



New Zealand South Island Geophysical Transect (SIGHT)

Cruise Report for R/V Maurice Ewing EW-9601A

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Summary

This report documents R/V Maurice Ewing cruise EW-9601, which formed a major part of a multidisciplinary, joint US - New Zealand investigation of continental deformation at convergent plate boundaries (SIGHT - the South Island Geophysical Transect). The Alpine Fault zone of the South Island of New Zealand marks the Pacific/Australian plate boundary, where oblique convergence of two thin continental crustal blocks has built the Southern Alps. The active-source component of SIGHT was designed to exploit the narrowness of the South Island by using onshore/offshore seismic techniques to provide a detailed image of the boundary from both sides.

The Ewing fired over 41,000 shots from its 20-gun tuned airgun source into a wide array of seismic receivers: the Ewing's 4-km-long multichannel streamer, eleven Woods Hole Oceanographic Institution *ocean-bottom hydrophones* (OBH) and nine U.S. Geological Survey *ocean-bottom seismometers* (OBS), and 200 Reftek portable seismometers deployed on three major transects and several cross-lines. All operational goals of the experiment were attained. Forty-four deployments and recoveries of OBH/S were accomplished; the multichannel streamer was deployed and recovered twice; and sixteen sonobuoys were launched. Preliminary velocity models were produced shipboard for one of the onshore explosion transects and one of the offshore OBH lines. Brute stacks of all MCS lines were produced shipboard, showing reflections from the entire crust and Moho. The resulting data sets will provide fundamental new information on the deep structure of the Pacific/Australian plate boundary and, when combined with the passive seismic, petrophysical, magnetotelluric, and (Geological data being acquired under the auspices of this project, enable new insights into the deformation of continental lithosphere under oblique compression.

SCIENTIFIC OBJECTIVES

This cruise forms a major part of a joint US- New Zealand investigation aimed at

improving our understanding of continental deformation at convergent plate boundaries. Mountain belts are the highly visible products of continental collisions and contain unique clues about the Theological properties of continental lithosphere and the processes by which it deforms. Within mountain belts, compression, overthrusting, and erosion often combine to expose large sections of high-grade metamorphic rocks and associated faults. Collisional mountain belts are usually paired with, and mechanically linked to, large asymmetric foreland basins that contain much of the world's hydrocarbons.

On the South Island of New Zealand, along the Pacific/Australian plate boundary, youthful oblique convergence of two thin continental crustal blocks - the submerged Lord Howe Rise to the west and the Chatham Rise/Campbell Plateau to the east - has resulted in a relatively narrow (-80 km wide) zone of active mountain building, the Southern Alps. The plate boundary has recently been forced into a conditemon of transpression through plate boundary reorganization processes. The South Island thus offers a natural laboratory for the study of partitemoning between convergence and translation. In the central Southem Alps of New Zealand, there is also the apparent paradox that the greatest present uplift and deformation is associated with relatively low seismicity. Finally, the narrowness of the South Island provides a unique opportunity to use marine onshore/offshore seismic techniques to provide a detailed image of the boundary from both sides.

The active-source seismic survey was designed to provide fundamental knowledge on deformation in a transpressional continental orogen by identifying potential strain markers in the lithosphere on both sides of the plate boundary. By tracing these strain markers such as the Moho, lower-crustal laminations, and crustal shear zones - we hope to constrain whether, and at what levels of the lithosphere, strain is accommodated by brittle faulting or plastic flow. The specific goals of the survey were to obtain wide-angle onshore/offshore, marine multichannel seismic, and OBH/S wide-angle data along three profiles, two across the orogen and one across undeformed rocks that form the orogen. The data acquired will constrain models of continental collision by providing information on :

- crustal thickness across the orogen
 - seismic velocity structure through the crust and upper mantle
 - structure and inferred deformation under the upthrust Southern Alps
 - change in structure across the plate boundary
 - seismic structure of the relatively undeformed crust on either side of the orogen
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- Deploy and recover 20 OBH/S on two 200 km profiles (9 OBH/s per profile) and a tie line (2 OBH/S) on each side of the South Island.
 - Fire the 20 - gun array into the OBH/S, MCS streamer, and the onshore array to give two 600 km long, composite profiles across the collisional orogen.
 - Obtain MCS data alon- these profiles.
 - Record sonobuoy and MCS data on the Dunedin and Stewart Island profiles.
 - Record a cross-pattern of profiles where the Haast schist projects offshore to measure P-wave anisotropy at seismic wavelengths.
 - Maintain good communications with the onshore base in Timaru.

- Produce SEGY archive files for the OBS/H data and sonobuoy data.
- Copy all MCS prestack data to DAT tapes.
- Produce a preliminary stack of the MCS data along the main profiles. All operational goals were achieved.

Cruise Participants



RV Ewing

- **W. Steven Holbrook** Co-Chief Scientist WHOI
- Fred J. Davey Co-Chief Scientist IGNS
- F. Beecher Wooding Research Specialist WHOI
- James Dolan Research Associate WHOI
- David DuBois Research Assistant WHOI
- Dan Lizarralde Graduate Student WHOI
- Jun Korenaga Graduate Student WHOI
- Greg Miller Physical Scientist USGS
- Robert Busby Consultant Channel Z Seismometry
- David Wilson Graduate Student Univ. of Otago
- Chis Henstock Graduate Student Univ. of Otago
- Joseph N. Stennett Science Officer LDEO
- William J. Robinson System Manager LDEO
- Charles W. Donaldson Electronic Technician LDEO
- John G. DiBernardo Airgun Technician LDEO
- Ropate Maiwiriwiri Airgun Technician LDEO
- Paul O. Olsgaard Airgun Technician LDEO
- Matthew J. Cheslik Airgun Technician LDEO

Cruise Data

Deployment data

Deployment #1 - West Coast (Lines 1W, 12W, 2W, 23W, 3W)

SITE	OBS	DATE/TIME	Deploy LAT.	Deploy LON.	DEPTH(M)	START TIME	DATE/TIME	Recover LAT.	Recover LON.
5	A2	2/09/96 23:56	42 48.702'S	169 53.162'E	520	2/13/96 07:00	2/17/96 16:00	N/A	N/A
6	C1	2/10/96 01:28	42 39.077'S	169 41.360'E	859	2/13/96 07:00	2/17/96 17:58	420 39.106'S	169 40.975'E
7	C9	2/10/96 03:27	42 26.972'S	169 26.759'E	1080	2/13/96 07:00	2/17/96 20:26	42 26.952'S	169 26.607'E
8	C3	2/10/96 05:40	42 12.418'S	169 09.356'E	1221	2/13/96 07:00	2/17/96 23:09	42 12.563'S	169 09.008'E
12	C4	2/10/96 18:10	42 29.570'S	168 18.422'E	1572	2/13/96 07:00	2/18/96 18:03	42 29.245'S	168 18.131'E
13	A3	2/10/96 20:47	42 44.142'S	168 38.618'E	1272	2/13/96 07:00	2/18/96 20:59	42 44.189'S	168 38.666'E
14	AI	2/10/96 22:37	42 53.741'S	168 52.026'E	1037	2/12/96 07:00	2/18/96 23:00	42 53.646'S	168 52.110'E
15	A8	2/11/96 00:35	43 05.335'S	169 08.476'E	860	2/13/96 07:00	2/19/96 01:24	43 05.241'S	169 08.609'E
16	A4	2/11/96 04:07	43 14.810'S	169 21.900'E	716	2/13/96 07:00	2/19/96 03:28	N/A	N/A

Deployment #2 - East Coast (Lines 4E, 41E, 1E, 12E, 2E, 25E, 5E, 6E)

SITE	OBS	DATE/TIME	Deploy LAT.	Deploy LON.	DEPTH(M)	START TIME	DATE/TIME	Recover LAT.	Recover LON.
24	A2	2/21/96 22:40	44 54.600'S	171° 48.388'E	120	2/24/96 02:00	3/02/96 18:10	44° 54.239'S	171° 48.495'E
25	A3	2/22/96 00:05	45 02.221'S	172 00.293'E	1082	2/24/96 02:00	3/02/96 20:20	45 02.043'S	172 00.294'E
26	C3	2/22/96 01:53	45° 11.268'S	172 14.402'E	1395	2/24/96 02:00	3/02/96 23:30	45° 11.177'S	172 14.496'E
27	AI	2/22/96 04:36	45 21.753'S	172 30.927'E	1452	2/24/96 02:00	3/03/96 02:10	45 21.744'S	172° 31.000'E
32	C1	2/22/96 16:19	45 04.399'S	172 49.309'E	1398	2/24/96 02:00	3/03/96 17:14	45 04.380'S	172 49.316'E
33	C4	2/22/96 18:22	44 53.109'S	172 34.006'E	1194	2/24/96 02:00	3/03/96 18:35	44 52.966'S	172 34.036'E
34	C9	2/22/96 19:52	44 44.499'S	172 22.418'E	324	2/24/96 02:00	3/03/96 21:15	44 44.389'S	172 22.465'E
35	A8	2/22/96 21:29	44 37.085'S	1720 12.524'E	117	2/24/96 02:00	3/03/96 22:35	44 37.071'S	172 12.461'E

Deployment #3 - Southern Cross (Lines SCI, SC2, SC3, SC4)

SITE	OBS	DATE/TIME	Deploy LAT.	Deploy LON.	DEPTH(M)	START TIME	DATE/TIME	Recover LAT.	Recover LON.
43	A8	3/05/96 02:07	45 21.40'S	171° 10.09 E	56	3/05/96 04:00	3/06/96 09:58	45 21.60'S	171 10.15'E
44	A2	3/05/96 03:16	45 16.00'S	171 00.99'E	32	3/05/96 04:00	3/06/96 11:10	N/A	N/A

OBS DATA QUALITY

Experiment 1

SITE	LAST TRACK START	TRACKS RECORDED	TRACKS ARCHIVED	DATE/TIME	PREDEPL(ms)	DATE/TIME	POSTRECOV(ms)	COMMENTS
5-A2	-	44	44	2/09/20:51	6.92	2/17/16:40	N/A	Disk crashed. Data logger reset. 2 Channels good - V., Hyd.
6-CI	-	151	151	2/09/19:23	5.64	2/17/16:35	-71.2	2 Channels good - V., Hyd.
7-C9	-	188	188	2/09/20:03	9.2	2/17/20:46	-76.4	2 Channels good - V., Hyd.
8-C3	-	155	155	2/09/17:39	3.84	2/17/23:38	-89.6	2 Channels good - V., Hyd.
12-C4	2/18/18:11	187	187	2/10/08:43	4.68	2/18/18:37	-94.0	2 Channels good - V., Hyd.
13-A3	2/18/18:53	188	188	2/10/09:32	0.45	2/18/21:25	-78.0	2 Channels good - V., Hyd.
14-A1	2/18/09:42	209	209	2/10/08:10	0.41	2/18/23:43	-96.0	2 Channels good - V., Hyd.
15-A8	2/19/01:36	394	394	2/10/07:32	9.60	2/19/01:46	-40.8	Vertical attenuated. Hor. 1, Hor. 2, Hyd. good.
16-A4	2/19/01:36	394	394	2/10/21:37	5.72	2/19/03:52	N/A	Data logger reset on recovery. Release damaged. Cannot redeploy. 4 Channels good - V., Hor. 1, Hor. 2, Hyd.

Experiment 2

SITE	LAST TRACK START	TRACKS RECORDED	TRACKS ARCHIVED	DATE/TIME	PREDEPL(ms)	DATE/TIME	POSTRECOV(ms)	COMMENTS
24-A2	3/02/09:58	500	500	2/21/18:22	9.76	3/02/18:56	-90.4	4 Channels V., Hor. 1, Hor. 2, Hyd.
25-A3	3/01/04:23	209	209	2/21/19:16	3.52	3/02/20:48	-92.0	2 Channels good - V., Hyd.
26-C3	3/01/04:41	209	209	2/21/23:25	7.16	3/02/23:54	-106.0	2 Channels good - V., Hyd.
27-AI	3/01/04:41	209	209	2/21/19:53	5.56	3/03/02:44	-107.0	2 Channels good - V., Hyd.
32-CI	3/01/04:41	209	255	2/22/07:26	3.88	3/03/17:34	-103.0	2 Channels good - V., Hyd.
33-C4	3/01/04:41	209	255	2/22/08:42	9.52	3/03/19:58	-101.0	2 Channels good - V., Hyd.
34-C9	3/01/04:41	209	255	2/22/06:43	6.56	3/03/21:34	-108.0	2 Channels good - V., Hyd.
35-A8	3/02/09:47	500	255	2/22/05:13	1.96	3/03/23:20	-63.28	4 Channels good - V., Hor. 1, Hor. 2, Hyd.

Experiment 3

SITE	LAST TRACK START	TRACKS RECORDED	TRACKS ARCHIVED	DATE/TIME	PREDEPL(ms)	DATE/TIME	POSTRECOV(ms)	COMMENTS
43-A8	3/06/09:38	84	94	3/04/11:15	6.8	3/06/10:20	2.72	4 Channels good - V., Hor. 1, Hor. 2, Hyd.
44-A2	3/06/10:28	86	86	3/04/09:50	4.04	3/06/11:34	-17.2	4 Channels good - V., Hor. 1, Hor. 2, Hyd.

- *Nav plot of OBH/S deployment locations for East and West lines*
- *Nav plot of OBS deployment locations for 'Southern Cross' lines*
- *OBH22 data plot of Line 3W*