MADCAP CRUISE- R/VATLANTIS 15-16

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The MADCAP (Melting and diking with compliance and pressure) cruise left Manzanillo, Mexico on Feb. 13, 2007 on the R/VAtlantis and arrived back into Manzanillo on March 19, 2007. The cruise combined two projects on the East Pacific Rise, within the RIDGE2000 "integrated study site". The first project (OCE-0426372) is an investigation of the structure beneath the East Pacific Rise using five compliance meters, three from LDEO of Columbia University and two from IPGP in Paris. The compliance measurements provide a vertical profile of shear velocity with the crust and upper mantle and the measurements are particularly sensitive to regions of melt. The P.I. on this project was Spahr Webb in collaboration with Wayne Crawford (IPGP). Scott Nooner (postdoctoral scientist) will be leading the analysis of the compliance data.

The second project (OCE-0426575) is an investigation of vertical motions along the segment of the East Pacific Rise between 9° and 10° using 20 bottom pressure recorders that will be deployed for a period of three years. Milene Cormier, Roger Buck and Spahr Webb are the P.I.s on this project. The vertical motions are expected to be associated with intrusive and extrusive events occurring in the vicinity of the instruments. Roger Buck will be leading a modeling effort with Scott Nooner's involvement.

The scientific party also included a post doctoral investigator from Paris, Pavel Issanov, a graduate student from LDEO; Chad Holmes, and three undergraduates, two from University of Missouri-Columbia: Josh Myer and John Kreuger, and one from City University of New York (Lehman College): Wanda Vargas. Some of auxiliary work described below was conducted partly as a teaching component of the cruise.

BOTTOM PRESSURE RECORDERS

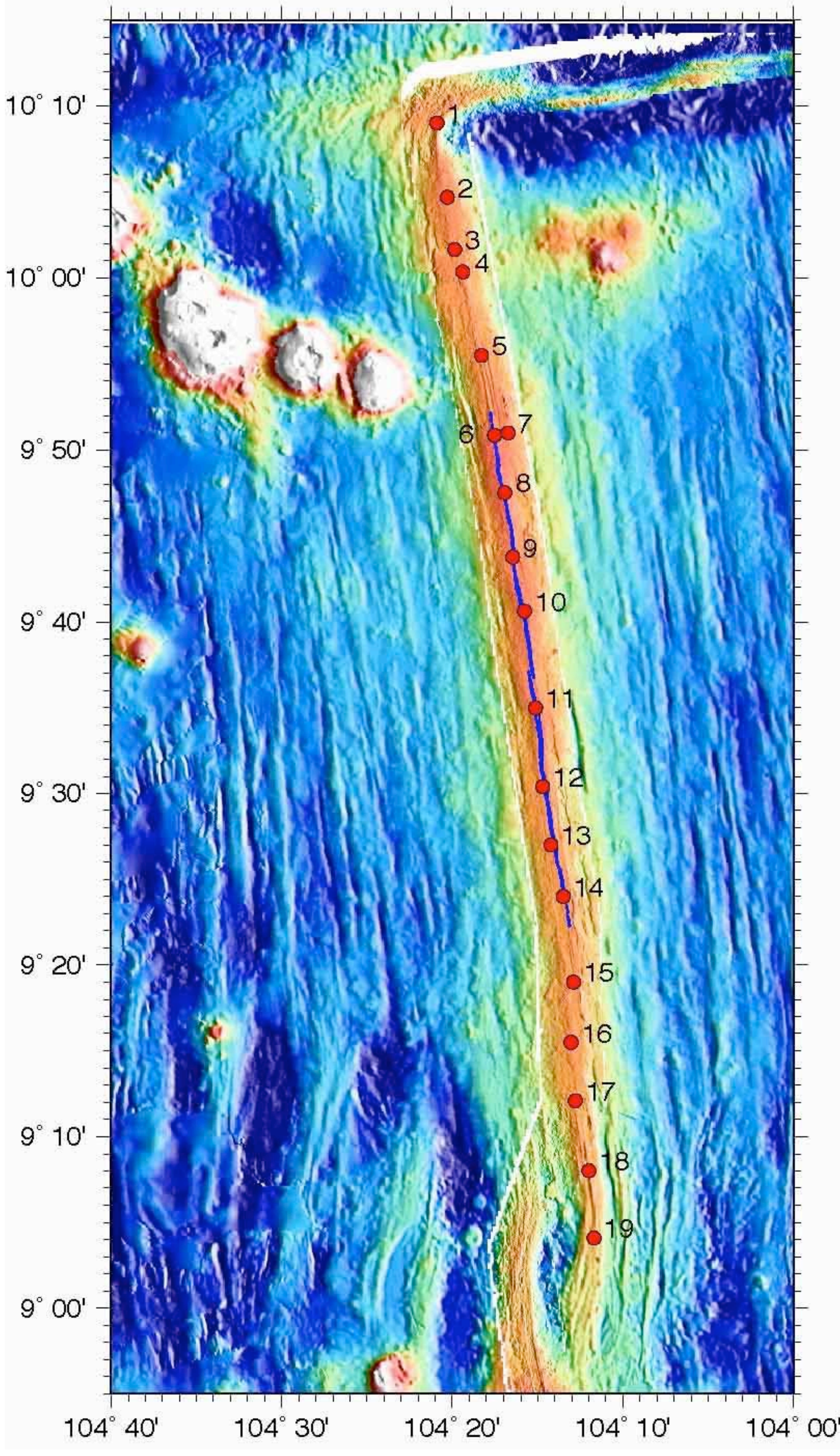
Nineteen BPRs have been deployed along the axis between the 9°03'N OSC and the Clipperton fracture zone (Figure 1). The BPRs, except for site B-7, have been deployed close to, but outside the axial eruptive fissure (where present). The largest vertical deformation is expected to occur within a few 100 m from a feeder dike (an eruptive fissure). However, the BPRs would not be expected to survive an eruption if positioned within the 10-15 m-deep eruptive fissures, but we hope they will "raft" passively with the solidified crust of active lava flows just outside an eruptive fissure. The 20th BPR was slightly damaged by a small leak during testing in November. We plan to repair this instrument and deploy it during a cruise we hope will occur early next year (PI Scott Nooner, the proposal is still under consideration by NSF from the August 15, 2006). We would use this 20th BPR to augment the cross array at 9° 48'N during the three year deployment and also to temporarily monitor tides during the Nooner experiment. The three BPRs in the closest vicinity of the recent eruption (B6, B7, and B8) were deployed using syntactic foam for flotation (borrowed from the deep submergence group). The pressure cases in these BPRs were also tested using the standard testing procedure for equipment to be deployed in the vicinity of Alvin operations.

The BPRs are configured as a short mooring. The lower half of the mooring is fastened rigidly to a wide tripod using a burnwire release. The rigid tripod keeps the Paroscientific pressure gauge at a fixed depth. The BPRs will be used to monitor vertical motions of the seafloor due to magma movement, intrusion and diking events in the vicinity of each BPR over the next three years. The Paroscientific gauge produces two frequency outputs, one related to absolute pressure and the other to temperature. Both frequencies will be measured once per minute using a frequency reference for the next three years and the data stored in flash memory. The stability of the frequency reference will be monitored every two weeks using a very accurate oven crystal oscillator. There is some evidence that much of the drift observed in long term Paroscientific gauge measurements is associated with drift of the frequency reference rather than drift of the Paroscientific gauge. We are hoping to obtain stabilities of better than 10 cm per year. A three ball glass float hangs above the main pressure case and will be used to bring the BPRs to the surface for recovery. Each instrument has an acoustic transponder release. Each instrument can respond to acoustic interrogation by relaying a digital code with the most recent pressure measurement accurate to 0.1m. This allows easy check on the state of health of the instrument on the seafloor. It should also allow us to detect major changes in elevation without recovery of the instrument.

Each BPR was tested before deployment by wireline, or else it was wireline deployed. This insured that both the BPR and acoustic release were functioning properly before deployment. We were concerned about possible acoustic release failures at long acoustic range, and indeed one acoustic release transducer failed testing and was replaced. We also deployed two BPRs on the seafloor for testing and also to collect pressure data to calibrate the differential pressure gages (DPGs) used on the compliance meters. For the calibrations, the BPRs were set to record pressure data every ten seconds. This is a fast enough sampling rate to record infragravity waves that the compliance meters also record. The signal-to-noise ratio for infragravity waves is much poorer on the Paroscientific gauge than on the DPGs but the calibration procedure worked very well, allowing calibration to better than 1% across the band from 0.0005 to 0.03 Hz.

We acoustically surveyed the BPRs. We estimate that instruments are located within better than 10 m (BPR 15 was not surveyed, but was deployed on wire, insuring precise positioning). Knowing the precise locations may be interesting if any instruments are swept up in an eruption. We hope the vertical profile and wide tripod base will help us recover the instruments following eruptions but recognize that a major eruption is likely to lead to loss of BPRs. We may be able to interrogate BPRs stuck in lava and determine their depth and position.

Locations of Bottom Pressure Recorders (BPRs)



Bottom pressure recorders (BPRs) deployed

Site #	BPR #	Latitude N (surveyed)	Longitude W (surveyed)	Depth, m (surveyed)	Date started, GMT	Time started, GMT	Comments
B1	16	10°09.0141'	104°20.9346'	2551	2/25/07	4:02	at Clipperton
B2	1	10°04.7282'	104°20.2179'	2542	2/24/07	22:15	
B3	5	10°01.6588'	104°19.8961'	2553	2/24/07	1:37	
B4	7	10°00.3535'	104°19.3668'	2541	2/24/07	16:30	
B5	14	9°55.5247'	104°18.2480'	2542	2/27/07		
B6	3	9°50.8439'	104°17.5101'	2505	3/2/07		bull's eye; syntactic foam
B7	8	9°51.0399'	104°16.7616'	2537	2/28/07	5:02	syntactic foam; 2km E of B6
B8	2	9°47.4989'	104°16.9001'	2510	3/2/07	2:15	bull's eye; syntactic foam
B9	19	9°43.7341'	104°16.4518'	2536	3/17/07	4:27	
B10	12	9°40.6018'	104°15.6981'	2534	3/3/07	20:42	
B11	6	9°35.0257'	104°15.3048'	2543	3/4/07	0:08	
B12	10	9°30.3978'	104°14.7812'	2558	3/4/07	1:42	
B13	17	9°27.0161'	104°14.2860'	2567	3/4/07	3:57	
B14	15	9°24.0011'	104°13.5472'	2582	3/16/07	22:14	
B15	18	9°19.0'	104°13.0'		3/16/07	20:38	wire deploy.; not surveyed
B16	9	9°15.2845'	104°13.0040'	2567	3/9/07	4:45	
B17	4	9°12.0845'	104°12.7527'	2588	3/9/07	23:01	
B18	11	9°07.9812'	104°11.9888'	2543	3/9/07		
B19	13	9°03.9742'	104°11.6944'	2608	3/10/07	3:32	OSC tip

COMPLIANCE MEASUREMENTS

The main purpose of this cruise to the EPR was to measure seafloor compliance at many sites in order to study the relationship of partial melt within the crust and uppermost mantle with tectonic features within the RIDGE ISS bull's eye. We conducted 45 deployments of compliance meters during the cruise. Compliance remains a very difficult measurement, requiring the compliance meters to be extremely well coupled to the seafloor. For this reason, data quality varies greatly between sites. About half the sites obtained top quality data. Instrument performance is discussed in a later section.

We conducted four groups of deployments focused on particular features. The results described here are very preliminary and will require more careful analysis. Compliance measurements are best analyzed in conjunction with seismic data and we will incorporate seismic data from other sources into our analysis.

During the cruise we demonstrated that observations of infragravity waves using the Paroscientific gauges on the BPRs at the same time as compliance meter DPG measurements could be used to very accurately calibrate the differential pressure gauges on the compliance meters over a very broad frequency band (from at least 0.0003 to 0.03 mHz). A major source of uncertainty in previous compliance measurements was whether the in-situ and laboratory calibrations on the DPGs were accurate. We found that our laboratory calibrations were quite accurate except at very low frequency (lower frequency than is relevant to the compliance measurements). The ease of deployment of instruments such as the BPR suggests such calibrations should be conducted occasionally in conjunction with OBS deployments of instruments from the OBSIP Pool to calibrate the DPGs on those systems.

The first set of compliance meter deployments was conducted along a line across the rise axis near 10° 20N, on the segment north of the Clipperton fracture zone. The on axis measurement at this site showed higher shear velocities in the lower crustal magma chamber than that seen at all of the on-axis sites south of Clipperton, confirming the general view that the southern end of the segment north of Clipperton is relatively magma starved.

A second group of deployments was conducted at about 10°N from the rise axis into the Watchstander group of seamounts to test whether there was a shallow connection between the seamount channel magma source and the rise axis. A site on one seamount showed evidence for a significant mid-crustal magma chamber, whereas sites between the seamount and the rise axis showed normal, higher shear velocities, suggesting no crustal connection. We will further analyze the compliance data to determine if there is evidence for any deeper connection.

A third set of deployments was conducted from 9° 50N northward, toward and across the Clipperton fracture zone. The purpose of this deployment was to look for a possible extension of the crustal magma chamber across the fracture zone under the 'rooster tail' bathymetric feature found there. The compliance measurements show the shear velocities in the crust remain quite low under the rise axis across the fracture zone. More careful analysis post cruise is required before we can be sure whether this is evidence for melt, or merely altered, porous crust as suggested by previous seismic work.

A fourth set of deployments was conducted along a line crossing the axis near 9° 20N. The on-axis measurements do not appear significantly different from our other on-axis measurements along this segment, but compliance remains high well off axis , suggesting a region of melt at axial magma chamber depths out to nearly 20km off axis. Toomey and Durey (work in progress) have previously reported a reflector in this region and also possible p to s conversions from a magma chamber. The compliance measurements appear to confirm this remarkable result. We would like to have more measurements to better map out the extent of this body, but it appears to be a significant signal.

These results described here are very preliminary. They are inferred from a quick comparison of site transfer functions which shows only how the sites differ qualitatively. We will be using standard inversion techniques to develop shear velocity models for each group of sites over the next several months.

The Guralp sensors used in the compliance meters proved very fragile during this leg. The big problem was the gear boxes used in the leveling and clamping systems in the sensors (primarily the leveling motors). The problem appeared in two forms: stuck motors which meant the systems did not level and one or more (usually) horizontal components failed to function and broken gear boxes. We have had several problems with these same sensors since we purchased them two years ago. Indeed a spare sensor was air shipped to Guralp in England for repair just before the cruise, but arrived back in Manzanillo still with a stuck horizontal component. Several long Inmarsat calls to England allowed us to finally diagnose the problems. Repair consisted of mainly shifting gear boxes and motors between sensors to keep as many instruments working as possible. It seems clear to us that the manufacturer could easily fix this problem and the manufacturer says it is finally working on the problem. This has been a problem that has affected many Pascal experiments as well. The problem is more severe with the compliance measurements because the sensors are cycled many times during each experiment rather than once as in a Pascal experiment. High quality compliance measurements also require all three components working perfectly whereas a stuck horizontal component on a sensor during a Pascal seismometer deployment has only a limited effect on the utility of that particular station.

We discovered another, more subtle problem with the Guralp sensor during the test cruises shortly before the main experiment. The horizontal sensors have relatively low clip levels that can easily be reached by tilting under seafloor currents. The clipping is hidden in the integrated output which appears normal. We discovered the clipping only by observing that the long period coherence between the horizontal and vertical components fell with increasing horizontal spectral levels past a certain threshold. This suggests that the Guralp will be a problematical sensor for broadband seafloor measurements anywhere where bottom currents are significant, unless it is shielded in some manner. A proposal is in the works to solve this problem which has the potential to greatly improve the usefulness of the horizontal components for all the instruments in the OBSIP fleet. We solved the problem for the current cruise by seeking “holes in the ground” where the Guralp would experience the weakest possible currents. This tactic was mostly very successful. We had another problem early on, (that was quickly fixed) with the burn wires used to drop the sensor from the arm used to carry the instrument to the seafloor.

One of the five compliance sensors got stuck at site “C-10” rather early on during the cruise, not returning from the seafloor despite both acoustic transponder release systems on the instruments acknowledging release commands sent from the surface. We suspect the instrument has gotten trapped in some manner. The instrument lies close the SIO OBSs stuck in the recent lava flow and it seems likely that it can be rescued using Jason during the leg following this one. Some time has been allotted on this leg to try to retrieve some of the many OBSs engulfed by the recent eruption.

Despite the many problems we are quite happy with the data obtained during this leg. We were able to address all the major questions that were the focus of the proposal. More measurements would have mostly just filled in the holes better. The one regret is that we did not have time to continue the measurements even further west and east at 9° 20’N than we did. This area appears to have a very broad region of slower than expected shear velocities in the middle crust. (Further analysis will be required to exactly determine what that means). It seems likely that conventional seismic observations are not telling us the full story about what is happening in the lower crust off axis.

Compliance Sites during MADCAP

Site	*Instrument*	*Sphere*	*Latitude Degree*	*Latitude, minutes*	*Longitude Degree*	*Longitude, minutes*	*Depth (m)*
C1	FR1	F1	10	29.6107	-103	39.5116	3055
C2	CMP1	L1	10	29.9211	-103	37.8854	3167
C3	FR2	F2	10	30.1145	-103	36.7264	2803
C4	CMP3	L3	10	30.1982	-103	35.7670	2960
C5	CMP2	L2	10	30.5919	-103	34.1631	3014
C6	FR1	F2	9	50.198	-104	06.400	2996
C6B	FR2	F2	9	49.877	-104	06.199	
C7	FR2	F2	9	48.6373	-104	14.8691	2659
C8	CMP1	L1	9	48.4782	-104	15.4264	2655
C9	CMP3	L3	9	48.4079	-104	17.0594	2507
C10	CMP2	L2	9	48.2859	-104	18.3078	2620
C11	FR1	F1	9	47.35	-104	22.59	
C12	CMP3	L3	10	01.3341	-104	10.8646	2379
C12B	CMP3	L3	10	01.21	-104	10.60	
C13	CMP1	L1	10	01.51	-104	16.40	
C13B	CMP1	L1	10	01.6074	-104	16.2917	2684
C15	FR1	F1	9	47.8890	-104	20.0461	2743
C14	FR1	F1	10	01.3330	-104	19.7063	2552
C16	FR2	F2	10	05.4065	-104	20.3163	2544
C17	CMP1	L1	10	10.0524	-104	21.8984	2569
C17B	FR2	F2	10	09.9835	-104	21.8330	2566
C18	FR1	F1	9	56.0775	-104	18.3328	2557
C20	CMP3	L3	10	01.6871	-104	16.3886	2687
C21	CMP1	L1	10	02.3092	-104	13.7626	2566
C22	CMP3	L3	10	08.7814	-104	21.3491	2635
C23	FR2	F2	10	01.1960	-104	17.2940	2698
C24	CMP3	L3	10	11.5012	-104	21.8350	2672
C25	FR2	F2	10	00.8991	-104	17.7650	2547
C26	CMP1	L1	9	56.0587	-104	18.2841	2560
C27	CMP3	L3	9	19.4292	-104	02.3817	2988
C28	FR1	F1	9	18.6342	-104	13.7112	2581
C28B	FR1	F1	9	18.65	-104	13.27	2575
C29	FR2	F2	9	18.3991	-104	15.1786	2668
C30	CMP3	L3	9	18.6573	-104	13.3284	2564
C31	FR2	F2	9	18.80	-104	11.80	2620
C31B	FR2	F2	9	18.80	-104	11.80	
C32	CMP1	L1	9	18.2570	-104	16.4354	2811
C33	FR2	F2	9	19.00	-104	09.38	
C34	CMP1	L1	9	18.8837	-104	10.8259	2736
C33C	CMP1	L1	9	18.9737	-104	09.6507	2916
C34B	FR2	F1	9	18.92	-104	10.53	
C35	CMP3	L3	9	19.4853	-104	02.2706	3011
C36	CMP3	L3	9	19.39	-104	05.40	3040
C37	FR2	F1	9	18.30	-104	17.50	

ANCILLARY OPERATIONS:
CTD-ROSETTE TOW-YOS, DREDGES, AND MULTIBEAM SURVEYS

On several occasions, there was sufficient time available between deployments, testing, surveys, or recoveries of the compliance meters or bottom pressure recorders to carry out a dredge or CTD-rosette survey of the water column. The rationale for carrying out these ancillary operations was as follows:

1) Investigating for plausible temporal variations in patterns of hydrothermal plumes

The last systematic survey of hydrothermal plumes between the 9°03'N OSC and the Clipperton Transform Fault was carried out in 1991, 16 years earlier [*Baker et al.,* 1994]. The tow-yo tracks were designed to complement the short tow-yo carried out last year between 9°46'-52'N with the *R/V NEW HORIZON* [*Tolstoy et al*., 2006].

2) Exploring for recent eruptions outside of the "bull's eye" area (9°45'-52'N)

Tow-yos #2 and #3 detected a significant hydrothermal plume between 9°58'N and 10°02'N. The detailed morphology of the ridge axis between 10°0.5'-2.0'N also suggests the presence of a thick lava field that flowed westward, near where the ridge axis is left-stepping by about 700 m. Dredge #3 was sited in that area and returned lava samples that are extremely fresh looking. Samples consist of very glassy pieces of sheet flow and are visually undistinguishable from dredge #2 samples that were collected across the 2006 lava flow at 9°51'-52'N.

3) Testing for possible off-axis volcanism where geophysical data suggest the presence of crustal and subcrustal melt

Tow-yos # 5 and 7 were carried out 8 km and 39 km east of the ridge axis, respectively, in areas where seismic data suggest the presence of crustal and subcrustal melt anomalies [*Toomey et al., Nature, in press*], something that the compliance experiments during this expedition seem to confirm. If melt anomalies indeed were present, they might fuel hydrothermal plumes in the water column; they might also produce off-axis eruptions that could be detected with the acoustic backscatter component of the SeaBeam 2112 multibeam sonar of the *ATLANTIS*. Neither plumes nor acoustic backscatter anomalies were detected from towyo #5 and a short multibeam survey in an area centered at 9°31'N - 104°10'W.

4) Education.

The CTD tow-yos and dredges provided immediate data, hereby contributing to the appreciation of mid-ocean ridge processes for the three undergraduate students on board (Joshua Myers, John Krueger, and Wanda Vargas). In that respect, the locations of the first two dredges were selected to bring up basalts from sections of the ridge axis with contrasting morphologies and history. Dredge #1 sampled the axis of accretion north of the Clipperton transform fault where it is defined by a 300m-wide, 30m-high, 2820 m deep ridge. It returned fragment of pillow basalts that appeared dull and slightly altered. Dredge #2 was sited south of the Clipperton transform fault over the inflated, shallow "bull's eye" area, right where the new lava flow was mapped last year from ALVIN dives and TowCam surveys [*Adam Soule and Dan Fornari, in preparation*]. As expected, dredge #2 returned extremely fresh-looking, extremely glassy fragments of sheet flow. The participation of the three undergraduates in this expedition has been funded under a NSF REU supplement (=Research Experience for Undergraduate).

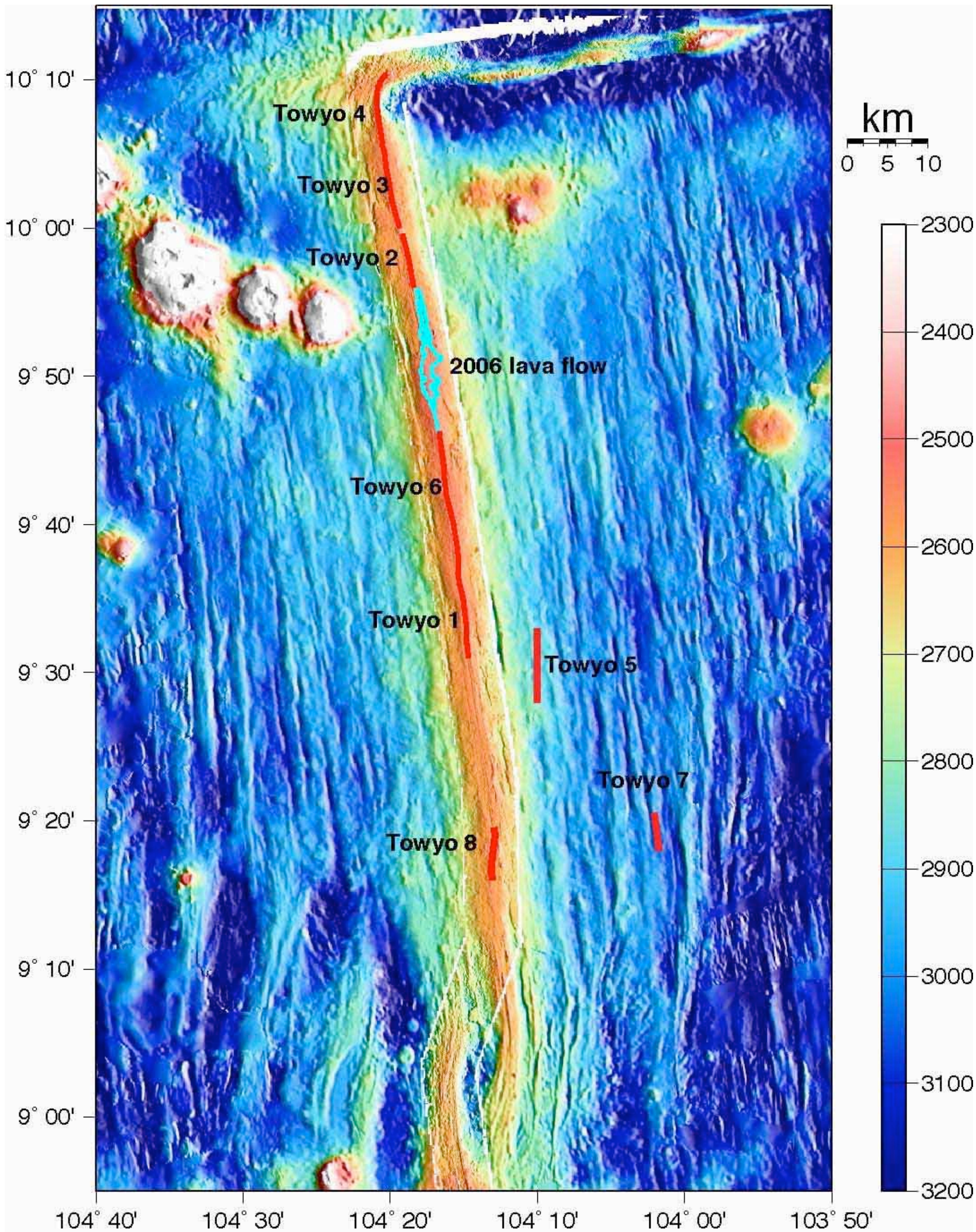
5) Applying emerging methodologies to measure properties of mid-ocean ridge basalt and water samples.

Collected samples will be distributed to any interested scientists. Ken Rubin (U. Hawaii) proposed to date the fresh-looking lavas using U-series techniques. Alan Wittington (U.

Missouri-Columbia) proposed to measure the viscosity of the lavas using glassy samples. Julie Carlut (Ecole Normale Supérieure, Paris) proposed to evaluate whether/how bacterial activity may alter the magnetization of fresh basalt. Mitch Schulte (U. Missouri-Columbia) proposed to analyze water samples for bacterial content.

CTD-Rosette tow-yos

Eight CT-rosette "tow-yos" were conducted during this leg, as summarized in the accompanying table and figures. The R/V ATLANTIS CTD-rosette package consists of a SBE 911plus/917plus CTD, a Chelsea/Seatech/WetLab CStar transmissometer, a SBE 43 oxygen sensor, a Wetlab ECO-AFL/FL fluorometer, and a rosette of 23 Niskin-style sampling bottles. The CTD-rosette package was towed at 0.5 to 0.7 knot while being alternately lowered and raised at 45 m/min between 2250m water depth and just 20 m off bottom, resulting in an along-track saw-toothed pattern (=tow-yo) with a spacing of 300-350 m. The backscatter sensor and beam transmissometer are the best tool for real-time detection of hydrothermal plumes, and Niskin bottles were fired when beam attenuation anomalies visualized on the monitor. The collected water samples were immediately refrigerated for later analysis. They will be left on the ship until its return to San Diego and then Fedex'ed in a cooler to University of Missouri-Columbia.
The along-axis tow-yos (1, 2, 3, 4, 6, and 8) were designed to complement the tow-yo carried out last year between 9°46'-52'N with the *R/V NEW HORIZON* [*Tolstoy et al.*, 2006]. Except for tow-yo #8 (9°16'-19.5'N), every on-axis tow-yos detected some form of hydrothermal plume. Overall, the plume distribution does not differ significantly from that mapped in 1991. However, tow-yos #2 and #3 detected a sizable hydrothermal plume between 9°58'N and 10°02'N; that information prompted the collection of dredge #3, which returned extremely fresh-looking fragments of sheet flow. Tow-yos # 5 and #7 were carried out along NS tracks 8 km and 39 km east of the ridge axis, respectively, in areas where seismic data suggest the presence of crustal and subcrustal melt anomalies [*Toomey et al., Nature, in press*]. Hydrothermal plumes were not detected with either tow-yo #5 (centered at 9°31'N - 104°10'W) or tow-yo #7 (centered at 9°21'N - 104°02'W). In fact, below 2600 m (the approximate depth of the ridge axis), the off-axis tow-yos displayed beam attenuation profiles that remain flat, and temperature profiles with the same monotonic increase reflecting the adiabatic gradient.


Towyo 4
Towyo 3
Towyo 2
2006 lava flow
Towyo 6
Towyo 1
Towyo 5
Towyo 7
Towyo 8
km
0 5 10
10° 10'
10° 00'
9° 50'
9° 40'
9° 30'
9° 20'
9° 10'
9° 00'
104° 40'
104° 30'
104° 20'
104° 10'
104° 00'
103° 50'
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200

TOW-YOs *(positions are ship's positions)*

Towyo #	Date	Start time GMT	Latitude N start	Longitude W start	End Time GMT	Latitude N end	Longitude W end
1	2/20/07	23:14	9°30.998'	104°14.667'	13:13 (Feb 21)	9°38.09'	104°15.457'
bottle 1	00:39 GMT, 9°31.026'N, 104°14.672'W, 2451 m						
bottle 2	03:42 GMT, 9°32.603'N, 104°14.809'W, 2391 m						
bottle 3	04:26 GMT, 9°33.128'N, 104°14.507'W, 2527 m						
2	2/26/07	16:10:00	9°55.99'	104°18.39'	22:25	9°59.545'	104°19.163'
bottle 1	18:01 GMT, 9°56.368'N, 104°18.473'W, 2482 m						
bottle 2	18:13 GMT, 9°56.462'N, 104°18.493'W, 2446 m						
bottle 3	20:34 GMT, 9°58.096'N, 104°18.817'W, 2451 m						
bottle 4	21:20 GMT, 9°58.691'N, 104°18.936'W, 2439 m						
bottle 5	21:35 GMT, 9°58.891'N, 104°18.978'W, 2421 m						
3	2/27/07	5:56	9°59.998'	104°19.19'	14:30	10°4.396'	104°20.306'
bottle 10	07:11 GMT, 10°0.020'N, 104°19.210'W, 2449 m						
bottle 11	07:42 GMT, 10°0.346'N, 104°19.210'W, 2486 m						
bottle 12	12:24 GMT, 10°3.492'N, 104°20.177'W, 2450 m						
4	3/5/07	6:17	10°04.29'	104°20.30'	~16:30	10°10.404'	104°20.321'
bottle 1	07:41 GMT, 10°4.488'N, 104°20.324'W, 2555 m						
bottle 2	10:17 GMT, 10°6.396'N, 104°20.609'W, 2476 m						
5 off-axis	3/5/07	23:21	9°27.995'	104°10.001'	~07:57 (March 6)	9°32.999'	104°9.998'
6	3/6/07	~09:30	9°38.207'	104°15.453'	~22:10	9°46.057'	104°16.679'
bottle 1	11:09 GMT, 9°38.680'N, 104°15.505'W, 2421 m						
bottle 2	12:27 GMT, 9°39.684'N, 104°15.649'W, 2497 m						
7 off-axis	3/15/07	6:38	9°18.000'	104°01.748'	~13:00	9°20.863'	104°2.050'
8	3/16/07	5:14	9°16.000'	104°13.050'	~13:00	9°19.54'	104°12.98'

Dredges

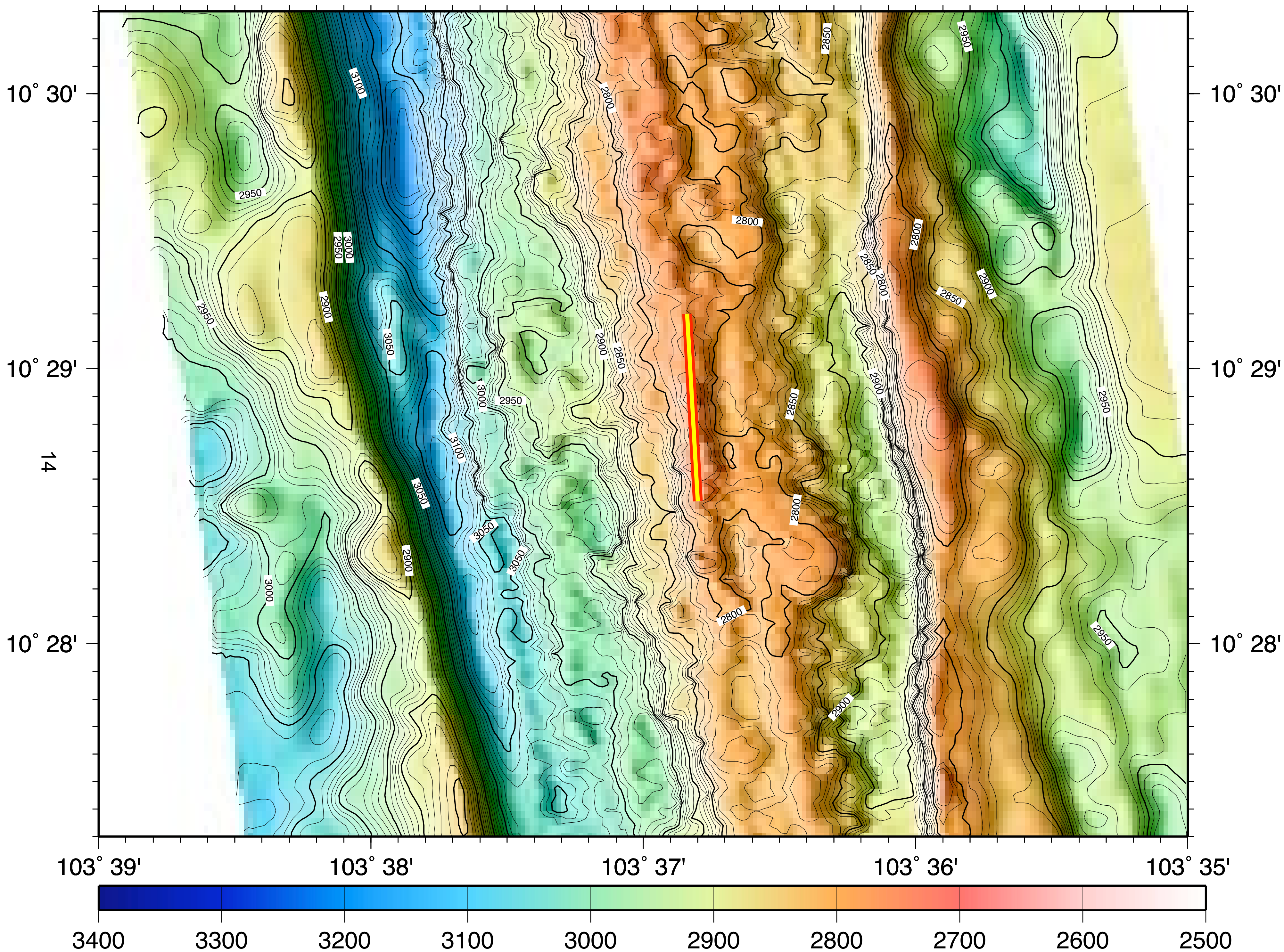
For dredging operations, the pinger was clamped on the traction cable 150 m above the dredge, the ship moved at about 1 knot, and the pinger altitude was maintained in the vicinity of 25 m. However, it was noted during the first two dredges that no significant tension spike (bites) where obtained in that configuration; instead, the bites occurred while a larger pinger separation developed while hauling in the wire at the end of the dredge tracks. A larger pinger separation (~50 m) was thus maintained during dredge #3, and large bites occurred more frequently. All three dredges returned large volume of basalt fragments. The content of each dredge was visually very uniform. Dredge #1 returned pillow fragments that were noticeably altered, and the other tow dredges very fresh-looking, very glassy pieces of sheet flows and lobate flows. The specifics of the three dredges (locations and dates) are listed in the accompanying table, dredge tracks are plotted in the accompanying maps, and samples are shown in the accompanying photos. Smaller samples were taken to the University of Missouri-Columbia, and larger samples are shipped to Lamont with the equipment container.

SeaBeam 2100 multibeam bathymetric surveys

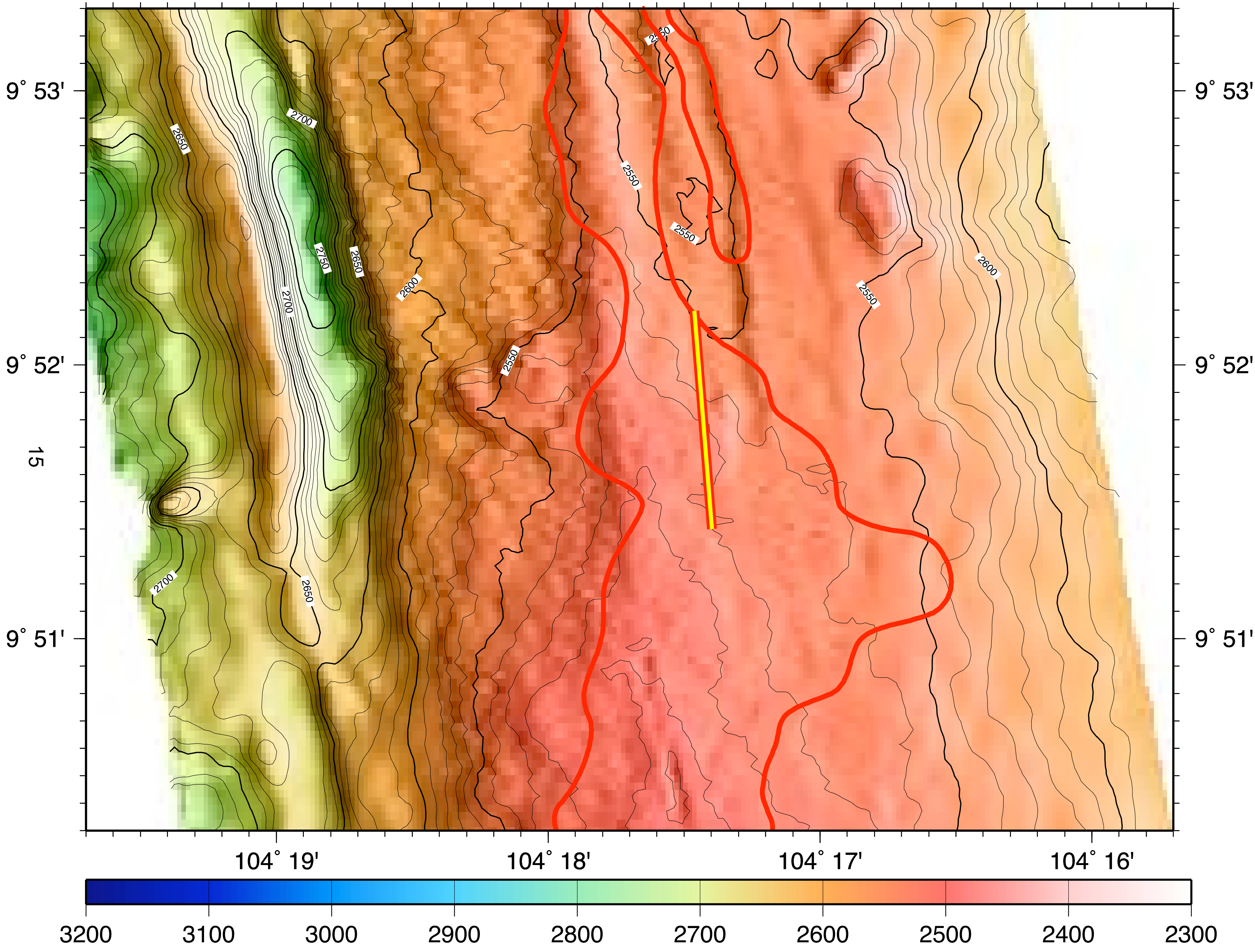
The study area is already well mapped from a variety of 12kHz multibeam bathymetric surveys. On February 16, a nighttime survey centered around 9°45'N, 104°14'W was conducted with the *ATLANTIS'* SeaBeam 2112, to test if off-axis bathymetry could be improved with a grid of overlapping swaths. Four 20km-long tracks spaced 2km apart were acquired, providing up to 4 time overlap. The resulting map did not show appreciable improvements compared to prior 12 kHz data.

On March 5, a short NS multibeam track was acquired off-axis at 104°10'W, from 9°33'N to 9°27'N, along the same track as tow-yo #5. Melt may be pooling at subcrustal level in that area [*Toomey et al., in press*], and the goal was to check whether acoustic backscatter data (acquired concurrently with multibeam data) showed any evidence for anomalously young lava flows. No such evidence was detected from the acoustic backscatter data.

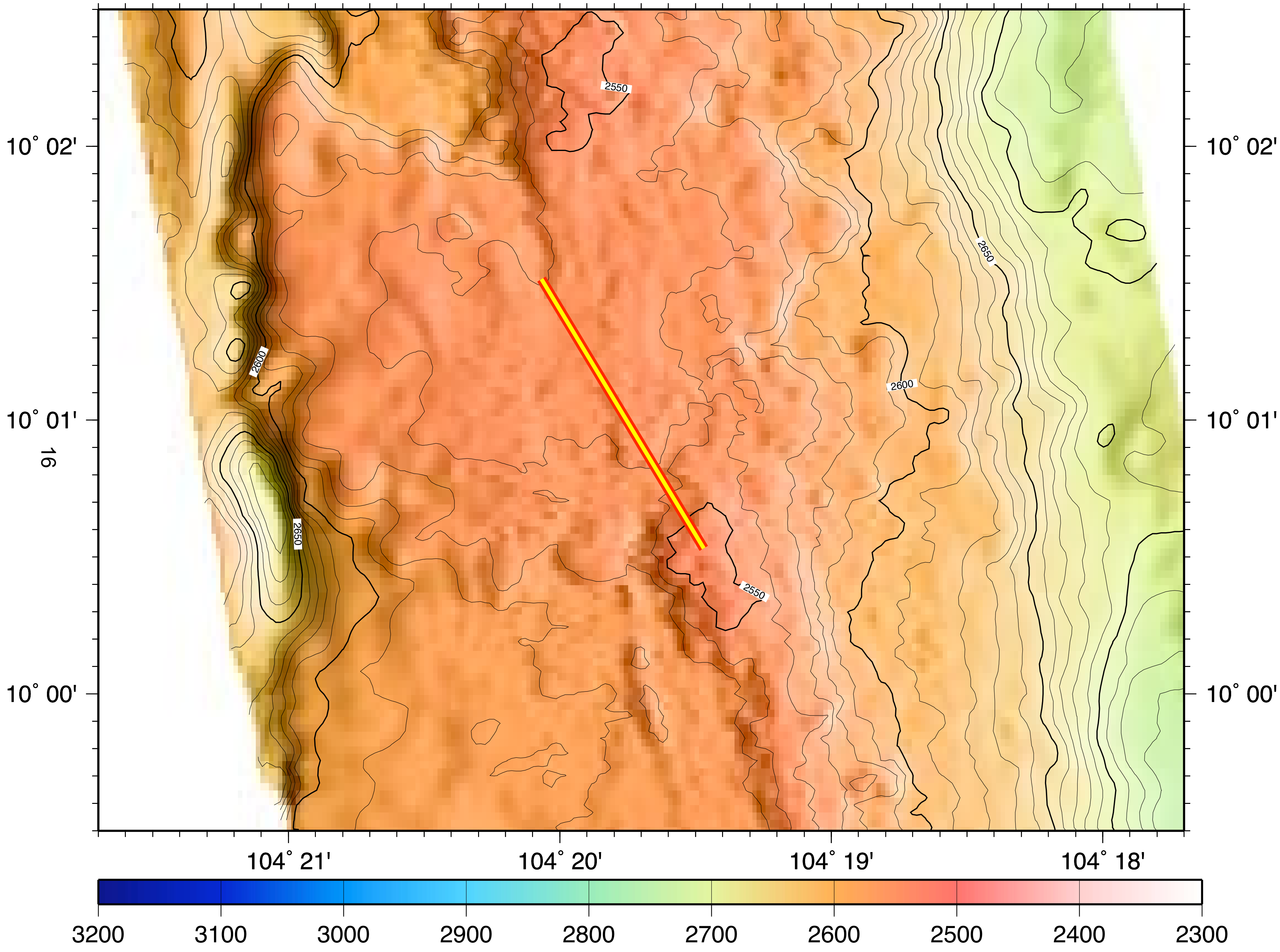
Dredge 1 - Feb. 17



Dredge 2 - February 27



Dredge 3 - March 12



AT15-16, DREDGES

Dredge #	Date	Time GMT on-bottom	Latitude N on bottom	Longitude W on bottom	Time GMT off bottom	Latitude N off bottom	Longitude W off bottom
1	2/17/07	17:54	10°28.519'	103°36.799'	19:05	10°29.201'	103°36.840'
2	2/27/07	22:44:45	9°51.400'	104°17.398'	00:07 (Feb 28)	9°52.196'	104°17.462'
3	3/12/07	3:40	10°00.531'	104°19.469'	5:38	10°01.515'	104°20.068'

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