Summary Cruise Activity Report, NBP0207

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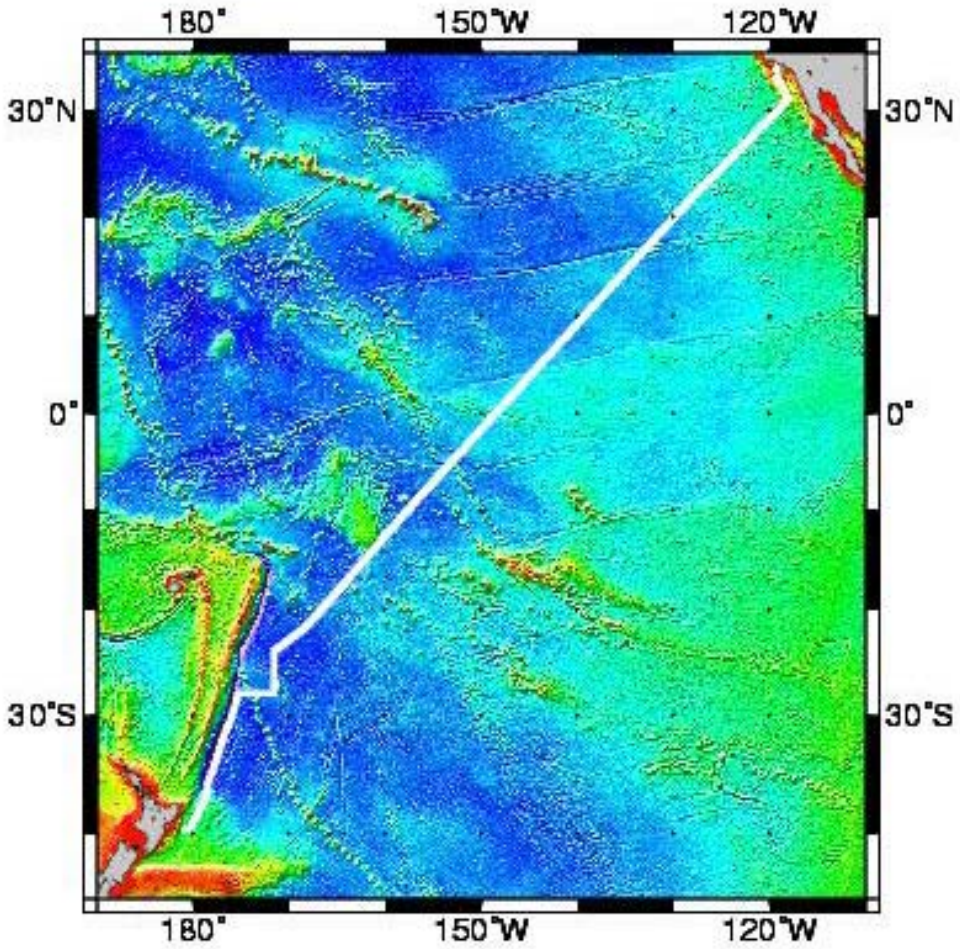

Figure 1. Track of cruise Nathaniel B. Palmer 02-07 (white line) overlain on predicted bathymetry grid (Smith and Sandwell, 1994).

Transit cruise NBP-0207 conducted a geophysical survey from Port Hueneme, California, to Lyttelton, New Zealand, from Nov. 10 to Dec. 6, 2002 (Figure 1). The chief scientist was Joann Stock and the co-chief scientists were Robert Clayton and Michael Gurnis (all from Caltech). We had numerous scientific objectives along the track. The major ones that required a deviation from a direct route port-to-port were: a) to survey some active faults in the California/Mexico continental borderland; b) to survey a 200 km long single-channel seismic line and 400 km long magnetics line across the Osbourn Trough just east of the Tonga Trench at 26º S latitude; c) to survey along a constant isograd (gravity anomaly value) outboard of the Kermadec trench to study the flexural strength of the Pacific plate where it is being subducted. Other objectives were addressed depending on their feasibility with the data collected. In addition, we taught a marine geophysics class to 15 students. Two volunteers (Chloe Winant, BS 2002,

Occidental College, and Auna Moser, BS 2002, Caltech) accompanied our group to stand watch during the times of the class meetings, and to assist with data processing and analysis.

We collected continuous gravity, magnetics, Simrad EM120 swath bathymetry, and Bathy2000, and 24 hours of single-channel seismic data. XBTs were launched as needed to determine the profile of sound speed with depth in the water column. Surveys were conducted continuously between the ports, with the permissions of the various nations through which we traveled (Mexico, Kiribati, Niue, Cook Islands, and New Zealand). The only exception was that a power failure on Nov. 13 caused us to lose between 30 minutes and 90 minutes of data from the different data sets.

Scientific highlights.

Bathymetry and tectonics of the California/Mexico continental borderland.
The line of multibeam and Bathy2000 observations in the Borderland was used to look at the character of some active faults of the region (Stock et al., 2003). For the line extending SW across the Patton escarpment, from the Borderland region to the Pacific Ocean seafloor within Mexican waters, gravity and bathymetry data were modeled to determine the crustal density structure (Aragon-Arreola and Clayton, 2003).

The Tongareva Triple Junction Trace.
The abyssal hill fabric measured on the E side of the Manihiki plateau records the transition of the spreading fabric from the N-S trending abyssal hills (related to Farallon-Pacific spreading) to the more E-W oriented abyssal hills (related to Phoenix-Pacific spreading). The data from NBP0207 were used in conjunction with data from other cruises to track the trace of this triple junction (Larson et al., 2002).

Seismic, magnetic, and gravity survey of the Osbourn Trough.
We conducted a survey line perpendicular to the Osbourn Trough (a fossil spreading center in the western Pacific Ocean, centered at about 26º S latitude). Our results further support the interpretation of Billen and Stock (2000) that this is, indeed, a former spreading center. We saw clear abyssal hill fabric that trends roughly E-W, perpendicular to the trend of the Osbourn Trough. We conducted one line of multichannel seismic data in order to evaluate whether the center of the trough contains excessively thick sediment (which would account for the negative gravity anomaly that is present there). We found, however, that the sediment thickness within the trough was no greater than in the surrounding region. This requires a different explanation for the presence of the gravity low. These data, in conjunction with more recent data collected by NBP0304 and NBP0304C, are the subject of a manuscript in preparation (N. Downey, Caltech, pers. comm., Dec. 2005).

We collected magnetic anomaly data simultaneously with the seismic line, in order to test for correlation of magnetic highs and lows with either (a) the bathymetry or (b) magnetic anomaly data collected in the vicinity by other cruises. The correlation with adjacent cruises was not exact, but some similarities were noted.

Fault map of the Kermadec Trench.

We collected a multibeam bathymetry line along the Kermadec trench, south of the Osbourn Trough and due east of the bathymetry collected on NBP9806a. The idea was to join the swath map of NBP0207 with that of NBP9806a to build up a more complete detailed map of the fault scarps and overall morphology of the outer trench wall, and to use this to study the flexural rigidity of the Pacific plate as it is bent into the subduction zone here.

Gravity survey along the Kermadec Trench.
The gravity survey along the Kermadec Trench was designed to provide another line of information that could be used to constrain the flexural strength of the Pacific plate by looking at the admittance between gravity and topography. The results of this survey, in combination with gravity data collected on parallel tracks on the NBP9806a cruise and on the subsequent NBP0304 and NBP0304C cruises, indicated that the Pacific plate loses elastic strength rapidly as it approaches the trench (Billen and Gurnis, 2005).

Directions of tectonic spreading fabric
Seafloor bathymetric fabric was automatically analyzed for every hour of swath bathymetry data. Results were classified as due to abyssal hill lineations, fracture zone morphology, or "other" (e.g., seamount volcanism). Directions of abyssal hill fabric were studied to evaluate possible changes in direction of spreading along the Pacific-Farallon corridor and to evaluate the tectonic spreading fabric in the Mesozoic seafloor provinces. We found excellently preserved abyssal hill fabric south of the Manihiki Plateau, trending WNW-ESE and then switching to an E-W trend closer to the Osbourn trough. The abyssal hill fabric at the Osbourn trough was E-W parallel to the trough and for some distance to the south. This is in clear support of a model in which the Manihiki Plateau and the Hikurangi plateau split apart from one another with a younger ocean basin formed in between them due to spreading at the Osbourn Trough. These results are included in a manuscript in preparation by Nathan Downey of Caltech (N. Downey, pers. comm., Dec. 2005).

Marine geophysics class.

During the cruise, we conducted an on-board marine geophysics class with 15 students. 13 of the students were from Caltech and two were from other schools: California State Polytechnic University at Pomona, and University of Texas at El Paso. There were 6 undergraduate students and 9 graduate students.

had 1 hour of formal class per day, with short homework assignments related to those classes. The students also stood science watch and analyzed data on a daily basis. Our underway gravity, magnetics, swath bathymetry, and single-channel seismic data were analyzed as part of the class. Each student was expected to do a short project about one aspect of the data and turn it in for a formal grade (if they were enrolled through Caltech). The students were not paid stipends for participation but their travel, lodging, and meal

expenses were covered (either by the OPP grant, or by separate funds from Caltech, which were available for the Caltech students enrolled in the class).

Table 1. Student participants in NBP-0207 marine geophysics class.

Student name	**Institution**	**Sex**	**Status**	**Citizenship**	**Ethnicity**
Lauren Annis	Cal Poly Pomona	F	Undergrad	USA	Caucasian
Elisabeth Adams	Caltech	F	Undergrad	USA	Caucasian
Manuel Aragon	Caltech	M	Grad	Mexico	Hispanic
Nathan Downey	Caltech	M	Grad	Canada	Caucasian
Nathan Fung	Caltech	M	Undergrad	USA	Asian
Min Chen	Caltech	F	Grad	China	Asian
Ying Tan	Caltech	F	Grad	China	Asian
Vala Hjorleifsdottir	Caltech	F	Grad	Iceland	Caucasian
Alisa Miller	Caltech	F	Grad	USA	Caucasian
Janessa Link	Caltech	F	Undergrad	USA	Caucasian
Laura Elliott	Caltech	F	Undergrad	USA	Caucasian
Gabriel Acevedo	UT El Paso	M	Undergrad	USA	Hispanic
Brian Savage	Caltech	M	Grad	USA	Caucasian
Chris DiCaprio	Caltech	M	Grad	USA	Caucasian
Ryan Petterson	Caltech	M	Grad	USA	Caucasian

Before the cruise left, each student was assigned a topic to read about and asked to prepare a half-hour talk about this topic to give to the other students on board the ship. This was part of the work on which the students were graded, and it provided background material for the group, regarding the scientific objectives of the cruise.

The students reported on the following topics for their class presentations:

Gabriel Acevedo – Sediment facies on the Pacific plate
Elisabeth Adams – the Line Islands
Manuel Aragon-Arreola – the California Continental Borderland
Lauren Annis – DSDP drill holes near the track, particularly those drilled to examine the Paleocene-Eocene oceanographic conditions
Min Chen – the Pacific Superswell
Chris DiCaprio – flexural strength of the plates
Nathan Downey – sedimentological features visible in seismic and echo-sounder profiles
Laura Elliott – abyssal hill fabric
Nathan Fung – extinct trench N of the Chatham Rise
Vala Hjorleifsdottir – geophysical characteristics of the major Pacific plate fracture zones
Janessa Link – the Tongareva Triple Junction
Alisa Miller – the Manihiki Plateau
Ryan Petterson – the Osbourn Trough

Brian Savage – the Louisville Ridge
Ying Tan – marine magnetic anomaly skewness used for paleo-latitude determinations

The class was a fall quarter Caltech class. Students received 12 class credits for taking this class (equivalent to 12 hours of work per week over the 10 week fall quarter).

Table 2. Topics covered during at-sea marine geophysics class, NBP0207.

Date	**Leader**	**Topic**
1. Oct. 22	J. Stock	Earth's gravity field and gravity anomalies
2. Oct. 29	J. Stock	Measuring the earth's gravity field at sea
3. Nov. 5	J. Stock	How to do a gravity tie calculation
4. Nov. 9th	RPC staff	Observe gravity tie; group embarks 3:30 p.m.
5. Nov. 10th ***ship departs***	RPC staff; students; ship's staff	Watchstanding and IT orientation, with ping editing orientation; student presentation: ***Manuel Aragon Arreola*** (Borderland faults); deck safety meeting and lifeboat orientation
6. Nov. 11th	RPC staff	Survey borderland faults; XBT launch training; magnetometer deployment
7. Nov. 12th	Stock; RPC staff	Marine magnetics– instrument design, dipole field equations, IGRF; ping editing training
8. Nov. 13th	students	2 student talks: ***Nathan Downey*** (seismic structure of sedimentary packages), ***Gabe Acevedo*** (sediment distribution in the Pacific Ocean Basin)
9. Nov. 14th	Stock	Marine magnetic anomalies – interpretation & examples from the Pacific ocean floor
10. Nov. 15th	Stock	Echo sounder and multibeam bathymetry instruments and data; Levitus tables for sound velocity in water; Carter's tables; density, temperature, and soundspeed in the oceans
11. Nov. 16th	All; students	Weekly science review #1; student presentation: ***Vala Hjorleifsdottir*** (characteristics of the major Far-Pac fracture zones)
12. Nov. 17th		No class ***(Sunday***)
13. Nov. 18th (Monday)	Clayton; students	Seismic survey planning; ***Ying Tan*** (paleomagnetic information determined from skewness of marine magnetic anomalies)
14. Nov. 19th	All; Stock	Discussion of student projects; detailed geology of fracture zones
15. Nov. 20th	students	2 student presentations: ***Laura Elliott*** (abyssal hill fabric), ***Lauren Annis*** (results from an ODP drilling transect across the equatorial Pacific)
16. Nov. 21	STUDENTS	2 student presentations: ***Min Chen*** (Pacific superswell) and ***Elisabeth Adams*** (Geology of the Line islands)
17. Nov. 22	Clayton	Seismic reflection technique (SCS) and data

		processing
18. Nov. 23	All; students	***Weekly science review*** and ***Janessa Link*** (Cretaceous plate tectonics of the western Pacific)
19. Nov. 24		***No class (Sunday)***
20. Nov. 25	Gurnis	Gravity and geoid
21. Nov. 26	students	Student presentations: ***Alisa Miller*** (Manihiki Plateau)
22. Nov. 27	students	Student presentations: ***Ryan Petterson*** (Osbourn Trough) ***Brian Savage*** (Louisville Ridge)
23. Nov. 28		Thanksgiving no class
24. Nov. 29	Students; Clayton	Student presentation: ***Nathan Fung*** (extinct trench N of Chatham rise); update on seismic data collection
25. Nov. 30	All; students	***weekly science review #3;*** student presentation: ***Chris diCaprio*** – flexural strength of the plates;
26. Dec. 1	Gurnis	Characteristics and rheology of fracture zones
27. Dec. 2		Missed day due to date line crossing
28. Dec. 3	Students	Review status of student projects
29. Dec. 4	students	Continue working on student project writeups
30. Dec. 5	all	Engine room tour; project reports due at midnight (end of Dec. 5)
31. Dec. 6th ***ship arrives***	RPC staff	gravity tie in port in Lyttelton; students depart the ship at 2 p.m.

Acknowledgments

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