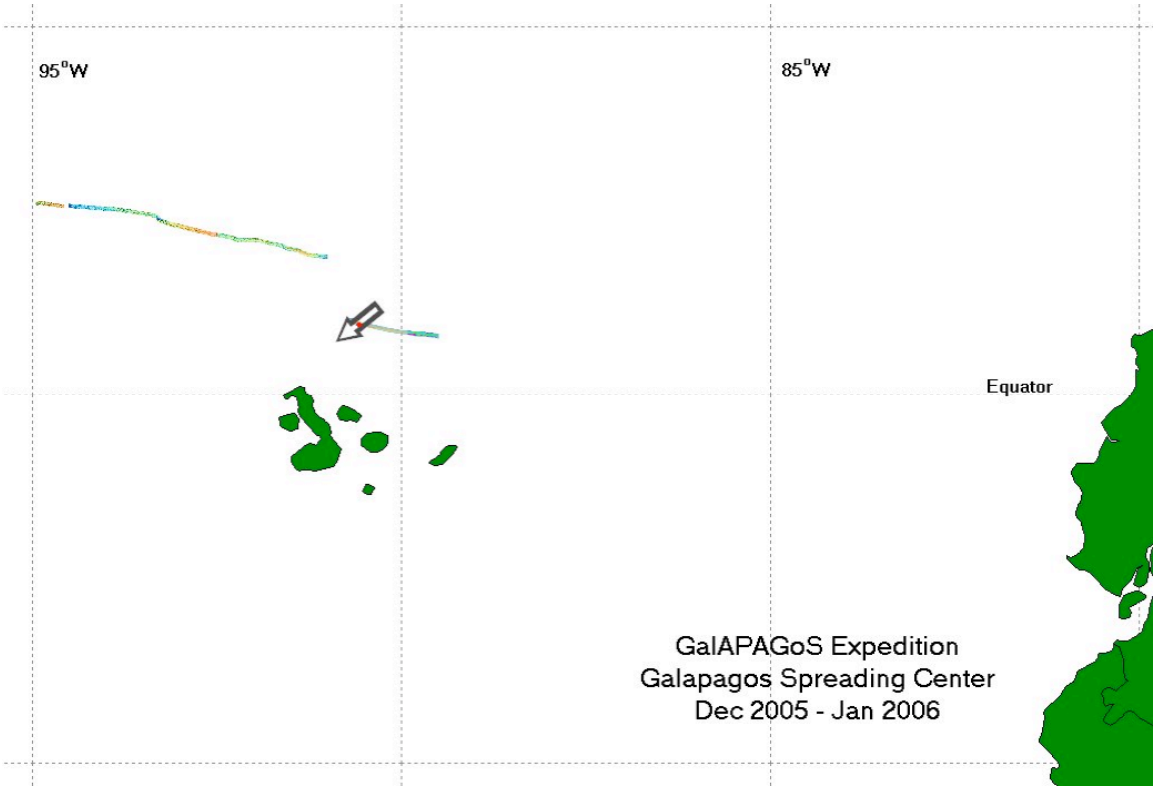
FINAL CRUISE REPORT
GalAPAGoS EXPEDITION (TN188, on *R/V Thomas G. Thompson*)



<u>TN188-Transit</u>: 11/23/05-12/3/05, San Diego-Puerto Ayora

<u>TN188-1</u>: 12/3/05-12/15/05. Puerto Ayora-Puerto Ayora

<u>TN188-2</u>: 12/15/05-1/10/06. Puerto Ayora-Puerto Ayora

Chief Scientist and lead PI, Prof. Rachel M. Haymon, UCSB
Co-PI's at sea:
Prof. Ken C, Macdonald, UCSB
Prof. Scott M. White, Univ. S. Carolina
Dr. Joeseph Resing, U. Washington and NOAA/PMEL
Dr. Edward T. Baker, NOAA/PMEL

Funding Agencies: National Science Foundation-Marine Geology and Geophysics Program and NOAA-Ocean Exploration Program

I. Purpose of the Expedition

Our mission during the GalAPAGoS Expedition (***Gal***apagos ***A***coustical, ***P***lumes, and ***Geo***biological ***S***urveys) was to explore a 400 nautical mile-long section of the intermediate-rate Galapagos Spreading Center (GSC: 94.5º-89.5ºW) where the spreading center is located above the mantle plume that has created the Galapagos Islands. Our goal was to discover hydrothermal-geological-biological responses to increasing magma supply and crustal thickness along the ridge crest, from the periphery to the center of mantle plume influence. During the expedition, we investigated the abundance and nature of hydrothermal venting, hydrothermal vent biota, and geologic behavior of the ridge crest from 94.5º-89.5ºW. Our field experiment was an interdisciplinary program of nested acoustic (EM-300 multibeam, DSL-120a and SM-2000 near-bottom sonar), and visual surveys (Medea camera system), coupled with hydrothermal plume detection and sampling (CTD/Niskin rosette casts and tows, and sensor deployment on the DSL-120a and Medea systems).

Our results have revealed how heat is being dissipated by hydrothermal activity along a hotspot-influenced portion of the mid-ocean ridge, and show the nature and timing of GSC volcanic activity. Our findings have implications for migration of hydrothermal vent biota along hotspot-influenced ridges, and also for crustal accretion along the GSC.

In addition to the research conducted, the expedition included an educational component. Twelve students (6 undergraduate and 6 graduate students) were aboard as part of seagoing courses (GS 182/282/281) at UCSB taught by Profs. Haymon and Macdonald. Three of the UCSB graduate students and one graduate student from Univ. S. Carolina also were working on cruise data as part of their dissertation research.

II. Cruise Logistics and Personnel

The GalAPAGoS Expedition took place on *R/V Thomas G. Thompson* from November 23, 2005 to January 10, 2006. The expedition included three legs.

During a transit (TN188-Transit) from San Diego to Puerto Ayora, from 11/23/05 to 12/3/05, the EM-300 multibeam system was used to map the East Pacific Rise crest from 11º-9ºN. The data were sent via HiSeasNet transmission during TN188-Transit to Drs. Suzanne Carbotte (LDEO) and Dan Fornari (WHOI) for presentation to the Ridge 2000 community at the Fall 2005 AGU meeting. The only science personnel aboard for TN188-Transit were the marine technicians for the ship (Mike Realander and Rob Hagg, from UW) and Will Handley from the Woods Hole Deep Submergence Lab (WHOI-DSL).

Leg 1 of the GalAPAGoS expedition took place from 12/3/05-12/15/05. During Leg 1, EM-300 data were collected while transiting from Puerto Ayora to the east end of the survey area on the GSC at 89.5ºW. After completing two weeks of survey work along the GSC in the study area, on December 14 the ship steamed back toward Puerto Ayora, collecting EM-300 multibeam data in transit, and arrived in Puerto Ayora on the morning of December 15. At that time, additional members of the science party came aboard, and one member of the *R/V Thompson* crew departed.

Leg 2 took place from 12/15/05-1/10/06. On 12/15/05, the ship steamed from Puerto Ayora to station, collecting EM-300 data east of Isabella Island in transit, and re-commenced operations along the GSC until January 8, 2006. On January 8 at ~1540 GMT, *R/V Thompson* departed the study area and headed back to Puerto Ayora. Additional EM-300 multibeam data was collected during the transit, which passed west of Fernandina and Isabella Islands. The ship arrived Puerto Ayora by 0700 local time on January 10, bringing an end to the expedition. Some science personnel were allowed to remain aboard until the morning of January 11.

Appendix 1 lists the crew and the science personnel who were aboard the ship during the TN188-Transit, TN188-1, and TN188-2.

III. Science Operations on Legs 1 and 2

EM-300 Multibeam Surveys:

We began our science operations on the GSC with an EM-300 multibeam line along the ridge crest that included the transform at 91ºW. The survey began 12/4/05 14:25 GMT, at lat. 0º 48.45'N, lon. 89º 30'W, and continued westward, with a northern jog along the 91ºW transform, until 12/5/05 15:49 GMT, at lat 2º 33.84'N, lon. 94º 34.22'W.

Throughout the cruise and on transits, the EM-300 system continued to be used to fill in more area of coverage along our initial line, and to fill in blank places in the high-resolution sonar maps that exist around the Galapagos Islands.

All of the data were processed at sea, and the resulting EM-300 bathymetry maps were used as basemaps for choosing DSL-120a tracklines. At the time of writing this report, the final compilation of all the EM-300 tracklines within the study area and along the transits had not yet been completed.

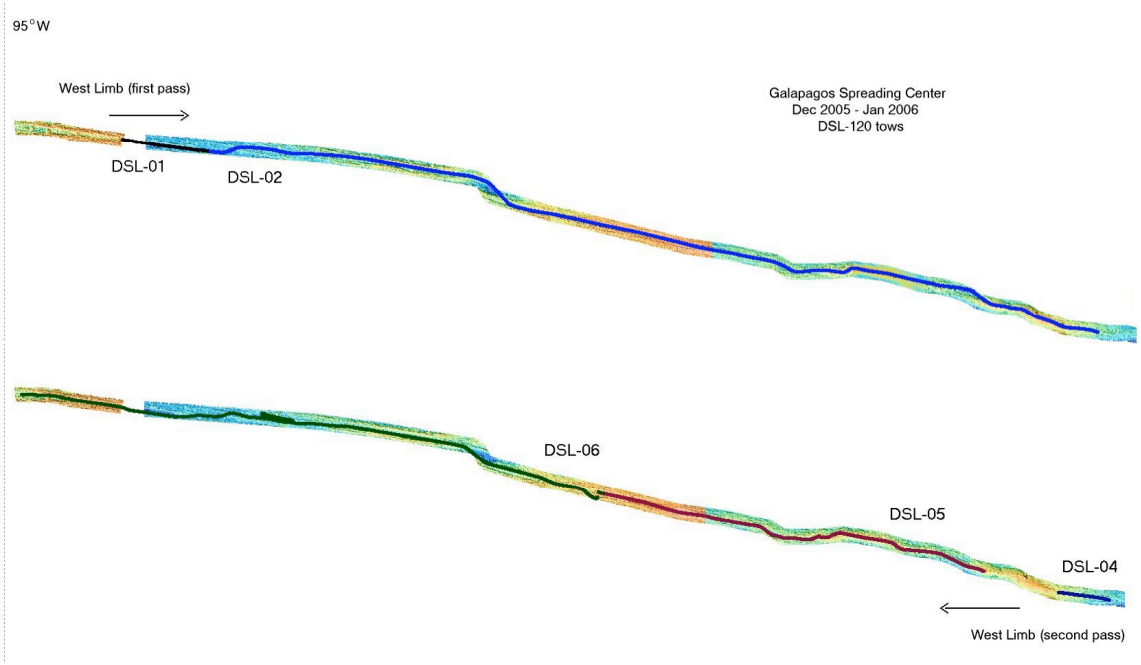
DSL-120a + SM-2000 + Plume Sensor Surveys:

For this expedition, the DSL-120a system collected three kinds of sonar data and was used as a platform for deployment of sensors for plume detection. The sonar datasets included DSL-120a sidescan sonar backscatter data, sidescan phase bathymetry, and SM-2000 downlooking swath bathymetry data. All of these datasets were processed at sea, and the resulting maps and sidescan backscatter images were used for selecting Medea tracklines. Most of the lines were flown at ~110 m altitude, and speeds of 1.0-1.7 kts. Because of calm seas and the towing dynamics of the sled, the best quality data was collected at speeds of 1.5-1.7 kts.

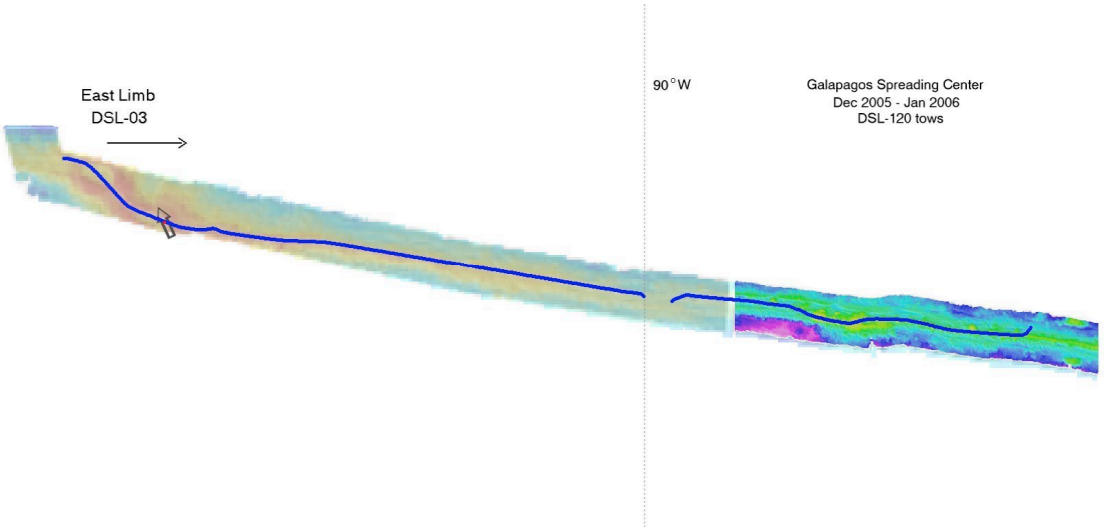
The chemical sensors deployed on the DSL-120a sled and clump weight included Eh, methane, optical scattering, Fe, Mn, and pH sensors. Data from all of these sensors was transmitted to the ship in real-time during surveys so that the locations of plumes could be noted during watches. Additionally, five MAPR's (Miniature Autonomous Plume Recorders that measure temperature and light scattering) were deployed at intervals of 20-60m on the cable above the DSL-120a clump weight. Three more MAPR's, an Eh sensor, and a Seacat CTD were deployed on a line hanging beneath the clump weight. The Seacat CTD at the bottom of the instrument array was towed at an altitude of ~50-60 m above the seafloor.

TheDSL-120a surveys commenced on 12/5/05 19:04 GMT at the western termination of the EM-300 line, at lat. 2º 33.36'N, lon. 94º 34.85'W. The survey of the western limb of the GSC (Line 1, including lowerings 1 and 2) continued to near the intersection of the ridge crest with the 91ºW Transform (see Appendix 2 and Figures below). The survey of the eastern limb of the GSC (Line 2, lowering 3) began on 12/15/05 near the southern intersection of the ridge crest with the 91ºW Transform, and continued east to 89º 34.58'W (Appendix 2 and Figures below). There is one small gap along-axis in this line near 90ºW, where the ship was briefly on a southerly heading. A third line (Line 3, lowerings 3, 5, 6) was run from east to west along the west limb of the GSC (Appendix 2, Figures below) to 94º 54.47'W. This line is not continuous in its data collection, due to problems with the SM-2000 that caused two recoveries of the vehicle before the SM-2000 could be fixed. There is a consequent gap in the third DSL-120a line from 91º 14.18'-30.18'W. The gap in the SM-2000 data for this line is 91º 14.18'-92º 52.91'W. The hydrothermal plume data gap in Line 3 was filled by data from CTD tows (see next section below).

LOCATIONS OF DSL-120A LOWERINGS ON WESTERN GSC: LINE 1 (ABOVE) AND LINE 3 (BELOW)



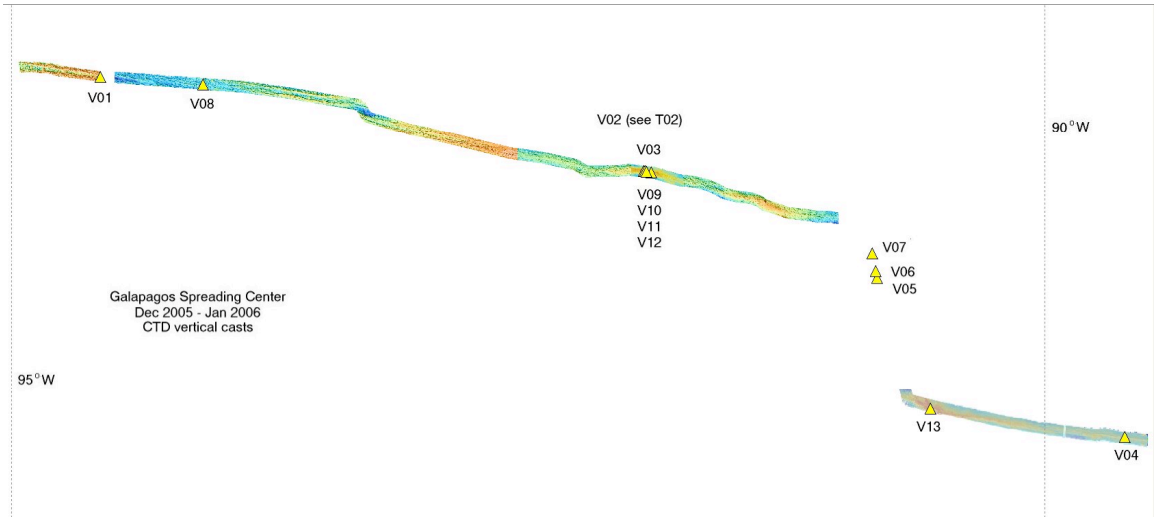
LOCATION OF DSL-120A LOWERING ON EASTERN GSC: LINE 2



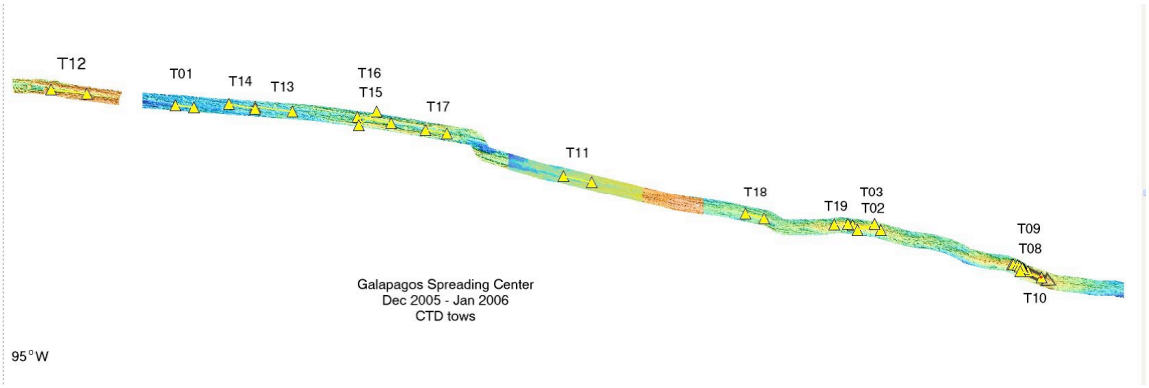
CTD/Niskin Rosette Vertical Casts and Tow-Yos

The CTD/Niskin Rosette was used throughout the expedition to conduct vertical casts (labeled V05C-#) and tow-yo transects (labeled T05C-#) with CTD, Eh, and light scattering sensors, and to collect samples of hydrothermal plumes and background waters. The locations of these casts and plumes are summarized in Appendix 3 and the Figures shown below.

LOCATIONS OF GSC VERTICAL CTD/NISKIN CASTS



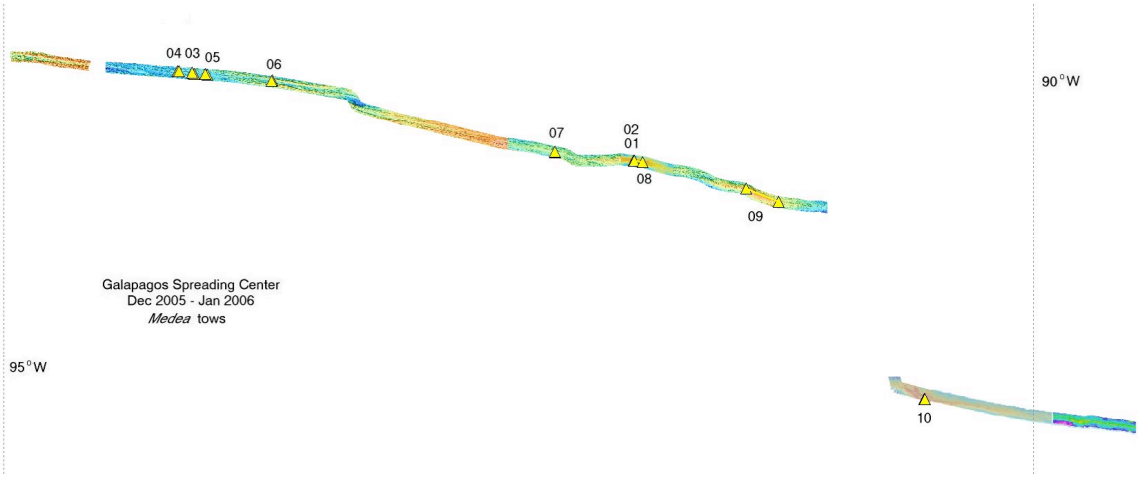
LOCATIONS OF WESTERN GSC TOW-YOS



Medea Camera Surveys

The Medea camera sled was used to locate and visually image seafloor features. For the GalAPAGoS Expedition, the Medea was equipped with HMI lights, a 3-chip digital color downlooking video camera, a downlooking color digital still camera and strobe light, a forward looking black and white video camera, a forward-looking Imagenex scanning sonar, a CTD, and two plume sensors (Eh and light scattering). All of these instruments transmitted data to the shipboard control van in real time. These data streams were continuously displayed on monitors in the van. Observations were logged in real time using the Jason Virtual Van event logger, and these logs were edited at sea following each lowering. The locations of the Medea lowerings are shown in Appendix 4 and in the Figure below.

LOCATIONS OF MEDEA LOWERINGS ON THE GSC



The final Medea lowering (Medea 10) was conducted in the eastern caldera of the Los Huellos double calderas on the western end of the Eastern GSC, near the southern intersection of the ridge crest with the 91ºW Transform.

IV. Summary of Scientific Results

1) Active and inactive high temperature (black smoker) vents occur on the GSC, throughout the western limb, thus high temperature flow at the seafloor is possible despite the thickening of the crust produced by the interaction with the hotspot. Active smokers and inactive chimneys were located along fissures in axial volcanic ridges at ~94º 4'W (Navidad Vents) and at ~94º 56-52'W (Iguanas and Penguinas Vents). Inactive spires were observed at three other locations: two fissured axial volcanic ridges, located east and west of the "Eye of Mordor" axial seamount near 91º 23'W, and also on top of the inner caldera wall on the west side of the Eastern Los Huellos caldera.

2) Most of the lavas observed were not very recently erupted, and most of the vents were mature or extinct. This indicates that the ridge is in a quiescent phase of volcanic and hydrothermal activity, and that one effect of the hotspot is to cause the ridge to be episodic in its behavior, in response to magmatic pulsing of the hotspot, rather than steady-state. Low-effusion rate eruptions, forming pillowed axial volcanic ridges and small seamounts, are the most common expression of the ridge volcanic system.

3) The total amount of hydrothermal venting along the GSC currently is only about one third of the level of venting observed on other intermediate-rate spreading centers. This may be due either to the thickening of the crust along the ridge by enhanced hotspot-related volcanism, or to the time-variant behavior of the volcanic-hydrothermal system, or possibly both.

4) Vent fauna along the GSC in our survey area are sparse. We found a community including tubeworms at the Navidad Vents near 94º 4'W, and a community of clams and mussels near 91º 54'W. We attribute this scarcity of vent animals mostly to the far distances between active vent sites, and also to the decline of diffuse flow and hydrogen sulfide in waning hydrothermal systems. This means that the vent communities on the Galapagos Spreading Center (like the animals on the Galapagos Islands!) are rather isolated from one another and from the global mid-ocean ridge.

We thank the captain and members of the *R/V Thompson* crew for their superior support of our efforts. We also thank the members of the WHOI Deep Submergence Lab for their excellent work that was so necessary to our success.

Further information about this cruise can be found at our website (made possible by NOAA-OE and web-coordinator Kelley Elliott):

http://oceanexplorer.noaa.gov/explorations/05galapagos/welcome.html

UNIVERSITY OF WASHINGTON SCHOOL OF OCEANOGRAPHY	Ship: R/V THOMPSON Port: Pto. Ayora, Galapagos	Cruise: Ø5L/TN-188 Dates: 11/23/05-1/10/06

VESSEL CREW LIST

Name	Position/ Duties	Nationality	MMD Number	D O B	Where Emb/Debarked
Smith, Philip A	Master	US	531442287	7/9/47	SanDiego/Papeete
Cox, Gene A	Ch Mate	US	549543559	6/7/40	SanDiego/Papeete
Drake, Thomas G	2 Mate	US	409863362	2/19/51	SanDiego/Papeete
Haroldson, Eric T	3 Mate	US	538904708	10/4/66	Seattle/Papeete
Clampitt, Brian W	AB	US	537644716	6/16/61	SanDiego
Branovitch, Larry L	AB	US	293468415	12/8/47	SanDiego/Papeete
Monocandilos, Anthony N	AB	US	272524345	2/11/52	SanDiego/Papeete
Spetla, Frank L Jr	AB	US	081528698	9/13/56	SanDiego/Papeete
Hansen, Michael A	AB	US	539743914	2/20/62	SanDiego/Papeete
Younker, Timothy R	AB	US	534585462	12/28/53	SanDiego/Papeete
Schroeder, Paul J	Ch Engr	US	066829	7/24/61	SanDiego/Papeete
Johnson, Robert	1 Asst Engr	US	081113	6/22/53	SanDiego/Papeete
Leonard, Richard D	2 Asst Engr	US	109429546	9/9/49	SanDiego
Gawel, Jan	3 Asst Engr	US	574948615	3/7/54	SanDiego
Henderson, Michael P	Oiler	US	036819	11/8/54	SanDiego/Papeete
Rowley, Russell R	Oiler	US	518669918-D1	8/30/50	SanDiego
Bartell, D Andrew	Oiler	US	539600725	12/6/55	SanDiego/Papeete
Smith, Javier	Wiper	US	532020436	8/9/83	Seattle/Papeete
McBriar, Frank D	Ch Stwd	US	539663522	6/1/56	Seattle/Papeete
Gideons, Raymond E	2 Cook	US	422065470	3/6/64	SanDiego
Singerline, Terence	AB	US	141725707	5/16/65	SanDiego/Papeete

UNIV OF WASHINGTON SCH OF OCEANOGRAPHY	**Ship:** R/V THOMPSON **Cr #:** TN-188 **Leg:** 1	Rachel Haymon (transit) **Dates:** 11/23-12/1/05

SCIENTIFIC PARTY LIST (NON-CREW/PASSENGER)

Name	Title	Institutional Affiliation	Nationality	Passport Number	D O B	Where Emb/Debark
Hagg, Robert K	T	U.Washington MarTech	US	157387521	7/26/62	San Diego/Papeete
Handley, William H	T	WHOI/DSL	US	710975167	10/1/62	San Diego/Galapagos
Realander, Michael J (lead)	T	U.Washington MarTech	US	214983349	2/4/49	San Diego/Papeete

Remarks:

Date: 10/21/05

Scientists	
Graduate Students	
Students	
Technicians	3
Observers	
Total Participants	3

UNIV OF WASHINGTON SCH OF OCEANOGRAPHY	Ship: R/V THOMPSON Cr #: TN-189 Leg: 2	Rachel Haymon Dates: 12/3-12/15/05

SCIENTIFIC PARTY LIST (NON-CREW/PASSENGER)

Name	Title	Institutional Affiliation	Nationality	Passport Number	D O B	Where Emb/Debark
Agee, Casey L	T	WHOI (contractor)	US	211961382	11/20/59	San Diego/Galapagos
Anderson, Peter G	GS	UC Santa Barbara	US	076423769	9/24/81	San Diego/Galapagos
Baker, Edward T	S	NOAA	US	801519477	5/21/45	San Diego/Galapagos
Buck, Nathaniel J	T	U.Washington	US	102809309	6/26/75	
Elliott, Kelley	T	UC Santa Barbara	US	017258095	8/20/83	San Diego/Galapagos
Hagg, Robert K	T	U.Washington MarTech	US	157387521	7/26/62	San Diego/Papeete
Handley, William H	T	WHOI/DSL	US	710975167	10/1/62	San Diego/Galapagos
Hansen, Scott A	T	WHOI/DSL	US	213176111	2/14/72	San Diego/Galapagos
Haymon, Rachel M	S	UC Santa Barbara	US	209433445	5/5/53	San Diego/Galapagos
Heintz, Monica B	GS	UC Santa Barbara	US	077601816	9/2/82	San Diego/Galapagos
Heyl, Taylor P	T	WHOI	US	045394835	12/14/79	San Diego/Galapagos
Lebon, Geoffrey T	T	U.Washington	US	209898156	3/21/58	San Diego/Galapagos
Meyer, Jason D	GS	U.SoCarolina	US	305990668	12/4/77	San Diego/Galapagos
Morgan, Jennifer P	T	U.Hawaii/HMRG	UK	304633609	11/7/76	San Diego/Galapagos
Pazmiño Manrique, Nelson A	S	INOCAR	Ecuador	OS 06.041	11/10/70	Galapagos
Petitt, Kayla P	St	UC Santa Barbara	US	075710813	4/3/84	San Diego/Galapagos
Pinner, John W IV	T	NOAA	US	401889511	12/14/77	
Realander, Michael J (lead)	T	U.Washington MarTech	US	214983349	2/4/49	San Diego/Papeete
Resing, Joseph A	S	U.Washington	US	157436937	9/17/64	San Diego/Galapagos
Sellers, Cynthia J	T	WHOI/DSL	US	208306471	8/3/57	San Diego/Galapagos
Sellers, William J	T	WHOI/DSL	US	155350601	10/4/56	San Diego/Galapagos
Smith, Jamie A	T	U.Hawaii/HMRG	US	027063961	12/6/80	San Diego/Galapagos
Sterling, Nile AK	T	WHOI/DSL	US	120712044	5/28/74	San Diego/Galapagos
Supak, Stacy	GS	UC Santa Barbara	US	112503130	7/23/80	San Diego/Galapagos
Walker, Sharon L	T	NOAA/PMEL	US	801751933	5/7/58	San Diego/Galapagos
Waters, Robert A	T	WHOI/DSL	US	201215616	2/5/61	San Diego/Galapagos
White, Scott M	S	U.SoCarolina	US	035831998	7/31/72	San Diego/Galapagos
Zambrano Zavala, Leila E	T	INOCAR	Ecuador	84350	10/24/67	San Diego/Galapagos

Remarks:

Date: 11/15/05

Scientists	5
Graduate Students	4
Students	1
Technicians	18
Observers	
Total Participants	**28**

UNIV OF WASHINGTON SCH OF OCEANOGRAPHY	**Ship:** R/V THOMPSON **Cr #:** TN-189 **Leg:** 3	Rachel Haymon **Dates:** 12/15/05-1/10/06

SCIENTIFIC PARTY LIST (NON-CREW/PASSENGER)

Name	Title	Institutional Affiliation	Nationality	Passport Number	D O B	Where Emb/Debark
Agee, Casey L	T	WHOI (contractor)	US	211961382	11/20/59	San Diego/Galapagos
Anderson, Peter G	GS	UC Santa Barbara	US	076423769	9/24/81	San Diego/Galapagos
Baker, Edward T	S	NOAA	US	801519477	5/21/45	San Diego/Galapagos
Buck, Nathaniel J	T	U.Washington	US	102809309	6/26/75	San Diego/Galapagos
Cháux Campo, Héctor Y	S	INOCAR	Ecuador	SJ 61.773	9/26/71	Galapagos
DelSontro, Tonya S	GS	UC Santa Barbara	US	303473402	7/23/80	San Diego/Galapagos
Desautels, Christine N	St	UC Santa Barbara	US	039121600	8/5/84	Galapagos
Eitzel, Melissa V	GS	UC Santa Barbara	US	056972787	4/2/80	Galapagos
Elliott, Kelley	T	UC Santa Barbara	US	017258095	8/20/83	San Diego/Galapagos
Fung, Cadi Y G	St	UC Santa Barbara	US	305636138	8/28/84	Galapagos
Giles, Grace F	GS	UC Santa Barbara	US	038210822	2/16/83	Galapagos
Hagg, Robert K	T	U.Washington MarTech	US	157387521	7/26/62	San Diego/Papeete
Handley, William H	T	WHOI/DSL	US	710975167	10/1/62	San Diego/Galapagos
Hansen, Scott A	T	WHOI/DSL	US	213176111	2/14/72	San Diego/Galapagos
Haymon, Rachel M	S	UC Santa Barbara	US	209433445	5/5/53	San Diego/Galapagos
Heintz, Monica B	GS	UC Santa Barbara	US	077601816	9/2/82	San Diego/Galapagos
Hernandez Vaca, Freddy E	S	INOCAR	Ecuador	0914131495	7/16/73	Galapagos
Heyl, Taylor P	T	WHOI	US	045394835	12/14/79	Galapagos
Kimball, Justine B	St	UC Santa Barbara	US	056062105	10/23/83	Galapagos
Lebon, Geoffrey T	T	U.Washington	US	209898156	3/21/58	San Diego/Galapagos
Macdonald, Kenneth C	S	UC Santa Barbara	US	154465420	10/14/47	Galapagos
Meyer, Jason D	GS	U.SoCarolina	US	305990668	12/4/77	San Diego/Galapagos
Morgan, Jennifer P	T	U.Hawaii/HMRG	UK	304633609	11/7/76	San Diego/Galapagos
Petitt, Kayla P	St	UC Santa Barbara	US	075710813	4/3/84	San Diego/Galapagos
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Supak, Stacy	GS	UC Santa Barbara	US	112503130	7/23/80	San Diego/Galapagos
Tsudama, Keith	St	UC Santa Barbara	US	402793416	4/26/84	Galapagos
Walker, Sharon L	T	NOAA/PMEL	US	801751933	5/7/58	San Diego/Galapagos
Waters, Robert A	T	WHOI/DSL	US	201215616	2/5/61	San Diego/Galapagos
White, Sarah M	St	UC Santa Barbara	US	039212040	7/27/84	Galapagos
White, Scott M	S	U.SoCarolina	US	035831998	7/31/72	San Diego/Galapagos

Remarks:

Date: 11/15/05

Scientists	7
Graduate Students	7
Students	6
Technicians	17
Observers	
Total Participants	**37**

APPENDIX 2
GalAPAGoS Expedition
Dec 2005 - Jan 2006

Segment	DSL lowering	Lat(deg)	Lat(min)	Long(deg)	Long(min)	date/time	Lat(decDeg)	Long(decDeg)
West Limb (first pass)	**DSL-01(start)**	2	34.1264	-94	35.0261	06/12/2005 00:58:00	2.568773	-94.583768
(west to east)	**DSL-01 (end)**	2	31.7469	-94	17.9459	06/12/2005 16:30:00	2.529115	-94.299098
Line 1								
	DSL-02(start)	2	32.0545	-94	21.0318	07/12/2005 04:01:00	2.534241	-94.350530
	DSL-02 (end)	1	53.2141	-91	8.0924	13/12/2005 07:00:00	1.886902	-91.134874
East Limb	**DSL-03(start)**	1	0.7879	-90	38.1625	16/12/2005 20:46:00	1.013132	-90.636041
(west to east)	**DSL-03 (end)**	0	49.7517	-89	34.5804	18/12/2005 14:30:00	0.829195	-89.576340
Line 2								
West Limb (second pass)	**DSL-04(start)**	1	52.6716	-91	3.2335	20/12/2005 11:31:00	1.877860	-91.053892
(east to west)	**DSL-04 (end)**	1	54.3006	-91	14.1848	20/12/2005 18:50:00	1.905010	-91.236414
Line 3								
	DSL-05(start)	1	58.7993	-91	30.1851	21/12/2005 16:01:00	1.979989	-91.503085
	DSL-05 (end)	2	15.7880	-92	52.8481	23/12/2005 19:35:00	2.263134	-92.880801
	DSL-06(start)	2	14.5942	-92	52.9093	24/12/2005 04:01:00	2.243236	-92.881821
	DSL-06 (end)	2	36.6930	-94	56.4718	27/12/2005 19:19:00	2.611550	-94.941197

APPENDIX 3
Vents 2004 - NZAPLUME III
R/V Tangaroa (Sept 2004)

Cast	StaName	Lat(deg)-N	Lat(min)-N	Long(deg)-W	Long(min)-W
1	V05C-01	2	33.800	-94	34.260
2	T05C-01 (start)	2	32.520	-94	23.070
	T05C-01 (end)	2	31.857	-94	18.858
(3)	V05C-02	(renamed to T05C0-2)			
3	T05C-02(start)	2	6.320	-91	56.250
	T05C-02(end)	2	5.850	-91	53.297
4	T05C-03(start)	2	5.928	-91	56.252
	T05C-03(end)	2	6.937	-91	53.921
5	V05C-03	2	6.389	-91	56.430
6	T05C-04(start)	0	59.960	-90	37.130
	T05C-04(end)	0	58.160	-90	34.020
7	V05C-04	0	49.193	-89	36.807
8	T05C-05(start)	0	52.056	-90	1.501
	T05C-05(end)	0	52.806	-90	5.808
9	T05C-06(start)	0	53.644	-90	12.026
	T05C-06(end)	0	54.859	-90	16.788
10	T05C-07(start)	0	56.450	-90	31.012
	T05C-07(end)	0	57.857	-90	34.698
11	V05C-05	1	35.306	-90	48.790
12	V05C-06	1	37.410	-90	49.090
13	V05C-07	1	42.610	-90	50.000
14	T05C-08(start)	1	58.331	-90	23.998
	T05C-08(end)	1	57.606	-90	21.968
15	T05C-09(start)	1	57.319	-90	21.369
	T05C-09(end)	1	57.914	-90	22.284
16	T05C-10(start)	1	55.459	-90	17.643
	T05C-10(end)	1	56.981	-90	22.559
17	T05C-11(start)	2	16.148	92	53.918
	T05C-11(end)	2	16.868	92	57.282
18	T05C-12(start)	2	36.000	-94	49.592
	T05C-12(end)	2	35.422	-94	45.059
19	T05C-13(start)	2	32.196	-94	5.987
	T05C-13(end)	2	31.164	-93	58.368
20	V05C-08	2	31.634	-94	4.503
21	T05C-14(start)	2	32.811	-94	11.490
	T05C-14(end)	2	31.697	-94	5.699
22	T05C-15(start)	2	30.040	-93	43.988
	T05C-15(end)	2	29.267	-93	39.580
23	T05C-16(start)	2	28.305	-93	43.698
	T05C-16(end)	2	31.053	-93	40.236
24	T05C-17(start)	2	27.292	-93	29.489
	T05C-17(end)	2	26.592	-93	25.158
25	T05C-18(start)	2	9.200	-92	20.990
	T05C-18(end)	2	8.215	-92	17.451
26	V05C-09	2	6.257	-91	56.136
27	T05C-19(start)	2	6.758	-92	1.994
	T05C-19(end)	2	6.932	-91	58.511
28	V05C-10	2	5.953	-91	54.293
29	V05C-11	2	6.264	-91	56.146
30	V05C-12	2	6.206	-91	55.578
31	T05C-20(start)	0	56.026	-90	32.064
	T05C-20(end)	0	57.804	-90	30.796
32	V05C-13	0	57.309	-90	33.201

APPENDIX 4
GalAPAGoS Expedition
Dec 2005 - Jan 2006

Medea lowering	Lat(deg)	Lat(min)	Long(deg)	Long(min)	date/time	Lat(decDeg)	Long(decDeg)
***Medea*-01(start)**	2	6.3220	-91	56.5380	12/14/05 2:41	2.105367	-91.942300
***Medea*-01 (end)**	2	6.3240	-91	56.5410	12/14/05 4:36	2.105400	-91.942350
***Medea*-02(start)**	2	6.3130	-91	56.5010	12/14/05 6:43	2.105217	-91.941683
***Medea*-02 (end)**	2	6.2660	-91	56.1850	12/14/05 15:22	2.104433	-91.936417
***Medea*-03(start)**	2	31.5800	-94	4.4090	12/28/05 19:22	2.526333	-94.073483
***Medea*-03 (end)**	2	31.9670	-94	4.9320	12/29/05 8:30	2.532783	-94.082200
***Medea*-04(start)**	2	32.3900	-94	9.2510	12/29/05 22:21	2.539833	-94.154183
***Medea*-04 (end)**	2	32.3900	-94	8.8230	12/30/05 4:00	2.539833	-94.147050
***Medea*-05(start)**	2	31.4520	-94	0.5770	12/30/05 7:45	2.524200	-94.009617
***Medea*-05 (end)**	2	31.6870	-94	1.1280	12/30/05 14:34	2.528117	-94.018800
***Medea*-06(start)**	2	29.7610	-93	41.6720	12/31/05 6:14	2.496017	-93.694533
***Medea*-06 (end)**	2	29.6500	-93	41.8450	12/31/05 20:45	2.494167	-93.697417
***Medea*-07(start)**	2	8.7390	-92	19.4620	1/1/06 17:50	2.145650	-92.324367
***Medea*-07 (end)**	2	8.9200	-92	19.4820	1/2/06 3:20	2.148667	-92.324700
***Medea*-08(start)**	2	6.3060	-91	56.2030	1/2/06 16:47	2.105100	-91.936717
***Medea*-08 (end)**	2	5.8870	-91	53.8100	1/4/06 5:11	2.098117	-91.896833
***Medea*-09(start)**	1	58.1710	-91	23.7080	1/4/06 21:18	1.969517	-91.395133
***Medea*-09 (end)**	1	54.4230	-91	14.1470	1/6/06 5:57	1.907050	-91.235783
***Medea*-10(start)**	0	56.4700	-90	31.7560	1/6/06 19:04	0.941167	-90.529267
Medea-10 (end)	0	56.5660	-90	31.5590	1/8/06 18:55	0.942767	-90.525983