MENDO

Lithospheric Evolution in Response to Triple Junction Migration:
Seismic Images of the Mendocino Triple Junction Region

The Onshore / Offshore Experiment

Newport, Oregon
June 8-26, 1994

PASSCAL Data Report 98-005

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LITHOSPHERIC EVOLUTION IN RESPONSE TO TRIPLE JUNCTION MIGRATION: SEISMIC IMAGES OF THE MENDOCINO TRIPLE JUNCTION REGION

MENDO94
THE ONSHORE/OFFSHORE EXPERIMENT

OBS/OBH DEPLOYMENTS
and
CALIFORNIA MARGIN ODP SITE SURVEY

CRUISE REPORT

W-9406A
R/V WECOMA

Newport, OR to Newport, OR
June 8 - June 26, 1994

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Scientific Objectives:

This cruise represents part of a two-year onshore/offshore seismic acquisition program to image the crust and upper mantle of northern California. The primary objective is to place constraints on how the northward migration of the Mendocino triple junction affects the crustal architecture of the California continental margin, which is undergoing a transition from a compressive to a transpressive tectonic regime. A better understanding of the processes associated with triple junction migration in this region will contribute to our understanding of the geological history of western California and of the seismic and volcanic hazards associated with the San Andreas fault system and the Cascadia subduction zone.

During the cruise described in this document, we deployed and retrieved ocean bottom seismographs (OBS) operated by the U. S. Geological Survey and ocean bottom hydrophones (OBH) operated by the Woods Hole Oceanographic Institution in order to record airgun shots from from a 8385 in^3 (137.5 liter) tuned airgun array deployed by the R/V Ewing, thus providing large-aperture seismic data for derivation of crustal velocity and structure. This information complements the multichannel seismic reflection information obtained simultaneously by the R/V Ewing. Additional seismographs were deployed on land to record the shots. This field effort builds on an onshore seismic refraction/reflection program conducted during August,1993, using approximately 600 seismometers and large explosive sources. The need to coordinate the efforts of two ships and a large onshore field crew during the 1994 field experiment placed unusual constraints on the timing of the OBS/OBH operations that were conducted from the R/V WECOMA.

A secondary objective of the cruise was to obtain high-resolution subsurface images around sites that have been proposed to the Ocean Drilling Program (ODP) as part of a major effort to constrain the paleo-oceanographic effects of the California current through acquisition of a series of long cores recording the sedimentary history of the California continental margin. Logistically, this program complemented the OBS/OBH effort because several proposed drilling sites fall within the boundaries of the OBS/OBH experiment, and time for surveying was available between OBS/OBH deployments. Digital 3.5 and 12 kHz echo-sounding data and digital single channel seismic reflection data using an 80 in^3 water gun as a source were acquired on grids surrounding 4 of the proposed drilling sites.

Finally, during the transit to and from Newport, we acquired several Acoustic Doppler Current Profiles (ADCP) to map currents offshore Cape Blanco.

Cruise Narrative:

This section contains a narrative of the cruise. Major activities are also summarized in Table 1, which shows both the budgeted time for various activities and the actual time required for those activities. Only actual times are shown for SCS data acquisition, since that activity was designed to fill gaps in the cruise schedule that were necessary because the R/V WECOMA had to wait for the R/V EWING to complete certain profiles before instruments could be retrieved. Although the single channel acquisition program had only contributed one additional day of ship time to the cruise, we had correctly anticipated that considerably more time would be available for that effort.

June 2: Beecher Wooding, David DuBois, Greg Miller and Vee-Ann Cross arrive in Newport OR from Woods Hole MA.

June 3: The truck with the shipment of equipment from Woods Hole arrives mid-morning and unloading begins. Anne Trehu arrives from Corvallis to help unload and to discuss the cruise plan with the scientific party and with Captain Doyle. Lab space in the newly refitted R/V WECOMA is ample to cover this multi-facetted effort. The wet lab becomes the staging area for the USGS OBS operation and for Beecher's part of the WHOI OBH operation. The aft section of the dry lab is dedicated to WHOI and OSU data processing computers (3 SUN SPARC stations, an HP LaserJet printer,and a PC). The central part of the lab becomes the WHOI OBH electronics lab, and the forward part is the center for digital echo sounding and single channel seismic acquisition. Jim Dolan and Ken Peal arrive in the evening.

June 4: Installation of the lab on the R/V WECOMA continues. Christof Lendl brings the OSU computer. Mitch Lyle and John Chambers arrive from Boise. The first major problem of the cruise occurs in the evening, when Anne Trehu receives a call from Mike Rawson aboard the R/V EWING with the news that the R/V EWING is in San Francisco rather than in Eureka, and that the casing for the multichannel streamer must be rebuilt. He estimates that the R/V EWING will not leave San Francisco before June 9 or 10. This represents a significant delay in the program of uncertain magnitude.

June 5: Installation of the lab on the R/V WECOMA and testing of instruments continues. Anne Trehu stops by to show the ship to her family. No further news on the status of the R/V EWING.

June 6: Installation of the lab on the R/V WECOMA and testing of instruments continues. We decide to delay departure of the R/V WECOMA from 0900 June 7 to 0900 June 8 in order to not get too far ahead of the R/V EWING.

June 7: Installation of the lab on the R/V WECOMA and testing of instruments continues.

June 8: The R/V WECOMA leaves the dock at 0905 and begins the transit to the experiment site. At 1633, the ADCP is turned on and three profiles are acquired offshore Cape Blanco. Weather is good.

June 9: The ADCP profiling is completed at 0345. Soon thereafter, we begin testing the WHOI acoustic releases. There is still no definite news on the R/V EWING start date, which translates into considerable uncertainty about when we should begin OBS deployments. By evening, it appears that the R/V EWING will probably be out of the shipyard on June 11, and we decide to start deployment of the first group of instruments on June 10. These instruments are programmed to have long recording periods, to accomodate uncertainties in the EWING schedule.

June 10: At 0600, we arrive at deployment site 1. 6 OBHs and 5 OBSs are deployed (GROUP I; sites 1-11) along lines 1 and 2 on June 10. The deployment began in 30-35 knot winds and 13 ft seas (table 2b), and ended in the evening with low winds and calm seas. Geographic and recording information for each site is summarized in Table 2a. Weather conditions during each deployment are summarized in Table 2b. The large crane was used for these deployments because the small articulating crane was not working.

June 11: We attempted to begin a SCS survey at ODP proposed site CA-7 at 0247. This effort was stymied by a series of problems with the water gun and streamer. June 11 was spent conducting a 3.5 and 12 kHz survey of the site and attempting to get the SCS system operational.

June 12. At 0545, we arrived at deployment site 12 and began deployment of GROUP II (sites 12-18), comprising 4 OBHs and 3 OBSs. These deployments proceeded uneventfully in moderate winds (8-18 knts). After finishing the deployment, we stayed on station for about 1.5 hours while the articulating crane was being fixed. The articulating crane was used for all subsequent instrument deployments and recoveries.

June 13. This day was spent doing a SCS survey of ODP proposed site CA-2. Because of problems with the recording system, only a portion of the data were recorded digitally. All of the data were recorded on the real-time analog display.

June 14. Recovery of GROUP I began at 0704 in rough seas. Three sites were recovered before 1253, by which time seas had deteriorated under sustained 40 knot winds, with gusts of 45 knots (under clear, sunny skies). We decided to transit to sites closer to shore to see if conditions would improve. The OSU marine techs and crew told us stories of such conditions being sustained for weeks on end in this region at this time of year! Recoveries could not resume until evening (1930), and proceeded through the night in moderate conditions.

June 15. The final attempted recovery was of a USGS OBS at site 6. This OBS did not respond to the transducer. A blind attempt was made to release it, and we stayed on site until it would have surfaced, had it released. After approx. 2 hours of searching the horizon, we abandoned the search and resumed transit to return to ODP proposed site CA-7, where 7.5 hours were spent collecting SCS data.

June 16. The first site of GROUP II, site 12, was recovered at 0045. This instrument had been deployed with GROUP II because of logistical reasons, but was functionally part of GROUP I. With 12 instruments aboard, we proceeded to begin the first redeployment of 8 instruments (GROUP III; sites 19-26). This redeployment was conducted in moderate conditions (18 knot winds, 7 ft seas) and was completed at 1715, at which time we proceeded to ODP proposed site CA-4 for a SCS survey.

June 17. At 1030, we began deployment of 3 instruments (GROUP IV; sites 27-29; table 2a) on Ewing line 8. This was completed at 1449, at which time we proceeded to ODP proposed site CA-1.

June 18. At 0953, we began to recover the six instruments of GROUP II in good conditions. Our enthusiasm about the good weather, however, was tempered by the disappointment resulting from the failure to record data on all 3 OBHs in this deployment group. The reasons for these failures were varied and are discussed in detail in Appendix A.

June 19. One additional OBS was deployed on line 8 (site 30) to target a feature of particular interest along this part of the Cascadia subduction margin. After this deployment, we returned to ODP proposed site CA-1, where SCS data were collected for about 10 hours.

June 20. The morning of June 20 was spent completing the second deployment (GROUP V; sites 31-35). Because of relatively good conditions (18-23 knot winds and 6 ft swells) and short transits between sites, this deployment was completed rapidly and we returned to CA-4.

June 21. We finished surveying at CA-4 at 0530. The recovery of 4 instruments from line 8 (GROUP IV and the first instrument of GROUP V) began at 1100 and finished at about 1700. We then transited slowly toward the seaward end of line 6 to continue instrument recoveries.

June 22. Instrument recoveries resumed at site 26 at 0530 and proceeded smoothly in good weather conditions until 2245. Sites 19-26 were recovered in this group. We then began a SCS survey at CA-2B at 2300.

June 23. The SCS survey continued until 1044. We then got underway to site 31. OBS/OBH recoveries resumed at 1520 and were completed at 2215. We then began setting up the SCS equipment to do a detailed survey of the deformation front near the intersection of MCS lines 3 and 6. Unfortunately, the data were very noisy. The problem was tracked down to the streamer, and the SCS survey was aborted (see Appendix C). We continued with a 3.5 KHz survey at this site until it was time to get underway to Eureka.

June 24. We arrived in Eureka at 1400 at the Sierra Pacific dock. Most of the OBS and OBH gear were offloaded onto the dock, awaiting arrival of the R/V Ewing, which was to transport the gear to Alaska for the next project. In the evening, most of the ship's personnel ventured ashore to explore Eureka.

June 25. The R/V Ewing arrived around 0600 and tied up just aft of the R/V Wecoma. It was not possible to load the OBS and OBH gear onto the R/V Ewing at this time because of streamer work on the R/V Ewing. Most of the gear sat on the dock until it was loaded onto the R/V Ewing on June 26. Most of the WHOI shipboard computer system was sent directly to Alaska via UPS. Most of the scientific party debarked at this time. Mitch Lyle, John Chambers, Pete Kalk and the OSU technical staff remained on board. The R/V Wecoma left Eureka for Newport at 1200. 3.5 and 12 KHz data and several ADCP profiles were collected on the transit back to Newport.

June 26. The R/V Wecoma arrived in Newport at 1530.

June 27. In Newport

Table 1.
Cruise summary for R/V WECOMA 9406A
Mendocino Triple Junction
June 8-26, 1994

date	**time** (local)	**summary of activity**	**estimated /actual time needed** (hours)
6/8/94	0905	Leave Newport for the seaward end of MCS line 2 (approx 360 nm)	36
	1633	Start ADCP survey, plan A.	
6/9/94	0345	ADCP survey completed.	
	0809	Start WHOI release tests.	8/9
	1700	Finish WHOI release tests.	
6/10/94	0600	Arrive at site 1 to begin GROUP 1 deployment (6 OBH, 5 OBS).	21/17.3
	2320	Finish deployment at site 11 of GROUP I. Underway to beginning of GROUP II.	
6/11/94	0055	Start SCS survey at CA-7. Because of problems with the water gun and streamer, this is primarily a 3.5 and 12 kHz survey.	?/26
6/12/94	0247	Stop survey at CA-7.	
	0545	Arrive at site 12 of GROUP II deployment (4 OBH; 3 OBS). Deployment includes approx 200 nm of transit.	20.5/12.7
	1828	Finish deployment at site 18 of GROUP II. Stay on site to fix articulated crane.	
	1945	Crane fixed. Underway to SCS CA-2 survey site.	
	2326	Deploy SCS for CA-2 survey.	?/24
6/13/94	2357	Finish CA-2 SCS survey.	
6/14/94	0704	Start GROUP I recovery at site 1.	30/31
	1253	Finish recovery of site 3 in rough seas. Stop recovery of the rest of GROUP I to wait for seas to calm down.	(this includes
	1930	Resume recovery of GROUP I at site 10. Sites recovered in the following order: 10, 11, 9, 8, 7, 5, 4, 6. OBS at site 6 was not recovered.	6.5 hrs waiting for calmer seas)
6/15/94	1400	Abandon search for OBS. Start SCS survey at site CA-7.	
	2130	Finish SCS survey at CA-7.	?/7.5
6/16/94	0045	Recover OBH at site 12 (first deployment of GROUP II).	
	0600	Start GROUP III deployment at sites 19-26 (5 OBH and 3 OBS on the seaward end of line 6 and along line 5)	20/11
	1715	Finish GROUP III deployment. Head to SCS survey site CA-4	
	2027	Arrive at SCS survey site CA-4 and begin survey.	?/9.5

6/17/94	0600	Leave CA4 and head to seaward end of line 8	
	1030	Start deployment of 2 OBH and 1 OBS on line 8 (GROUP 4)	6/4.3
	1449	Go to SCS site CA1	
	1700	SCS profiling at CA1	?/13
6/18/94	0600	Leave CA1 and head for north end of line 3 (56 nm)	
	0953	Pick up 3 OBH and 3 OBS from line 3 (82 nm transit).	20/13
6/18/94	2300	Finish pickup of instruments and get underway to OBS site 30 on line 8	
6/19/94	0934	At OBS station 30	
	0959	Underway to SCS site CA-1	
	1223	Start SCS survey at CA-1	?/9.75
	2212	Finish SCS. Underway to east end of line 6.	
6/20/94	eta 0300	Redeploy 3 OBH and 2 OBS line 6 (GROUP 5)	8
	1100	Finish redeployment. Transit to CA-4 for SCS survey (60 nm)	6
	1700	Arrive at CA-4. Survey for 15 hrs	15
6/21/94	0800	Transit to OBS site 27 (55 nm)	5.5
	1330	Start pickup of 4 instruments on line 8.(10.5 hrs) .	10.5
6/22/94	0000	Finish pickup of line 8. Start transit to site 23 (68 nm)	7
	0700	Arrive at site 23. Pick up 23 to 19, heading south. (14.5 hours)	14.5
6/22/94	2130	Finish line 5 pickup. Spend 12 hours at CA-2 doing SCS. If there are delays earlier in the program, SCS time here will be decreased accordingly.	12
6/23/94	0930	Finish SCS and transit toward west end of line 6.(60 nm)	6
	1530	Start line 6 pickup of 5 instruments.	
	2214	Finish line 6 pickup.	12/6.75
	2300	Deploy SCS system for high-resolution survey of the deformation front between MCS3 and MCS6.	
6/24/94	0248	Abandon SCS survey because of equipment problem. Continue with a 3.5 KHz survey.	
	1120	Head for Eureka.	
	1400	Tie up at the Sierra Pacific dock in Eureka. Start packing and unloading ship.	
6/25/94	1220	Leave Eureka. Trehu, Lendl, and WHOI and USGS personnel remain on shore. Lyle and Chambers ride back to Newport.	
6/26/94	1530	Arrive Newport.	
6/27/94		Finish unloading.	

Table 2: Deployment Information Summary

site no.	inst. ID	latitude	longitude	water depth*	inst. type	drop time (PDT)	start recording (GMT)	release time (GMT)**	comment
1	23	39 16.783	124 58.183	3045	WHOI	6/10/0722	6/12/1900	6/14/1320	
2	C1	39 17.80	124 49.283	2825	USGS	6/10/0856	6/12/1200	6/14/1606	4 comp
3	21	39 19.283	124 37.583	3090	WHOI	6/10/1048	6/12/1200	6/14/1802	
4	C9	39 20.200	124 30.067	2350	USGS	6/10/1224	6/12/1200	6/15/1628	4 comp
5	24	39 21.100	124 22.683	1706	WHOI	6/10/1430	6/12/1200	6/14/1500	
6	B1	39 21.983	124 15.200	1223	USGS	6/10/1606	6/12/1200	6/15/1832	not recovered
7	17	39 22.900	124 08.017	825	WHOI	6/10/1711	6/12/1200	6/15/1305	
8	A3	39 23.850	124 00.983	495	USGS	6/10/1810	6/12/1200	6/15/0752	4 comp
9	16	39 24.683	123 53.800	105	WHOI	6/10/1922	6/12/1200	6/15/0642	
10	C3	39 40.600	123 53.667	115	USGS	6/11/2111	6/12/1200	6/15/0241	no data
11	18	39 38.083	124 07.933	995	WHOI	6/11/2258	6/12/1200	6/15/0421	
12	22	39 30.883	124 50.30	2825	WHOI	6/12/0633	6/12/1900	6/16/0746	
13	26	39 47.017	125 9.967	2953	WHOI	6/12/0920	6/15/0700	6/19/0456	no data
14	C4	40 00.033	124 54.667	1570	USGS	6/12/1136	6/15/0700	6/19/0143	2 comp
15	A1	40 12.383	124 38.65	610	USGS	6/12/1326	6/15/0700	6/18/2340	2 comp moved site upslope to avoid rough bottom
16	20	40 22.567	124 28.050	640	WHOI	6/12/1503	6/15/0700	6/18/2111	no data moved site to get into trough
17	27	40 33.000	124 41.983	404	WHOI	6/12/1650	6/15/0700	6/18/1923	no data
18	A2	40 42.000	124 57.000	2360	USGS	6/12/1828	6/15/0700	6/18/1704	2 comp moved station NW to get to flat topo
19	24	39 57.783	125 27.283	2950	WHOI	6/16/0600L	6/17/1700	6/23/0445	
20	C3	40 09.967	125 28.200	2375	USGS	6/16/0854	6/17/1900	6/23/0240	4 comp
21	18	40 18.383	125 28.983	1890	WHOI	6/16/1042	6/17/1700	6/23/0051	
22	17	40 27.517	125 29.733	2810	WHOI	6/16/1230	6/17/1700	6/22/2221	
23	C1	40 34.950	125 30.15	2893	USGS	6/16/1324	6/17/1900	6/22/2035	4 comp
24	21	40 52.833	125 15.233	2990	WHOI	6/16/1642	6/17/1700	6/22/1725	
25	22	40 55.083	125 31.967	3075	WHOI	6/16/1906	6/17/1700	6/22/1503	
26	A3	40 56.800	125 45.000	3131	USGS	6/16/2136	6/20/1900	6/22/1225	4 comp

27	23	41 15.483	125 05.783	3100	WHOI	6/17/1000	6/18/0000	6/21/1808	moved site west to avoid 50m scarp
28	C9	41 20.067	124 47.75	1085	USGS	6/17/1200	6/19/1700	6/21/2058	4 comp
29	16	41 24.750	124 30.033	345	WHOI	6/17/1400	6/18/0000	6/21/2334	
30	C4	41 22.30	124 39.88	1150	USGS	6/19/0930	6/20/0200	6/21/2213	no data 4 comp
31	20	40 46.567	124 29.183	250	WHOI	6/20/0400	6/20/1800	6/23/2223	
32	A1	40 47.30	124 35.783	519	USGS	6/20/0545	6/20/1800	6/23/2352	4 comp
33	27	40 48.18	124 42.7	1000	WHOI	6/20/0730	6/20/1800	6/24/0047	
34	26	40 49.6	124 51.98	2250	WHOI	6/20/0915	6/20/1800	6/24/0215	toe of deformation front althoug map says abyssal plain
35	A2	40 50.8	125 59.967	2800	USGS	6/20/1100	6/20/1800	6/24/0412	4 comp change site to decrease site spacing

* Water depth calculated assuming sound velocity in water of 1500 m/s. Depth not corrected for the depth of the transducer below the sea surface.

* In most cases, the release time corresponds to the end of recording time. Exceptions are USGS OBS's recording four component data and having longer than 72 hours between the start recording time and the release time.

Table 2b. Weather conditions during deployments

R/V WECOMA
Cruise W 9406 A

Station	Date	Time	Wind Direction (° true)	Wind Speed (Knots)	Swell Direction (° true)	Swell Height (ft)	Visibility (Naut mi)	Weather
1	6/10/94	0723	330	36	355	12	10	Partly Cloudy
					320	8-10		Haze
2	6/10/94	0856	320	35	350	14	11	Slight Haze
3	6/10/94	1048	300	36	340	13	10	Hazy
4	6/10/94	1225	325	34	355	13	8	Haze
					340	13		
5	6/10/94	1430	325	30	355	13	8	Haze
					330	13		
6	6/10/94	1606	310	24	340	8	8	Haze, Partly Cloudy
7	6/10/94	1711	330	17	330	6-8	8	Haze
8	6/10/94	1815	310	15	320	6-8	8	Haze
9	6/10/94	1923	245	4	300	5-7	8	Haze, Partly Cloudy
10	6/10/94	2111	variable	weak	320	6	7	Hazy
11	6/10/94	2259	330	30	320	7	8	Haze
12	6/12/94	0633	310	25	330	5	12	Overcast
13	6/12/94	0920	310	17	320	5	2	Patchy Fog
14	6/12/94	1136	300	21	320	5	2	Patchy Fog
15	6/12/94	1326	325	8	310	5	10	Overcast
16	6/12/94	1503	335	9	310	5	5	Overcast
17	6/12/94	1651	245	13	310	4	12	Cloudy
18	6/12/94	1828	210	10	310	4	12	Cloudy
19	6/16/94	0634	355	18	320	7	12	Partly Cloudy
20	6/16/94	0805	340	17	290	6	12	Partly Cloudy
21	6/16/94	0925	340	17	290	7	12	Partly Cloudy
22	6/16/94	1048	340	16	310	7	12	Partly Cloudy
23	6/16/94	1204	330	16	320	7	12	Partly Cloudy
24	6/16/94	1419	325	18	310	7	12	Partly Cloudy
25	6/16/94	1555	340	23	330	7	12	Partly Cloudy
26	6/16/94	1706	330	24	340	7	12	Partly Cloudy
27	6/17/94	1128	335	16	340	6	12	Cloudy
28	6/17/94	1304	325	12	340	6	12	Cloudy
29	6/17/94	1440	325	12	310	6	12	Partly Cloudy
31	6/20/94	0358	345	18	340	6	12	Cloudy
32	6/20/94	0447	355	22	345	6	12	Cloudy
33	6/20/94	0540	355	22	345	6	12	Cloudy
34	6/20/94	0647	350	20	345	6	12	Cloudy
35	6/20/94	0739	355	23	345	6	12	Cloudy

Data acquired:

The deployment pattern for the OBS/OBH array was designed to optimize large aperture data acquisition along a network of deep crustal multichannel seismic (MCS) reflection profiles acuqired by the R/V Ewing within logistical constraints imposed by the time required to recover, reprogram, and redeploy instruments. Logistical constraints limited us to two deployments of each instrument (with the exception of the one instrument that was not recovered after the first deployment). Figure 1 shows the location of the MCS profiles. The start and end times of each R/V Ewing profile are summarized in Table 3. Parameters for moderate-size regional earthquakes that occurred during the deployment period are also included. Figure 2 shows the OBS (circles) and OBH (squares) deployment sites. Geographic coordinates of deployment sites and the time period recorded at each site are summarized in Table 2. Figure 3 shows the R/V Wecoma track chart with the ODP site-surveys identified.

Two of the Ewing profiles (WA/MCS 1 and WA/MCS 6) represent offshore extensions of profiles shot onshore in 1993 and were primary targets for OBS/OBH data acquisition. Half of the available instruments on each deployment were located along each of these profiles. These profiles were each shot twice: once with an approximate shot interval of 50 s (WA) and once with an approximate shot interval of 20 s (MCS). The longer shot interval was needed to avoid having water-borne energy from the previous shot interfering with the faster and lower amplitude crustal arrivals in the offset range of interest. The shorter interval was needed to obtain high fold MCS data. The adequacy with which the previous shot noise can be removed from the data post-facto is controversial, and this data set should permit us to evaluate whether shooting lines twice with two different shot intervals is needed. Two instruments failed to record data on WA/MCS1. All instruments recorded WA/MCS6. These profiles were recorded on dense onshore arrays and on the distributed 2-D array that recorded the entire experiment.

Although MCS 3 was also a primary target for the onshore instruments, we were only able to deploy a sparse array of OBS/OBH instruments on this profile. Moreover, this deployment was plagued by several instrument failures. The data that were recorded, however, are of excellent quality. This profile was also recorded on a dense onshore array.

MCS 2 and MCS 8 were secondary targets and provide additional crossings of the continental margin south and north of the MTJ for comparison with the primary profiles. These two profiles were also instrumented with sparse arrays of onshore instruments. MCS 5 was also an important secondary target for the OBS/OBH experiment because this profile provides a crossing of the ridge and trough structure associated with the Mendocino transform fault seaward of where it is affected by triple junction processes. In addition, as much fan data was collected as possible in order to extend our 3-dimensional coverage of crustal structure. A matrix summarizing the complete data set is shown in table 4.

Most of the merging of the data with the shot instant information from the R/V Ewing and reformatting of the data into SEGY disk file format was accomplished on board (Table 4). This was an ambitious undertaking, and its success was due to hard work and to the excellent computer facilities provided on board by WHOI, USGS, and OSU. These facilities are discussed below and included a network of SUN workstations. Once the data were converted to SEGY format, they were filtered and plotted using SIOSEIS seismic processing software. Raster plot files were then converted to postscript format for output on an HP LaserJet printer. The speed and high resolution (600 dpi) of the printer made it a compact yet practical method to obtain a permanent record of the processing done on board.

Most of the data were displayed and printed in this manner while at sea. It was very satisfying to step ashore with a thick folder documenting the data.

Several examples of shipboard record sections are shown in figures 4-8. Figure 4 shows a record section recorded on the vertical component of an OBS from WA-1. Figure 5 shows data recorded on an OBH during WA-6. Figure 6 shows a fan shot recorded at site 12 from shots along WA-1. Data have been filtered with the pass band of 8-30 Hz, a reduction velocity of 8.0 km/s and two adjacent traces have been stacked together for the displays in figures 4-6. One interesting feature of these record sections is the generally better signal propagation south of the Mendocino transform fault, in spite of the fact that weather conditions were better during WA6. We tentatively attribute this to two factors: less ship traffic during bad weather, and higher attenuation in sediments of the Eel River Basin.

Figures 7 and 8 show data collected on OBS A1 during MCS3. Data have been filtered with the pass band of 8-30 Hz, a reduction velocity of 6.5 km/s and three adjacent traces have been stacked together for these displays, which illustrate variability in the amplitude of the the water-borne energy. At this site, water-borne energy has a very long coda and severely affects the data from shots north of the site (figure 7). It is much less of a problem for shots south of the site, where the coda is shorter and high velocity signals can be seen cross-cutting the water-borne arrivals (figure 8).

Shipboard computer system:

A powerful computer network, comprising SUN, PC-type and Mactintosh computers and associated peripherals belonging to OSU, WHOI and USGS was installed on board. The expanded laboratory on the Wecoma permitted us to install and use this network in relative comfort.

The components of this network are listed in Table 5. This network permitted simultaneous playback, reformatting, processing, and display of the data. The ethernet connection between these computers was a critical part of this facility, permitting convenient transfer of files among the various computers and peripherals and shared use of the peripherals. In fact, the ethernet was a bottleneck in the system because it was so heavily used. The other, and primary, bottleneck was due to the the slow rate of data transfer on and off exabyte tape.

Communications:

The cruise discussed in this document represented only one part of a four part data acquisition effort. The schedule was driven by MCS data acquisition on the R/V Ewing. The other two parts were land-based efforts to record the Ewing shots on several densely-sampled profiles and on a sparse, 2-dimensional grid of seismic stations. Good communication among the four groups involved was very important and generally successful.

Our primary mode of communication was through cellular phone. This was the most convenient means of communication, since a phone was available in the lab and use of the phone did not require technical assistance from the ship's crew or OSU technical staff. The quality of the connection was generally excellent when the ship was within 100 km of the shore. Much of this success is probably attributable to the special antenna mounted on the R/V Wecoma. The cellular phone on the R/V Ewing, which had been rented for the project, had a much more limited operating range. Occasionally, the R/V Wecoma had to be an intermediate link between the land operation and the R/V Ewing.

The cellular phone was also used for transfer of R/V Ewing navigation and shot instant data via modem. The R/V Ewing used INMARSAT to transfer their data to Lamont, where it was deposited in a directory on a SUN workstation that could be accessed via the internet through anonymous ftp. Although we initially planned to retransmit those data to the R/V Wecoma via INMARSAT, it rapidly became apparent that a less expensive alternative would be preferrable. We therefore attempted to transfer the data via modem and cellular phone. Prior to transferring the data, we transferred it to the OSU Oceanography SUN computer via ftp and compressed it. The compressed data files were transferred from OSU to the ship via modem using *kermit* in binary mode. The ship's modem is run through a PC; at OSU, we used a modem operated by the University ComputingSystem, and accessed the Oceanography network through *telnet*. Although the ship's modem supports baud rates up to 7200 bpi, the quality of the line on the cellular phone generally limited us to a baud rate of 4800 bpi, which was determined automatically by the modem. A connection at 7200 bpi was made once, but was lost within a few minutes. It is worth noting that it was frequently necessary to restart *kermit* several times because file header information was often not correctly transferred; once the header was transferred, however, transmission of the rest of the file almost always proceeded without error. We also note that the estimated transmission times calculated by *kermit* were generally too long by a factor of about about 5. The compressed files were transferred from the PC to the SUN workstations via the ship's ethernet, and then uncompressed for further processing.

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TABLE 3: START AND STOP TIMES OF EWING PROFILES.

Line ID	Start time (GMT) m/d/h/m/s	End time (GMT) m/d/h/m/s	First shot	Last shot
MCS-1b	6/12/21/04/13	6/13/05/12/46	151	1594
WA-1	6/13//06/34/52	6/13/16/46/34	100	854
MSC-1c	6/13/18/35/55	6/13/22/26/07	137	763
MCS-11	6/14/00/05/40	6/14/04/48/27	100	854
MCS-2	6/14/06/40/04	6/14/17/50/23	100	2001
MCS-10a	6/14/19/05/53	6/14/23/59/51	100	867
MCS-10b	6/15/00/00/10	6/15/07/05/50	868	2036
MCS-7	6/15/21/35/13	6/16/00/03/41	98	533
MCS-7a	6/16/02/45/01	6/16/23/05/21	100	3453
MCS-Bn	6/17/04/33/31	6/17/09/55/42	99	1113
MCS-12	6/17/10/27/55	6/17/16/59/54	109	1246
MCS-3	6/17/19/14/56	6/18/18/16/58	100	4225
MCS-4	6/19/00/02/03	6/19/07/36/56	100	1424
MCS-5	6/19/09/30/27	6/19/23/40/43	100	1617
MCS-8	6/20/03/42/11	6/20/13/55/00	110	1917
MCS-An	6/20/14/36/29	6/21/00/26/24	104	1892
WA-6	6/21/02/29/37	6/21/17/01/51	116	1067
MCS-6	6/21/23/38/59	6/22/13/30/22	100	2568
MCS-As	6/22/14/59/49	6/22/23/59/52	100	1832

Blanco Fracture Zone earthquake: 6/14/02/04
Eureka (Mendocino Fracture Zone) earthquake: 6/19/10/39

note: MCS lines have a shot interval of approximately 20 s. WA lines have a shot interval of approximately 50 s. MCS-3 has a shot interval of 40 s at the ends of the line and a shot interval of 20 s in the middle.

note: 6/12 is Julian Day 163.

TABLE 4: DATA ACQUISITION SUMMARY

X - recorded and reformatted to segy format before the end of the cruise.
Y - recorded but not reformatted before the end of the cruise.
0 - not recorded.

STATION	INST ID	MCS 1b	WA 1	MCS 1c	MCS 11	MCS 2	MCS 10	MCS 7	MCS 7A	MCS Bn	MCS 12	MCS 3	MCS 4	MCS 5	MCS 8	MCS An	WA 6	MCS 6	MCS As	MCS Bs	Blanco	Eureka
1	23	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
2	C1	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
3	21	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
4	C9	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
5	24	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
6	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
7	17	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	A3	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
9	16	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
10	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	18	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	0
12	22	X	X	X	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0	0	Y	0
13	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	C4	0	0	0	0	0	0	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0
15	A1	0	0	0	0	0	0	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0
16	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	A2	0	0	0	0	0	0	X	X	X	X	X	0	0	0	0	0	0	0	0	0	0
19	24	0	0	0	0	0	0	0	0	0	0	X	X	X	X	Y	X	X	Y	0	0	X
20	C3	0	0	0	0	0	0	0	0	0	0	X	X	X	Y	Y	0	0	0	0	0	X
21	18	0	0	0	0	0	0	0	0	0	0	X	X	X	X	Y	X	X	Y	0	0	X
22	17	0	0	0	0	0	0	0	0	0	0	X	X	X	X	Y		X	Y	0	0	X
23	C1	0	0	0	0	0	0	0	0	0	0	X	X	X	Y	Y	0	0	0	0	0	X
24	21	0	0	0	0	0	0	0	0	0	0	X	X	X	X	Y	X	X	Y	0	0	X
25	22	0	0	0	0	0	0	0	0	0	0	X	X	X	X	Y	X	X	Y	0	0	X
26	A3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	X	0	0	0	0
27	23	0	0	0	0	0	0	0	0	0	0	0	X	X	X	Y	X	0	0	0	0	X
28	C9	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	Y	X	0	0	0	0	0
29	16	0	0	0	0	0	0	0	0	0	0	0	X	X	X	Y	X	0	0	0	0	X
30	C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	X	Y	Y	0	0
32	A1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	Y	Y	0	0	0
33	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	X	Y	Y	0	0
34	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	X	Y	Y	0	0
35	A2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	X	Y	Y	0	0	0

TABLE 5: SHIPBOARD COMPUTER NETWORK

Name	Description	Owner
oldman	Sun Sparc 10	OSU
dudley	x-term	OSU
snidely	x-term	OSU
indigo	Sun Sparc 1+, SunOS 4.1.3, ~ 3.0 GBytes	WHOI
alpamayo	Sun Sparc LX, Solaris 2.0, ~ 2.0 GBytes	WHOI
baileycs	PC, NEC286, DOS 5.0	WHOI
obs	PC, 386, 2.2 GByte, Exabyte	USGS
panhead	Masscomp	USGS
obh2	PC, NEC386, DOS 5.0	WHOI
pumori	HP LaserJet 4	WHOI
quakes	Sun Sparc LX, Solaris 2.0, 1.0 GByte	OSU