

# **CRUISE REPORT**

## **Lexen Fluids**

**Collaborative lexen research: Direct sampling of the oceanic sub-surface biosphere at old and young seamounts.**

R/V ATLANTIS II / JASON EXPEDITION  
TO THE ENDEAVOUR SEGMENT, JUAN DE FUCA RIDGE,  
AXIAL SEAMOUNT, AND THE BARES SEAMOUNTS

August 29<sup>th</sup> – September 23<sup>rd</sup> 2002

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**Principal Investigator: H. Paul Johnson**  
**Co-Principal Investigators: John A. Baross**  
**David A. Butterfield**  
**John I. Hedges**  
**Matthew McCarthy**

**University of Washington**  
**Seattle, WA 98195-7940**

Compiled by Tor Bjorklund

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## CRUISE SUMMARY

### **Collaborative Research: Direct sampling of the Oceanic Sub-surface Biosphere at Old and New Seamounts**

**Abstract of Scientific Goals** – The primary goal of the cruise was to test the hypothesis that there is a substantial microbial biosphere residing within the upper 600 meters of the oceanic igneous crust. We proposed to test this hypothesis at four paired sites on the Juan de Fuca Ridge.

(A) Young and (B) old normal ocean crust (Endeavour axis vs. ODP Hole 1026b),  
And...

(B) young and (D) old seamounts (Axial vs. Baby Bare Seamount).

The ages for the sites varied from the eruption at Axial Seamount in 1998 to the 3.5 My crust at the 1026b and Baby Bare Seamount. Secondary goals for the cruise included estimating the global osmium flux from low temperature vents (M.Sharma, Dartmouth, U.) and the deployment of a larvae colonization experiments (J.Voight, The Field Museum), with both of these NSF projects contributing ship time to the field program.

**Methodology** – Sampling of the hydrothermal fluid that is uncontaminated both microbiologically and chemically from new and (particularly) old oceanic crust is a challenging exercise that has not, prior to this cruise, been completely solved. The water/rock interface at the seafloor is generally extensively covered with bio-films, bottom seawater is a biologically-rich environment, and the orifices where hydrothermal fluids vent from the crust are very non-uniform cracks in brittle rock surrounded by sediments and precipitates that make poor seals with and sampling instrument. In young oceanic crust (Axial Seamount and Endeavour), adequate sampling sites with diffuse low temperature (<100° C) venting had been previously identified, but the sampling of fluid from within older crust was still a major challenge.

ODP Hole 1026b, which has been venting 63° C hydrothermal fluid through the drill pipe and CORK for the 6 years since drilling, provided the opportunity for sampling old (3.5My) normal crust, but the presence of drilling contamination (drilling mud and CORK grease) and a heavily corroded drill pipe would cast doubt on any chemical or microbiological results without a controlled sampling from a similar environment. The nearby (6 km) Baby Bare Seamount provided the ideal control on contamination, as natural diffuse venting had been observed over much of the surface of this small (and completely surrounded by sediment) rock exposure. However, the very biologically active water/rock interface at Baby Bare Seamount required that we sampler fluid from below the surface – without the contamination problems associated with drilling. To obtain these samples, we designed a method for driving stainless steel probes (1.5, 3 and 5 meters long) into the rocks of the seamount, using OSU piston coring facility. This ‘probe insertion’ method was tested with two cruises in Puget Sound prior to the Atlantis cruise, and several modifications were needed to the original design.

Several other innovations were required prior to the Atlantis cruise. In order to determine the composition of the very dilute DOC and DIC (dissolved organic carbon

and dissolved inorganic carbon) in the hydrothermal fluid and to obtain adequate samples for the measurement of C-14 residence time of the crustal fluid, we needed to develop hydrothermal fluid samplers with a capacity 3 orders of magnitude larger than the normal 500 ml available using the present 'major' samplers. To this end, we designed, constructed and tested two 'barrel samplers' each capable of taking 55 gallons of hydrothermal fluid per deployment. To determine the time variability of fluid organic chemistry over a period of a year (which may vary tidally or in response to local tectonic activity), a Lang fluid sampler was constructed and deployed, capable of taking 48 2-liter individual samples over the next 12 months at the Baby Bare probes. To monitor flow and temperature variations from both young and old crust (also in response to tidal and tectonic forcing) we assisted in the development of a new pipeMAVS flow meter in collaboration with a commercial company (NOBSKA, Inc.) and deployed 3 of these instruments at Axial and Baby Bare seamounts and at Main Endeavour Hydrothermal Field.

**Results** – The entire cruise was unusually successful and almost all of the scientific goals for the first year of the 2 year field program were reached. Major factors for this success include good weather (for 4 weeks on the Juan de Fuca Ridge!), few instrument or equipment failures, and a substantial amount of good luck. A primary component in this success, however, was the almost flawless operation of the new ROV Jason II and the dedication of the Jason team to accomplish the scientific and logistic goals of the cruise. Although there was considerable pre-cruise concern over being designated as 'the first scientific user' of a new ROV (which abundant experience has shown to be an extremely un-enviable position), this anxiety was misplaced. The new ROV worked extremely well during all dives, and, with the single (and relatively minor) exception of the SM2000 sonar, performed every requested task. Dives were long (days) and productive, and always ended because our fluid samplers were 'full' or (incredibly!) the Task List for that site was finished. We did not have a single Jason dive which terminated because 'something important broke'. Finally, the officers and (in particular) the deck crew of the Atlantis contributed to our success, even though as non-ALVIN operation, we were well outside their normal routine.

In short summary, the probes inserted into Baby Bare Seamount worked; two probes were successfully driven into the summit and immediately started venting 20° C hydrothermal fluid. This fluid was repeatedly sampled and monitored from these probes during the cruise and is being analyzed for chemistry and microbial populations. A pipeMAVS is now monitoring the flow and temperature from one of the probes and the LANG sampler is sampling fluid from the other at 48 discrete intervals over the next 12 months. Hole 1026b was successfully sampled for organic and inorganic chemistry and microbial cultures from the fluid are now being nurtured in the UW laboratory. A large number of diffuse vents in the Main Endeavour and Raven Fields (a distinct field 200 meters north of MEF) were sampled for microbial and chemical studies, a conductive heat flow profile (11 stations) was made across the entire axial valley and an ADCP deployment was made in the middle of the axial valley to determine the general tidal motions within the axial valley. Finally, at Axial Seamount, 7 different hydrothermal sites were sampled as part of the previous LEXEN (Baross/Butterfield) long-term time

series sampling program over the past 4 years and a pipeMAVS is monitoring flow of hydrothermal fluid from our cement box in the ASHES field for tidal and earthquake modulation studies. In terms of year-long time-series measurements, we have flow/temperature monitors at Baby Bare, Endeavour, and Axial, 3 HOBO strings at Endeavour/Easter Island site, the LANG sampler at Baby Bare and several MAVS current meters deployed at Endeavour.

The general statistics for the cruise speak for themselves; eleven Jason-II dives (002 to 0012) with 323 hours of bottom time (equivalent to 71 ALVIN dives at 4.5 hours each). Five sites were studied (Baby Bare, Wuzza Bare, Axial Seamounts, Endeavour axis and ODP Hole 1026b). Ten elevator deployments, 18 thermal blanket deployments, 850 LITERS of fluid from the barrel sampler during 6 deployments, 60 liters of fluid from the LANG sampler, 136 discrete fluid samples taken in the Butterfield sampler (mounted under the stern of Jason-II), 9 gas tight and 13 major fluid samplers taken, 9 push cores, 4 bio-grabs (large), 9 rocks recovered, 3796 digital still images taken, 11 CTD casts, a 10-meter piston core and 5 sets of larvae settling experiments deployed.

### **Participants**

**Jason Team** – A. Bowen, T. Crook, R. Elder, P. Forte, M. Heinz, J. Howland, W. Sellers, A. Sterling, A. Stone, C. Taylor, J. Varnum, R. Waters.

**Science Party** - H.P. Johnson, T. Bjorklund, W. Brazelton, D. Butterfield, C. Channing, J. Huber, M. Johnson, P. Kalk, C. Kammerer, S. Lang, W. Martin, M. McCarthy, F. McCrosky, M. Mehta, W. Moore, M. Pruis, K. Roe, M. Sharma, J. Voight.

## Cruise Participants

### Scientists:

Johnson, H. Paul	Johnson@ocean.washington.edu
Butterfield, David A.	butterfield@pmel.noaa.gov
McCarthy, Mathew D.	mdmccar@cats.ucsc.edu
Voight, Janet R.	jvoight@fieldmuseum.org
Sharma, Mukul	Mukul.Sharma@Dartmouth.EDU
Kalk, Peter A.	
Pruis, Mathew J.	mpruis@ocean.washington.edu
Bjorklund, Tor A.	tor@ocean.washington.edu
Huber, Julie A.	huberja@ocean.washington.edu
Lang, Susan Q.	sqlang@ocean.washington.edu
Mehta, Mausmi P.	mausmi@ocean.washington.edu
Brazelton, William J.	braz@u.washington.edu
Moore, Willard S.	moore@geol.sc.edu
Channing, Catherine	cathychanning2@hotmail.com
McCroskey, Floyd G.	floydg@ocean.washington.edu
Roe, Kevin K.	roe@pmel.noaa.gov
Martin, William R. II	bmartin@pmel.noaa.gov
Kammerer, Christian F.	cfkammer@midway.uchicago.edu
Johnson, Matthew R.	matty_@hotmail.com
Van Hilst, Christina	
Sims, David L.	

### Jason Crew:

Bowen, Andrew D.	Elder, Robert L.	Varnum, James H.
Stone, Ann E.	Crook, Thomas	Waters, Robert A.
Taylor, Christopher L.	Sterling, N. Akel	Forte, Philip E.
Williams, Robert L.	Sellers, William J.	Heintz, Matthew C.
Howland, Jonathan C.		

### Ships Crew:

Chiljean, Gary, B.	Doherty, William H.	Leonard, Peter T.
Bean, Richard C.	Jurgs, Ronald E.	Bailey, Wayne A.
Martinez, Eduwiges	Halloran, Mary Ellen	Brannen, Kyle D.
Threadgold, G. Kevin	Estaniel, Edwin A.	Hill, Robert J.
Fisk, Kevin C.	Matthews, Richard E.	Passaro, Anthony R.
Viera, Marcel	Mathison, Philip L.	Chandler, Gary E.
Fisher, Kevin M.	Brown, Anthony L.	Adapon, Jockie L.
Ells, Christina L.		

				<b>29</b> Left Astoria Transit	<b>30</b> Transit On site 17:00 Seabeam survey	<b>31</b> Launch X'ponder Survey X'ponder Jason Dive <b>J2-002</b> : Survey <b>Wuzza Bare</b> site
				241	242	243
<b>1</b> Jason survey of <b>Wuzza Bare</b> site. Recover Jason, Switch wire	<b>2 Baby Bare:</b> Piston Core #1 CTD cast # 1,2 & 3 <b>Wuzza Bare:</b> Probe # 1	<b>3 Wuzza Bare:</b> Probe #2 CTD cast # 4 Launch Jason dive <b>J2-003</b>	<b>4 Baby Bare:</b> Test LANG sampler Dive on BB summit Launch Jason dive <b>J2-004</b> Explore BB	<b>5 Recovered J2-004</b> CTD # 5 (ambient) Probes 3,4 & 5.	<b>6 Baby Bare:</b> Launched <b>J2-005</b> . water sampled. Probes 3 & 4. Launch Barrel sampler (B.S.)	<b>7 Baby Bare:</b> Deploy Lang Sampler Recover Jason, Recover B.S.
244	245	246	247	248	249	250
<b>8</b> Jason dive <b>J2-006</b> Install Lang sampler	<b>9 continue J2-006</b> Launch B.S. #1 Launch B.S.r #2 Install B.S. #1	<b>10 continue J2-006</b> Recover Lang sampler B.S. #1 returned B.S. #2 recovered B.S. returned again Jason recovered CTD # 6	<b>11 1026b</b> Launch Lang sampler Launch B.S. #1 Launch <b>J2-007</b> CTD # 7 (ambient)	<b>12 1026b</b> Fill all elevators Recover all elevators Transit to BB Deploy B.S. Deploy Butterfield sampler	<b>13</b> Recover B.S. Recover Jason Transit to Axial Leave 3:00pm Recover Wuzza Bare X'ponders	<b>14 At Axial</b> Jason Dive <b>J2-008</b> Launch Lang sampler @ 12:15 at M33
251	252	253	254	255	256	257
<b>15 Marker 33 Axial</b> Launched B.S. Recovered Lang sampler Jason Recovered Transit to Endeavour	<b>16 J2-009</b> <b>at Endeavour</b> Mid valley: ADCP, T.B., Wood, MAV. CTD # 8 Clambled CTD # 9 East field	<b>17 J2-010</b> Recover @ Raven MEF: Thermal Blanket & fluid samples	<b>18 recover J2-010</b> Noon-weather CTD ambient water west of axis about 5 miles	<b>19 J2-011</b> <b>at Endeavour</b> Launch Lang sampler Launch Barrel sampler Launch instrument elevator	<b>20 J2-011 Cont.</b> Recovered B.S. Recovered Lang sampler (didn't work) Recover B.S. Thermal Blanket Deployments East Field.	<b>21</b> Recover elevator Recover Jason Recover X'ponders Transit to BB Launch Elevator and Lang Sampler. Launch <b>J2-012</b>
258	259	260	261	262	263	264
<b>22</b> Recover Elevator with 2 Ti probes attached. Recover Jason, end <b>J2-012</b> . Leave for Newport	<b>23</b> Arrive Newport 9:00AM					
265	266					

Targets

**Endeavour Site**

<b>TGT#</b>	<b>Xpos</b>	<b>Ypos</b>	<b>Lat</b>	<b>Lon</b>	<b>UtmX</b>	<b>UtmY</b>
0	0.00	0.00	0 0.00	0 0.00	0.00	0.00
1	5061.17	5840.12	47 56.78548	-129 -5.80918	492770.21	5310350.12
2	5028.53	5825.48	47 56.77759	-129 -5.83537	492737.60	5310335.53
3	5069.20	6684.19	47 57.24096	-129 -5.80274	492779.28	5311193.85
4	5110.07	6835.30	47 57.32251	-129 -5.76995	492820.28	5311344.85
5	5119.44	6783.83	47 57.29473	-129 -5.76243	492829.57	5311293.39
6	4898.39	6090.42	47 56.92055	-129 -5.93979	492607.98	5310600.53
7	4861.84	5998.58	47 56.87099	-129 -5.96911	492571.37	5310508.77
8	4928.82	5931.26	47 56.83466	-129 -5.91538	492638.16	5310441.39
9	4930.85	6004.75	47 56.87432	-129 -5.91375	492640.28	5310514.85
10	4926.10	6018.65	47 56.88182	-129 -5.91756	492635.56	5310528.75
11	4977.74	5936.80	47 56.83766	-129 -5.87612	492687.02	5310446.87
12	5001.28	6177.54	47 56.96757	-129 -5.85724	492710.83	5310687.49
13	5038.75	6078.03	47 56.91387	-129 -5.82717	492748.12	5310587.97
14	5039.86	5991.00	47 56.86690	-129 -5.82628	492749.12	5310500.97
15	5045.89	5979.00	47 56.86043	-129 -5.82145	492755.12	5310488.97
16	5153.11	5944.76	47 56.84195	-129 -5.73542	492862.14	5310454.61
17	4907.57	6069.86	47 56.90946	-129 -5.93243	492617.12	5310579.97
18	4880.62	5999.80	47 56.87165	-129 -5.95405	492590.12	5310509.97
19	5249.24	5938.24	47 56.83843	-129 -5.65829	492958.12	5310447.97
20	5067.02	6042.92	47 56.89492	-129 -5.80449	492776.30	5310552.83
21	4759.96	5955.55	47 56.84777	-129 -6.05086	492469.58	5310465.89
22	5449.29	5988.95	47 56.86580	-129 -5.49778	493157.94	5310498.42
23	4945.33	6120.99	47 56.93705	-129 -5.90213	492654.89	5310631.03
24	5012.61	6158.03	47 56.95704	-129 -5.84814	492722.12	5310667.97
25	5012.61	6158.03	47 56.95704	-129 -5.84814	492722.12	5310667.97
26	5011.89	6108.23	47 56.93016	-129 -5.84872	492721.34	5310618.19

DSL/DSOG Operations Summaries

Cruise Id: WHOI: AT7-20 DSL: Johnson02 Science: LEXEN  
 Chief Scientist (s): Paul Johnson/UW, Janet Voight/The Field Museum, Chicago, IL  
 Vessel: RV ATLANTIS, WHOI  
 Port of Embarkation: Astoria, OR  
 Port of DisEmbarkation: Newport, OR  
 Start Date of Cruise: 08/29/02  
 End Date of Cruise: 09/23/02  
 Operational Area(s): Northern Juan De Fuca Ridge  
 OpArea Latitude: ~ 46-48 N  
 OpArea Longitude: ~ 123-130 W  
 UTM Zone: 9  
 Operations: DSOG: JASON2 Ops, Elevators  
 Other: Probes, Thermal Blanket, CTD's, Piston Sediment Cores, Gravity Sediment Cores  
 Navigation: No ALVIN Dives  
 Ship: C/A GPS (NOT PCode), ALBL  
 JASON2: ALBL/PRV Mode, DOPPLER (DVL\_Nav??)  
 Other Ops: Unknown (ALBL??)

**JASON2 Sensors:** SM2000, DFC  
**Personnel:** Andy Bowen, Jonathan Howland, Matt Heintz, Tom Crook, Will Sellers, Bob Eider, Phil Forte (ALVIN Group)  
 Bob Waters, Chris Taylor, Ann Stone, Jim Varnum, Akel Sterling (HMRGData), Peter Collins (Mode only), Steve Lerner (Mode Only)

JASON2 - Lowering Summaries (All Times GMT)

Lowering Id	Start/Launch	Start Data	End Data	End/On Deck	Line/Area	Data (Hrs:Mns:Secs)	Lowering (Hrs:Mns:Secs)	Coverage (Nmiles)	Comments	
J2-002	8/31/2002 20:18	8/31/2002 22:27	9/2/2002 4:22	9/2/2002 6:08	Wuzzy Bare	29:55:00	33:50:00	(na)	First Lowering	
J2-003	9/3/2002 21:25	9/3/2002 22:54	9/4/2002 8:59	9/4/2002 10:28	Wuzzy Bare	10:05:00	13:03:00			
J2-004	9/4/2002 17:19	9/4/2002 19:07	9/5/2002 9:55	9/5/2002 10:59	Baby Bare	14:48:00	17:40:00			
J2-005	9/6/2002 11:09	9/6/2002 13:01	9/7/2002 20:58	9/7/2002 23:16	Baby Bare	31:57:00	36:07:00			
J2-006	9/8/2002 14:15	9/8/2002 15:54	9/10/2002 22:26	9/10/2002 23:48	1026-B & Baby Bare	54:32:00	57:33:00		Longest	
J2-007	9/11/2002 21:19	9/11/2002 22:53	9/13/2002 15:40	9/13/2002 16:31	Baby Bare	40:47:00	43:12:00			
J2-008	9/14/2002 14:10	9/14/2002 15:09	9/16/2002 0:54	9/16/2002 2:00	Axial	33:45:00	35:50:00			
J2-009	9/16/2002 16:36	9/16/2002 18:03	9/16/2002 18:43	9/16/2002 19:51	Endeavor	0:40:00	3:15:00			
J2-010	9/17/2002 14:13	9/17/2002 15:39	9/18/2002 17:27	9/18/2002 19:35	Endeavor	25:48:00	29:22:00			
J2-011	9/20/2002 3:00	9/20/2002 4:22	9/21/2002 16:19	9/21/2002 17:40	Endeavor	35:57:00	38:40:00			
J2-012	9/22/2002 1:10	9/22/2002 3:30	9/22/2002 14:06	9/22/2002 16:11	Baby Bare	10:36:00	15:01:00			
<b>Totals:</b>								288:50:00	323:33:00	0.00

- Jason 2 number hours on the bottom = 323:33:00
- Jason 2 number of Lowerings = 11
- Number of Deployments:
  - Elevators = 10  
Paul Johnson
  - Gas Tights = 9 Samples Taken  
Dave Butterfield
  - Majors = 13 Samples Taken  
Dave Butterfield
  - Thermal Blanket = 18  
Paul Johnson  
(9) @ Baby Bare + (7) @ Endeavor + (2) @ Baby Bare
  - Wood – (5) Sites  
Janet Voight  
Wuzza Bare – Baby Bare – ODP/ 1026B – Axial – Endeavor-
  - Butterfield Sampler & Volume collected = 136 Samples ~100 Liters  
Dave Butterfield
  - Barrel Sampler & Gallons of Fluid collected =(6) Sites = ~850 Liters  
Matt McCarthy  
Baby Bare – 1026B-1026B-Baby Bare ( Probe 3) – Axial ( Marker #33)-  
Endeavor( Marker #7)
  - Lang Sampler & Volume collected = (4) plus (2) *wire test* ~ 60 Liters  
Susan Lang  
(9) Push Cores
- Number of DFC cam Pictures = 3796 pictures  
Digital still camera data = 3.2 gb  
Jonathan Howland
- Number of BIO Samples Collected – (4) Grabs  
Janet Voight  
(1)Grotto on Endeavor – (1) Hulk – (1) Axial @ Bagcity- (1) Baby Bare
- Number of Rocks Collected = 9 Rocks  
Catherine Channing  
(6) Baby Bare + (3) Axial