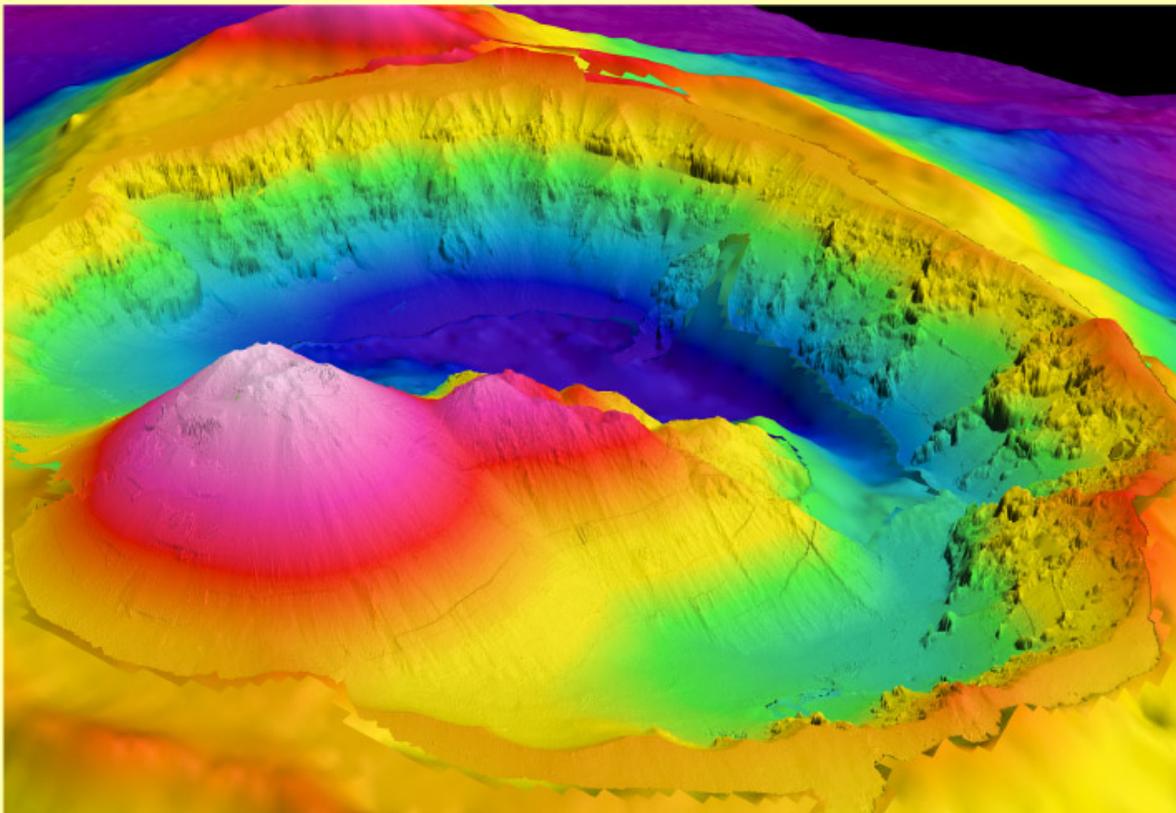


New Zealand American Submarine Ring of Fire 2007

**Brothers volcano, Kermadec arc
Ngatoro Rift and Havre Trough**

R/V *Sonne* ROVARK Cruise
ABE Dives 203 - 210

July 28 - August 16, 2007
Auckland to Auckland, New Zealand



Brothers volcano, Kermadec arc

ABE SM2000 bathymetry draped over EM300 bathymetry. 1.5 x vertical exaggeration.

Back of cover

New Zealand American Submarine Ring of Fire 2007 (NZASRoF'07 / ROVARK)

Brothers volcano, Kermadec arc Ngatoro Rift and Havre Trough

R/V SONNE

July 27 to August 16, Auckland to Auckland, New Zealand

Cruise Report compiled by Susan Merle
with assistance from Bob Embley, Cornel de Ronde and Bryan Davy

Cover. ABE SM2000 bathymetry data (2 m resolution) overlaid on EM300 bathymetry (25 m resolution). 1.5 x vertical exaggeration. Three dimensional image of Brothers volcano, looking into Brothers caldera from the south. The smooth cone (left foreground) is the site of recent volcanic eruptions and has ongoing hydrothermal venting from its summit crater. The smaller, more degraded cone to the right is probably older, but is still host to an intense hydrothermal system at its summit. The eroded topography of the caldera wall indicates older, pre-caldera lavas and other volcanic rocks that have undergone submarine slope failure at least partly induced by hydrothermal “weathering”. *EM300 bathymetry (lower resolution bottom layer) courtesy of NIWA. 3D image courtesy of NOAA Vents.*

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Credits for bathymetry data compiled to create some of the maps in this report:

NZASRoF'07 (ROVARK) cruise EM120 bathymetry provided by IFM-GEOMAR, GNS Science, and NOAA Office of Ocean Exploration.

Bathymetry data referred to in this report as “courtesy of GNS Science” (Figures 2, 7, and 9) are comprised of data collected during these earlier cruises:

R/V *L'Atalante* EM12 surveys:

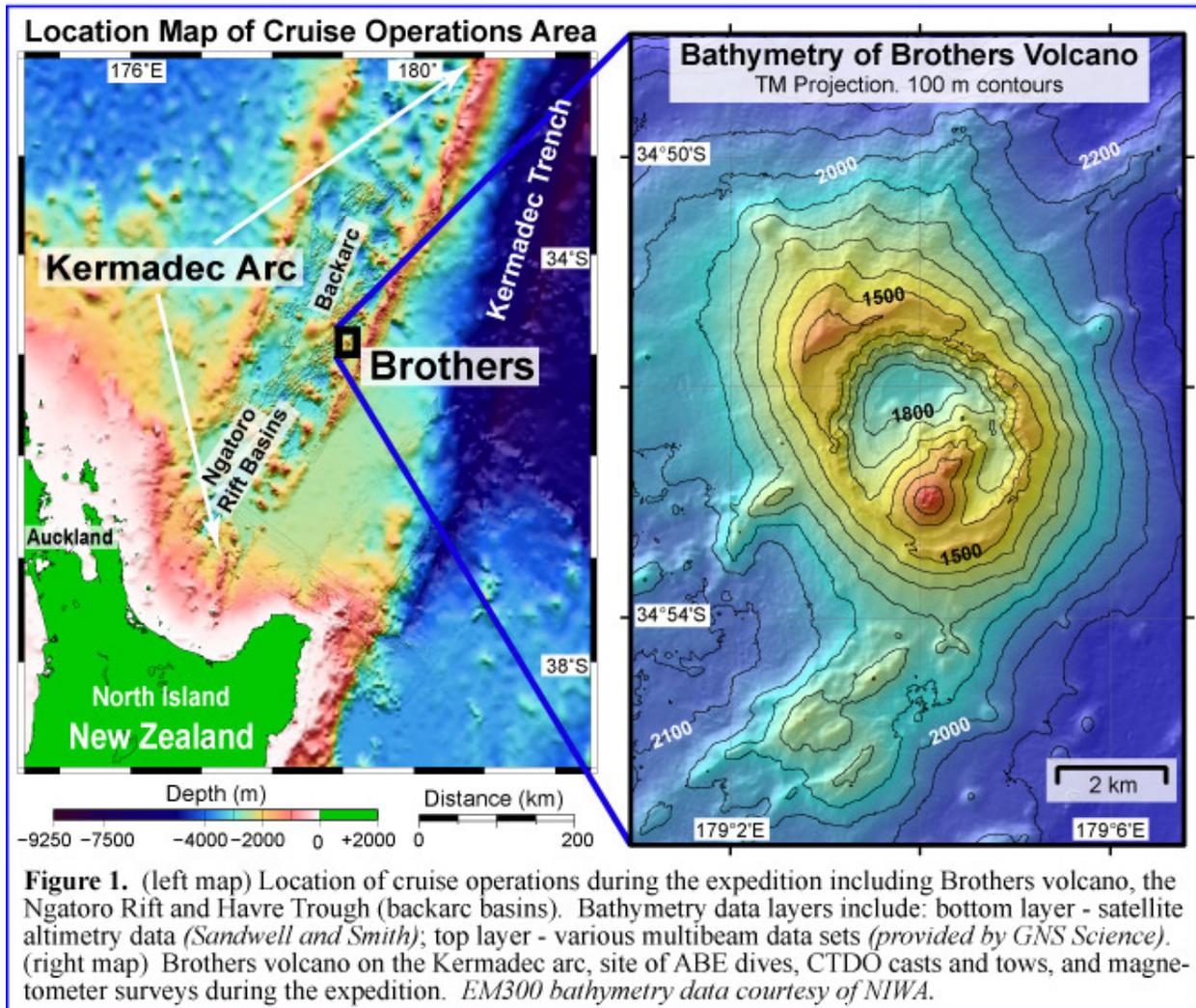
- Geodynz (1993) - ORSTOM, Univ of Nice, GNS Science and NIWA
- PACANT (1996) - IFREMER

R/V *Yokosuka* Seabeam 2112 surveys:

- YK04-09 (2004) - JAMSTEC and GNS Science
- YK06-14 (2006) - JAMSTEC and GNS Science.

R/V *Tangaroa* EM300 survey:

- TAN0411 NZAPLUME III (2004) - NIWA and GNS Science.



1.0 NZASRoF'07 Expedition Summary

Bob Embley and Cornel de Ronde

- **Expedition jectives**

- (1) Detailed mapping of the seafloor, water column conductivity-temperature-depth-optical (CTDO) and magnetic field at Brothers using the autonomous underwater vehicle (AUV) "ABE",
- (2) CTDO tow-yo's and vertical casts at Brothers, Healy and Rumble III volcanoes,
- (3) Regional multibeam mapping of Havre Trough (Kermadec back-arc area), and
- (4) Vertical CTDO casts in the Ngatoro Rift area and select basins in the backarc.

The main focus of the cruise for the New Zealand/American team was to use ABE (Autonomous Benthic Explorer) - a variation of an AUV - to map in high resolution and using a number of sensors, the caldera of Brothers volcano, located 400 km NE of New Zealand along the Kermadec volcanic arc. A second aim was to map and sample the water column of numerous deep (>3000 m) basins in the backarc using the GNS CTDO profiling system. In total, 10 basins

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were surveyed for hydrothermal emissions, including the very deep (>3500 m) Ngatoro Rift basin, with final results pending after shore-based laboratory analysis. Finally, 3 volcanoes were re-sampled for their hydrothermal plumes (Brothers, Healy, Rumble III) using the GNS CTDO system as part of an ongoing time series project on venting along the Kermadec arc.

- **Primary Results**

(1) The primary product of the NZASRoF'07, or ROVARK expedition, is the first high-resolution holistic map of an active submarine arc volcano. Multiple sensors deployed on ABE produced co-registered layers of bathymetry, total magnetic field, water temperature and conductivity, water turbidity, electrical redox potential (Eh), and (on some dives) pH. The success of this approach is underscored by the robust correlations made between the crustal magnetization, submarine geomorphology and hydrothermal indicators in Brothers caldera.

This in turn provided unique and valuable discoveries, including a previously unknown active hydrothermal vent field located along the western caldera wall at Brothers, and confirmation of a probably ancient hydrothermal vent field located in the southeastern part of the caldera.

(2) The first systematic survey for hydrothermal anomalies in the Havre Trough lying west of the Kermadec arc was conducted while ABE was surveying the seafloor and during transits to and from Auckland. More specifically, casts were done in ~15-20 km intervals along the youngest, deepest, and arguably most significant backarc basin, the Ngatoro Rift, and a number of smaller basins of varying age and/or sediment in-fill (see Fig. 9 later) Results are pending for the shore-based analyses of noble gases of the water samples (a key hydrothermal indicator) collected during the CTDO casts.

ACKNOWLEDGEMENTS

Funding for the New Zealand American Submarine Ring of Fire 2007 expedition was provided by the NOAA Ocean Exploration Program (OE) - USA, GNS Science - New Zealand (FRST contract #C05X0406) , and IFM-GEOMAR - Germany. The ABE personnel from Woods Hole Oceanographic Institute performed exceptionally while conducting AUV operations during this expedition. The R/V *Sonne* was a superb vessel to conduct the various cruise operations and its captain and crew ensured operations ran smoothly and safely.

2.0 NZASRoF 2007 (ROVARK) Scientific Party and Affiliations

2.1 Chief Scientist(s) and Institutions

Chief Scientist: Dr. Colin Devey (IFM-GEOMAR, Germany)

Co-Chief Scientist: Dr. Cornel de Ronde (GNS Science, New Zealand)

Co-Chief Scientist: Dr. Robert Embley (NOAA PMEL, USA)

Dr. Dana Yoerger (WHOI – ABE Team Leader)

2.2 ABE AUV, CTD, and EM120 Operations Personnel

Name	Nationality	Affiliation
Edward Baker*	USA	NOAA/PMEL
Andrew Billings	USA	Woods Hole Oceanographic Inst.
Bryan Davy*	New Zealand	GNS Science
Cornel de Ronde*	New Zealand	GNS Science
Al Duester	USA	Woods Hole Oceanographic Inst.
Robert Embley*	USA	NOAA/PMEL
Kevin Faure*	New Zealand	GNS Science
Ron Greene	USA	CIMRS/ Oregon St. U./NOAA/PMEL
Matthew Leybourne*	New Zealand	GNS Science
Susan Merle	USA	CIMRS/ Oregon St. U./ NOAA/PMEL
Joseph Resing*	USA	JISAO/U. Washington/NOAA/PMEL
Sharon Walker	USA	NOAA/PMEL
Dana Yoerger	USA	Woods Hole Oceanographic Inst.
Michael Hacking	New Zealand	Gibson Group TV Productions

*NZASRoF'07 Principal Investigators

2.3 IFM-GEOMAR QUEST 7 ROV Personnel

Name	Occupation
Colin Devey	Chief Scientist IFM-GEOMAR
Peter Herzig	IFM GEOMAR
Erik Labahn	ROV Engineer
Martin Pieper	Mechanical Engineer
Andy Foster	Engineer (Schilling)
Thomas Kuhn	Geologist – ROV Team leader and pilot
Karsten Witkiewicz	Electronics engineer
Arne Meier	ROV/Winch Technician
Claus Hinz	IT-Engineer
Greg Engemann	Engineer (Schilling)
Hannes Huusmann	Video Student
Robert Surma	German Lloyd Insurers
Sara Yierul	TV Team
Thomas Kutschker	TV Team



NZASRoF'07 (ROVARK) Personnel: 1st row: Sharon Walker, Susan Merle. 2nd row: Dana Yoerger, Al Duester, Ed Baker, Kevin Faure. 3rd row: Michael Hacking, Bob Embley, Matt Leybourne, Bryan Davy, Joe Resing. 4th row: Andrew Billings, Ron Greene, Cornel de Ronde.



IFM-GEOMAR QUEST 7 ROV Personnel: Front: Erik Labahn. First row standing l to r: Karsten Witkiewicz, Colin Devey, Thomas Kihn, Andy Foster, Martin Pieper. Back row: Robert Surma, Hannes Huusmann, Greg Engemann, Claus Hinz, Arne Meier.

Figure 2

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3.0 NZASRoF'07 Cruise Operations

3.1 General Information

Geographic Area of Operations

Kermadec arc, western Pacific. CTDO and ABE dives all at Brothers Volcano (Fig. 2). Multibeam and CTDO surveys also in Havre Trough to the west of the Kermadec arc (Fig. 9).

Expedition Dates

July 28 to August 16, Auckland to Auckland, New Zealand

Vessel Identification

R/V *Sonne*

Primary Equipment

- (1) Autonomous Benthic Explorer (ABE) dives
- (2) Simrad EM120 mapping system
- (3) ADCP
- (4) GNS towed magnetometer
- (5) GNS CTDO profiler/rosette
- (6) Remotely operated vehicle *Quest 7* owned by GEOMAR (Note: Engineering test dives with this system were also conducted on cruise).

Summary of Digital Data Collected

- (1) CTDO (raw data) 9 MB.
- (2) 1574 CTDO water subsamples collected. These include for: helium isotopes (³He), methane, pH, total carbon dioxide, total dissolvable trace metals, dissolved trace metals, particulate bulk chemistry, particle morphology and geochemistry.
- (3) Multibeam (Simrad EM120) 1.7 GB. 383 data files.
- (4) ABE data files 1.2 GB. Data types included: SM2000 high resolution bathymetry 200kHz multibeam sonar; 3-component Develco fluxgate magnetometer; SeaBird 9/11+ CTD systems, SeaPoint optical backscatter sensor (OBS); Eh sensor

3.2 Cruise Operations Log

New Zealand-American Submarine Ring of Fire 2007 (ROVARK)

July 28 - August 16, 2007 (R/V *Sonne*)

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
Color scheme: general comments (black); EM120 surveys (green); CTD casts (brown); ABE dives (blue); ROV dives (red)					
UTC time is 12 hours earlier than Auckland local time					
29-Jul	0:00	28-Jul	12:00	Depart Auckland	
			16:00	Steaming NW in gale. Collecting EM120 multibeam data (ROVARK-001 survey). Seas are bad so the data quality is marginal.	20' seas; speed ~6 kn
30-Jul	6:00	29-Jul	18:00	Seas calming down	Speed ~10 kn
30-Jul	14:25	30-Jul	2:25	CTD V07A-01 Cast 1 starts. Brothers cone. Started at summit then moved to NE satellite cone and continued.	34 53.014'S 179 4.038'E
30-Jul	~15:00	30-Jul	3:00	ROV wire testing	

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
	16:52	30-Jul	4:52	CTD V07A-01 Cast 1 ends	34 52.765'S 179 4.273'E
30-Jul	18:21	30-Jul	6:21	ABE dive #203 begins. NW Wall site.	34 51.971'S 179 3.007'E
				ABE dive 203 aborted - leaking connectors and transponder problems.	
30-Jul	22:46	30-Jul	10:46	ABE dive #203 ends	34 51.519'S 179 3.547'E
30-Jul	23:00	30-Jul	11:00	Head off to trench to test the ROV wire in deep water. Start logging EM120 multibeam data (Rovark-002 survey).	34 51.519'S 179 3.547'E
31-Jul	10:15	30-Jul	20:15	Arrive at trench site. Stop logging EM120 multibeam. ROV deep wire test began.	
				Winch level wind started eating itself. Deep wire test abandoned. Spent 13+ hours spooling the cable back on the winch. The sled feeding the cable was not up to the task.	
31-Jul	21:00	31-Jul	9:00	Finished winding cable back on the drum.	
31-Jul	21:15	31-Jul	9:15	Start EM120 multibeam survey -Kermadec trench area and back to Brothers (Rovark-003).	35 48.47'S 179 4.73'W
				While at trench site realized that the ABE nose cone was corroded and time was needed to work on that.	
1-Aug	8:30	31-Jul	20:30	Stop logging EM120 multibeam for CTD at Basin H	34 27.352'S 179 25.716'E
1-Aug	9:01	31-Jul	21:01	CTD V07A-02 cast 2 starts. Basin H	34 27.352'S 179 25.716'E
1-Aug	11:47	31-Jul	23:47	CTD V07A-02 cast 2 ends	
1-Aug	12:10	1-Aug	0:10	Start logging EM120 multibeam (Rovark-004)	34 28.26'S 179 24.9'E
1-Aug	13:58	1-Aug	1:58	Stop logging EM120 multibeam for CTD at Basin G2	34 45.000'S 179 9.150'E
1-Aug	14:02	1-Aug	2:02	CTD V07A-03 cast 3 starts. Basin G2	34 45.000'S 179 9.150'E
1-Aug	16:41	1-Aug	4:41	CTD V07A-03 cast 3 ends	
1-Aug	16:46	1-Aug	4:46	Start logging EM120 multibeam. Survey to Basin G1	34 45.01'S 179 9.13'E
1-Aug	17:30	1-Aug	5:30	Stop logging EM120 multibeam for CTD at Basin G1	34 45.87'S 179 12.76'E
1-Aug	17:37	1-Aug	5:37	CTD V07A-04 cast 4 starts. Basin G1.	34 45.87'S 179 12.76'E
1-Aug	19:53	1-Aug	7:53	CTD V07A-04 cast 4 ends	
1-Aug	21:15	1-Aug	9:15	Begin Magnetometer survey at Brothers	
1-Aug	21:31	1-Aug	9:31	Start logging EM120 multibeam during magnetometer survey at Brothers.	
2-Aug	1:51	1-Aug	13:51	End magnetometer survey	
2-Aug	1:55	1-Aug	13:55	Stop logging EM120 multibeam. End of survey Rovark-004.	34 50.49'S 179 6.89'E
2-Aug	2:30	1-Aug	14:30	Begin USBL calibration for ROV navigation.	
2-Aug	6:00	1-Aug	18:00	End USBL calibration. Serial port problems.	
2-Aug	9:13	1-Aug	21:13	ABE dive # 204 begins. NW Wall site - inside caldera portion.	34 51.971'S 179 3.006'E
2-Aug	16:55	2-Aug	4:55	CTD V07A-05 cast 5 starts at Brothers South Rift (Dziak seismic zone).	34 54.43'S 179 4.03'E
2-Aug	1840	2-Aug		CTD V07A-05 cast 5 ends.	
2-Aug	19:50	2-Aug	7:50	CTD V07A-06 cast 6 starts at Basin F.	34 57.49'S 179 5.64'E
2-Aug	21:36	2-Aug	9:36	CTD V07A-06 cast 6 ends.	
2-Aug	22:37	2-Aug	10:37	CTD V07A-07 cast 7 starts at Brothers NW caldera wall.	3451.75'S 179 3.5'E

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
3-Aug	0:06	2-Aug	12:06	CTD V07A-07 cast 7 ends.	
3-Aug	2:09	2-Aug	14:09	ABE Dive 204 ends.	34 51.727'S 179 3.965'E
3-Aug	3:09	2-Aug	15:09	CTD T07A-01 cast 8 starts. Tow over Brothers cone (NE to SW).	34 51.874'S 179 5.196'E
3-Aug	3:20	2-Aug	15:20	Working on ROV deployment adjustments	
3-Aug	4:00	2-Aug	16:00	Adjustment complete.	
3-Aug	7:17	2-Aug	19:17	CTD T07A-01 cast 8 ends.	34 54.29'S 179 2.518'E
3-Aug	9:03	2-Aug	21:03	CTD T07A-02 cast 9 starts. Tow over Brothers caldera (NW to SE over NW caldera wall site and cone)	34 51.286'S 179 3.288'E
3-Aug	14:15	3-Aug	2:05	CTD T07A-02 cast 9 ends.	34 54.54'S 179 4.76'E
3-Aug	15:58	3-Aug	3:58	ABE dive #205 begins. NW side of main and satellite cones.	34 55.500'S 179 0.000'E
3-Aug	19:55	3-Aug	7:55	Start logging EM120 multibeam on transit to Basin I.	34 42.72'S 178 54.89'E
3-Aug	22:12	3-Aug	10:12	Stop logging EM120 multibeam.	
3-Aug	22:22	3-Aug	10:22	CTD V07A-08 cast 10 starts at Basin I.	34 19.65'S 178 42.79' E
4-Aug	0:58	3-Aug	12:58	CTD V07A-08 cast 10 ends.	
4-Aug	1:13	3-Aug	13:13	Start logging EM120 multibeam on transit back to Brothers.	34 24.015'S 178 43.861'E
4-Aug	5:53	3-Aug	17:53	Stop logging EM120 multibeam. Arrive back at Brothers.	
4-Aug	7:00	3-Aug	19:00	Quest 7 ROV in water at Brothers.	
4-Aug	15:00	4-Aug	3:00	Quest 7 ROV on board	
4-Aug	17:05	4-Aug	5:05	ABE Dive #205 ends	34 52.378'S 179 4.769'E
4-Aug	17:31	4-Aug	5:31	Start logging EM120 multibeam (Rovark_007) to map large edifice on satellite data then do CTD on backarc cone. Towing surface magnetometer at same time - 10 kts max.	34 52.02'S 179 3.59'E
4-Aug	20:20	4-Aug	8:20	Motion sensor error on EM120. Start another survey number (Rovark_008).	34 42.16'S 178 31.29'E
4-Aug	21:31	4-Aug	9:31	Stop logging EM120 multibeam.	34 37.19'S 178 22.96'E
4-Aug	21:35	4-Aug	9:35	CTD V07A-09 cast 11 starts at Volcano "X" in backarc.	34 37.13'S 178 22.89'E
4-Aug	22:45	4-Aug	10:45	CTD V07A-09 cast 11 ends.	
4-Aug	23:06	4-Aug	11:06	Start logging EM120 multibeam survey (Rovark_008 line 4) back to Brothers. Towing surface magnetometer at same time - 10 kts max.	34 37.24'S 178 23.56'E
5-Aug	5:40	4-Aug	17:40	Stop logging multibeam and magnetics. Arrive at Brothers for ABE Dive 2-06	
5-Aug	7:02	4-Aug	19:02	ABE dive #206 begins. Finished NW wall; on to west wall and part of caldera floor.	34 51.930'S 179 3.940'E
5-Aug	??08:00	4-Aug	??20:00	Start logging EM120 multibeam (Rovark_008 line 19) during transit to Basin E1.	
5-Aug	19:00	5-Aug	7:00	Stop logging EM120 multibeam. Aborted CTD cast up north due to time constraints.	34 50.95'S 179 4.37'E
5-Aug	22:32	5-Aug	10:32	ABE Dive #206 ends	34 52.576'S 179 3.298'E
5-Aug	22:48	5-Aug	10:48	Start logging EM120 multibeam on transit to Auckland (Rovark_008 line 37). Will stop for CTDs at basins along the way.	34 52.64'S 179 3.37'E

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
6-Aug	1:22	5-Aug	13:22	Stop logging EM120 multibeam for CTD.	35 14.49'S 178 42.84'E
6-Aug	1:39	5-Aug	13:39	CTD V07A-10 cast 12 starts at Basin E1.	35 14.769'S 178 42.259'E
6-Aug	4:26	5-Aug	16:26	CTD V07A-10 cast 12 ends.	
6-Aug	4:37	5-Aug	16:37	Start logging EM120 multibeam while continuing transit to Auckland.	
6-Aug	6:34	5-Aug	18:34	Stop logging EM120 multibeam for CTD.	35 31.27' S 178 27.43'E
6-Aug	6:37	5-Aug	18:37	CTD V07A-11 cast 13 starts at Basin C.	35 31.294'S 178 27.37'E
6-Aug	8:45		20:45	CTD V07A-11 cast 13 ends.	
6-Aug	9:02	5-Aug	21:02	Start logging EM120 multibeam (Rovark_009? line3). Continuing transit to Auckland with stops for CTDs.	35 33.33'S 178 27.68'E
6-Aug	10:03	5-Aug	22:03	Stop logging EM120 multibeam for CTD.	35 44.327'S 178 29.869'E
6-Aug	10:18	5-Aug	22:18	CTD V07A-12 cast 14 starts at Rumble III volcano.	35 44.4'S 178 29.67'E
6-Aug	10:52	5-Aug	22:52	CTD V07A-12 cast 14 ends.	
6-Aug	11:00	5-Aug	23:00	Start logging EM120 multibeam from Rumble III to Basin B.	35 44.4'S 178 29.67'E
6-Aug	11:53	5-Aug	23:53	Stop logging EM120 multibeam for CTD.	
6-Aug	12:08	6-Aug	0:08	CTD V07A-13 cast 15 starts at Basin B.	35 49.78'S 178 19.65'E
6-Aug	14:28	6-Aug	2:28	CTD V07A-13 cast 15 ends.	
6-Aug	14:40	6-Aug	2:40	Start logging EM120 multibeam (Rovark_009 line 12). Continuing with transit to Auckland. Not tracking bottom due to wrong minimum depth parameter.	35 49.78'S 178 19.65'E
6-Aug	14:48	6-Aug	2:48	Reset multibeam logging (Rovark_009 line 13) Collecting data during transit.	35 50.09'S 178 17.56'E
7-Aug	5:08	6-Aug	17:08	Stop logging EM120 multibeam (Rovark_009 line 43). At 200 meter limit for data collection.	36 29.758'S 176 3.794'E
7-Aug	~08:00	6-Aug	20:00	Approximate arrival at Auckland harbor for personnel transfer.	
7-Aug	~1700	7-Aug	~0500	Leave Auckland after personnel transfer.	
7-Aug	21:26	7-Aug	9:26	Start logging EM120 multibeam (Rovark_010 line 1) during transit back to Brothers.	36 31.07'S 176 4.90'E
8-Aug	1:48	7-Aug	13:48	Stop logging EM120 multibeam for CTD.	
8-Aug	2:02	7-Aug	14:02	CTD V07A-14 cast 16 starts at Basin A1.	36 38.612'S 177 10.477'E
8-Aug	3:56	7-Aug	15:56	CTD V07A-14 cast 16 ends.	
8-Aug	4:03	7-Aug	16:03	Start logging EM120 multibeam (Rovark_010 line 10).	36 36.64'S 177 10.365'E
8-Aug	4:47	7-Aug	16:47	Stop logging EM120 multibeam for CTD.	36 41.862'S 177 3.52'E
8-Aug	4:54	7-Aug	16:54	CTD V07A-15 cast 17 starts at Basin A2.	36 41.928'S 177 3.410'E
8-Aug	6:49	7-Aug	18:49	CTD V07A-15 cast 17 ends.	
8-Aug	7:04	7-Aug	19:04	Start logging EM120 multibeam (Rovark_010 line 13).	
8-Aug	8:26	7-Aug	20:26	Stop logging EM120 multibeam for CTD.	36 29.413'S 177 14.664'E
8-Aug	8:29	7-Aug	20:29	CTD V07A-16 cast 18 starts at Basin A3.	36 29.55'S 177 14.642'E
8-Aug	10:32	7-Aug	22:32	CTD V07A-16 cast 18 ends.	
8-Aug	~10:40	7-Aug	~22:40	Start logging EM120 multibeam (Rovark line?)	36 28.924'S 177 14.49'E
8-Aug	11:20	7-Aug	23:20	Stop logging EM120 multibeam for CTD.	36 23.75'S 177 12.94'E

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
8-Aug	11:20	7-Aug	23:20	CTD V07A-17 cast 19 starts at Basin A4.	36 24.01'S 177 13.03'E
8-Aug	13:28	8-Aug	1:28	CTD V07A-17 cast 19 ends.	
8-Aug	13:36	8-Aug	1:36	Start logging EM120 multibeam (Rovark_011 line 5).	36 24.24'S 177 12.93'E
8-Aug	15:54	8-Aug	3:54	CTD V07A-18 cast 20 starts at Basin A5.	36 5.91'S 177 32.18'E
8-Aug	16:01	8-Aug	4:01	Stop logging EM120 multibeam during CTD.	
8-Aug	17:39	8-Aug	5:39	CTD V07A-18 cast 20 ends.	
8-Aug	17:45	8-Aug	5:45	Start logging EM120 multibeam (Rovark_011 line 11).	36 5.93'S 177 32.27'E
8-Aug	22:09	8-Aug	10:09	Stop logging EM120 multibeam for CTD.	35 24.72'S 178 9.67'E
8-Aug	22:14	8-Aug	10:14	CTD V07A-19 cast 21 starts at Basin D.	35 24.8'S 178 9.64'E
9-Aug	0:21	8-Aug	12:21	CTD V07A-19 cast 21 ends.	
9-Aug	0:28	8-Aug	12:28	Start logging EM120 multibeam (Rovark_011 line 22).	35 24.70'S 178 9.57'E
9-Aug	5:05	8-Aug	17:05	Stop logging EM120 multibeam. Back at Brothers	
9-Aug	5:52	8-Aug	17:52	ABE Dive #207 begins. Bathy/magnetics surveys of west wall and temperature survey over satellite cone.	34 52.885'S 179 3.349'E
9-Aug	??	8-Aug	??	ROV navigation calibration survey.	
9-Aug	10:20	8-Aug	22:20	Start logging EM120 multibeam (Rovark_012 line 1). Heading to last basin south for CTD.	
9-Aug	13:50	9-Aug	1:50	Stop logging EM120 multibeam for CTD.	35 12.09'S 178 31.45'E
9-Aug	13:55	9-Aug	1:55	CTD V07A-20 cast 22 starts at Basin E2.	35 12.16'S 178 31.28'E
9-Aug	16:00	9-Aug	4:00	CTD V07A-20 cast 22 ends.	
9-Aug	??16:15	9-Aug	??04:15	Start logging EM120 multibeam (Rovark_012 line 10) filling in data gaps to the west and north heading back to Brothers.	
9-Aug	20:05	9-Aug	8:05	Stop logging EM120 multibeam. Turned off because of a frequency interference with ABE.	34 50.47'S 178 45.615'E
10-Aug	0:05	9-Aug	12:05	ABE Dive #207 ends.	34 52.774'S 179 4.461'E
10-Aug	0:27	9-Aug	12:27	Surface-towed magnetometer in the water.	
10-Aug	0:33	9-Aug	12:33	Start surface-towed magnetometer and EM120 multibeam surveys from Brothers to Healy and back to Brothers.	34 53.28'S 179 5.00E
10-Aug	7:00	9-Aug	19:00	End magnetometer survey # 2. Stopped logging EM120 multibeam. Back at Brothers.	35 55.602'S 179 1.526'E
10-Aug	8:55	9-Aug	20:55	Sitting at Brothers waiting for ROV deployment and for ABE to recharge its batteries.	
10-Aug	~10:30	9-Aug	22:30	QUEST 7 ROV in water at Brothers.	
10-Aug	13:35	10-Aug	1:35	ABE Dive #208 begins. Caldera floor, northwest and eastern walls.	34 55.500'S 179 0.000'E
10-Aug	19:00	10-Aug	7:00	QUEST 7 ROV on board.	
10-Aug	20:12	10-Aug	8:12	Start logging EM120 multibeam (Rovark_013 line 1) from Brothers to Basin J.	34 40.73'S 179 2.17'E
11-Aug	0:53	10-Aug	12:53	Stop logging EM120 multibeam for CTD.	
11-Aug	0:57	10-Aug	12:57	CTD V07A-21 cast 23 starts at Basin J.	34 10.846'S 179 22.426'E
11-Aug	3:16	10-Aug	15:16	CTD V07A-21 cast 23 ends.	

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
11-Aug	3:30	10-Aug	15:30	Start logging EM120 multibeam (Rovark_013 line 11). Heading back to Brothers. Logging this for backscatter data.	34 10.792'S 179 22.526'E
11-Aug	17:03	10-Aug	19:03	Stop logging EM120 multibeam.	
11-Aug	9:34	10-Aug	21:34	ABE Dive #208 ends.	34 52.379'S 179 5.052'E
11-Aug	11:00	10-Aug	23:00	Quest 7 ROV in the water at Brothers caldera north wall.	
11-Aug	19:05	11-Aug	7:05	QUEST 7 ROV on board.	
11-Aug	19:57	11-Aug	7:57	CTD V07A-22 cast 24 starts at Brothers caldera west wall.	34 52.17'S 179 3.13'E
11-Aug	21:12	11-Aug	9:12	CTD V07A-22 cast 24 ends.	
11-Aug	21:38	11-Aug	9:38	ABE Dive #209 starts. Survey Brothers east wall.	34 52.255'S 179 5.155'E
				Did not do EM120 survey to Healy because have the data already.	
12-Aug	0:46	11-Aug	12:46	CTD T07A-03 cast 25 starts. Tow through Healy caldera and over cone (NE to SW)	34 58.801'S; 179 1.788'E
12-Aug	6:04	11-Aug	18:04	CTD T07A-03 cast 25 ends.	35 0.833S; 178 58.574'E
				Back to Brothers Caldera - Not Logging EM120 multibeam.	
12-Aug	7:42	11-Aug	19:42	CTD T07A-04 cast 26 starts. Tow at Brothers - NE to SW over N flank and over shelf at top of caldera wall ("Tiki Bar")	34 50.630'S; 179 3.653'E
12-Aug	11:30	11-Aug	23:30	CTD T07A-04 cast 26 ends.	34 52.877'S; 179 2.647'E
12-Aug	14:08	12-Aug	2:08	ABE Dive #209 ends.	34 52.358'S 179 4.934'E
12-Aug	~14:30	12-Aug	~02:30	Start transponder recovery at Brothers.	
12-Aug	17:30	12-Aug	5:30	Transponder recovery complete.	
12-Aug	18:22	12-Aug	6:22	CTD V07A-23 cast 27 starts at Brothers south of cone summits (for nubile methane).	34 53.08'S 179 4.33'E
12-Aug	19:49	12-Aug	7:49	CTD V07A-23 cast 27 ends.	
				Transit to Healy Volcano. No EM120 multibeam survey.	
12-Aug	21:18	12-Aug	9:18	CTD V07A-24 cast 28 starts at Healy cone.	35 0.69'S 178 58.76'E
12-Aug	22:25	12-Aug	10:25	CTD V07A-24 cast 28 ends.	
12-Aug	23:50	12-Aug	11:50	CTD V07A-25 cast 29 starts at Healy caldera.	34 59.617'S 179 0.465'E
13-Aug	1:22	12-Aug	13:22	CTD V07A-25 cast 29 ends.	
13-Aug	1:30	12-Aug	13:30	Transit back to Brothers for ABE dive.	
13-Aug	4:00	12-Aug	16:00	ABE Dive #210 starts. Southern side of main and satellite cones.	34 53.066'S 179 4.925'E
13-Aug	6:00	12-Aug	~18:00	Begin transit to trench for winch test.	
13-Aug	6:53	12-Aug	18:53	Start logging EM120 multibeam ~10 nm from Brothers to prevent crosstalk with LBL ABE transponders (Rovark_015 line 1).	34 52.56'S 179 15.00'E
13-Aug	14:15	13-Aug	2:15	Stop logging EM120 multibeam at the trench cable test site (~7000 meters water depth).	35 30.59'S 179 14.52'W
13-Aug	18:30	13-Aug	6:30	Completed testing the cable at the trench site after 4+ hours.	

Date (Local)	Time (Local)	Date (UTC)	Time (UTC)	Event	Comments
13-Aug	19:09	13-Aug	7:09	Start logging EM120 multibeam on transit from trench site to Brothers (Rovark_016 line 17).	35 30.73'S 179 14.93'W
14-Aug	1:45	13-Aug	13:45	Stop logging EM120 multibeam ~10nm from Brothers to prevent interference with ABE LBL.	34 50.23'S 179 30.41'E
14-Aug	5:49	13-Aug	17:49	ABE Dive #210 ends.	34 53.026'S 179 4.777'E
14-Aug	10:40	13-Aug	22:40	Start logging EM120 multibeam for survey back to Auckland (Rovark_017 line 1).	34 49.83'S 178 51.8'E
15-Aug	11:00	14-Aug	23:00	End of EM120 multibeam survey Rovark_018.	~36 30.9'S 177 29.04'E
15-Aug	11:05	14-Aug	23:05	Heading east at less than 1knot for ROV ops on the back deck.	
15-Aug	18:43	15-Aug	6:43	Heading west back toward Auckland at full speed. Not sure when we turned around.	36 31.8'E 177 28.3'W
16-Aug	~08:00	15-Aug	20:00	Arrived in Auckland harbor. End of cruise.	

4.0 ABE Scientific Data

4.1 ABE: General Vehicle Description and Sensors During NZASRoF'07

Dana Yoerger (modified from rovark_abe_sumamry.pdf)

General description:

The sensors onboard the Autonomous Benthic Explorer (ABE) consist of a number of vehicle attitude sensors such as depth, altitude, heading, pitch and roll. In addition, ABE carries a suite of dedicated science-specific sensors. ABE is a fully autonomous underwater vehicle used for exploring the deep ocean up to depths of 4,500 meters. ABE produces bathymetric and magnetic maps of the seafloor and has also been used for near-seabed oceanographic investigations to quantify hydrothermal vent fluxes. More recently, ABE has been used to locate, map, and photograph deepsea hydrothermal vent sites following preliminary work by towed and lowered instruments. ABE is a three body, open frame vehicle that utilizes glass balls as flotation in two free-flooded upper pods while the single, lower housing is host to the batteries that power the vehicle and all of its electronics. This separation of buoyancy and payload gives a large righting moment which simplifies control and allows the vertical and lateral thrust propellers to be located inside the protected space between the three, faired bodies. ABE has five thrusters allowing it to move in any direction. It can travel forward at a cruising speed of 0.6m/sec but one of ABEs most unique characteristics is that it can also hover and reverse, characteristics that are particularly valuable in the hostile and rugged terrain routinely encountered when investigating the deep seafloor. The navigation system onboard ABE consists of two proven and complementary systems. For general use, ABE uses long baseline transponders, identical to those used by the research submersible *Alvin* and ROV *Jason II*, and these allow deep seafloor survey lines over distances of ca. 5 kilometers to be carried out within one array. ABE also carries an acoustic doppler velocity log (DVL) which provides short-range, high-precision navigation. With these navigation systems, ABE has the ability to follow tracklines with a repeatability of order 10 m line-spacing, or better.

4.1.1 ABE Sensors During NZASRoF'07

1. SIMRAD SM2000 200kHz multibeam sonar, rated to 3,000 m
2. Imagenex 675kHz scanning sonar, rated to 4,500m
3. 3-component Develco fluxgate magnetometer, rated to 4,500 m
4. SeaBird 9/11+ CTD systems, rated to 4,500 m
5. SeaPoint optical backscatter sensor (OBS) rated to 4,500 m
6. Oxidation reduction potential (Eh sensor)

All data were stored on the vehicle and retrieved upon recovery.

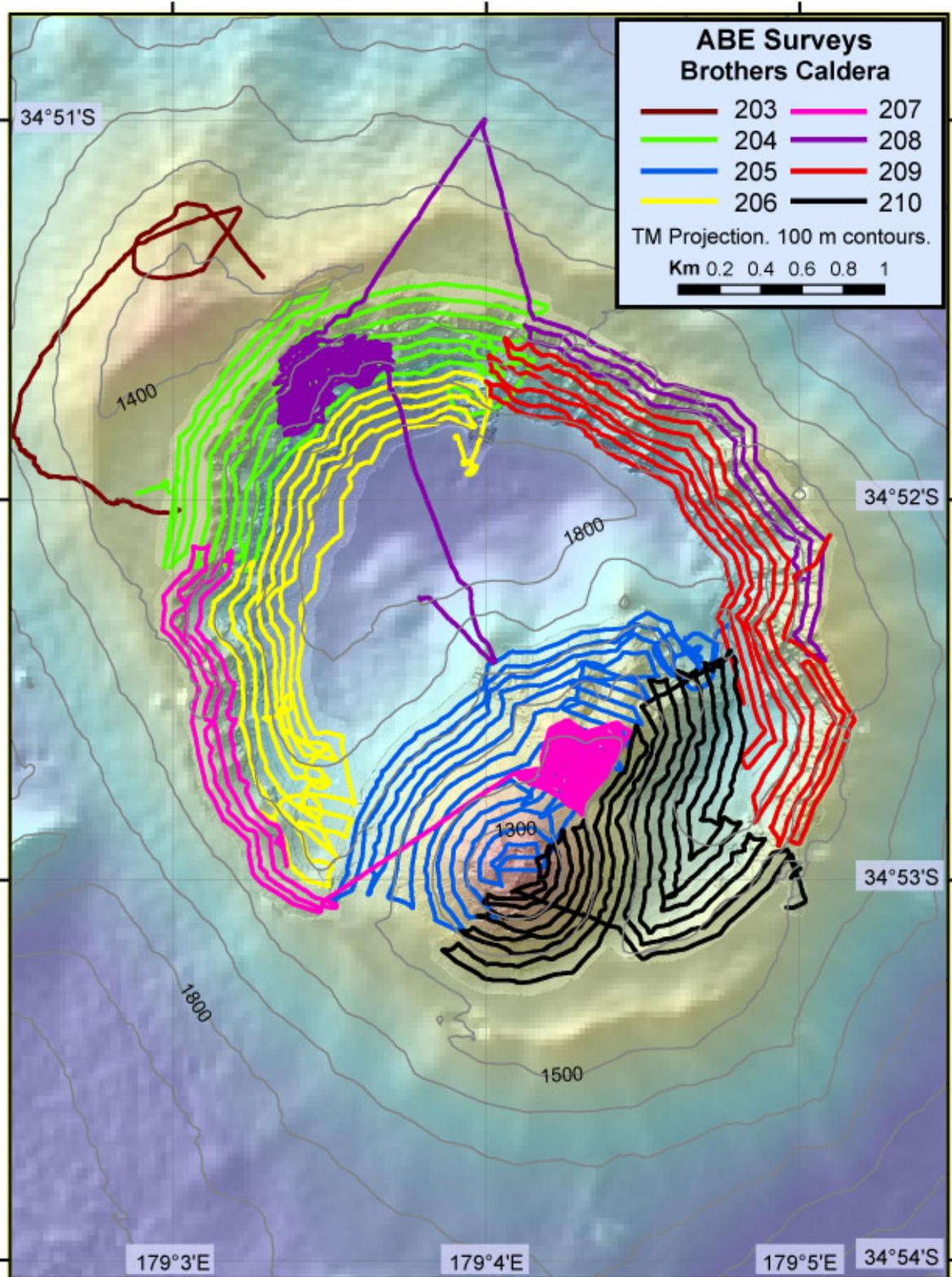


Figure 3. ABE survey track lines overlaid on pre-existing bathymetry at Brothers volcano. 8 dives (203 – 210) occurred at Brothers caldera during the cruise. *Modified after figure by Dana Yoerger, rovark_abe_sumamry.pdf. Pre-existing EM300 bathymetry data courtesy of NIWA.*

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4.2 ABE Dive Statistics - NZASRoF'07 (Dana Yoerger)

dive	total time	survey time	sleep time	descent	ascent/recovery	survey km
203	4.3	0.8	0.0	1.6	1.9	1.5
204	16.8	12.0	1.6	1.4	1.8	20.1
205	24.2	14.7	6.6	1.2	1.8	25.3
206	15.4	12.0	0.0	1.7	1.6	19.7
207	18.1	15.4	0.0	1.4	1.2	23.8
208	19.5	14.9	1.2	2.0	1.4	24.4
209	16.4	13.1	0.3	1.4	1.6	21.7
210	25.7	13.2	9.6	1.3	1.6	24.7
Totals	140.4	96.1	19.3	12.0	12.9	161.2

4.3 Overview of ABE Dives

Dana Yoerger (from rovark_abe_sumamry.pdf)

Note: UTC is 12 hours earlier than local Auckland time. Summary times are local. For UTC times refer to the Cruise Operations Log (section 3.2)

Summary: ABE 203

Start time: 2007/07/30 18:21:19. Survey start: 2007/07/30 20:03:45. Survey end: 2007/07/30 20:51:4.

Surface time: 2007/07/30 22:20:43. Recovery time: 2007/07/30 22:46:16.

Launch: 34 51.971'S 179 3.007'E. Recovery: 34 51.519'S 179 3.547'E.

The first dive, ABE203, was shortened due to engineering problems on the vehicle. The vehicle failed to compute long-baseline navigation fixes properly, this problem was traced to a failure in the mechanism used to reject transponder surface bounces. More importantly, the vehicle dropped its ascent weights less than an hour into the first trackline. An electrical fault in the weight dropper system caused by seawater intrusion into an electrical connector triggered the early weight drop. Troubleshooting this problem revealed corrosion on the sealing surfaces of two connectors; these were remachined with the assistance of the *Sonne's* engineers. Another connector was corroded but had not leaked. After repairs, the vehicle was reassembled and passed all tests.

Summary: ABE 204

Start time: 2007/08/02 09:13:11. Survey start: 2007/08/02 10:46:28. Survey end: 2007/08/02 22:46:18.

Surface time: 2007/08/03 01:48:24. Recovery time: 2007/08/03 02:09:26.

Launch: 34 51.971'S 179 3.006'E. Recovery: 34 51.727'S 179 3.965'E.

On the second dive, **ABE204**, the vehicle performed a bathymetric and magnetic survey at a height of 50 m on the northwest side of the inner wall of the caldera. The vehicle anchored due to low battery after a run of 12 hours covering 21.1 km. All sensors but the new pH/Eh sensor worked well.

Summary: ABE 205

Start time: 2007/08/03 15:57:48. Survey start: 2007/08/03 18:04:24. Survey end: 2007/08/04 08:43:40.

Surface time: 2007/08/04 16:48:23. Recovery time: 2007/08/04 17:05:24.

Launch: 34 55.500'S 179 0.000'E. Recovery: 34 52.378'S 179 4.769'E.

ABE205 surveyed the northern side of the cone inside the caldera. The vehicle covered 24.9 km and anchored due to low battery. Unfortunately, a flooded connector on the Eh sensor resulted in a loss of all analog sensors (Eh, optical backscatter, and magnetometer). Additionally, the independent mapper device carried on ABE did not log any data due to a setup problem. The vehicle did collect bathymetry as expected and also logged CT data as normal.

Summary: ABE206

Start time: 2007/08/05 07:01:50. Survey start: 2007/08/05 08:53:33. Survey end: 2007/08/05 20:51:38.
Surface time: 2007/08/05 22:16:26. Recovery time: 2007/08/05 22:32:27.

Launch: 34 51.930°S 179 3.940°E. Recovery: 34 52.576°S 179 3.298°E.

ABE206 surveyed the northwest portion of the inner caldera wall below the level covered in ABE204, then connected the northwest area to the northern side of the cone covered in ABE 205. All sensors worked well with the exception of the Eh/Ph sensor. The Nakamura Eh sensor performed well. Eh measurements indicating vent activity were noted near the known vents on the northwest wall and at a new spot on the west wall.

Summary: ABE207

Start time: 2007/08/09 05:52:37. Survey start: 2007/08/09 07:22:57. Survey end: 2007/08/09 22:48:10.
Surface time: 2007/08/09 23:56:00. Recovery time: 2007/08/10 00:05:31.

Launch: 34 52.885°S 179 3.349°E. Recovery: 34 52.774°S 179 4.461°E.

ABE207 surveyed the upper part of the west inner wall of the caldera, then performed a temperature survey over the small cone. All sensors performed nominally with the exception of the Eh/pH sensor. The Nakamura Eh sensor performed as expected. The area on the west wall above the spot where the Eh hits were seen on ABE206 showed both Eh and a large optical backscatter anomaly.

Summary: ABE208

Start time: 2007/08/10 13:34:58. Survey start: 2007/08/10 16:04:17. Survey end: 2007/08/11 06:59:44.
Surface time: 2007/08/11 09:25:15. Recovery time: 2007/08/11 09:34:16.

Launch: 34 55.500°S 179 0.000°E. Recovery: 34 52.379°S 179 5.052°E.

ABE208 did a magnetic line across the floor of the caldera, made a temperature survey on the northwest wall, ran two magnetometer lines north of the caldera, then surveyed the bathymetry and magnetics along the top of the northeast wall. The Eh/pH sensor showed some reasonable results, the Eh signal correlated well with the Nakamura Eh sensor. All other sensors performed as expected.

Summary: ABE209

Start time: 2007/08/11 21:38:01. Survey start: 2007/08/11 23:06:52. Survey end: 2007/08/12 12:15:40.
Surface time: 2007/08/12 13:52:42. Recovery time: 2007/08/12 14:08:44.

Launch: 34 52.255°S 179 5.155°E. Recovery: 34 52.358°S 179 4.934°E.

ABE209 did bathymetric and magnetic mapping on the northeastern inside wall of the caldera. Hydrothermal activity was spotted at the northern end of the survey, probably associated with the known vent fields on the northern wall.

Summary: ABE210

Start time: 2007/08/13 04:00:29. Survey start: 2007/08/13 05:24:55. Survey end: 2007/08/13 18:37:59.
Surface time: 2007/08/14 05:26:06. Recovery time: 2007/08/14 05:49:09.

Launch: 34 53.066°S 179 4.925°E. Recovery: 34 53.026°S 179 4.777°E.

ABE210 completed the map of the inner walls of the caldera. This required that we first move a transponder (11.5). We recovered, set, and surveyed the transponder while ABE was on charge. Hydrothermal activity was spotted at several spots on the main and satellite cone.

4.4 ABE Multibeam Surveys

Bob Embley

The bathymetric map (2-m grid) generated by the ABE SM2000 multibeam sonar during dives 203-210 (Fig. 5) reveals a wealth of detail on the geology of the caldera walls and eruptive cones. The two cones are starkly contrasted by their degree of erosion, with the younger southwestern cone onlapping the older, eroded cone to the northeast. The walls are incised with numerous slumps scars, with some of the most prominent ones on the northwest wall where the high-temperature hydrothermal system (NW Caldera site) has extensively altered and weakened the underlying volcanic sequence. This map provides the basis for a first order geomorphic analysis of a submarine arc volcano caldera. The SM2000 bathymetry grids are also used to correct for topographic effects during the inversion of the magnetic field grids to calculate crustal magnetization values.

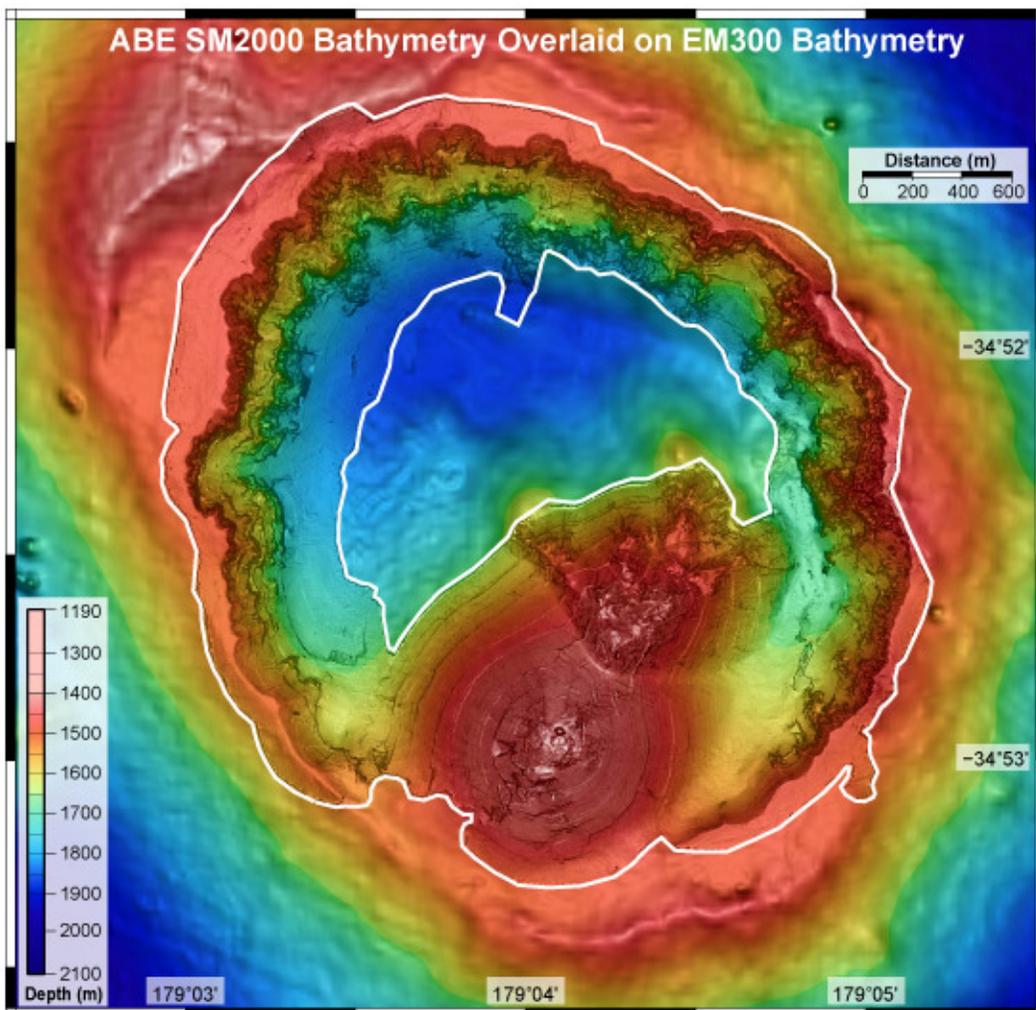


Figure 4. ABE SM2000 multibeam bathymetry (2m resolution) overlaid on EM300 bathymetry (25m resolution) at Brothers caldera. The white line indicates the SM2000 data boundary. ABE depths range from 1196 to 1883 m. Mercator projection. *Pre-existing EM300 bathymetry data courtesy of NIWA.*

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4.5 ABE Magnetometer Data

Bryan Davy

modified after web log entry: <http://oceanexplorer.noaa.gov/explorations/07fire/logs/aug1/aug1.html>

High resolution magnetic anomaly information was provided by surveying with ABE (Fig. 5). ABE caldera surveys consisted of a series of dives where it flew along parallel lines approximately 50 m above the volcano, collecting magnetic anomaly measurements (using the palm-sized magnetometer mounted on ABE) as well as swath bathymetry, conductivity, temperature and chemical measurements. The magnetic anomaly measurements are used to estimate the magnetization of the volcano.

A primary goal of the magnetics surveys (see also section 7.0) over Brothers volcano was to determine the effect of hydrothermal alteration on the crustal magnetization of an arc volcano. Brothers is known to have numerous hydrothermal vent sites within the caldera. The high temperature of this fluid alters the chemistry of the magnetic titanomagnetite minerals within the lavas, transforming them to minerals which preserve much less magnetization (e.g., pyrite). Both actively venting sites and ancient sites which are no longer venting can be recognized by the magnetically 'quiet' zones (i.e., low values of magnetization) which result from the hydrothermal alteration.

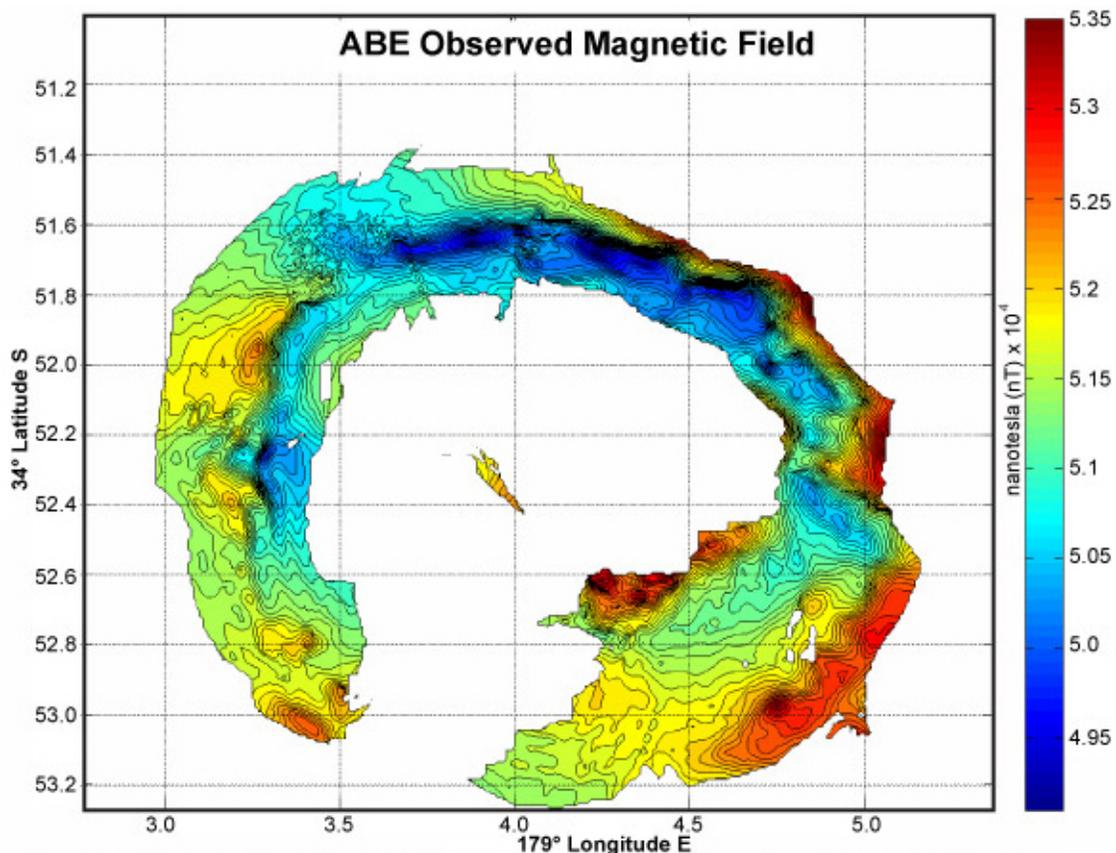


Figure 5. During ABE dives 204 and 206 - 210 magnetic anomaly data were collected using a palm sized magnetometer mounted on the vehicle. This plot shows the observed magnetic field. *Figure courtesy of Bryan Davy, GNS Science.*

4.6 Plume Mapping with the ABE AUV

Edward Baker

A CTDO and other sensors were mounted on ABE for two coordinated projects: (1) a comprehensive survey of Brothers to map in unique detail the distribution of hydrothermal discharge inside a volcanic caldera, and (2) high resolution surveys at two locations to measure the vertical flux of heat and chemicals from different vent fields. These include an area overtop the diffuse vents of the Cone site(s) and the high temperatures vents of the NW Caldera site (see tracks 207 and 208 in Fig. 3). Both projects are under study at the present time. Preliminary results from the survey of the entire volcano show that in addition to the known sites, hydrothermal discharge is also common along the fault exposures that circle the inside of the caldera.

5.0 EM120 Multibeam Bathymetry Data

5.1 EM120 General Description and Coverage

Susan Merle

The EM120 is a Simrad system (hull-mounted on the R/V *Sonne*) with 191 beams and a maximum of 150° coverage. The system operator generally set the angles at 60° each side, giving a maximum coverage of 120°. Bathymetry, sidescan, and amplitude data were collected during the cruise as EM120 mapping was one of the primary operations of the expedition. Specific survey times are listed in the Cruise Operations Log (Section 3.2). EM120 surveys took place while in transit to and from other operation sites (CTDO ops in particular), and while ABE was surveying at Brothers. The data are somewhat noisy due to bad weather during many of the surveys. More than 3,000 kilometers of track lines were collected adding up to ~33,000 km² of multibeam bathymetry coverage (Fig 6). Data were collected to both in-fill gaps from previously collected multibeam data acquired by GNS Science, and to add to the inventory of swath data for this region.

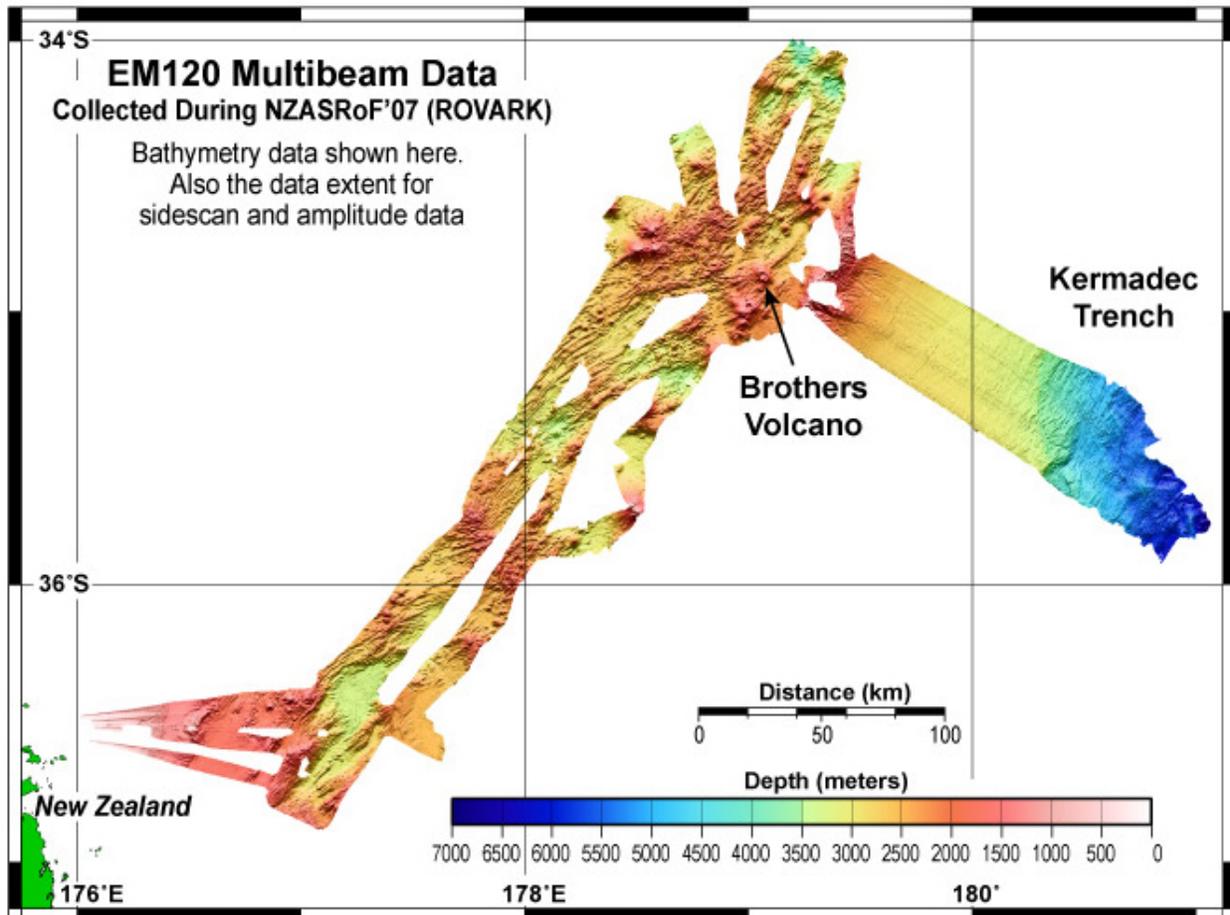


Figure 6. EM120 multibeam data collected during the expedition. The EM120 bathymetry data were collected to both in-fill gaps from previously collected multibeam data acquired by GNS Science, and to add to the inventory of swath data for this region.

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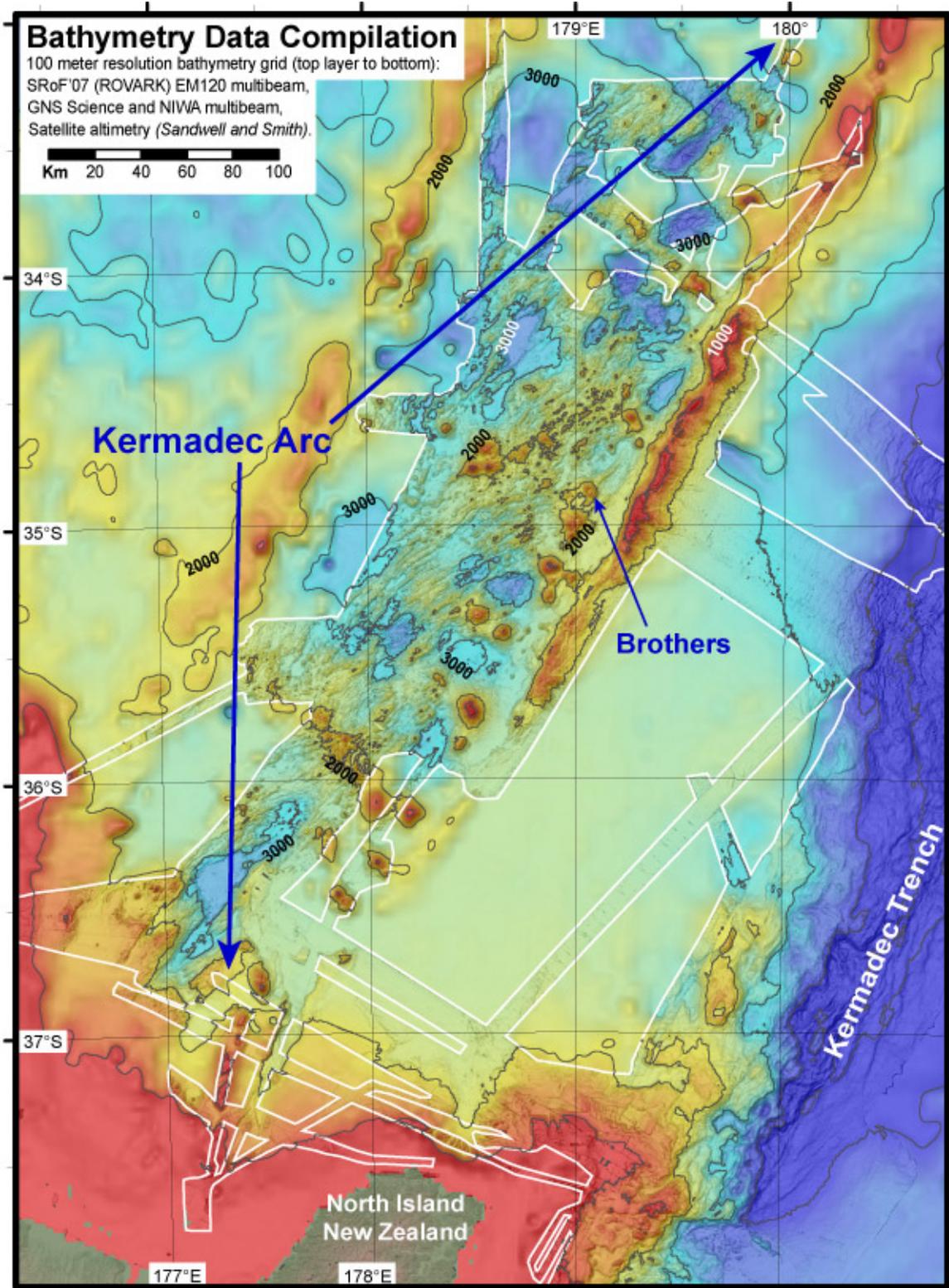


Figure 7. Bathymetry in the area of the 2007 expedition. White lines represent the multibeam data boundaries. The multibeam data are overlaid on satellite altimetry data. Mercator projection. 1000 m contours.

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6.0 CTDO Shipboard Program

6.1 General Description

Cornel de Ronde

The primary objective of the shipboard CTDO program was to explore for the first time, the numerous basins of the Havre Trough—backarc to the Kermadec arc—for evidence of hydrothermal activity. These basins typically have sill depths greater than 2,800 m with the floor of the Ngatoro Rift extending down to >3,500 m. The latter is the closest basin to continental New Zealand and represents the youngest phase of rifting in the backarc. Numerous earthquake epicenters have been located along the western margin of the Ngatoro Rift, indicative of ongoing tectonism in the region. The smaller basins commonly have an orientation SW-NE though on occasion they can strike W-E (Fig. 9). They range from sediment-dominated to signs of extensive (and likely recent) rifting. A second objective was to continue long-term (since 1999) monitoring of ongoing hydrothermal activity via tow-yo's and vertical casts over several volcanoes of the Kermadec arc. These include Brothers, Healy and Rumble III volcanoes (Figs. 9 and 10).

The instrument used to collect the water-column data was the GNS Science CTDO (conductivity-depth (pressure)-temperature-optical) profiling system. The bottles are closed on command from the ship, usually when a scientist monitoring the sensors sees strong evidence of a plume, invariably from the optical light backscattering sensor, or nephelometer. The CTDO carries other sensors that measure pH, oxidation reduction potential, methane, and altitude. Specific chemistry sample types and numbers collected during NZASRoF'07 are listed below:

6.2 NZASRoF'07 (ROVARK) CTD Sample Types and Numbers

Sharon Walker

Sample type	Abbreviation	# of samples	Responsible PI
Helium isotope analysis	^3He	268	John Lupton (john.e.lupton@noaa.gov) NOAA PMEL, Newport OR
Methane	CH ₄	378	Kevin Faure (K.Faure@gns.cri.nz) GNS Science, Lower Hutt New Zealand
pH (acidity)	pH	533	Joseph Resing (joseph.resing@noaa.gov) NOAA PMEL Seattle WA / UW
Total carbon dioxide	TCO ₂	87	Joseph Resing
100 Total dissolvable trace metals	TDMe	240	Matt Leybourne (M.Leybourne@gns.cri.nz) GNS Science, Lower Hutt New Zealand
Dissolved trace metals	DMe	26	Matt Leybourne
Particulate bulk chemistry	XRF	31	Joseph Resing
Particle morphology and type	SEM	11	Joseph Resing

In total, 1574 samples were collected from 431 niskin bottles tripped during 29 CTDO casts which took 67 hours to deploy and recover.

6.3 CTDO Results

Edward Baker and Cornel de Ronde

Seventeen casts were conducted in various basins (Fig. 9) during the cruise, with no confirmed real-time evidence of hydrothermal activity encountered in any of them. As not all laboratory analyses have been completed, this conclusion is a preliminary one.

CTDO tows and casts over Brothers and Healy volcanoes (Fig. 10) confirmed that both remain active almost 10 years after the discovery of hydrothermal discharge on each. At Brothers, for example, vent fields both on the NW wall of the caldera and on the two peaks of the southern cone were discharging substantial plumes.

6.4 NZASRoF'07 CTD Cast Table

Sharon Walker (Positions are approximate. Analysis is preliminary.)

Cast #	Station Name	start	hour UTC	end	hour UTC	Z (m)	3 He	C H 4	p H	T C O 2	T D M e	D M e	X R F	SE M	Lat(S)	Long(E)		
							Number of each sample type per cast											
1	V07A-01	30-Jul	0225			1260	8	18	24	4	8	3	3	1	34.8836	179.0673		
	Brothers cone: started at summit ...																	
				30-Jul	0452	1365									34.8794	179.0712		
	...then moved to NE satellite cone and continued sampling above that																	
2	V07A-02	31-Jul	2101	31-Jul	2347	3316	10	18	24		8				34.4559	179.4286		
	Basin "H"																	
3	V07A-03	1-Aug	0202	1-Aug	0441	2774	11	19	24		8				34.7500	179.1525		
	Basin "G2"																	
4	V07A-04	1-Aug	0537	1-Aug	0753	2618	12	19	24	6	8				34.7645	179.2127		
	Basin "G1"																	
5	V07A-05	2-Aug	0455	2-Aug	0640	1882	11	12	11		11				34.9072	179.0672		
	Brothers South Rift (Dziak seismic zone)																	
6	V07A-06	2-Aug	0750	2-Aug	0936	2232	7	10	9		9				34.9582	179.0940		
	Basin "F"																	
7	V07A-07	2-Aug	1037	2-Aug	1206	1625	11	11	20		11	4	4	2	34.8625	179.0583		
	Brothers caldera NW wall																	
	T07A-01(start)	2-Aug	1509												34.8646	179.0866		
	tow over Brothers cone (NE->SW over Brothers cone)																	
8	T07A-01(end)	2-Aug		2-Aug	1917		5	16	21	5	15			1	34.9048	179.0420		
	T07A-02(start)	2-Aug	2103												34.8548	179.0548		
	tow through Brothers caldera (NW->SE over NW caldera wall site and cone)																	
9	T07A-02(end)			3-Aug	0215		11	13	15	11	11		4	2	34.9090	179.0793		
10	V07A-08	3-Aug	1022	3-Aug	1258	3408	11	19	24		11				34.3275	178.7132		
	Basin "I"																	
11	V07A-09	4-Aug	0935	4-Aug	1045	1335	3	15	20		5				34.6188	178.3815		
	Volcano "X" in backarc																	
12	V07A-10	5-Aug	1339	5-Aug	1626	3500	11	17	23		11				35.2462	178.7043		
	Basin "E1"																	
13	V07A-11	5-Aug	1837	5-Aug	2045	3032	8	8	12		8				35.5216	178.4562		
	Basin "C"																	
14	V07A-12	5-Aug	2217	5-Aug	2252	465	11	11	23	11	11	6	6		35.7400	178.4945		
	Rumble 3																	
15	V07A-13	6-Aug	0008	6-Aug	0228	3043	10	9	19	8	11		1	1	35.8297	178.3275		
	Basin "B"																	
16	V07A-14	7-Aug	1402	7-Aug	1556	3068	10	13	18		10				36.6435	177.1746		
	Basin "A1"																	
17	V07A-15	7-Aug	1653	7-Aug	1849	2976	10	12	16		10				36.6988	177.0568		
	Basin "A2"																	
18	V07A-16	7-Aug	2029	7-Aug	2232	3267	9	13	16		9	2	2		36.4925	177.2440		
	Basin "A3"																	
19	V07A-17	7-Aug	2320	8-Aug	0128	3275	13	14	19	5	9	2	2	1	36.4002	177.2172		
	Basin "A4"																	
20	V07A-18	8-Aug	0354	8-Aug	0539	2718	10	11	12		5				36.0985	177.5363		
	Basin "A5"																	
21	V07A-19	8-Aug	1014	8-Aug	1221	3453	10	12	16		5				35.4133	178.1607		
	Basin "D"																	
22	V07A-20	9-Aug	0155	9-Aug	0400	3213	10	12	16		6				35.2027	178.5213		
	Basin "E2"																	
23	V07A-21	10-Aug	1257	10-Aug	1516	3616	12	14	19	8					34.1808	179.3738		
	Basin "J"																	
24	V07A-22	11-Aug	0757	11-Aug	0912	1580	8	9	16	5	6	3	3		34.8695	179.0522		
	Brothers caldera - West wall																	
	T07A-03(start)	11-Aug	1246												34.9800	179.0298		

Cast #	Station Name	start	hour UTC	end	hour UTC	Z (m)	3 He	C H 4	p H	T C O 2	T D M e	D M e	X R F	S E M	Lat(S)	Long(E)
tow through Healy caldera and over cone - NE->SW																
25	T07A-03(end)			11-Aug	1804		7	15	20	2	10	2	2	2	35.0139	178.9762
	T07A-04(start)	11-Aug	1942												34.8438	179.0609
Brothers tow - NE->SW over N flank and over shelf at top of caldera wall ("Tiki Bar")																
26	T07A-04(end)			11-Aug	2330		6	9	13	2	6				34.8813	179.0441
27	V07A-23	12-Aug	0622	12-Aug	0749	1387	9	11	20	7	6				34.8847	179.0722
Brothers - cast S of cone summits (for nubile meethane)																
28	V07A-24	12-Aug	0918	12-Aug	1025	1281	7	9	16	6	5	2	2		35.0115	178.9793
Healy cone																
29	V07A-25	12-Aug	1150	12-Aug	1322	1488	7	9	23	7	7	2	2	1	34.9936	179.0078
Healy caldera																

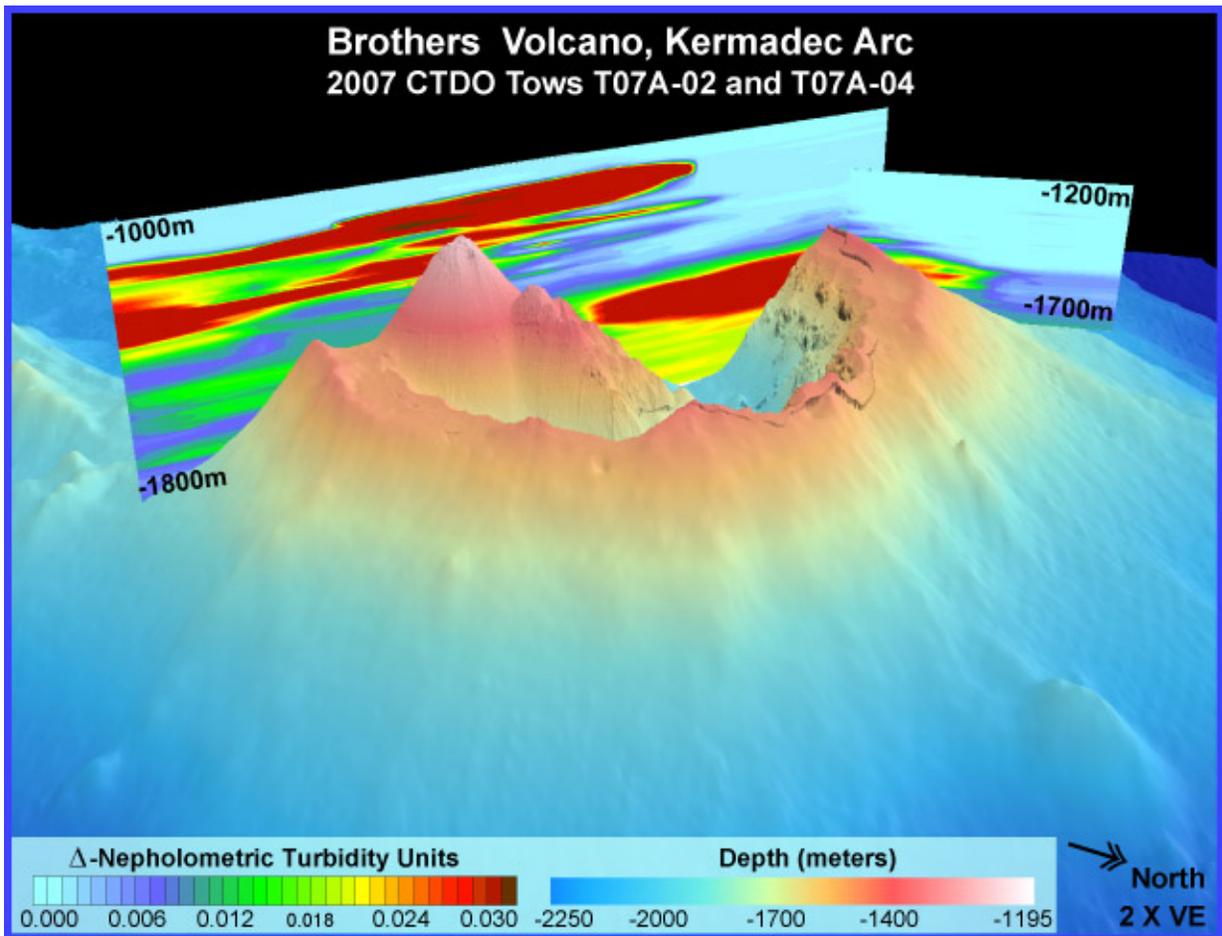


Figure 8. Two of three 2007 CTDO towyos over Brothers volcano. Tow T07A-02 went from NW to SE over the NW caldera wall site and largest caldera cone. Tow T07A-04 went from NE to SW over the north flank of the volcano. 2 x vertical exaggeration. ABE SM2000 bathymetry (NZASRoF'07) overlaid on EM300 bathymetry (courtesy of NIWA). CTD fence diagrams created by Sharon Walker, (NOAA Vents) inserted into 3D bathymetry, Susan Merle (OSU/NOAA Vents).

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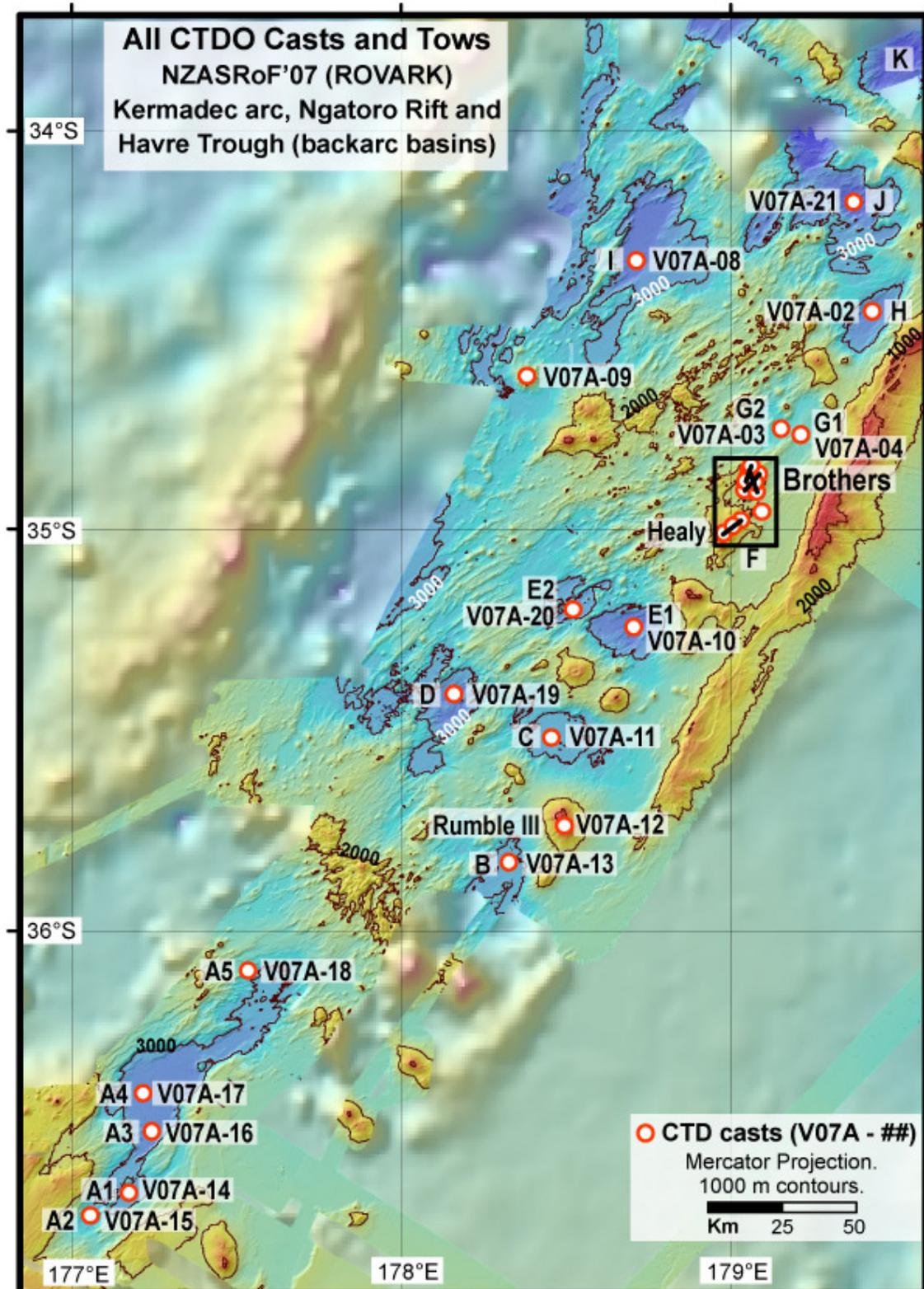


Figure 9. All CTD0 vertical casts and tows during the expedition (29 total). Letters (A - K) indicate basin “names”. Black rectangle outlines the region of Figure 10. Bathymetry data provided by GNS Science overlaid with NZASRoF’07 (ROVARK) EM120 data, all overlaid on satellite altimetry data (*Sandwell and Smith*).

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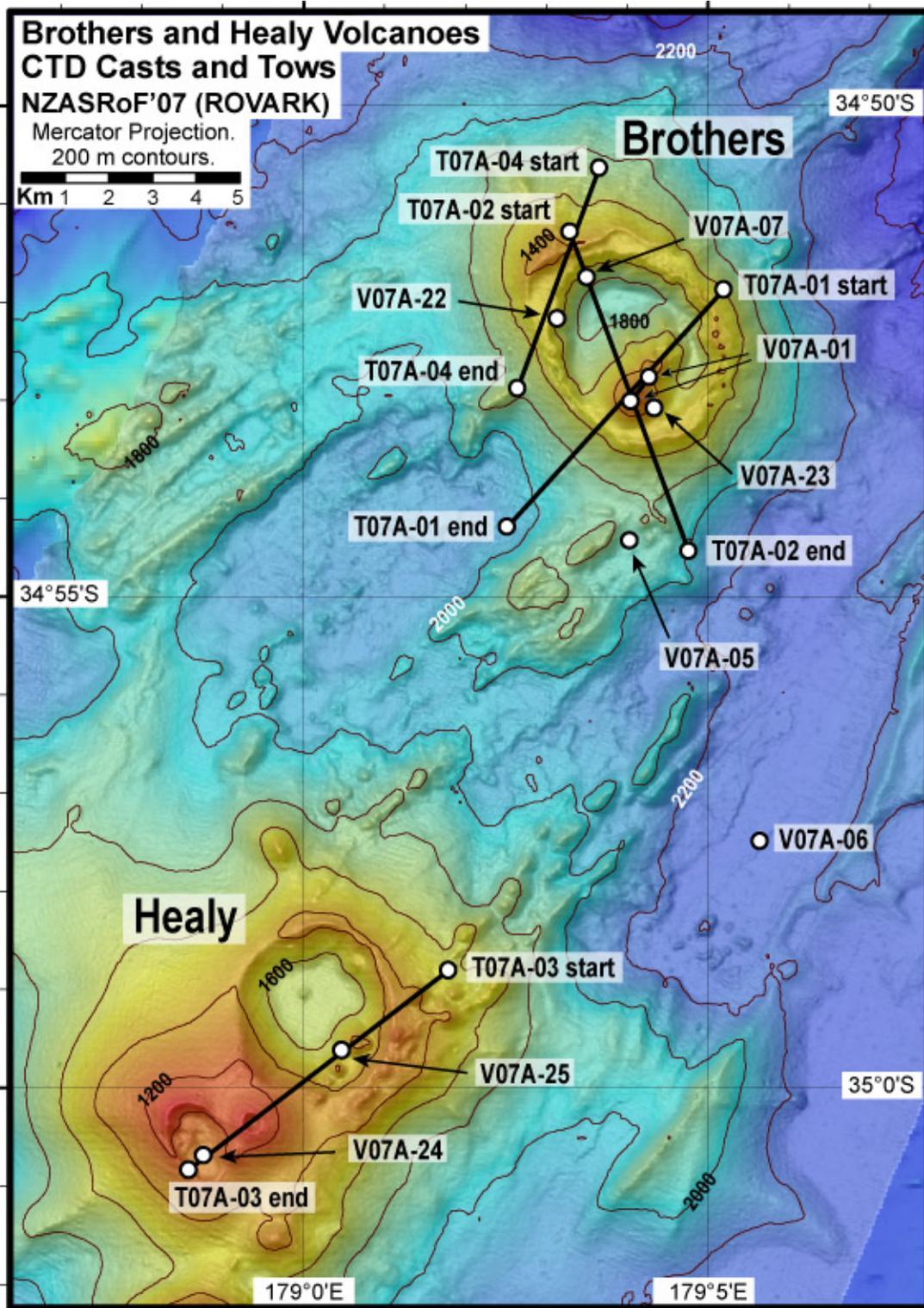


Figure 10. 2007 CTD vertical casts and tows at Brothers and Healy volcanoes, Kermadec arc. V07A-## indicates a vertical cast. T07A-## indicates a tow, the track of which is represented by the thick black lines. *EM300 bathymetry data courtesy of NIWA.*

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7.0 Surface Towed Magnetometer Surveys

Bryan Davy

modified after web log entry: <http://oceanexplorer.noaa.gov/explorations/07fire/logs/aug1/aug1.html>

The R/V *Sonne* towed a magnetometer near the sea-surface behind the ship, measuring the magnetic field above the volcano. The volcano, however, lies in water depths between 1,500 and 2,500 m below the near-surface towed magnetometer. Thus, the magnetics survey only reveals very broad, km-scale magnetic anomaly variations associated with the volcanic structure. The survey showed that Brothers has a reversed magnetic anomaly (relative to the International Geomagnetic Reference Field) over the caldera (Fig. 11). The towed magnetometer survey was undertaken to provide context for the near-seafloor surveys made by ABE. An additional survey was made over Healy volcano for comparison which showed a similar reversed magnetic anomaly associated with the main caldera.

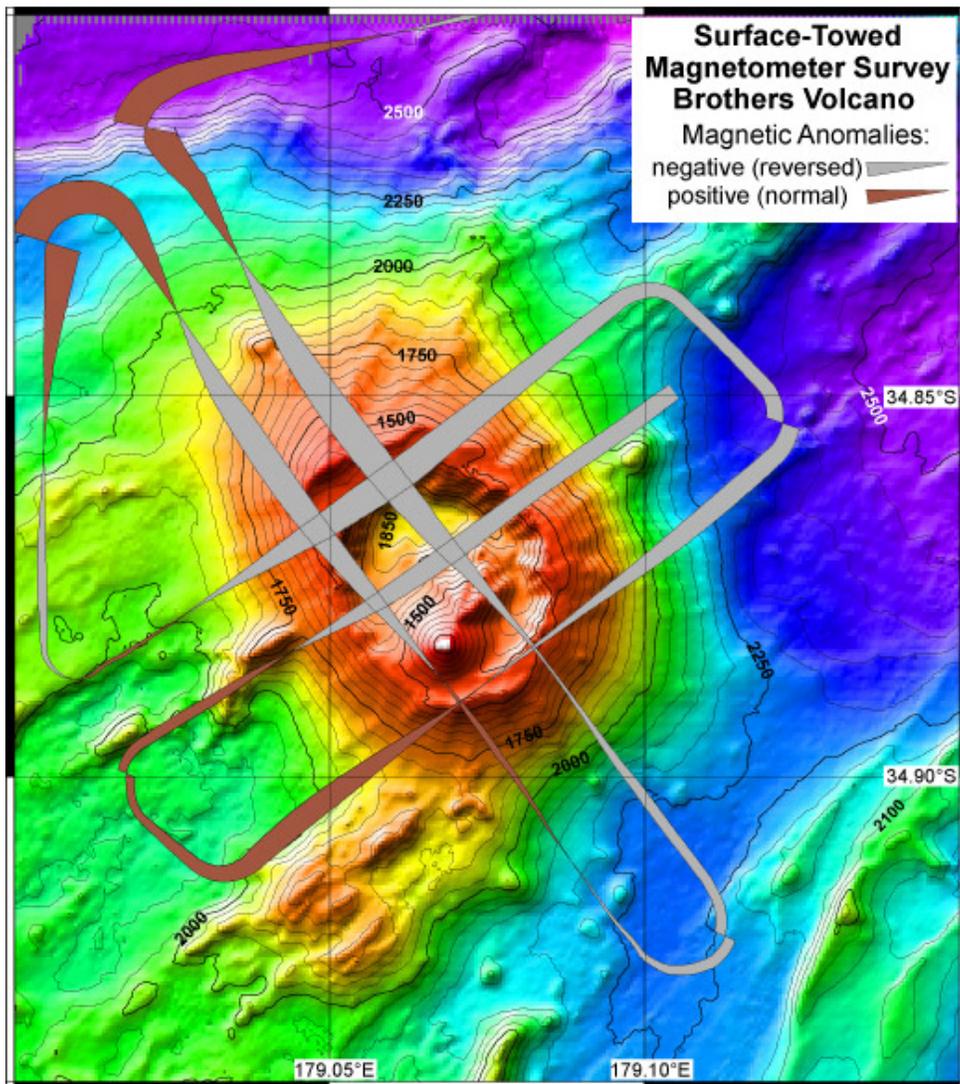


Figure 11. Near-surface towed magnetometer survey of Brothers volcano during the expedition. The survey results indicate that overall Brothers caldera has an associated reverse (negative) magnetic anomaly. 50 m contours. EM300 bathymetry courtesy of NIWA. Figure courtesy of Bryan Davy, GNS Science.

8.0 Outreach and Educational Activities

Susan Merle, Bob Embley, Cornel de Ronde

The NOAA Ocean Exploration website includes 6 background pieces provided pre-cruise and 9 at-sea web logs. “Ask an Explorer” questions were also answered while at sea. A photo and video log was added to the website, post-cruise. Videos provided prior to the expedition include a podcast and several bathymetry fly-throughs. An additional fly-through over the high-resolution ABE data was sent to the website from Auckland after the expedition. The expedition was featured in the New Zealand media (TV news, newspapers and radio interviews) and a short documentary was made by Mr. Michael Hacking that will be produced by Catalyst TV in Australia (<http://www.abc.net.au/catalyst/>). Also aboard the R/V *Sonne* were documentary makers from Germany (WDR TV). Some of the ABE-derived bathymetric data will be used in a special project at New Zealand’s national museum, Te Papa, that will recreate a ‘virtual dive’ on Brothers volcano for the public to experience what it would be like to dive inside the caldera of this volcano.

<http://www.oceanexplorer.noaa.gov/explorations/07fire/welcome.html>