

August 2005  
Site Survey Package 1 to ODP Site Survey Panel  
**Site Surveys**  
**from the TUIM-03 Cruise**  
**in support of Proposal 567-FULL:**  
*Paleogene South Pacific APC Transect: Heat  
Transport and Water Column Structure  
During an Extreme Warm Climate*

**Site Descriptions and Maps**

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**BSU CGISS Technical Report 2005-03**

**1 Aug 2005**

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# **SITE SURVEY DESCRIPTIONS FOR IODP DRILLING PROPOSAL 567-FULL: Tui Malia Leg 3 (R/V Melville), 9 Feb -21 Mar 2005**

## **Introduction**

In the austral summer of 2005 the R/V Melville conducted a site-survey cruise in support of IODP proposal #567: *Paleogene South Pacific APC Transect*. The results of that cruise, presented here, include 12 detailed surveys of potential drilling locations, 9 jumbo piston cores and 6 gravity cores. There are two important results of the Melville cruise that bear upon the science that can be achieved on an eventual scientific ocean drilling cruise; results that restrict the geographic area that can be sampled, but increase the number of critical paleoceanographic questions that can be addressed by an eventual South Pacific APC Transect.

### **Drilling Proposal prior to the 2005 Survey:**

Our proposal was to conduct a north-south transect set in the high (paleo) latitudes of the South Pacific with the intent of recovering Paleogene and younger sediment. Results should document the behavior of subtropical to subpolar oceanic and atmospheric circulation systems during the warm climate regime of the Eocene. Drilling on 56 m.y. old crust will ensure recovery of the Paleocene/Eocene boundary interval characterized by a sudden and extreme warming. Our original proposal outlined a plan that had seven objectives: 1) define the poleward extent of the subtropical gyre, 2) establish the position of the polar front, 3) determine sea-surface temperatures and latitudinal temperature gradient, 4) determine the width and intensity of the high-productivity zone associated with these oceanographic features, 5) characterize the water masses formed in the sub-polar region, 6) determine the nature of the zonal winds and how they relate to oceanic surface circulation, and 7) document changes in these systems as climate evolves from the warm late Paleocene to the cold Antarctic-dominated regime of the early Oligocene.

### **Drilling Proposal modified by the 2005 Survey:**

The Southwest Pacific Basin is a very poorly known part of the global ocean and as a result some of our cruise was exploratory in nature. A primary result of this exploration is the documentation of a broad region of no sediment - a 55 Myr hiatus - that lies between the latitudes of approximately 31° and 39°S. This means that the northern part of our originally proposed paleolatitude profile will not provide a paleoceanographic record. Nonetheless we will be able to address most aspects of our original objectives, but with less positional control on the transect for the first two.

In addition, the site survey cruise identified three more first-order paleoceanographic and paleoclimatic questions that can be addressed by drilling. First, our coring along 50° south latitude documented that the carbonate compensation depth is quite deep, at about 4750 meters. For much of its history, the ocean crust in the far South Pacific will have been above the CCD permitting both Neogene and Paleogene paleoceanographic reconstructions based upon both calcareous and siliceous microfossils. The presence of Neogene carbonates is an unexpected bonus.

Our longest piston core, from 50°27'S, recovered siliceous ooze with ice rafted debris, and another siliceous core had an ice-rafted basalt pebble on the top of the recovered sediment. These indications suggest that drilling the South Pacific Transect will recover a complete ice rafting record of Antarctica, a record that should be available on Milankovitch as well as tectonic timescales. Much of this record will be in carbonate sediment permitting multiple-proxy examination of the changing climates of the Southern Ocean.

Finally the more southerly of our sites backtrack to paleolatitudes equivalent to the latitude of the Drake Passage. The Oligocene to Miocene opening and deepening of this passage and the earlier opening of the Tasman Gateway south of Australia, are the critical tectonic events that controlled Southern Ocean circulation and inaugurated the modern regime of whole-ocean circulation modeled by the "conveyor belt" diagrams. To the extent that modern ocean circulation and global heat transport depend on the existence of the Drake Passage, the determination of its history and the details of the oceanic response to its development form a critical question in paleoceanography. Sediment recovered during drilling of the South Pacific Latitudinal Transect will bring a wealth of new information to this question. Similarly, the drilling transect will be able to document the changes in South Pacific ocean circulation associated with the opening of the Tasman Gateway at the end of the Eocene and will be critical to understand the feedbacks that established the Oligocene "Icehouse".

### **Structure of Technical Report 2005-03**

Following this introduction, site descriptions are listed in numerical order, not based on paleolatitude or age. Each chapter will contain basic information about one of the surveys shown below and will show seismic profiles and give sediment descriptions. Site locations are shown in *Figure Intro-1*. The following sites are located on ca. 56 Ma crust to provide information on the early Eocene evolution of the south Pacific: SP-1A (71°S paleolatitude at 55 Ma), SP-2A (69°S at 55 Ma), SP-3A (65°S at 55 Ma), SP-4A (61°S at 55 Ma), and SP-5A (57°S at 55 Ma). In addition SP-15 is located on 80 Ma crust and was located at 59°S at 55 Ma. Two additional sites were located on about 40 Ma crust: SP-13 (64° S at 40 Ma) and SP-14 (59°S at 40 Ma). Finally, we have included site survey descriptions of a series of sites which were surveyed but which had no sediment to drill: SP-6, SP-7, SP-9, and SP-11. We decided to include these sites to better document the extreme paucity of sediment underneath the Paleogene South Pacific gyre.

Figure Intro-1: Trackline of Tui Malia Leg 3, February March 2005. Yellow dots mark site surveys on 55 Ma crust, while red dots mark surveys on 40 Ma crust. SP-15 is on 82 Ma crust.

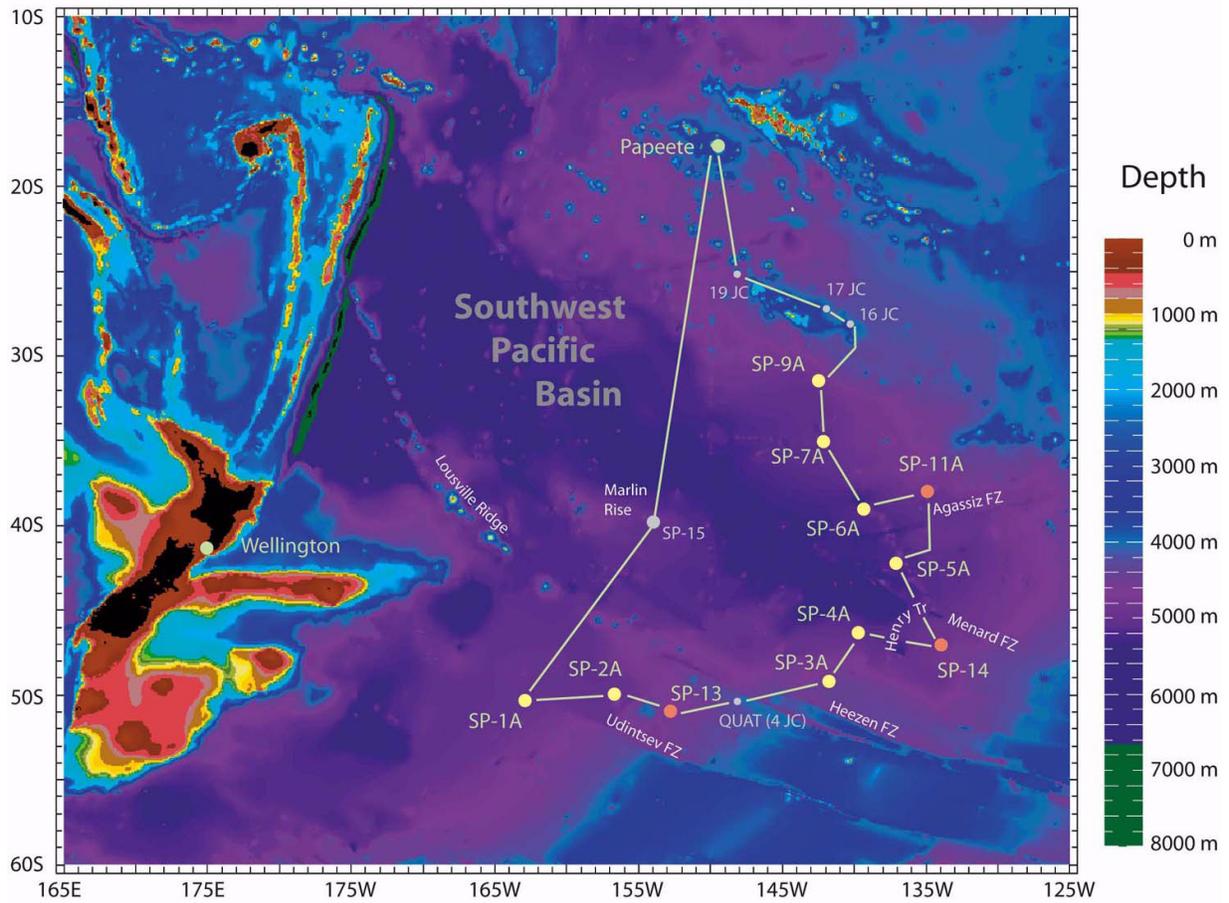
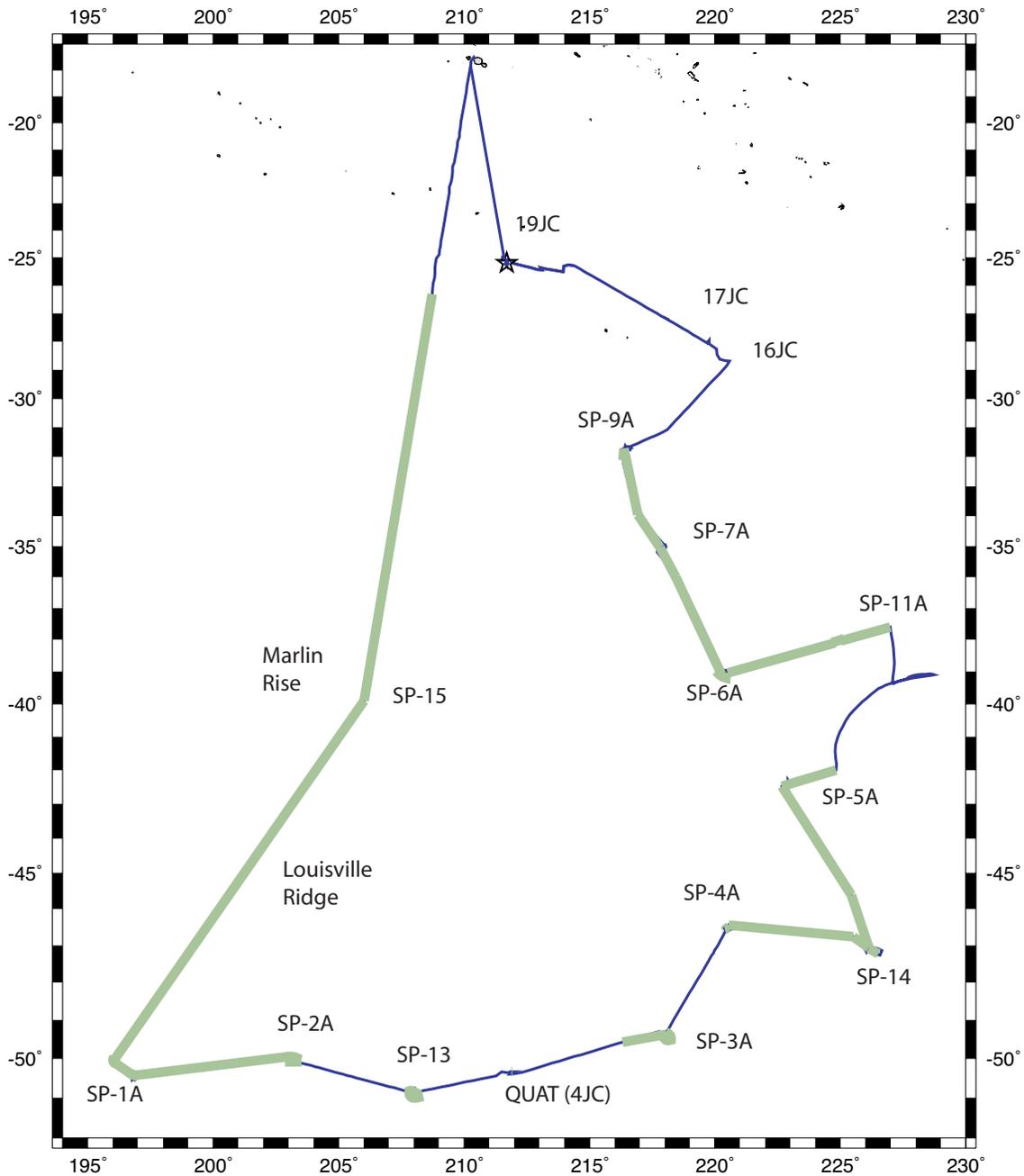
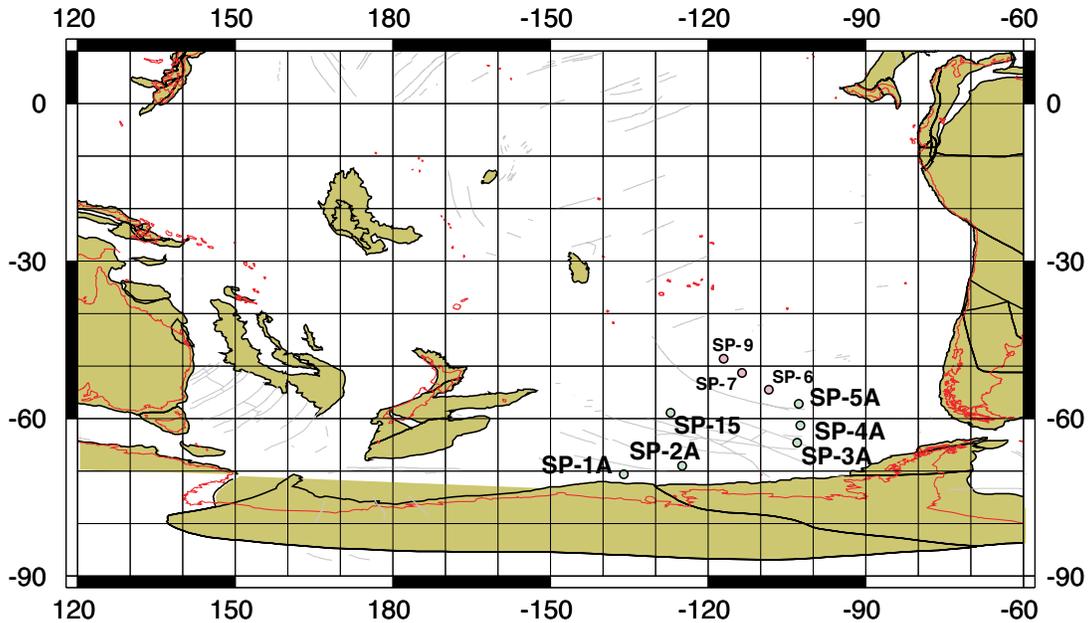


Figure Intro-2: Seismic reflection surveys were conducted at survey sites as well as underway, using a 150 c.i. GI gun source and the Scripps 4-channel streamer.



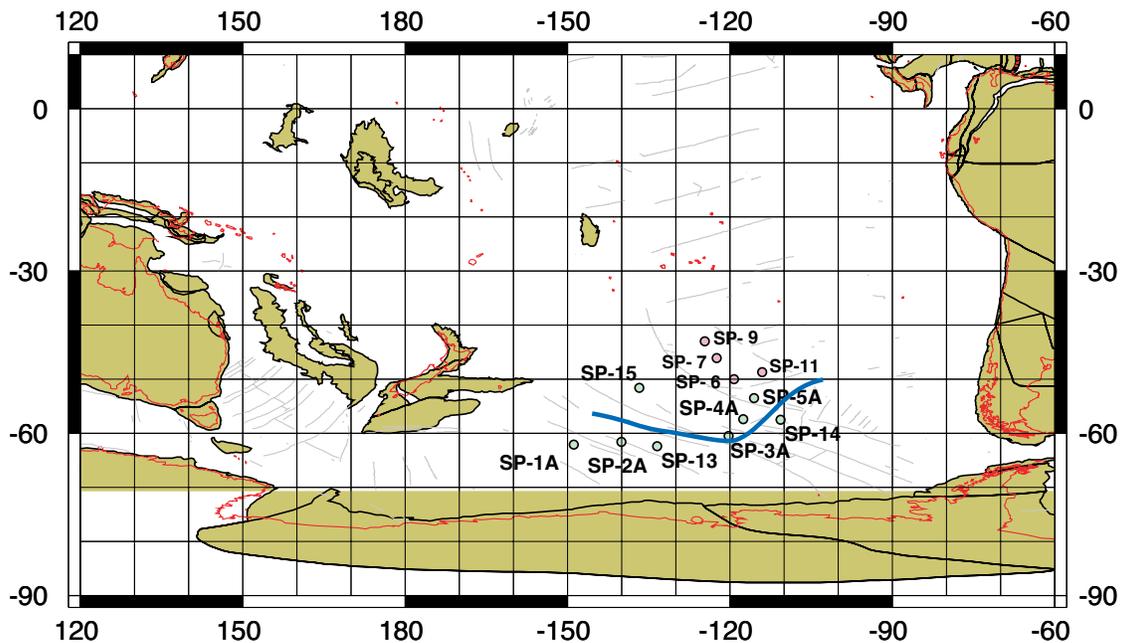
**Cruise: TUIM03MV Chief Scientist: Mitch Lyle**  GI Airgun Seismic Data coverage  
 Begin date/port: 09-Feb-2005 Papeete, Tahiti  
 End date/port: 21-Mar-2005 Papeete, Tahiti  
 Last position: 19-Mar-05 / 0000Z 25-11S 148-17W course: 131 speed: 1.0 knots

Figure Intro-3a: 55 Ma Positions of Proposed drillsites, backtracked using Ocean Drilling Strati-graphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>) North American paleomagnetic reference frame of Harrison and Lindh (1982). Green sites mark surveys with proposed drillsites; pink sites are bare of sediment.



### 55.0 Ma Reconstruction

Figure Intro-3b: 35 Ma Positions of Proposed drillsites, backtracked as in Figure intro-3a. Green sites mark surveys with proposed drillsites; pink sites are bare of sediment. Blue line marks northern boundary of >100 m thickness of sediments.



### 35.0 Ma Reconstruction

## **SITE SP-1A (SW Pacific, near Udintsev FZ)**

**50° 29.140'S, 163° 16.770' W**

### **SITE OBJECTIVES**

SP-1A is the southernmost site of the South Pacific Latitudinal transect. It is presently located SW of the Udintsev Fracture Zone, just north of the modern South Pacific polar front (Figure SP1A-1) on crust with an age of 56 Ma (anomaly 25n). SP-1A and SP-2A are the two polar sites for the proposed transect. SP-1A will be used to define circulation and SST near the Antarctic continent for the late Paleocene and early Eocene across the P/E boundary (55 Ma) and through maximum Cenozoic warmth (ca. 50 Ma). The site is likely to provide paleoceanographic data throughout the Eocene, although paleodepths will exceed 4000 m after about 40 Ma. If the CCD remained at roughly 4700 m since the Eocene/Oligocene boundary, SP-1A should have carbonate preserved in the sediments up until the early Miocene. At 55 Ma, the backtracked location of SP-1A was 70.6° S, 136° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-1A is situated about 1° to the southwest of Udintsev Fracture Zone, on abyssal hill topography. Based on magnetic maps (Cande et al., 1989) and personal communications with Steve Cande, we chose the location on magnetic anomaly 25n, roughly at 56 Ma (Cande and Kent, 1995) and definitely older than the P/E boundary in the middle of anomaly 24r. We used the TUIM-03 site survey to confirm the anomaly location. Water depth in the general vicinity is about 5 km.

### **TUIM-03 Survey**

SP-1A was surveyed in February 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. The site was also piston cored, and a 17.4 m core was recovered.

SP-1A is in a region of abyssal hills, with highs to 4800 m and basins to 5250 m. The fabric of the hills matches the magnetic anomaly fabric, and trends SW-NE (Figure SP1A-2). Sediment thickness at the site ranges from 50 msec at the top of the abyssal hills to a maximum of a little more than 300 msec. Average for the site is about 200 msec. Surface sediments consist of a diatom-rich clay, ranging to diatom ooze at depth. Small numbers calcareous microfossils were found in the sediment as well.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-02JC 50° 27.137'S S, 163° 07.629'W, 4906 m (uncorr.) 17.4 m sediment from TUIM-03.

The core consists of light olive brown to olive gray silty diatom ooze to diatom clay. Accessory microfossils include radiolaria, sponge spicules, and rare coccoliths. Near the bottom of the core,

calcareous microfossils (foraminifera and nannofossils) become significantly more abundant.

## **SEISMIC INTERPRETATION**

**Primary Site (SP-1A):** TUIM-03-SP1A line 6, 2005 JD050 17:49:15 gmt, CDP 4050 (cross with SP1A line 2)

Crustal age: 56 Ma

Location: 50° 29.140'S 163° 16.770'W

Site water depth: 4971 m (6.628 sec TWTT)

Sediment thickness: 0.314 sec (245 m)

Proposed Drilling Depth: 250 m

SP-1A was chosen at the intersection of Lines 2 and 6 from the TUIM-03 survey. The sediment here is slightly thicker than average but we decided to site SP-1A here primarily because of a well-developed basal sediment section. In addition, the target area is large and basement is relatively flat in the vicinity of the proposed site. Sediment cover is also sufficiently thick in the vicinity to drape over basement highs. The subbottom profiler section (Figure SP1A-6) demonstrates about 75 msec (roughly 60 m) of layered sediments in the upper sediment column.

## **GEOLOGIC HAZARDS**

There are no known geologic hazards--pelagic sediments over oceanic basalts.

## **OTHER HAZARDS**

There are no manmade hazards in the vicinity.

## **SEISMIC DATA AVAILABLE from TUIM-03**

SP-1A Line 1

SP-1A Line 2

SP-1A Line 3

SP-1A Line 4

SP-1A Line 5

SP-1A Line 6

## **FIGURES**

Fig SP1A-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-1A is marked.

Fig SP1A-2: Swathmap bathymetry for the SP-1A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP1A-3: MST physical properties data for MV0502-2JC.

Fig SP1A-4: Seismic profile SP1 line 6 across SP-1A, from TUIM-03. Proposed drill site is marked.

Fig SP1A-5: Crossline seismic profile SP1 line 2 from TUIM-03. Proposed drill site is marked.

Fig SP1A-6: Chirp subbottom profile from line 6 across SP-1A, from TUIM-03. Proposed drill

site is marked.

## REFERENCES

- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP1A-1: Location map for SP-1A shown with the Tui Malia Leg 03 site survey trackline.

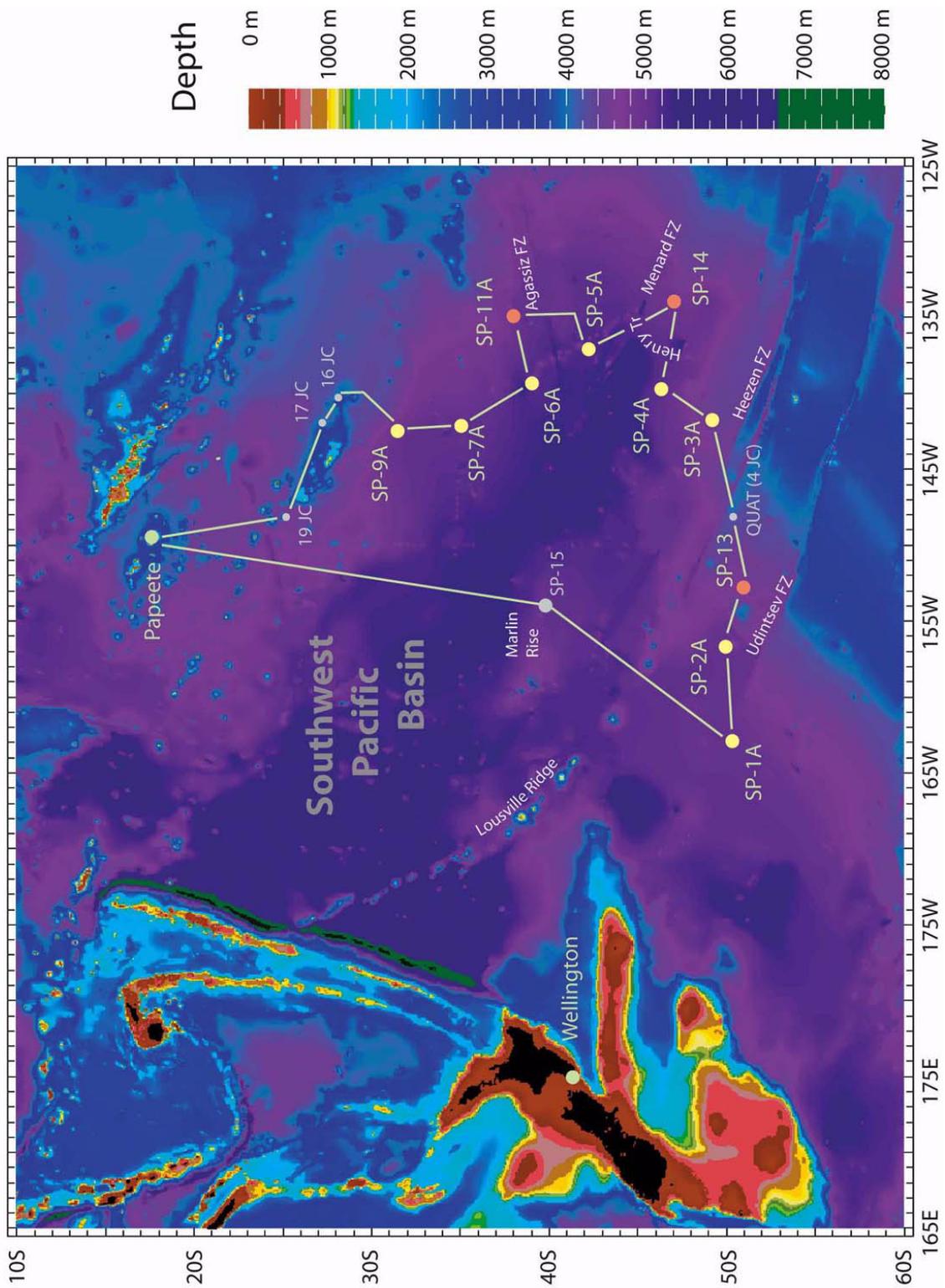




Fig SP1-3: Physical properties measured on piston core MV0502-02JC, taken at SP-1A

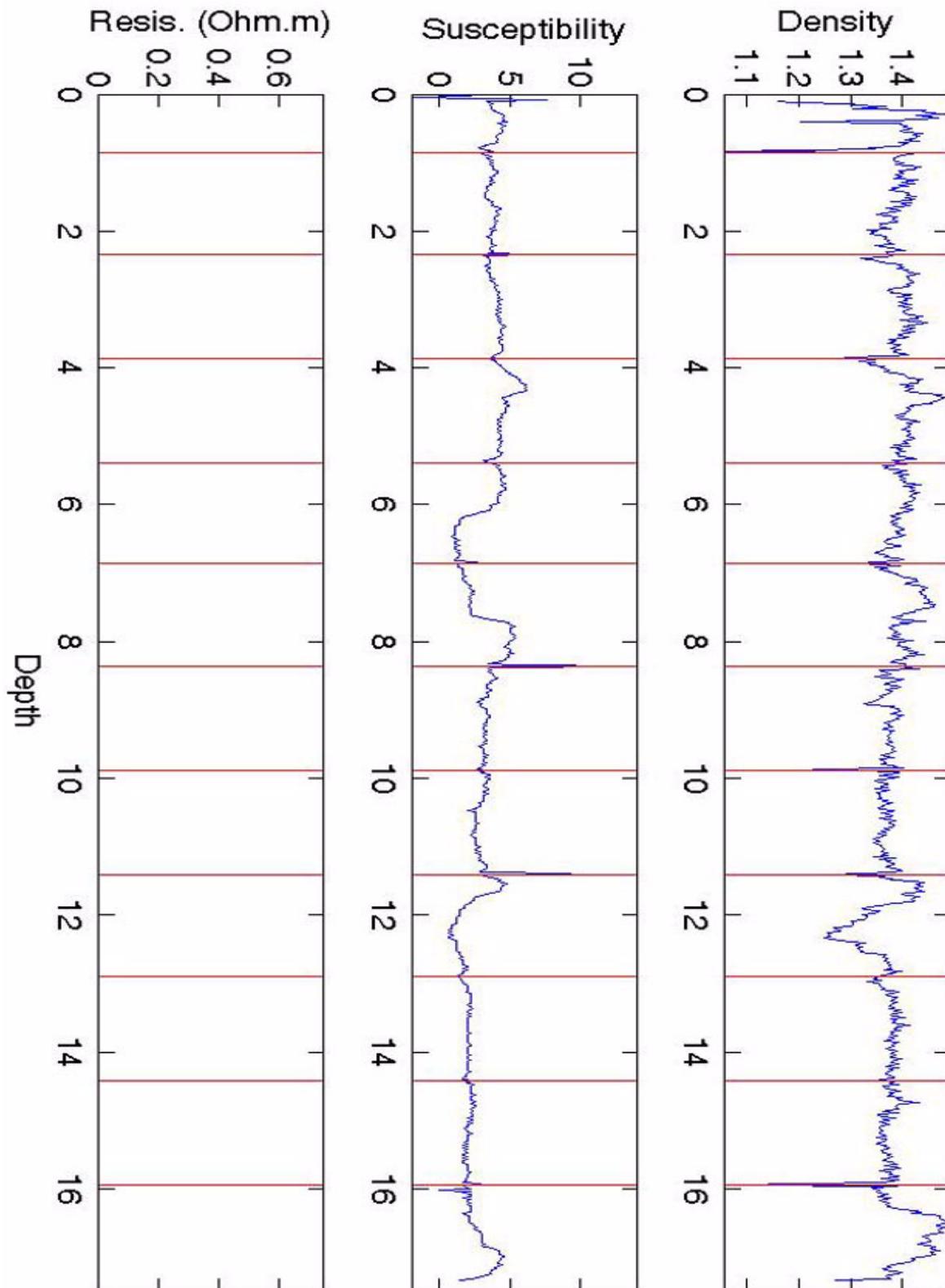


Figure SP1A-4: The seismic profile SP-1A line 6.

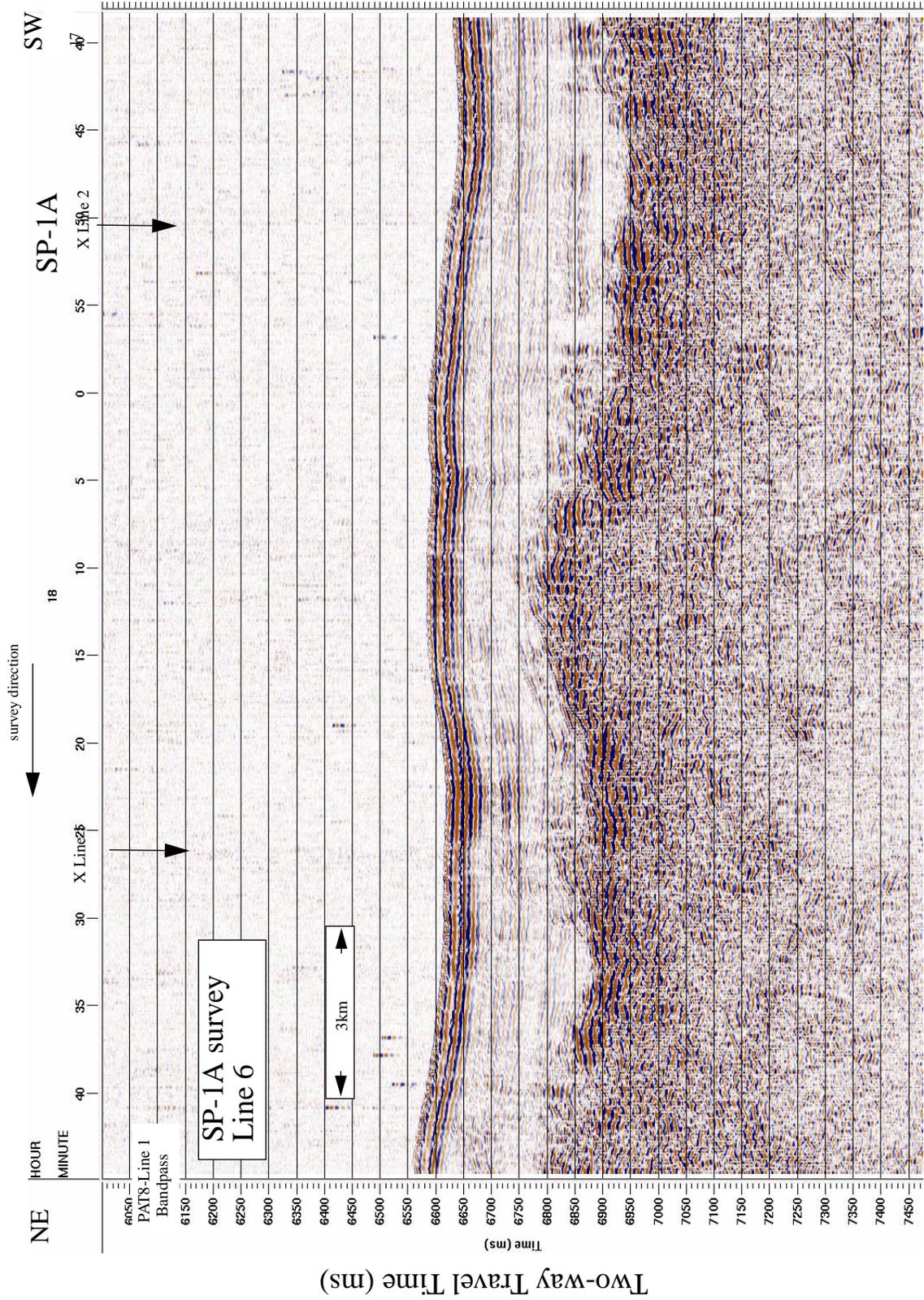


Figure SP1A-5: The crossline, seismic profile SP-1A line 2, across the proposed location of SP-1A.

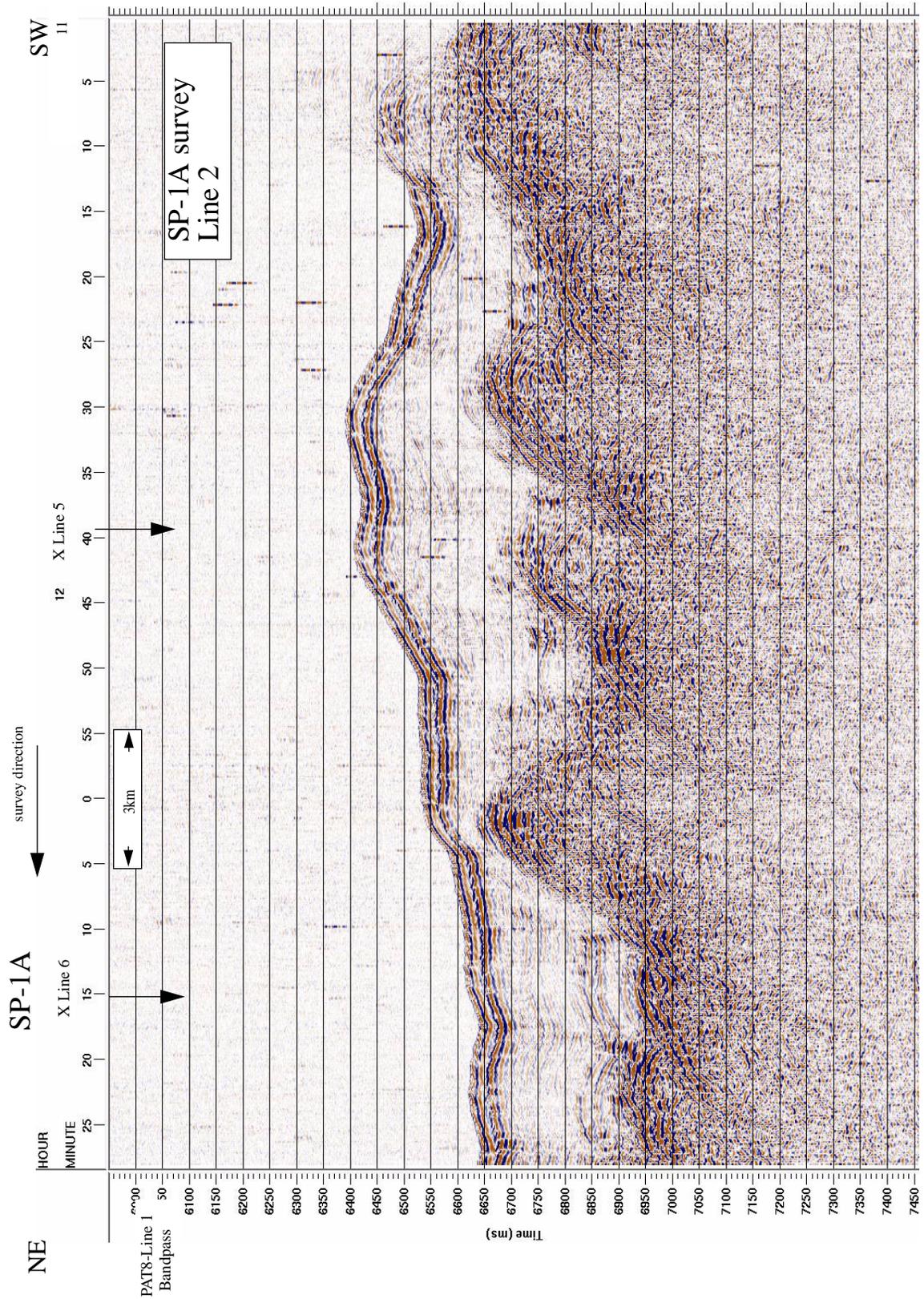
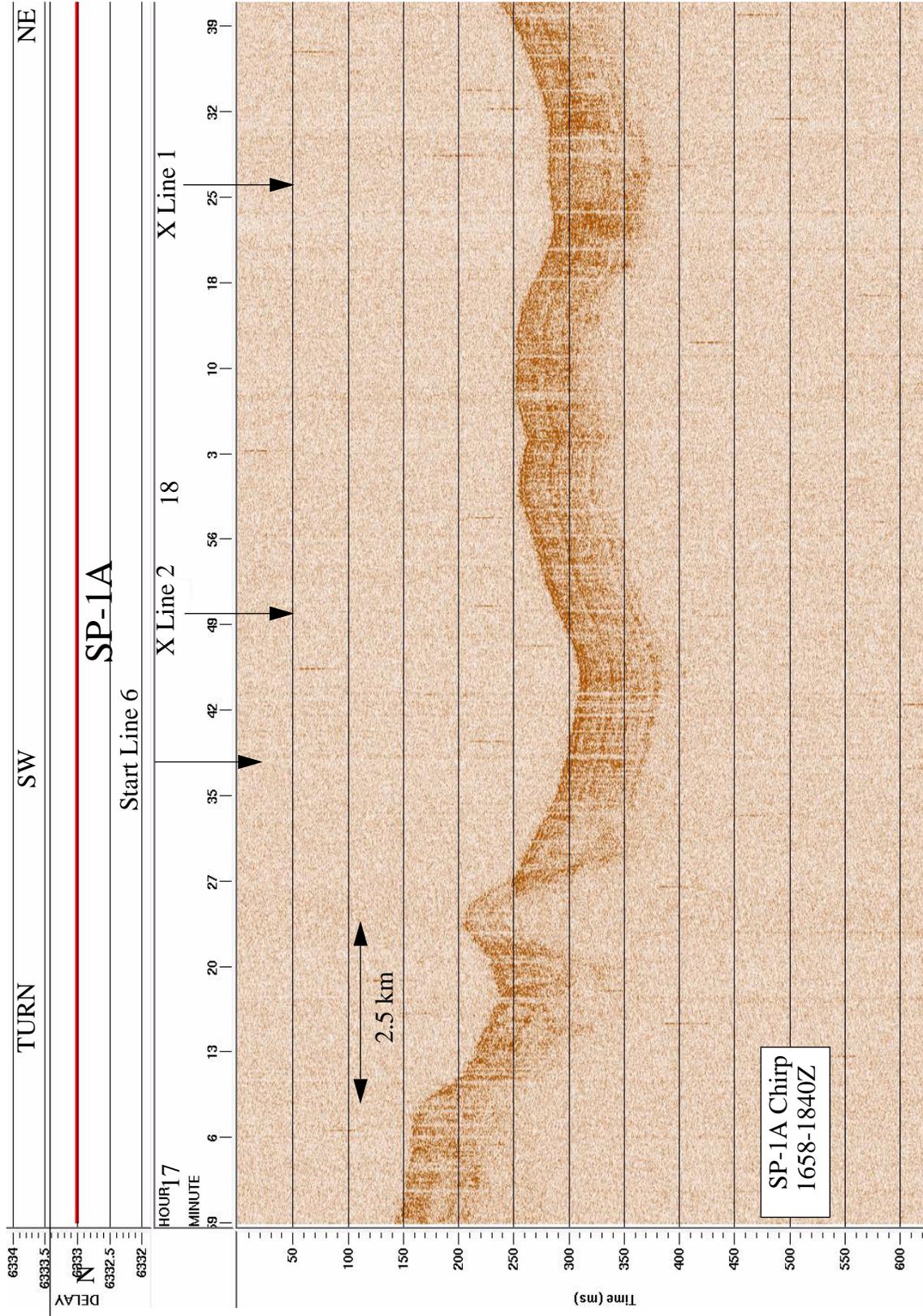


Figure SP1A-6: The Knudsen chirp subbottom profiler record (line 6) across the proposed location of SP-1A.



## **SITE SP-2A (SW Pacific, North of Udintsev FZ)**

**49° 56.315'S, 156° 50.581' W**

### **SITE OBJECTIVES**

SP-2A is located just N of the Udintsev fracture zone, west of SP-1A (Figure SP2-1) on crust with an age of 56 Ma (anomaly 25n). SP-1A and SP-2A are the two polar sites for the proposed transect. SP-2A will be used to define circulation and SST near the Antarctic continent for the late Paleocene and early Eocene across the P/E boundary (55 Ma) and through maximum Cenozoic warmth (ca. 50 Ma). It is likely to provide paleoceanographic data throughout the Eocene, although paleodepths will exceed 4000 m for sediments younger than about 40 Ma. If the CCD remained at roughly 4700 m since the Eocene/Oligocene boundary, SP-1A should have carbonate preserved in the sediments up until the early Miocene. At 55 Ma, the backtracked location of SP-2A was 69° S, 124.9° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-2A is situated about 1° to the northwest of Udintsev Fracture Zone, on abyssal hill topography. Based on magnetic maps (Cande et al., 1989) and personal communications with Steve Cande, we chose the location on magnetic anomaly 25n, roughly at 56 Ma (Cande and Kent, 1995). We used the TUIM-03 site survey to confirm the anomaly location. Water depth in the general vicinity is about 5 km.

### **TUIM-03 Survey, R/V Melville**

SP-2A was surveyed on February 21, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector). The seismic reflection survey was recorded on the LDEO 24 channel streamer, without birds (no battery packs). The survey was complicated by the remnants of tropical Cyclone Olaf traveling SE through the vicinity. We were forced to cut off the seismic survey after only 4 lines, and were unable to core because of the high sea state. Because of the ubiquitous and relatively uniform sediment cover, we could locate a good drill site despite these problems.

SP-2A is in a region of low abyssal hills, with highs to 4950 m and basins to 5175 m. The fabric of the hills matches the magnetic anomaly fabric, and trends SW-NE (Figure SP2-2). Sediment thickness at SP-2A is relatively uniform, 100-200 msec over both basins and hills.

### **LITHOLOGIC DESCRIPTION**

#### Nearby sediment cores:

*MV0502-02JC 50° 27.137'S S, 163° 07.629'W, 4906 m (uncorr.) 17.36 m sediment (from TUIM-03 site SP-1A; Figure SP2-3).*

The core consists of light olive brown to olive gray silty diatom ooze and diatom clay. Accessory microfossils include radiolaria, sponge spicules, and rare coccoliths. Near the bottom of the core,

calcareous microfossils (foraminifera and nannofossils) become significantly more abundant.

*ELT 14-2 51°54.8'S 159°54.5'W, 4636 m, 11.95 m sediment*

Alternating carbonate-rich and opal-rich clays and oozes. Thickness of the layers is on the order of a meter (Figure SP2-4). This core is located near the Pleistocene carbonate compensation depth.

### **SEISMIC INTERPRETATION**

Primary Site (SP-2A): TUIM-03-SP2A line 3, 2005 JD052 18:29:20 gmt, CDP 4050 (crossline: SP2A line 1)

Crustal age: 56 Ma

Location: 49° 56.315'S 156° 50.581'W

Site water depth: 5075 m (6.767 sec TWTT)

Sediment thickness: 0.181 sec (145 m)

Proposed Drilling Depth: 150 m

SP-2A was chosen along Line 3 of the survey because basement is flat and the sediment is relatively thick. In addition, the target area is large with uniform sediment cover. Throughout the area the sediment drapes over basement highs, but sediment packages thin to about 100 msec over the higher basement topography. The subbottom profiler section (Figure SP2-7) images about 80 msec (roughly 60 m) of layered sediments in the upper sediment column.

### **GEOLOGIC HAZARDS**

There are no known geologic hazards--pelagic sediments over oceanic basalts.

### **OTHER HAZARDS**

There are no manmade hazards in the vicinity.

### **SEISMIC DATA AVAILABLE from TUIM-03**

SP-2A Line 1

SP-2A Line 2

SP-2A Line 3

SP-2A Line 4&5

### **FIGURES**

Fig SP2-1: Location map for South Pacific Latitudinal Transect. Proposed drill site SP-2A is shown.

Fig SP2-2: Swathmap bathymetry for the SP-2A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP2-3: MST physical properties data for MV0502-2JC.

Fig SP2-4: Carbonate and organic carbon profiles down nearby core Eltanin 14-2.

Fig SP2-5: Seismic profile SP2 line 3 across SP-2A, from TUIM-03. Proposed drill site is marked.

Fig SP2-6: Crossline seismic profile SP2 line 1 from TUIM-03.

Fig SP2-7: Chirp subbottom profile from line 3 across SP-2A, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP2-1: Location map for SP-2A shown with the Tui Malia Leg 03 site survey trackline.

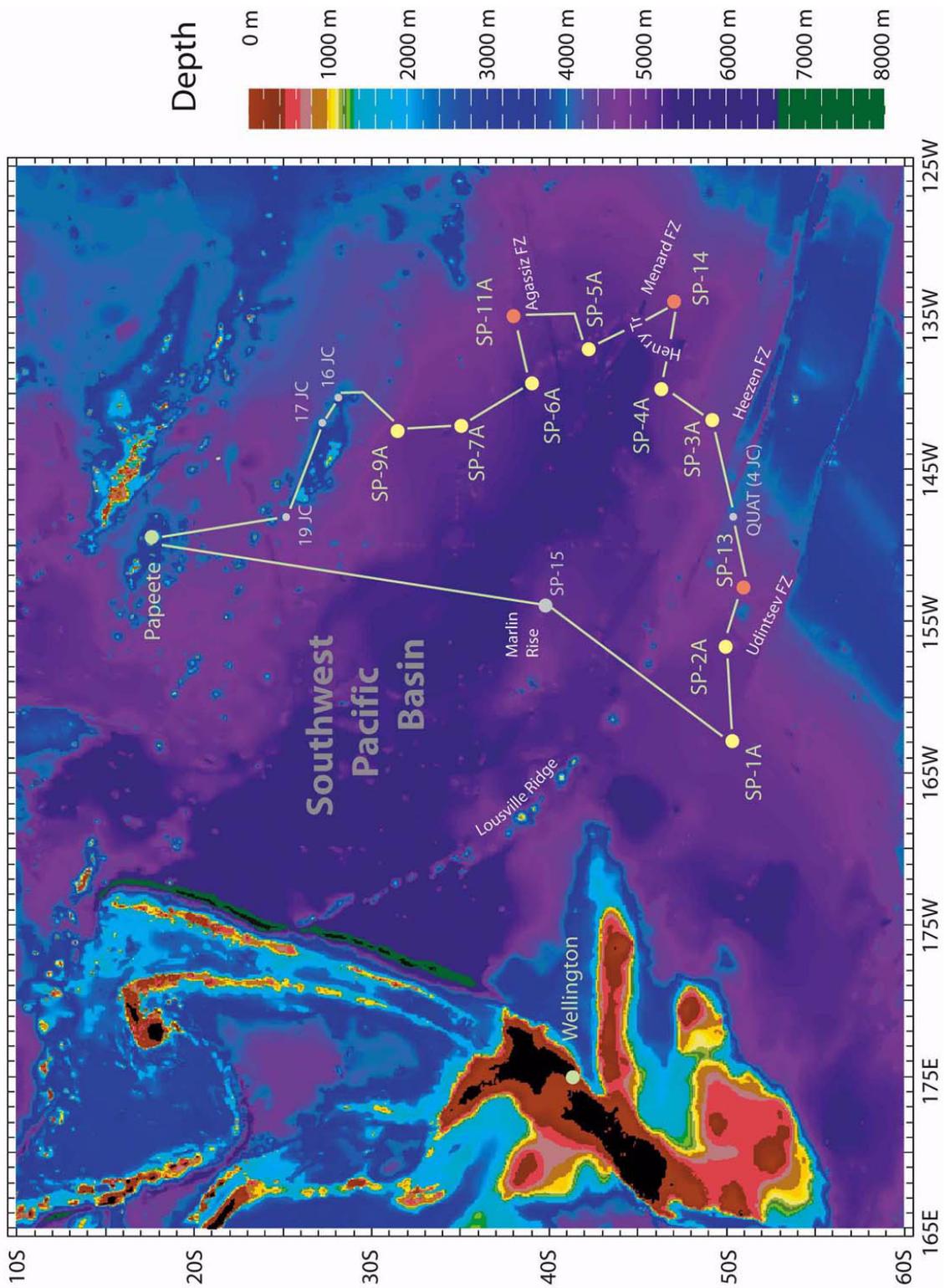


Figure SP2-2: Swathmap bathymetry in the region surrounding SP-2A from TUIM-03 survey cruise.

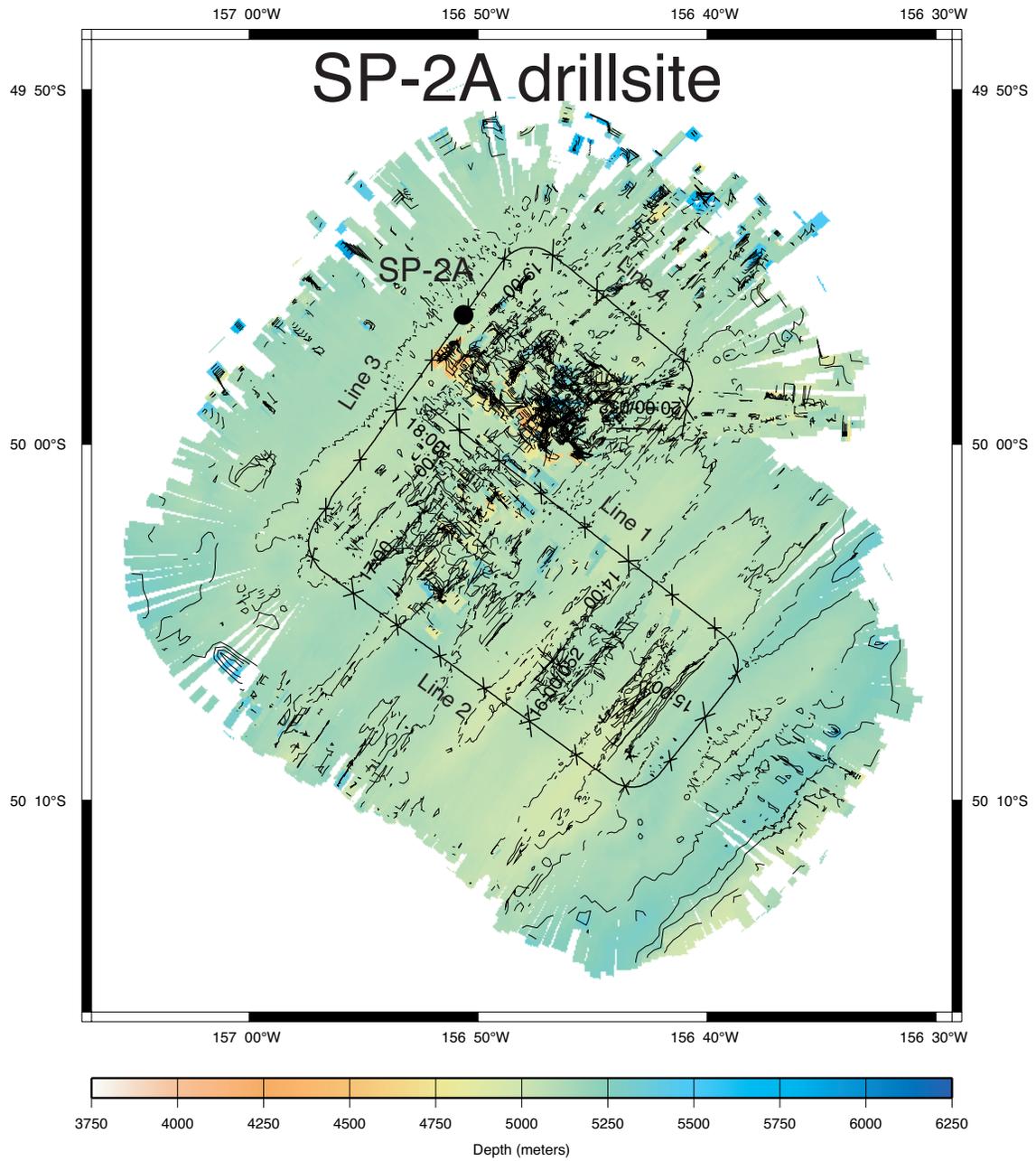


Fig SP2-3: Physical properties measured on piston core MV0502-02JC, taken at SP-1A

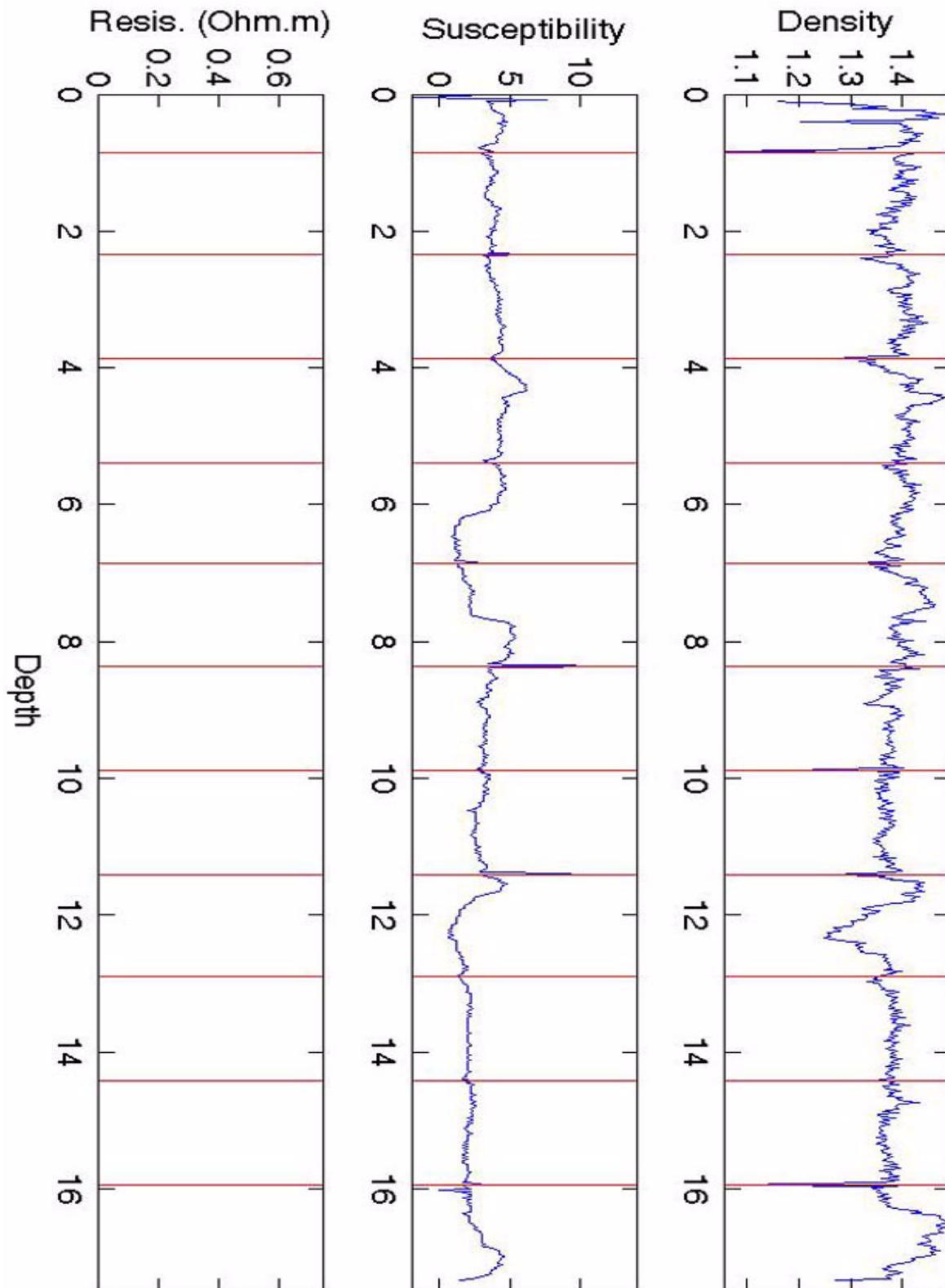
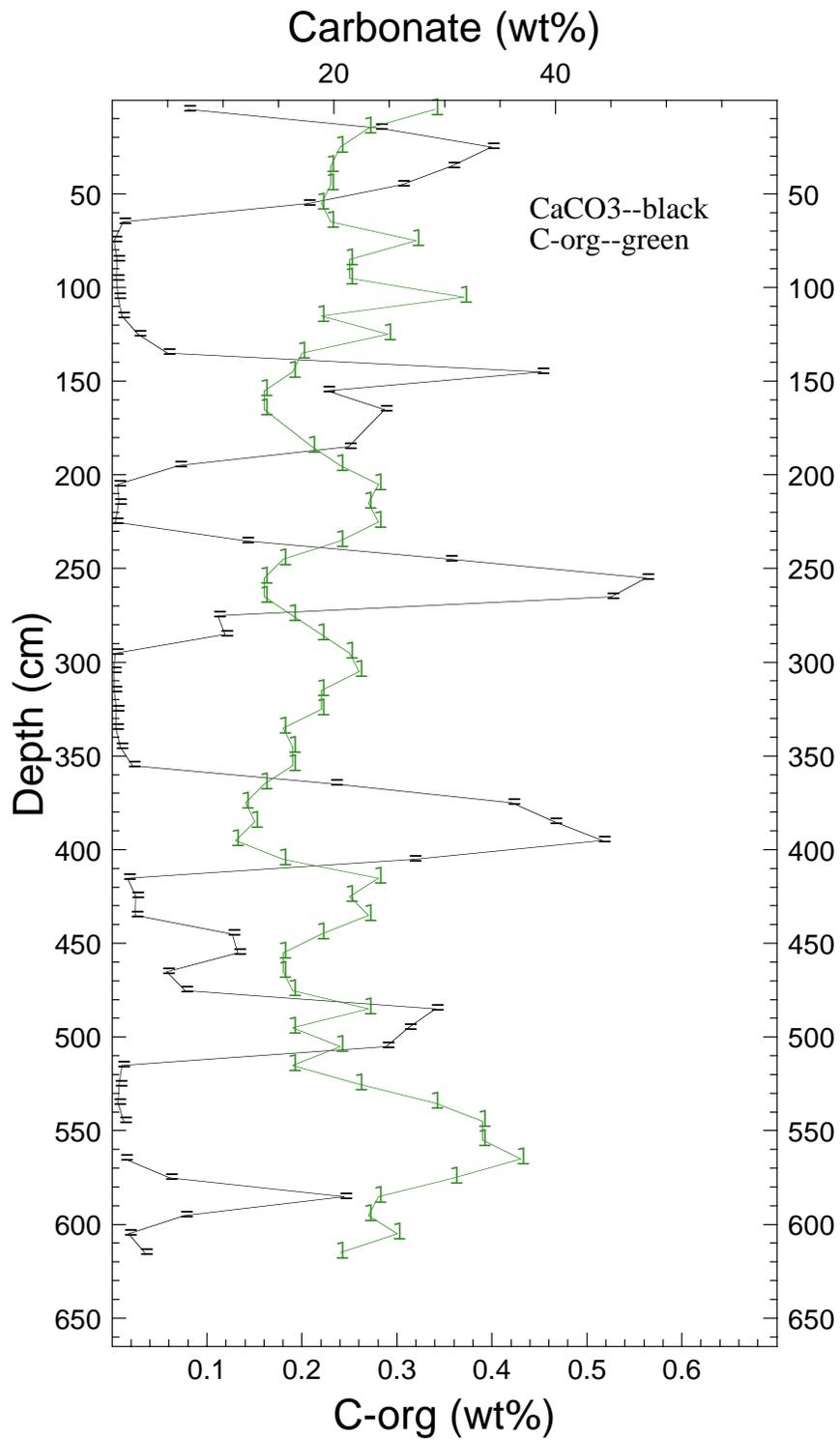


Figure SP2-4: Carbonate cycles in Eltanin 14-2 (51.9°S, 159.9°W, 4636m; Olivarez Lyle, unpublished data).



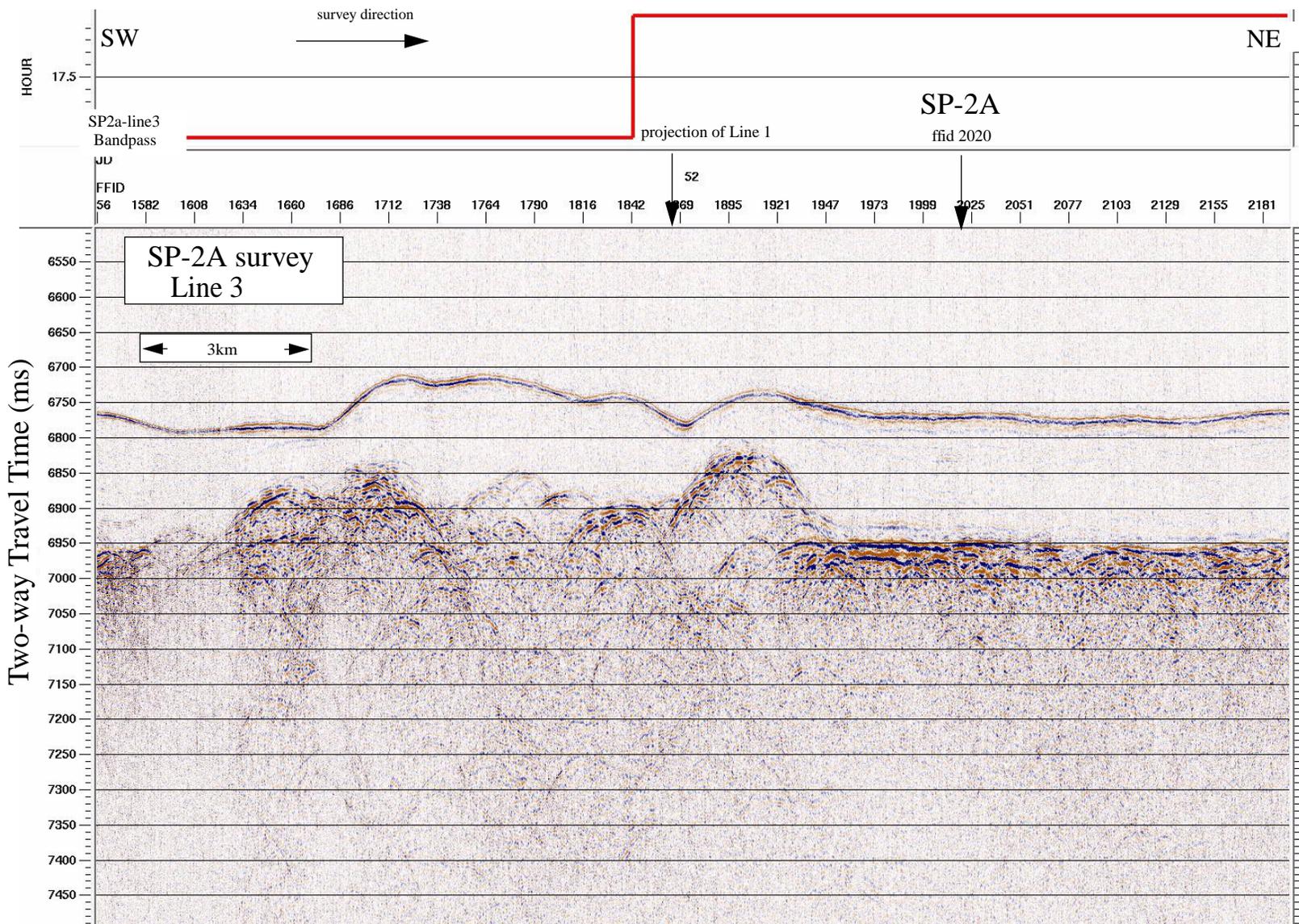


Figure SP2-5: The seismic profile SP-2A line 3 showing the proposed drill site.

Figure SP2-6: The crossline, seismic profile SP-2A line 1, across the proposed location of SP-1A.

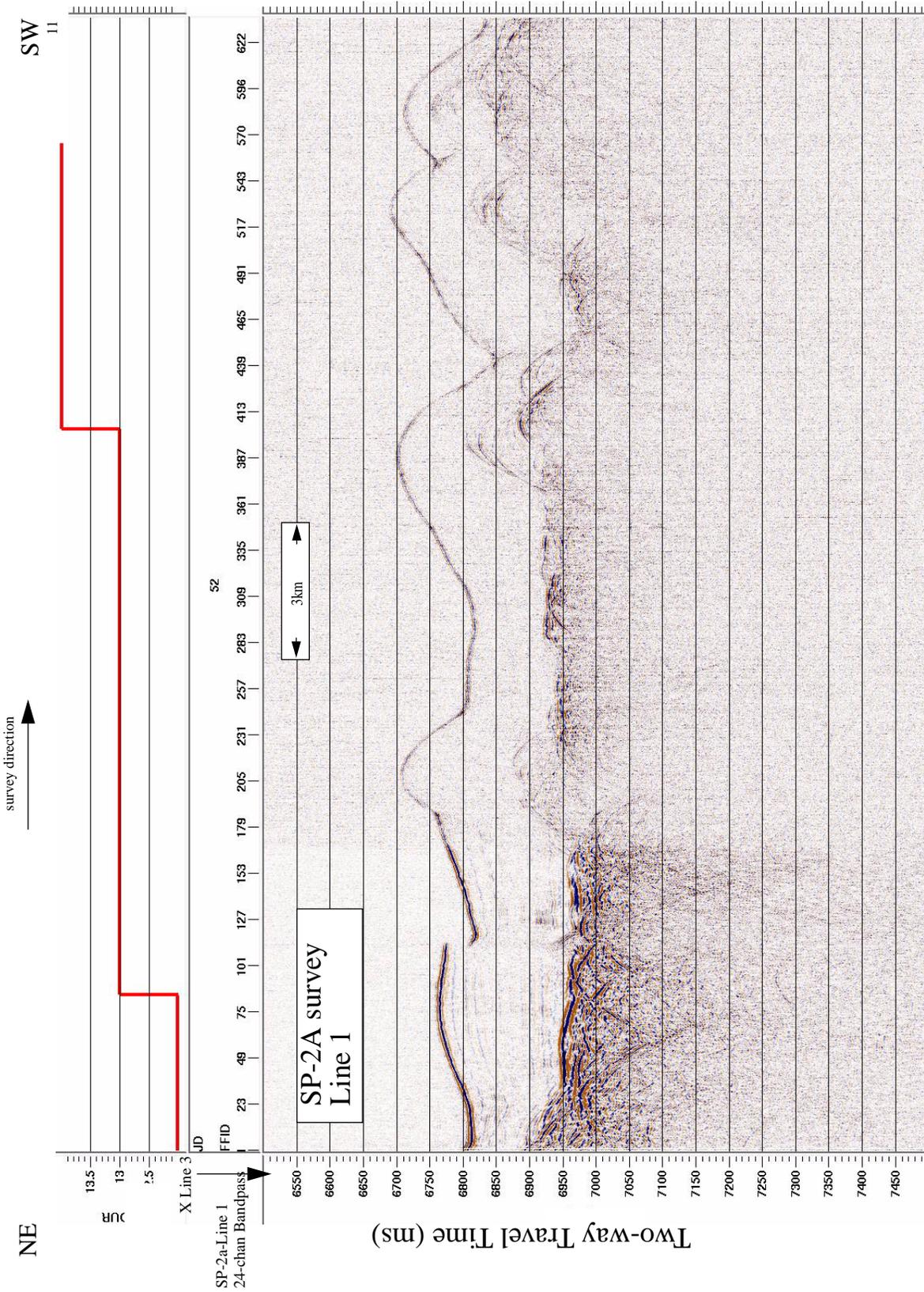
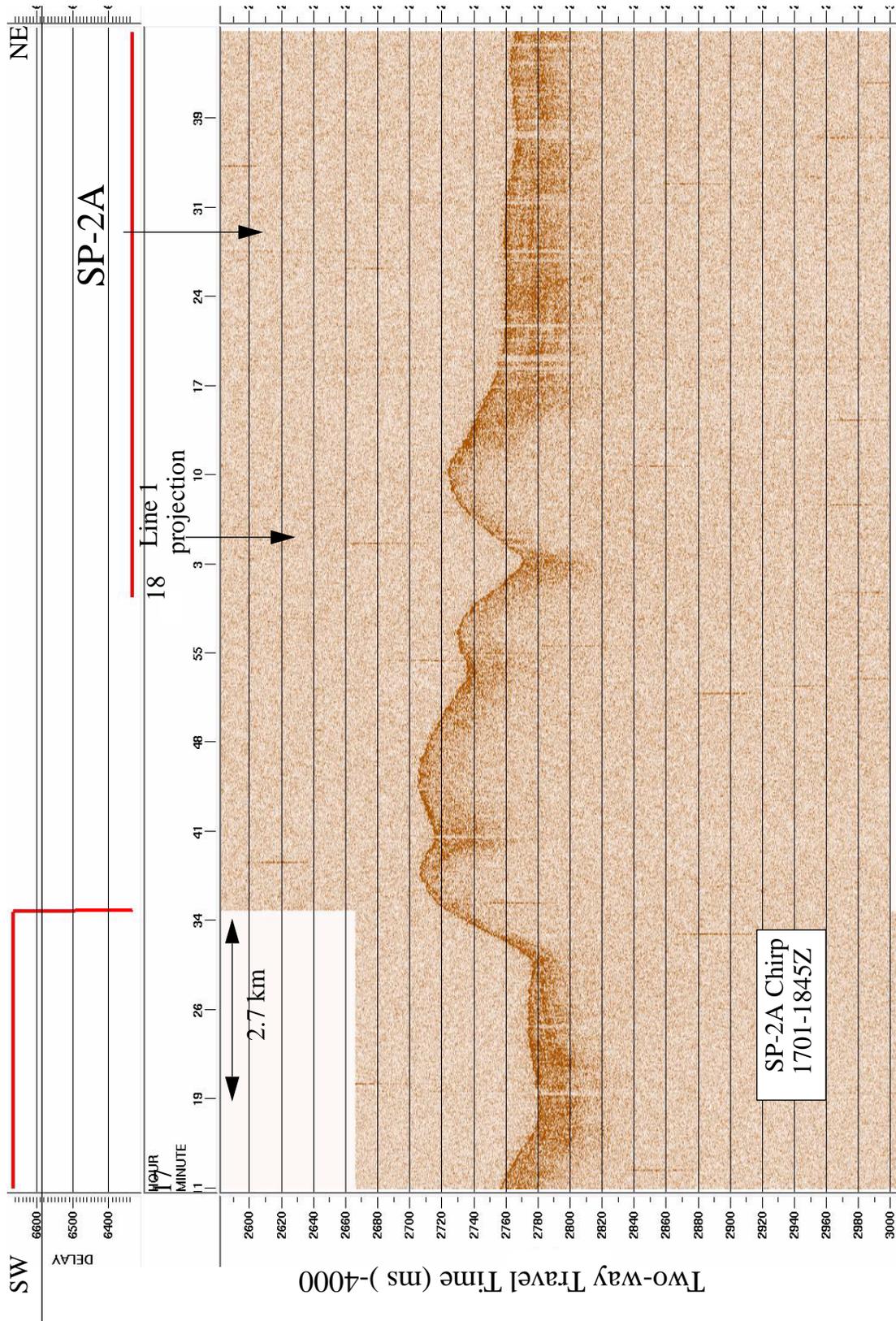


Figure SP2-7: The Knudsen chirp subbottom profiler record (line 6) across the proposed location of SP-2A. Two way travel time is displayed with 4000 msec subtracted from the original TWTT.



## **SITE SP-3A (SW Pacific, N of Heezen FZ)**

**49° 23.242'S, 141° 59.344' W**

### **SITE OBJECTIVES**

SP-3A should have been in the transition zone between polar and south Pacific water masses, in the region that now contains the polar, subantarctic, and subtropical fronts. It is sited on 56 Ma crust (magnetic anomaly 25n) to capture the Paleocene/Eocene transition (55 Ma) on the small part of mid-ocean ridge crust that was above the shallow Eocene CCD (about 3200 m in the tropical Pacific). It will provide paleoceanographic data throughout the Eocene, although paleodepths will exceed 4000 m after about 40 Ma and carbonates will be missing for much of the middle and late Eocene. At 55 Ma, the backtracked location of SP-3A was 65° S, 103° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-3A is located about 2° NW of the Heezen Fracture Zone, on abyssal hill topography, ranging in depth between 4300 and 4900 m (Figure SP3-1). Based on magnetic maps (Cande et al., 1989) and personal communications with Steve Cande, we chose the survey area on magnetic anomaly 25n, roughly at 56 Ma (Cande and Kent, 1995). We collected magnetic profiles on the TUIM-03 site survey to confirm the anomaly location.

### **TUIM-03 Survey**

SP-3A was surveyed on 25 February 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. We used the Scripps 4-channel streamer to record the seismic reflection because noise on the 24-channel streamer can be considerable in a high sea state. The site was also gravity cored, and a 2.8 m core was recovered.

SP-3A is in a region of abyssal hills, with high topography in the south of the survey area, deepening to the north (Figure SP3-2). The trend of the abyssal hills is roughly 025°. The maximum height is at the turn between line 6 and 7 in the south, reaching about 4310 m. The basin to the north is at a depth of about 4800 m. Surficial sediments are carbonate ooze grading to diatom ooze. Sediment cover at the site is ubiquitous but thin--the thickest sediments are a little more than 100 msec, and the average is probably between 50 and 75 msec.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-06GC from TUIM-03; 49° 23.095'S 141° 59.722'W, 4727 m (uncorr.) 2.78 m sediment .

The surface sediments recovered in MV0502-06GC consist of a foraminiferal ooze grading to a brown diatom ooze below 100 cm, grading back to a carbonate ooze with diatoms below 200 cm. The meter scale sediment cycles are reminiscent of Eltanin 14-2, to the south.

## SEISMIC INTERPRETATION

Primary Site (SP-3A): TUIM-03-SP3A line 1, 2005 JD057 01:42:54 gmt, CDP 2916

Crustal age: 56 Ma

Location: 49°23.242'S 141° 59.344'W

Site water depth: 4703 m (6.270 sec TWTT)

Sediment thickness: 0.104 sec (83 m)

Proposed Drilling Depth: 88 m

In general, sediments at SP-3A are thicker to the west end of the survey, and topography is flatter. We chose SP-3A on a well-imaged sediment packaged on Line 1, about 3 km west of the cross with Line 4.

## GEOLOGIC HAZARDS

There are no known geologic hazards--pelagic sediments over oceanic basalts.

## OTHER HAZARDS

There are no manmade hazards in the vicinity.

## AVAILABLE DATA from EW9709

seismic and chirp lines:

SP-3A Lines 1 through 8.

## FIGURES

Fig SP3-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-1A is shown.

Fig SP3-2: Swathmap bathymetry for the SP-3A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP3-3: MST physical properties data for MV0502-06GC.

Fig SP3-4: Seismic profile SP3 line 1 across SP-3A, from TUIM-03. Proposed drill site is marked.

Fig SP3-5: Crossline seismic profile SP3 line 4 from TUIM-03.

Fig SP3-6: Chirp subbottom profile from line 1 across SP-3A, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
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- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP1A-1: Location map for SP-1A shown with the Tui Malia Leg 03 site survey trackline.

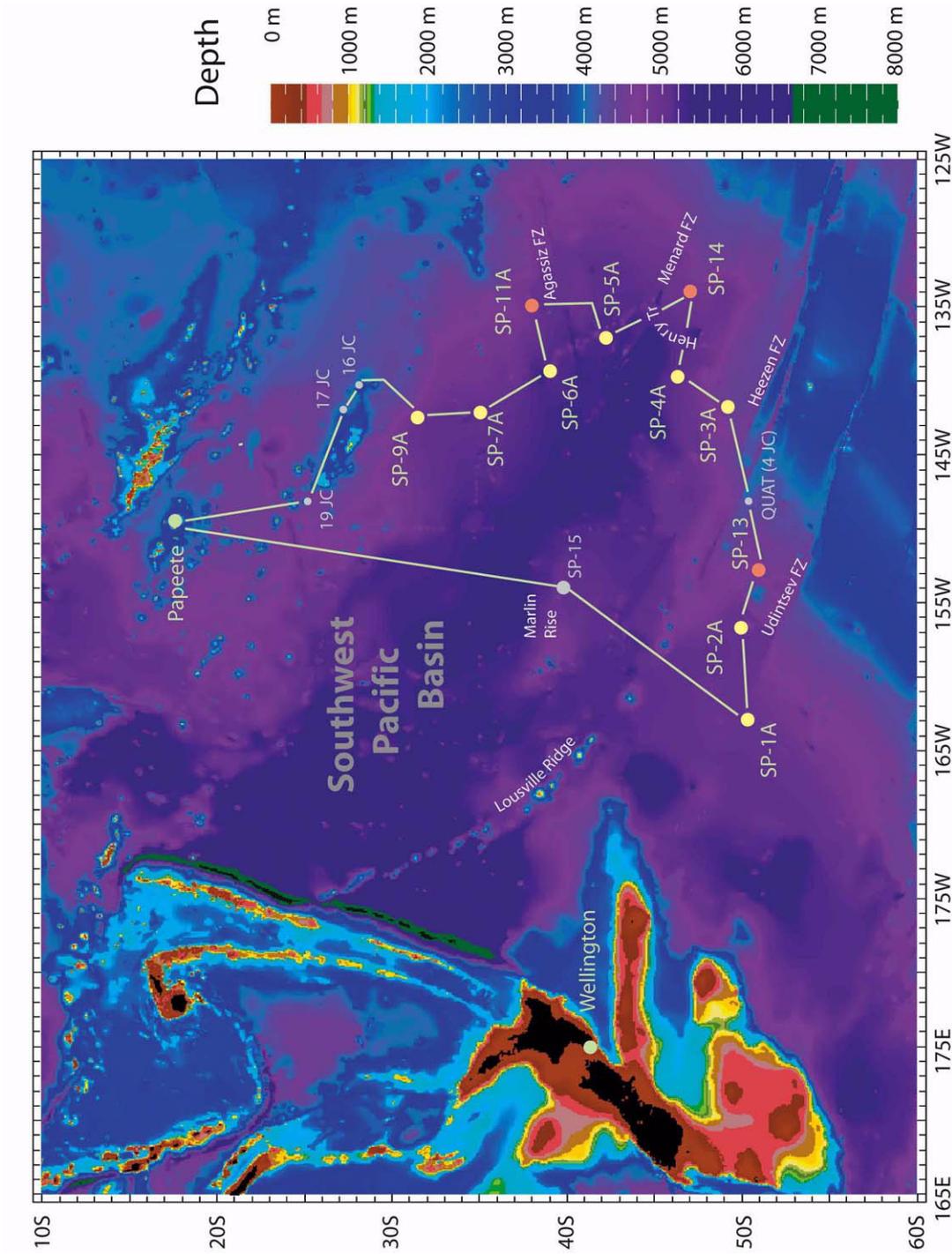


Figure SP3-2: Swathmap bathymetry in the region surrounding SP-3A from TUIM-03 survey cruise. Proposed drillsite is marked.

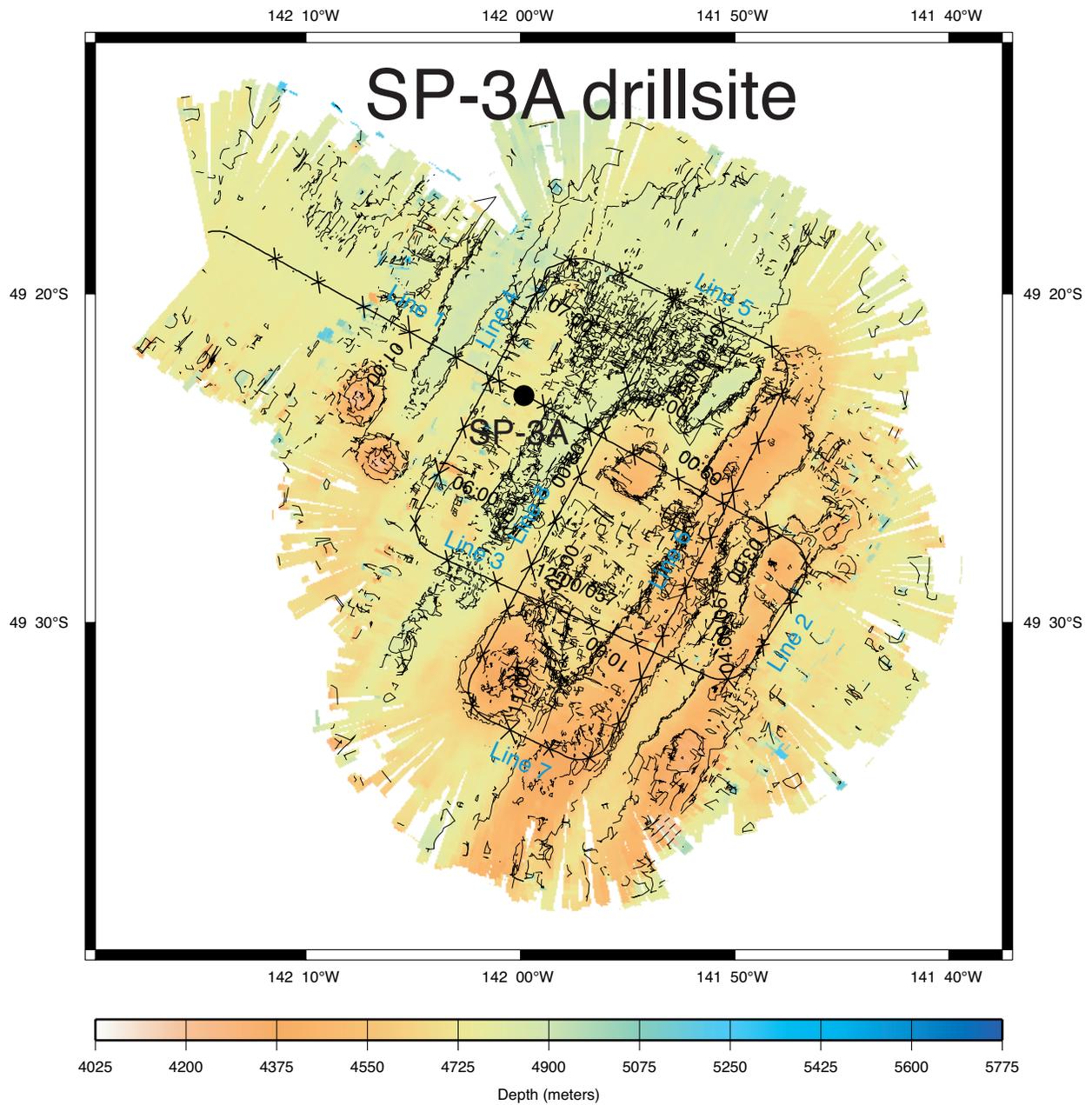


Fig SP3-3: Physical properties measured on piston core MV0502-06GC, taken at SP-3A

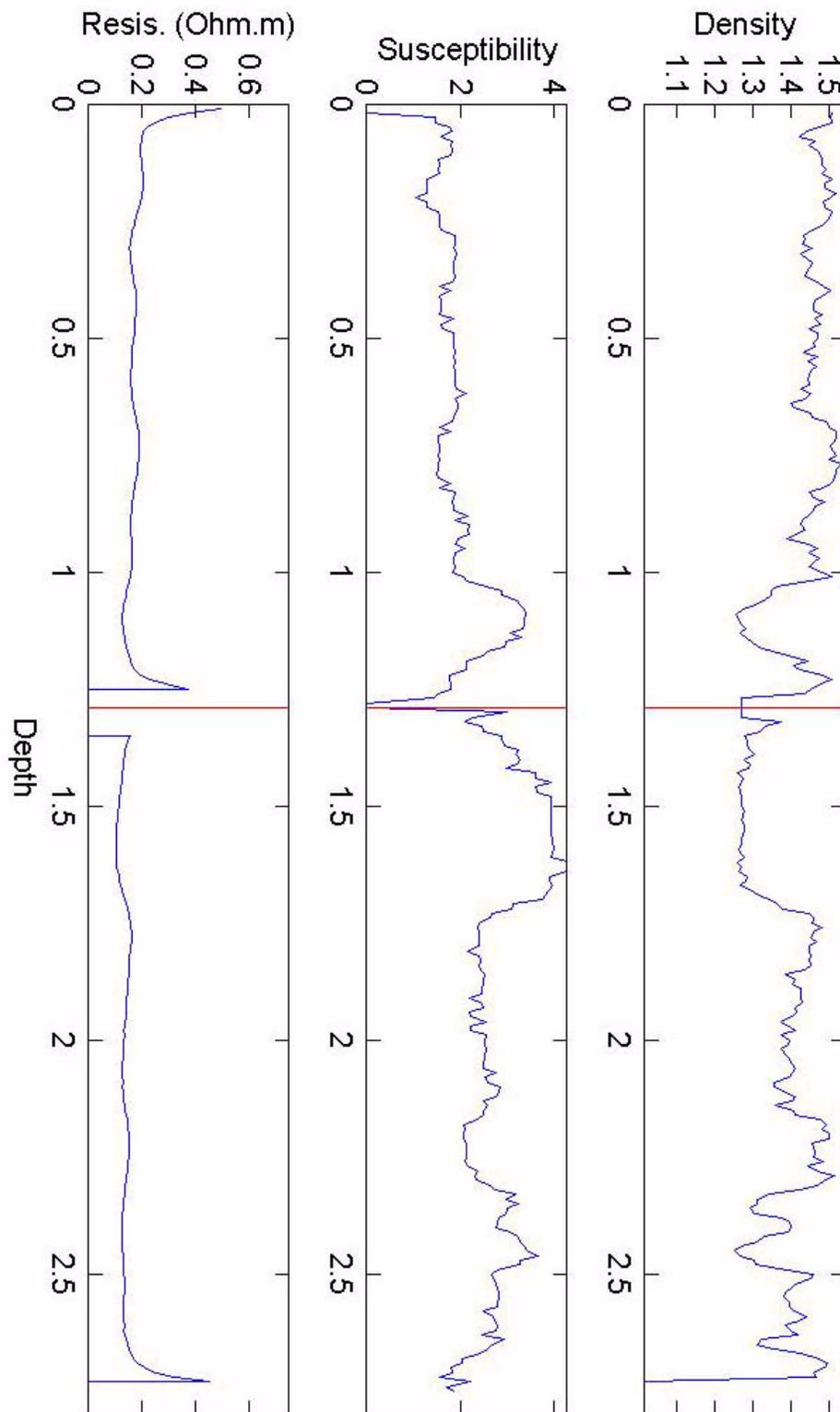


Figure SP3-4: The seismic profile SP-3A line 1. The proposed drillsite is marked.

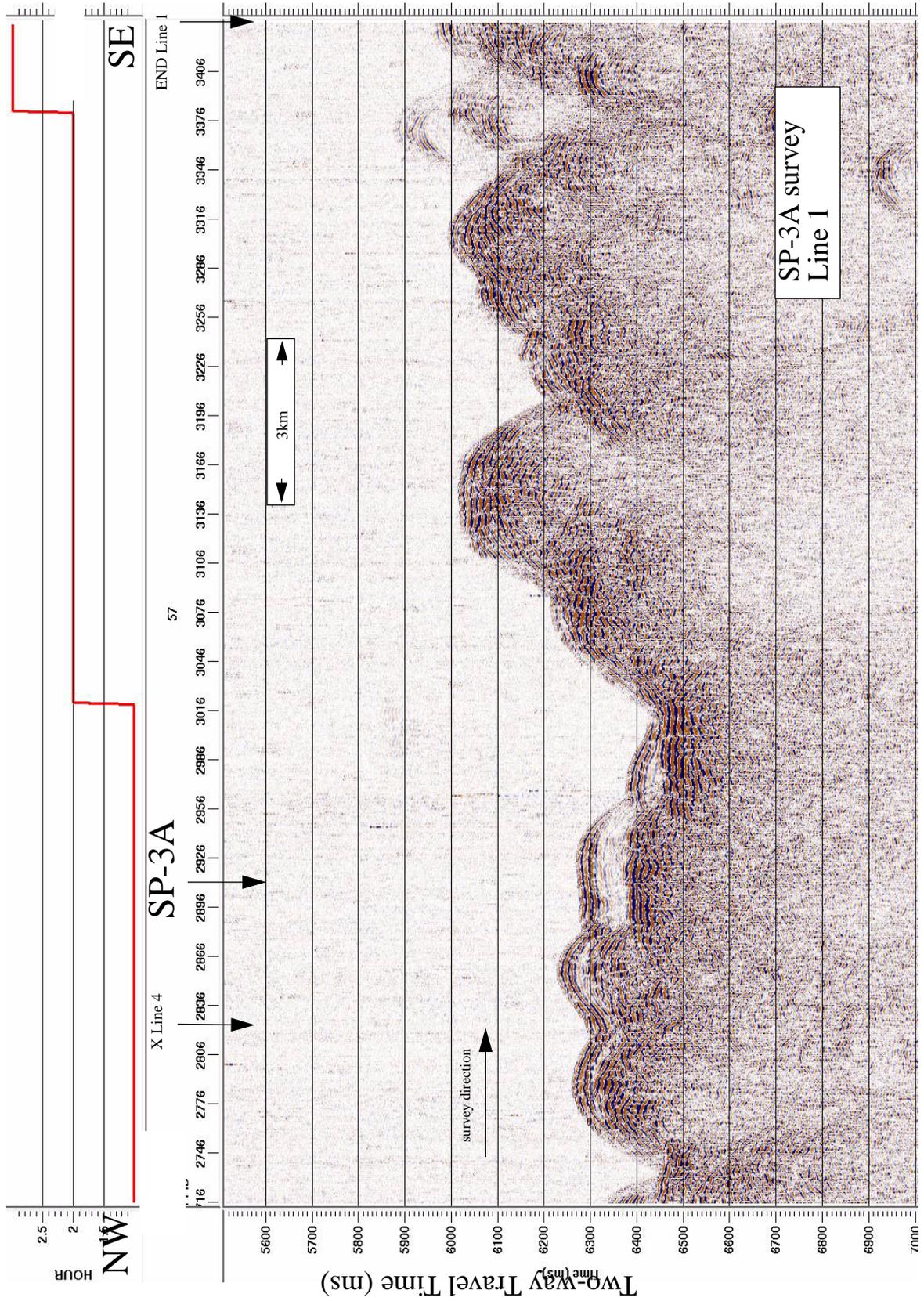


Figure SP3-5: The crossline, seismic profile SP-3A line 4, near the proposed location of SP-3A.

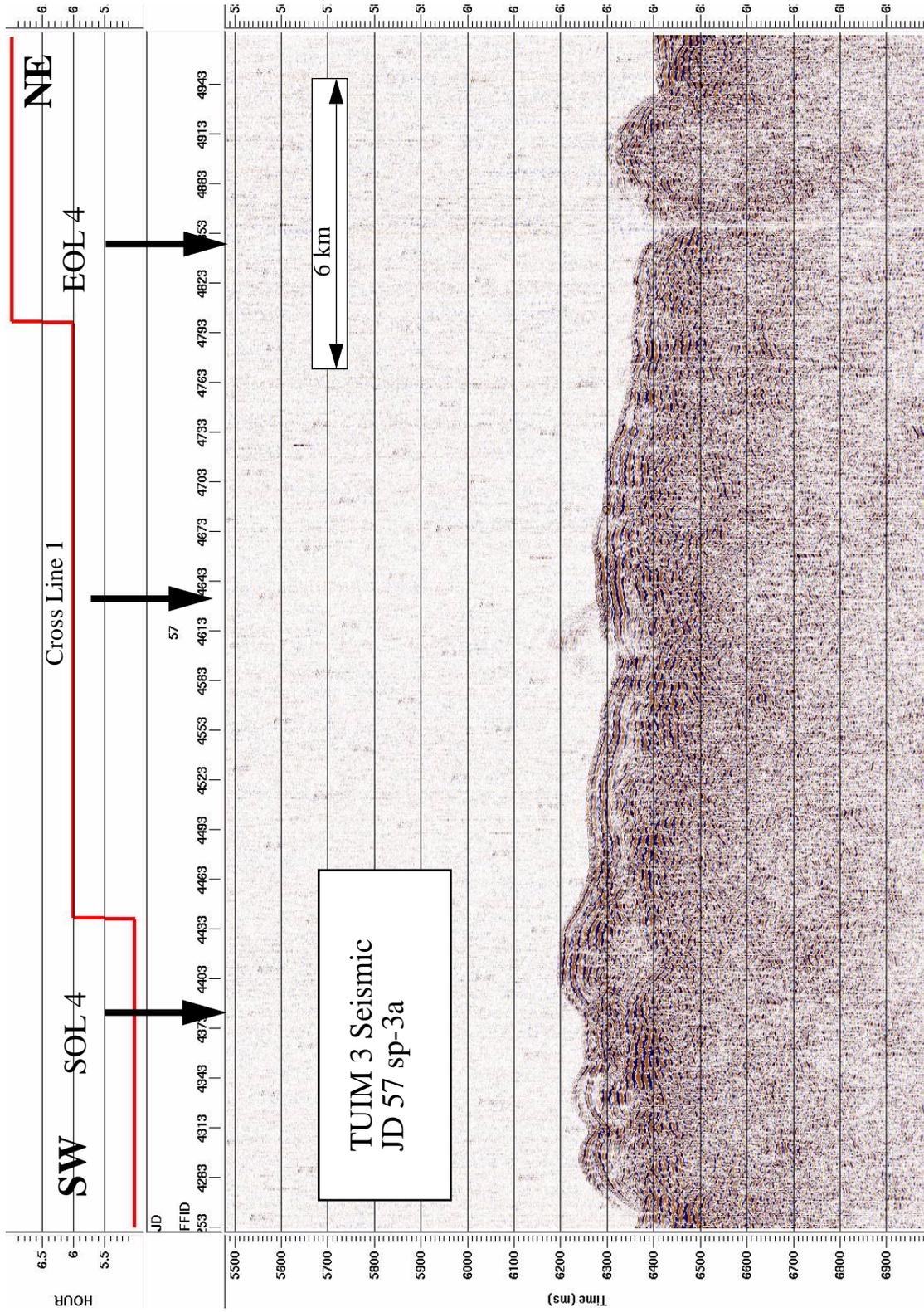
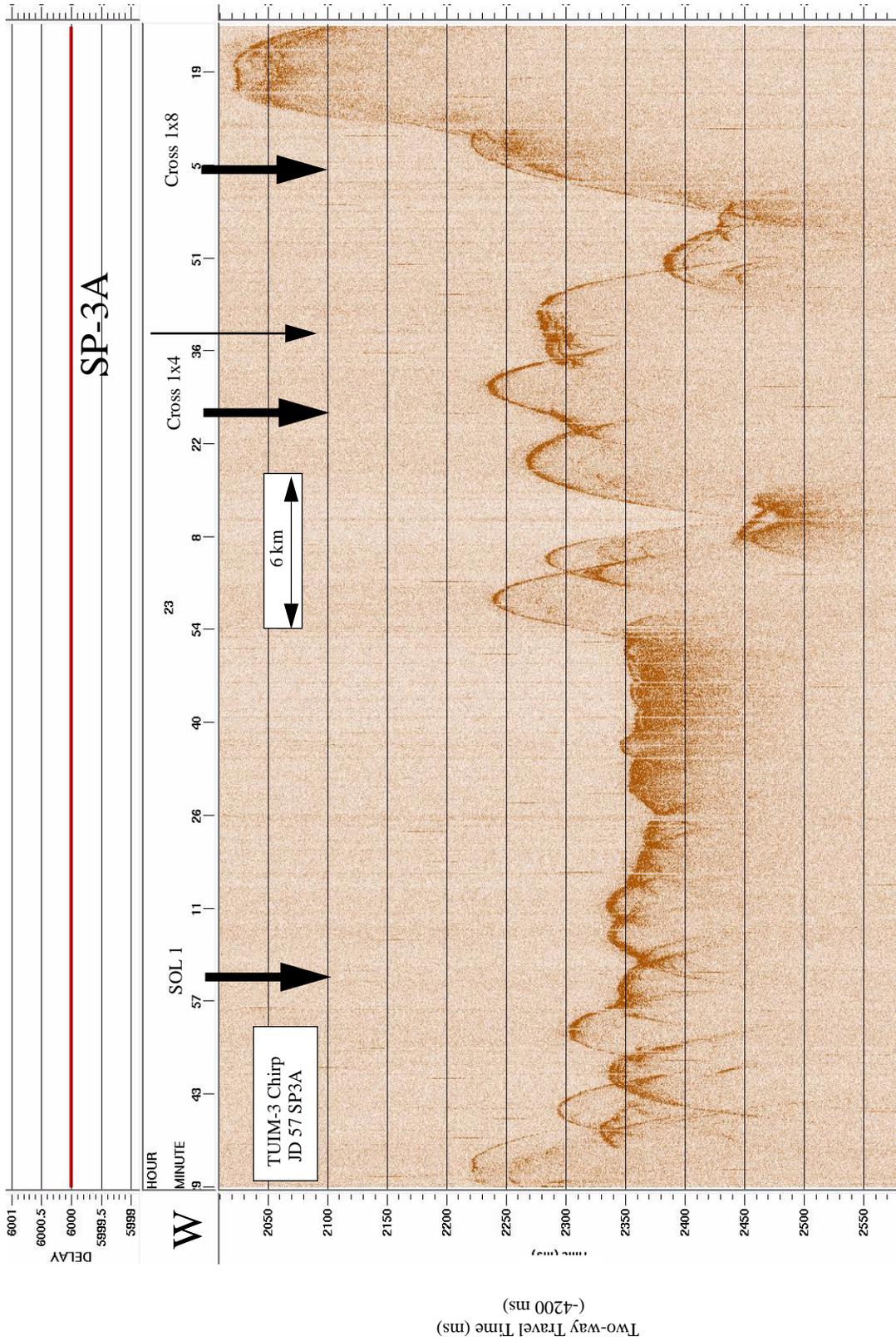


Figure SP3-6: The Knudsen chirp subbottom profiler record (line 1) across the proposed location of SP-3A.



## **SITE SP-4A (SW Pacific, W of Henry Trough)**

**46° 30.372'S, 139° 21.210' W**

### **SITE OBJECTIVES**

SP-4A is the 61°S site of the early Eocene South Pacific Latitudinal transect. It is located west of the Henry Trough, on crust of indeterminate age, but perhaps about the age of magnetic anomaly 27n (62 Ma, Cande and Kent, 1995). A rise jump during magnetic anomaly 21N (47 Ma; Cande et al., 1982) formed the Henry Trough and transported the 56 Ma crust we have been searching for to the SE. The site is important because its paleolatitude of about 61°S at 55 Ma means that it should be located in the transition between polar and temperate water masses. The thinning sediment cover (see below) is evidence of that transition. The sediments of SP-4A should help to define temperature and ocean circulation during the late Paleocene, across the P/E, and into the Eocene. The sediments of SP-4A are likely to provide paleoceanographic data throughout the Eocene, although paleodepths will exceed 4000 m after about 40 Ma. At 55 Ma, the back-tracked location of SP-A was 61° S, 102° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-4A is situated about 3 degrees west of the Henry Trough (Figure SP4-1), a tectonic scar from a rise jump at about 47 Ma (Cande et al., 1982). The crust is relatively gentle abyssal hill topography, with basin depths of about 5.2 km. Because of the rise jump, it is difficult to trace magnetic anomalies on the west side of the Henry Trough. However, extrapolation from the south suggests that the crust was formed during magnetic anomaly 27n, about 62 Ma (Cande and Kent, 1995).

### **TUIM-03 Survey**

SP-4A was surveyed on February 27 and 28, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville (Figure SP4-2). The first line of the survey was recorded on the LDEO 24-channel streamer, with no birds. Because the sea state caused significant noise, the rest of the survey was run with the Scripps 4-channel streamer. A piston core was taken between the two seismic surveys, recovering 16.4 m of brown siliceous clay (both radiolaria and diatoms) with manganese nodules (Figure SP4-3).

The region surveyed for SP-4A consists of basins to a depth of about 5250 m, and a series of small volcanic hills, reaching heights between 5000 and 4300m, arrayed in a rough circle around the area. The entire area is coated with at least 40 msec TWTT of sediment, reaching thicknesses of up to 80 msec in the basins.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-07JC from TUIM-03 46° 26.951'S S, 139°26.825'W, 5297 m (uncorr.) 16.4 m sediment.

MV0502-07 was topped by nodules in both the trigger core and piston core. The piston core also had a rounded basalt pebble that was probably ice-rafted to the site. The sediments are siliceous clays at the surface, followed below by 3 m of barren clay, and bottoming in a radiolarian/diatom ooze.

### **SEISMIC INTERPRETATION**

Primary Site (SP-4A): TUIM-03-SP4A line 9, 2005 JD059 21:41:09 gmt, CDP 6541.

Crustal age: 62 Ma?

Location: 46° 30.372'S 139° 21.210'W

Site water depth: 5186 m (6.914 sec TWTT)

Sediment thickness: 0.073 sec (58 m)

Proposed Drilling Depth: 60 m

SP-4A was chosen in a basin to the west of the main survey, at the end of Line 9 from the TUIM-03 survey. The sediment here is about average thickness for the surrounding basins (Figure SP4-4). SP-4A is situated here because the sedimentary section and basement are well-imaged. The subbottom profiler can detect layering only about 20 m into the section.

### **GEOLOGIC HAZARDS**

There are no known geologic hazards--pelagic sediments over oceanic basalts.

### **OTHER HAZARDS**

There are no manmade hazards in the vicinity.

### **AVAILABLE DATA from TUIM-03**

seismic and chirp lines:

SP-4A Lines 1 through 9

### **FIGURES**

Fig SP4-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-1A is marked.

Fig SP4-2: Swathmap bathymetry for the SP-1A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP4-3: MST physical properties data for MV0502-7JC.

Fig SP4-4: Seismic profile SP4 line 9 across SP-4A, from TUIM-03. Proposed drill site is marked.

Fig SP4-5: Crossline seismic profile SP4 line 3 from TUIM-03.

Fig SP4-6: Chirp subbottom profile from line 9 across SP-4A, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.
- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP4-1: Location map for SP-1A shown with the Tui Malia Leg 03 site survey trackline.

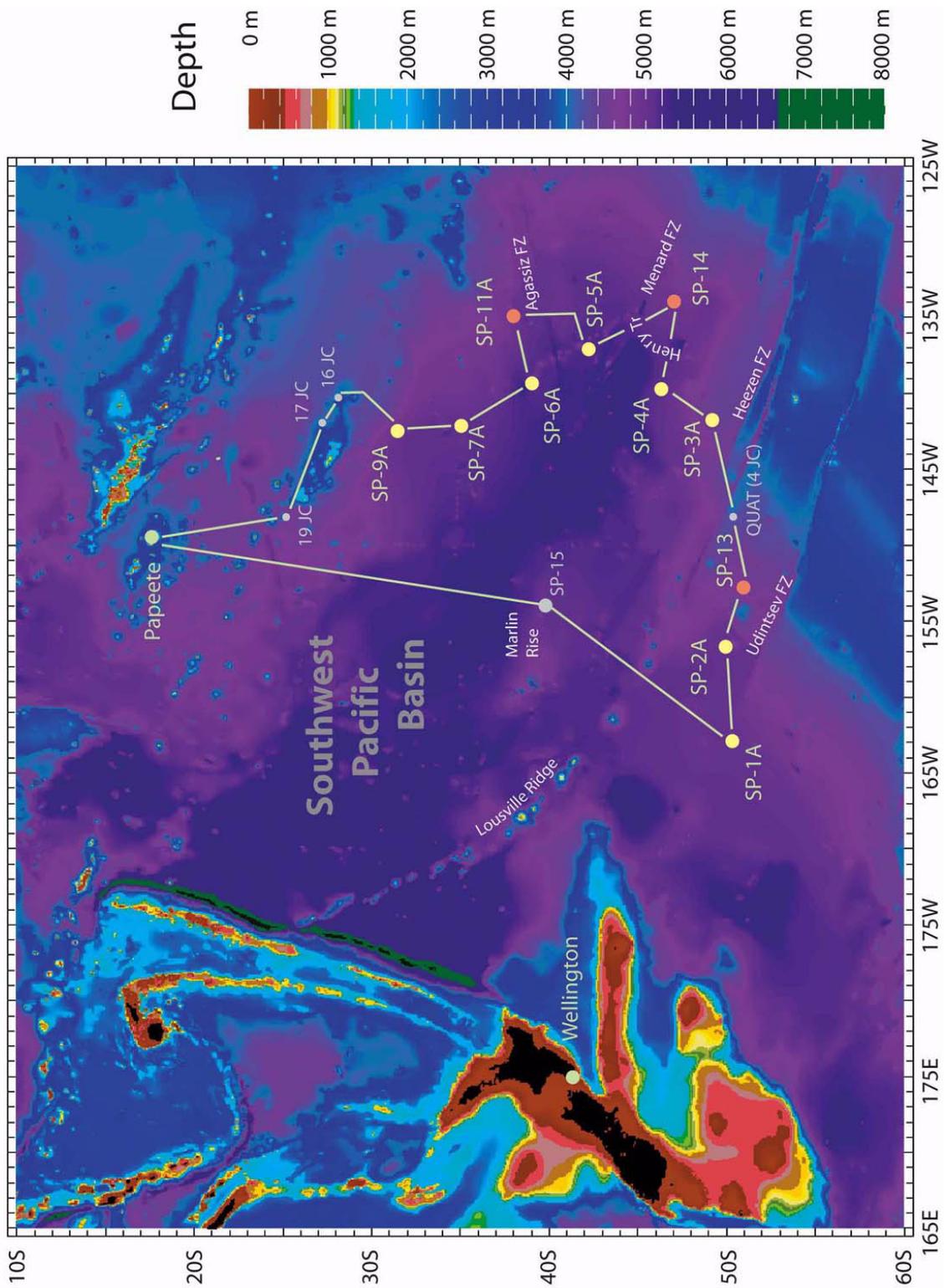


Figure SP4-2: Swathmap bathymetry in the region surrounding SP-4A from TUIM-03 survey cruise. Proposed drillsite is marked

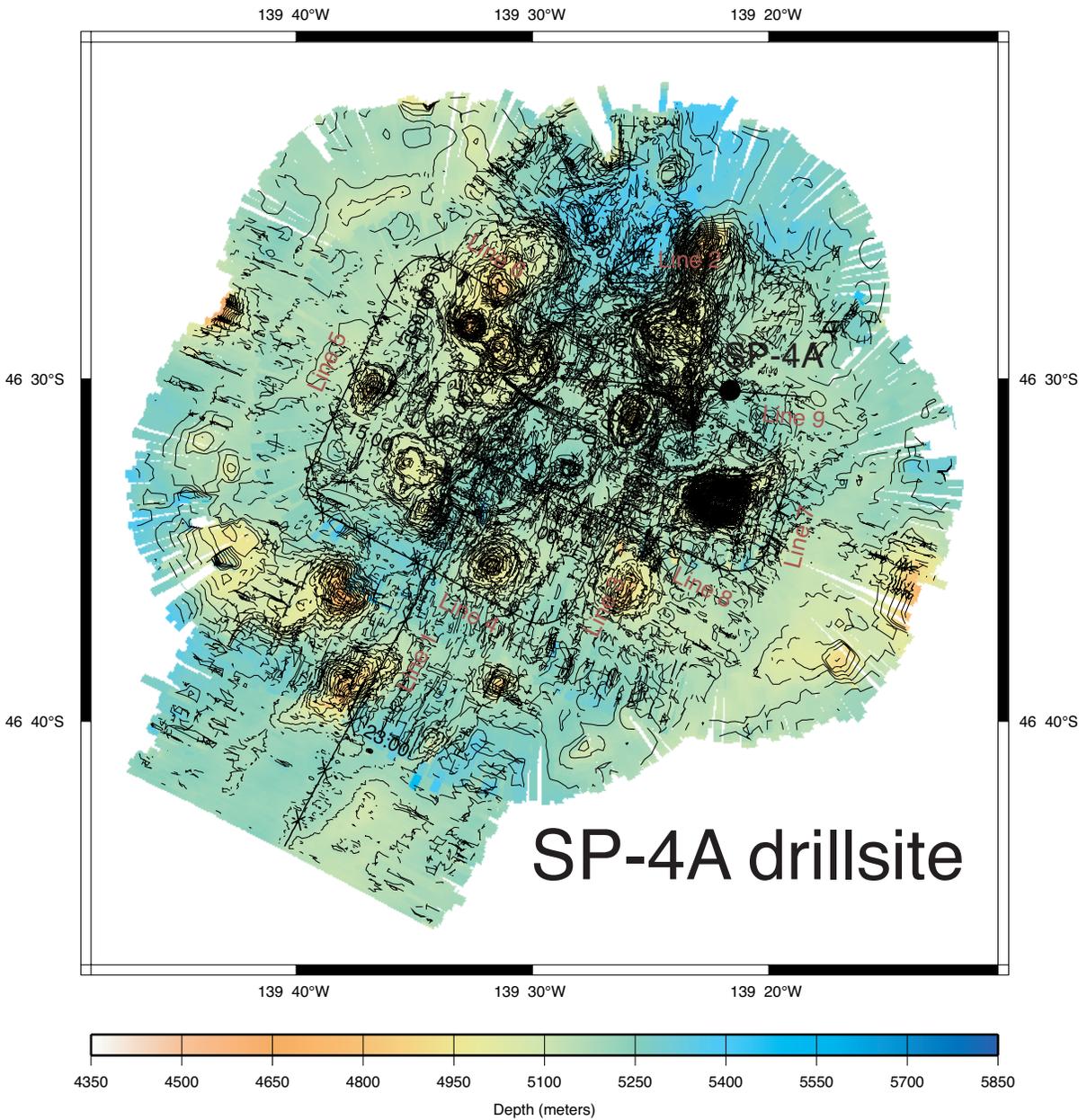


Fig SP4-3: Physical properties measured on piston core MV0502-07JC, taken at SP-4A

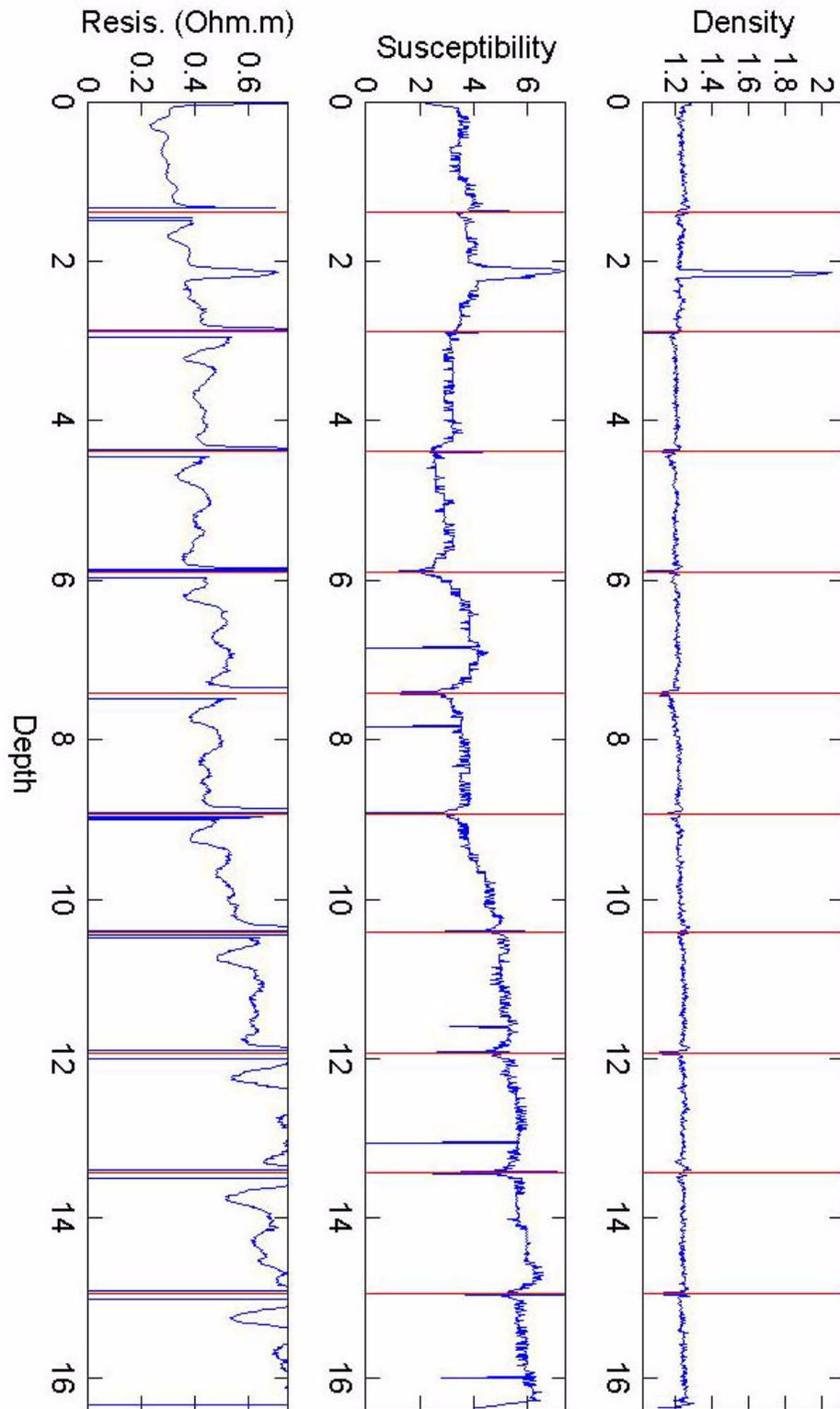


Figure SP4-4: The seismic profile SP-4A line 9. Proposed drillsite is marked.

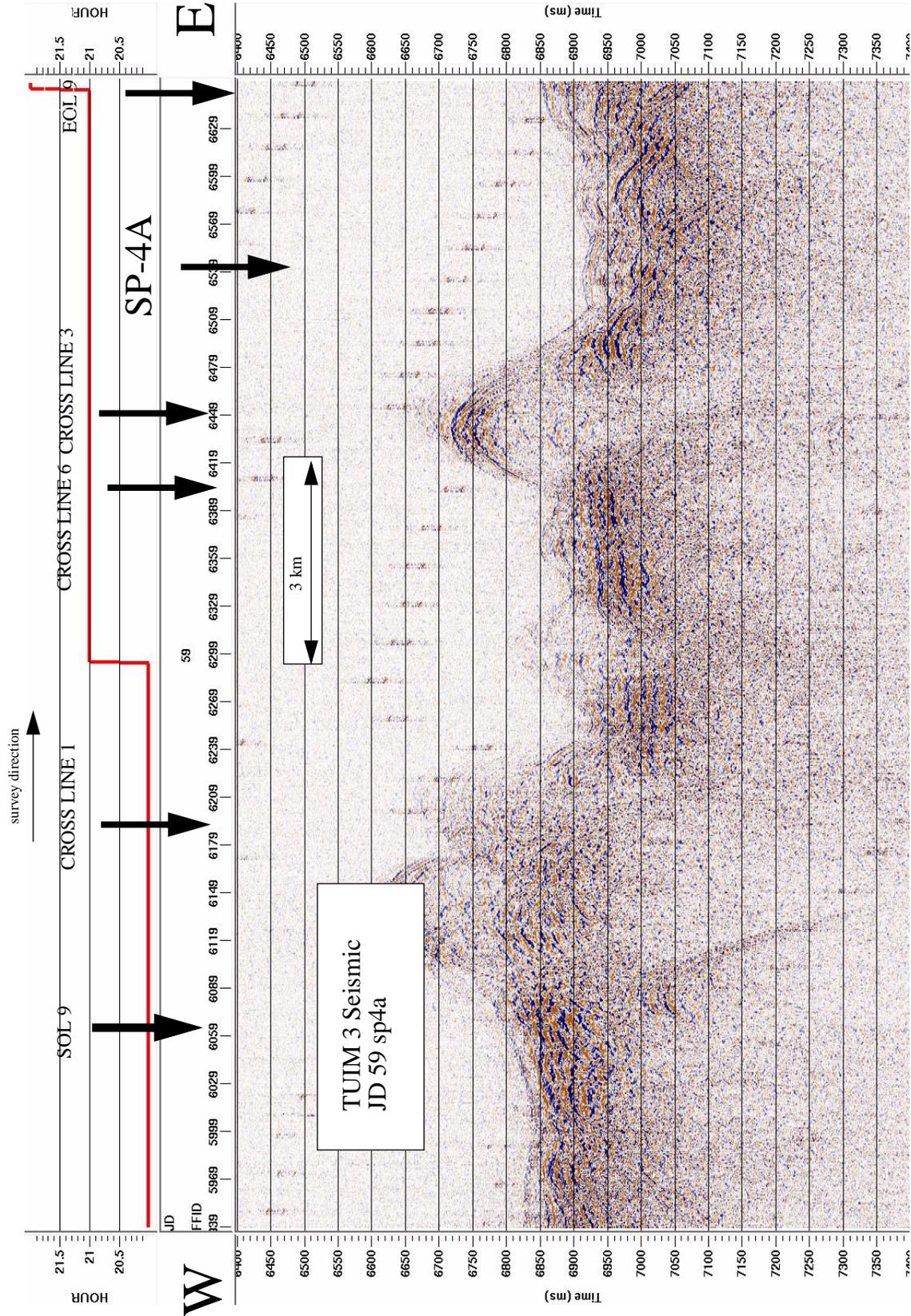


Figure SP4-5: The crossline, seismic profile SP-4A line 3..

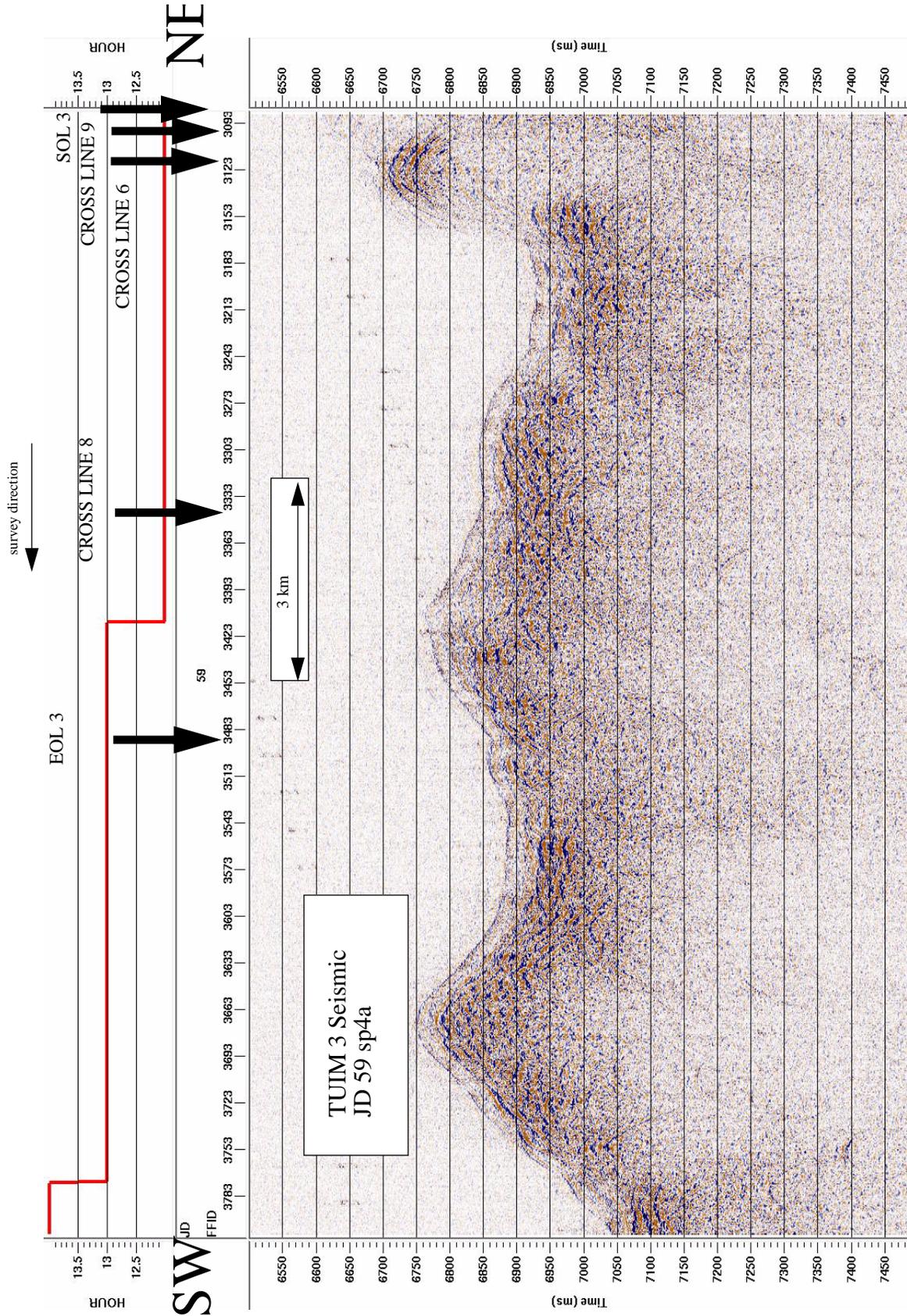
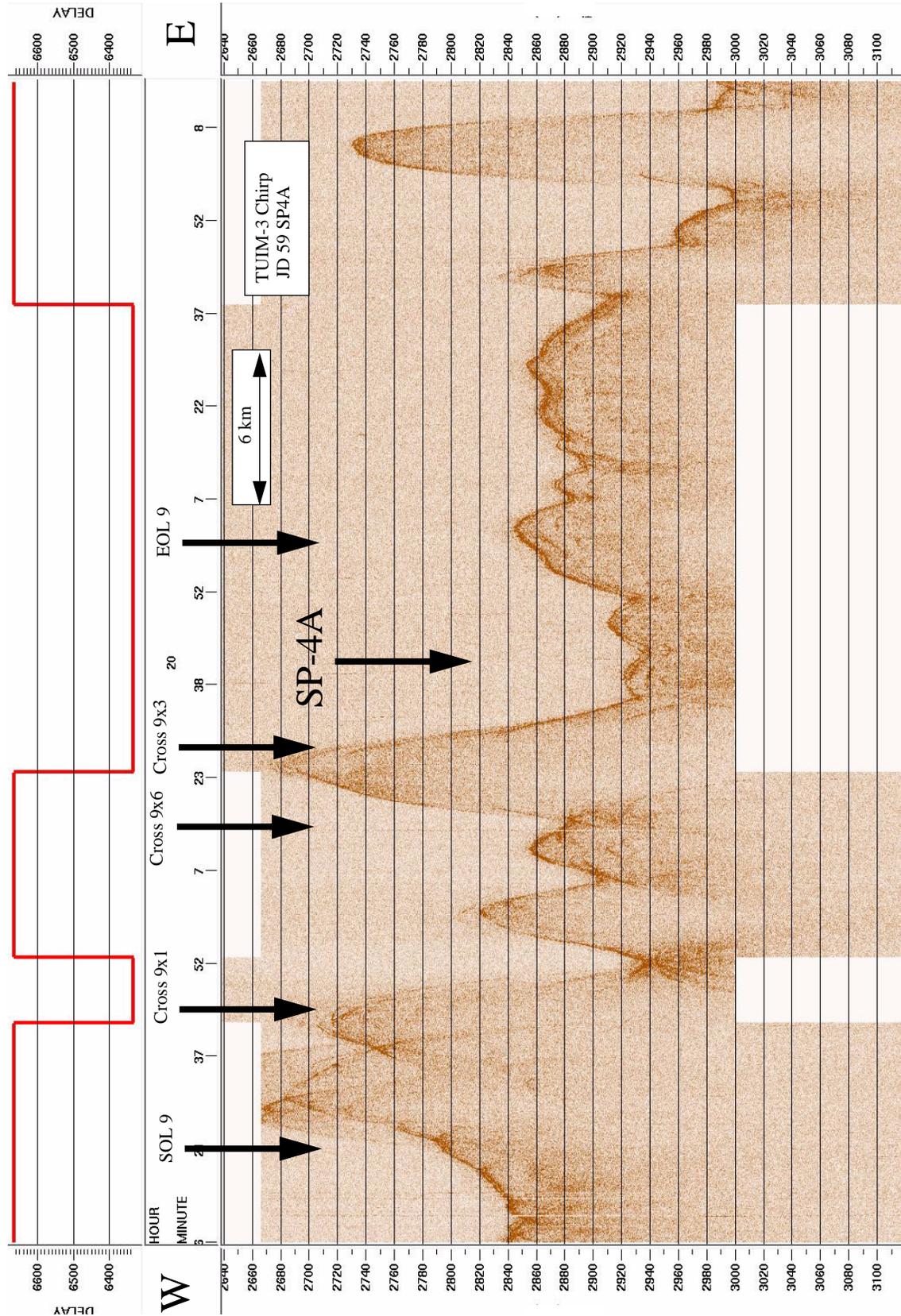


Figure SP4-6: The Knudsen chirp subbottom profiler record (line 9) across the proposed location of SP-4A.



## **SITE SP-5A (SW Pacific, N of Menard FZ)**

**42° 45.272'S, 137° 9.322' W**

### **SITE OBJECTIVES**

SP-5A is the 57°S site of the early Eocene South Pacific Latitudinal transect. It is located north of Menard Fracture Zone, to the northwest of Henry Trough, on magnetic anomaly 25r (about 57 Ma; Cande and Kent, 1995). The drillsite at SP-5A should delineate the northern edge of the polar-temperate water mass transition in the Eocene south Pacific, and help to define ocean temperature and ocean circulation. The thin sediment cover means that a relatively short interval of time near the Paleocene-Eocene boundary can be studied in detail, although low resolution studies may be possible through the remainder of the section. At 55 Ma, the backtracked location of SP-5A was 57°S, 103°W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-5A is situated about 3° north of the disturbed crust associated with the Henry Trough and about a degree north of the Menard Fracture Zone (Figure SP5-1). The whole region north of the Henry Trough has rough topography, although the crustal grain is that of abyssal hills. In the survey area itself, the relief was about 1300 m between basins and tops of the hills (Figure SP5-2). Although we could discern sediment within the survey area, we were not able to locate a good drill site. While looking through the seismic reflection data on the approach to the site, we were able to find a potential drillsite.

### **TUIM-03 Survey**

SP-5A was surveyed on March 4 and 5, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville (Figure SP5-2). The first line of the survey and the transit seismic reflection survey approaching the site were recorded on the Scripps 4-channel streamer (Figure SP5-3). After taking a gravity core (MV0502-10GC), the remainder of the site was surveyed with the LDEO 24-channel streamer, with no birds. The uppermost sediments were a brown nannofossil clay with manganese nodules grading to a clay.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-10GC from TUIM-03 42° 25.79'S S, 136°58.66'W, 4924 m (uncorr.) 0.6 m sediment.

MV0502-10 contained manganese nodules at the surface, and two large nodules at 29-34 cm and 40-48 cm. The very surface sediment is a brown nannofossil clay, which shortly graded into a brown clay.

### **SEISMIC INTERPRETATION**

Primary Site (SP-5A): TUIM-03-Transit 6, 2005 JD063 20:51:26 gmt, FFID 7192.

Crustal age: 57 Ma  
Location: 42° 45.272'S 137° 9.322'W  
Site water depth: 5210 m uncorr (6.946 sec TWTT)  
Sediment thickness: 0.038 sec (30 m)  
Proposed Drilling Depth: 30 m

SP-5A was chosen immediately south of the detailed SP-5A survey because the approach was through a relatively broad basin (Figure SP5-3), while the survey area had extreme topography (abyssal hills on steroids; Figure SP5-2). While it was possible to discern sediment within the survey area, we were never able to identify a good area for drilling. The relief was simply too great and there were not good flat drilling targets.

### **GEOLOGIC HAZARDS**

There are no known geologic hazards--pelagic sediments over oceanic basalts.

### **OTHER HAZARDS**

There are no manmade hazards in the vicinity.

### **AVAILABLE DATA from TUIM-03**

seismic and chirp lines:  
Transit 6 FFID 7100 to 7480  
SP-5A Lines 1 through 10

### **FIGURES**

Fig SP5-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-5A is shown.

Fig SP5-2: Bathymetric map of the SP-5A detailed survey, showing the extreme relief.

Fig SP5-3: Swathmap bathymetry taken on the SP-5A approach. The turn marks the beginning of the SP-5A survey. The proposed SP-5A drill site is marked.

Fig SP5-4: Seismic profile Transit 6 FFID 7100 to 7480, showing the proposed SP-5A drill site.

Fig SP5-5: Seismic profile SP5A line 1, showing the rugged topography in the detailed survey area.

Fig SP5-6: Chirp subbottom profile from Transit 6 between 20:20 and 21:20 on JD63, showing the proposed drillsite at 20:51:26 gmt.

### **REFERENCES**

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
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the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP5-1: Location map for SP-5A shown with the Tui Malia Leg 03 site survey trackline.

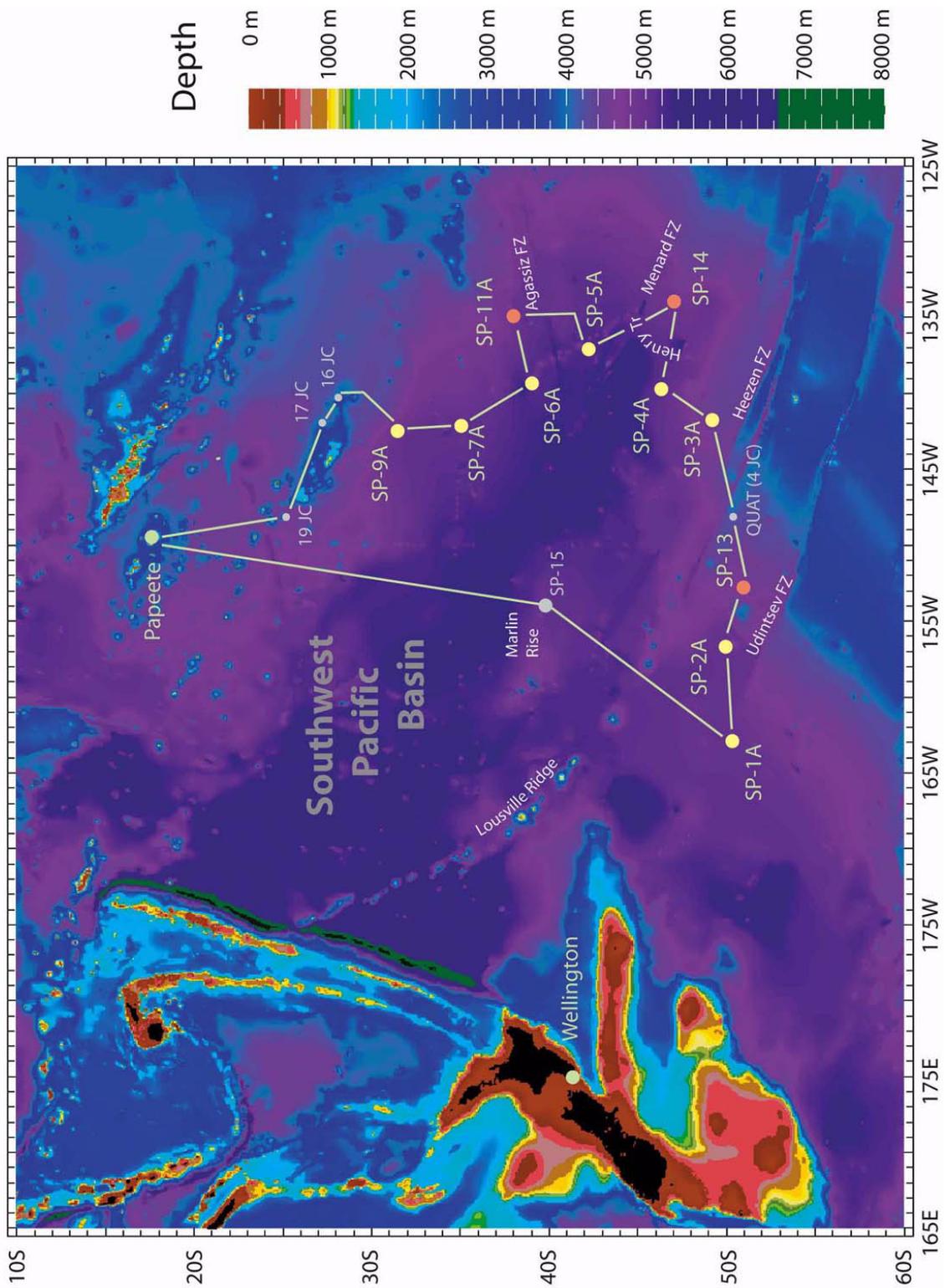


Fig SP5-2: Bathymetric map of the SP-5A detailed survey area, showing the extreme relief.

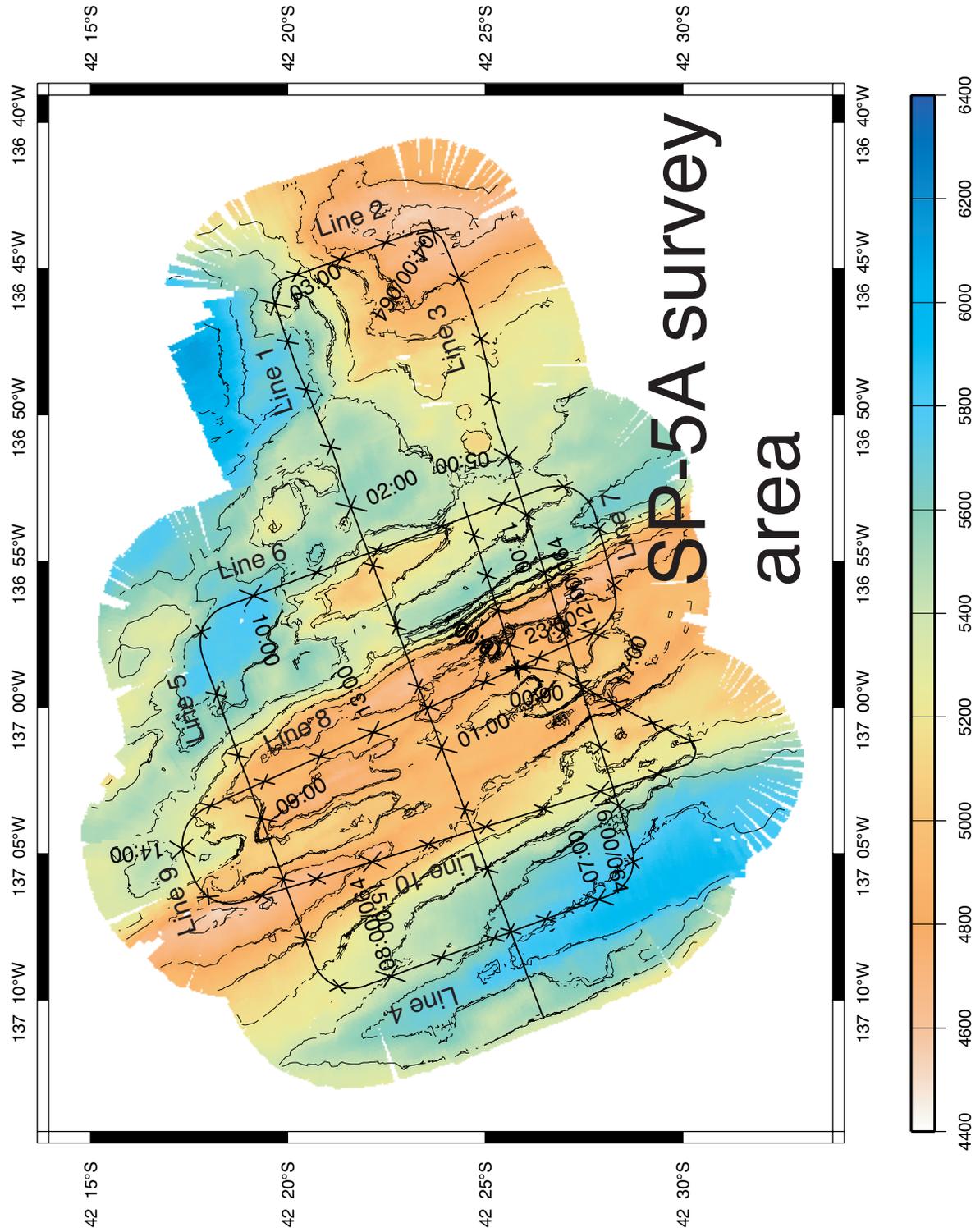


Fig SP5-3: Swathmap bathymetry taken on the SP-5A approach. The turn marks the beginning of the SP-5A survey. The proposed SP-5A drill site is marked.

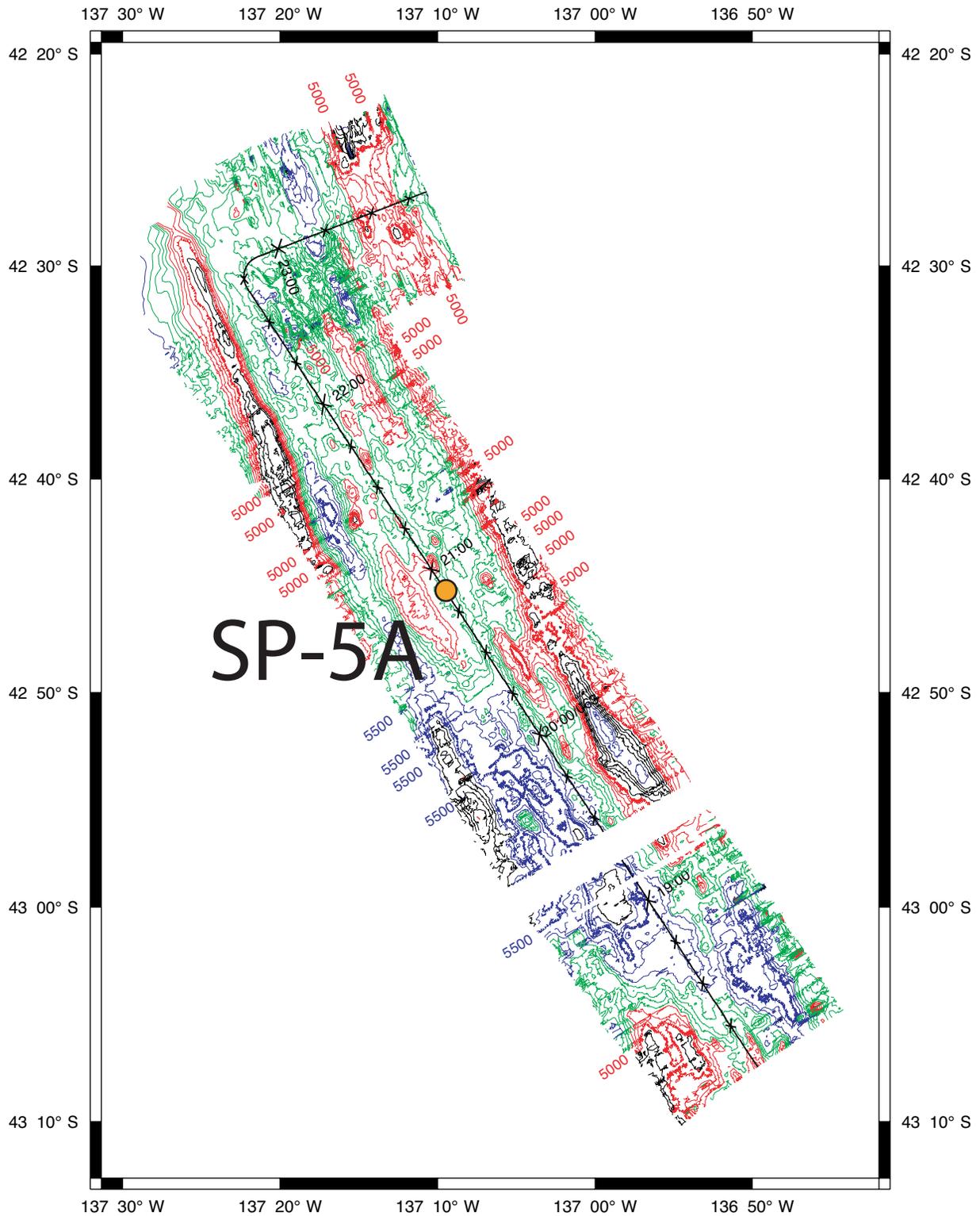


Figure SP5-4: The seismic line from the end of Transit 6. Proposed drillsite is marked.

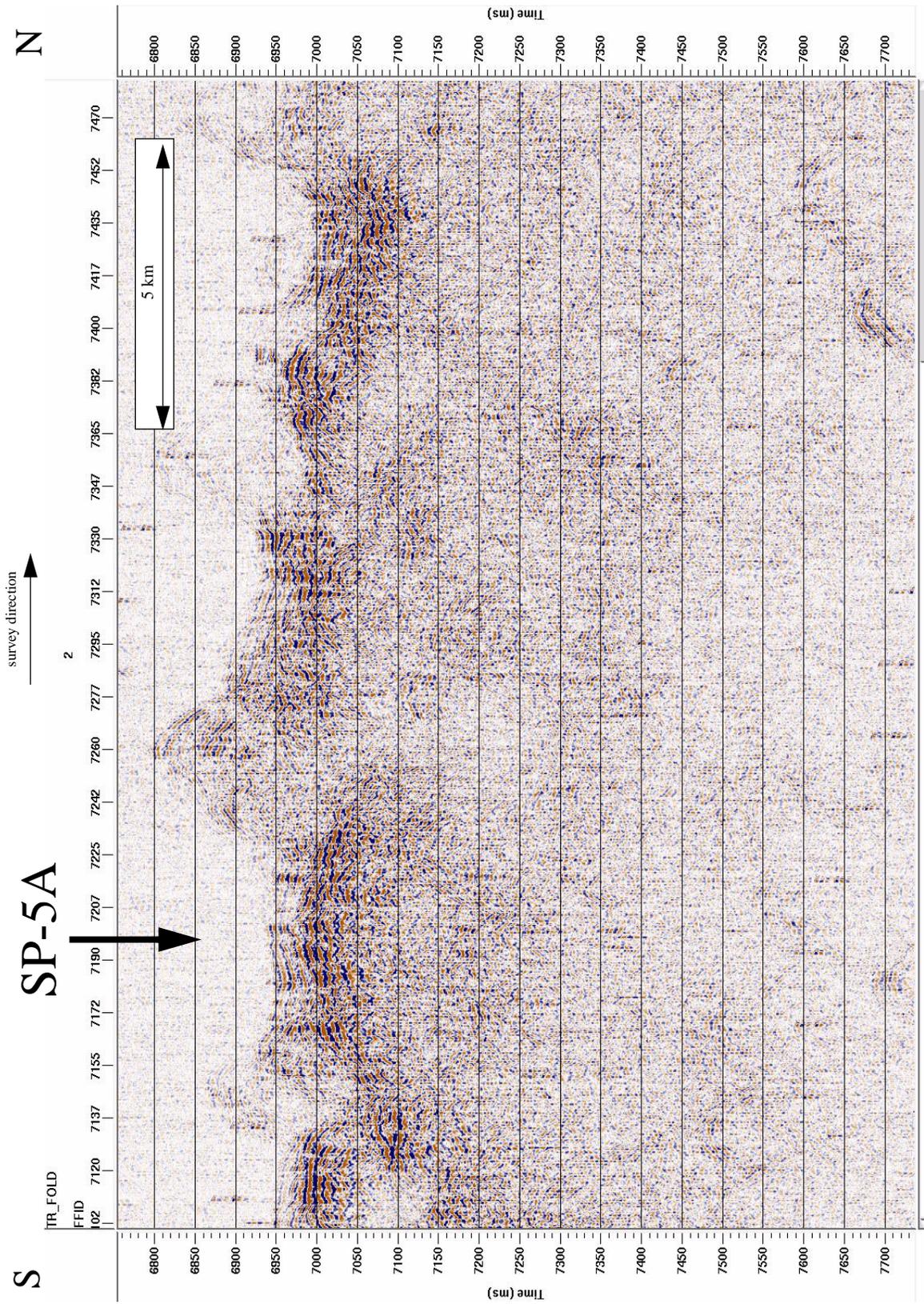


Fig SP5-5: Seismic profile SP5A line 1, showing the rugged topography in the detailed survey area.

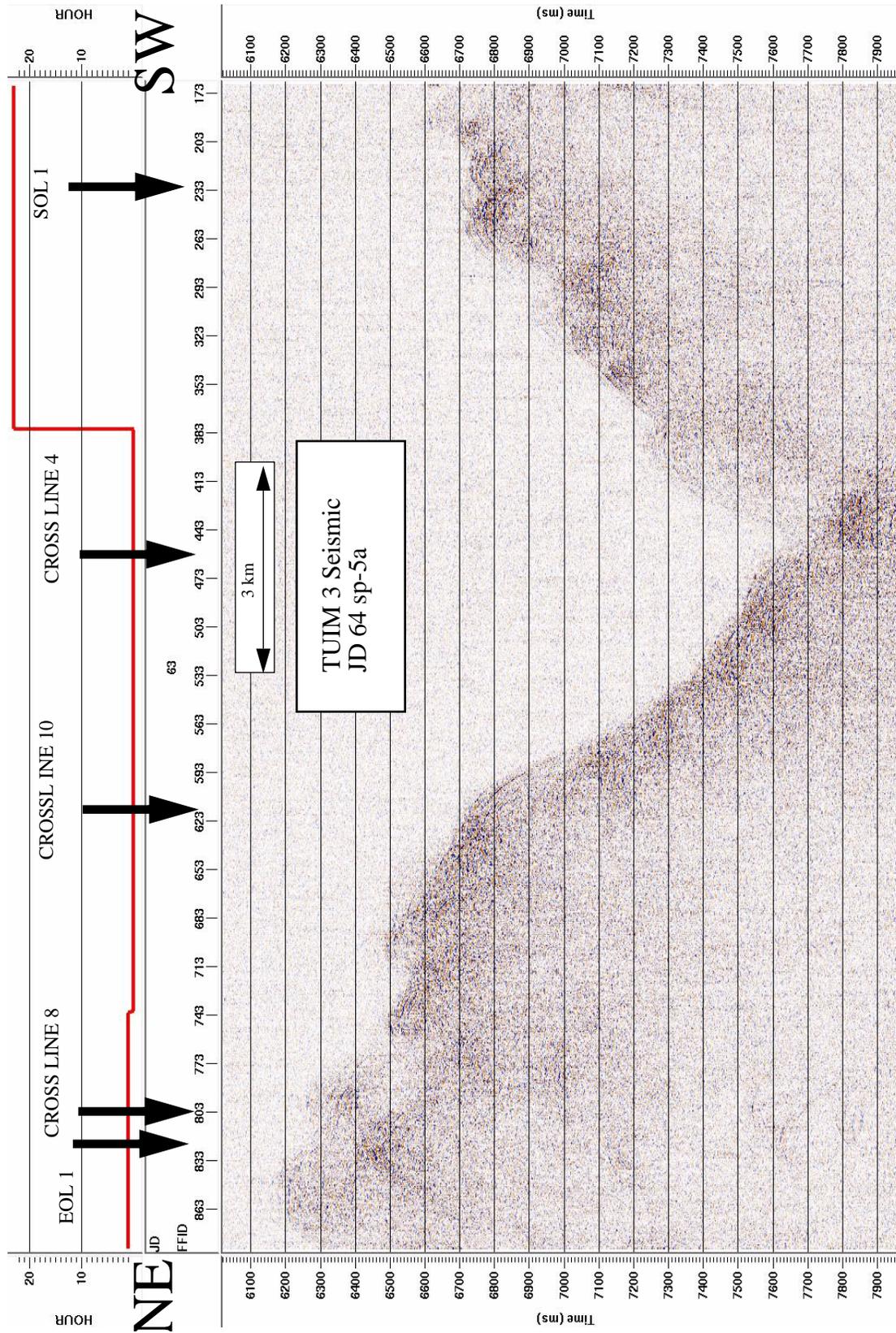
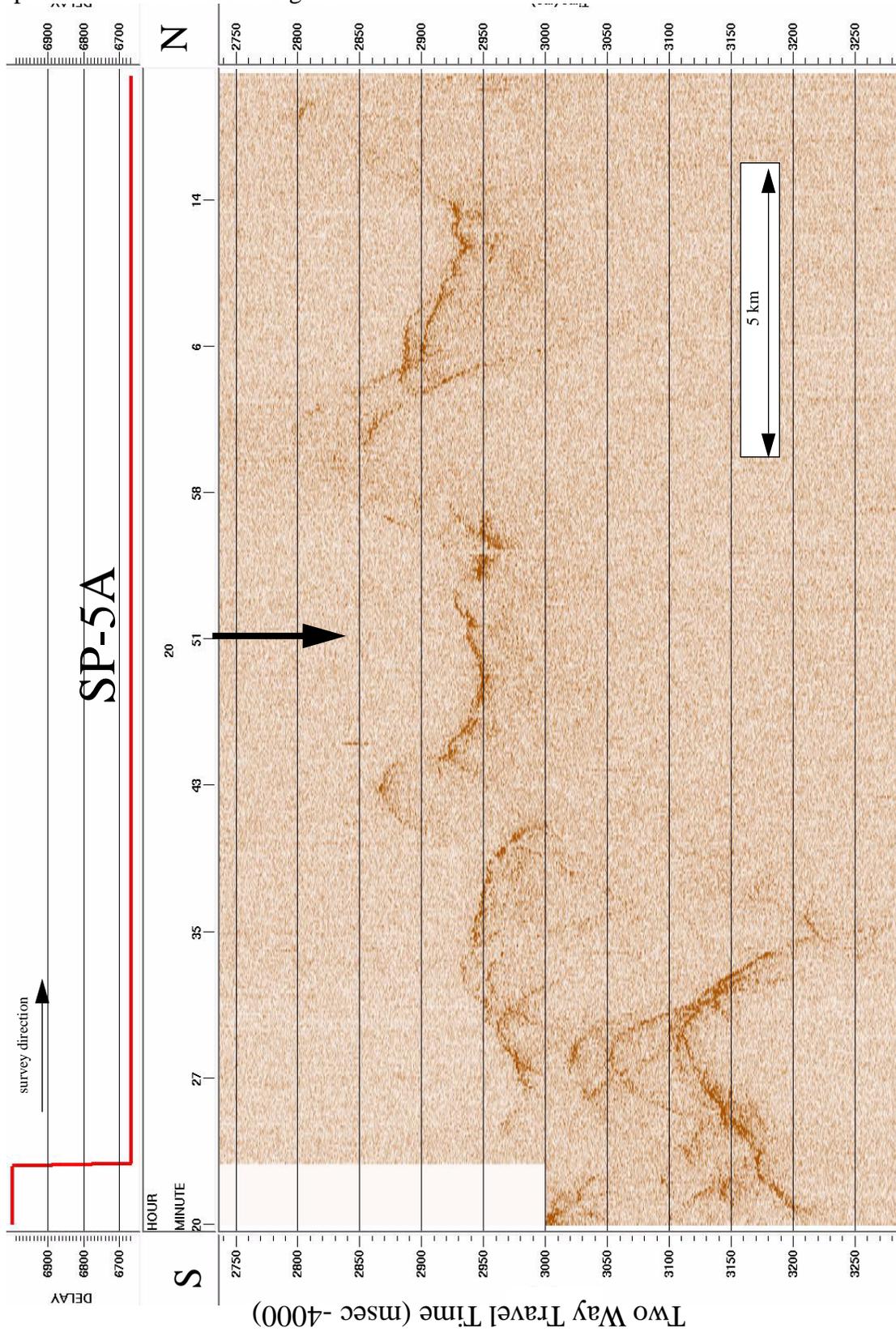


Fig SP5-6: Chirp subbottom profile from Transit 6 between 20:20 and 21:20 on JD63, showing the proposed drillsite at 20:51:26 gmt.



## **SITE SP-6A (Surveyed, but no drillsite located)**

**39° 00'S, 139° 40' W**

### **SITE OBJECTIVES**

SP-6A was to be a site on 55 Ma crust at about 54°S paleolatitude to sample the oceanographic transition between the Southern Ocean and the south Pacific gyre. However, the TUIM-03 survey could not identify any sediment to core.

### **GENERAL DESCRIPTION**

SP-6A is situated just north of the Agassiz Fracture Zone on significantly rougher crust than SP-11A, to the east (Figure SP6-1). The rough-smooth crustal transition occurs between magnetic anomalies 23n and 22n, and seems associated with the rise crest jump to the Henry trough region, which occurred at An21 (Cande et al., 1982). We also noted a doubling of spreading rate associated with the rough-smooth transition. As at Site SP-11A, we could not locate any sediment from seismic reflection or chirp at the site. We cored a shallow flat spot, but collected only 30 cm of sediment and chips of ferromanganese crust.

### **TUIM-03 Survey**

SP-6A was surveyed on March 9 and 10 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. The 4-channel streamer was deployed during the transit, but we changed to the LDEO 24-channel streamer for the sites survey.

The site has more rugged relief than average abyssal hills, but they are spaced 10-12 km apart similar to typical abyssal hill topography. There is more than 500 m of relief between hills and basins (Figure SP6-2). No sediment could be found at SP-6A using seismic reflection or chirp data, although it was occasionally difficult to distinguish between side echos and sediment cover in the rugged terrain. Examples of the seismic and chirp profiles are shown in Figures SP11-3 and SP11-4. We cored one area with possible sediment with a gravity core (MV0502-11GC) and recovered only a core catcher sample. The SP-6A survey and transits to surrounding survey sites document a large region region bare of sediment encompassing SP-11A, SP-6A, and SP-7A, and SP-9A.

### **LITHOLOGIC DESCRIPTION**

MV0502-11GC: 39° 06.06'S, 139°42.41'W, 5255 m depth

Only a core catcher sample was recovered in the gravity core. The sample consists of brown zeolitic clay with numerous small nodules and nodule fragments.

### **AVAILABLE DATA from TUIM-03**

seismic and chirp lines:  
SP6A lines 1 through 8

## FIGURES

Fig SP6-1: Location map for South Pacific Latitudinal Transect. P

Fig SP6-2: Swathmap bathymetry for the SP-6A region, from the TUIM-03 site survey.

Fig SP6-3: Seismic profile SP6 line 1 across SP-6A, from TUIM-03. No sediment could be discerned in any of the seismic reflection profiles.

Fig SP6-4: Chirp subbottom profile from line 1 across SP-6A, from TUIM-03. No sediment was seen in any of the chirp profiles.

## REFERENCES

Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.

Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP6-1: Location map for SP-11A shown with the Tui Malia Leg 03 site survey trackline.

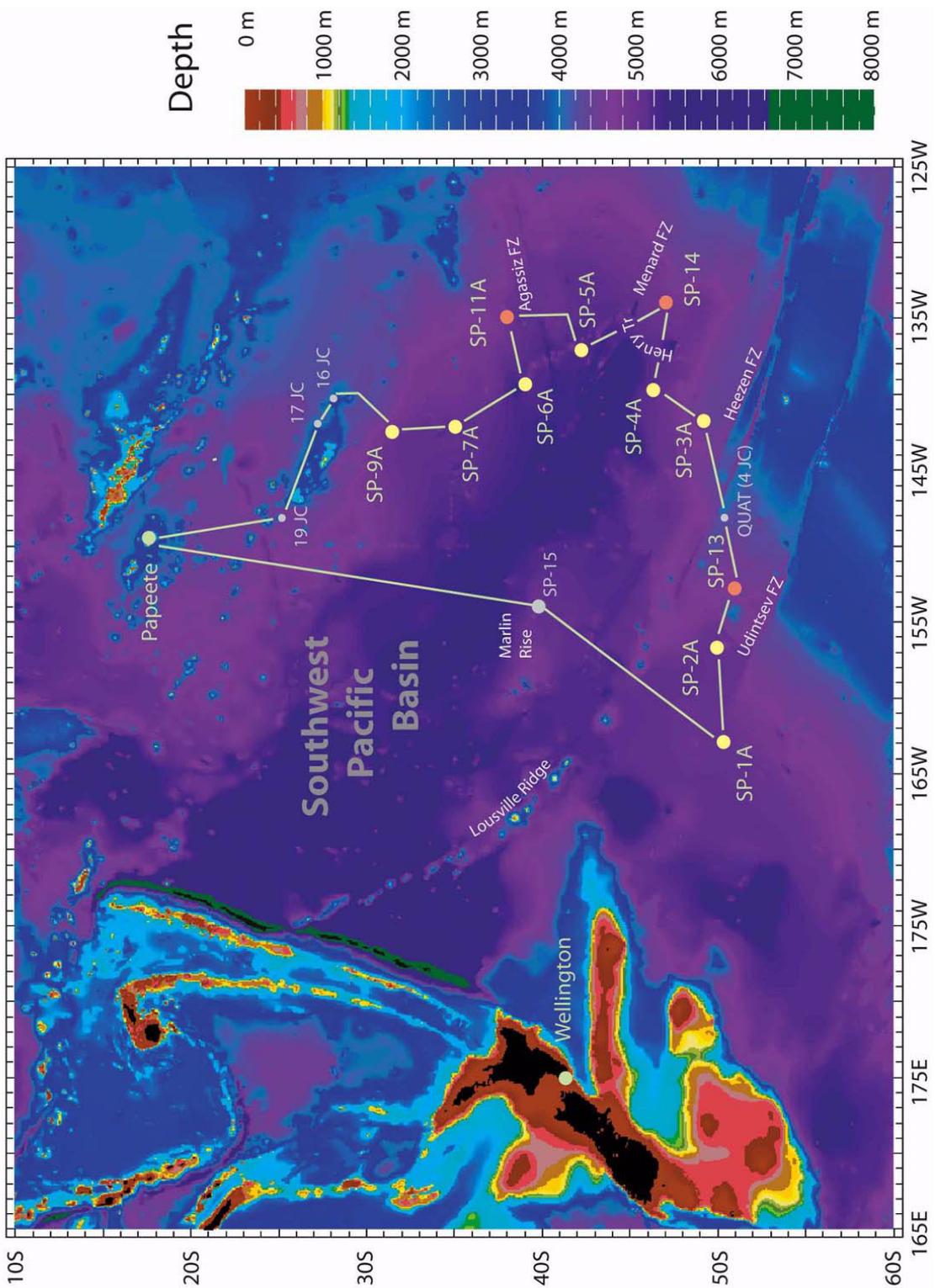


Figure SP6-2: Swathmap bathymetry in the region surrounding SP-6A from TUIM-03 survey cruise.

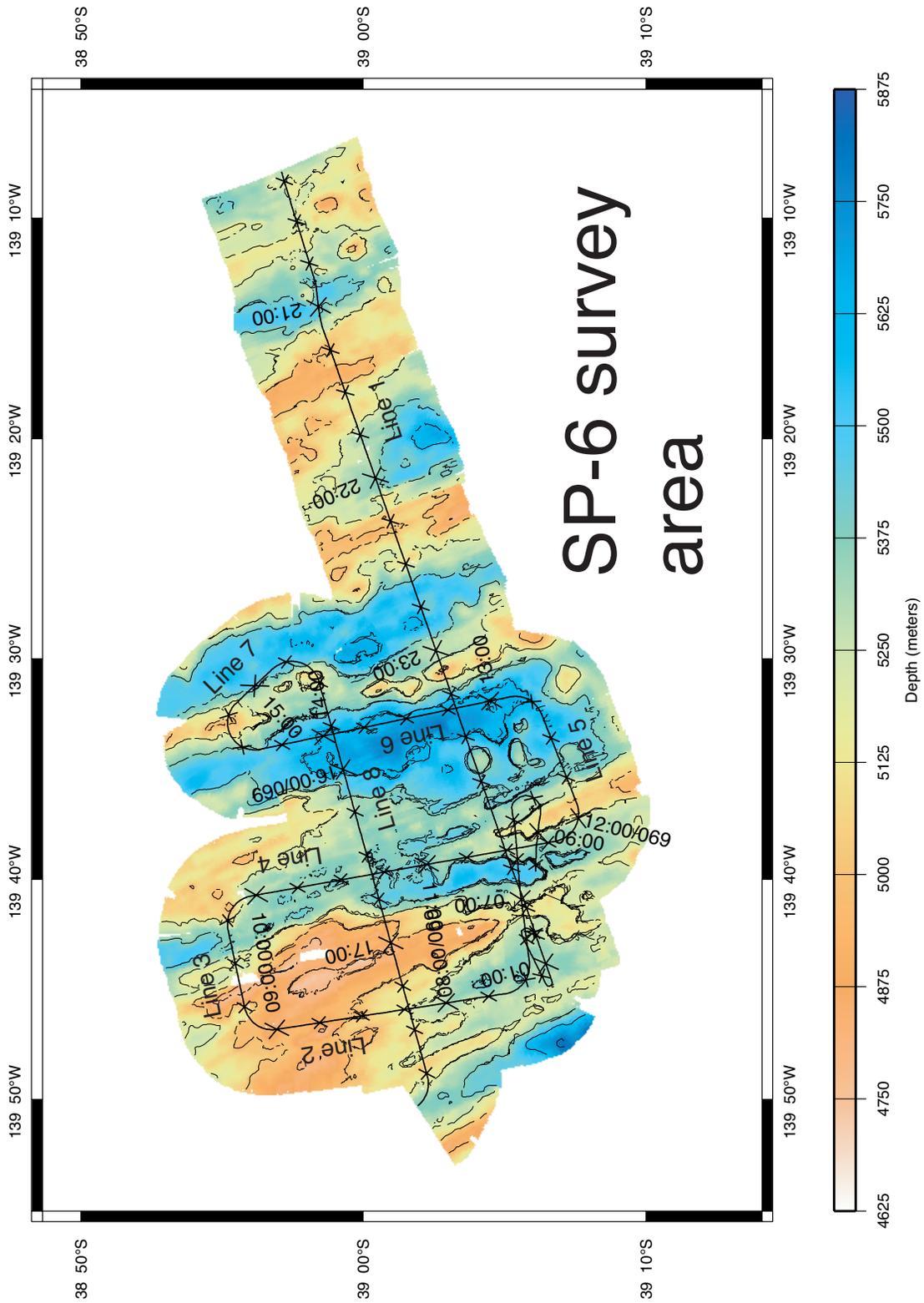


Figure SP6-3: The seismic profile SP6 line 1.

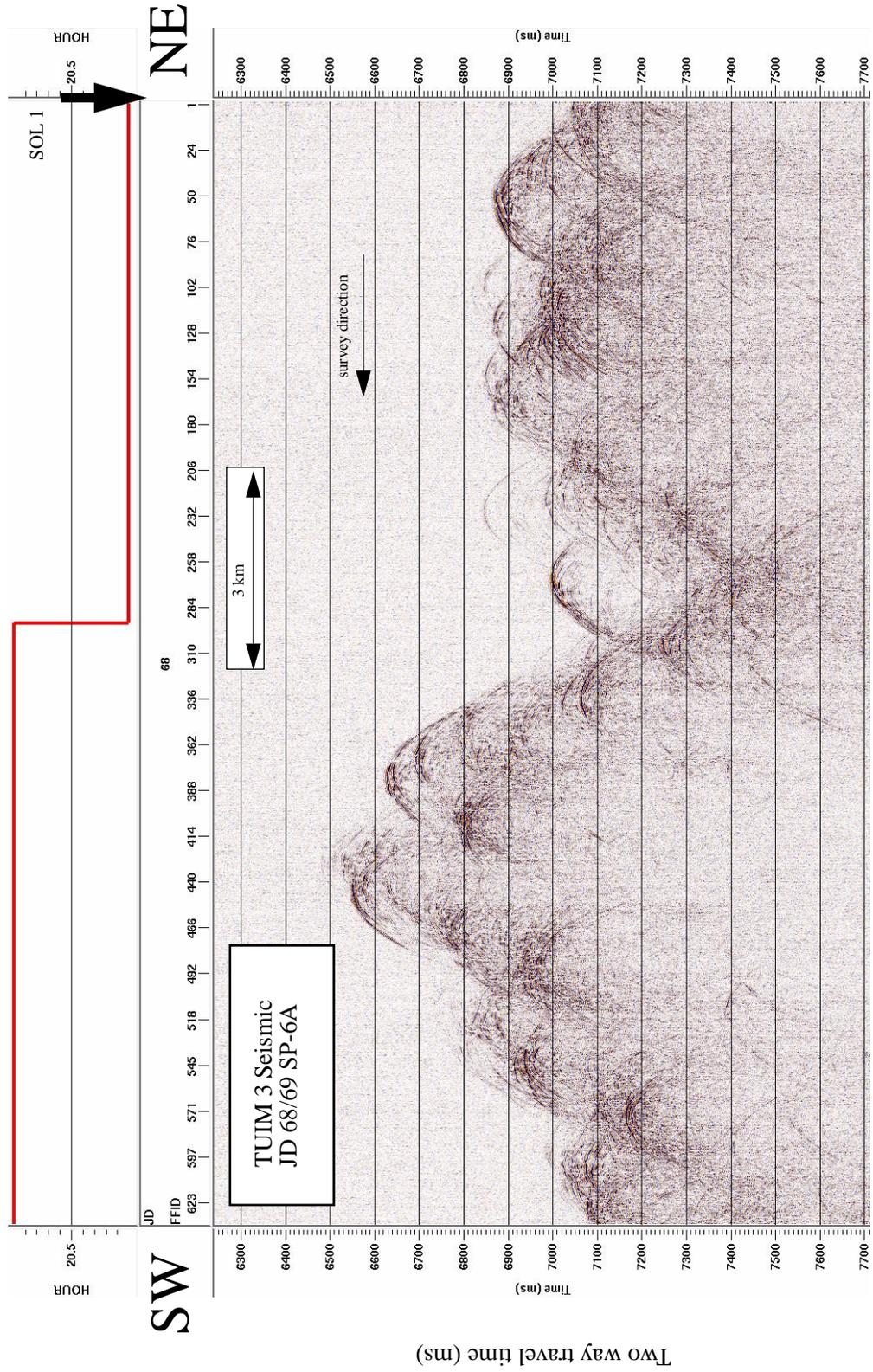
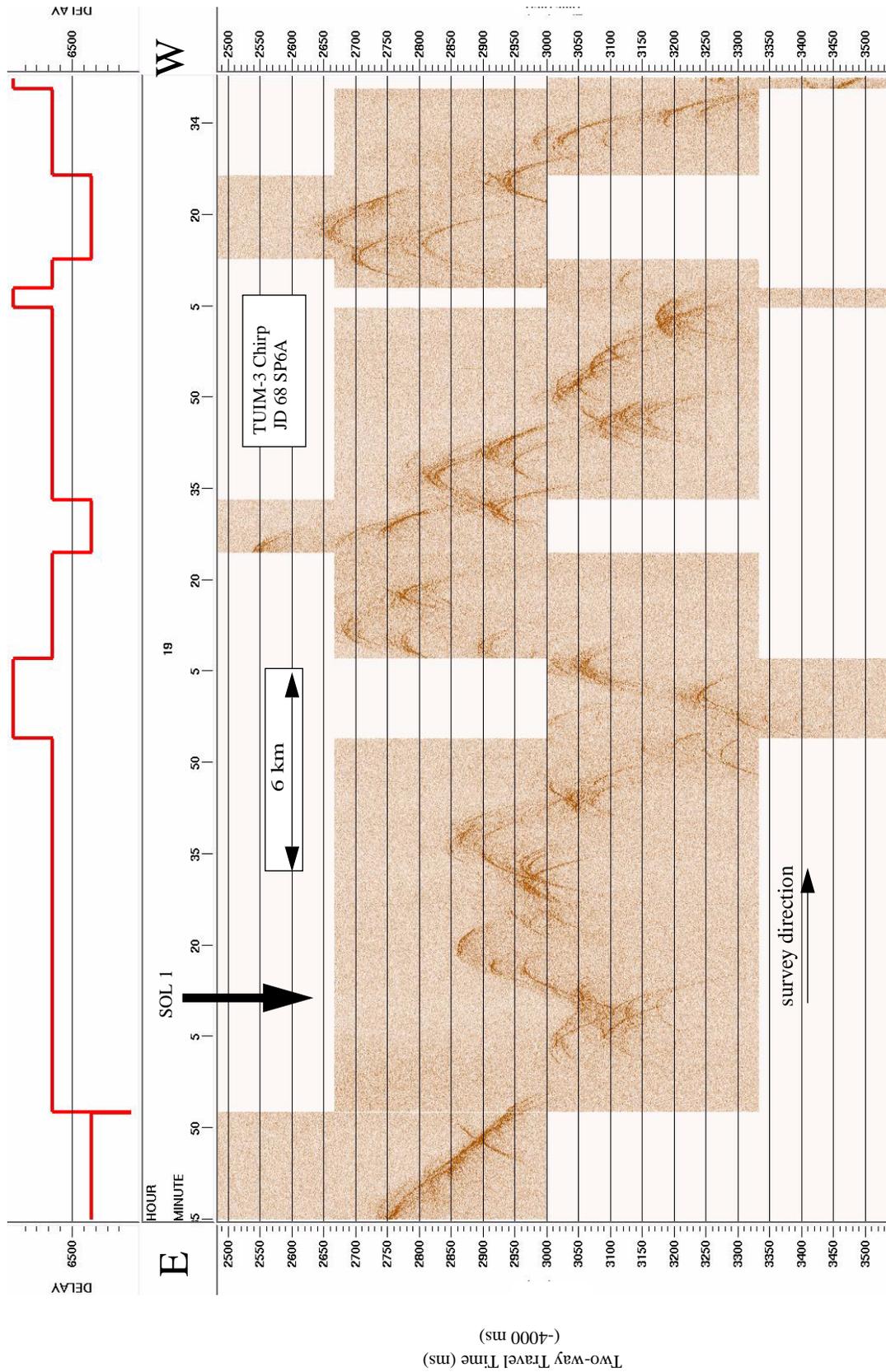


Figure SP6-4: The Knudsen chirp subbottom profiler record (line 1) from the SP-6A survey.



## **SITE SP-7A (Surveyed, but no drillsite located)**

**35° 00' S, 141° 55' W**

### **SITE OBJECTIVES**

SP-7A was to be a site on 55 Ma crust at about 51°S paleolatitude to sample the oceanographic transition between the Southern Ocean and the south Pacific gyre. We expected to find relatively thin sediment cover here because it should have spent more time than other sites within the gyre region. We did not expect to find bare rock. The TUIM-03 survey could not find sediment to drill by IODP and could not identify any consistent sediment to core.

### **GENERAL DESCRIPTION**

SP-7A is situated at 35°S, on rough abyssal hills about 4 degrees west of the Adventure Trough. Relief on the abyssal hills was as much as 800 m. The abyssal hills trend about 340°, similar to trends Sites SP-6A and SP-9A, the other 55 Ma sites along this section of crust.

### **TUIM-03 Survey**

SP-7A was surveyed on March 11 and 12 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. Because we were hit by another storm with gale force winds and the seas built back up to over 4 meters, we deployed only the 4-channel streamer during this survey. We attempted a gravity core but scrubbed the operation when we started to take seas over the side.

The site has more rugged than average abyssal hill topography. Ridges are spaced 10-12 km apart. There is more than 500 m of relief between hills and basins, between about 5400 and 4600 m (Figure SP7-2). No sediment could be found at SP-7A using seismic reflection or chirp data, although it was occasionally difficult to distinguish between side echos and sediment cover in the rugged terrain. Examples of the seismic and chirp profiles are shown in Figures SP7-3 and SP7-4. The SP-7A survey and transits to surrounding survey sites document a large region region bare of sediment encompassing SP-11A, SP-6A, and SP-7A, and SP-9A.

### **LITHOLOGIC DESCRIPTION**

No core taken--left site under gale force winds and high seas.

### **AVAILABLE DATA from TUIM-03**

seismic and chirp lines:  
SP7A lines 1 through 9

### **FIGURES**

Fig SP7-1: Location map for South Pacific Latitudinal Transect.

Fig SP7-2: Swathmap bathymetry for the SP-7A region, from the TUIM-03 site survey.

Fig SP7-3: Seismic profile SP6 line 1 across SP-7A, from TUIM-03. No sediment could be dis-

cerned in any of the seismic reflection profiles.

Fig SP7-4: Chirp subbottom profile from line 1 across SP-7A, from TUIM-03. No sediment was seen in any of the chirp profiles.

## REFERENCES

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP7-1: Location map for SP-11A shown with the Tui Malia Leg 03 site survey trackline.

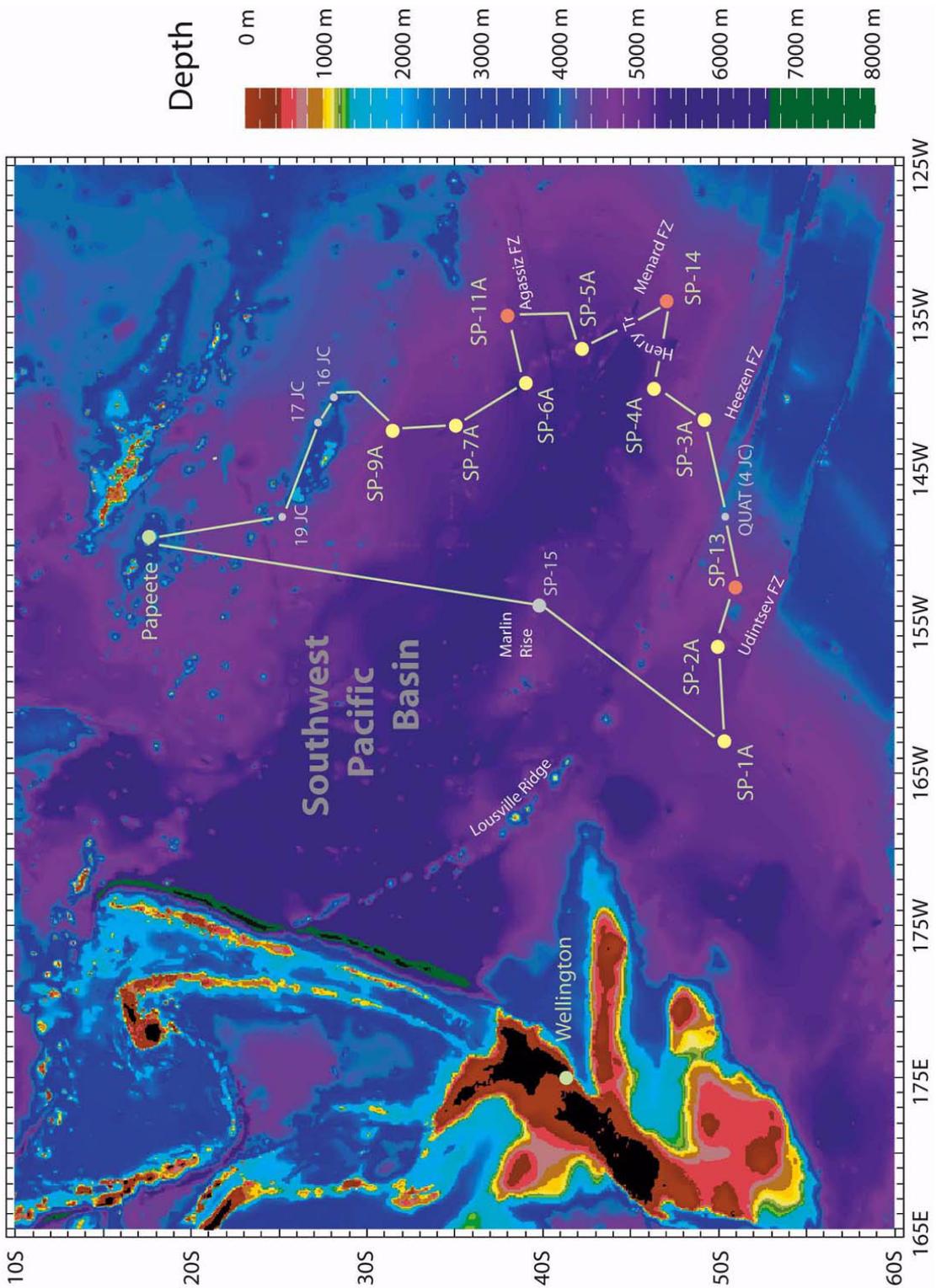




Figure SP7-3: The seismic profile SP6 line 1.

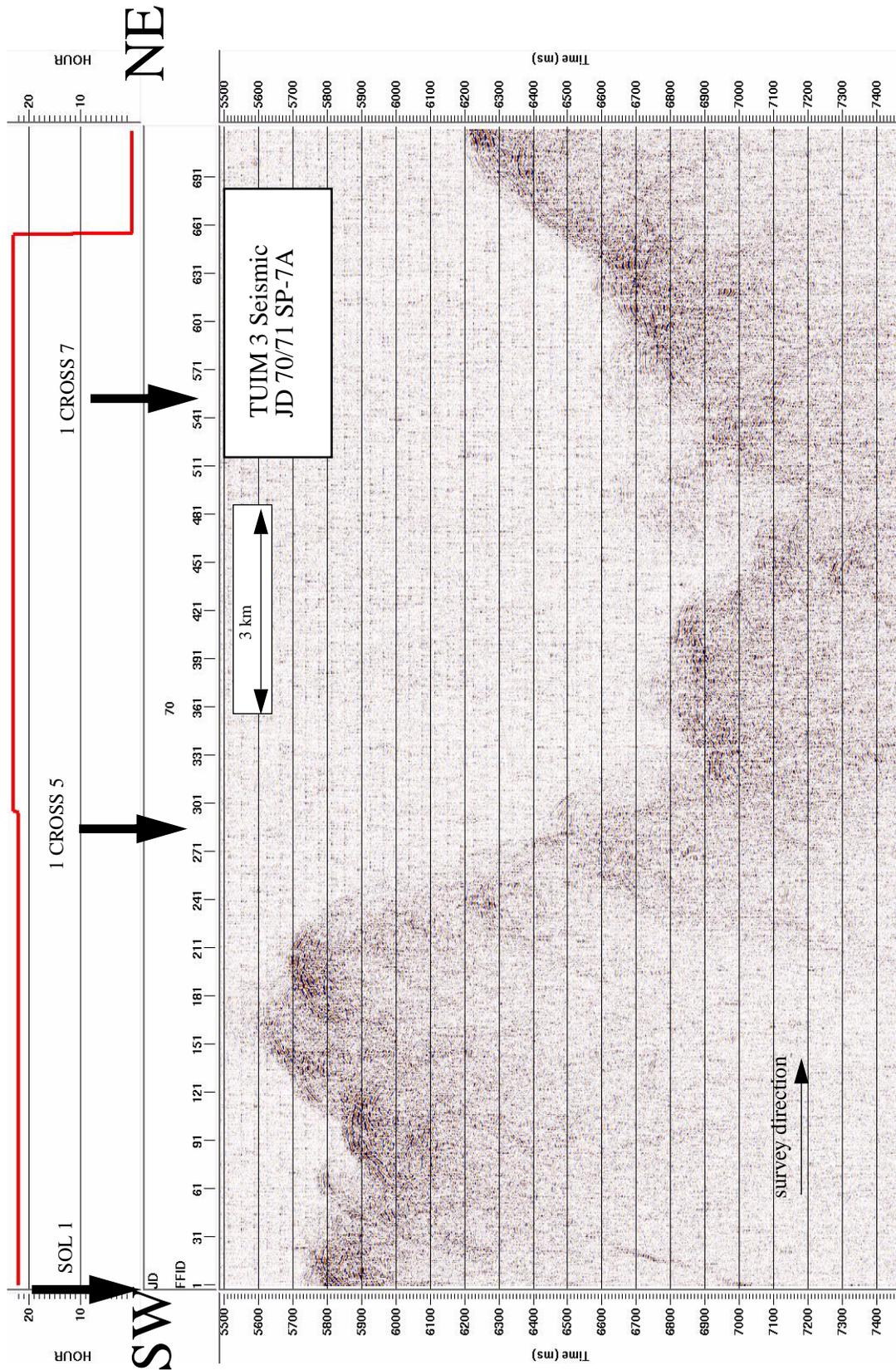
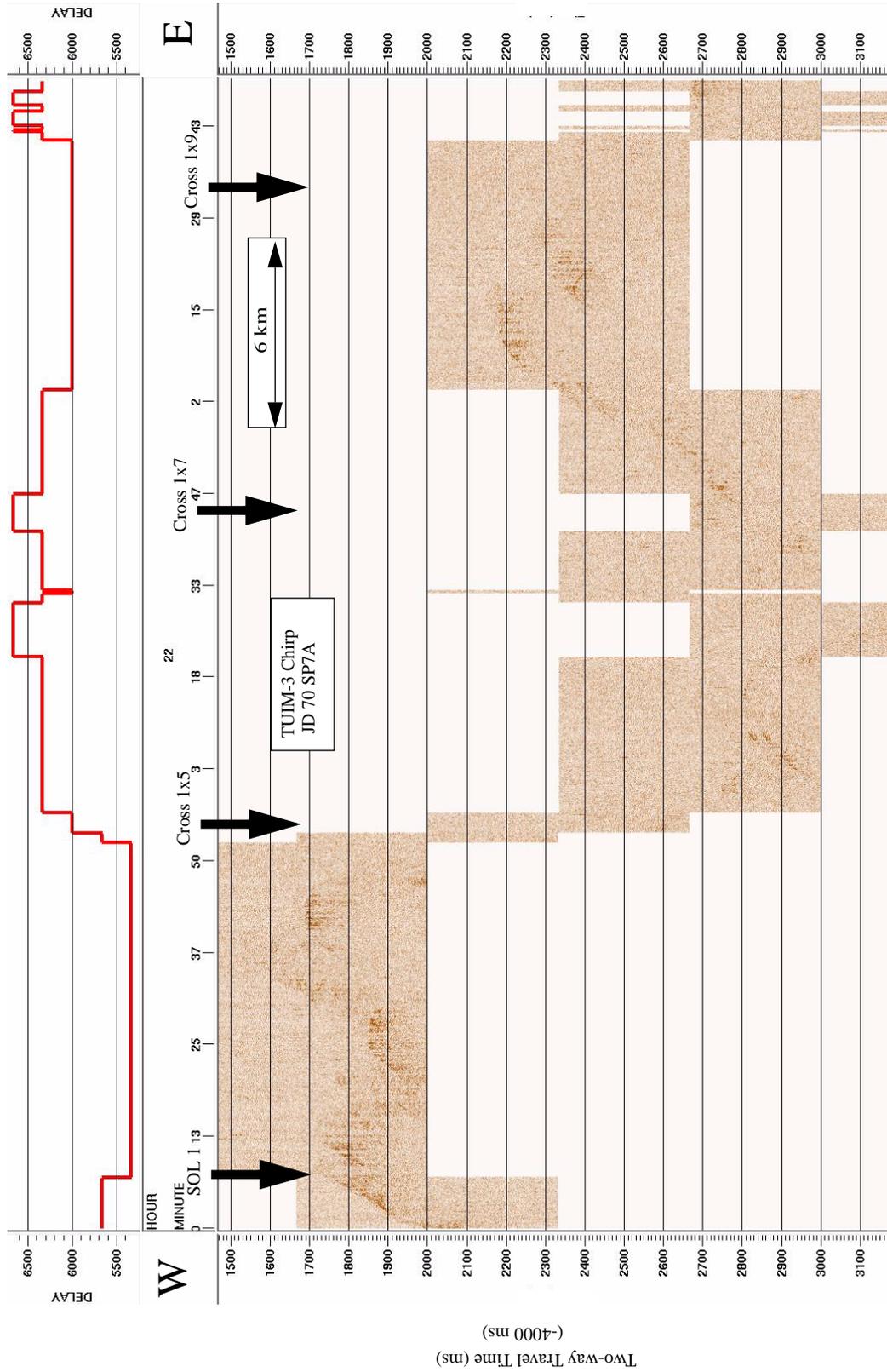


Figure SP7-4: The Knudsen chirp subbottom profiler record (line 1) from the SP-7A survey.



## **SITE SP-9A (Surveyed, but no drillsite located)**

**31° 42.194' S, 143° 30.331' W**

### **SITE OBJECTIVES**

SP-9A was to be a site on 55 Ma crust at about 49°S paleolatitude to sample the oceanographic transition between the Southern Ocean and the south Pacific gyre. We expected to find relatively thin sediment cover here because it should have spent more time than other sites within the gyre region. We did not expect to find bare rock. The TUIM-03 survey could not find sediment to drill by IODP. The survey did locate a sediment pond approximately 1 km<sup>2</sup> out of the 1000 surveyed from which to take a piston core.

### **GENERAL DESCRIPTION**

SP-9A is situated near 32°S, straddling magnetic anomaly 25n (Cande and Kent, 1995). It lies on rough abyssal hills about 4 degrees west of the Adventure Trough. It also lies about 100 km west of the smooth-rough crustal transition also noted at SP-6A. Depths within the site range from 5500 m at the deepest point to about 4600 m on the ridge top. The typical range is between 4750 and 5250 m, or about 500 m.

Relief on the abyssal hills was as much as 800 m. The abyssal hills trend about 340°, similar to trends Sites SP-6A and SP-9A, the other 55 Ma sites along this section of crust.

### **TUIM-03 SURVEY**

SP-9A was surveyed on March 11 and 12 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. We used the 24-channel streamer during the entire survey. We found one sediment pocket at the cross of line 9 and line 6, from which we took a gravity core followed by a piston core (MV0502-14GC and -15JC).

The site has more rugged than average abyssal hill topography. Ridges are spaced 10-12 km apart. There is more than 500 m of relief between hills and basins, between about 5400 and 4700 m (Figure SP9-2). We could locate only one patch of sediment at SP-9A, about 1 km across in either direction, with about 24 m of sediment, which we cored. We could find no other sediment using seismic reflection or chirp data, although it was difficult to distinguish between side echos and sediment cover in the rugged terrain. Examples of the seismic and chirp profiles are shown in Figures SP9-3 and SP9-4. The sediment pond was sufficiently small that we do not propose it as a drillsite. The SP-9A survey and transits to surrounding survey sites document a large region bare of sediment encompassing SP-11A, SP-6A, and SP-7A, and SP-9A.

### **LITHOLOGIC DESCRIPTION**

MV0502-15JC: 31° 42.194' S, 143° 30.331' W, 5082 m water depth, 8.35 m sediment  
Faintly mottled very dark brown to very dusky red zeolitic clay. Barren of microfossils.  
The sediment is reminiscent of metalliferous sediment from near the East Pacific Rise.

**AVAILABLE DATA from TUIM-03**

seismic and chirp lines:  
SP9A lines 1 through 9

**FIGURES**

Fig SP9-1: Location map for South Pacific Latitudinal Transect.

Fig SP9-2: Swathmap bathymetry for the SP-9A region, from the TUIM-03 site survey.

Fig SP9-3: Seismic profile SP9 line 6 across the sediment pond, from TUIM-03.

Fig SP9-4: Chirp subbottom profile from line 6 across SP-9A, from TUIM-03. The chirp profile was most useful for quickly defining the sediment pond.

**REFERENCES**

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP9-1: Location map for SP-9 shown with the Tui Malia Leg 03 site survey trackline.

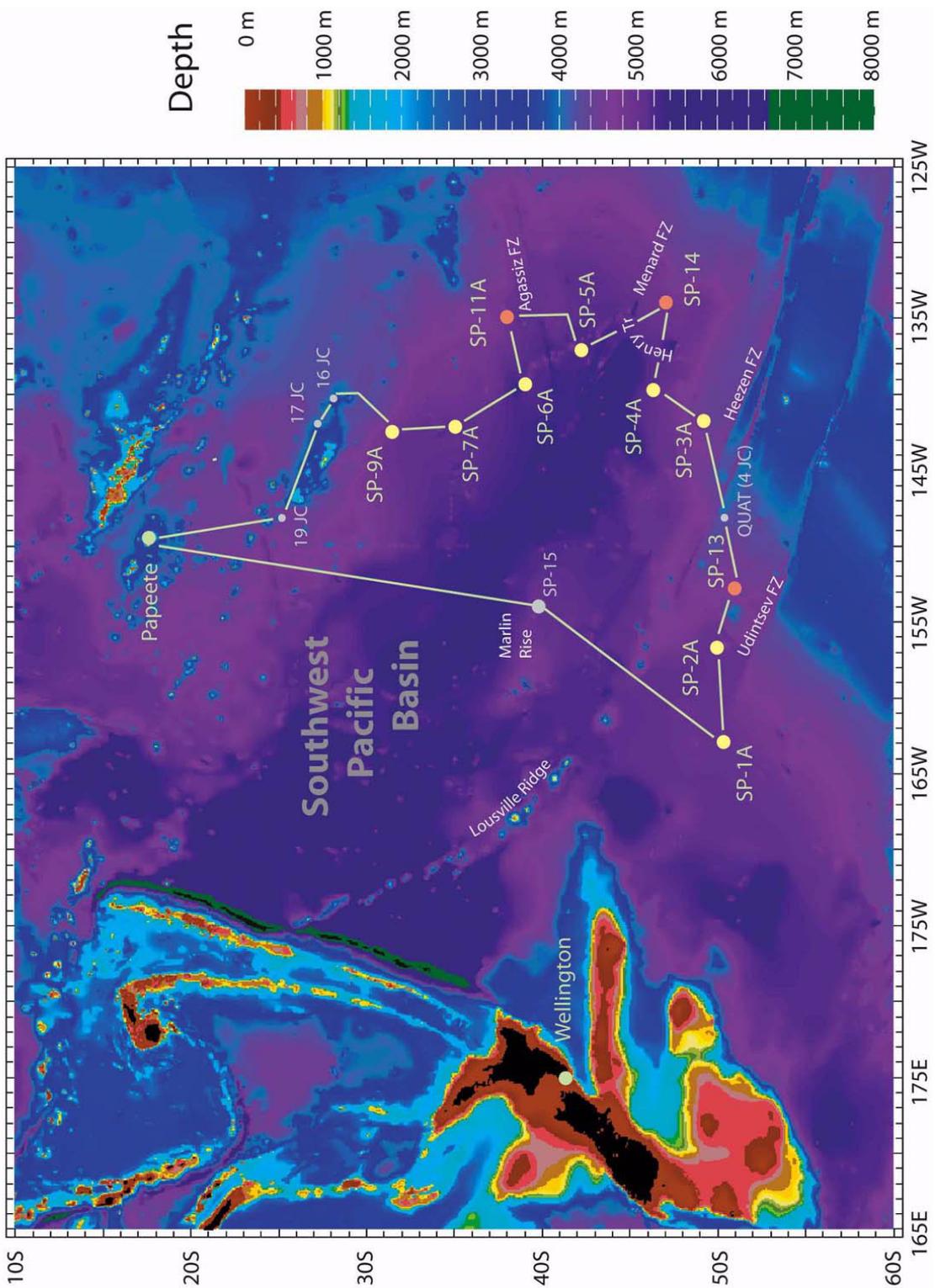


Figure SP9-2: Swathmap bathymetry in the region surrounding SP-9 from TUIM-03 survey cruise.

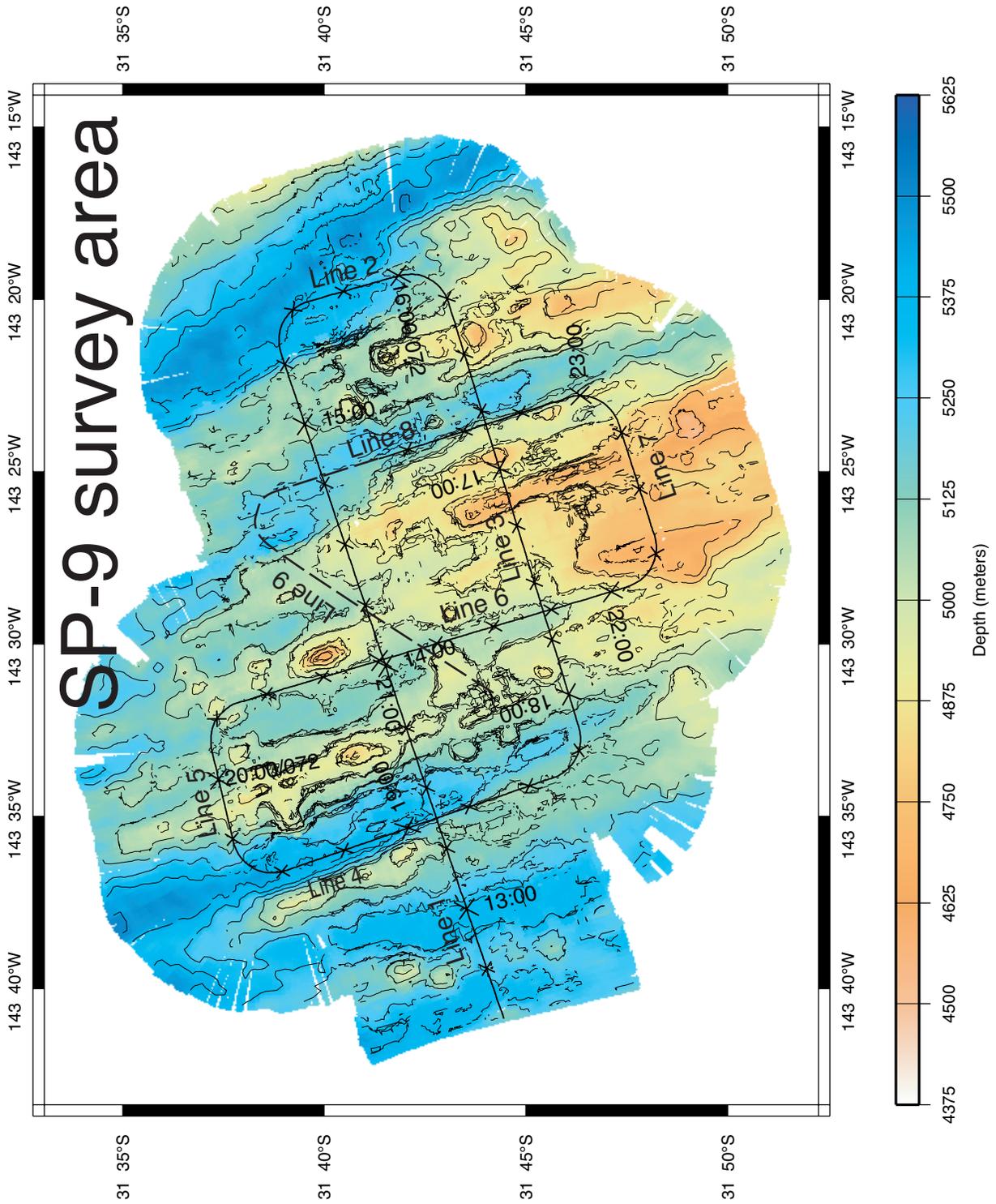


Figure SP9-3: The seismic profile SP9 line 6. Core MV0502-15JC was taken near the cross of line 6 and line 9.

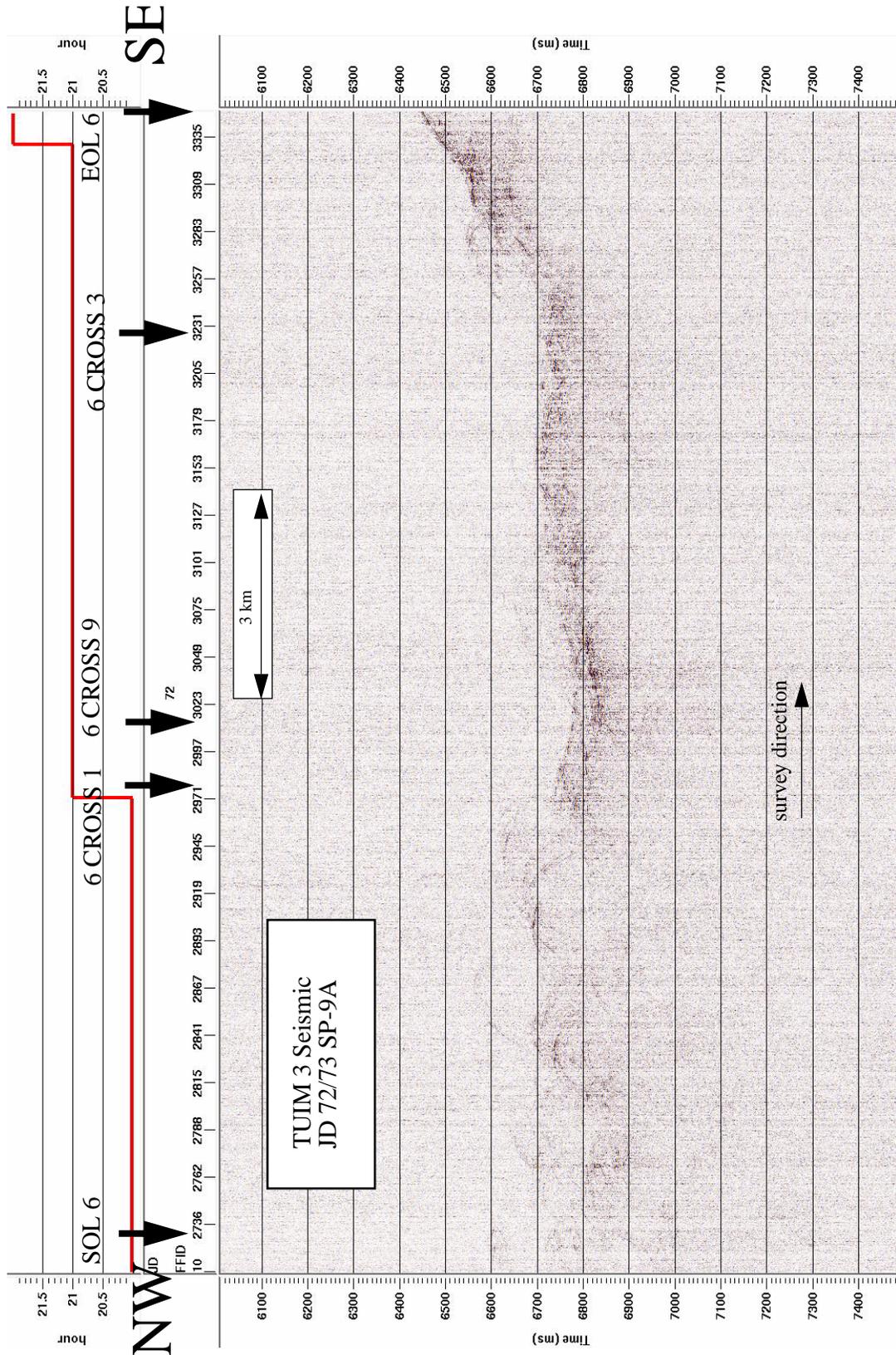
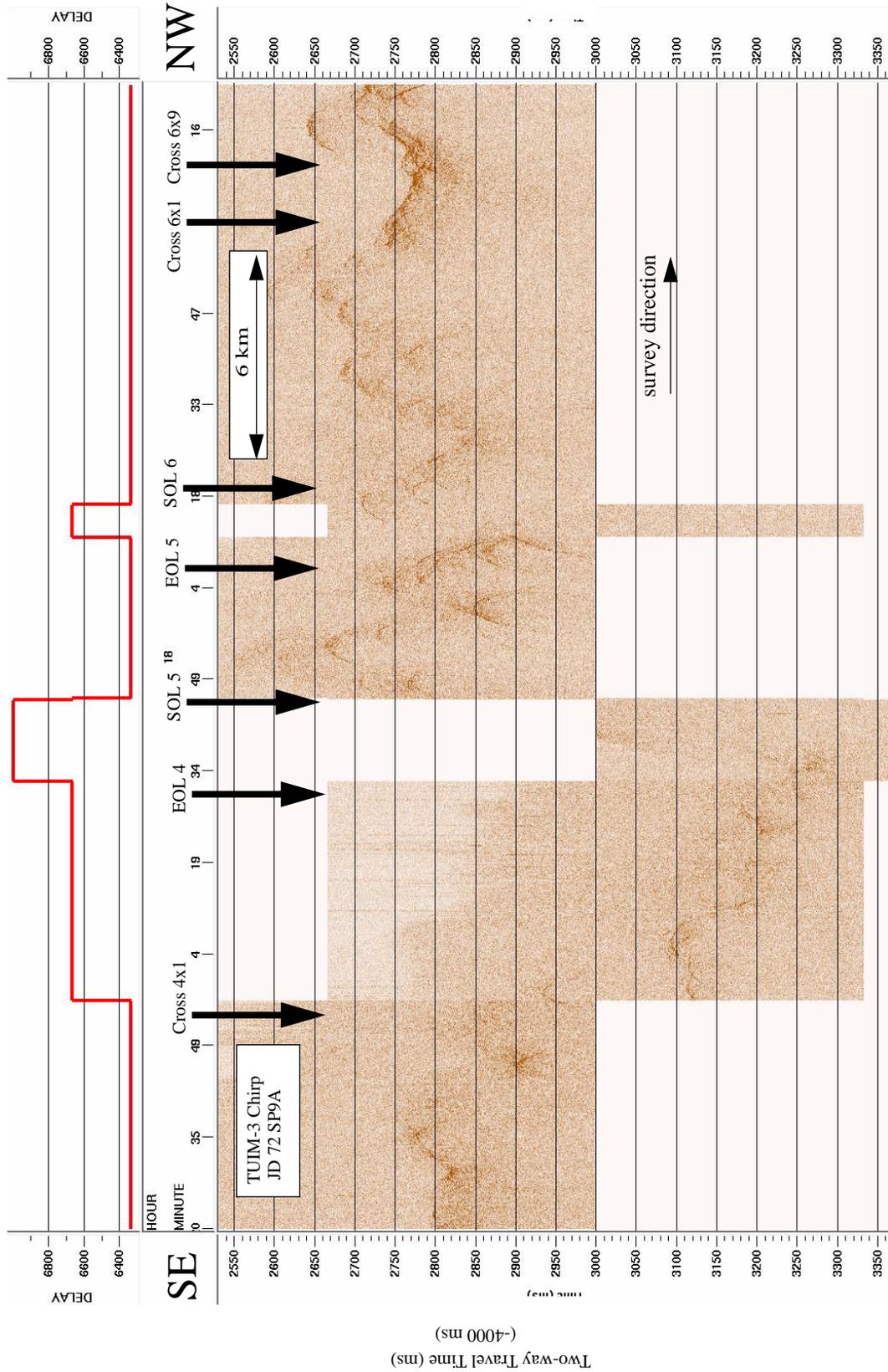


Figure SP9-4: The Knudsen chirp subbottom profiler record (lines 4 through 6) from the SP-9 survey.



## **SITE SP-11A (Surveyed, but no drillsite located)**

**38° 06'S, 135° 12' W**

### **SITE OBJECTIVES**

SP-11A was intended to be a site on 40 Ma crust at about 50°S paleolatitude to sample the southern edge of the subtropical south Pacific gyre. Surveying in the surrounding region could not identify any sediment to core.

### **GENERAL DESCRIPTION**

SP-11A is situated just north of the Agassiz Fracture Zone on smooth crust (low relief abyssal hills, Figure SP11-1, -2). The site was originally intended to be sited on magnetic anomaly 18n, but the poor weather associated with Hurricane Percy caused us to detour north and relocate the site on magnetic anomaly 20n (about 43 Ma; Cande and Kent, 1995).

### **TUIM-03 Survey**

SP-11A was surveyed on March 8 and 9 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. The 4-channel streamer was deployed because seas were still high from the passing of the remnants of Hurricane Percy. A relatively small survey was planned because of the sea state and winds, but the survey was broken off when we could not detect any sediment at all with either chirp or seismic reflection.

The site has gentle topography on smooth crust, with a few very small seamounts in the vicinity (Figure SP11-2). The entire region was bare of sediment, as is shown by the example seismic and chirp profiles (Figures SP11-3 and SP11-4). In addition, the entire transit from SP-11A to SP-6A was similarly clean of sediment. This survey marks where we can document the beginning of a large region of no sediment encompassing SP-11A, SP-6A, and SP-7A.

### **LITHOLOGIC DESCRIPTION**

No core taken. No detectable sediment by either chirp or seismic reflection.

### **AVAILABLE DATA from TUIM-03**

seismic and chirp lines:  
SP11A lines 1 through 6

### **FIGURES**

Fig SP11-1: Location map for South Pacific Latitudinal Transect. Survey for SP-11 is marked.

Fig SP11-2: Swathmap bathymetry for the SP-11A region, from the TUIM-03 site survey.

Fig SP11-3: Seismic profile SP11 line 1 across SP-11A, from TUIM-03. No sediment could be discerned in any of the seismic reflection profiles.

Fig SP11-4: Chirp subbottom profile from lines 1 and 2 across SP-11A, from TUIM-03. No sediment was seen in the chirp profile.

## **REFERENCES**

Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Figure SP11-1: Location map for SP-11A shown with the Tui Malia Leg 03 site survey trackline.

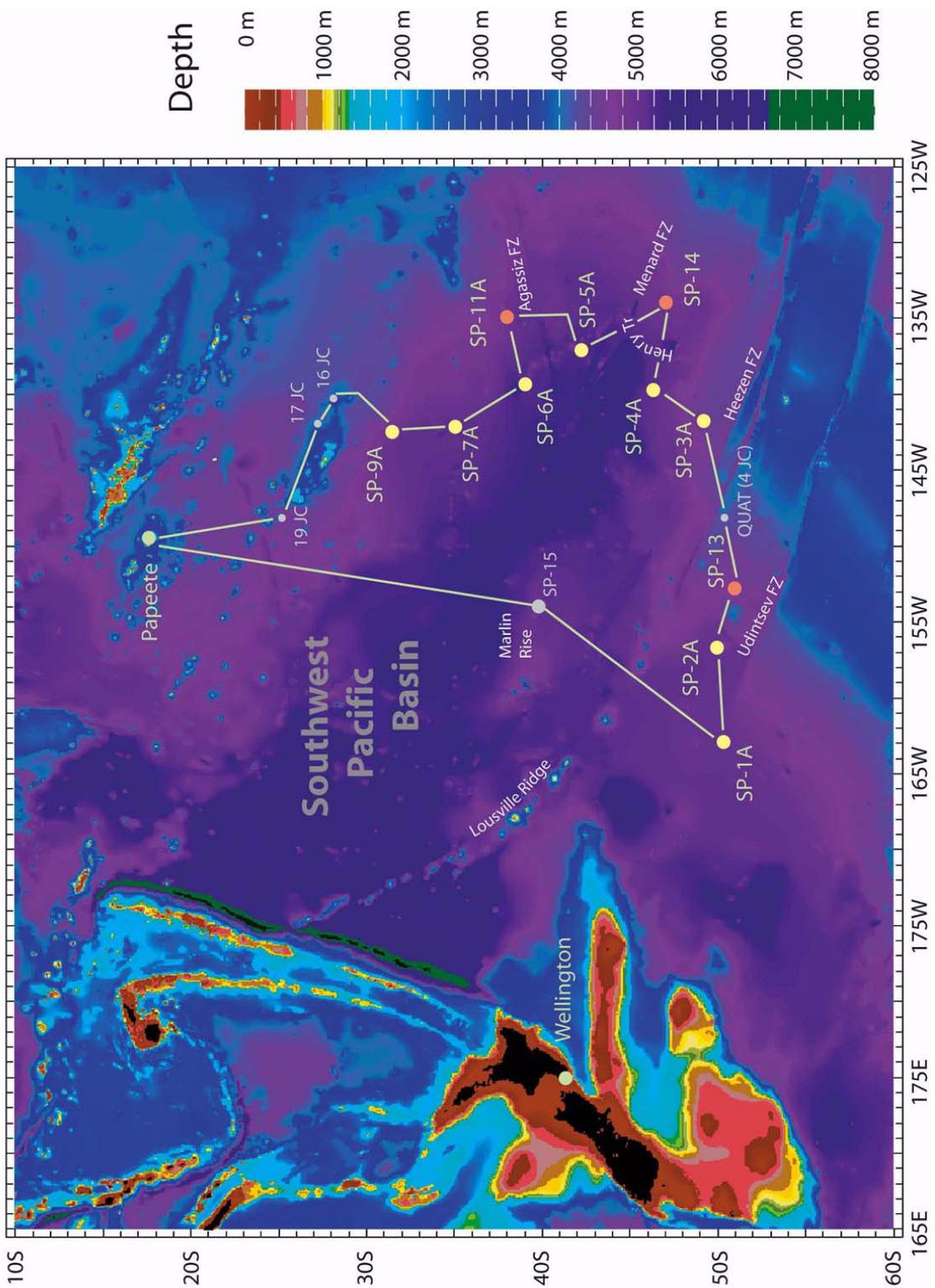


Figure SP11-2: Swathmap bathymetry in the region surrounding SP-11A from TUIM-03 survey cruise.

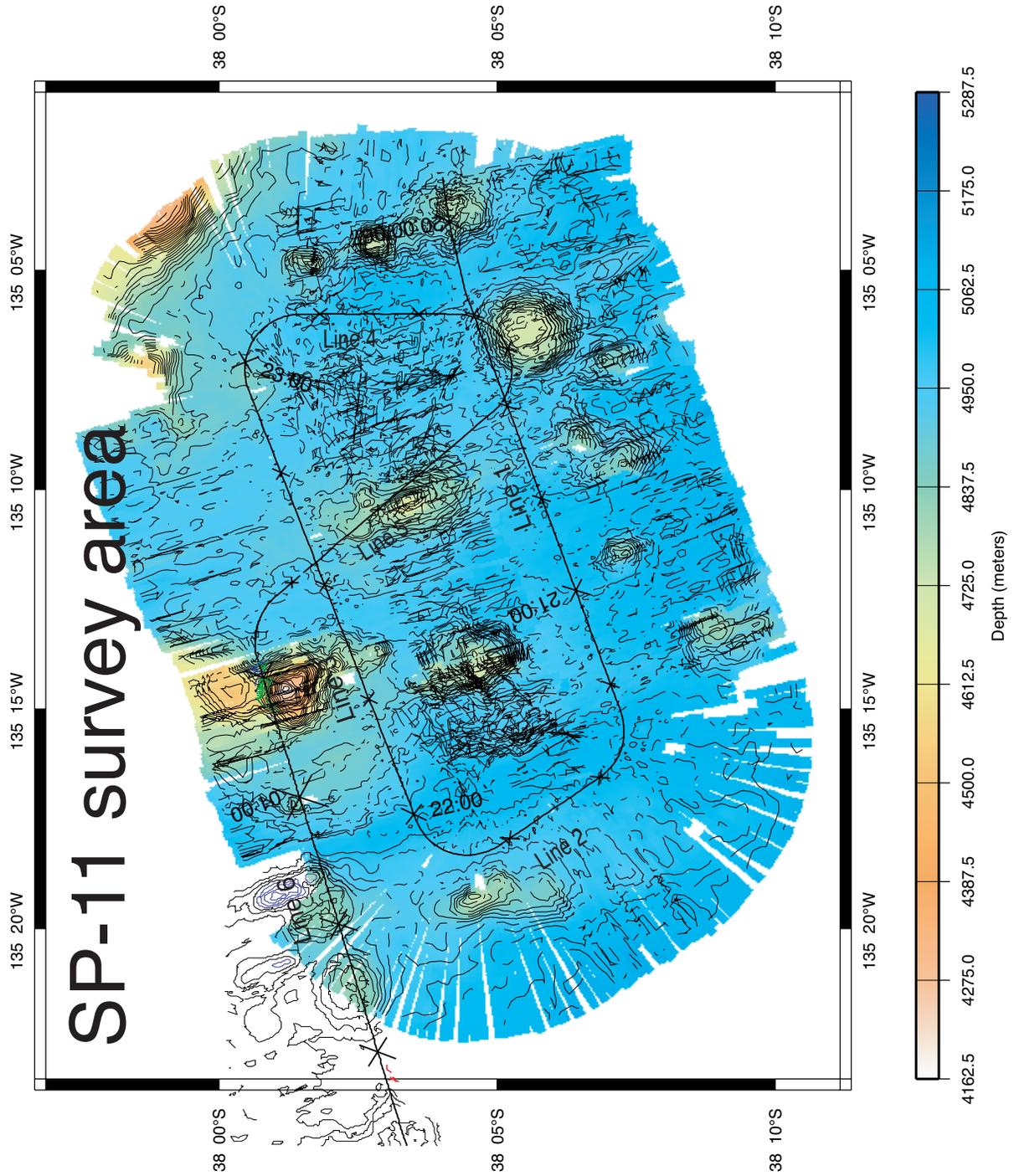


Figure SP11-3: The seismic profile SP-11 line 1.

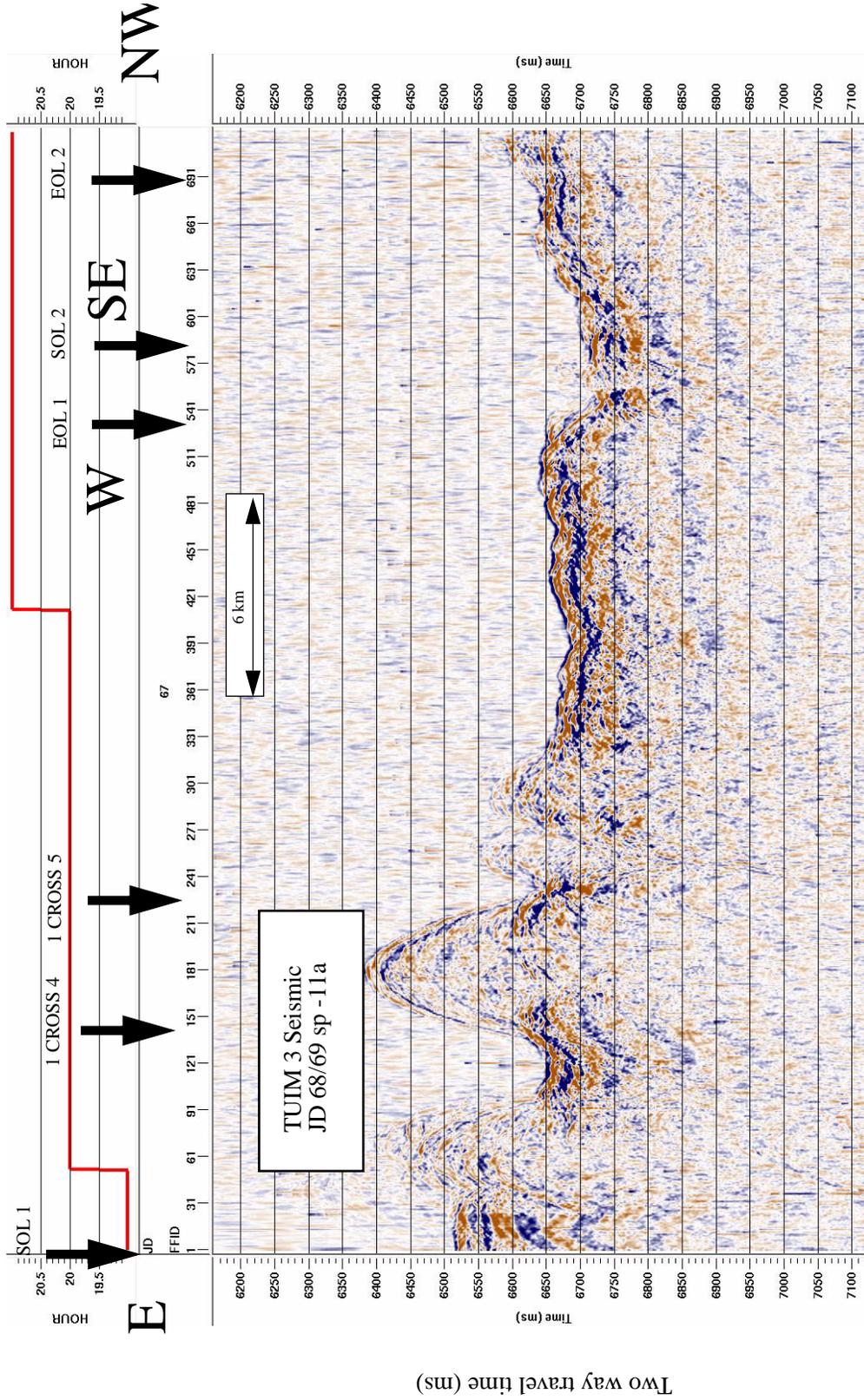
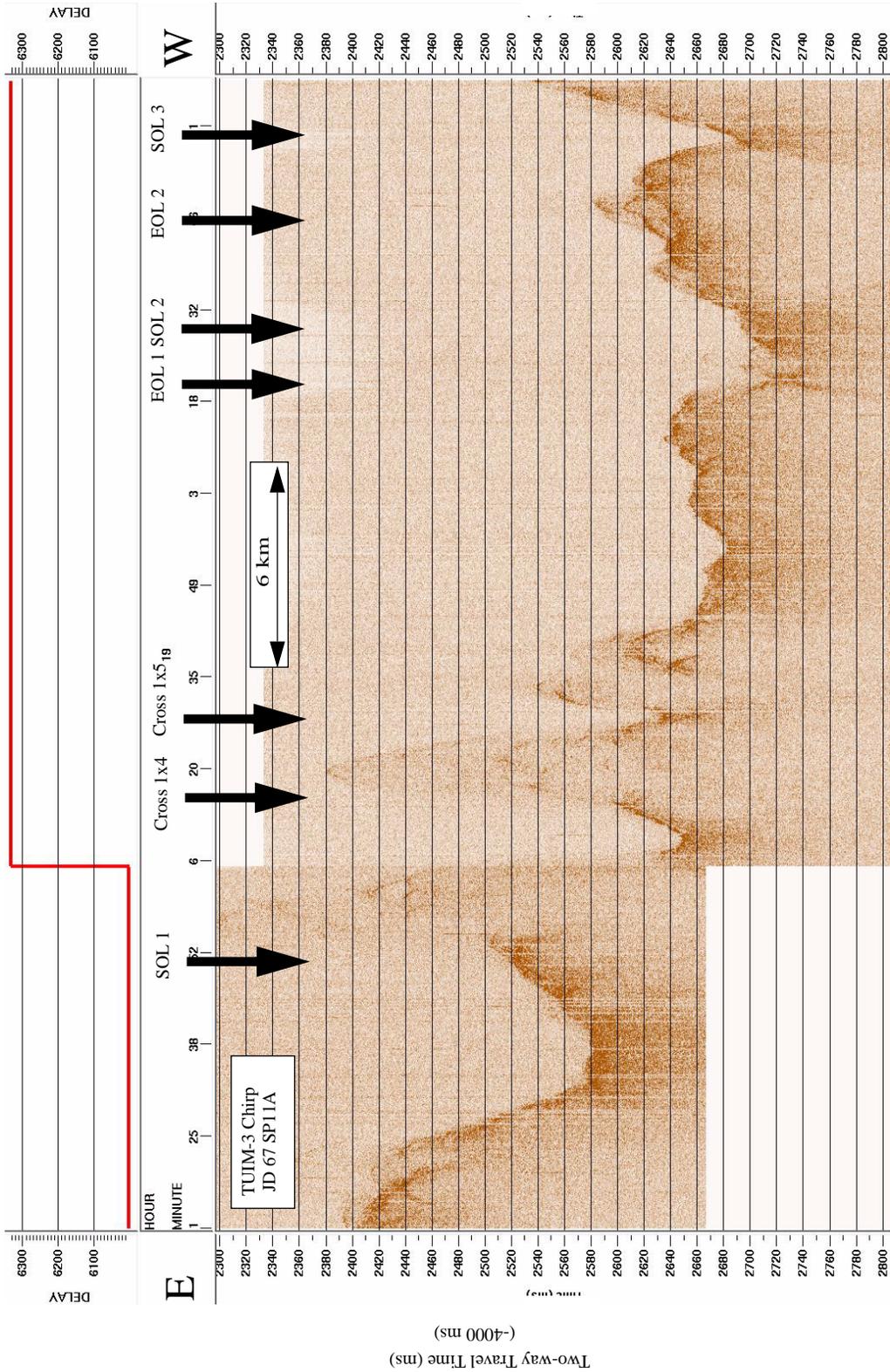


Figure SP11-4: The Knudsen chirp subbottom profiler record (line 1 and 2) from the SP-11A survey.



## **SITE SP-13 (SW Pacific, N of Udintsev FZ)**

**50° 46.605'S, 151° 58.022' W**

### **SITE OBJECTIVES**

SP-13 is the southernmost site of the middle Eocene (40 Ma) transect. It is located north of the Udintsev Fracture Zone and to the southeast of SP-2A (Figure SP13-1). SP-2A is sited at magnetic anomaly An 25n to sample the Paleocene-Eocene boundary, while SP-13 is sited on An 18n, on about 40 Ma crust. Drilling at SP-13 will recover a sediment section to study the polar region over the Eocene-Oligocene boundary interval. At 40 Ma, the backtracked location of SP-13 was 64° S, 131° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame. At 35 Ma (just older than the E-O boundary), the site was located at 62°S, 133°W

### **GENERAL DESCRIPTION**

SP-13 is situated about 1° to the northwest of Udintsev Fracture Zone, on abyssal hill topography. Based on magnetic maps (Cande et al., 1989) and personal communications with Steve Cande, we chose the location to be located on magnetic anomaly 18n, roughly at 40 Ma (Cande and Kent, 1995). We used the TUIM-03 site survey to confirm the anomaly location. Water depth in the general vicinity is about 4.8 km.

### **TUIM-03 Survey**

SP-13 was surveyed on February 23, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector). The data were acquired on the LDEO 24-channel streamer, without birds (no battery packs were sent with the birds). Because of high seas, the data were relatively noisy. A piston core was attempted at the site, but it pretripped because seas were running around 3-5 m during coring

SP-13 is located in a region of relatively rough topography. An uplifted block of crust was located at the southern edge of the survey region, forcing the survey to be relocated to the north. The seamount reached above 4000 m, but the crust to the north ranged in depth from 4300 m to 4875 m. We chose the drillsite in a deep because of better imaged (and flat) basement. The modern carbonate compensation depth is in the vicinity of 4700 m, so we expect surface sediments to be diatom-rich clays, becoming more carbonate-rich in older sediments.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-04JC from TUIM-03; 50° 20.40'S S, 148° 07.55'W, 4203 m (uncorr.) 17.2 m sediment.

MV0502-04JC is a pale brown to white siliceous foram-bearing nannofossil ooze. Color changes are meter-scale cyclic light dark cycles, indicating changes in carbonate content. The shallow depth of the core probably minimizes the carbonate dissolution.

## **SEISMIC INTERPRETATION**

Primary Site (SP-13): TUIM-03-SP13 line 9, 2005 JD054 12:47:39 gmt, FFID 4340

Crustal age: 40 Ma

Location: 50° 46.605'S 151° 58.022'W

Site water depth: 4772 m (uncorrected; 6.362 sec TWTT)

Sediment thickness: 0.202 sec (162 m)

Proposed Drilling Depth: 167 m

The position for SP-13 was chosen near the north end of SP13 Line 9 from the TUIM-03 survey to avoid anomalous sedimentation around the southern seamount shown in Figure SP13-2. The sediment at the site is somewhat thicker than average but it has a well-imaged basement contact (Figure SP13-4). Sediment cover seems to drape over most of the topography and averages 50-100 msec TWTT in thickness. Typically we could resolve no distinct seismic horizons within the sediment section. There is a small interval on line 11 with a horizon near basement. We decided against drilling in this area because the sediment column was atypical. Chirp subbottom profiling could image through up to 100 ms of sediment and did not identify layering in the sediments either.

## **GEOLOGIC HAZARDS**

There are no known geologic hazards--pelagic sediments over oceanic basalts.

## **OTHER HAZARDS**

There are no manmade hazards in the vicinity.

## **AVAILABLE DATA from TUIM-03**

Seismic and chirp lines:

SP-13 lines 1 through 11

## **FIGURES**

Fig SP13-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-13A is shown.

Fig SP13-2: Swathmap bathymetry for the SP-13 region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP13-3: MST physical properties data for MV0502-4JC, cored to the north of SP-13 on TUIM-03.

Fig SP13-4: Seismic profile SP13 line 9 across SP-13A, from TUIM-03. Proposed drill site is marked.

Fig SP13-5: Crossline seismic profile SP13 line 11 from TUIM-03.

Fig SP1A-6: Chirp subbottom profile from line 9 across SP-13, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
- Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.
- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP13-1: Location map for SP-13A shown with the Tui Malia Leg 03 site survey trackline.

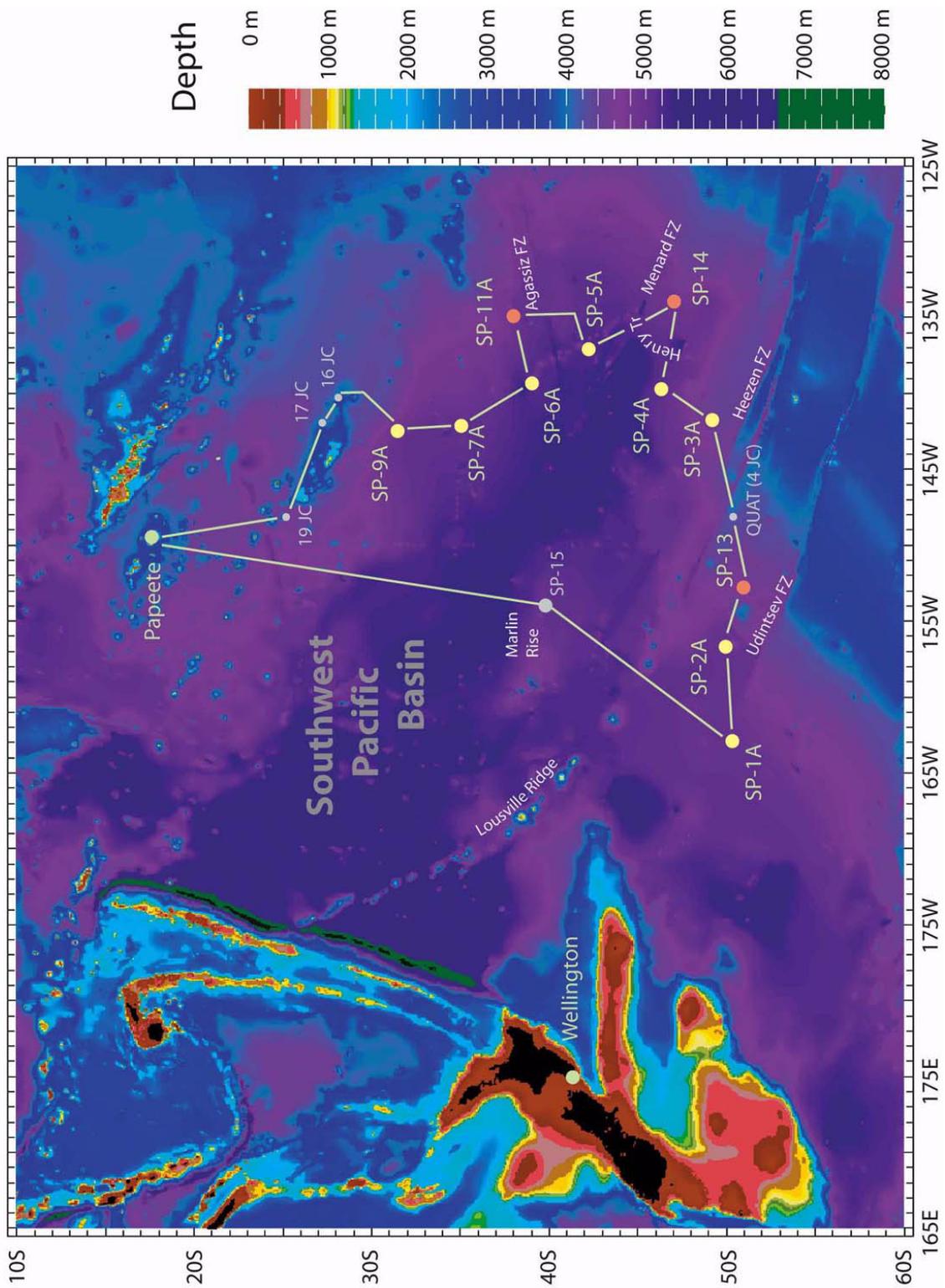




Fig SP13-3: Physical properties measured on piston core MV0502-04JC, taken at the shallow edge of Tharp Fracture Zone, between SP-13 and SP-3A

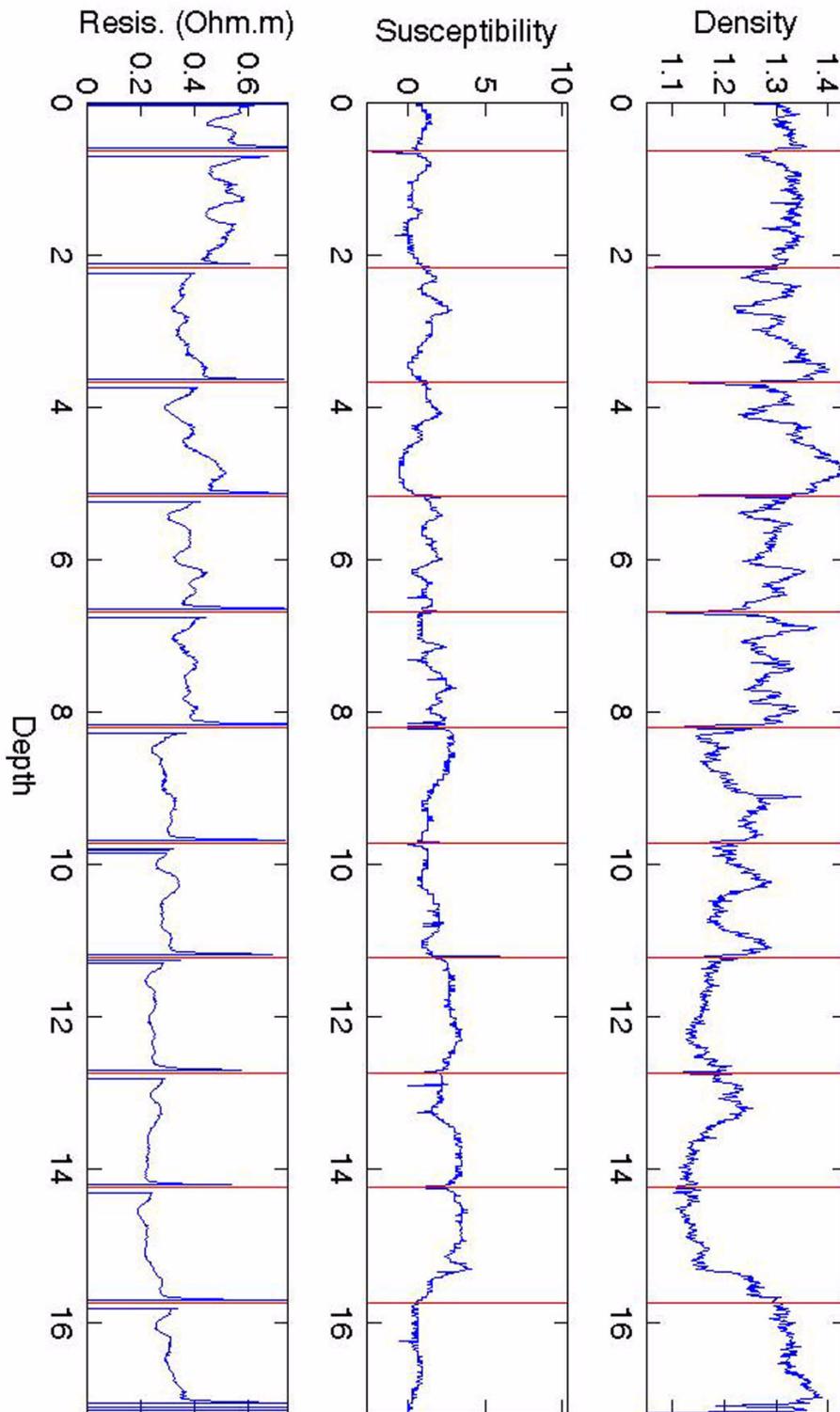


Figure SP13-4: The seismic profile SP-13 line 9

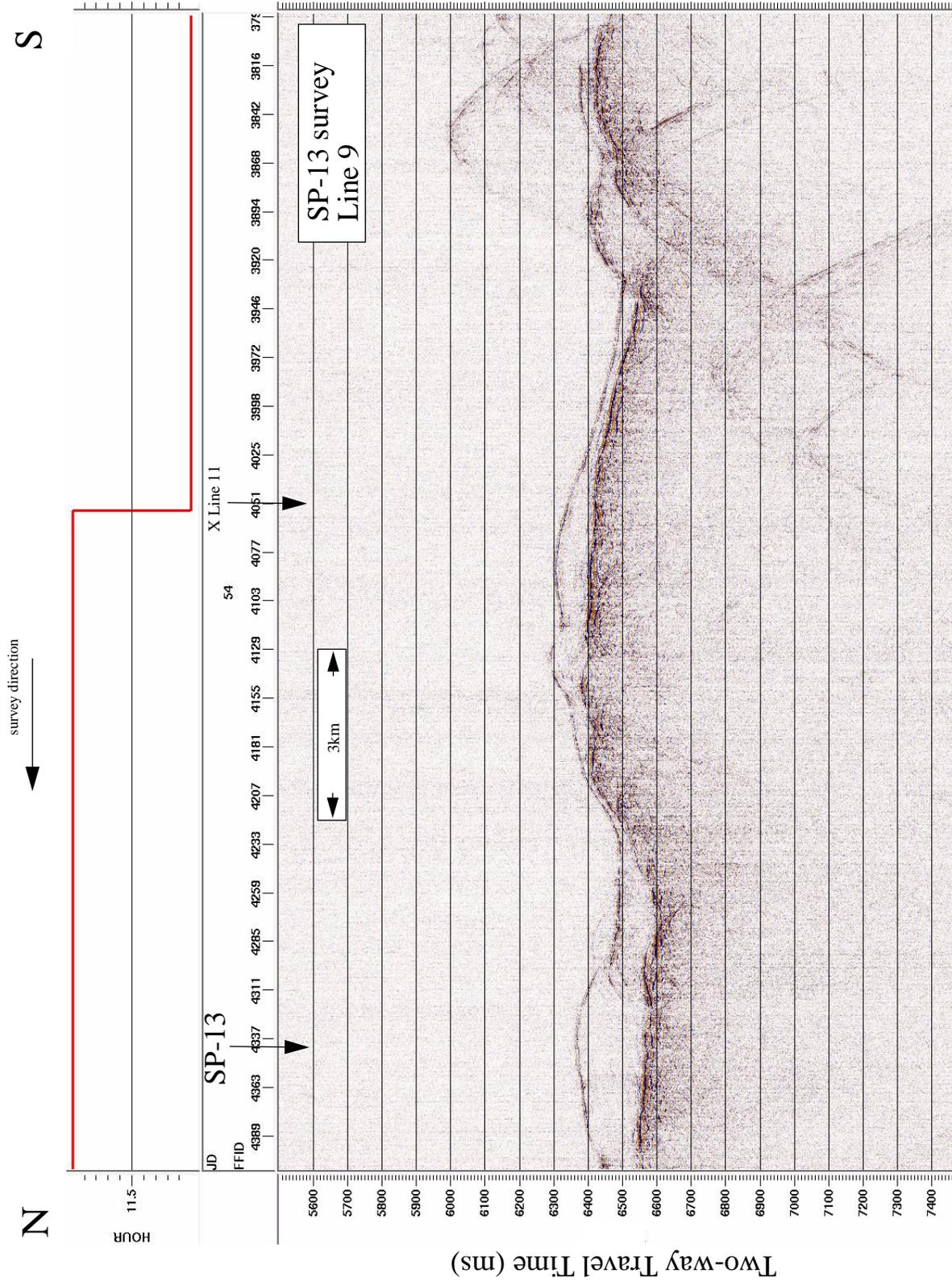


Figure SP13-5: The crossline, seismic profile SP-13 line 11, south of proposed SP-13

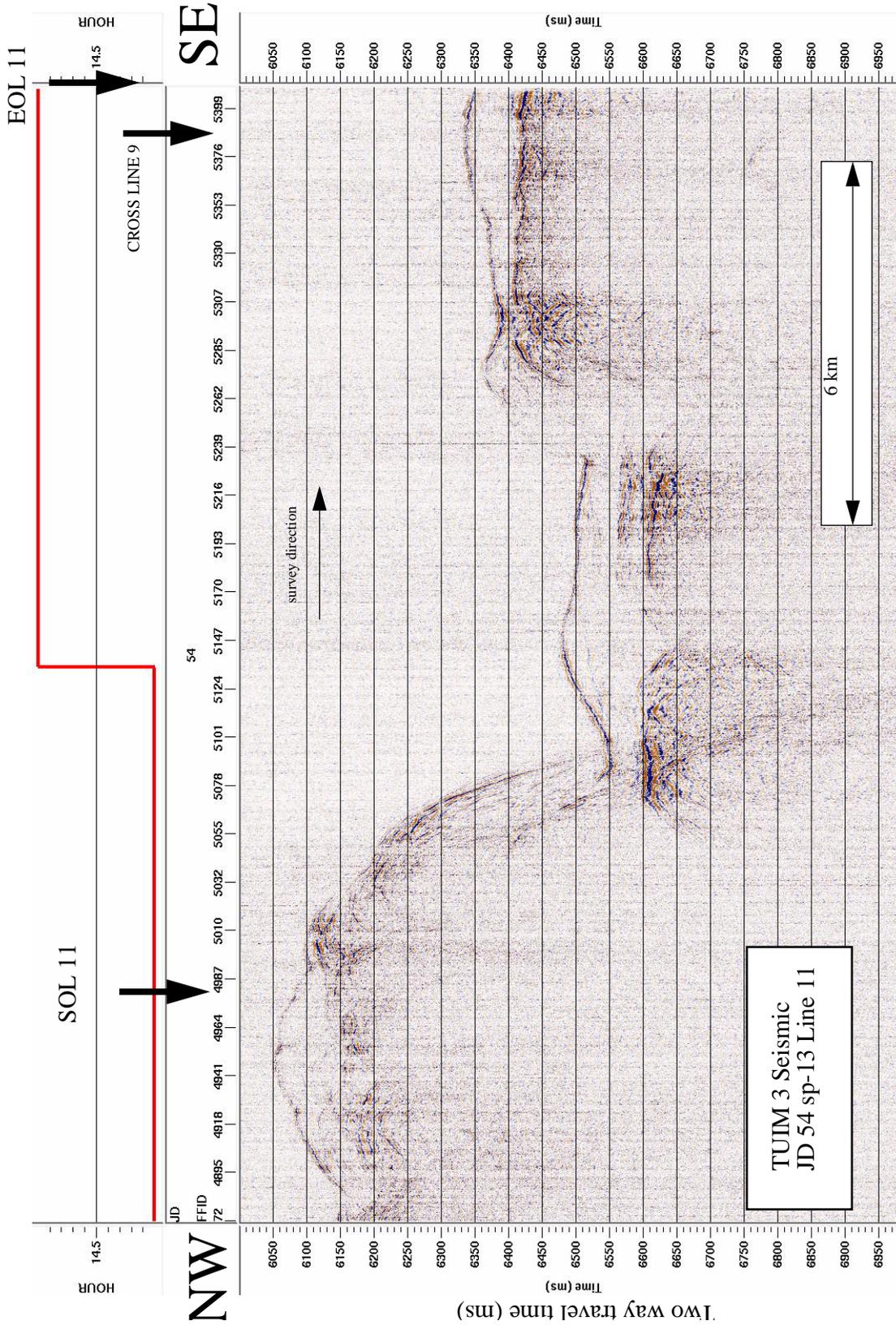
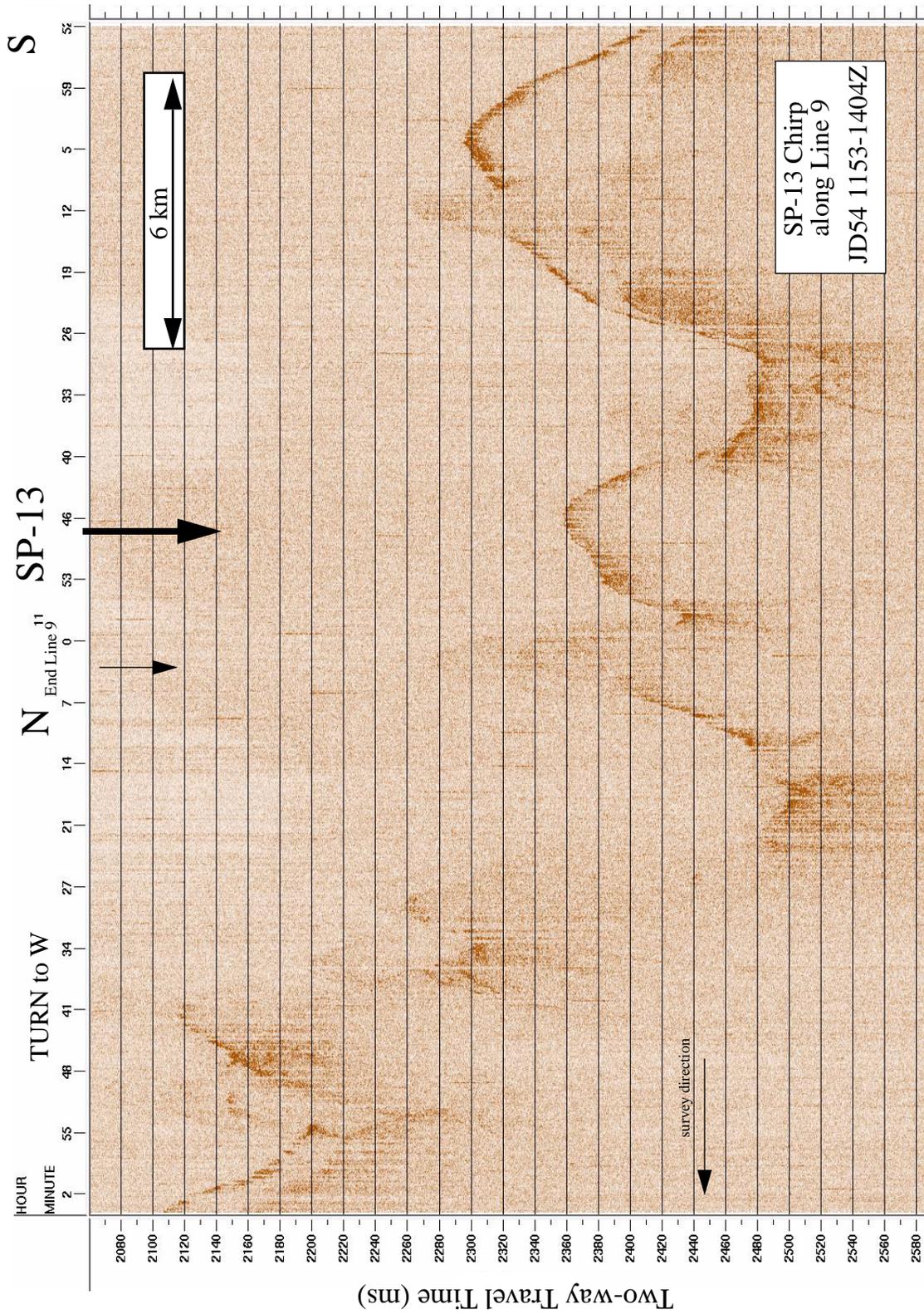


Figure SP13-6: The Knudsen chirp subbottom profiler record (most of line 9) across the proposed location of SP-13.



## **SITE SP-14 (SW Pacific, E of Henry Trough)**

**47° 06.035'S, 133° 59.935' W**

### **SITE OBJECTIVES**

SP-14 is sited on 40 Ma crust (An 18n) to study the polar-subtropical transition from the late Eocene across the Eocene-Oligocene boundary. It was located in the transition between polar and temperate water masses for the entire interval. Sediments recovered here should provide key paleoceanographic information about temperature, ocean circulation, and paleoproductivity during the Greenhouse-Icehouse climate transition. In addition, drilling SP-14 will provide important data about the initiation of the Antarctic Circumpolar Current in the Pacific. Because of its shallow depth and good preservation of carbonates, SP-14 should also have a critical role defining the Miocene development of cold polar conditions. SP-14 was located at about 58°S from 40 Ma through the Eocene-Oligocene transition based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame

### **GENERAL DESCRIPTION**

SP-14 is situated about 2 degrees east of the Henry Trough (Figure SP14-1), a tectonic scar from a rise jump at about 47 Ma (An 21; Cande et al., 1982). The site is located at the position of anomaly 18n, roughly 40 to 39 Ma. The abyssal hill topography in the region is somewhat exaggerated, with basin depths of about 5.2 km and ridgetops to about 4.6 km.

### **TUIM-03 Survey**

SP-14 was surveyed on March 1 to 3, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville (Figure SP4-2). The first line of the survey was recorded on the Scripps 4-channel streamer deployed on the transit from SP-4A. The LDEO 24-channel streamer, with no birds, was deployed for the remainder of the lines (3 through 8). One piston core was attempted after Line 1 was finished, but the core stuck in the bottom and the wire broke with only a 22,000 lb pull. The location of the lost core and 4700 m of lost wire is recorded in the hazards section. During the second seismic reflection survey the spare piston core was rigged, and used to take a 14.2 m core

The region surveyed for SP-14, although relatively rugged, consists of abyssal hills with the expected trend for normal seafloor. The basins are relatively narrow and the tops of the abyssal hills are broad. The hilltops have relatively thick sediment deposits on them, reaching almost 250 m at the proposed SP-14 drillsite.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-09JC from TUIM-03 46° 57.53'S S, 133°52.50'W, 4710 m (uncorr.) 14.2 m sediment.

MV0502-09JC was topped with two small nodules in both the trigger and piston core. The top of the sediment column is a foram-nannofossil ooze, grading to siliceous ooze, then clay. The sedi-

ments at the base of the core return to a nannofossil ooze with discoasters, indicating an age greater than 1.8 Ma.

### SEISMIC INTERPRETATION

Primary Site (SP-14): TUIM-03-SP14 line 3, 2005 JD061 17:26:47 gmt, FFID 1965; Crossline: SP14 line 8.

Crustal age: 40 Ma

Location: 47° 06.035'S 133° 59.935'W

Site water depth: 4658 m uncorr (6.211 sec TWTT)

Sediment thickness: 0.311 sec (249 m)

Proposed Drilling Depth: 253 m



SP-14 was chosen just beyond the cross of SP14 line 3 (Figure SP14-4) and SP14 line 8 (Fig SP14-6). The chosen position is slightly more centered in the basin, away from structure at either side, shown in the detail along line 3 (Figure SP14-5). The subbottom profiler penetrated about 50 m of layering in the vicinity of the proposed drillsite.

### GEOLOGIC HAZARDS

There are no known geologic hazards--pelagic sediments over oceanic basalts.

### OTHER HAZARDS

A piston core and 4700 m of trawl wire were lost during the TUIM-03 site survey at 47°04.21' S, 133° 51.46' W. The area should be avoided for drilling operations.

### AVAILABLE DATA from TUIM-03

seismic and chirp lines:

SP-14 Lines 1 through 8

### FIGURES

Fig SP14-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-1A is marked.

Fig SP14-2: Swathmap bathymetry for the SP-1A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP14-3: MST physical properties data for MV0502-9JC.

Fig SP14-4: Seismic profile SP14 line 3 across SP-14, from TUIM-03. Proposed drill site is marked.

Fig SP14-5: Migrated detail from Line 3 showing the proposed SP-14 drillsite

Fig SP14-6: Crossline seismic profile SP14 line 8 from TUIM-03. Proposed drillsite is marked

Fig SP4-7: Chirp subbottom profile from line 3 across SP-14, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.
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- Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP14-1: Location map for SP-1A shown with the Tui Malia Leg 03 site survey trackline.

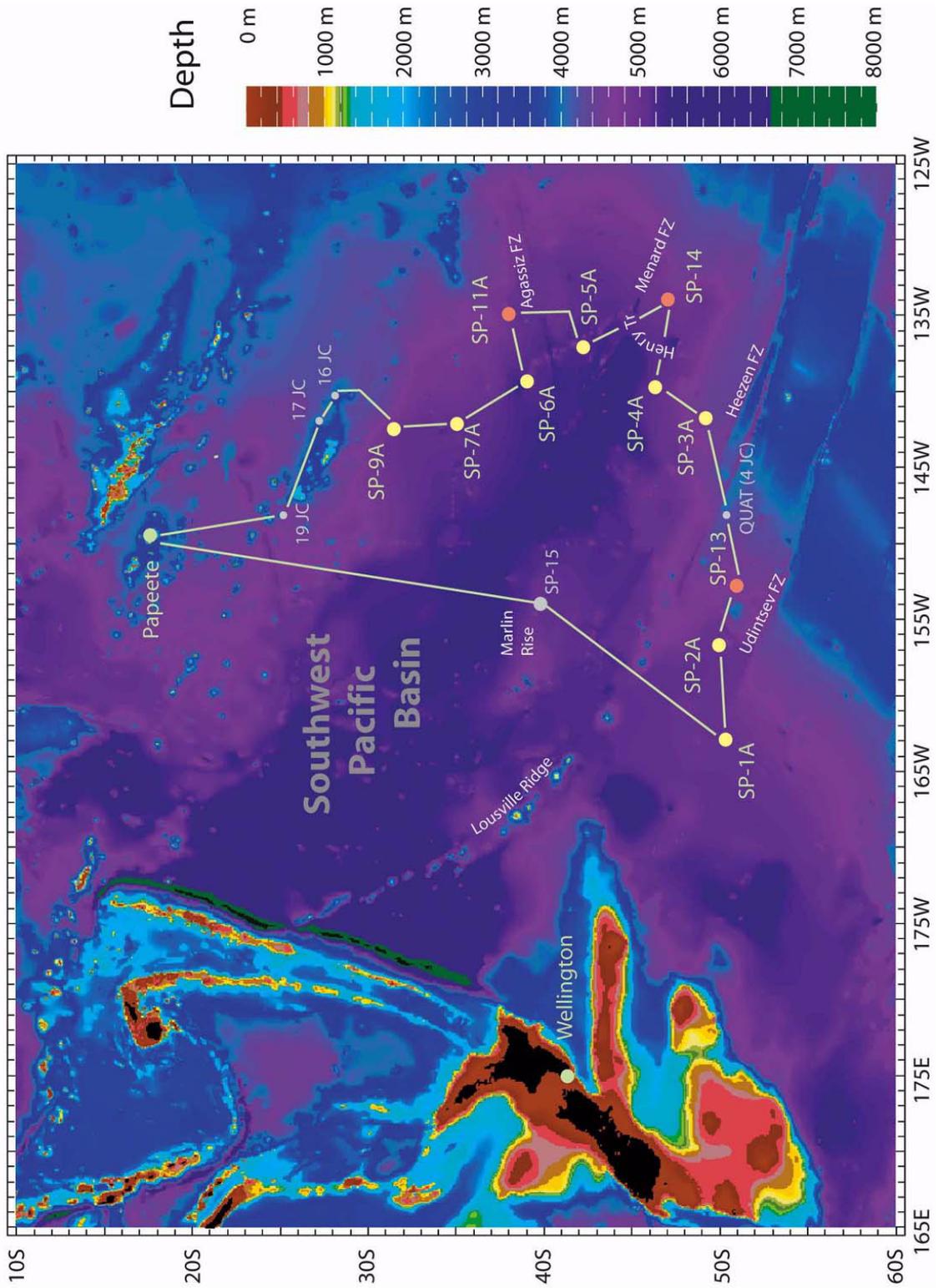


Figure SP14-2: Swathmap bathymetry of the region surrounding SP-14 from the TUIM-03 survey cruise. Proposed drillsite is marked

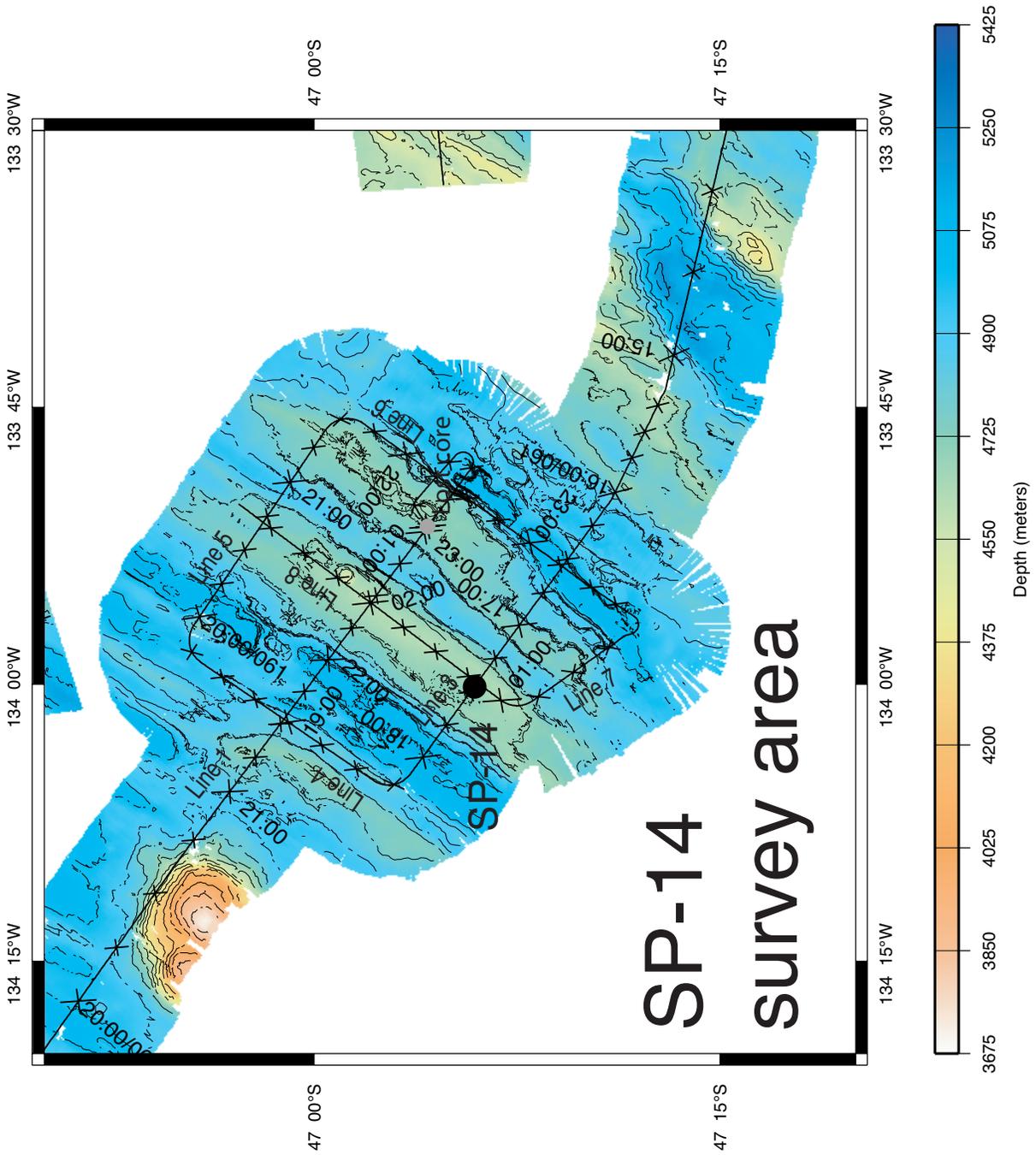


Fig SP14-3: Physical properties measured on piston core MV0502-09JC, taken at SP-14.

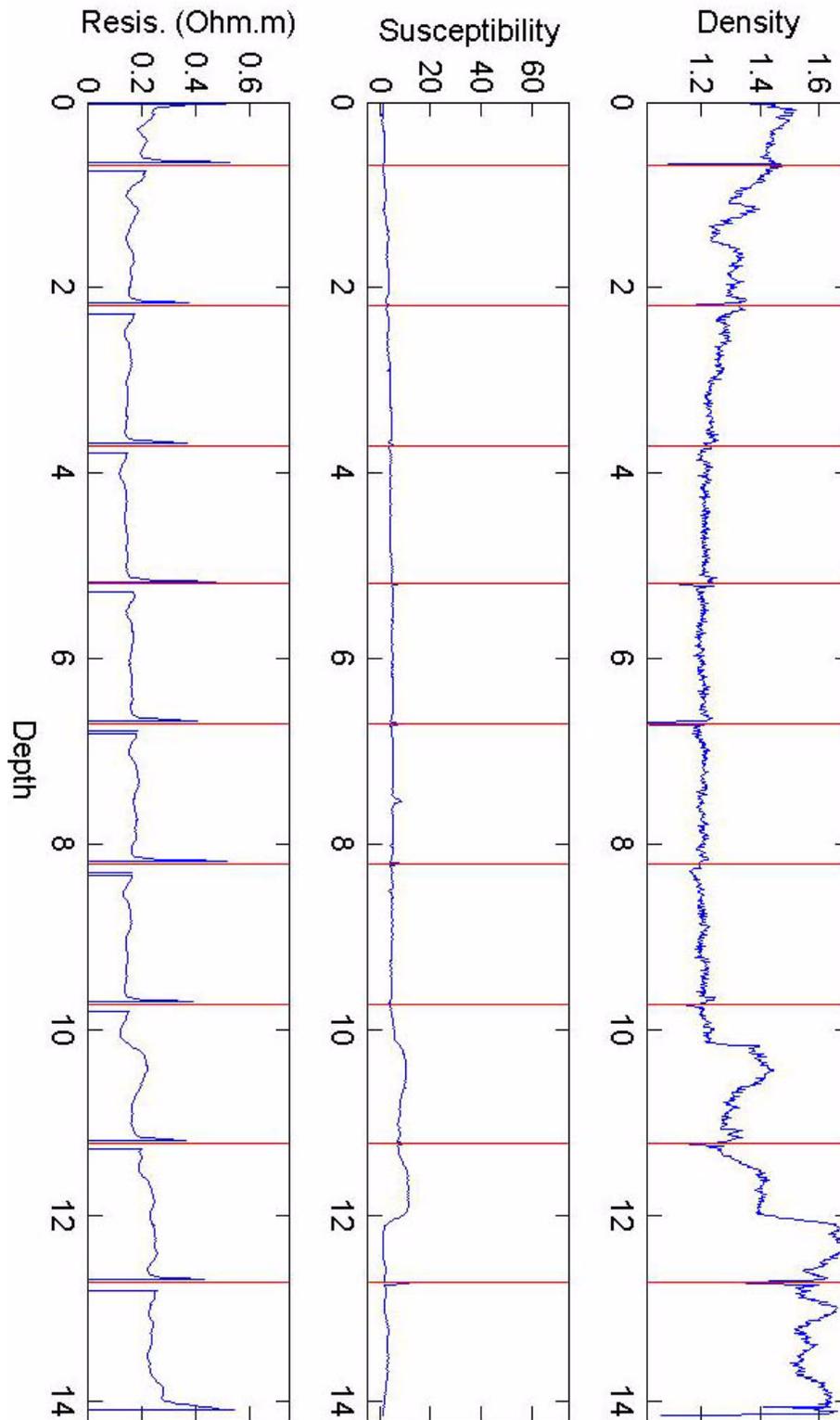


Fig SP14-4: Seismic profile SP14 line 3 across SP-14, from TUIM-03. Proposed drill site is marked.

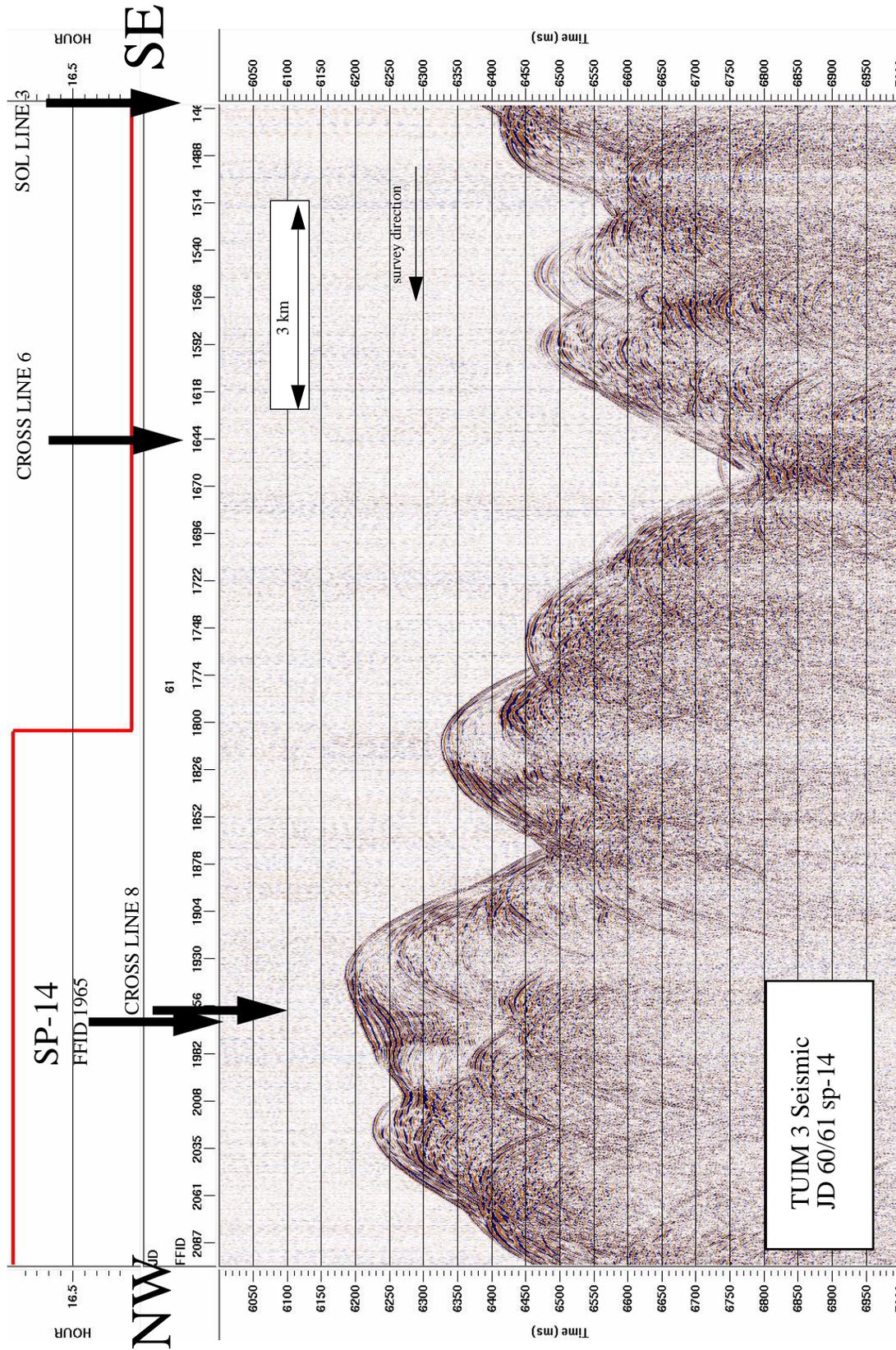
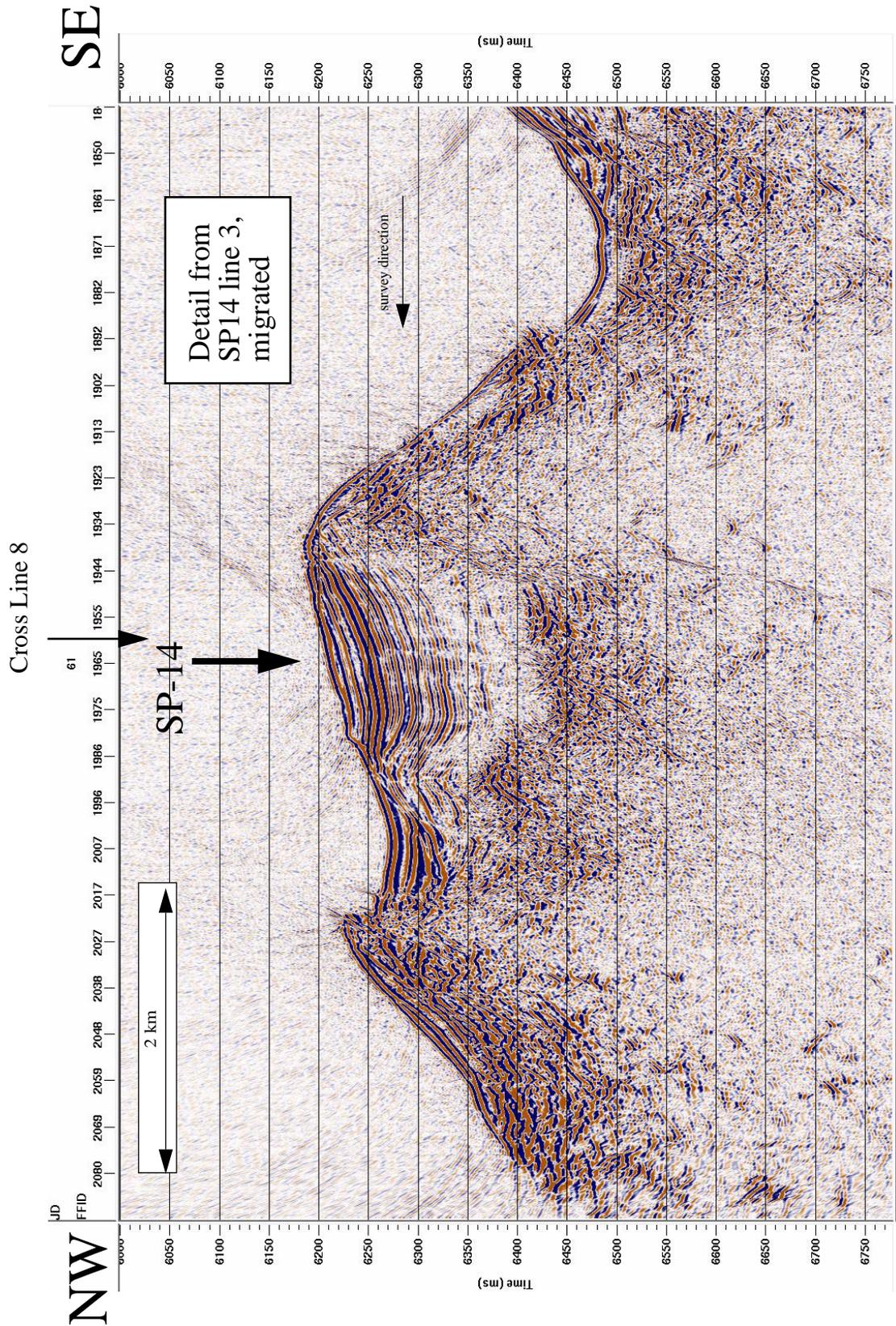


Fig SP14-5: Migrated detail from Line 3 showing the proposed SP-14 drillsite



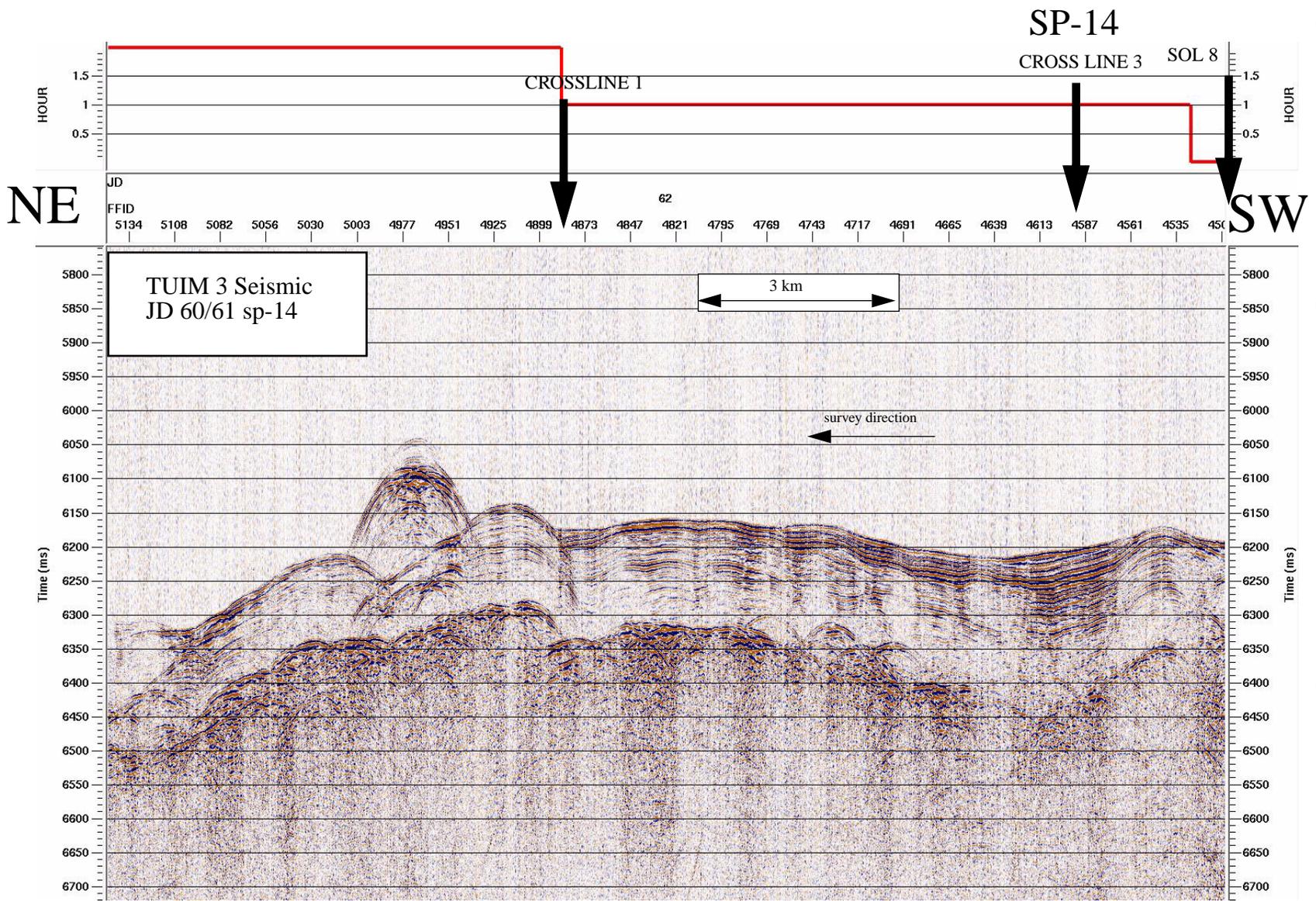


Fig SP14-6: Crossline seismic profile SP14 line 8 from TUIM-03. Proposed drillsite is marked..



## **SITE SP-15 (Marlin Rise, SW Pacific)**

**40° 00.614'S, 154° 2.501' W**

### **SITE OBJECTIVES**

SP-15 is intended to provide a record of winds in the South Pacific for the entire Cenozoic, collect a late Cretaceous record of the subantarctic-temperate transition, and provide sediment records of the Cretaceous-Tertiary and Paleocene-Eocene boundaries. The site was added after site surveys on 55 Ma crust could not locate any sediment north of about 55°S. At 55 Ma, the backtracked location of SP-1A was 59° S, 127° W based upon the magnetic reference frame used by the Ocean Drilling Stratigraphic Network (<http://www.odsn.de/odsn/services/paleomap/paleomap.html>). In this application, the North American paleomagnetic reference frame of Harrison and Lindh (1982) was used as the basis of the reference frame.

### **GENERAL DESCRIPTION**

SP-15 is situated on Marlin Rise, a relatively shallow structure on Cretaceous crust in the Southwest Pacific Basin (Figure SP15-1). The crust was generated on the Aluk Plate (Cande et al., 1982). Based on magnetic anomalies (Cande et al., 1989, and Cande, personal communication) SP-15 is sited on the beginning of magnetic anomaly 33r (ca. 79 Ma; Cande and Kent, 1995). Water depth in the general vicinity is about 4.8 km.

### **TUIM-03 SURVEY**

SP-15 was surveyed on February 15, 2005 with seabeam 2000 swathmap bathymetry, Knudsen digitally-recorded chirp subbottom profiling and 150 c.i. GI gun seismic reflection profiling (45 c.i. generator chamber, 105 c.i. injector) aboard the R/V Melville. The Scripps 4-channel streamer was used to record the seismic reflection survey. The site was also piston cored, and a 14.0 m core was recovered.

SP-15 is in a region of small abyssal hills, with highs to 4725 m and basins to 4800 m. The fabric of the hills matches the magnetic anomaly fabric, and trends SW-NE (Figure SP15-2). Sediment thickness at the site is roughly 100 ms TWTT (about 80 m). The sediments are sufficiently transparent to acoustic energy that the chirp was able to image basement. Surface sediments consist of brown zeolitic clay with red-brown semi-opaque oxides.

### **LITHOLOGIC DESCRIPTION**

Nearest sediment core: MV0502-01JC from TUIM-03. 40°00.531'S S, 154° 02.601'W, 4775 m (uncorr.) 14.0 m sediment.

The core consists of light brown to dark brown clays and zeolitic clays with Fe-Mn oxides.

## SEISMIC INTERPRETATION

Primary Site (SP-15): TUIM-03-SP15 line 4, 2005 JD046 15:17:19 gmt, FFID 27980 (cross with SP15 line 1)

Crustal age: 79 Ma

Location: 40° 00.614'S 154° 02.501'W

Site water depth: 4778 m uncorr (6.370 sec TWTT)

Sediment thickness: 0.111 sec (89 m)

Proposed Drilling Depth: 90 m

SP-15 was chosen at the intersection of Lines 1 and 4 from the TUIM-03 survey (Figure SP15-4). The sediment here is slightly thicker than the average for the site, but it is well-imaged in both crosses. Sediments at SP-15 exhibit classic pelagic drape over the gentle abyssal hill topography, and are acoustically transparent (Figure SP15-5).

## GEOLOGIC HAZARDS

There are no known geologic hazards--pelagic sediments over oceanic basalts.

## OTHER HAZARDS

There are no manmade hazards in the vicinity.

## AVAILABLE DATA from EW9709

seismic and chirp lines:

SP15 lines 1 through 4

## FIGURES

Fig SP15-1: Location map for South Pacific Latitudinal Transect. Proposed drill site of SP-1A is marked.

Fig SP15-2: Swathmap bathymetry for the SP-1A region, from the TUIM-03 site survey. Proposed drill site is marked.

Fig SP15-3: MST physical properties data for MV0502-2JC.

Fig SP15-4: Seismic profile SP1 line 6 across SP-1A, from TUIM-03. Proposed drill site is marked.

Fig SP1A-5: Crossline seismic profile SP1 line 2 from TUIM-03. Proposed drill site is marked.

Fig SP1A-6: Chirp subbottom profile from line 6 across SP-1A, from TUIM-03. Proposed drill site is marked.

## REFERENCES

- Cande, S.C., E.M. Herron, and B.R. Hall (1982) The early Cenozoic history of the southeast Pacific. *Earth Plan. Sci Lett.*, 57, 63-74.
- Cande, S.C., J.L. LaBrecque, R.L. Larson, W.C. Pitman III, X. Golovchenko, and W.F. Haxby (1989) Magnetic lineations of the world's ocean basins. *American Association of Petroleum Geologists Map Series*.

Cande, S.C., and D.V. Kent (1995) Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.*, 100, 6093-6095.

Harrison, C.G.A., and Lindh, T., 1982, A polar wandering curve for North America during the Mesozoic and Cenozoic: *Journal of Geophysical Research*, v. 87, no. B3, p. 1903-1920.

Figure SP15-1: Location map for SP-15 shown with the Tui Malia Leg 03 site survey trackline.

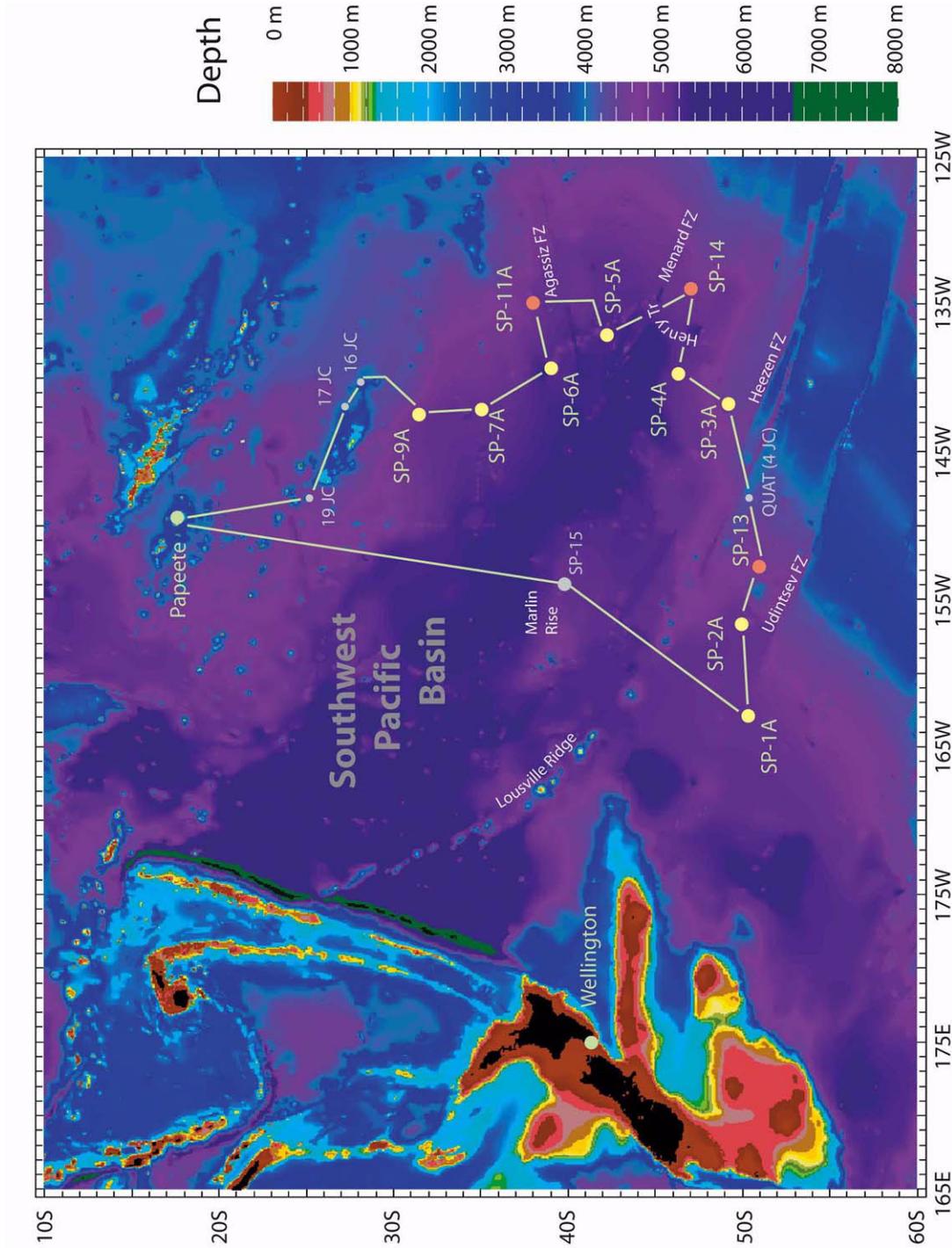


Figure SP15-2: Swathmap bathymetry in the region surrounding SP-15 from TUIM-03 survey cruise.

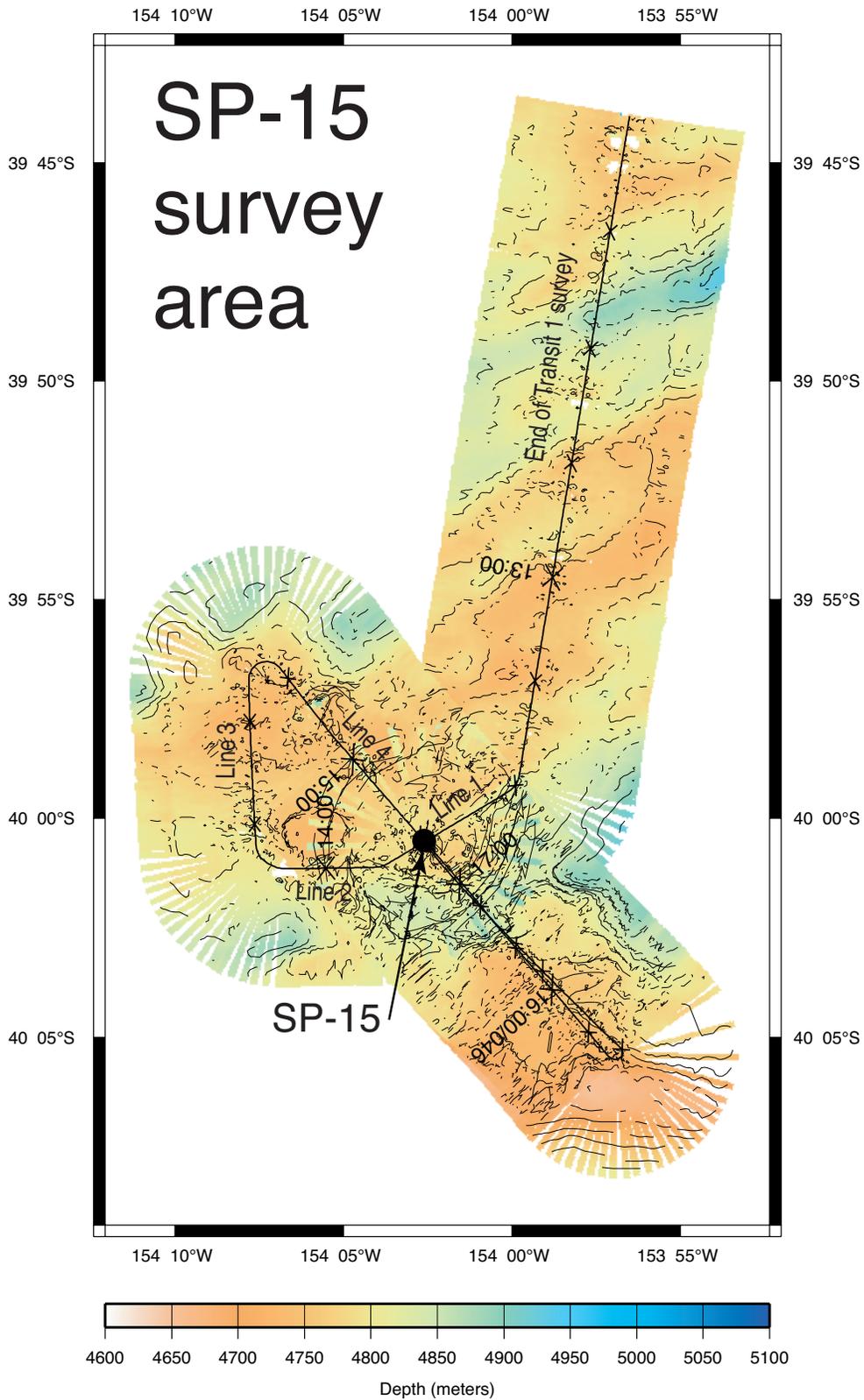


Fig SP15-3: Physical properties measured on piston core MV0502-01JC, taken at SP-15

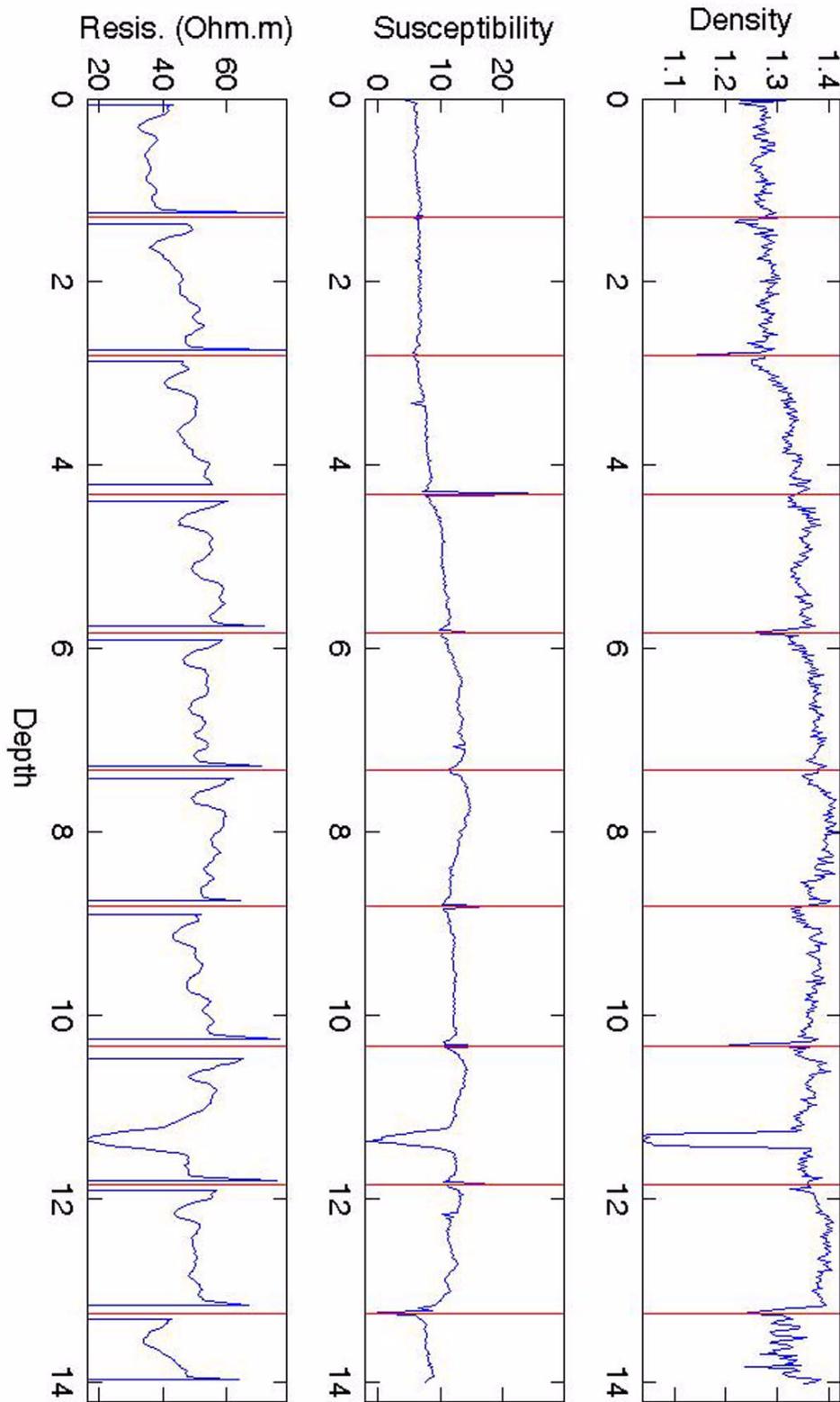


Figure SP15-4: The seismic profile SP-15 lines 1 through 4.

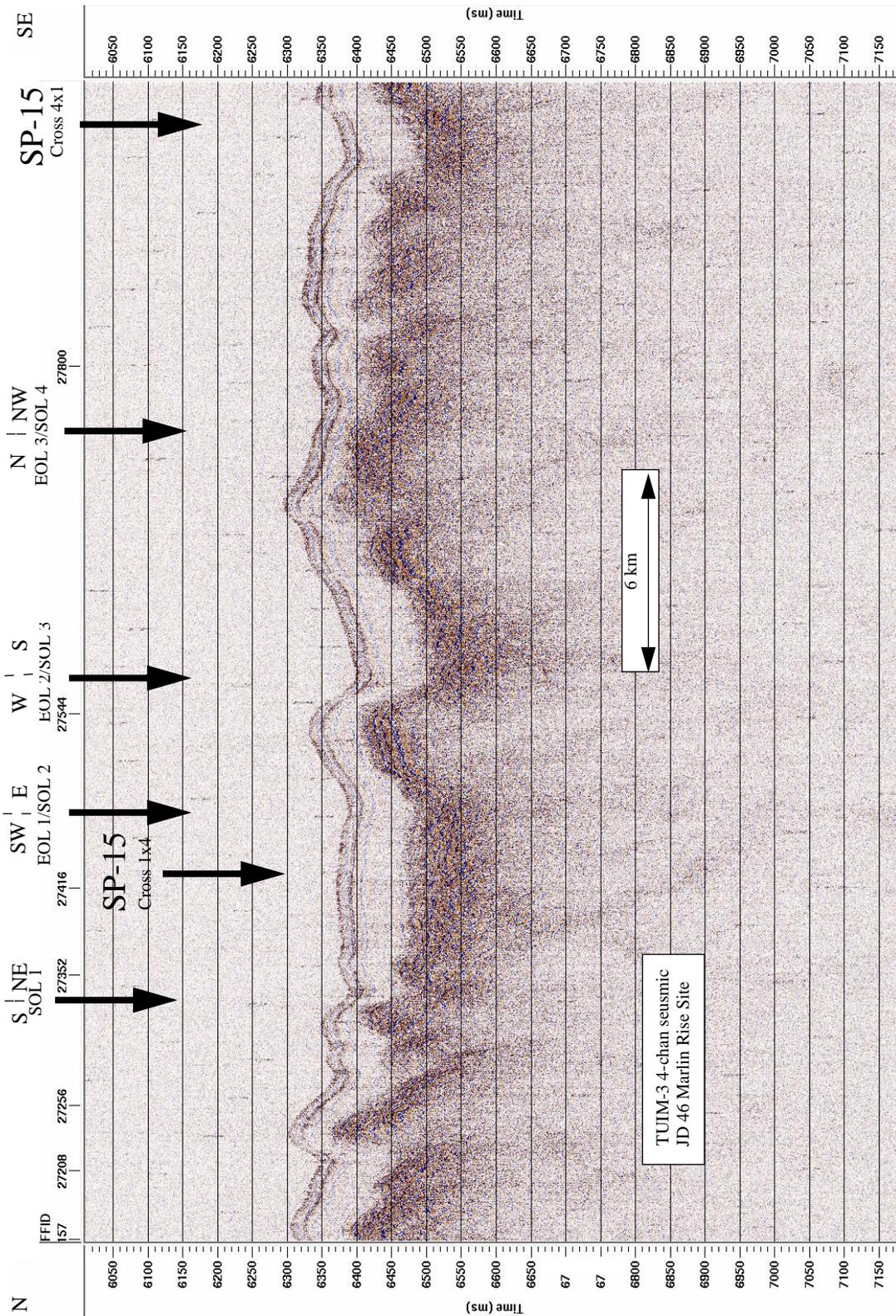


Figure SP15-5: The Knudsen chirp subbottom profiler record (line 4) across the proposed location of SP-1A.

