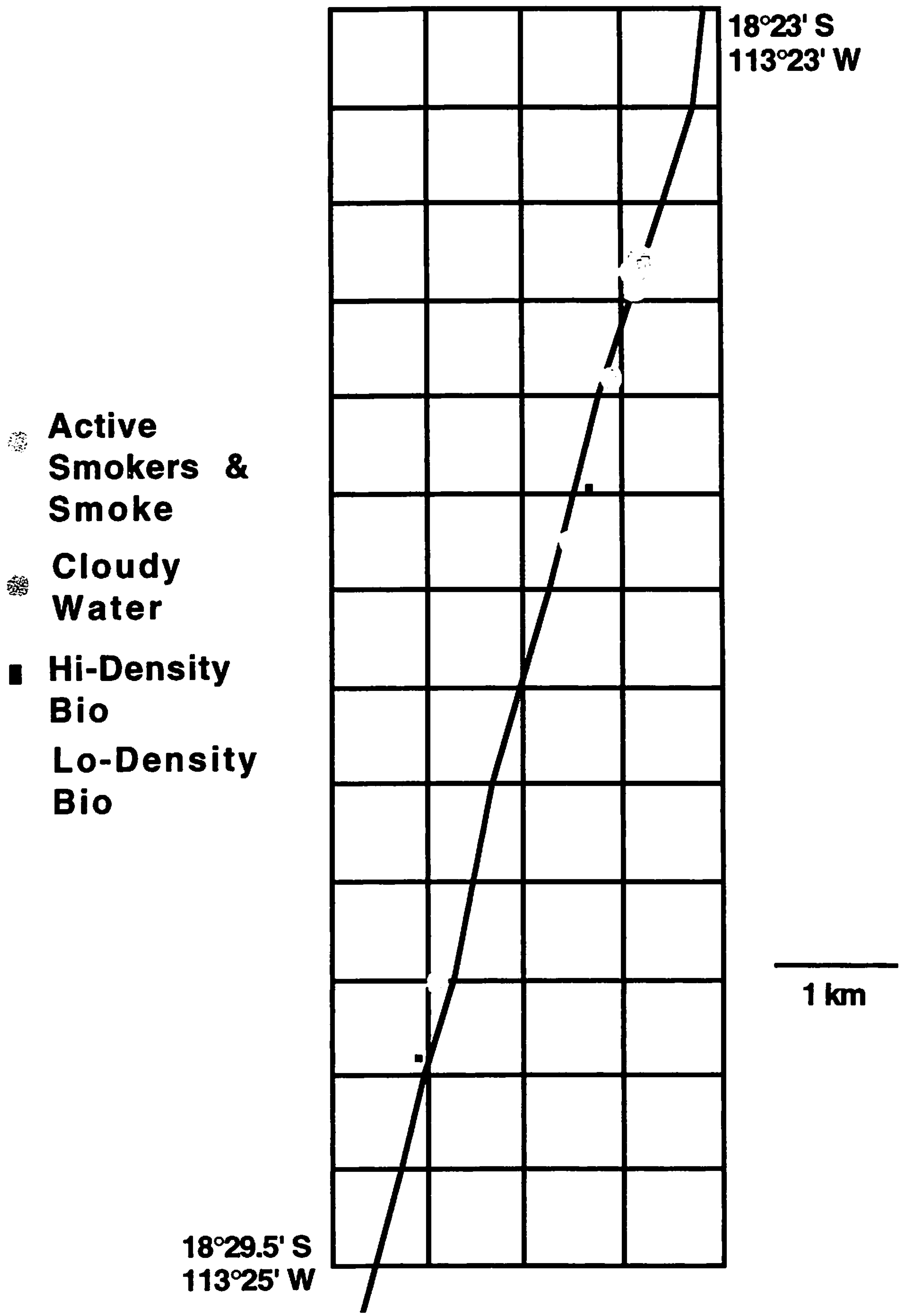


North Hump
Area and
"Roadtrip"
connecting
Spire + N Hump

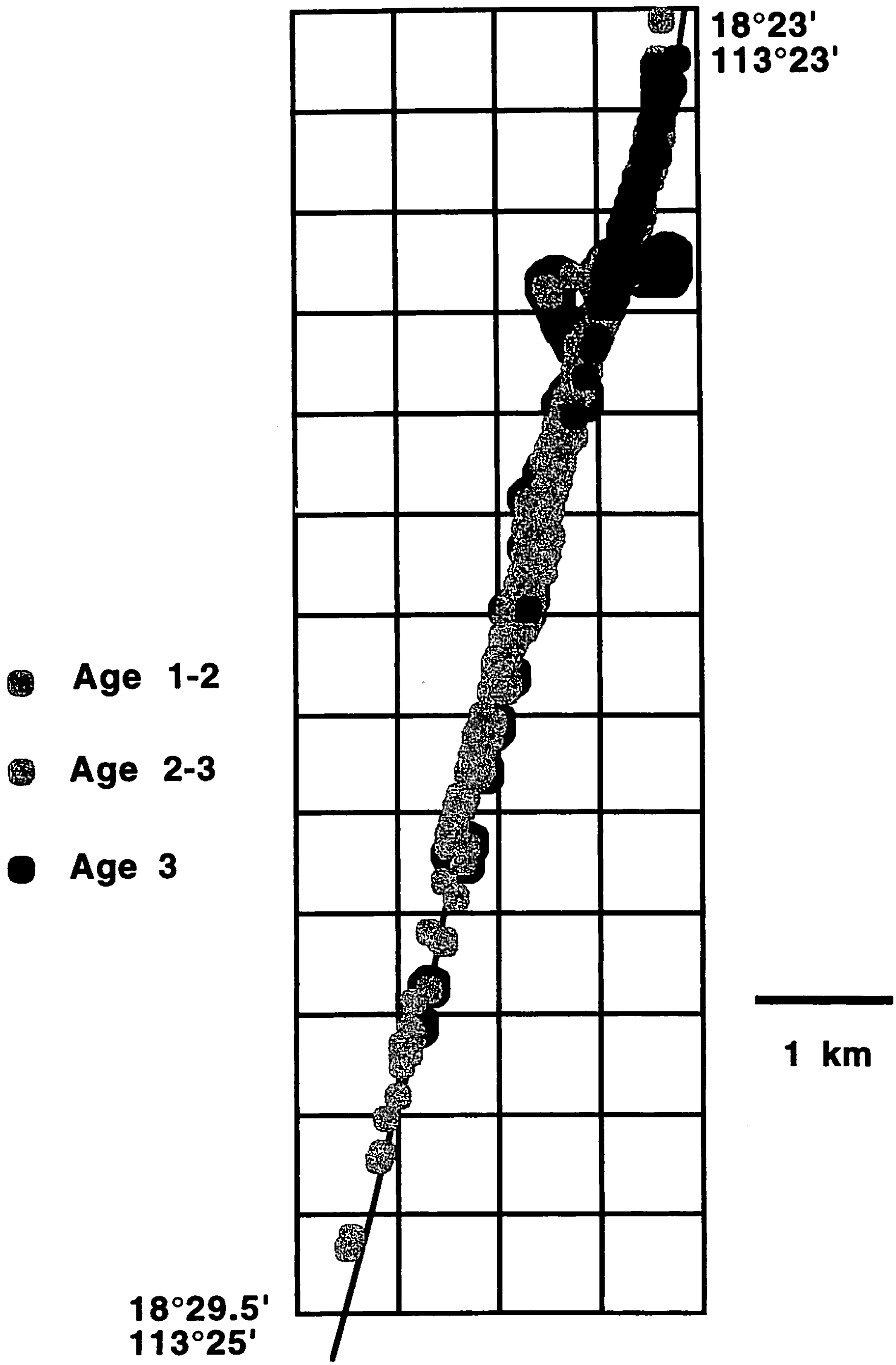
SOJN02MV -- north-hump -- ARG



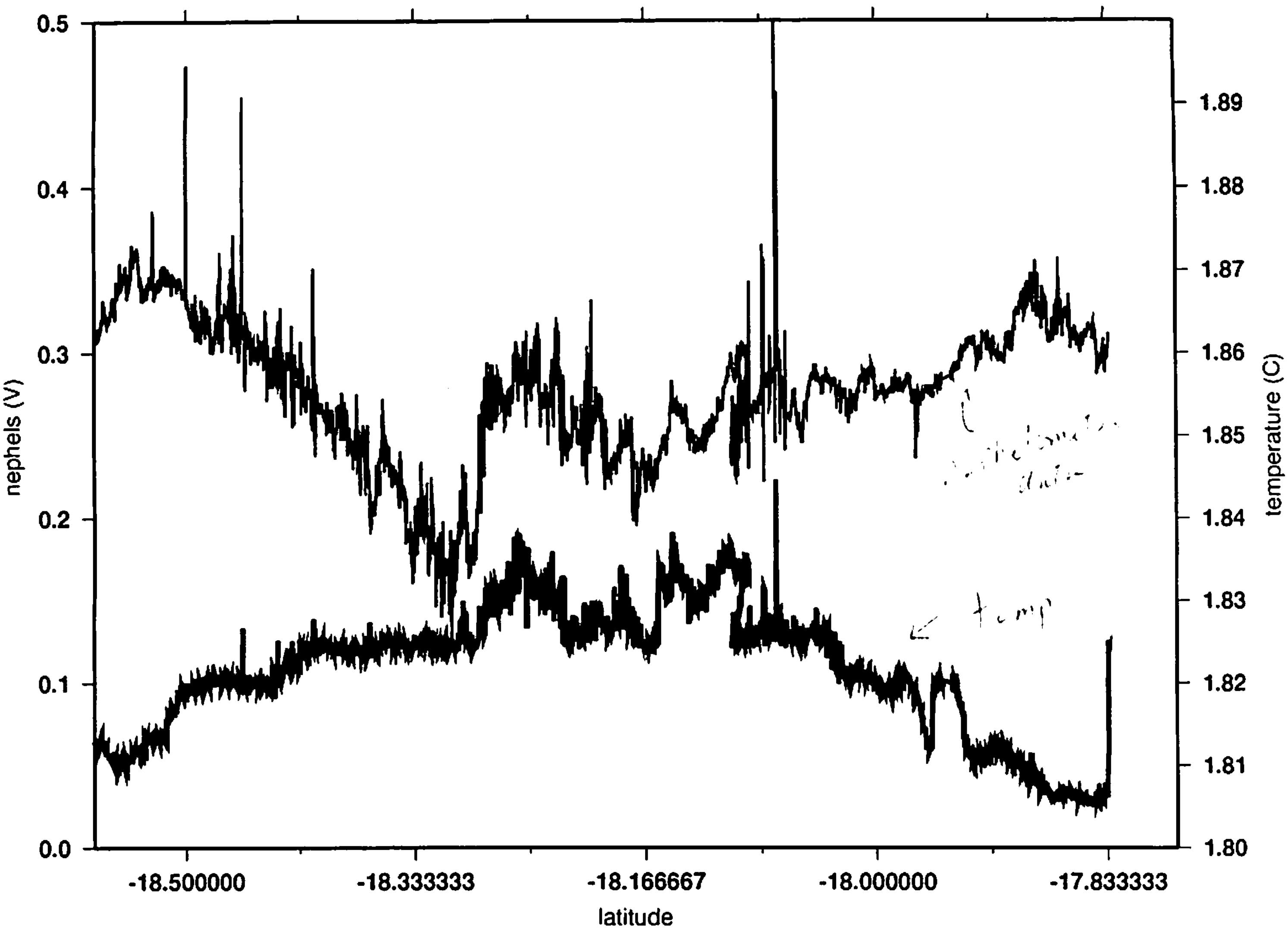
Hump Survey Smokers & Animal Communities
(30 sec lat/long grid)



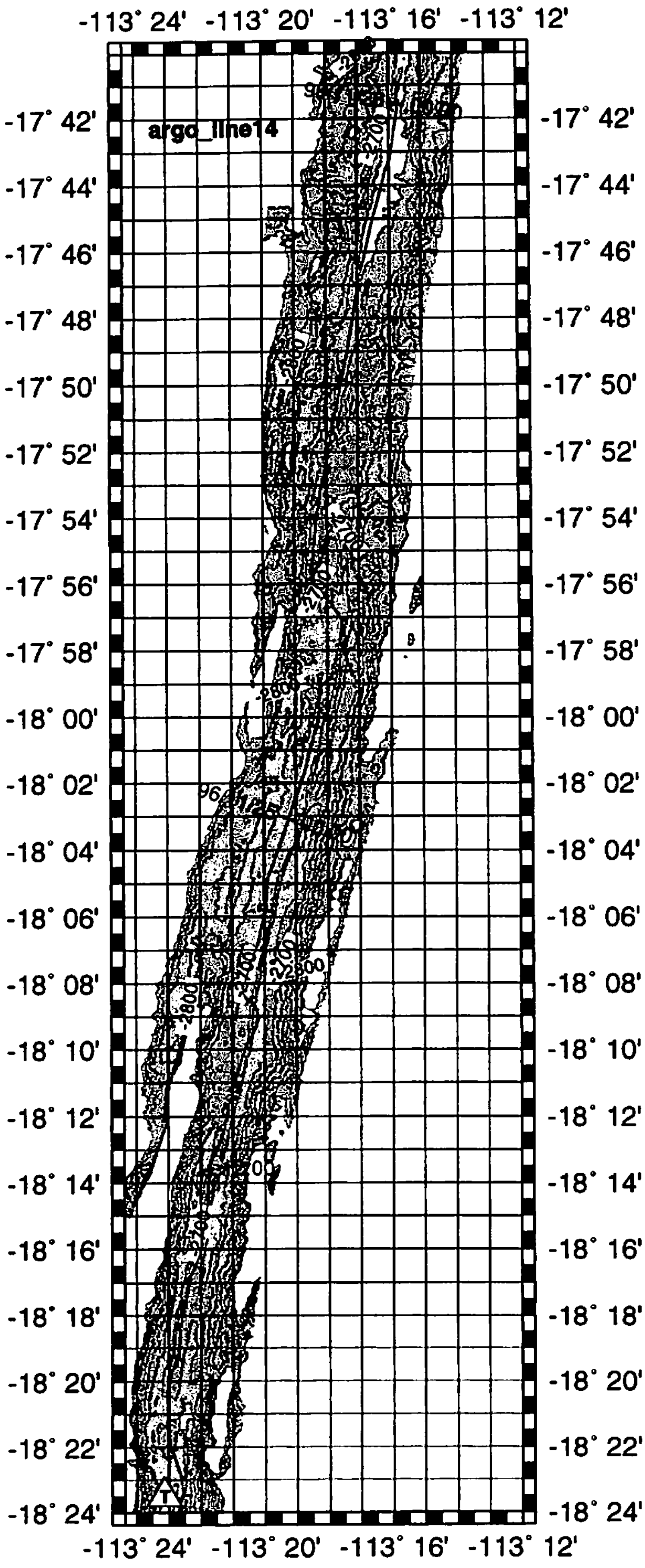
Hump Survey Relative Lava Ages
(30 sec lat/long grid)



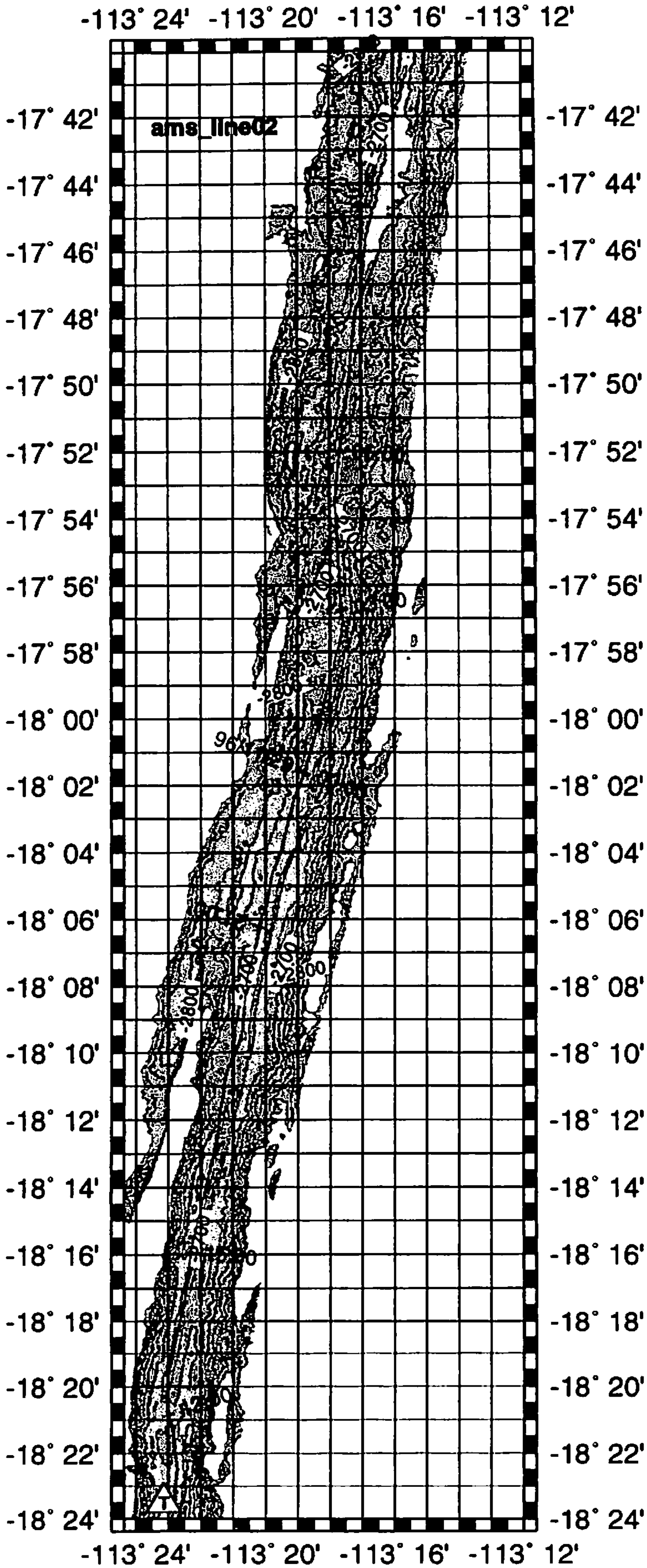
Plot of AMS02



SOJN02MV -- roadtrip -- ARG



SOJN02MV -- roadtrip -- AMS



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SEASEX Data Archive Catalog

12/2/96

Appendix 2

Data Type	2-Nov	6-Nov	7-Nov	8-Nov	9-Nov
bold = digital	argo test	DSL 120-1	DSL 120-1	Argo failed	Argo winch
				Line #1	accident
AMS/DSL 120					
Raw hourly files		√	√		
Sonar swath files		√			
EVT		√			
(Dawn/copy RMH)					
MET* (Mag & TRS)		√			
(Dan/Susan/copy RMH)					
Vehicle CTD*		√			
(Susan/copy RMH)					
NAV		√			
Telemetry Stream		√	√		
Raw sonar tapes		SON001-008	SON009-015		
Tar processed tapes (2)		Survey1	Survey1		
EPC rolls		#1	#2	AMS 3.5 kHz	Toyo Roll #1
Video tapes			#1-#8		
ARGO					
EVT Dawn/copy RMH	√			√	
MET+ (Mag & TRS)	√			√	√
(Dan/Susan/copy RMH)					
Vehicle CTD*	√			√	√
(Susan/copy RMH)					
NAV				√	√
Telemetry Stream	√			√	√
IMA	√			√	√
ESC processed files				esc003	
G I S layers				√	
Sonar raw data tapes	ARGSON1-2			ARGSON003	
ESC tapes	ESC001-002			ESC003	
ESC proofs					
EPC rolls					
Video tapes	AV001-006			AV007-009	
Handwritten EVT sheets				√	√
*** Susan keeping track of all wireline CTD/MAPR data**					
FILM					
video best hits					
35mm 1600					
MAPS					
Position plots					
Sea Beam maps					
120 mosaics					

+in MET files, first 3 fields are maggie, 4th field is TRS

Data Type	10-Nov	11-Nov	12-Nov	13-Nov	14-Nov
bold = digital	Line 2	Line 3	Line 3/4	Line 4	Lines 4/5
	Spike				
ARGO					
EVT	√	√	√	√	√
(Dawn/copy RMH)					
MET+ (Mag & TRS)	√	√	√	√	√
(Dan/Susan/copy RMH)					
Vehicle CTD*	√	√	√	√	√
(Susan/copy RMH)					
NAV	√	√	√	√	√
Telemetry Stream	√	√	√	√	√
IMA	√	√	√	√	√
ESC processed files	esc004-009	esc009-014	esc016-021	esc022	esc027-029
G I S layers	√	√	√	√	√
Sonar raw data tapes	ARGSON4-8	ARGSON9-16	ARGSON16-24	ARGSON24-27	ARGSON27-34
ESC tapes	ESC004-008	ESC009-015	ESC015-021	ESC022-023	ESC023-029
ESC proofs	esc004-009	esc009-014	esc016-021	esc022	esc027-029
ESC Tar Processed	√	√	√	√	√
EPC rolls	#1,3,5,6		Roll #02		Roll #03
Vehicle Video tapes	AV010-036	AV034-072	AV070-111	AV109-120	AV118-159
Sonar Screen video tapes				Tapes #1-3	Tapes #4-15
Handwritten EVT sheets	√	√	√	√	√

*** Susan keeping track of all wireline CTD/MAPR data**

+in MET files, first 3 fields are maggie, 4th field is TRS

Data Type	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov
bold = digital	Line 5	Line 6	Line 6	Line 7	Line 7
					transit to OBSs
ARGO					
EVT	√	√	√	√	√
(Dawn/copy RMH)					
MET+ (Mag & TRS)	√	√	√	√	√
(Dan/Susan/copy RMH)					
Vehicle CTD*	√	√	√	√	√
(Susan/copy RMH)					
NAV	√	√	√	√	√
Telemetry Stream	√	√	√	√	√
IMA	√	√	√	√	√
ESC processed files	esc029-034	esc036-041	esc041-048	esc048-054	esc054-057
G I S layers	√	√	√	√	√
Sonar raw data tapes	ARGSON34-44	ARGSON44-50	ARGSON50-57	ARGSON58-67	ARGSON67-74
ESC tapes	ESC029-035	ESC035-041	ESC041-048	ESC048-054	ESC054-057
ESC proofs	esc029-035	esc036-041	esc041-048	esc048-054	esc054-057
ESC Tar Processed	√	√	√	√	√
EPC rolls	Roll #04	Roll #05			
Vehicle Video tapes	AV157-198	AV196-237	AV235-276	AV274-315	AV313-336
Sonar Screen video tapes	Tapes #16-27	Tapes #27-37	Tapes #37-49	Tapes #50-61	Tapes #61-68
Handwritten EVT sheets	√	√	√	√	√
*** Susan keeping track of all wireline CTD/MAPR data**				Note:	
				No ARGSONs	
				061 or 062	

+in MET files, first 3 fields are maggie, 4th field is TRS

Data Type	20-Nov	21-Nov	22-Nov	23-Nov	24-Nov
bold = digital	OBS recovery	Lines 8/9	Lines 9-12	Lines 12/13	Lines 13/14
		Hump			Hump/Road Trip
ARGO					
EVT	√	√	√	√	√
(Dawn/copy RMH)					
MET+ (Mag & TRS)		√	√	√	√
(Dan/Susan/copy RMH)					
Vehicle CTD*		√	√	√	√
(Susan/copy RMH)					
NAV		√	√	√	√
Telemetry Stream		√	√	√	√
IMA		√	√	√	√
ESC processed files		esc058-061	esc061-067	esc067-073	esc073-079
G I S layers		√	√	√	√
Sonar raw data tapes		ARGSON75-78	ARGSON78-85	ARGSON85-93	ARGSON93-102
ESC tapes		ESC058-061	ESC061-067	ESC067-073	ESC073-079
ESC proofs		esc058-061	esc061-067	esc067-073	esc073-79
ESC Tar Processed		√	√	√	√
EPC rolls					
Vehicle Video tapes	MEDEA 1-6	AV337-357	AV355-396	AV394-435	AV433-474
Sonar Screen video tapes		Tapes #69-73	Tapes #74-86	Tapes #87-98	#99-110
Handwritten EVT sheets		√	√	√	√

*** Susan keeping track of all wireline CTD/MAPR data**

+in MET files, first 3 fields are maggie, 4th field is TRS

SEASEX Data Archive Catalog

12/2/96

Data Type	25-Nov	26-Nov	27-Nov	28-Nov	29-Nov
bold = digital	Line 14	Lines 14/15	Line 15	DSL 120-2	Line16
	Road Trip	Road Trip/Spike	Spike		Spike
ARGO					
EVT	√	√	√		√
(Dawn/copy RMH)					
MET+ (Mag & TRS)	√	√	√		√
(Dan/Susan/copy RMH)					
Vehicle CTD*	√	√	√		√
(Susan/copy RMH)					
NAV	√	√	√		√
Telemetry Stream	√	√	√		√
IMA	√	√	√		√
ESC processed files	esc079-85	esc085-91	esc091-93		esc104-105
G I S layers	√	√	√		√
Sonar raw data tapes	102-107	108-115	115-118		119-120
ESC tapes	ESC079-085	ESC085-091	ESC091-093		ESC104-015
ESC proofs	esc079-085	esc085-091	esc091-093		esc104-105
ESC Tar Processed	√	√	√		√
EPC rolls					
Vehicle Video tapes	AV472-513	AV511-552	AV550-570		AV571-579
Sonar Screen video tapes	#111-122	#123-129			
Handwritten EVT sheets	√	√	√		√
			Note:		
			No ESC tapes		
			094-103		
AMS/DSL 120					
Raw hourly files				√	√
Sonar swath files				√	√
EVT			√	√	√
(Dawn/copy RMH)					
MET* (Mag & TRS)			√	√	√
(Dan/Susan/copy RMH)					
Vehicle CTD*			√	√	√
(Susan/copy RMH)					
NAV				√	
Telemetry Stream			√	√	√
Raw sonar tapes				SON017-022	SON022-024
Tar of raw files				Tapes #1-3	Tapes #4-5
Tar processed tapes (2)				Survey2	Survey2
EPC rolls			Roll #1		

+in MET files, first 3 fields are maggie, 4th field is TRS

Data Type	**30-Nov**		
bold = digital	Line16		
	Spike		
ARGO			
EVT	√		
(Dawn/copy RMH)			
MET+ (Mag & TRS)	√		
(Dan/Susan/copy RMH)			
Vehicle CTD*	√		
(Susan/copy RMH)			
NAV	√		
Telemetry Stream	√		
IMA	√		
ESC processed files	esc105-110		
G I S layers	√		
Sonar raw data tapes	120-125		
ESC tapes	ESC105-110		
ESC proofs	esc105-110		
ESC Tar Processed	√		
Vehicle Video tapes	AV577-612		
Handwritten EVT sheets	√		
ALSO:			
ESC best hits tape (including images for mosaics) - 2 copies			
Tar of all raw ATT/CTD/EVT/IMA/MET/NAV files - 2 copies			

+in MET files, first 3 fields are maggie, 4th field is TRS

Date: Tue, 3 Dec 1996 04:57:06 GMT
From: scheirer (Daniel S. Scheirer)
To: haymon
Subject: appendix with data descriptions...

Argo/AMS120 Daily Data Information

Appendix 3

Dan Scheirer, 01 December 1996

Every day, within a few hours of the GMT day-change, Peter Lemmond provided a number of files on a publically available disk which contai the navigation, attitudes, metrabyte (magnetics and transmissometer), CTD, and Imagenex data collected during the day which just ended. The-- files were "first-cut" processed by Peter to produce consistent and individual files for each data-type; in addition, navigation editing based on apparent speed filters and editing of outliers in the CTD string were done. The file naming scheme (e.g. suffixes of .raw or .1 or .raw.1) is not consistent among the different data types.

After the daily data dump, shell-scripts were run to plot the data and to summarize their statistics. Then each file was interpolated/binned into a common time base every 5 seconds to facilitate merging together; this operation, performed with the newly written C program interpolate_dsl.c, had options for passing the average value or the median value for time bins which had more than one entry; later, linear interpolation was applied to fill in any data-gaps.

Scott White and Ken Macdonald picked fish-track fixes where we were outside of the transponder nets, based on reasonable fish lags behind the ship. No fish depth was provided in these hand-entered records. They also removed a number of clearly bad fixes which passed the first-cut processing.

Finally, we picked the location of the ridge axis high for every minute of latitude (and some additional picks where the ridge axis curved), based on 10m contour maps of 100m-gridded SeaBeam2000 data which was collected during the last leg. We then calculated the distance of each fix away from this ridge axis and appended this distance (west of axis<0., east of axis>0.) to the navigation files to facilitate distance comparisons near the ridge axis.

The following summarizes the contents of the files comprising the daily dumps. Argo (ARG) days contained all of these datasets; AMS120 (AMS) days did not collect Imagenex data. A brief description of the 120kHz data is provided at the end of these notes.

For reference, most of our Argo surveying was conducted at 1.0kt over the ground, which equals 30m/minute or 0.5m/sec. Most of the AMS120 surveying was at 1.7kts, which equals 50m/minute or 0.8m/sec.

##
Navigation, NAV

1st-cut processed files are called: 961113.NAV.ARG.raw.1 (UTM coords)
and: 961113.NAV.ARG.raw.1.gll (lat-lon coords)

Data are provided every 10-20 seconds, although there are frequent gaps when changing between transponder baselines and where surveying beyond the bounds of the transponder array. Peter Lemmond wrote a routine to convert the UTM (zone 12) eastings and northings provided by default into longitudes and latitudes.

Size: up to 450kb per day (~6000 lines of data)

Sample line from NAV.ARG.raw.1 file:

```
PNS 96/11/21 11:20:09.00 LBL NEN MED 248636.34 7965369.35  739.30   0.0 00
(code, date, time, code, code, code, utm easting(m), utm northing(m), depth(from net) ? ? )

Sample line from NAV.ARG.raw.1.gll file:
PNS 96/11/21 11:20:09.00 LBL GLL MED -113.37912370 -18.38683047 739.30 0.0 00
(code, date, time, code, code, code, longitude, latitude, depth(from net) ? ? )

################################################################################
Attitudes, ATT
-------------

1st-cut processed files are called: 961113.ATT.ARG.1
```

Data are provided every 0.35 seconds. Approximately 10% of these records are stamped with times either earlier than or identical to the records immediately preceding them. For future processing, I ignore such lines (although the data look fine).

The gyro did not work after the 1st ARGO lowering (where a number of boards fried after 5 minutes on the bottom). The altimeter went through times with some or many spurious readings (<0.9m altitudes). The Paroscientific depths did not match the depths derived from the CTD mounted on the tow-fish; they had mismatches of 15-25m, with the Paroscientific reading shallower. These comparisons were made by applying to the CTD data the pressure-to-depth conversion used by the Paroscientic, so there is apparently an error in the pressure calibration values of one or both of the instruments. No systematic comparison of the depths/pressures derived from the MAPRs was made (this might best be done in the Argo test lowering, where everything was attached to the sled).

Size: up to 27Mb per day (~250,000 lines of data)

```
Sample line from ATT.ARG.1 file:
PAS 96/11/23 00:00:33.78 JAS 116.2 145.8  -0.2  -0.5   7.7 2653.832 181.5  17.9 -0.6024 -0.4477   0.0
0.0
(code, date, time, code, gyro, compass, pitch(deg, bow_up>0.), \
    roll(deg, port_up>0.), altitude(m), depth(m, from pressure),  \
    reset_val_gyro(deg), mag_deviation_applied(deg),
    ?     ?      ?     ?)


################################################################################
Metrabyte, MET (3-component maggie and transmissometer)
-------------

1st-cut processed files are called: 961113.ATT.ARG.1
```

Data are provided every 1.88 seconds. 0%-1% of these records are stamped with times either earlier than or identical to the records immediately preceding them. For future processing, I ignore such lines (although the data look fine). 0.5%-1% of these records do not have data in all of the columns; these lines are also ignored. Some of the files have 1 or 2 lines which contain "XRD", "YRD", "ZRD", or "TRD" instead of a valid numeric value. These lines are ignored, but typically represent places where the 4 Metrabyte values get out of synch (the 3 mag and the transmissometer values get permuted.

Also, frequent Metrabyte crashes (fixed by metkill and metgo by the event-logging watchstander) resulted in small (<5min gaps) every day, and a large gap for the 2nd half of the first AMS120 line.

The maggie readings may be converted to nT by multiplying the mV readings by 24 then adding -60,000. The 0-5V range represents magnetic values between -60,000 --> 60,000 nT. On the cruise, we do not have a conversion between transmissometer (mV) readings and attenuation values (1/m). Susan Baron did a calibration test for the transmissometer on-deck in air and when blocked. The transmissometer anomalies associated with hydrothermal sources were typically 5-40 mV decreases relative to background values.

Also, from time to time, there are shifts in the background values of the transmissometer, larger than the anomalies caused by hydrothermal plumes.

Size: up to 4Mb per day (~40,000 lines of data)

Sample line from MET.ARG.1 file:

```
MET 96/11/13 00:00:09.27 MET  XMG: +02592.00  YMG: +01223.60  ZMG: +01853.20 \
   XMS: +03998.24
(code, date, time, code, Xmag(mV), Ymag(mV), Zmag(mV), Transmissometer(mV) )
```

\##

CTD, CTD

1st-cut processed files are called: 961113.CTD.ARG.raw.1

Data are provided every 1.0 seconds. In a few of these files, 1-3 of the data records are stamped with times either earlier than or identical to the records immediately preceding them. For future processing, I ignore such lines (although the data look fine).

Only near the end of the cruise were the proper calibration values inserted into the processing code which computed the C, T, and pressure. (See ATT entry above for disagreement between Paroscientific pressure depth and the CTD-derived depth.)

Size: up to 11Mb per day (~86,000 lines of data)

Sample line from CTD.ARG.raw.1 file:

```
CTD 96/11/13 00:06:47.19 SBE CTD 00:06:47.19 SBE 312F5CDD2FA7 3.210002 \
    1.856504 3467.933906 0.000000 0.000000 0.000000 0.000000
(code, date, time, code, code, time, code, hexadecimal-reading, Cond(S/m) \
   Temp(degC), Pressure(psi), ?, ?, ?, ? )
```

\##

Imagenex, IMA

1st-cut processed files are called: 961113.IMA.ARG.raw.1

Data are provided every 0.1 seconds. But the time stamps between successive zaps varies significantly. Little was done with these files while out at sea.

Size: up to 52Mb per day (~1,000,000 lines of data)

Sample lines from CTD.ARG.raw.1 file:

```
IMA 96/11/13 16:43:00.37 IMA 20.900000 49.210000
IMA 96/11/13 16:43:00.42 IMA 21.200000 47.380000
(code, date, time, code, angle(deg), range(msec) )
```

\##

A few notes on the AMS/DSL 120 data:

We only had time to do the most cursory inspection of the 120 kHz data.

A list of processed files for one hour is below.

```
-rw-rw-r--  1 scheirer 34307328 Nov 28 21:33 DSL120.961106_2200.amp.dat
-rw-rw-rw-  1 scheirer      583 Nov 28 21:37 DSL120.961106_2200.amp.grd.Z
-rw-rw-r--  1 scheirer  7071776 Nov 28 21:37 DSL120.961106_2200.amp.ras
-rw-r--r--  1 scheirer  7071773 Nov 28 21:39 DSL120.961106_2200.amp.ras.gamma
-rw-r--r--  1 scheirer   291723 Dec  1 02:36 DSL120.961106_2200.amp.ras.gamma.ps.Z
-rw-rw-r--  1 scheirer 23407537 Nov 28 21:35 DSL120.961106_2200.bat.dat.Z
-rw-rw-rw-  1 scheirer      579 Nov 28 21:37 DSL120.961106_2200.bat.grd.Z
-rw-r--r--  1 scheirer  4879285 Dec  1 03:38 DSL120.961106_2200.bat.ras.8bit.Z
-rw-r--r--  1 scheirer   399301 Dec  1 02:34 DSL120.961106_2200.bat.ras.8bit.ps.Z
-rw-rw-r--  1 scheirer 20606009 Nov 28 21:38 DSL120.961106_2200.bat.ras.Z
-rw-rw-rw-  1 scheirer      289 Nov 28 21:33 DSL120.961106_2200.bat.sfd.Z
-rw-r--r--  1 scheirer      128 Nov 30 05:25 run_view_bathy.Z
```

The .ras files are Sun raster files of the sidescan and bathymetry data; a .sfd file contains information about the creation of each of these files, and the .grd file contains raster file information. The bat.ras is a 32-bit pseudo-Sun raster file; use view_bathy to convert this to an 8-bit representation. When plotted with xv or converted to postscript files, time increases towards the bottom of the file, each row is a ping, and the total swath width is 1km.

The amp.dat and bat.dat include the raw ping data, and each ping has 7000 pixels of sidescan and 2048 "beams" of bathymtry. The bat.dat files may be manipulated with MBsystem although they need merging with navigation; the amp.dat files are supposed to be as well, but the 7000 values per ping seems to be too large for the MB programs.

The bathymetry data appear to have great need for smoothing (and concurrent decimation), especially near the edge of the swath.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2 ARGO II 20:10 23:10 Test- No Nav
3	4	5	6 AMS 12 Lowering 1 07:40 xxxxxxx xxxxxxx Spike area Line 1 07:40 xxxxxxx xxxxxxx	7 xxxxxxx xxxxxxx xxxxxxx 19:50 xxxxxxx xxxxxxx xxxxxxx 19:50	8 ARGO II 01:30 06:10 01:30 06:10 w/ tail 5 min on bottom Tow-Yo 1 13:50 xxxxxxx	9 02:10
10 ARGO II Lowering 2 04:00 xxxxxxx xxxxxxx xxxxxxx Spike area Line 2 04:00 xxxxxxx xxxxxxx xxxxxxx no gyro, depth bad T&D on CTD bad alt, bad Imagenex	11 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Line 3 xxxxxxx xxxxxxx 19:30 xxxxxxx	12 xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx Lost wire CTD	13 02:10 ARGO II Lowering 3 17:40 xxxxxxx 02:10 Line 4 17:40 xxxxxxx no press depth, no gyro Tow-Yo 2 04:00 9:20	14 xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx	15 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Line 5 01:00 xxxxxxx xxxxxxx xxxxxxx	16 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Line 6 05:10 xxxxxxx xxxxxxx xxxxxxx
17 ARGO II Lowering 3 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Line 6 xxxxxxx xxxxxxx xxxxxxx xxxxxxx	18 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Line 7 xxxxxxx xxxxxxx 16:00 xxxxxxx	19 xxxxxxx xxxxxxx 16:30 xxxxxxx xxxxxxx 16:30 OBS Recovery xxxxxxx xxxxxxx	20 xxxxxxx xxxxxxx xxxxxxx xxxxxxx	21 ARGO II Lowering 4 10:30 xxxxxxx xxxxxxx Hump area Line 8 Line 9 10:30 xxxxxxx 20:20 no gyro	22 xxxxxxx xxxxxxx xxxxxxx xxxx Line 10 Line 11 Line 12 03:00 10:40 17:50 xxxx	23 xxxxxxx xxxxxxx xxxxxxx xxxxxxx x
24 ARGO II Lowering 4 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Hump to Spike area Line 14 01:20 xxxxxxx xxxxxxx xxxxxxx	25 xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx	26 xxxxxxx xxxxxxx xxxxxxx xxxxxxx Spike area Line 15 00:20 xxxxxxx xxxxxxx xxxxxxx CTD data glitchy 961126/961127 maybe 961125	27 AMS 12 xxxxxxx xxxxxxx 13:20 22:30 Line 2 xxxxxxx xxxxxxx 13:20 22:20	28 Lowering 2 xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx xxxxxxx	29 ARGO II L xxxxxxx 11:50 17:00 : Spike ar Line 16 xxxxxxx 11:50 17:00 no gyro, Imagenex bad 2nd hal	1:40 21:40

Appendix 4