CRUISE REPORT

DIRECT AND INDIRECT MEASUREMENTS OF THE THERMAL BUDGET OF TWO LARGE HYDROTHERMAL SYSTEMS ON THE JUAN DE FUCA RIDGE.

R/V THOMPSON/JASON EXPEDITION
TO THE ENDEAVOUR SEGMENT, JUAN DE FUCA RIDGE

September 27 - October 8, 2000

Funded by the National Science Foundation

Principal Investigator: H. Paul Johnson
Co-Principal Investigator: Susan L. Hautala
Co-Investigator: Christopher D. Jones

University of Washington
Seattle, WA 98195-7940

Compiled by Tomoko Kurokawa

TABLE OF CONTENTS

CRUISE SUMMARY

DIRECT AND INDIRECT MEASUREMENTS OF THE THERMAL BUDGET OF TWO LARGE HYDROTHERMAL SYSTEMS ON THE JUAN DE FUCA RIDGE.

This program will determine the thermal budget of oceanic crustal formation using measurements of vertical heat flux on the Endeavour segment of the Juan de Fuca Ridge. During the two field programs, we will systematically survey areas of diffuse hydrothermal venting within the axial valley using acoustic scintillation thermometry and near bottom geophysical measurements, and then quantify the vertical thermal flux using vertical arrays of thermistors and acoustic current meters. The proposed survey will eventually cover an 800 m x 3500 m area of the valley surrounding and containing two of the large vent fields at the axis of the Endeavour Segment: the Main Endeavour Field (MEF) and the High Rise Field (HR). The proposed detailed measurements of near-bottom vertical heat flux will allow us to (1) determine the horizontal dimensions of the crustal fluid circulation cells, (2) identify potential re-charge zones associated with the large hydrothermal fields, (3) define the radius-of-entrainment for these fields, and (4) partition the heat of crustal formation between focussed high temperature vents, diffuse flow and conductive heat flux.

A key problem in modeling sub-surface fluid circulation is that the fluid trajectories within the crust are undefined, with only the locations of the obvious high temperature vents being well-characterized. On the Endeavour Segment, locations of these large hydrothermal fields are unusually systematic, with approximately 2 km spacing between four of the high temperature fields associated with massive sulfide deposits. Anecdotal evidence indicates that diffuse low temperature vents are common over much of the valley floor, and may dissipate most of the heat of crustal formation. However, no systematic survey of diffuse vents has ever been done, and the spacing between these low temperature vents is unknown. To measure the total energy associated with diffuse vents, and to use the geometry of their surface expression to constrain crustal circulation paths, we must locate low levels of up-welling fluid quickly and reliably over large areas of the sea floor. Near-bottom surveys of the axis can identify these up-welling zones, and the associated heat flux can then be quantified using arrays of thermistor strings and acoustic flow meters.

Acoustic scintillation thermometry (AST) uses the changes in the backscattered signal between successive sonar scans of an area of the seafloor to determine slight fluctuations in water temperature, and has previously detected near-bottom temperature variations of $\pm$ 0.03°C using a fixed source/receiver. We will apply this remote sensing capability using a SM-2000 sonar mounted on the ROV Jason to survey the axial valley floor in moving profiles for zones of up-welling hydrothermal fluid. We will also survey smaller areas of the valley using fixed stations, where the sonar scans a circle with a 200 meter diameter from a non-moving vehicle. In our proposed 2-year field season, we will survey the entire axial valley in the near-bottom mode, make direct measurements of vertical flux in areas of diffuse venting and deploy our thermal blanket for conductive heat flux measurements. Locations of maxima and minima in vertical heat flux will reflect the ascending/descending limbs of sub-surface circulation cells beneath the valley floor. Potential re-charge zones for the large high temperature hydrothermal systems will also be identified as regions where the thermal boundary layer is anomalously thin, and where there is low conductive heat flow in the adjacent rocks. Finally, our proposed measurements will assist in determining the partitioning of the thermal energy of crustal formation between conductive, diffuse and high temperature modes for this ridge segment.

SCIENTIFIC CREW LIST

Name	Title	Institutional Affiliation
Johnson, Paul	Chief Scientist	U. Washington
Hautala, Susan	Co-Chief Scientist	U. Washington
Fredericks, Bill	Scientist	U. Washington
Garcia-Berdeal, Irene	Scientist	U. Washington
Gilbert, Lisa	Scientist	U. Washington
Guralnick, Rob	Scientist	U. Colorado
Higgins, Eric	Scientist	U. Washington
Jones, Chris	Scientist	U. Washington
Kurokawa, Tomoko	Scientist	U. Washington
Lam, Phyllis	Scientist	U. Hawaii
Pruis, Matt	Scientist	U. Washington
Realander, Michael	Marine Technician	U. Washington
Tivey, Maurice	Scientist	WHOI
Tsurumi, Maia	Scientist	U. Victoria
Voight, Janet	Scientist	Chicago Field Museum
Bowen, Andy	Jason Expedition Leader	WHOI
Crook, Tom	Jason Group	WHOI
Elder, Bob	Jason Group	WHOI
Heintz, Matt	Jason Group	WHOI
Howland , Jonathan	Jason Group	WHOI
Lerner, Steve	Jason Group	WHOI
Mark Drewery	Jason Group	WHOI
Sellers, Will	Jason Group	WHOI
Taylor, Fran	Jason Group	WHOI
Webster, Sarah	Jason Group	WHOI

Instrument Location

Instrument	No.	X (meters)	Y (meters)	Target No.	Data
MAV	47	492564.5	5310142	17	N/A
MAV	48	492640.7	5310536	9	N/A
MAV	49	493216	5312338	36	Yes
MAV	51	492596.7	5310154.2	16	Yes
MAV	51:2nd	493159.6	5312210.4	42	Yes
MAV	52	493210.7	5312359.4	43	N/A
MAV	54	492718	5310774.5		Yes
MAV	55	492632.5	5310680.2	15	Yes
MAV	57	493231	5312326		N/A
MAV	58	492602.1	5310469.2	14	Yes
MAV	58:2nd	493176	5312207	41	Yes
MAV	59	492640.7	5310536	10	No
MAV	60	492714.2	5310527.7	11	Yes
MAV	62	493228.7	5312355.6	44	N/A
MAV	63	493161.7	5312185	29	N/A
MAV	64	492630.3	5310514.3	19	N/A
MAV	66	492768.4	5310776.3	13	N/A
TB	1	492783	5310797	22	N/A
TB	2	492820	5310721	27	N/A
TB	3	492866	5310723	52	N/A
TB	4	492780	5310780	53	N/A
SF Mag	1	492784	5310794	22	N/A
SF Mag	2	492847	5310744	24	N/A
SF Mag	4	492564	5310137	17	N/A
SF Mag	5	492316	5310891	25	N/A
HT HOBO	1	492613	5310445	24	N/A
HT HOBO	2	493226.6	5312321.6	33	N/A
LT HOBO	33	492794	5311224.5	50	N/A
LT HOBO	34	493217.3	5312325.5	45	N/A
LT HOBO	35	492796	5311216	47	N/A

INSTRUMENT DEPLOYMENT SUMMARY

All the data are from the Log Book recorded by watch leaders except the ones with *, which are from Jason TARGET files and "site" data with blakets , which are added after the cruise by refering to JdFR MER map.

Instrument	No.	Term	Base type	Target No.	X (meters)	Y (meters)	Z (meters)	Heading angles	Site	Deployment time	Recovery time	Data
MAV-3	47	Long	claw	17	492564.5	5310142	2198.6	165	Beach 1	09/30/2000 17:37	Long term	N/A
	48	Long	claw	9	*492583.4	*5310530.8	2189.9	93	North of Easter Island	09/30/2000 2:30	Long term	N/A
	49	Short	bag	36	493216	5312338	2186	145 (+180?)	Clam Bed 4	10/05/2000 16:43	10/06/2000 7:47	Yes
(#48 w/ the pressure	50	Never deployed										
sensor)	51	Short	claw	16	492596.7	5310154.2	2196.8	350	Beach 2	09/30/2000 16:55	10/04/2000 2:03	Yes
	51:2nd	Short	bag	42	*493159.6	*5312210.4		150	Clam bed 3	10/05/2000 14:12	10/06/2000 6:28	Yes
	52	Long	bag	43	493210.7	5312359.4	2191	237?(90 to MAV)	Clam bed 6	10/05/2000 19:05	Long term	N/A
	53	No Good										
	54	Short	claw	No Target	492718	5310774.5	2194	243	West Hulk	09/30/2000 6:32	10/04/2000 4:59	Yes
	55	Short	bag	15	*492632.5	*5310680.2		55	Grotto	09/30/2000 13:58	10/04/2000 6:02	Yes
	56	No Good										
	57	Long	bag	No Target	493231	5312326	2183	6	Clam bed 5	10/05/2000 16:25	Long term	N/A
	58	Short	bag	14	492602.1	5310469.2	2192.5	130	Milli Q 1	09/30/2000 11:43	10/04/2000 7:44	Yes
	58:2nd	Short	bag	41	493176	5312207	2193	151	Clam bed 2	10/05/2000 13:46	10/06/2000 6:32	Yes
	59	Short	bag	10	492640.7	5310536	2189.9	116	North of S&M	09/30/2000 4:27	10/04/2000 6:50	No
	60	Long (recovered)	bag	11	*492714.2	*5310527.7			"South Dudley"	09/30/2000 7:39	10/07/2000 1:51	Yes
	61	Never deployed										
	62	Long	bag	44	493228.7	5312355.6	2184	73?(90 to MAV)	Clam bed 7	10/05/2000 20:15	Long term	N/A
	63	Long	bag	29	493161.7	5312184.98	2186	206	Clam bed 1	10/05/2000 7:46	Long term	N/A
	64	Long	claw	19	492630.3	5310514.3	2198	160	Milli Q 2	09/30/2000 20:05	Long term	N/A

Instrument	No.	Term	Base type	Target No.	X (meters)	Y (meters)	Z (meters)	Heading angles	Site	Deployment time	Recovery time	Data
	65	Never deployed										
	66	Long	bag	13	*492768.4	*5310776.3		180	East Hulk	10/06/2000 17:28	Long term	N/A

Instrument	No.	Term	Base type	Target No.	X (meters)	Y (meters)	Z (meters)	Heading angles	Site	Deployment time	Recovery time
MAV-2		JAS 286	deployed on Jason								
		JAS 287	deployed on Jason, recorded data at 1/2 Hz continuously during the dive.								
Thermal Blanket	1	Long		22	492783	5310797		N/A	"NE of Hulk"	10/01/2000 2:09	10/04/2000 4:12
				27	492820	5310721	2213	N/A	"East Hulk"	10/04/2000 4:26	10/06/2000 16:03
				52	492866	5310723	2203	N/A	"East Hulk"	10/06/2000 16:29	10/06/2000 23:46
				53	492780	5310780	2208	N/A	"NE of Hulk"	10/07/2000 0:58	Long term
SF Magnetometer	1	Long	tripod	22	492784	5310794	2206	289	next to Hulk	10/01/2000 3:05	Long term
	2	Long	tripod	24	492847	5310744	2202.5	276	center valley, Hulk	10/01/2000 3:51	Long term
	4	Long	tripod	17	*492564	*5310137			at beach	10/01/2000 8:37	Long term
	5	Long	tripod	25	492316	5310891	2090	160+/-90	on west ridge	10/01/2000 7:23	Long term
HT HOBO	1	Long	insertion	24	492613	5310445	2182	N/A	Millie Q	10/01/2000 6:22	Long term
	2	Long	insertion	33	493226.6	5312321.6	2178	N/A	Clam bed, in chimny	10/05/2000 10:30	Long term
LT HOBO	33	Long		50	492794	5311224.5	2179	N/A	"New area"	10/06/2000 4:32	Long term
	34	Long		45	*493217.3	*5312325.5		N/A	"New area"	10/05/2000 22:55	Long term
	35	Long		47	492796	5311216	2182	N/A	"New area"	10/06/2000 4:39	Long term

Data
No
Yes
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A

TRACK LINE STATUS

These are the original waypoints calculated for the SM-2000 survey not necessarily meet with actual points.

Line No.	waypoint	UTM x	UTM y	waypoint	UTM x	UTM y	Status
1	1	492500	5310000	2	493663	5313195	Completed
2	3	493616	5313212	4	492453	5310017	Completed
3	5	492406	5310034	6	493569	5313229	Completed
4	7	493522	5313246	8	492359	5310051	**Completed
5	9	492312	5310068	10	493475	5313263	Completed
6	11	493428	5313281	12	492265	5310086	Completed
7	13	492218	5310103	14	493381	5313298	Completed
8	15	493334	5313315	16	492171	5310120	Completed
9	17	492124	5310137	18	493287	5313332	Completed
10	19	493710	5313178	20	492547	5309983	Completed
11	21	492594	5309966	22	493757	5313161	Completed
12	23	493804	5313144	24	492641	5309949	Completed
13	25	492688	5309932	26	493851	5313127	Not started
14	27	493898	5313110	28	492735	5309915	Not started
15	29	492782	5309897	30	493945	5313092	Not started

** Line4 is missing approximately 25 min. data at the southern end due to a problem on SM 2000.

TRANSPONDER LOCATIONS

Transponder	REC/XMIT	Latitude (N)	Longitude (W)	UTM X	UTM Y	Depth (m)
H	9.0/11.5	47 54.88599	-129 -6.20608	492271.54	5306832.12	1977
I	9.0/ 7.5	47 57.75302	-129 -4.96340	493824.75	5312141.18	2000.4
K	9.0/10.5	47 56.01802	-129 -5.73213	492864.35	5308928.34	1920.6
L	9.0/10.0	47 57.36433	-129 -5.00449	493772.85	5311421.22	1881.1
M	9.0/ 8.5	47 56.22351	-129 -7.01043	491273.62	5309311.18	1865.4
N	9.0/ 7.5	47 57.65460	-129 -6.20849	492275.42	5311960.72	1866.2
O	9.0/ 9.5	47 55.99211	-129 -5.64396	492974.05	5308880.22	1894.5

AST Crop Circle Survey

Station	X UTM	Y UTM	Location	Depth (m)	Altitude (m)	Heading	Start Time
A	492763	5310800	20m N of MAV66 (TAG13)		8		10/6/00 1741
A-2					4		10/6/00 1745
B	492738	5310798	MAV 54, 35m W of Station A		5	225	10/6/00 1756
B-2					5	135	10/6/00 1801
C	492648	5310690	20m NE of MAV55 (TAG15)		5	234	10/6/00 1744
C-2					8	234	
C-3					10	234	
D	492611.5	5310546.9	MAV48 (TAG9)	2193.94	5.6	213	10/6/00 1909
D-2	492612.2	5310547.2		2189	10.4	215	10/6/00 1913
E			20m to MAV64 (TAG19)	2192.4	5.8	148	10/6/00 1943
E-2					10		10/6/00 1748
F	492611.2	5310536.4	20m? to MAV48 (TAG9)	2198.8	0	271	10/6/00 2002
G	492601.7	5310450.5	MAV58 (TAG14)	2192.7	5.5	008-007	10/6/00 2050
G-2					3-3.4		10/6/00 2052
H	492592.3	5310159.8	25m to MAV47 (TAG17)	2201	5.5	233	10/6/00 2153
H-2	492592.3	5310159.8		2203	3.6-3.5	233	10/6/00 2156
H-3	492591.2	5310159.5		2203	3.7	149	10/6/00 2201
H-4	492591.2	5310159.5		2203	3.7	80	10/6/00 2205
H-5	492594.5	5310159.6		2203	3.7	82	10/6/00 2207
H-6	492590.2	5310159.5		2203	3.4	10	10/6/00 2210
H-7	492592	5310159.5		2203	3.5	302-303	10/6/00 2213
H-8	492567.1	5310159.4		2203	3.2	93	10/6/00 2229

TARGET LOCATIONS - JAS 286

Target	X	Y	LAT (N)	LON (W)	UTM X	UTM Y	COMMENT	GMT	
0	0000.00	0000.00	47 53.63400	-129 -9.87000	487703.90	5304520.86	Local origin for LBL XY coordinates		
1	5855.12	7616.63	47 57.74413	-129 -5.17216	493565.00	5312125.00	NA corner of CTD box – no t u sed		09/29
2	5404.16	7766.16	47 57.82483	-129 -5.53399	493115.00	5312275.00	NA corner of CTD box – no t u sed		09/29
3	5374.21	7676.09	47 57.77622	-129 -5.55802	493085.00	5312185.00	NA corner of CTD box – no t u sed		09/29
4	5845.21	7526.58	47 57.69554	-129 -5.18011	493555.00	5312035.00	NA corner of CTD box – no t u sed		09/29
5	5815.26	7431.51	47 57.64424	-129 -5.20414	493525.00	5311940.00	NA corner of CTD box – no t u sed		09/29
6	5339.26	7581.01	47 57.72492	-129 -5.58606	493050.00	5312090.00	NA corner of CTD box – no t u sed		09/29
7	5426.32	7658.15	47 57.76654	-129 -5.51620	493137.00	5312167.00	NA corner of CTD box – no t u sed		09/29
8	5040.50	5940.04	47 56.83940	-129 -5.82577	492749.69	5310450.03	Target for UW elevator 14.5/9.0 “C”	2020	09/29
9	4873.83	6020.67	47 56.88291	-129 -5.95950	492583.37	5310530.84	MAV-LT, #48 placed on bottom	0228	09/30
10	4932.86	6026.97	47 56.88631	-129 -5.91213	492642.32	5310537.06	MAV-ST, #59 placed on bottom	0347	09/30
11	5004.85	6017.66	47 56.88129	-129 -5.85437	492714.19	5310527.66	MAV-LT, #60 dropped at elevator	0746	09/30
12	5061.33	6257.70	47 57.01082	-129 -5.80906	492770.89	5310767.54	MAV-LT, #66 placed on bottom	0855	09/30
13	5058.84	6266.42	47 57.01553	-129 -5.81106	492768.41	5310776.26	MAV-LT, #66 moved on bottom	0924	09/30
14	4892.86	5961.94	47 56.85122	-129 -5.94422	492602.30	5310472.11	MAV-ST, #58 placed on bottom	1143	09/30
15	4922.84	6170.14	47 56.96357	-129 -5.92017	492632.50	5310680.19	MAV-ST, #55 placed on bottom	1342	09/30
16	4887.62	5644.01	47 56.67966	-129 -5.94843	492596.66	5310154.31	MAV-ST, #61 placed on bottom	1719	09/30
17	4854.33	5631.60	47 56.67296	-129 -5.97514	492563.40	5310141.94	MAV-LT, #47 placed on bottom	1757	09/30
18	4918.27	5999.37	47 56.87142	-129 -5.92384	492627.72	5310509.49	MAV-LT, #64 placed on bottom	1956	09/30
19	4921.16	6003.53	47 56.87366	-129 -5.92152	492630.61	5310513.64	MAV-LT, #64 moved on bottom	2005	09/30
20	4894.87	6000.88	47 56.87223	-129 -5.94262	492604.35	5310511.03	Marked black smoker M-Q	2033	09/30
21	5081.24	6193.19	47 56.97601	-129 -5.79308	492790.69	5310703.03	DSL elevator on bottom 14.0/9.0 “H”	0106	10/01
22	5073.34	6287.40	47 57.02685	-129 -5.79942	492782.92	5310797.21	Thermal blanket deployed, Maggie#1	0209	10/01
23	5079.37	6264.00	47 57.01422	-129 -5.79458	492788.91	5310773.81	Float about 5M off bottom	0303	10/01
24	5136.45	6237.72	47 57.00004	-129 -5.74878	492845.87	5310747.47	SF maggie #2 center valley, Hulk	0353	10/01
25	4615.30	6342.99	47 57.05685	-129 -6.16693	492325.65	5310853.37	SF maggie #5 on west ridge	0723	10/01
26	4987.31	7223.96	47 57.53224	-129 -5.86844	492698.21	5311733.52	NA accidental target	0647	10/03
27	5111.10	6211.46	47 56.98587	-129 -5.76912	492820.53	5310721.25	Thermal blanket deployed	0426	10/04
	4854.94	5626.65	47 56.67029	-129 -5.97465	492564.00	5310137.00	SF maggie #4, at beach		

JASON 286:

IN WATER – 2237 29 SEPT 00
ON BOTTOM – 0040 30 SEPT 00
LV BOTTOM – 0911 04 OCT 00
ON DECK - 1111 04 OCT 00

TARGET LOCATIONS - JAS 287

Target	X	Y	LAT (N)	LON (W)	UTM X	UTM Y	COMMENT	GMT
0	0000.00	0000.00	47 53.63400	-129 -9.87000	487703.90	5304520.86	Local origin for LBL XY coordinates	
28	5411.62	7619.79	47 57.74584	-129 -5.52800	493122.28	5312128.67	UW elevator 14.5/9.0 "C"	0626 10/05
29	5451.02	7676.17	47 57.77626	-129 -5.49639	493161.67	5312184.98	MAV #63 placed on bottom	0741 10/05
30	5459.43	7692.86	47 57.78527	-129 -5.48964	493170.09	5312201.66	Possible MAV site	0829 10/05
31	5445.19	7695.98	47 57.78695	-129 -5.50106	493155.88	5312204.79	Possible MAV site, worms	0910 10/05
32	5500.34	7702.53	47 57.79049	-129 -5.45682	493210.94	5312211.28	Potential old Em exp.	0932 10/05
33	5516.15	7810.07	47 57.84852	-129 -5.44413	493226.85	5312318.76	Black smoker !!, Placed HOBO	1006 10/05
34	5517.00	7823.56	47 57.85580	-129 -5.44345	493227.71	5312332.24	Bad target	1038 10/05
35	5505.28	7821.99	47 57.85495	-129 -5.45285	493216.01	5312330.68	Good MAV location	1039 10/05
36	5504.95	7832.89	47 57.86084	-129 -5.45312	493215.69	5312341.58	Good MAV site	1044 10/05
37	5524.96	7856.08	47 57.87335	-129 -5.43707	493235.69	5312364.74	North hydrothermal boundry	1100 10/05
38	5516.31	7869.49	47 57.88058	-129 -5.44400	493227.08	5312378.15	North hydrothermal boundry	1122 10/05
39	5496.36	7794.62	47 57.84019	-129 -5.46001	493207.07	5312303.34	South hydrothermal boundry	1134 10/05
40	5456.60	7718.38	47 57.79904	-129 -5.49191	493167.29	5312227.17	Hydrothermal area	1145 10/05
41	5465.36	7698.07	47 57.78808	-129 -5.48489	493176.01	5312206.86	MAV #58 placed on bottom	1349 10/05
42	5448.92	7701.58	47 57.78998	-129 -5.49807	493159.61	5312210.39	MAV #51 placed on bottom	1417 10/05
43	5500.81	7852.59	47 57.87147	-129 -5.45644	493211.58	5312361.28	MAV #52 placed on bottom	1913 10/05
44	5517.96	7847.15	47 57.86853	-129 -5.44268	493228.70	5312355.82	MAV #62 placed on bottom	2019 10/05
45	5506.60	7816.76	47 57.85213	-129 -5.45180	493217.32	5312325.46	Placed HOBO #34	2339 10/05
46	5583.40	7804.36	47 57.84544	-129 -5.39017	493293.97	5312312.97	CTD vertical profile	0138 10/06
47	5086.96	6706.45	47 57.25298	-129 -5.78849	492797.04	5311216.08	Deploy HOBO #35	0442 10/06
48	5405.02	7575.58	47 57.72199	-129 -5.53330	493115.63	5312084.49	?	
49	5406.39	7425.69	47 57.64110	-129 -5.53220	493116.82	5311934.65	?	
50	5079.71	6713.24	47 57.25664	-129 -5.79431	492789.81	5311222.88	HOBO #33	1236 10/06
51	5170.26	6195.88	47 56.97746	-129 -5.72166	492879.58	5310705.61	Aborted thermal blanket target	? 10/06
52	5156.79	6213.67	47 56.98706	-129 -5.73246	492866.15	5310723.41	Thermal blanket placed	1616 10/06
53	5071.97	6270.32	47 57.01763	-129 -5.80052	492781.53	5310780.14	Thermal blanket placed	0056 10/07
54	5122.54	6815.49	47 57.31182	-129 -5.75995	492832.70	5311325.04	Vent	0520 10/07
55	5144.74	6936.04	47 57.37687	-129 -5.74214	492855.01	5311445.51	No meaning	0528 10/07

JASON 287:

IN WATER – 0317 05 OCT 00
ON BOTTOM – 0522 05 OCT 00
LV BOTTOM – 1300 07 OCT 00
ON DECK - 1503 07 OCT 00