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Report and preliminary results of RV SONNE cruise SO-228, Kaohsiung-Townsville, 04.05.2013-23.06.2013, EISPAC-WESTWIND-SIODP

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Cruise Report

EISPAC-WESTWIND-SIODP

RV SONNE Cruise SO-228

Kaohsiung (04.05.2013) - Townsville (23.06.2013)

Mohtadi, M., Bergmann, F., Blanquera, R.V.C., Buleka, J., Carag, J.W.M., Carriére-Garwood, J., Dassié, E.P., Fernando, A.G.S., Gernhardt, F., Ghasemifard, H., Groeneveld, J., Hathorne, E.C., Huang, C-C., Huang, E., Janßen, C.G., Kerrigan, E., Kienast, M., Kremer, A., Kwiatkowski, C.R., Lehnen, C., Lückge, A., Mai, H.A., Martínez-Méndez, G., Meyer-Schack, B.I.G., Nishibayashi, M.H., Plaß, A., Quevedo, J.M.D., Rincon, M., Schwenk, T.A., Seeba, H., Setiawan, R.Y., Steinke, S., Tevlone, A., Wenau, S., Yu, P-S.

Content

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Thanks are also due to the German Research Ministry (BMBF) for the funding of this cruise within the project "EISPAC: **Ei**szeitliche **Sp**eicherung von **a**tmosphärischem **C**O_2 im Ozean", "WESTWIND: Hydrologie des **West**-Pazifischen **W**arm Pools und deren Einfluss auf den **In**donesischen **D**urchstrom", and "SIODP: **S**eismische Vermessung für den **IODP**-Vollantrag 799".

1 Participants

Scientific Party SO-228/1

May 04 – May 30, 2013

Kaohsiung - Jayapura

Name	Discipline	Institute
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May 30 – June 23, 2013

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May 04 – June 23, 2013

Kaohsiung – Townsville

Name	Rank
Meyer, Oliver	Master
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Büchele, Ulrich	Officer Navigational Watch
Hoffsommer, Lars	Officer Navigational Watch
Hainke, Geert	Officer Navigational Watch
Heuser, Sabine	Surgeon
Rex, Andreas	Chief Engineer
Genschow, Steffen	2nd. Eng.
Pieper, Carsten	2nd. Eng.
Beyer, Thomas	Electrician
Meinecke, Stefan	Electron. Eng.
Borchert, Wolfgang	System Manager
Rosemeyer, Rainer	Fitter
Bolik, Torsten	Motorman
Kuderski, Jens	Motorman
Kuhn, Benedict	Apprentice / MPR
Thimm, Sebastian	Apprentice / MPR
Tiemann, Frank	Chief Cook
Garnitz, André	2nd Cook
Pohl, Andreas	Chief Steward
Steep, Maik	2nd Steward
Mucke, Peter	Boatswain
Bierstedt, Torsten	Multi-purpose Rating / A.B.
Eidam, Oliver	Multi-purpose Rating / A.B.
Fischer, Sascha	Multi-purpose Rating / A.B.
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Fig. 1.1: Scientific party of expedition SO-228/1.

Fig. 1.2: Scientific party of expedition SO-228/2.

2 Research program

EISPAC (leg 1):

In this program we set forth a scientific plan to obtain marine sediment cores from the western tropical Pacific that can be used to test the hypothesis that atmospheric CO_2 was sequestered into an abyssal water mass located in the Pacific during glacials for thousands of years and then ventilated rapidly during deglacials through intermediate waters that circulate through the Southern Ocean. Our plan calls for the acquisition of a depth transect of cores from the high sediment accumulation rate continental margin of the western tropical Pacific. In the western Pacific it is possible to obtain high resolution geochemical reconstructions from sediment cores. We seek to obtain a suite of cores from between 400 and 3000 meters that will penetrate to the last glacial termination (at least 20 kyBP) in order to reconstruct water column $\Delta^{14}C$ and $\delta^{13}C$ profiles for the open Pacific. At the present time there is no comprehensive depth transect of this kind through the Pacific that provides a high resolution reconstruction of $\Delta^{14}C$ and $\delta^{13}C$. Whereas various attempts to reconstruct $\Delta^{14}C$ and $\delta^{13}C$ at discrete depths within the Pacific have been carried out, there are important shortcomings in the existing records. Most important is a lack of data from intermediate water depths (400-1000m) in the open Pacific. Our coring plan would fill these gaps and allow us to provide the necessary critical test of the so-called abyssal reservoir hypothesis for glacial-interglacial CO_2 cycles.

WESTWIND (leg 1 & 2):

The hydrologic cycle of the Western Pacific Warm Pool (WPWP) is presently influenced by variations in El Niño-Southern Oscillation (ENSO) as well as by high latitude climate. Despite the significance of this cycle for the regional climate and its active role in global circulation, its long-term variation and its influence on the Indonesian Throughflow (ITF) are largely unknown. Aiming at a better understanding of the processes in order to improve the simulation of the dynamics of the WPWP in the models, it is proposed to core rapidly accumulating sediments off Papua New Guinea, the Philippines, and NE Australia, a critical region for understanding the response of the tropical hydrologic cycle to different forcings, but where very few high-quality paleoclimate reconstructions are available. These new records will enable the reconstruction of zonal and meridional gradients in temperature, salinity, and precipitation, and isolate the relative influence of different potential forcings under different scenarios. Results of this research project will advance knowledge on the climate sensitivity of the WPWP, and enable more reliable projections of potential future changes, particularly in face of increasing human-caused climate change.

SIODP (leg 1):

The aim of this program is to conduct seismic survey (multi-channel seismic, MSC) in the vicinity of two sites that are proposed as drill sites in the IODP-full proposal 799 (Paleoceanographic records of the Western Pacific Warm Pool variability by Rosenthal, Mountain, Mohtadi et al.) in the Davao Bay and North off Papua New Guinea. In addition, it is planned to carry out a 2-day seismic survey in the study area of EISPAC in order to detect potential new sites for the IODP proposal as well as a better assessment of the sedimentation regime around the EISPAC core sites. The science plan of the IODP proposal received very strong, positive reviews, yet the lack of seismic data was criticized. It is suggested to re-submit the proposal and rank the proposed drill sites based on the obtained seismic survey data.

3 Narrative of the cruise

04.05.2013, Saturday

In the morning nearly the entire scientific crew of the cruise SO-221 boarded the RV SONNE at the port of Kaohsiung, Taiwan. The main task of this day was to unload the three containers and to set up the scientific equipment.

Fig. 3.1: RV SONNE at the pier in Kaohsiung, Republic of China.

05.-08.05.2013, Sunday-Wednesday

Early in the morning the RV SONNE left the harbor in Kaohsiung and headed towards the first study area east of Mindanao off the Bay of Bislig. The four transit days were spent for setting up the labs and the seismic equipment, and assembling the Multi-corer and the Gravity corer.

09.05.2013, Thursday

RV SONNE arrived at the NE corner of the study area for a 5000 m deep CTD-rosette water sampling station, which was also used to calibrate the bathymetric devices on board. Sampling of the water column was restricted to the upper 4000 m and used for various analyses including stable oxygen and carbon isotopes of seawater, rare earth and trace elements, alkalinity, nannoplankton assemblages (coccolithophorides), stable oxygen and nitrogen isotopes of nitrate, and nutrient concentrations. Later in the afternoon the seismic survey of the study area between 126°28' E– 126°55' E and 07°45' N – 08°20' N started and continued for the following two days.

10.-11.05.2013, Friday-Saturday

The seismic data collected during these 2 days revealed a very steep and complex bathymetry with various canyons characterized by drift bodies and mass wasting deposits in the entire study area. Nonetheless, a number of relatively shallow sites between 400 m and 2100 m water depth with up to 30 m of undisturbed sediments could be discovered on the upper continental margin in the southern part of the study area.

11.05.-14.05.2013, Saturday-Tuesday

During these days several sites were sampled by Gravity and Multi-corer and CTD-Rosette water sampler. Deployment of all casts was hindered by strong surface and subsurface currents (Mindanao Current and Mindanao Undercurrent) and required sophisticated

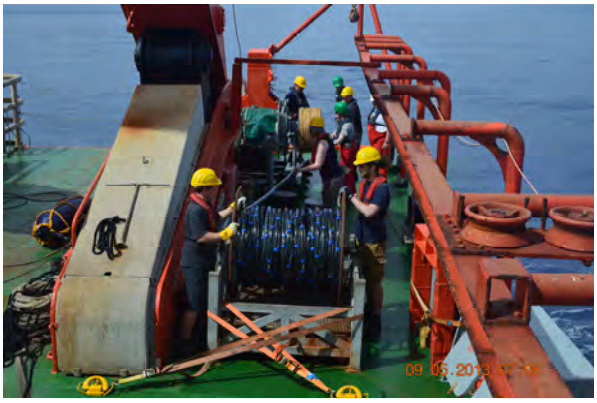



Fig. 3.2: Assembling the Gravity corer (left) and collecting the streamer (right).

maneuvers and positioning of the ship before, during, and after each gear. The bathymetric survey of this first study area was completed during the night shift and at the end of the day 11 sites (GeoB 17401 to 11) could be sampled before departing towards the second study area in the Gulf of Davao, southern Mindanao.

15.05.2013, Wednesday

Early in the morning RV SONNE reached the SE corner of the study area at about 3000 m water depth, where another CTD-rosette water sampler cast was carried out in order to re-calibrate the bathymetric facilities and also to depict the various water masses in this area. The seismic survey of the southern part of the Gulf of Davao started early in the afternoon and lasted until Saturday morning, aiming at providing cross-seismic profiles of the upper 300 m of sediments at Site MD98-2181 for the IODP full proposal 799 and also targeting new potential IODP sites in the Gulf of Davao.

16.05.-18.05.2013, Thursday-Saturday

These days were spent for an extensive seismic and bathymetric survey in the Gulf of Davao until 6°30’N. South of 6°10’N, most of the seafloor was either barren of sediments or characterized by mass wasting deposits or undisturbed sediments of only few ten meters. Cross profiles at only one relatively deep site (3000 m water depth) revealed about 300 m of undisturbed and well-layered sediments. In contrary, in the small basin between 6°10’N and 6°30’N several cross-seismic profiles indicated at least 5 potential sites for the IODP around 2000 m to 2200 m water depths with 300 m of undisturbed sediments. In the meantime all the cores collected off E Mindanao were cut, described, sampled and color-scanned in the lab, then wrapped and stored in the reefer. Comparison of the color-scan data showed common features in various cores allowing a tentative estimate of sedimentation rates and temporal resolution at different sites.

18.05.-19.05.2013, Saturday-Sunday

The entire Saturday and Sunday morning were spent for collecting samples from four of the five potential IODP sites identified by the seismic survey. The MD98-2181 site was omitted due to time constrains.

19.05.-24.05.2013, Sunday-Friday

All these days were spent for the long transit between Mindanao and N of Papua New Guinea, the third study area. Sediments from the second study area (Gulf of Davao) were processed on board and stored in the reefer.

25.05.-26.05., Saturday-Sunday

In the morning of May 25 RV SONNE arrived at the third study area in the Bismarck Sea southwest of the Manus Island. After deploying the CTD-Rosette water sampler through 1600 m of water column the seismic team started to collect data between 144°10’-144°50’E and 2°20'-3°S for the IODP full proposal 799. The greatest part of the area is characterized by a shallow slope and up to 200 m of undisturbed sediments. Several crossing profiles revealed the thickest pile of undisturbed sediments at two positions at 1350 m water depth in the north and at 1850 m water depth in the south of the study area.

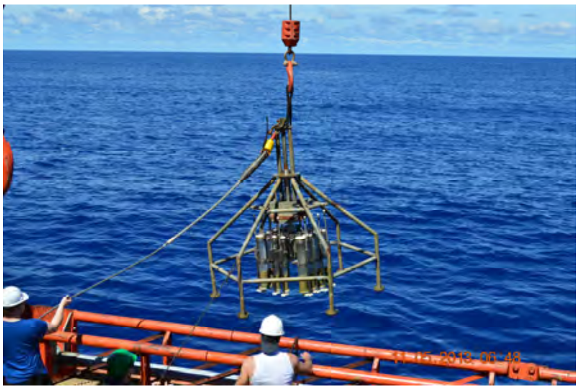


Fig. 3.3: Deploying (left) and sampling (right) of the Multi-corer.

<u>27.05.-28.05., Monday-Tuesday</u>

Until Monday morning both positions were sampled with Gravity corer and Multi-corer. In the morning the vessel left for the fourth working area off the Sepik mouth between Koil, Wei, Kadovar, and Blupblup Islands and water depths between 300 m and 1000 m. Until Tuesday morning the entire area was surveyed and two stations at 560 m (GeoB 17421) and 340 m (GeoB 17422) were selected for Gravity and Multi-coring. In order to account for the high sedimentation rates in this area, two Gravity cores were deployed at each station.

<u>29.05.-30.05., Wednesday-Thursday</u>

The vessel left the study area towards Jayapura, where the first leg of the cruise ended. Two out of the four cores retrieved during the previous day were opened, described, sampled and color-scanned on Wednesday, and 18 participants made their final preparations for disembarking at Jayapura. On Thursday 11 participants embarked the vessel and RV SONNE left Jayapura for the second leg of the cruise at 5 PM.

Fig. 3.4: Cutting (left) and color scanning (right) of the Gravity cores in the Geo-lab.

<u>31.05.-01.06., Friday-Saturday</u>

On Friday the last two cores of the previous leg were opened and processed. Meanwhile, we reached the NW part of the West Melanesian Trench and collected a 6 m Gravity core from 3100 m water depth (GeoB 17423). The core was cut and sampled on Saturday during the transit to the next study area north of the Manus Island.

02.06.-03.06., Sunday-Monday

After the sediment sound survey overnight the sampling started at two stations at ~2200 m (GeoB 17424) and 1600 m (GeoB 17425) water depth at 8 am. Around 8 pm the station work was finished and we steamed towards the next study area N of the Islands New Hanover and New Ireland at about 150°E. On Monday the retrieved cores were cut and sampled at the Geo-Lab.

04.06.-05.06., Tuesday-Wednesday

After the overnight sediment survey two stations at ~1350 m (GeoB 17426) and ~950 m (GeoB 17427) were sampled with the CTD-Rosette (at the deeper station), Gravity corer and Multi-corer. Samples were processed at the same day and on Wednesday on the way back to the next study area N off the Sepik River mouth.

06.06.-07.06., Thursday-Friday

In the morning of Thursday the station work at about 1050 m water depth (GeoB 17428) started with two CTD casts down to 500 m for chlorophyll and turbidity measurements and to 1000 m for temperature, salinity, oxygen content and water sampling, respectively. Two Gravity corers and a Multi-corer were deployed at the same position before this area was left towards the next study area around the Manam Island. On Thursday morning, two positions at 1600 m (GeoB 17429) and 1050 m (GeoB 17430) were cored with Gravity corer and Multi-corer.

08.06.-09.06., Saturday-Sunday

The sediment survey in the area south of the Karkar Island and east of Madang continued for the entire night and Saturday morning. At each of the two stations in the southern part of the survey area at 1100 m (GeoB 17431) and 1400 m (GeoB 17432) water depth a Gravity corer and a Multi-corer were deployed. At the second station the water column was measured and sampled. The sediment survey continued in the area N of New Guinea and S of Long Island. Most of the rugged seafloor was barren of sediment in this area and at the only station in the basin at 1400 m water depth (GeoB 17433) the surface and subsurface currents were nearly too strong for deploying the casts. While water samples and surface sediments could be collected successfully, the Gravity corer was empty.

10.06.-11.06., Monday-Tuesday

The extensive site survey on the northern and eastern slopes of the Huon Peninsula did not reveal any site between 500 m and 1500 m water depth with sediment coverage indicating that the entire sediment discharge of the small rivers draining to the northern and eastern coasts is transported either through canyons into deeper depths or through strong surface currents to remote areas. On Tuesday, site GeoB 17434 was selected at 4200 m water depth at the northernmost part of the Solomon Sea in order to detect different water mass properties prior to their entry to the Bismarck Sea.

12.06.-13-06., Wednesday-Thursday

Two sites with up to 70 m of undisturbed sediments were found in the westernmost part of the Huon Gulf (GeoB 17435) at 1000 m water depth and NE of Hercules Bay (GeoB 17436) at 850 m water depth. At each site two Gravity corer and one Multi-corer casts were deployed, with additional two CTD-Rosette casts at the Hercules Bay: the first cast for chlorophyll measurement only (to 500 m) and the second cast for sampling.

14.06.-16.06., Friday-Sunday

These 3 days were spent for the transit from the Solomon Sea to the Coral Sea NE off Australia.

17.06.-19.06., Monday-Wednesday

On Monday morning and at the final station within PNG waters two Gravity corer and one Multi-corer casts were deployed at ~1800 m water depth between “Boot Reef” and “Eastern Fields” south of the Gulf of Papua. During the next two days the vessel steamed southwards to the next study area off Cairns.

19.06., Wednesday

On Wednesday afternoon we reached the last study area in the Noggin Canyon off Cairns. Two stations were originally selected at around 1300 m water depth, only one was sampled (GeoB 17438) with Gravity corer. However, the tube did not penetrate into the sediments and was bent due to the coarse-grained, gravel-sized angular and sub-angular debris covering the seafloor in this area (Fig. 3.5.).

Fig. 3.5: sample material collected from the core-catcher at GeoB 17438 (left), where the tube was bent (right).

20.06.-23.06., Thursday-Sunday

The last days of the cruise were spent for preparing the disembarkation, loading the containers and cleaning the labs. RV SONNE reached the roads of Townsville on June 22 and the scientific party disembarked the vessel at the same day via boat.

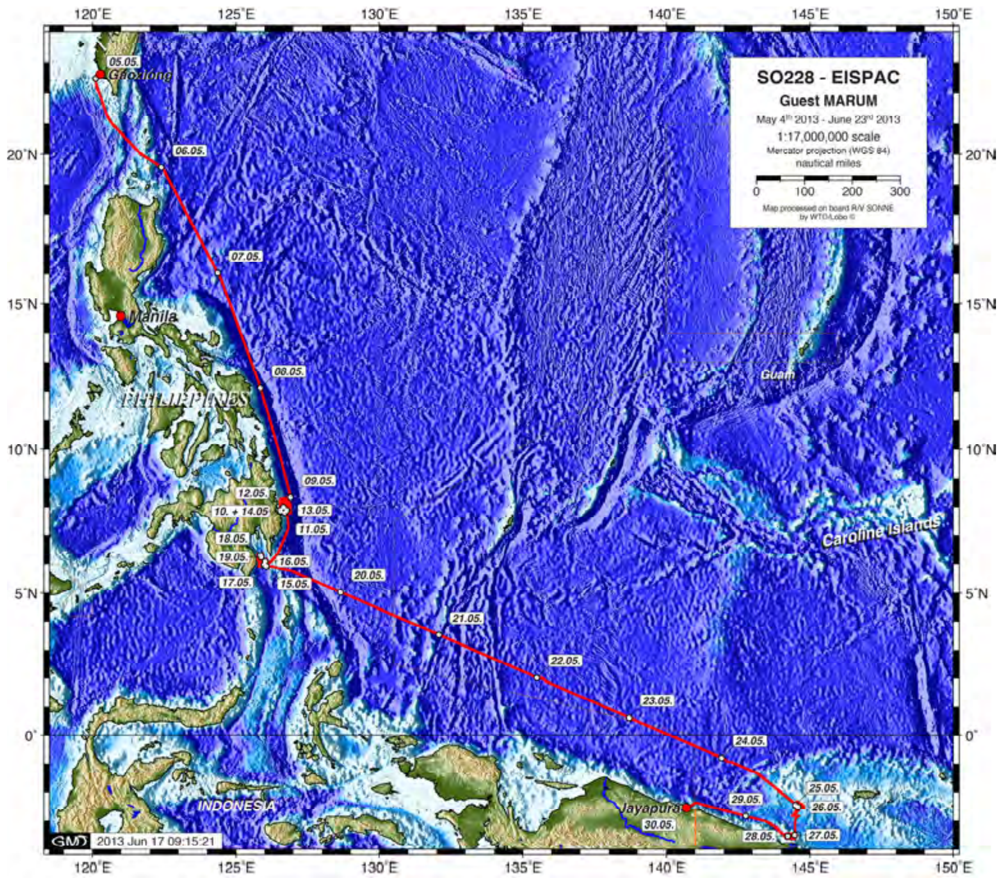


Fig. 3.6: Cruise plot of SO-228/1.

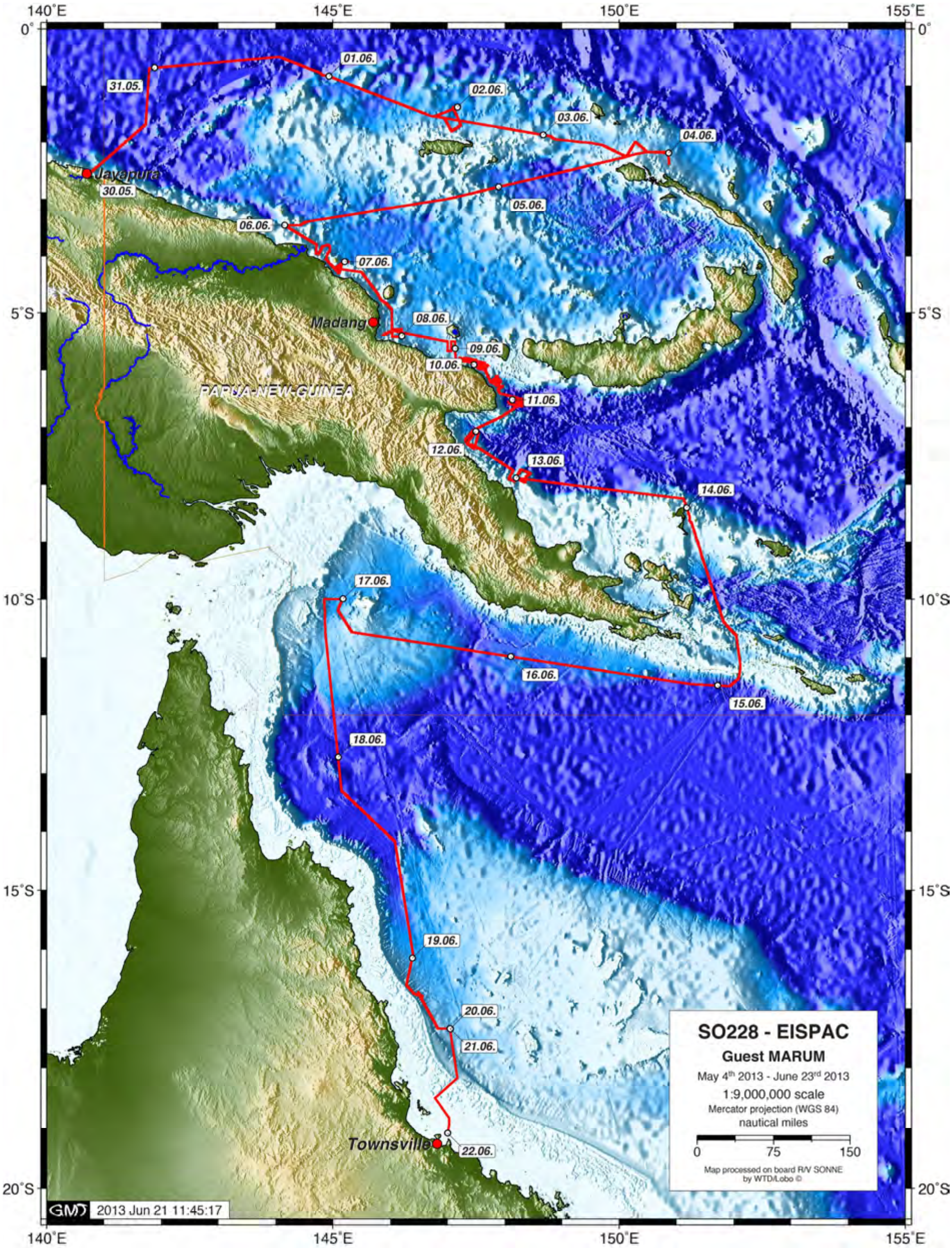


Fig. 3.7: Cruise plot of SO-228/2.

4 CTD profiling and water sampling

(Carriére-Garwood, Dassié, Groeneveld, Hathorne, Kerrigan, Kienast, Kwiatkowski, Martínez-Méndez, Plaß)

4.1 Introduction

A CTD was used to measure the physicochemical properties of the water column. Besides, at 3 stations (see table below) the CTD was complemented with a Fluorescence sensor to obtain profiles of turbidity and fluorescence which allowed the identification of the chlorophyll maxima and minima. Based on these properties, the various existing water masses in the sampled areas and the structure of the water column could be identified allowing the subsequent definition of depths for rosette water sampling. The water samples will be devoted to analyses of stable isotopes ($\delta^{18}O$ and $\delta^{13}C$, 10 ml per sample, MARUM), Nd isotopes (20 l per sample, GEOMAR), Rare Earth Elements (REE) concentrations (250 ml per sample, GEOMAR), alkalinity, pH and metal/calcium (M/Ca) ratios (100 ml, MARUM) and nutrients (60 ml per sample, DAL).

Fig. 4.1: CTD-Rosette water sampler.

Fig. 4.2: Removing the turbidity sensor.

4.2 Instrumentation

A Seabird SBE911 CTD was used to obtain data on the physicochemical properties of the water column. In addition to the standard conductivity, temperature and pressure, SBE911 also measured dissolved oxygen (self-regenerative Clark-sensor with Teflon membrane). Water sampling was performed with a rosette water sample equipped with 24 Niskin bottles (10 l volume each) at 15 stations. A total of 18 CTD deployments were carried out during the expedition SO-228. No samples were taken during the CTD run using the fluorescence sensor (Table 4.1).

4.3. CTD profiles and main water masses

The western equatorial Pacific is an important player in the global ocean circulation. As part of the return upper branch of the global ocean circulation, warm waters are transported into the Indian Ocean through the Indonesian Throughflow (e.g. Gordon, 1986). Besides, it is also the region of the Pacific Warm Pool, which is key in the development of the El Niño Southern Oscillation (ENSO) phenomenon (e.g. Webster and Lukas, 1992). Yet another role of this region in global oceanography and climate is related to the advection of intermediate waters from the Southern Ocean into the northern Pacific which may have carried outgassed CO_2 during glacial terminations. Various water masses embedded in surface and deep currents interact in this region. Those water masses are for the most part identifiable on CTD profiles collected during the SO-228 expedition.

Table 4.1: CTD-Water sampler stations during expedition SO-228.

GeoB No.	Latitude (+N, -S)	Longitude (°E)	Water Depth (m)	Instrument Depth (m)	Depth sampled (m)	Samples
17401-1	8°19.579’	126°54.579’	5160	4000	50, 150, 260, 310, 350, 420, 500, 620, 750, 1000, 1125, 1250, 1500, 1750, 2500, 3800	MARUM, DAL, UP, GEOMAR
17403-1	7°49.472’	126°40.713’	1318	1250	50, 140, 150, 190, 260, 340, 360, 520, 750, 1000, 1250	MARUM, DAL, UP, GEOMAR
17404-1	7°53.889’	126°32.554’	404	380	15, 40, 80, 105, 140, 150, 250, 370	MARUM, DAL, UP, GEOMAR
17407-1	7°54.697’	126°46.153’	2178	2000	50, 100, 150, 227, 250, 500, 650, 750, 1000, 1100, 1250, 1300, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1800, 1900, 2000	MARUM, DAL, UP, GEOMAR
17412-1	5°55.840’	126°04.016’	2996	2900	50, 100, 150, 200, 220, 260, 286, 450, 540, 640, 1000, 1800, 2100, 2400, 2900	MARUM, DAL, UP, GEOMAR
17413-1	6°20.835’	125°50.918’	2076	500	Fluorescence, no sampling	
17413-2	6°20.820’	125°50.893’	2082	2000	20, 50, 65, 100, 150, 350, 550, 800, 1000, 1500, 1900, 2000	MARUM, DAL, UP, GEOMAR
17417-1	-2°24.989’	144°29.957’	1637	1580	25, 50, 80, 100, 110, 150, 170, 200, 300, 400, 600, 720, 900, 1400, 1580	MARUM, DAL, UP, GEOMAR
17420-1	-3°38.47’	144°29.02	722	600	20, 60, 130, 155, 320, 420, 580	MARUM, GEOMAR
17424-1	-1°22.828’	147°10.455’	2100	2000	5, 20, 50, 78, 170, 300, 470, 540, 680, 770, 1260, 1470, 2000	MARUM, GEOMAR
17426-1	-2°11.214’	150°51.667’	1365	1250	5, 45, 70, 120, 170, 200, 225, 260, 275, 300, 415, 450, 485, 505, 600, 670, 800, 870, 1000, 1100, 1250	MARUM, DAL
17428-1	-3°27.542’	144°4.153’	1058	500	Fluorescence, no sampling	
17428-2	-3°27.542’	144°4.153’	1058	1000	5, 10, 15, 40, 75, 150, 175, 240, 325, 500, 600, 700, 850, 1000	MARUM, GEOMAR
17432-1	-5°20.675’	146°11.983’	1388	1300	5, 25, 50, 80, 125, 140, 180, 280, 350, 480, 525, 560, 650, 760, 910, 1050, 1110, 1170, 1220, 1300	MARUM, DAL, GEOMAR
17433-1	-5°37.232’	147°8.024’	1384	1300	5, 30, 60, 90, 160, 200, 330, 450, 539, 622, 708, 900, 1000, 1100, 1221	MARUM, DAL, GEOMAR
17434-1	-6°35.656’	148°16.157’	4208	4100	20, 120, 200, 600, 820, 1100, 1300, 1450, 1600, 2600, 4100	MARUM, DAL, GEOMAR
17436-1	-7°53.388’	148°12.122’	845	500	Fluorescence, no sampling	
17436-2	-7°53.388’	148°12.122’	845	800	10, 35, 57, 65, 140, 200, 320, 375, 560, 700, 800	MARUM, GEOMAR

All stations off Mindanao and within Davao Bay clearly depict the upper salinity maximum associated with the North Pacific Subtropical Water (NPSTW; 20-25°C; >35; Fine et al. 1994), as well as the salinity minimum (34.4-34.5) generally associated with North Pacific Intermediate (NPIW) and Antarctic Intermediate Waters (AAIW) (Fig. 4.3). Distinguishing these two intermediate waters proved challenging at these latitudes. As stated by Qu and Lindstrom (2004), “the low-salinity signal of AAIW is lost […] to the north of about 8°N”, in agreement with the lack of a clear salinity signal associated with either intermediate water in our water column profiles. The waters in the thermocline are generally referred as Thermocline Water (TW, Wyrkti, 1962).

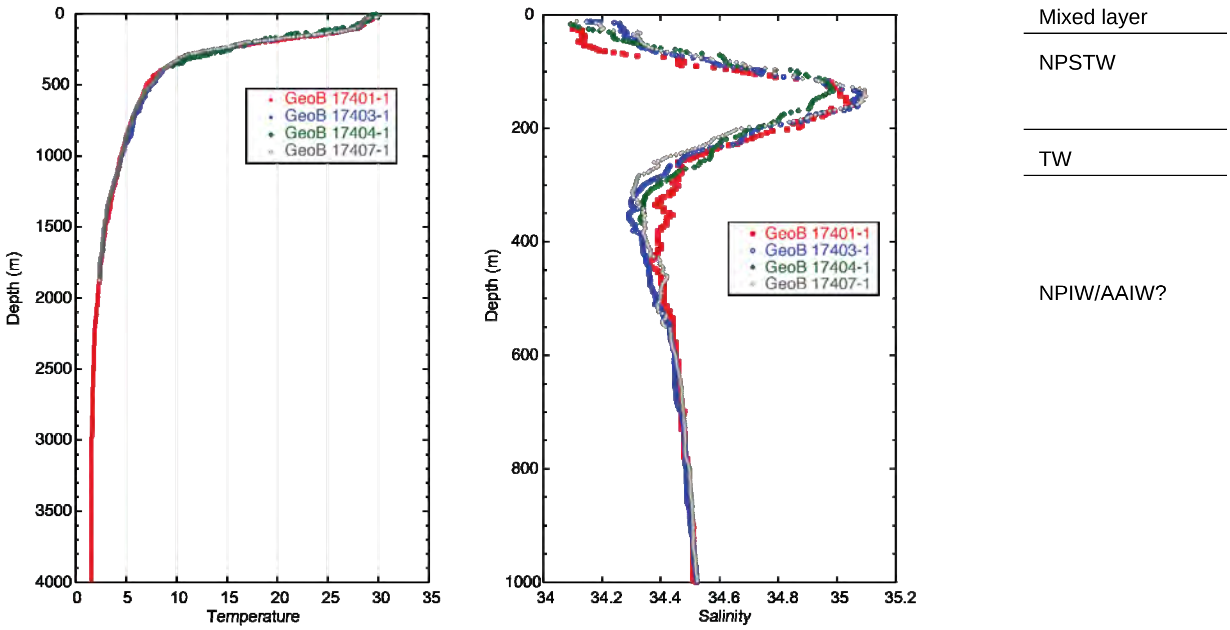


Fig. 4.3: Temperature (left) and Salinity (right) profiles off Mindanao. The salinity maximum denotes the presence of the North Pacific Subtropical Water (NPSTW) while the salinity minimum should correspond to either North Pacific Intermediate Water (NPIW) or Antarctic Intermediate Water (AAIW) or a mixture of the two.

The AAIW is further characterized by high oxygen concentrations and low phosphate content (Qu and Lindstrom, 2004). Unfortunately, the oxygen sensor on the CTD was unreliable in the strong currents off Mindanao. The substantial structure in down-cast O_2 profiles was not reproducible in up-cast profiles (Fig. 4.4). Ultimately, the phosphate content and the $\delta^{13}C$ signature of the water samples, to be measured at Dalhousie and at MARUM respectively, will help determining the origin of intermediate water masses off Mindanao.

A comparison between casts conducted off the east coast off Mindanao and those conducted within Davao Bay (Fig. 4.5) suggests that the same water masses are present at both locations. Surface waters from the northerly station, within Davao Bay, (e.g. GeoB 17413-2) are fresher than surface waters at the other locations. This freshness that extends until the salinity maximum (~200 m depth) most likely reflects river runoff into Davao Bay. The effect of this river input is also represented by the strong Fluorescence maximum observed at the northern location (Fig. 4.5).

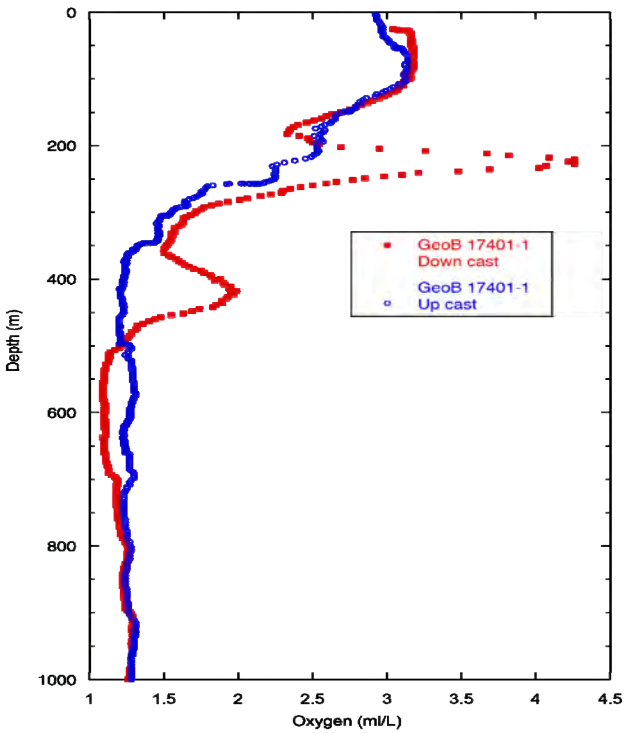


Fig. 4.4: Up and down oxygen profiles measured in the CTD casts off Mindanao. The lack of coherency shows the effect of the strong Mindanao Current in the oxygen sensor.

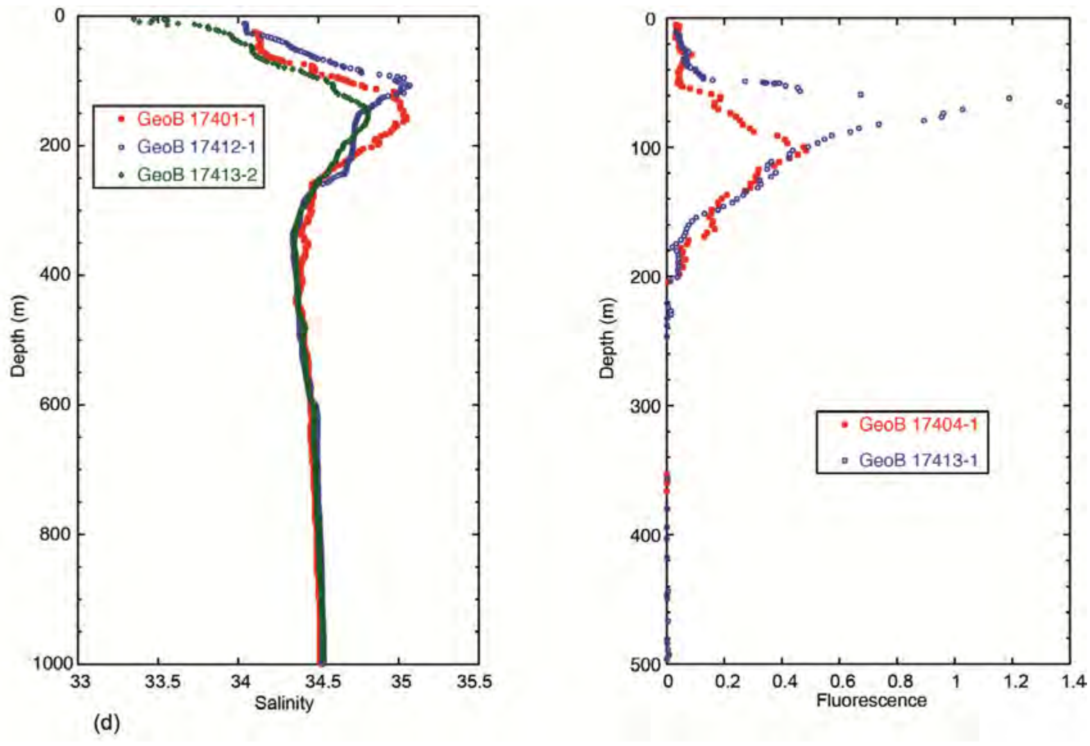


Fig. 4.5: Salinity (left) and Fluorescence (right) profiles off Mindanao and Davao Bay.

The profiles measured in the Southern sampling region, off Papua New Guinea (PNG), show a similar structure, yet, different water masses come into play here.

The salinity maximum located at around 120 m water depth corresponds, here, to Subtropical Mode Water (STMW, Roemmich and Cornuelle, 1992) (Fig. 4.6). The salinity minimum at these stations does correspond to AAIW, which is advected northwards by the

New Guinea Undercurrent (NGUC). Aside for the minimum in salinity AAIW is characterized by elevated oxygen content. We observed that at intermediate levels there are small changes in salinity whereas the oxygen content changes largely with depth at stations along the PNG coast. Recently, various types of AAIW have been discriminated on the basis of various physicochemical properties, e.g. T-S, nutrients, $\delta^{13}C$, oxygen content (Bostock et al., 2013). We interpret that the low salinity and high oxygen in the upper intermediate water levels correspond to the so-called Southern Ocean AAIW (SO AAIW, Bostock et al., 2013), which is still relatively young (well oxygenated) at this location. The lower part of the intermediate levels, with low salinity but also much lower oxygen concentration (Fig. 4.6), likely corresponds to the so-called Tasman AAIW (Bostock et al., 2013). The Tasman AAIW is derived from the AAIW formed in the SE Pacific and therefore, it has lost much of its oxygen on its journey along the Subtropical Gyre.

Below the AAIW the minimum in oxygen and the slight increase in salinity indicate the presence of Upper Circumpolar Deep Water (UCDW). This water mass overlies Low Circumpolar Deep Water (LCDW) (e.g. Park et al., 1993), which has slightly higher oxygen as it carries the remaining of the well oxygenated upon formation NADW. Both will ultimately derive in Pacific Deep Water (PDW). The abyssal depths are filled by Antarctic Bottom Water (AABW) (below 3200 m in Fig. 4.6).

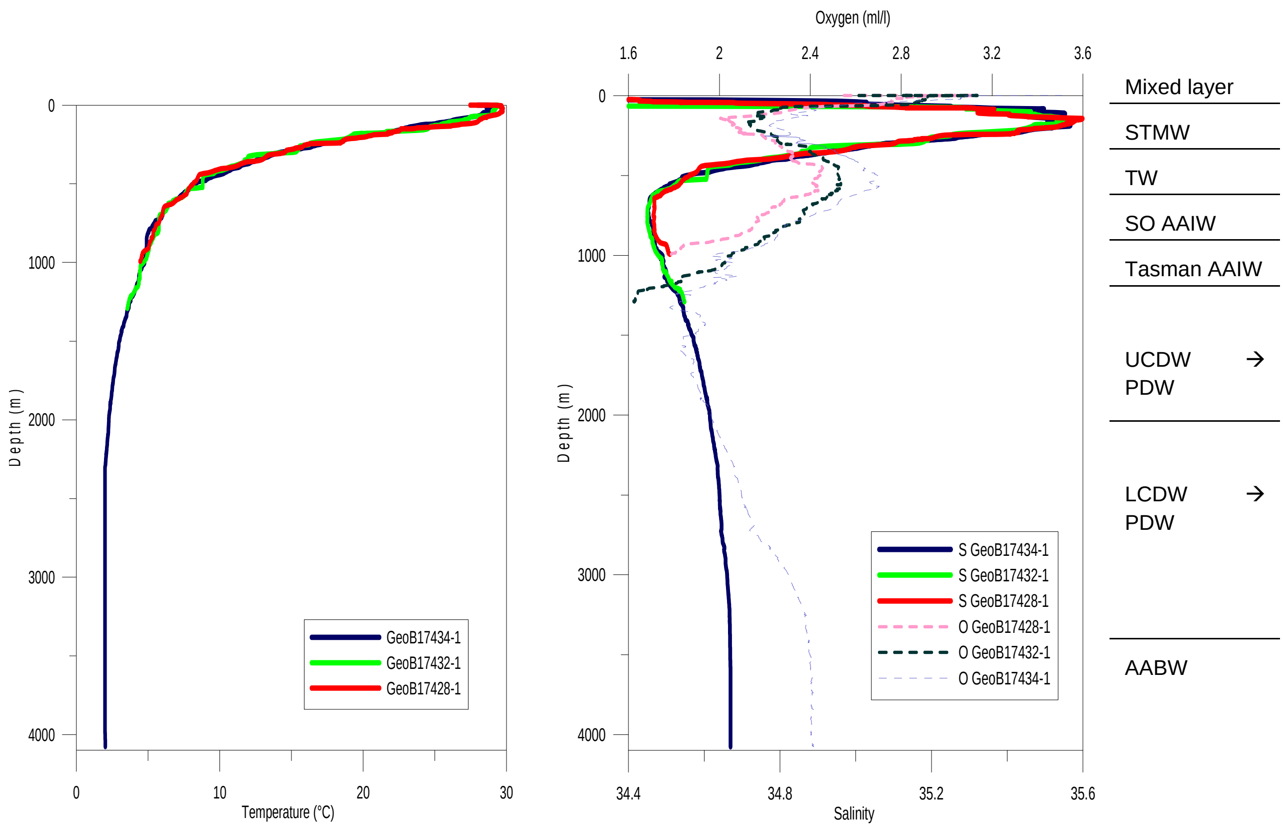
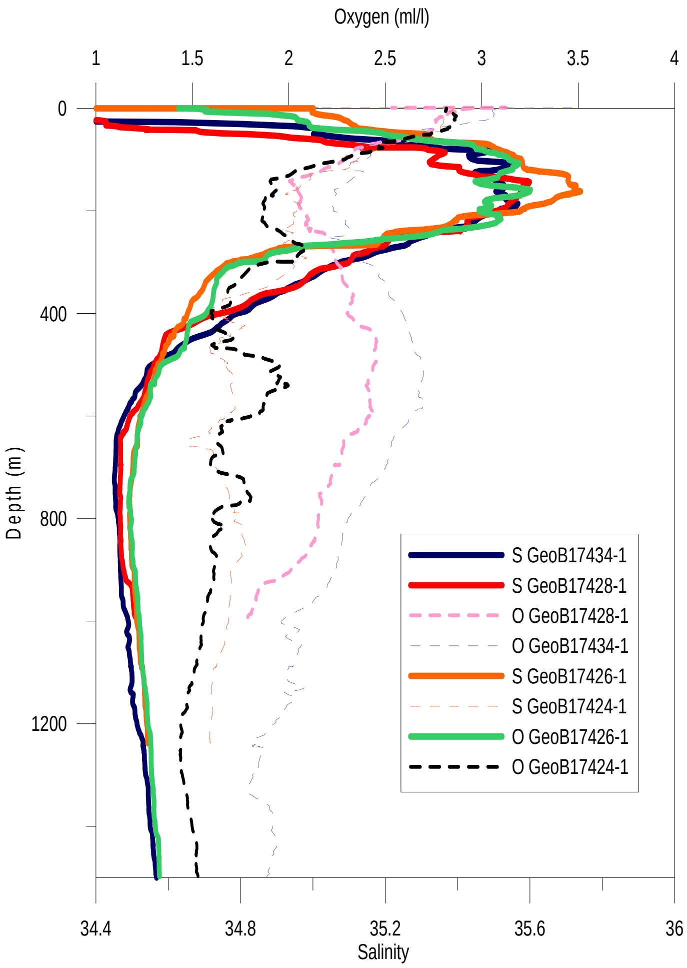


Fig. 4.6: Temperature (left), Salinity, and oxygen (right) profiles at Stations S and N of the Vitiaz Strait.

Station GeoB17534-1 is at the entrance of the Vitiaz Strait, while stations GeoB17432-1 and GeoB17428-1 are passed the Strait. The deep waters are prevented to enter the Bismarck Sea by topography and only the intermediate levels make it through the Strait. It is surprising to observe that there is virtually no change in the structure of the upper water column T-S properties as the waters cross the Vitiaz Strait. We were expecting some changes due to increase mixing between the two types of AAIW steered by the shoaling of the pathway, however, no such changes were observed. The only change observed was in the oxygen concentration, it becomes increasingly depleted as the waters travel northwards.



In the East Carolina Basin (e.g. stations GeoB17428-1 and 17426-1) the salinity maximum, corresponding to STMW, is slightly more pronounced. Additionally, the intermediate levels appear more depleted in oxygen, which may indicate a stronger influence of the Tasman AAIW in this area.

The sampling strategy was designed to capture the different water masses. Hence, the nutrient, stable isotopes, and Nd isotopes analyses planned will contribute to clarify the preliminary picture presented in this report and better assess the circulation scheme in the region.

Fig. 4.7: Salinity and oxygen profiles at Stations south and north of the Vitiaz Strait and in two stations outside the Bismarck Sea.

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4.4. Sample uptake and processing

4.4.1. Stable Isotopes

Water samples for measuring the $\delta^{13}C$ of the dissolved inorganic carbon ($\delta^{13}C_{DIC}$) and the $\delta^{18}O$ of H_2O were collected at every sample depth at 16 stations during the expedition SO-228 (Table 4.1) using Niskin bottles. Part of the water collected in the Niskin bottles was siphoned into 100 ml glass bottles avoiding bubbles and with enough water to fill the bottles twice. The samples devoted to $\delta^{13}C$ were poisoned with 50 µl of $HgCl_2$ to prevent biological modification of the actual $\delta^{13}C_{DIC}$ composition and sealed with wax. The samples are stored at 4°C until measuring at the MARUM isotope laboratory in Bremen. Additionally, the overlaying water of the Multi-Cores (MUC) was also sampled for determination of the $\delta^{13}C$ of the dissolved inorganic carbon ($\delta^{13}C_{DIC}$) and $\delta^{18}O$ of H_2O at the bottom of all stations using a PE tube. The same treatment was given to these water samples than to those of the Niskin bottles. The results of both measurements will be compared, the MUC values should provide the absolute bottom of the water column as the CTD was always stopped some 100-150 m above the sea floor.

4.4.2. Alkalinity, pH, and metal/Ca ratios of the water column

The aim of collecting water samples to measure alkalinity, pH, and metal/Ca (M/Ca) ratios throughout the water column was to broaden the available information, and hence potential impacts, on the incorporation of trace metals into planktonic and benthic foraminifera. Combining the CTD data with alkalinity and pH allows calculating the different parameters of the carbonate system in the water column and its impact on Mg/Ca in foraminifera. The effects of dissolution (low saturation state) and the carbonate ion effect (primary effect on incorporation of Mg into benthic foraminifera) are relatively well-known in benthic foraminifera, but the effect on planktonic foraminifera is largely unknown. Determining the deep parameters will additionally help to calibrate benthic Mg/Ca. The carbonate saturation state of the deepest samples will indicate how the preservation of foraminifera in the sediment cores will be.

Seawater samples for M/Ca ratios were taken to determine how a conservative element like Mg might vary when significant fresh water input occurs (i.e. Davao Bay and off Papua). Also, the variation of other elements like Ba (productivity) and Mn and Fe (redox/oxygen content) is not conservative and has the potential to be used as proxy in foraminifera to reconstruct these parameters.

Alkalinity and pH

Seawater samples were taken from specific water depths based on the CTD-profiles for temperature, salinity, oxygen, and density (Table 4.1 and 4.2). For each cast up to eight samples were collected into 100 ml bottles, which were rinsed with MilliQ (three times) and once with the seawater from their respective depths. After collection the samples were temporarily stored in a fridge (4°C) to prevent any reactions to occur before analysis. Starting with the deepest (i.e. furthest away from atmospheric equilibrium) sample, the pH was measured with a WTW pH 3210 device which was calibrated once a day. After this measurement, a manual titration was performed using 10 mmol HCl. At a pH between 3-4 the final pH was measured. Combining this with the concentration of the acid and the change in volume, the alkalinity was calculated. For each sample this procedure was repeated three times in order to estimate the errors of determination. Combining the alkalinity and pH with the temperature and salinity data of the CTD the remaining parameters of the carbonate system can be calculated (i.e. Dissolved Inorganic Carbon, carbonate ion concentration, and the state of saturation (Omega)).

The stations and depths for which alkalinity and pH were determined in water samples are displayed in Table 4.2.

Fig. 4.8: Sampling for alkalinity and pH analyses.

Fig. 4.9: WTW pH 3210 device.

Metal/Ca ratios in seawater

Metal/Ca ratios will be measured in the same seawater samples in which alkalinity and pH were determined. An aliquot of 2 ml of the seawater samples was filtered through a 0.45 µm filter to exclude any particulates and then acidified with 50 µL of clean, 70% nitric acid for preservation. After shipping to Bremen the samples will be diluted 10-fold and analyzed on an ICP-OES for the respective metal/Ca ratios (i.e. Mg/Ca, Sr/Ca, Mn/Ca, Fe/Ca, Ba/Ca).

Shipboard Results

A total of 32 samples (East Mindanao, four stations, 96 titrations), 16 samples (Davao Gulf, two stations, 48 titrations), 16 samples (Bismarck Sea, two stations, 48 titrations), 15 samples (off Sepik River, two stations, 45 titrations), 16 samples (East Carolina Basin, two stations, 48 titrations) 8 samples (Astrolabe Bay, one station, 24 titrations), and 16 samples (Solomon Sea, two stations, 48 titrations) respectively, were processed for determining alkalinity and pH. Each sample was processed three times to calculate the error of determination. These were 0.04 mmol/kg (1.8%) for alkalinity and 0.03 (0.3%) for pH. Three of the analyzed Multi-corer samples gave unrealistic results which can most likely be related to a combination of changing pressure while reaching the surface and the presence of strong initial gradients in the top part of the sediment which would be mobilized by the pressure changes. Those carbonate parameters are, thus, not representative for the bottom water conditions. Additionally, a surface (1-2 m water depth) water sample was taken at station 17420-1 using a bucket. This sample yielded the highest pH and lowest alkalinity values.

Changes in pH mostly follow a strong decrease from the surface down to about 200 m (8.2 to 8.0), with a minimum around 500 m (7.6; possibly related to the presence of the AAIW), below this depth, pH changes are small but generally slightly increasing again (7.6-7.9) (Fig. 4.10).

Table 4.2: CTD/Water samples for alkalinity, pH, and metal/Ca ratios during expedition SO-228.

Location	GeoB No.	Water Depth of sampling (m)	Alkalinity	M*/Ca sample
East Mindanao (32 samples)	17401-1	50, 150, 350, 420, 620, 1500, 2500, 3800	x	x
	17403-1	50, 150, 190, 260, 340, 520, 1250, MUC	x	x
	17404-1	15, 40, 80, 105, 140, 370, MUC	x	x
	17407-1	50, 150, 227, 500, 1250, 1550, 1800, 2000, MUC	x	x
Davao Gulf (16 samples)	17412-1	50, 100, 200, 260, 450, 640, 1000, 2900	x	x
	17413-2	20, 65, 150, 350, 550, 1000, 1500, 2000	x	x
Bismarck Sea (16 samples)	17417-1	25, 50, 100, 110, 170, 300, 600, 1580	x	x
	17433-1	5, 160, 200, 450, 539, 708, 1000, 1300	x	x
Off Sepik River (15 samples)	17420-1	1, 20, 60, 155, 320, 420, 580	x	x
	17428-2	5, 10, 15, 75, 175, 325, 600, 1000	x	x
East Carolina Basin (16 samples)	17424-1	5 ,20, 170, 300, 540, 770, 1260, 2000	x	x
	17426-1	5, 170, 260, 450, 600, 670, 800, 1250	x	x
Astrolabe Bay (8 samples)	17432-1	5, 180, 350, 480, 650, 760, 1170, 1300	x	x
Solomon Sea (16 samples)	17434-1	20, 200, 600, 1100, 1450, 1600, 2600, 4100	x	x
	17436-2	10, 35, 57, 65, 140, 560, 700, 800	x	x

*M = metal

Variations in alkalinity are significantly different between the locations and vary even within one area. A first factor is the presence of a low salinity layer at the surface (alkalinity = 1,800-2,200 mmol kg-1 vs 2,400 mmol kg-1 for higher salinity), i.e. off Papua and in Davao Gulf. Additionally, alkalinity seems to be depending (and thus, might be characteristic) on specific water masses (Fig. 4.11).

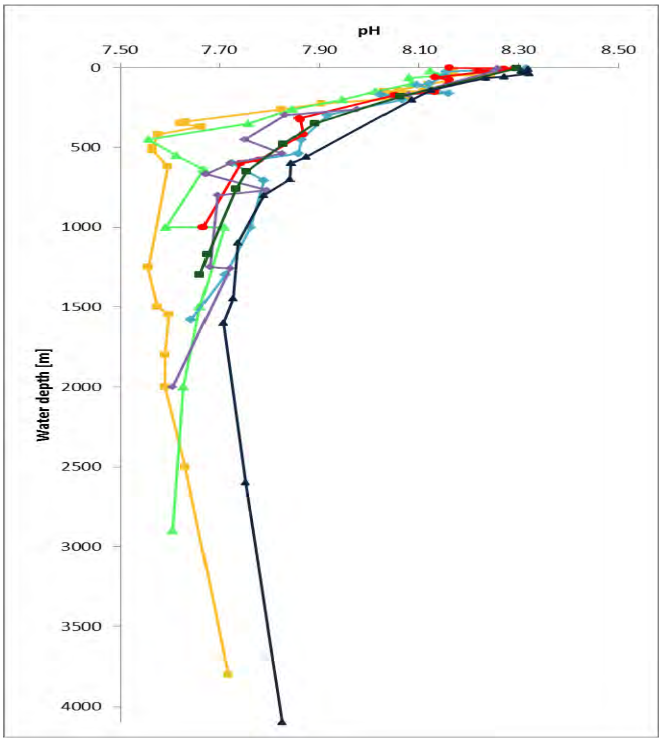
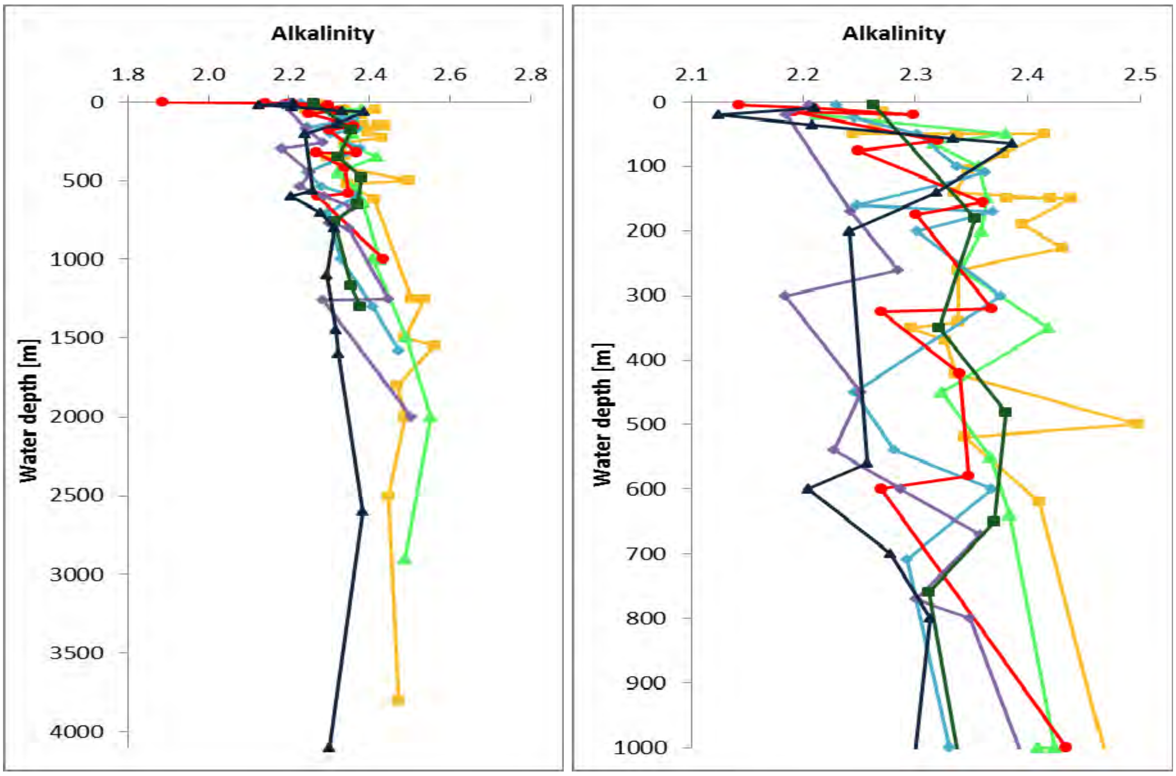


Fig. 4.10 (left): pH composite of the stations: East Mindanao (orange), Davao Gulf (light green), Bismarck Sea (light blue), off Sepik River (red), East Carolina Basin (purple), Astrolabe Basin (dark green) and Solomon Sea (dark blue).

Fig. 4.11 (bottom): Alkalinity composite of the stations: East Mindanao (orange), Davao Gulf (light green), Bismarck Sea (light blue), off Sepik River (red), East Carolina Basin (purple), Astrolabe Basin (dark green) and Solomon Sea (dark blue). a) Alkalinity for the complete water column; b) Alkalinity for 20-1,000 m water depth for better visualization of the differences in alkalinity which are most likely related to the presence of different water masses. Alkalinity is in mmol/kg.



4.4.3. Nd Isotopes and REE

The rare earth elements (REE) form a coherent group of elements whose ionic radii decrease with atomic number causing a systematic variation in seawater speciation across the series (e.g. Elderfield, 1988). This property, along with the fact that cerium is unique amongst the REE being oxidized to insoluble CeIV (Moffett, 1990), make seawater REE distributions useful tracers of marine particle scavenging (Byrne & Kim, 1990), river input (Sholkovitz et al., 1999), and seawater oxygenation (German et al., 1995). Additionally, the radiogenic isotopic composition of neodymium (^{143}Nd resulting from the decay of ^{147}Sm, both members of the REE group) in seawater has been used as a water mass tracer in oceanographic and paleoceanographic studies (Frank, 2002; Goldstein and Hemming, 2003 and references therein) because of the quasi-conservative behavior of Nd in seawater. The Nd isotope composition of seawater is not affected by biological fractionation and is distinct for different deep and intermediate water masses reflecting the age of the source. Water masses originating from regions with young mantle rocks such as the Pacific Ocean have higher, more radiogenic, ε_{Nd} values. In contrast, old continental rocks, for example around the North Atlantic, result in more negative (non-radiogenic) values (e.g. Piepgras and Wasserburg, 1987; Rickli et al., 2009). Despite this great potential as water mass tracer the sources of Nd to the ocean and the potential alteration of the Nd isotopic signature along a flow path remain poorly constrained. Therefore, during SO-228 water samples were taken for REE and Nd isotope measurements (Tables 4.1 and 4.3.) from areas where strong and globally important ocean currents interact with the shelf and slopes of the large islands of the maritime continent. Additionally; SO-228 provided a great opportunity to study the influence of the Sepik River input on seawater REE chemistry.

Fig. 4.12: Sampling for Nd: cartridge filters (left) and about 20 l of filtered seawater from different depths (right).

Large water samples of approximately 20 l in volume were filtered directly from the Niskin bottles of the CTD rosette through cartridge filters (PALL corporation AcroPak 500 Surpor 0.2 μm) attached with PE tubing. Cartridge filters were rinsed with 18.2 MΩ water and stored in the fridge for reuse. Samples for REE analysis were 250 or 125 ml in volume and were either filtered directly from the Niskin bottles, also through the cartridge filters, or a >1 l sub-sample was taken to the lab and vacuum filtered through a 50 mm diameter 0.2 μm cellulose nitrate membrane filter (Millipore or Whatman). Most of these membrane filters were pre-weighed in the home laboratory to enable the mass of suspended particles to be determined. Therefore, a measuring cylinder was used to ensure the total volume filtered was as precisely 1 l as possible. The used filters were returned to their individually labeled petri-dishes, sealed with Parafilm, and placed in the freezer to avoid decomposition of the suspended matter. An aliquot of the filtered water was taken and acidified to pH < 2 using distilled HCl. For some samples, where a higher particle concentration was suspected or visible, an unfiltered aliquot was also taken and acidified to pH < 2 using distilled HCl. In all cases where samples were filtered to investigate the suspended particles the sample was shaken very well directly before an aliquot was taken.

At Multi-Corer (MUC) sites where the near bottom waters were sampled the water from directly above the sediment water interface was sampled from the MUC tubes. Approximately 1.5 l of water from cores with a clear and visibly undisturbed interface was sampled using a PE tube. Great care was taken not to get too close to the sediment in the lower half of the core. Aliquots of 1 l of MUC water were vacuum filtered through a 0.2 μm cellulose nitrate membrane filter and acidified to pH < 2 using distilled HCl. At some sites true surface water was sampled using an acid cleaned plastic bucket and a rope. Great care was taken to ensure the sample was taken upstream of any ship effluent or coring device.

To enable the largest volume of samples to be taken some of the 20 l samples were processed on board to pre-concentrate the REE through Fe co-precipitation (e.g. Stichel et al., 2012). All 20 l samples were acidified to pH 2.2 or lower shortly after collection using distilled HCl. For the samples to be processed further on board, 500 μl of FeCl solution was added, the samples well shaken, and allowed to equilibrate for 24 hours. Following equilibration Suprapur grade Ammonia solution was added stepwise to obtain a pH between 7.5 and 8. The resulting FeOOH precipitate was allowed to settle for 48 hours before most of the supernatant was siphoned off using a water ray pump. The remaining solution and FeOOH precipitate containing the REE were transferred to a 2 l bottle and the 20 l cubic-containers rinsed and acid cleaned for reuse.

Table 4.3: CTD/Water samples for REE and Nd isotopes during expedition SO-228.

GeoB No.	Water Depth (m)	Depth sampled (m)	Samples Nd 20 l	Samples REE 250 ml
17401-1	5160	50, 350, 420, 620, 1000, 2500, 3800	x	x
17402-1	553	MUC water		x
17403-1	1318	50, 150, 340, 1250		x
17403-3	1318	MUC water		x
17404-1	404	15, 105, 140, 370		x
17404-2	402	MUC water		x
17407-1	2178	2000		x
17407-2	2178	MUC water		x
17412-1	2996	50, 450, 2100	x	x
17413-2	2082	2000		x
17413-3	2082	MUC water		x
17417-1	1637	25, 170, 600, 900, 1580	x	x
17418-B	1337	0		x
17418-1	1337	MUC water		x
17419-B	1883	0		x
17420-1	722	0, 20, 155, 320, 580	x	x
17422-2	367	MUC water		x
17424-1	2225	20, 170. 300, 470, 540, 680, 770, 1260, 2000		x
17424-1	2225	20, 170. 300, 540, 770, 1260, 2000	x	
17424-2	2100	MUC water		x

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4.4.4. Seawater nutrient content

In order to determine the nutrient content of each water mass in the region, selected depths were sampled from 12 CTD casts during the SO-228 expedition (Tables 4.1 and 4.4). At each sampled depth, a syringe with a 0.45-μm filter was used to fill two vials with ~10 ml of seawater for nutrient analysis, as well as one Nalgene bottle with ~50 ml of seawater for nitrate analysis. All syringes, vials and bottles were acid-washed prior to sampling, and thoroughly rinsed with the water to be collected. The samples were frozen at -20°C immediately after collection and will be shipped with dry ice upon disembarking in Townsville, Australia. The samples will then be analyzed at Dalhousie University upon reception of the shipment.

Table 4.4: CTD/Water samples for nutrient analyses collected during expedition SO-228.

Location	GeoB No.	Water Depth of sampling (m)	Nutrients	Nitrate
East Mindanao	17401-1	155, 420, 580	x	x
	17403-1	50, 140, 150, 190, 260, 340, 360, 520, 750, 1000, 1250	x	x
	17404-1	15, 40, 80, 105, 140, 250, 370	x	x
	17407-1	50, 100, 150, 227, 250, 500, 650, 750, 1000, 1100, 1250, 1300, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1800, 1900, 2000	x	x
Davao Gulf	17412-1	50, 100, 150, 200, 220, 260, 286, 450, 540, 640, 1000, 1800, 2100, 2400, 2900	x	x
	17413-2	20, 50, 65, 100, 150, 1900, 2000	x	x
Bismarck Sea	17417-1	25, 50, 80, 100, 110, 150, 170, 200, 300, 400, 600, 720, 900, 1400, 1580	x	x
Off Sepik River	17420-1	155, 420, 580	x	x
N New Ireland	17426-1	5, 45, 70, 120, 170, 200, 225, 260, 275, 300, 415, 450, 485, 505, 600, 670, 800, 870, 1000, 1100, 1250	x	x
Astrolabe Bay	17432-1	180, 525, 1050, 1300	x	x
Solomon Sea	17433-1	5, 31, 91, 149, 194, 319, 530, 695, 1076, 1300	x	x
	17434-1	20, 120*, 200, 600, 820, 1100, 1300, 1450, 1600, 2600, 4100	x	x

**Nitrate analyses only*

4.4.5. Underway filtration

During transit, seawater was filtered using the ship's contamination-free seawater intake (depth of 5 m) for alkenone analysis. Seawater was passed through a Millipore cellulose filter (0.4 µm pore size, 140 mm diameter, 2-3 l/min) that was placed on a Geotech all-PVC/PP filter holder. A new filter was installed every 1-2° of latitude or longitude for a duration of 1-4 hours. Prior to ending each filtration, seawater exiting the filtration apparatus was collected for $\delta^{18}O$ measurements. Filters were then frozen at -20°C and water samples refrigerated. The filters will be shipped in dry ice upon disembarking in Townsville, Australia, while the water samples will travel to Bremen prior to being shipped to Dalhousie University where all analyses will be performed.

Fig. 4.13: Filter holder (left) and used cellulose filter (right).

Table 4.5: Coordinates for the onset of each filtration performed during SO-228.

Filter number	Latitude	Longitude
1	21°4.3' N	120°38.3' E
2	20°27.3' N	121°14.2' E
3	19°33.1' N	122°25.1' E
4	18°27.7' N	123°2.9' E
5	17°30.0' N	123°34.0' E
6	16°25.0' N	124°9.9' E
7	15°26.2' N	124°37.5' E
8	14°32.8' N	124°57.6' E
9	13°32.8' N	125°19.9' E
10	12°29.3' N	125°43.6' E
11	11°37.7' N	126°0.1' E
12	10°37.7' N	126°17.8' E
13	9°33.8' N	126°35.7' E
14	8°14.6' N	126°34.9' E
15	7°16.3' N	126°49.8' E
16	5°55.0' N	126°4.9' E
17	6°9.3' N	126°5.7' E
18	5°50.1' N	126°35.5' E
19	5°10.1' N	128°19.9' E
20	4°39.5' N	129°29.7' E

21	4°11.4’ N	130°34.2’ E
22	3°39.9’ N	131°46.1’ E
23	3°1.1’ N	133°14.6’ E
24	2°24.1’ N	134°39.0’ E
25	1°55.2’ N	135°46.9’ E
26	1°26.5’ N	136°50.3’ E
27	0°48.4’ N	138°17.1’ E
28	0°6.0’ N	139°53.9’ E
29	0°37.5’ S	141°33.1’ E
30	2°39.1’ S	144°29.9’ E
31	0°35.5’ S	142°59.0’ E
32	0°49.3’ S	144°51.8’ E
33	1°34.43’ S	146°57.04’ E
34	2°11.80’ S	150°19.9’ E
35	2°57.5’ S	147°10.7’ E
36	5° 22.0’ S	146°18.7’ E
37	6°39.0’ S	148°11.5’ E
38	7°54.4’ S	148°20.6’ E
39	8°14.4’ S	151°03.3’ E
40	9°33.0’ S	151°32.7’ E
41	11°29.0‘ S	151°36.0‘ E
42	11°15.2‘ S	149°51.4‘ E
43	10°50.4‘ S	147°07.8‘ E
44	10°12.6‘ S	144°51.5‘ E
45	12°19.0‘ S	145°02.8‘ E
46	13°52.6‘ S	145°46.2‘ E

4.4.6. Pteropods investigation

Pteropods are marine organisms (Mollusca) that calcify an aragonite skeleton. This characteristic allows them to be preserved in marine sediments. Pteropods are sensitive water mass indicators. Therefore, pteropod taxonomic composition of sediments can reveal much about watermass movements. Pacific Ocean equatorial surface water pteropod community is characterized by *Clio pyramidata*, *Diacria costala*, and *Diacria rampali* (Schalk, 1990). Investigation of this Pteropod community in Multi-core sediments will reveal information about the watermass distribution and variability.
Multi-cores from several stations will be devoted to Pteropod investigations. We will first focus on stations where Conductivity Temperature and Depth (CTD) measurements were taken (Table 4.6.).

Table 4.6: Multi-corer stations sampled for pteropod analyses.

	Multi-Core Length	Geographic Location- Surface curents
GeoB 17424	22cm	South Equatorial Current
GeoB 17426	29cm	South Equatorial Current
GeoB 17430	41cm	New Guinea Counter Current
GeoB 17432	33cm	New Guinea Counter Current
GeoB 17433	46cm	New Guinea Counter Current
GeoB 17436	15cm	New Guinea Counter Current

The initial focus will be to create modern calibration by comparing pteropods found in the core top (first cm) of Multi-cores to current climatic parameters (Sea Surface Temperature and Sea Surface Salinity). This calibration will be compared with existing surface dwelling foraminifera calibrations. This calibration will be applied to pteropods found down core, allowing for paleoclimatic reconstructions.

$\delta^{18}O$ and Mg/Ca modern calibration

Sediments samples will be taken from the upper 1cm sediment layer from the Multi-cores. Those sediments will be sieved (e.g. Fig. 4.14A.) using grid size sieves of 340 and 150µm. The typical Equatorial Pacific surface water pteropods *Clio pyramidata* (e.g. Fig. 4.14B.), *Diacria costala*, and *D. rampali* will be hand-picked under a binocular (e.g. Fig. 4.14C.). Geochemical measurements, such as oxygen isotope ($\delta^{18}O$) and Mg/Ca will be made. Calibration between pteropod geochemical measurements and climatic parameters will be created.

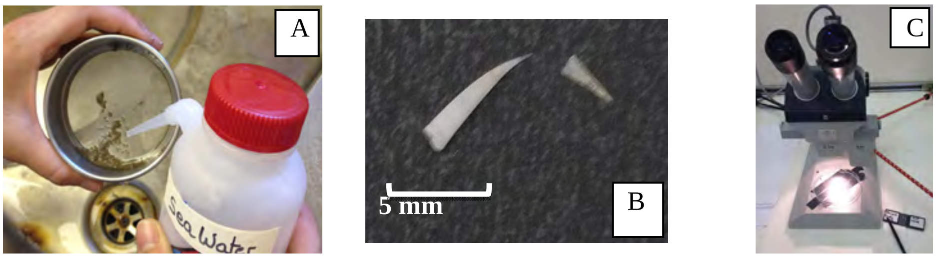


Fig. 4.14: A: 340 µm Sieve. B: Picture of pteropods *Clio pyramidata*. C: Binocular to look for Pteropods

Pteropod variability with time

Every sample taken at 1cm increment down-core will be processed following the same method as presented in the above section. Geochemical measurements will also be made, allowing reconstruction of surface water variability with time.

References:

Schalk P.H. (1990). Spatial and seasonal variation in pteropods (Mollusca) of Indo-Malayan waters related to watermass distribution. *Marine Biology*, 105, 59-71.

Table 4.7: Water samples analyzed for pteropods (gray fields).

	Ship Pump - 5 meter depth				CTD Water Filtration from the bottles										
	Water Samples		Filtration at	Filtration											
	50mL	20mL	Station	during transit	5	10	20	25	31	37	45	50	57	61	70
GeoB 17424															
GeoB 17425															
GeoB 17426															
GeoB 17427															
GeoB 17428															
GeoB 17429															
GeoB 17430															
GeoB 17431															
GeoB 17432															
GeoB 17433															
GeoB 17434															
GeoB 17435															
GeoB 17436															

5 Seismo-acoustic surveys

(Bergmann, Gernhardt, Schwenk, Wenau)

5.1 Swath Bathymetry

5.1.1 System Overview and Data Processing

During Cruise SO-228 the hull-mounted Kongsberg Simrad system EM120 was used for bathymetric mapping continuously in a 24 hour schedule in all four survey areas. The system worked reliable and no data gaps exist. To calibrate the depth determination algorithms in each survey area a deep CTD station was performed to provide a regional water sound velocity profile.

The Kongsberg Simrad EM120 system allows an accurate bathymetric mapping down to full ocean depth. Basic components of the system are two linear transducer arrays in a Mills cross configuration with separate units for transmitting and receiving. The nominal sonar frequency is 12 kHz with an angular coverage sector of up to 150° and 191 beams per ping. The achievable swath width on a flat bottom will normally be up to six times the water depth dependent on the character of the seafloor. The angular coverage sector and beam pointing angles may be set to vary automatically with depth according to achievable coverage. This maximizes the number of usable beams. The beam spacing is normally equidistant, but equiangular is also available. For depth measurements, 191 isolated depth values are obtained perpendicular to the track for each ping. Using the 2-way-travel-time and the beam angle known for each beam, and taking into account the ray bending due to refraction in the water column by sound speed variations, depth is calculated for each beam. A combination of amplitude (for the central beams) and phase (slant beams) is used to provide a measurement accuracy practically independent of the beam pointing angle. Beside the depth values, the EM120 provides also backscatter values and pseudo-sidescan images. During the cruise, the opening angle was mostly set to values to 120°, which provided the best quality of the outer beams.

The data quality during the first survey (east of Mindanao) was really poor. The data are characterized by numerous wrong depth detections resulting in data holes. Partly, the system detected layers in the water column as seafloor producing unrealistic flat seafloors several hundred meters shallower as the real seafloor seen in the Parasound. The reason for the poor data quality might be that the seafloor is very rough in this area, probably causing a lot of scattering of the sound energy. However, due to several surveys during nights it was possible to close most gaps and to have nearly 100 % coverage of the southern part of the study area, where coring activity was concentrated. The data quality during the second survey (Davao Bay) was good, only minor errors occurred, all concentrated in the inner beams where the amplitude depth detection method is applied. During the third and fourth survey (off Papua-New Guinea) the data quality was moderate with a lot of wrong pings in the center of the swath and a distinct wobbling in the outermost part of the swath.

Due to the poor quality, a time consuming processing was applied to the data from the first survey using the free software multibeam, which includes flagging of outer beams, “rails” identification and interactive editing using a 3D editor. Data from the second, third and fourth survey were processed using the commercial software Fledermaus-Pro. Using the so-called CUBE algorithm produced a data set of such good quality, that only minor interactive editing was needed. The resulting grids were displayed with the free software GMT or with Fledermaus-Pro.

5.1.2 Preliminary results

Fig. 5.1 shows the bathymetric data from the southern part of the first working area, where nearly 100% coverage could be reached. The data covers depths between 100 and 5300 m. It is easily visible, that the seafloor is dissected by several depressions and elevations. Some of the depressions show canyon-like characteristics, especially in the southern part of the map, where three tributaries from the shelf edge join in 1000 m water depths to one large canyon, which can be traced until the eastern border of the study area down to water depths of 5000 m. The shelf incisions may represent canyons connected during lowstand to rivers on Mindanao. Other depressions show a more amphitheater-shape, typical for scars produced by slope failures. Since this region is quite close to a subduction zone in the east and therefore often earthquakes occurred, it is reasonable to conclude that slope failures and resulting mass-transport deposits were relatively often triggered by earthquakes.

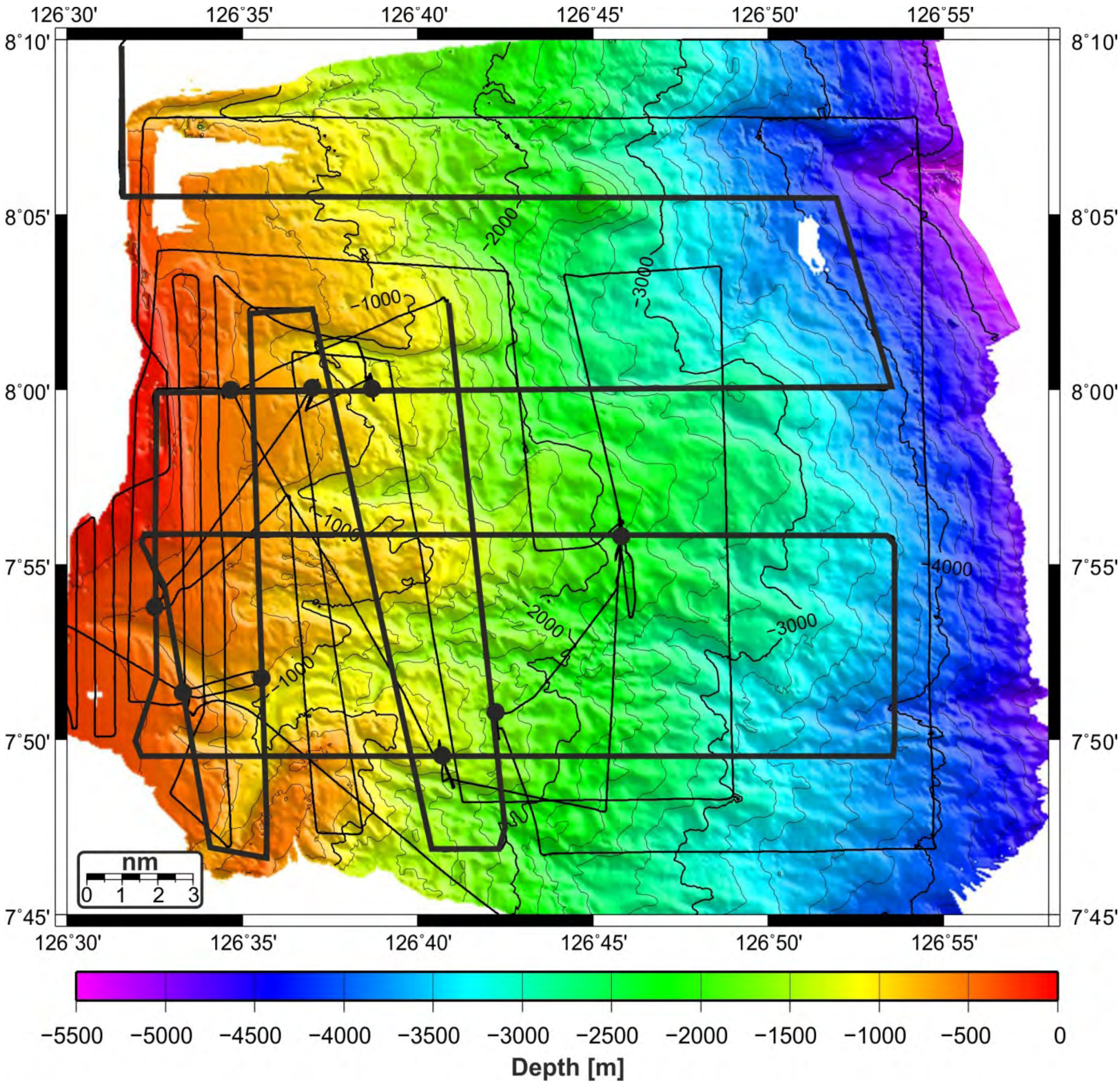


Fig. 5.1: Bathymetric map of the southern part of the working area east of Mindanao, where surveying and coring activities were concentrated. Thick black lines represent multi-channel seismic data profiles. Black circles show the location of coring stations.

The bathymetry of the Davao Bay (Fig. 5.2) is dominated by north-south trending ridges, which are probably of tectonic origin, and basins in-between. The ridges rise up to 1000 m water depth, whereas the deepest part of the covered basins shows a water depth of 3100 m. The relief of the ridges can reach more than 1000 m and they show different shapes from straight to sinuous. Not surprisingly, numerous headwalls and scars can be observed on the flank of the ridges indicating frequent mass-wasting activities. The easternmost ridge in the working area shows also valley-like incisions, which are partly connected to channel-like depressions in the basins, probably shaped by turbidity currents. In the north-western basin,

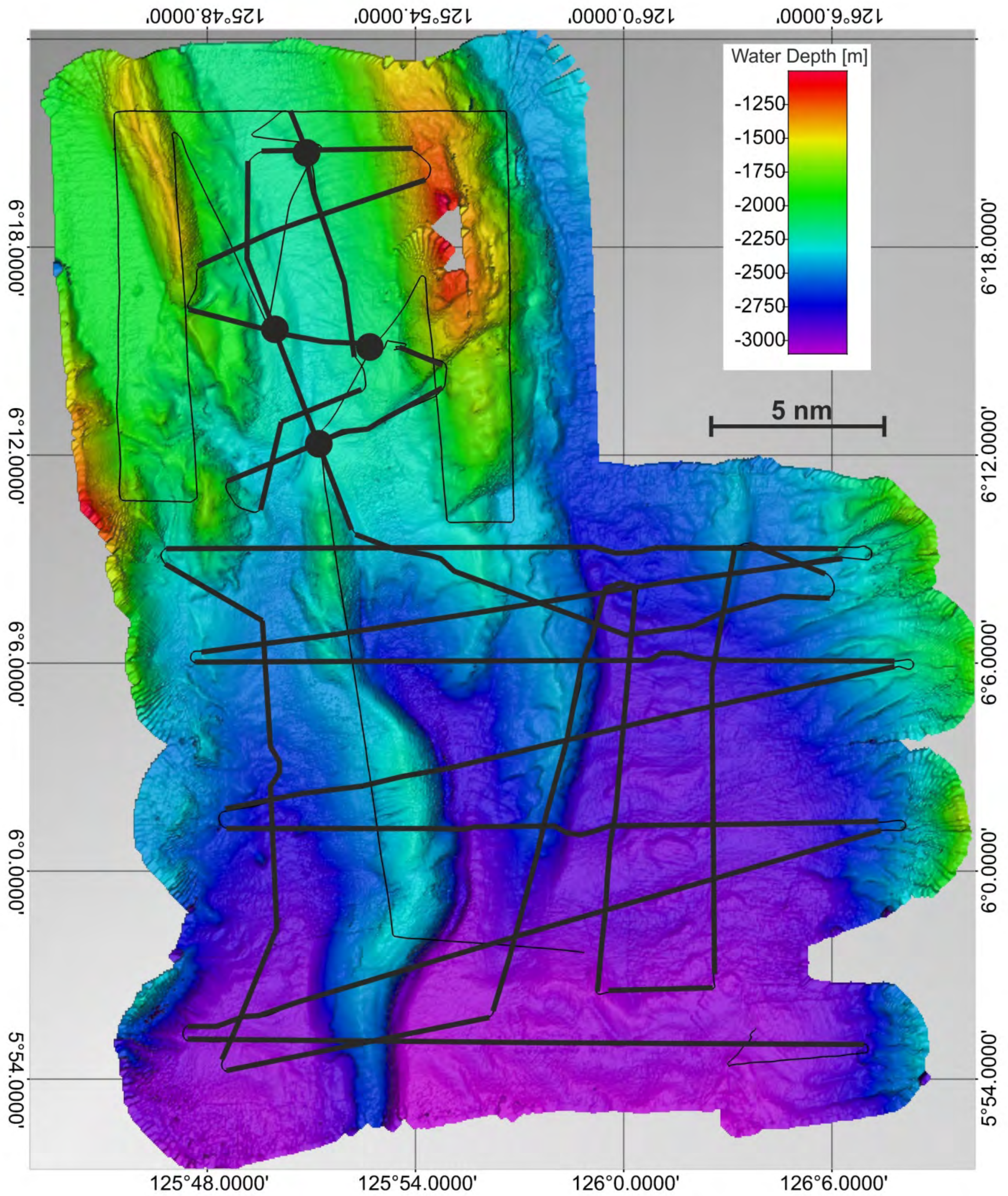


Fig. 5.2: Bathymetric map of the working area in the Davao Bay. Thick black lines show multichannel seismic profiles, black dots represent coring locations.

a channel could be identified which runs from north to south at the foot of the western ridge and terminates in the western basin of the southern part.

Data from the third survey off Papua New Guinea covers water depths from 1000 to 2000m (Fig. 5.3). The seafloor is shallowest in the northeast and deepest in the southwest. In the northern part the deeper areas are separated from the shallower areas by distinct steps in the seafloor, which are up to 100 m high. Thereby the shallower parts build up distinct elevations of several miles width. Downslope of these steps the seafloor shows partly a hummocky characteristic. All these features indicate that the region is influenced by slope failures and associated headwalls and mass transport deposits. In the southern part of the study area an elongated elevation of 50 m height can be identified. This elevation is surrounded by depressions, which are probably moats produced by bottom currents. However, the development this elevation is not clear yet.

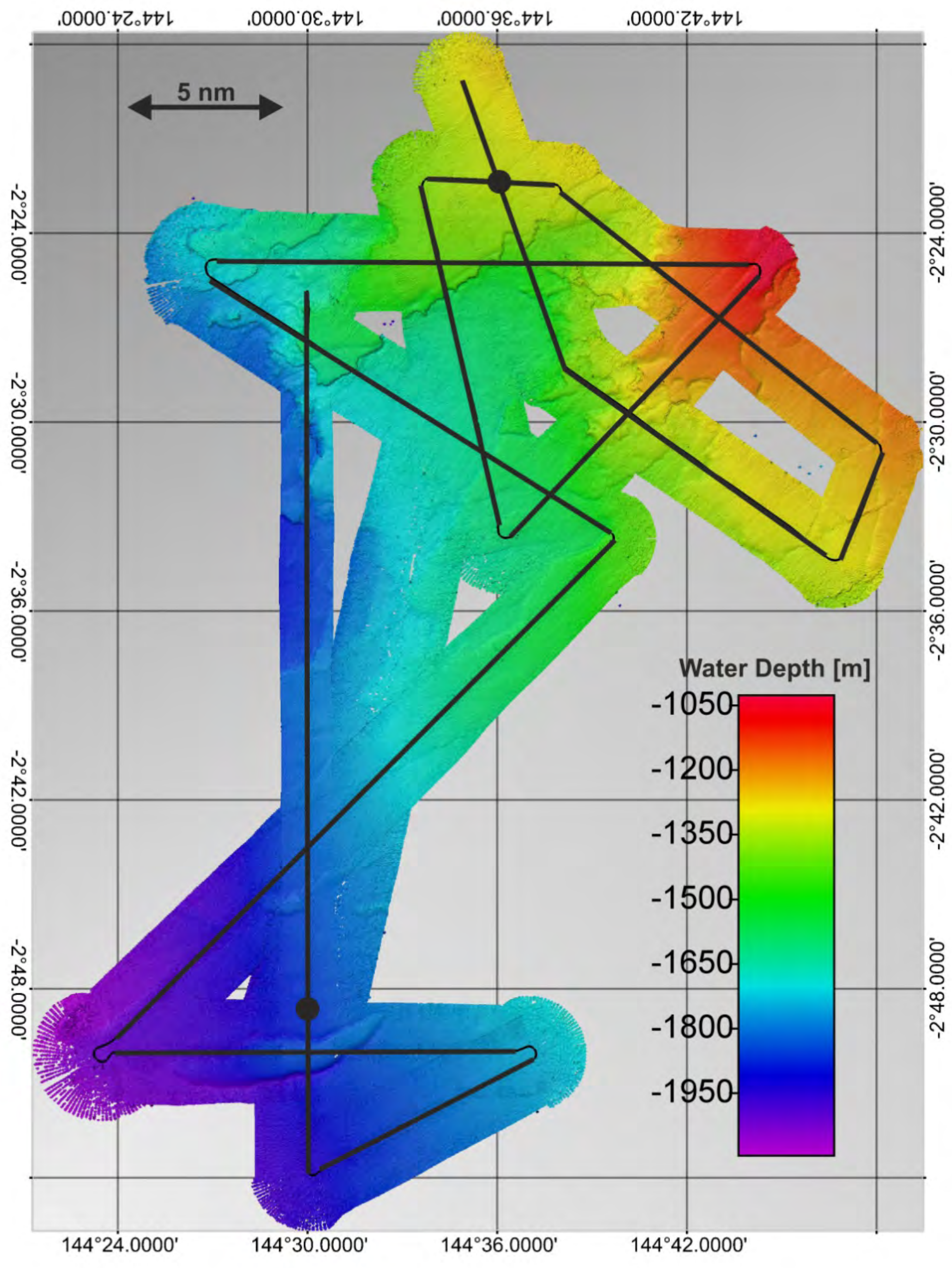


Fig. 5.3: Bathymetric map of the working area off Papua New Guinea. Thick black lines show multichannel seismic profiles, black dots represent coring locations.

The bathymetric data from the fourth survey show the upper slope west of the Sepik River mouth (Fig. 5.4). Water depths span from 300 to 1400 meters. The upper slope is separated into two different compartments: The eastern part is characterized by some small meandering channels, which display depths between 20 and 100 meters and widths of around a few 100 meters. The channels are partly located in a broad valley. In contrast, the western part shows a plateau-like elevation. This elevation is smooth in its shallowest part, but in water depth below 500 m some smaller depressions, which are probably the result of slope failures, can be identified. The slope terminates into a distinct basin. On the lower slope, a ridge - bending to the northwest - rises up by more than 100 meters.

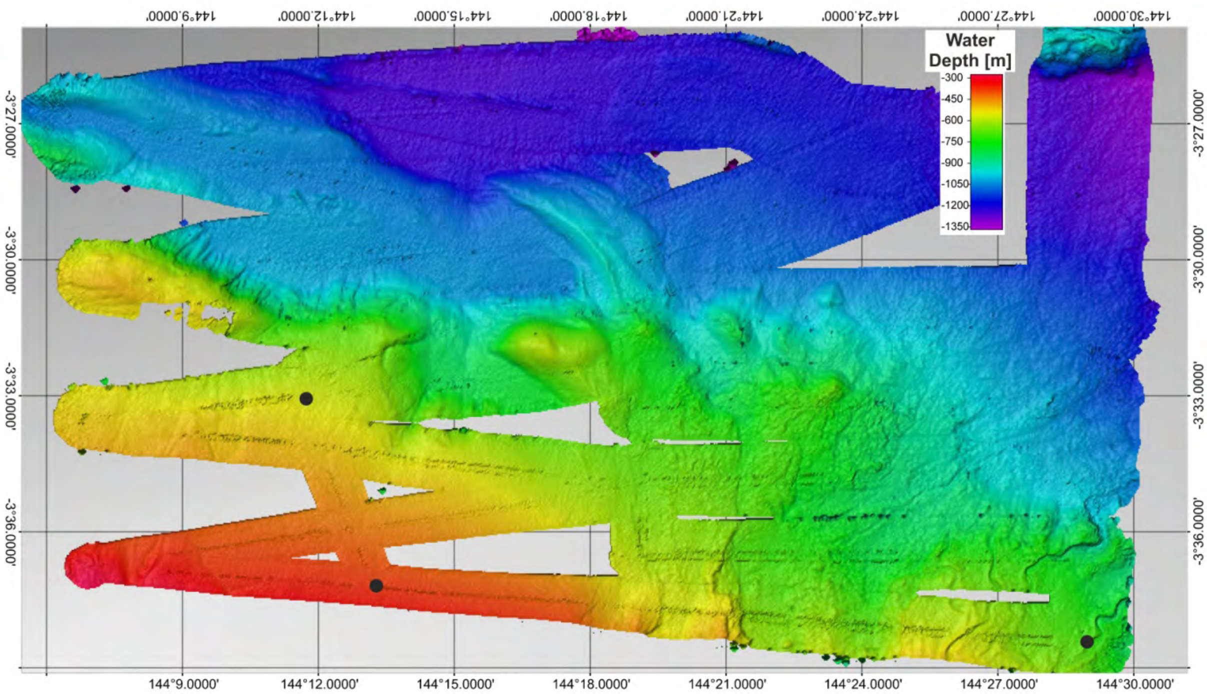


Fig. 5.4: Bathymetric map of the upper slope west of the Sepik River. Black dots show the position of stations. The data are only roughly processed and show therefore numerous artefacts, especially in the region of the central beams.

The seismo-acoustic team disembarked at the end of the first leg. Bathymetric maps of the second leg were therefore unprocessed and are available as appendix at the end of the cruise report.

5.2 PARASOUND sediment echosounder

5.2.1 System overview and data processing

The hull-mounted parametric echosounder PARASOUND DS3 was running in a 24-h schedule in all working areas were permission was available to provide high resolution information on the uppermost 10-100 m of sediment deposition. The system was used for searching suitable coring locations, but also as pre-site survey for IODP Proposal 799-full. Except of one crash in the first night, which was finally the result of a broken switch and caused a 45 min data gap, the system worked continuously without significant technical problems. Since the PHF depth failed at steep slopes, the EM120 depth was chosen as system depth. The automatic modus of the window delay was chosen using the PHF depth. With these settings, nearly no actions of the watch keepers were required. Even when the system failed at steep slopes, ping rate and window delay was set automatically back to useful values when flatter seafloor areas were surveyed.

Parasound DS3 works as a narrow beam parametric sediment echosounder, sounding primary frequencies of 18 kHz (Primary High Frequency, PHF) and adjustable 18.5 – 28 kHz, thus generating two secondary frequencies, one in the range of 0.5 – 10 kHz (Secondary Low Frequency, SLF), and one in the range of 36.5 – 48kHz (Secondary High Frequency, SHF). The secondary frequencies develop through nonlinear acoustic interaction of the primary waves at high signal amplitudes, the so-called parametric effect. This takes place only in the emission cone of the high frequency primary signals which is limited to an aperture angle of only 4.5° x 5° for the Parasound DS3. To achieve this small cone a transducer array of 128 transducers on a rectangular plate of approximately 1 m^2 in size is used. Therefore the footprint size is only 7% of the water depth and vertical and lateral resolution is significantly improved compared to conventional sediment echosounder systems.

For the standard operation a SLF frequency of 4 kHz and a sinusoidal source wavelet of 2 periods were chosen to provide a good relation between signal penetration and vertical resolution. On most lines (i.e., all pre-site survey profiles) the system was operated in the quasi-equidistant mode. This mode provides an optimal lateral coverage of the sea floor, since the echosounder calculates an intertwined trigger sequence using the ‘unused’ travel time of the signal in the water to emit additional pulses in a matter, which generates an equally spaced transmit/receive sequence with at least twice the rate of a standard send-receive-send-sequence. On selected profiles and during stations the system was operated in the single pulse mode, which allow recording of the full water column.

During the cruise, the PHF and SLF data were acquired and stored in the PARASOUND format ASD. A 200 m window of the SLF data was also stored in the more common PS3 format. To identify suitable coring locations, but also for profile planning, the PS3 data were routinely converted into sgy data with the custom-made software ps32sgy (manufactured by H. Keil, University of Bremen) and loaded into the interpretation software The Kingdom Software. During conversion, the data were also processed by applying a band-pass filter and by subtracting the mean to reduce noise. Outliers within the navigation data in the header were eliminated, and the positions were converted to UTM projection. Finally, the envelope of the seismic trace was calculated, and the data were resampled to decrease file sizes.

5.2.2 Preliminary results

As visible also in the bathymetric data, the seafloor in the first working area (off east Mindanao) is far away from being smooth, and therefore searching for suitable coring stations was a real challenge. Over long distances, the Parasound profiles are dominated just by diffraction hyperbolae or show no real signal penetration. However, a few spots where sediment was deposited could be found, either as small drift-like features, or as fillings of depressions. In general the data suggest that the sedimentation in this area is not only affected by tectonics and downslope mass movements, but also by strong contour currents.

The most promising spots for coring were found in shallow water depths around 400 m close to the shelf canyons in the southern part of the study area. Fig. 5.5 shows the Parasound profile crossing the location of station GeoB17404. The data reveal that on both sides of the canyon the deposits appear as undisturbed, parallel layered units. The signal penetration of up to 30 m is one of the highest observed in this study area. Due to their position beside the canyon and the decreasing thickness with distance to the canyon it seems reasonable to interpret these deposition units as levee deposits.

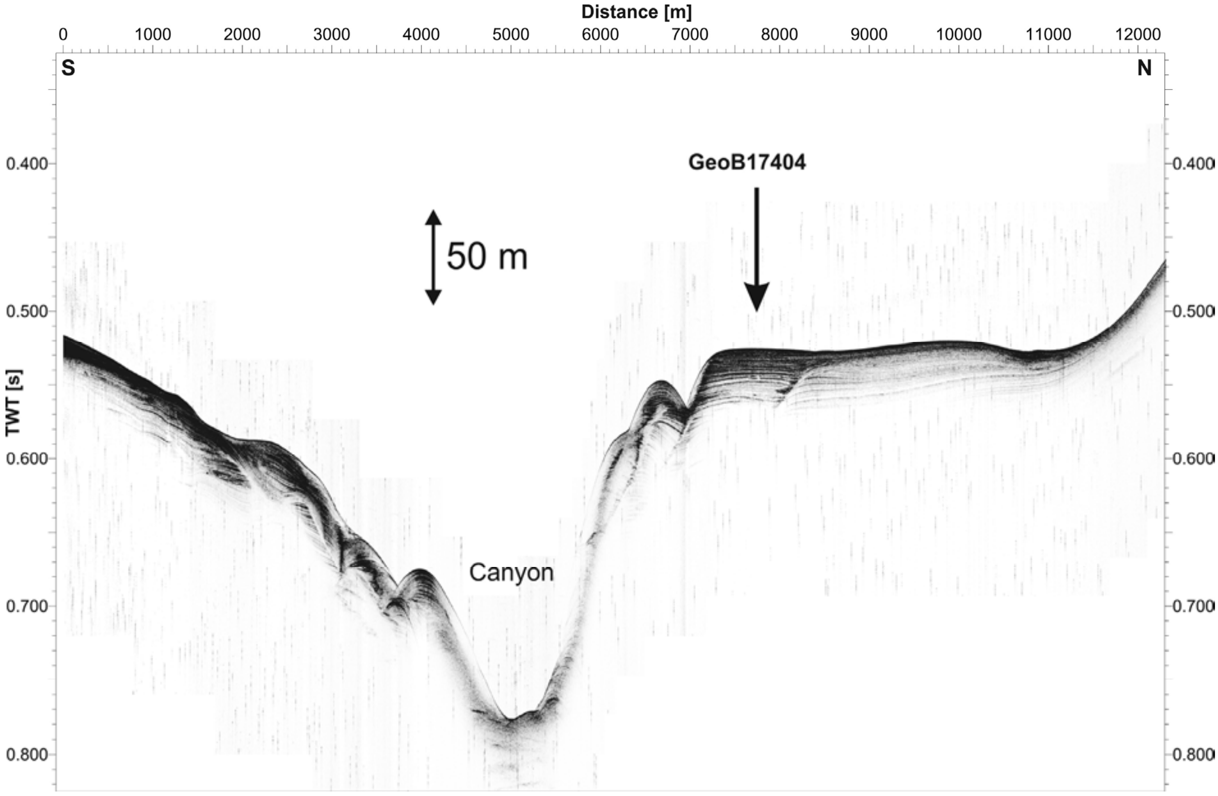


Fig. 5.5: Parasound profile crossing a ~150 m deep canyon on the upper slope off Mindanao. The position of coring site GeoB17404 is indicated.

For the second working area (Davao Bay) it turned out that the most promising sites for both sediment coring and IODP drilling are located in the northernmost surveyed basin. Fig. 5.6 shows Parasound data collected on seismic Profile GeoB13-070, which images the basin from west to east. In the west, two terraces were crossed, which show nearly horizontal, parallel reflectors indicating undisturbed sediments. In the centre of the profile, a channel had been evolved. East of the channel, the slope steeps gently until another terrace had been reached. Within the slope area, transparent to chaotic acoustic facies suggests the presence of a mass transport deposit (MTD) or at least downslope creeping of sediments. East of the MTD on the terrace, again undisturbed sediments are visible. The signal penetration into the undisturbed sediments on both sides of the channel exceeds 50 m, which indicates soft sediments. Two cores were taken on this profile.

The major part of the third working area (off Papua New Guinea) is characterized by parallel, continuous reflectors of different amplitudes as visible in Fig. 5.7, which is an example from the southern part. The reflection pattern suggests a kind of rhythmic sediment input. The signal penetration reaches up to 70 m indicating relative soft sediments. This interpretation is supported by the fact, that the Gravity core GeoB17419 is one of the longest taken on this cruise. The profile shown in Fig. 5.7 crosses an elevation of 50 m relief and a width of ~ 4 km. Comparison of the reflection pattern on the elevation and beside reveal that layers are thinner on the elevation as beside. Therefore the sedimentation process is probably not pure pelagic, but a significant portion of lateral sediment transport is expected.

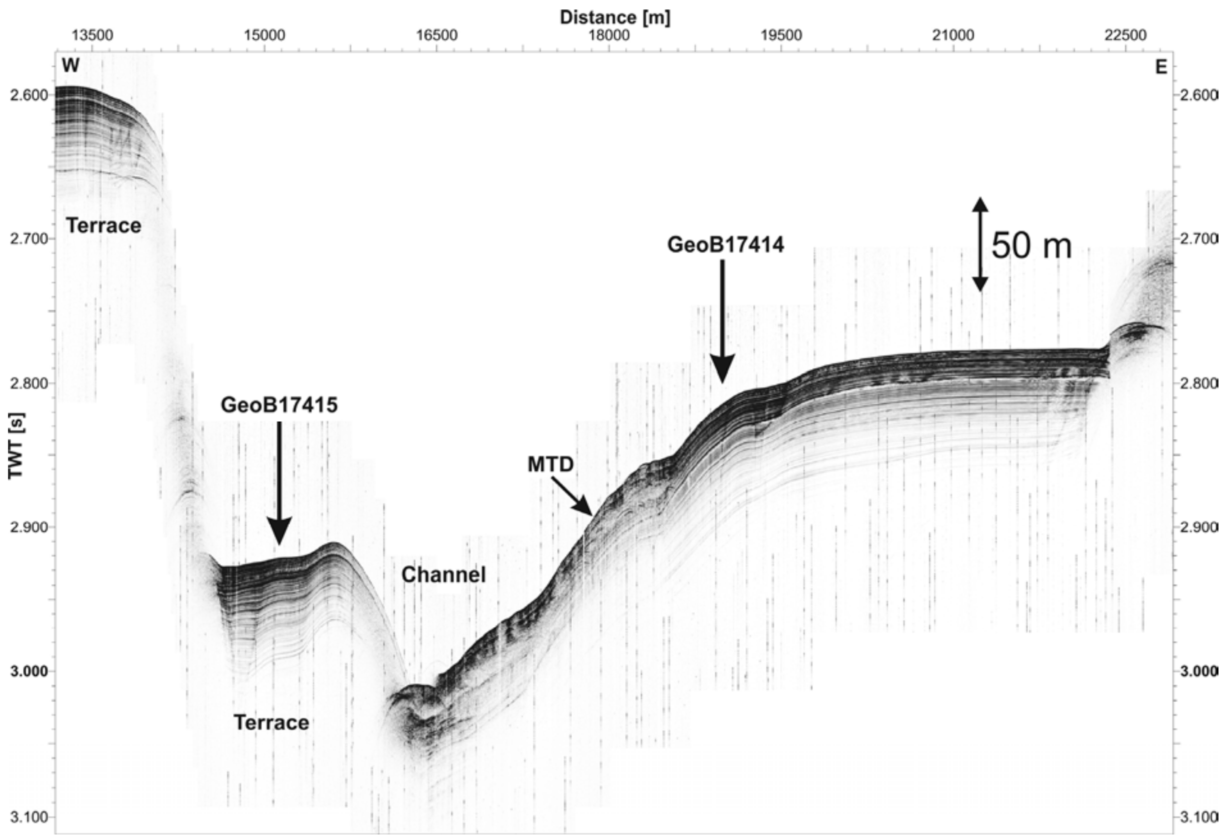


Fig. 5.6: Parasound profile crossing the northernmost basin visited in the Davao Bay. The position of coring sites GeoB17414 and GeoB17145 are indicated.

The Parasound survey in the fourth working area on the upper slope of Papua New Guinea was carried out for searching of suitable coring stations only. As result of a 24 hour survey it turned out that just the southwestern part of the survey area hosts some promising coring locations, because the other regions are dominated either by channels or by large mass transport deposits (MTDs). Fig. 5.8 shows the sedimentation pattern around Station GeoB17421. The Parasound data show at the coring location parallel, continuous reflectors of varying amplitudes indicating an undisturbed hemipelagic sedimentary environment. The signal penetration reaches up to 70 meters. Chaotic to transparent acoustic units, which intercalate the parallel reflectors western of the station, suggest that here the hemipelagic sedimentation is interrupted by mass transport deposits, probably debrites. Also the floor of the canyon east of the station is dominated by up to 25 m thick mass flow deposits.

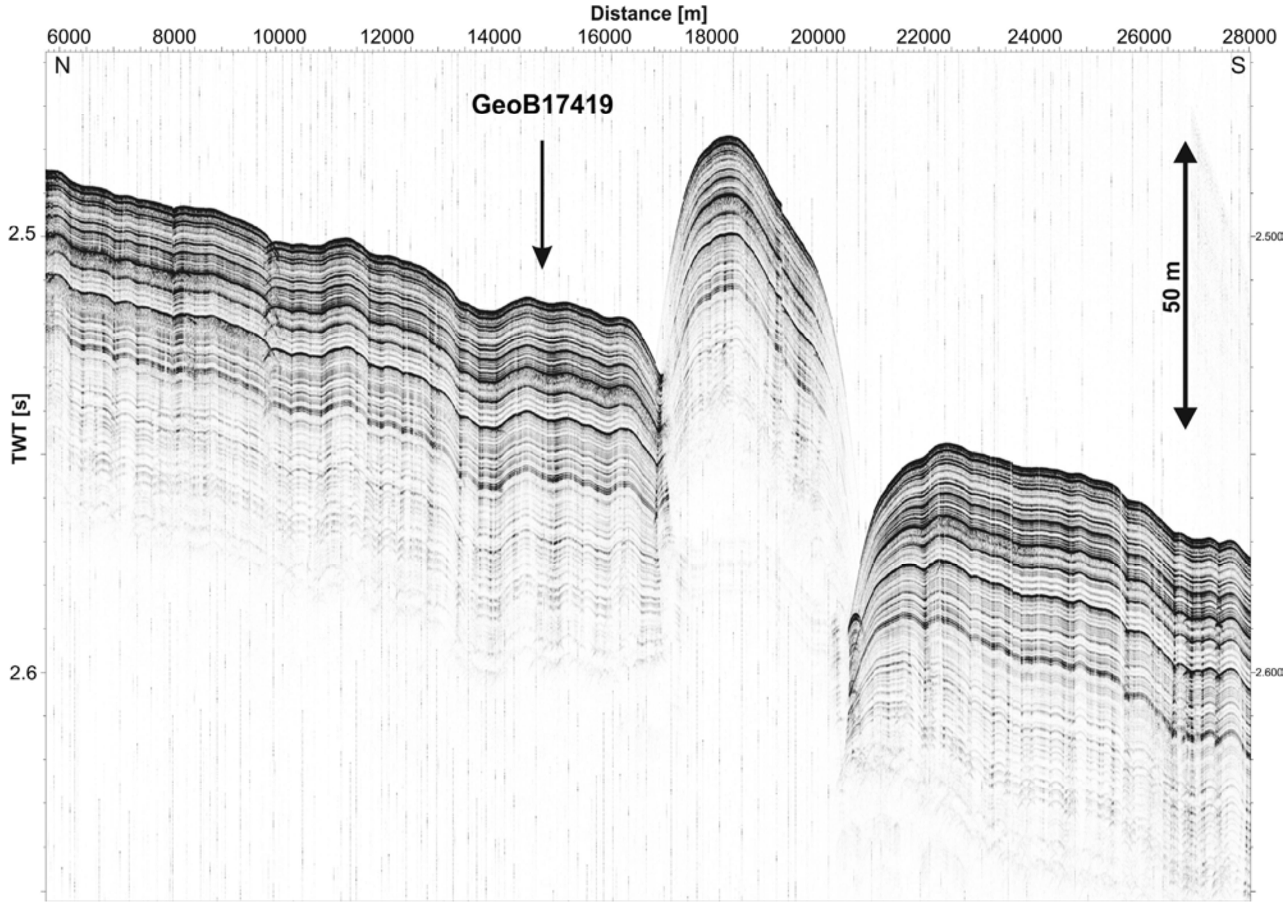


Fig. 5.7: Parasound Profile crossing an elevation in the southern part of the working area off Papua New Guinea. The position of coring site GeoB17419 is indicated.

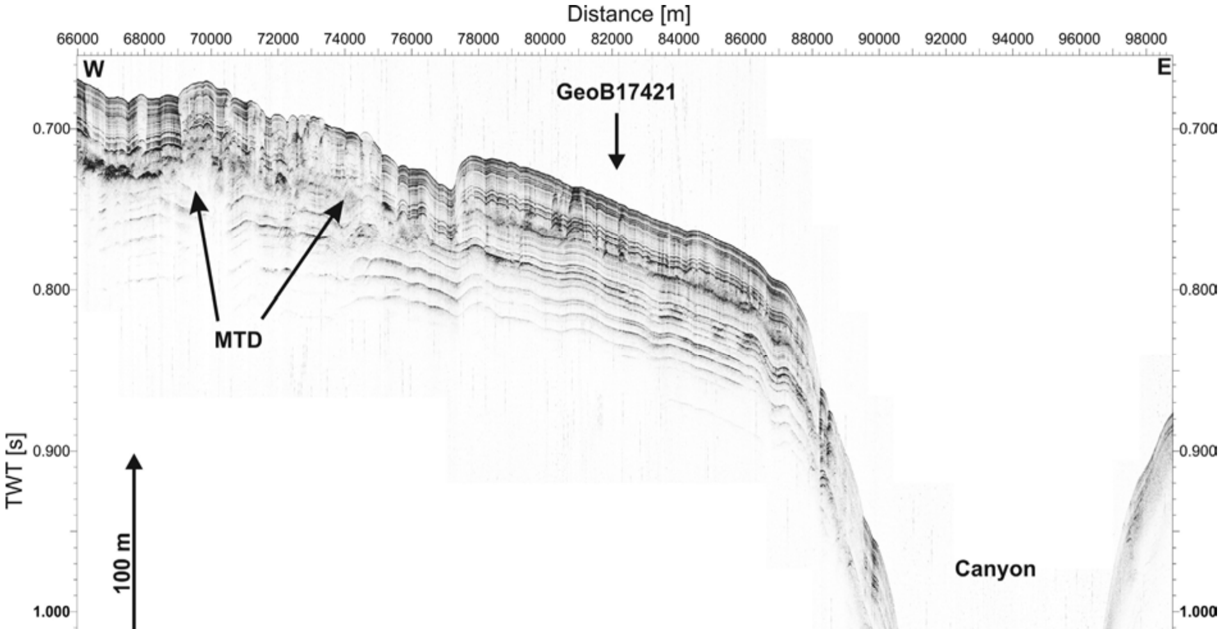


Fig. 5.8: Parasound Profile along the upper slope off Papua New Guinea. The position of coring site GeoB17421 is indicated.

5.3 Multi-channel seismic

5.3.1 Technical description

The GeoB multichannel seismic equipment was used during Cruise SO-228 to carry out pre-site surveys for the IODP proposal 779-full to provide high resolution seismic images of the upper hundreds of meter of the seafloor. One seismic source was used at the starboard stern of the ship and a short streamer was deployed on the port side. In the following, all components are described in detail.

The seismic source used was a Sodera GI-Gun. During the first survey (east of Mindanao) the gun was shot with 0.4 L generator volume and 0.4 L injector volume (frequency range app. 30-600 Hz) operated in harmonic mode. Since the S/N ration was disappointing during the first survey, the gun was changed to 1.7 L volume for both chambers (harmonic mode) for the second and third survey (Davao Bay and Papua-New Guinea) to reach sufficient penetration depth. The gun was towed on the starboard side using the standard hanger assembly app. 20 m behind the stern. The gun depth was controlled by a buoy above the hanger to a total towing depth of ca. 1m. Towing geometries are shown in Fig. 5.9. The gun was fired in the first survey area at an interval of 5000 to 8000 ms, depending on the water depth. During the second and third survey, firing rate was always 7000 ms.

On the port side of the ship's stern a conventional analogue streamer (Teledyne) was towed. It contains 16 groups of hydrophones with a spacing of 6.25, thus providing a total length of the active section of 100 m. Separation of the active section from the ship was maintained by an elastic stretch section of 25 m length and a lead-in of 58 m length. 20m behind the streamer a small tail buoy was connected to allow a visual position control and keep the streamer in a line. The streamer buoyancy was adjusted with lead attachments. No active depth levellers were available on this cruise. Checking the shape of the sea floor reflection (Ghost) shows variable depths of the streamer depending of the course and velocity through water of the ship in relation to the (strong) surface currents. Even partly a distinct ghost was visible, the streamer was let in this depth due to fisherman activities with a lot of crossings of small boats.

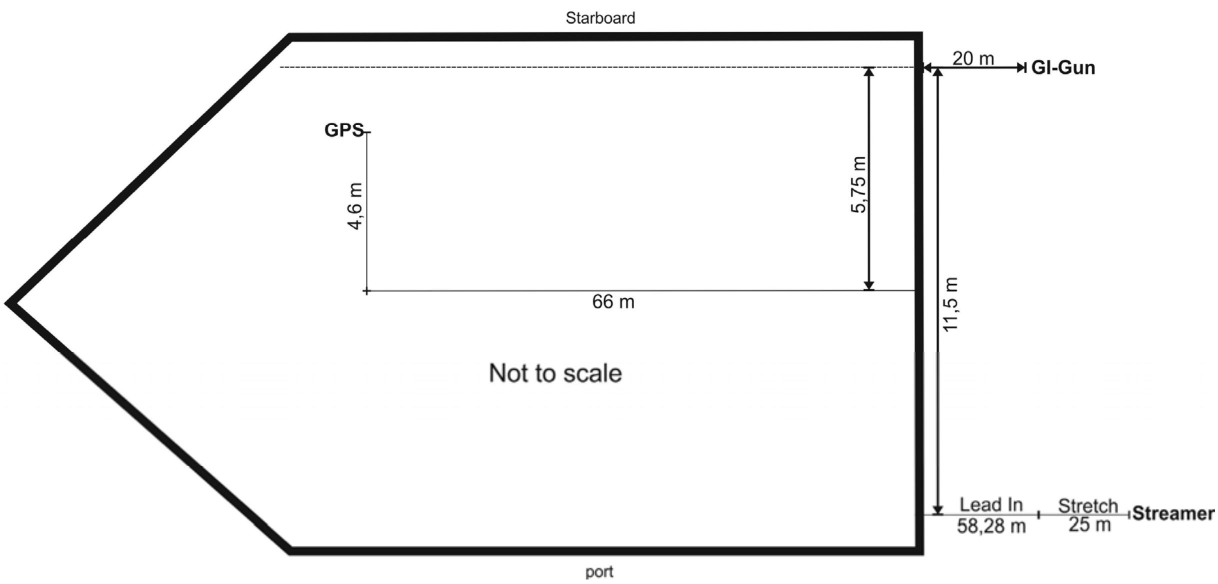


Fig. 5.9: Towing geometry of the seismic equipment.

For data recording of the 16 channel analog streamer, the custom-designed and PC-based 16-channel seismic acquisition unit (SAU3) was used. The system consists of a 16 channel USB-AD-converter (NI USB 6259) with an additional analog amplifierboard and channel based antialias filters, limiting the maximum frequency to 500 Hz. The SAU3 was connected to a standard Lenovo Notebook equipped with the custom reliable MaMuCS (Marine MultiChannel Seismics) software for data recording, storage and online visualisation. It provides online data display of shot gathers as well as a brute stack section of the range of channels of the user's choice, and stores data in SEG-Y format on the internal hard disk drive. First back-up copies were created during intervals of no seismic activity on an external disk. The total recording length was set to 3000 ms at a sample rate of 250 µs, a recording delay between 0 and 4000 ms was applied to the data depending on the actual water depth. After some tests, the measurement range of the AD-Converter was adjusted to 1 V.

The trigger unit controls the timing of the seismic source and the recording unit. The custom made 6 channel trigger generator (SCHWABOX), which is built into the SAU3 system was used in conjunction with a two channel trigger amplifier driving the solenoid valves of the GI-gun. The SCHWABOX is connected via USB to the recording notebook and programmed with a small custom software tool. The system allows defining arbitrary combinations of trigger signals. Trigger times can be changed at any time during the survey. Through this feature, the recording delay can be adjusted to any water depth without interruption of data acquisition. As only one gun was used, trigger times depend only on the water depth.

Time synchronization of all systems was done based on GPS time, using the shipboard system GPS signal distributed via Ethernet UDP broadcast in the ship’s network. Raw navigation data was recorded for the whole cruise on a separate navigation PC which also provided a map view of the study areas.

The data quality varies significantly. During the first survey off East-Mindanao, the S/N ratio is quiet poor. Yet, it is not fully clear, why. However, it seems to be a mix of reasons. First, the seafloor was very rough in this area causing a lot of scattering of the sound energy. This was also observed in the PARASOUND and EM120 data, which shows poor quality as well. Second, after starting surveying the second area it turned also out that we might have had a problem with the gun, since S/N ratio did not improved even we changed to the 1.7 L chamber volume. After some other trials we changed the sockets for the trigger amplifier, and even it is not clear why, the sound energy of the gun increased so the S/N ratio became acceptable. Third, there was real problem with the ship´s electric net due to a short circuit creating a strong 50 Hz signal and it harmonics, which affected the recorded seismic signal. Also this problem was solved during the second survey that the 50 Hz noise was on a "normal" level. And finally, it turned out the streamer is quite sensitive to changes in the speed through water. Since the areas were characterized by surface currents up to 2 kn, it was tried to adapt the speed depending on the course to avoid velocities of more than 5 kn through water.

Especially the second survey was affected by a lot of fishing boats crossing the course of the ship or anchoring on the planned profiles. Both led to numerous maneuvers, therefore many seismic profiles do not follow a straight line.

5.3.2 Onboard processing

Brute stacks of the recorded data were created already online by the custom recording software MaMuCS. Onboard processing of seismic data was carried out using the commercial software package VISTA for Windows (GEDCO). For cruise planning in the second and third working area, raw data were filtered, gained and shot stacks were created. These shot stacks were loaded into the commercial seismic interpretation system The Kingdom Software (Seismic Micro Inc.). This step provided a very fast means to visualize the recorded data nearly immediately after recording in a geo-referenced system and allowed a highly flexible survey planning based on the observed sedimentary structures.

5.3.3 Preliminary results

The first survey (off East Mindanao) started at the 09.05.2013 at around 06:30 UTC and finished at the 11.05.2013 at 03:10 UTC (= 44:40h in total). Data were collected on 15 Profiles (Fig. 5.10) with a total length of ~210 nm. 28,906 shots were recorded. The survey was interrupted by ~1.5 hours during Profile GeoB13-041 due to a break of the air umbilical at the hanger of the gun. Also the connection between buoy and hanger had to be renewed.

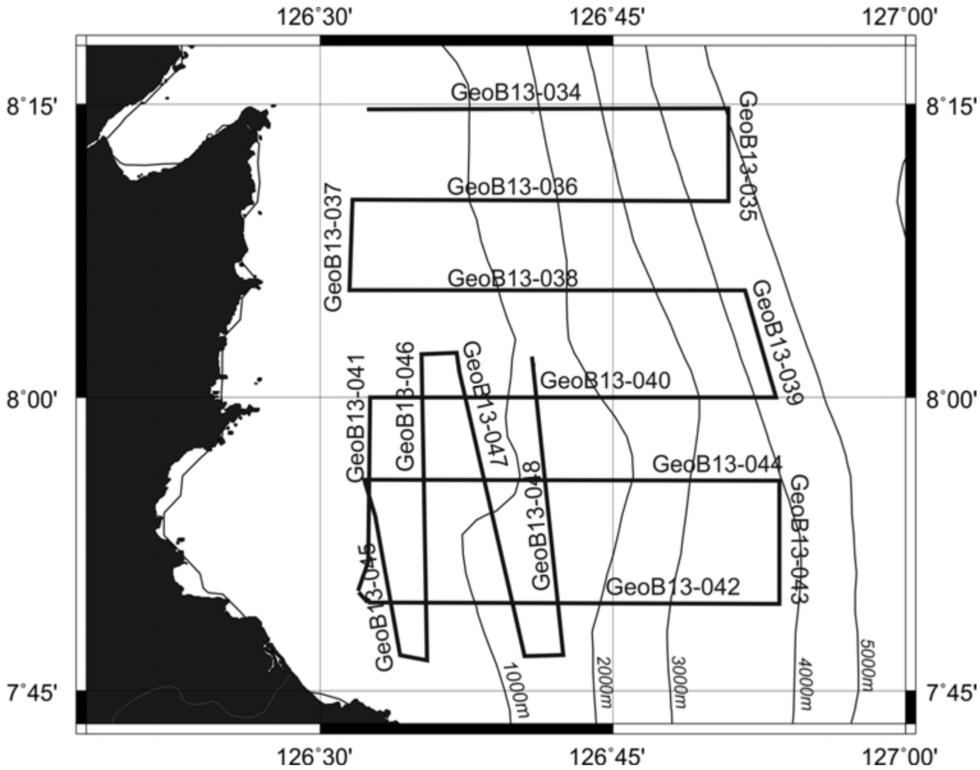


Fig. 5.10: Map of seismic profiles shot east of Mindanao.

As mentioned in the chapters dealing with bathymetric and sediment echosounder data, the seafloor in the first working area east of Mindanao is really rough. Consequently, the multichannel seismic data show on many lines a lot of diffraction hyperbolae and side echoes. It will be a time-consuming task to process the data. In the brute stacks, it is hard to identify any location for suitable IODP sites, however, this can be only verified after a full multichannel processing.

Best data were collected in shallow waters around 500 m depth, were sedimentary structures are visible beneath flat terraces between deeply incised canyons. Profile GeoB13-045 (Fig. 5.11) shows that especially north of the canyons nearly 250 m of sediments were deposited, probably as levee deposits. However, this water depth is not perfect for the targets of IODP proposal 799-full. The seismic data reveal also, that the canyons were once much deeper incised, and show now a filling of at least 250 m.

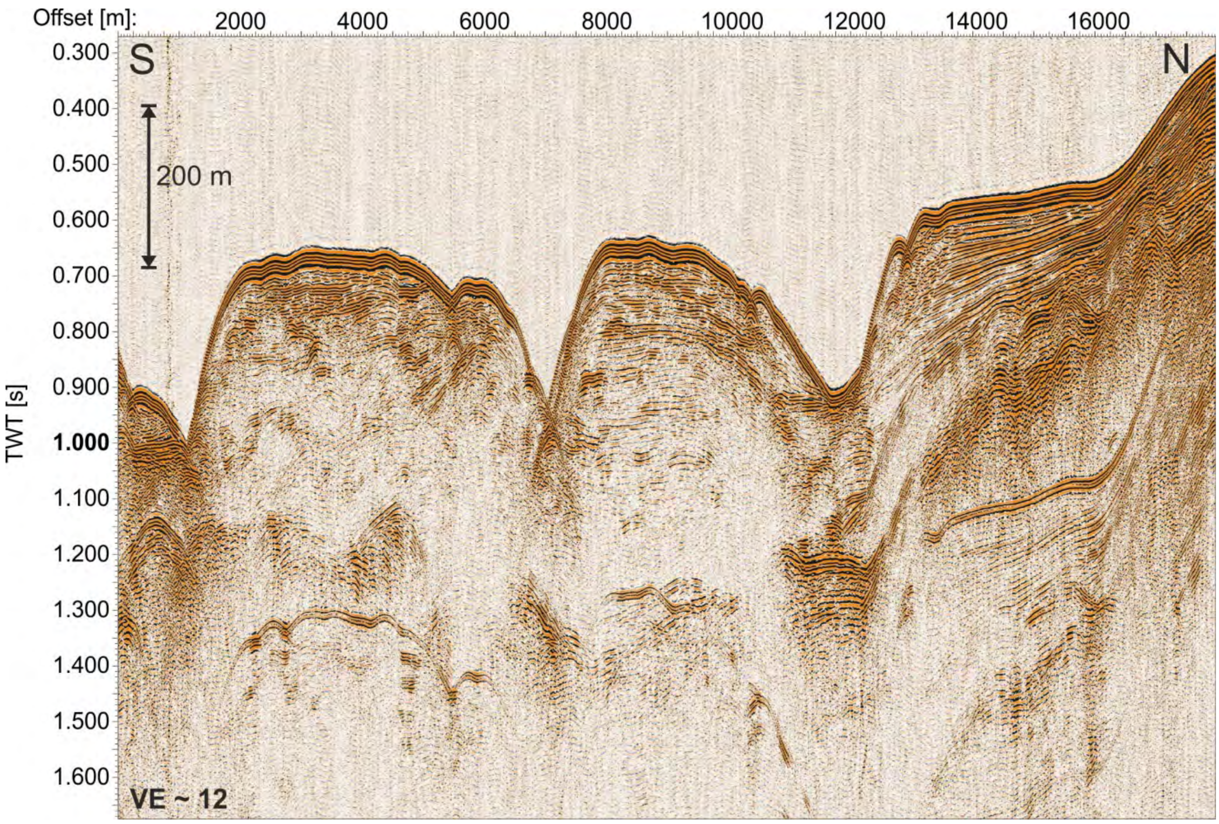


Fig. 5.11: Brute stack of seismic data collected on Profile GeoB13-045 crossing from north to south three shelf canyons.

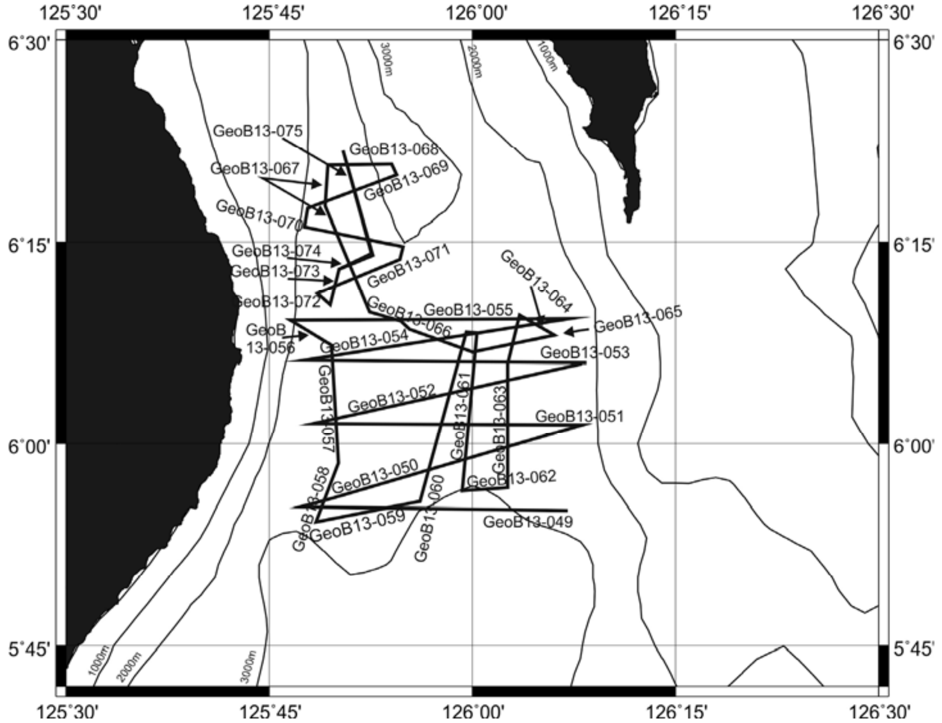


Fig. 5.12: Map of seismic profiles shot in the Davao Bay

The second survey (Davao Bay) started at the 15.05.2013 at around 04:00 UTC and finished at the 18.05.2013 at around 00:45 UTC (= 68:45h in total). Data were collected on 27 Profiles (Fig. 5.12) with a total length of ~290 nm. 34,272 shots were recorded. The survey was interrupted by ~ 2.5 hours at the end of Profile GeoB13-070 due to a total Black-Out of the ship which required a very fast retrieval of the seismic equipment. After retrieval it turned out that the umbilical was heavily damaged and had to be exchanged. Finally, also the compressor of the ship had technical problems which could be solved after one hour.

The surveying of the second working area (Davao Bay) concentrated first on the southern part of the bay. The sedimentation of the basins is dominated by mass transport deposits. Undisturbed sediments could be only roughly seen on top of the ridges, however, due to the reflection geometry the image quality is poor for these areas. Finally the survey was extended to a northern basin, where promising locations for IODP sites were detected. However, also this data set has to be fully processed before a valid statement can be given. Profile GeoB13-070 (Fig. 5.13) crosses the basin from west to east and shows a filled channel in its centre, surrounded by other sediment deposits. West of the channel, the sediments build up terraces characterized by parallel, continuous reflectors. East of the channel the deposits look more complex. Mass transport deposits can be partly identified, but it seems that some areas might be free of such disturbed deposits and therefore suitable drill sites should be assigned here. But it is also noteworthy to realize, that the thickness of undisturbed sediment packages does not exceed 300 m.

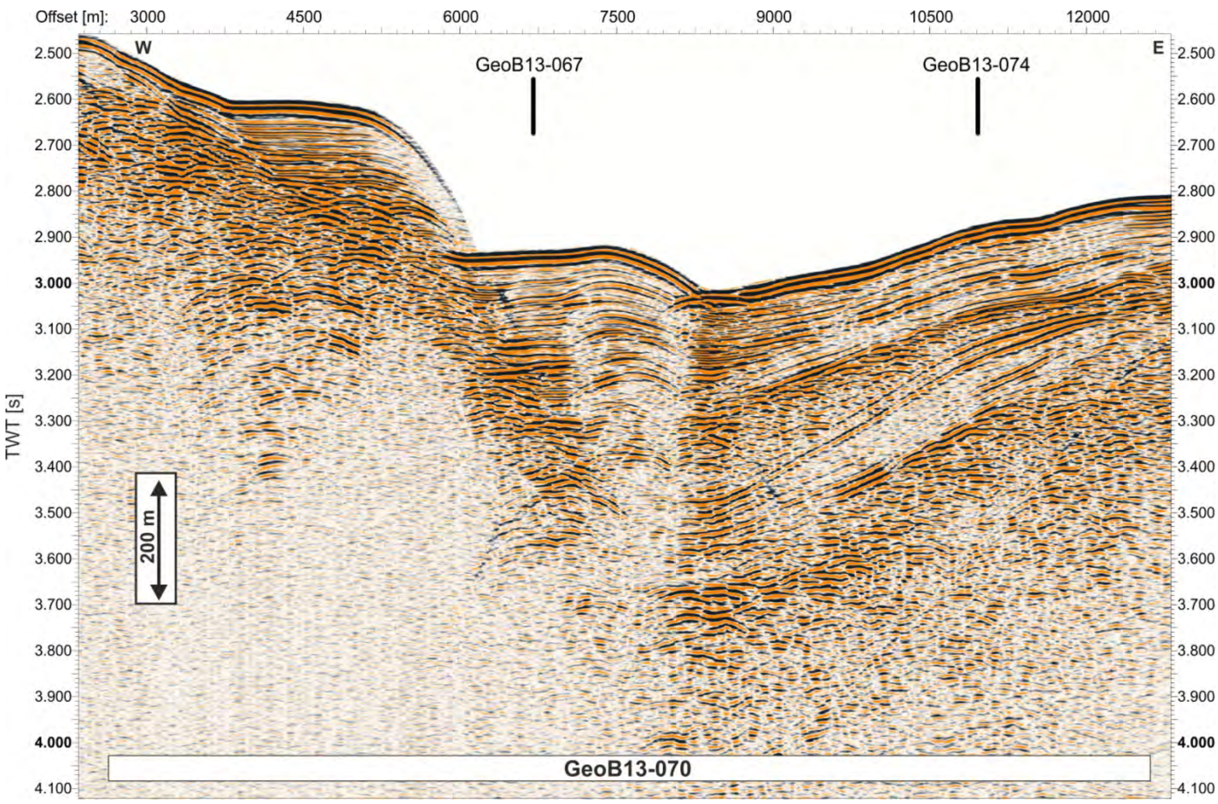


Fig. 5.13: Shot stack of multichannel seismic data collected on Profile GeoB13-070. The profile crosses the northernmost basin of the working area from west to east. Crossings with north-south orientated profiles are indicated.

The third survey north of Papua-New Guinea started at the 24.05.2013 at around 23:30 UTC and finished at the 26.05.2013 at around 09:15 UTC (= 33:45h in total). Data were collected on 13 Profiles (Fig. 5.14) with a total length of ~170 nm. 17,153 shots were recorded.

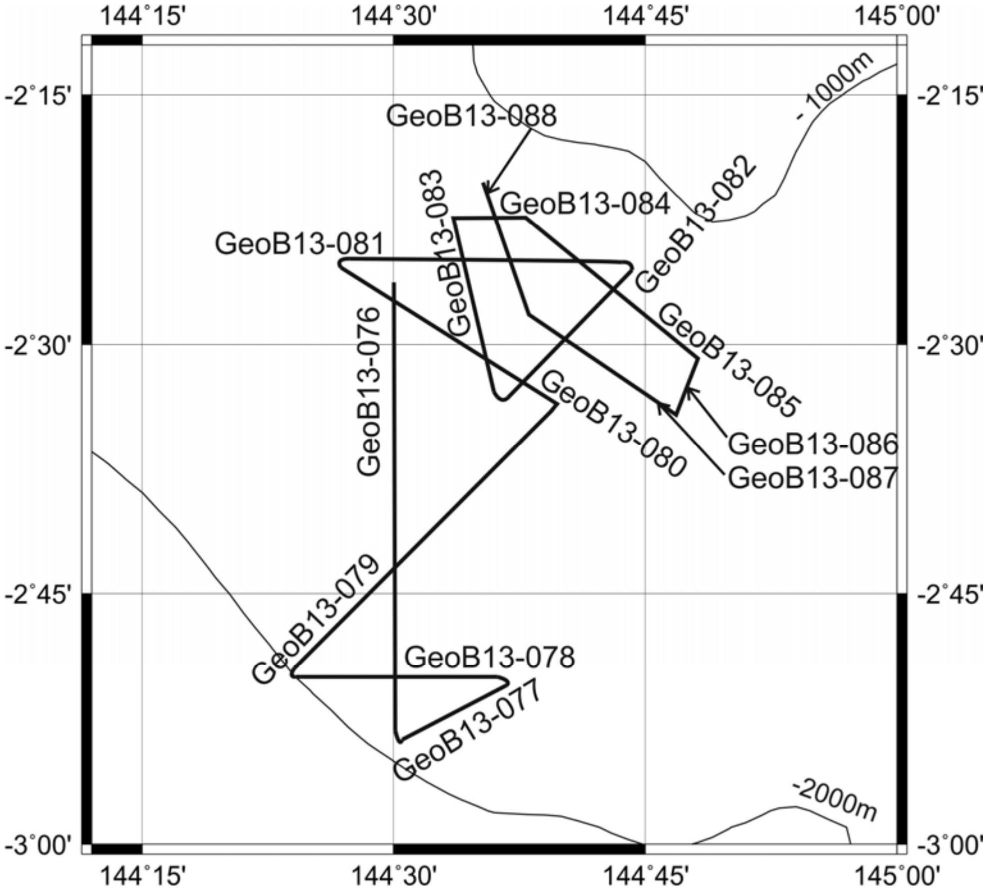


Fig. 5.14: Survey map of seismic profiles north of Papua New Guinea.

The survey of the third working area started with a north-south running profile, which connects the dedicated IODP sites in the Proposal 779-Full. As expected from results of a former RV Marion Dufresne cruise, the upper tens of meter showed parallel layered, undisturbed sediments. However, the total thickness of sediments above the basement never exceeds 70-80 meters, which is too thin for the targets of the IODP proposal. Cruising to north-east revealed thicker sediment packages there. As visible in Profile Geob13-081 (Fig. 5.15), these packages can reach up to 200 meters and appears as distinct blocks on the basement bordered by steep steps of the seafloor. All seismo-acoustic data sets suggest that these steps representing headwalls as result of slope failures, and that the thicker packages are units which were not affected by mass wasting. A detailed analysis after a full processing has to be carried out to decipher if there are totally undisturbed units with a continuous succession of sediments without unconformities. A first interpretation of the data suggests that the upper and the lower part of the sediments can be traced through the whole area, but that an intermediate part had been removed in the region of mass wasting.

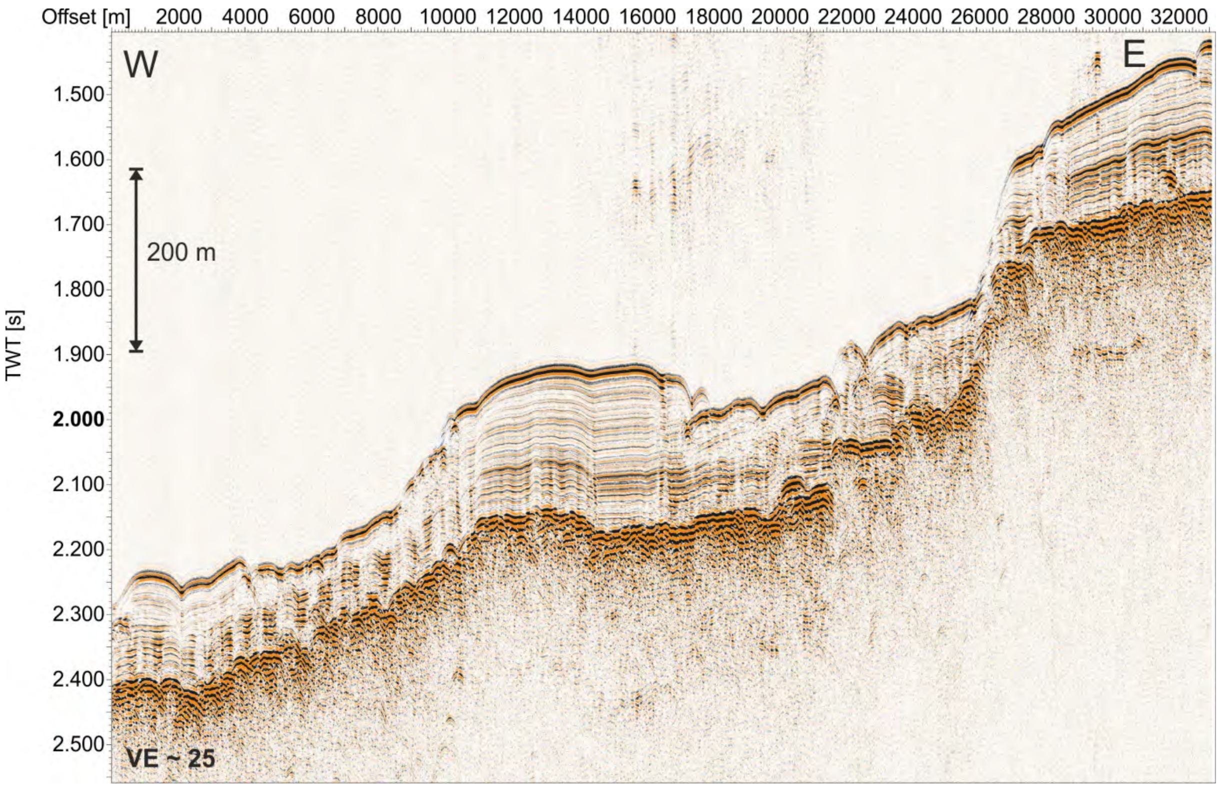


Fig. 5.15: Shot stack of multichannel seismic data collected on Profile GeoB13-081. The profile crosses the northern part of the working area from west to east and displays one of the thicker packages of undisturbed sediment.

5.4 Profile lists

1) Profile list of working area 1 (east of Mindanao)

Time start of profile UTC	Time end of profile UTC	Latitude start of profile xx° xx.x‘	Longitude start of profile xx° xx.x‘	Latitude end of profile xx° xx.x'	Longitude end of profil xx° xx.x'	MaMUCS FFN start	MaMuCS FFN end	Profile number
Thursday, 09. May 2013								
6:41	10:30	8°15.30	126° 32.75	8° 14.632	126° 50.882	131	2648	**GeoB13-034**
10:33	11:23	8° 14.370	126° 51	8° 10.181	126° 51.021	2680	3074	**GeoB13-035**
11:27	15:12	8° 10.004	126° 50.76	8°10,08	126°31,81	3116	5608	**GeoB13-036**
15:18:00	16:05:00	8°9,677	126°31,512	8° 5.635	126° 31.51	5682	6260	**GeoB13-037**
16:11:00	20:10:00	8° 5.449	126° 31.68	8° 5.49	126° 51.84	6318	8977	**GeoB13-038**
20:13:00	21:17:00	8° 5.268	126° 51.998	8° 0.167	126° 53.493	9006	9550	**GeoB13-039**
21:20:00	01:24:00	7° 59.979	126° 53.3	8°0,024	126°32,07	9581	12277	**GeoB13-040**
Friday, 10.May 2013								
01:31:00	04:16:00	7°59,526	126°32,475	7° 49.619	126° 32.066	12356	13176	**GeoB13-041**
04:20:00	08:33:00	7° 49.497	126° 32.337	7° 49.51	126° 53.53	13222	16005	**GeoB13-042**
08:37:00	09:58:00	7° 49.72	126° 53.62	7° 55.73	126° 53.59	16035	16731	**GeoB13-043**
10:01:00	14:06:00	7° 55.84	126° 53.35	7°55,8	126°32,5	16763	19500	**GeoB13-044**
14:14:00	15:59:00	7°55,438	126°32,167	7° 47.014	126° 34.046	19597	20855	**GeoB13-045**
16:23:00	19:39:00	7° 46.921	126° 35.660	8° 2.2240	126° 35.173	21144	23053	**GeoB13-046**
20:05:00	23:08:00	8° 2.04	126° 37.13	7° 47.05	126° 60.33	23818	26000	**GeoB13-047**
23:40:00	03:10:00	7°47,24	126°42,51	8°02,01	126°40,90	26375	28906	**GeoB13-048**

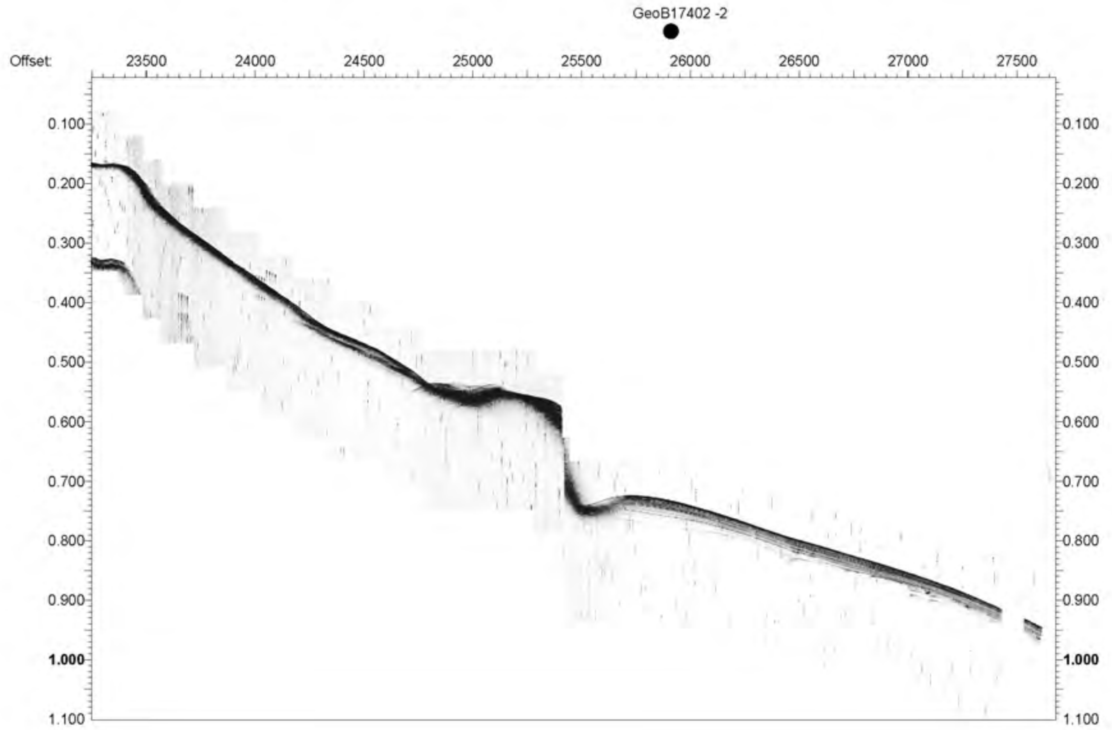
2) Profile list of working area 2 (Davao Bay)

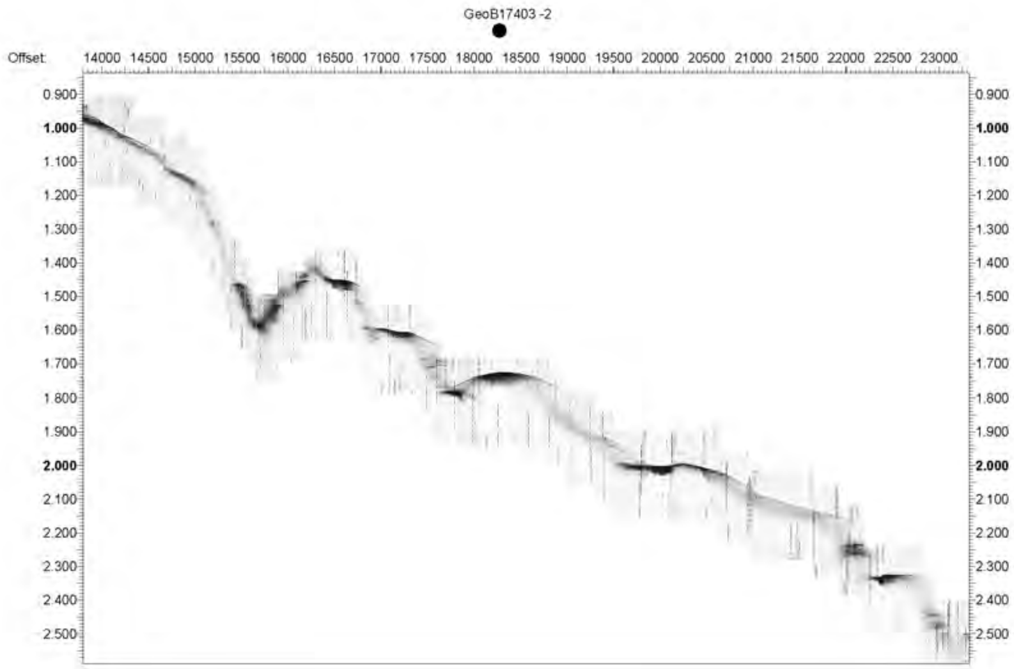
Time start of profile UTC	Time end of profile UTC	Latitude start of profile xx° xx.x'	Longitude start of profile xx° xx.x'	Latitude end of profile xx° xx.x'	Longitude end of profile xx° xx.x'	MaMUCS FFN start	MaMuCS FFN end	Profile number
Wednesday 15. May 2013								
03:58:00	06:28:00	5° 55.021	126° 6.625	5° 55.07	125° 54.65	604	1879	**GeoB13-049**
06:28:00	08:16:00	5° 55.07	125° 54.65	5° 55.12	125° 47.37	1880	2814	**GeoB13-049_1**
08:32:00	12:34:00	5° 55.79	125° 48.2	6° 1.18	126° 7.49	2950	5019	**GeoB13-50**
12:53:00	17:31:00	6° 1.41	126° 8.12	6° 1.23	125° 48.57	5182	7563	**GeoB13-51**
17:42:00	22:11:00	6° 1.72	125° 48.51	6° 5.90	126° 7.93	7658	9965	**GeoB13-52**
22:25:00	03:06:00	6° 6.07	126° 7.99	6°06,017	125°47,75	10085	12487	**GeoB13-53**
Thursday 16.May 2013								
03:29:00	07:35:00	6°06,3741	125°48,697	6° 08.99	126° 06.911	12672	14777	**GeoB13-54**
07:48:00	12:36:00	6° 09.36	126° 6.82	6°9,31	125°46,88	14880	17360	**GeoB13-55**
12:50:00	13:38:00	6°8,857	125°46,789	6°7,25	125°48,586	17472	17879	**GeoB13-56**
13:41:00	15:52:00	6°7,06	125°49,64	5°58.25	125°49.98	17908	19033	**GeoB13-57**
15:54:00	16:53:00	5°58.25	125°49.98	5°54.43	125°48.41	19047	19558	**GeoB13-58**
17:01:00	18:43:00	5°54.24	125°48.64	5°56.014	125° 56.25	19619	20498	**GeoB13-59**
18:46:00	21:30:00	5°56.014	125° 56.25	6° 7.99	125° 59.41	20520	21949	**GeoB13-60**
21:49:00	00:23:00	6° 8.01	126° 0.37	5°56,472	125°59,2	22094	23414	**GeoB13-61**
Friday 17. May 2013								
00:30:00	01:20:00	5°56,472	125°59,41	5°56,60	126°2,544	23475	23900	**GeoB13-62**
01:24:00	04:31:00	5°56,757	126°2,603	6° 9.244	126° 3.196	23936	25535	**GeoB13-63**
04:40:00	05:13:00	6° 9.403	126° 3.733	6° 8.557	126° 5.884	25609	25894	**GeoB13-64**
05:37:00	06:55:00	6° 7.926	126° 4.893	6° 6.822	126° 0.08	26106	26772	**GeoB13-65**
06:58:00	09:07:00	6° 6.862	125° 59.886	6° 9.69	125° 52.34	26796	27897	**GeoB13-66**
09:09:00	11:46:00	6° 9.79	125° 52.22	6° 20.38	125° 49.18	27918	29267	**GeoB13-67**
11:55:00	12:52:00	6°20,77	125°49,65	6° 20.809	125° 53.853	29340	29769	**GeoB13-68**
13:09:00	14:43:00	6° 19.917	125° 54.216	6° 17.390	125° 47.745	29973	30777	**GeoB13-69**
15:05:00	17:12 ??	6° 16.137	125° 47.598	??	??	30970	31640	**GeoB13-70**
19:43:00	20:04:00	6°14.68	125°54.78	6° 13.51	125° 54.16	31672	31848	**GeoB13-70_1**
20:04:00	21:26:00	6° 13.51	125° 54.16	6° 11.23	125° 48.59	31848	32556	**GeoB13-71**
21:50:00	22:21:00	6° 10.59	125° 49.58	6° 12.91	125° 50.12	32755	33027	**GeoB13-72**
22:23:00	22:54:00	6° 13.02	125° 50.25	6° 13.84	125° 52.47	33050	33315	**GeoB13-73**
23:11:00	23:34:00	6° 15.00	125° 52.18	6° 16.67	125° 52.03	33462	33651	**GeoB13-74**
23:34:00	00:46:00	6° 16.67	125° 52.03	6°21,79	125°50,39	33651	34272	**GeoB13-75**

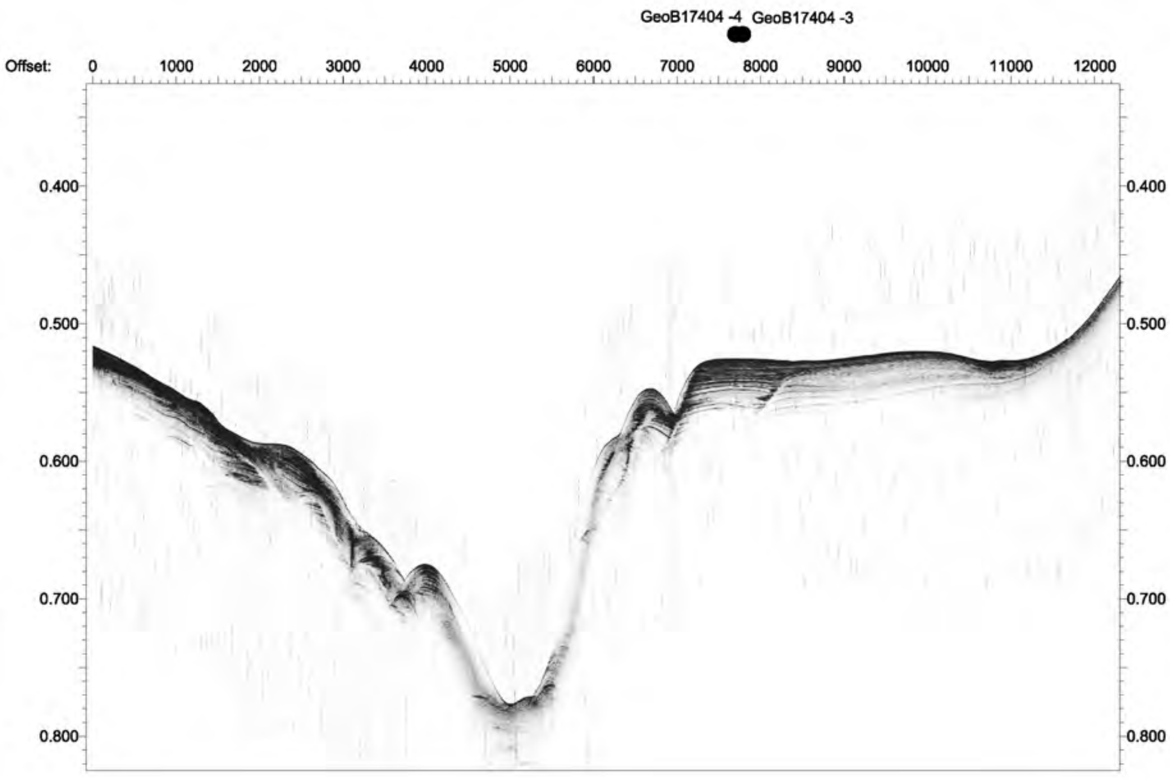
Profile list of working area 3 (off Papua New Guinea)

Time **start of profile** **UTC**	**Time** **end of profile** **UTC**	**Latitude** **start of profile** **xx° xx.x'**	**Longitude** **start of profile** **xx° xx.x'**	**Latitude** **end of profile** **xx° xx.x'**	**Longitude** **end of profile** **xx° xx.x'**	**MaMUCS FFN** **start**	**MaMuCS FFN** **end**	**Profile number**
Friday, 24. May 2013								
23:53:00	04:15:00	- 2° 26.540	144° 30.034	-2° 45.75	144° 30.021	45	2268	**GeoB13-076**
Saturday, 25. May 2013								
04:15:00	05:58:00	-2° 45.75	144° 30.021	-2° 53.79	144° 30.01	2268	3147	**GeoB13-076_1**
06:03:00	07:27:00	-2° 53.83	144° 30.33	-2° 50.22	144° 37.18	3191	3918	**GeoB13-077**
07:40:00	09:58:00	-2° 49.98	144° 36.41	-2° 50.00	144° 23.91	4026	5210	**GeoB13-078**
10:20:00	14:36:00	-2° 49.58	144° 23.91	-2° 33.790	144° 39.674	5394	7593	**GeoB13-079**
14:42:00	17:36:00	-2° 33.413	144° 49.430	-2° 25.37	144° 26.89	7640	9133	**GeoB13-080**
17:46:00	21:02:00	-2° 24.84	144° 27.069	-2° 24.99	144° 44.20	9223	10900	**GeoB13-081**
21:09:00	23:29:00	-2° 25.49	144° 44.19	-2° 33.657	144° 36.386	10960	12163	**GeoB13-082**
23:37:00	01:34:00	-2° 33.426	144° 36.031	-2° 22.492	144° 33.633	12220	13204	**GeoB13-083**
Sunday, 26. May 2013								
01:41:00	02:23:00	-2° 22.246	144° 33.992	-2° 22.472	144° 37.895	13260	13622	**GeoB13-084**
02:30:00	04:58:00	-2° 22.869	144° 38.187	-2° 30.699	144° 48.079	13674	14947	**GeoB13-085**
05:05:00	05:47:00	-2° 31.174	144° 48.122	-2° 04.256	144° 46.922	15005	15372	**GeoB13-086**
05:54:00	07:33:00	-2° 34.295	144° 46.411	-2° 28.89	144° 39.06	15428	16376	**GeoB13-087**
07:47:00	09:17:00	-2° 28.13	144° 38.08	-2° 20.270	144° 35.317	16378	17153	**GeoB13-088**

5.5. Parasound images of all sediment coring stations during the 1st leg



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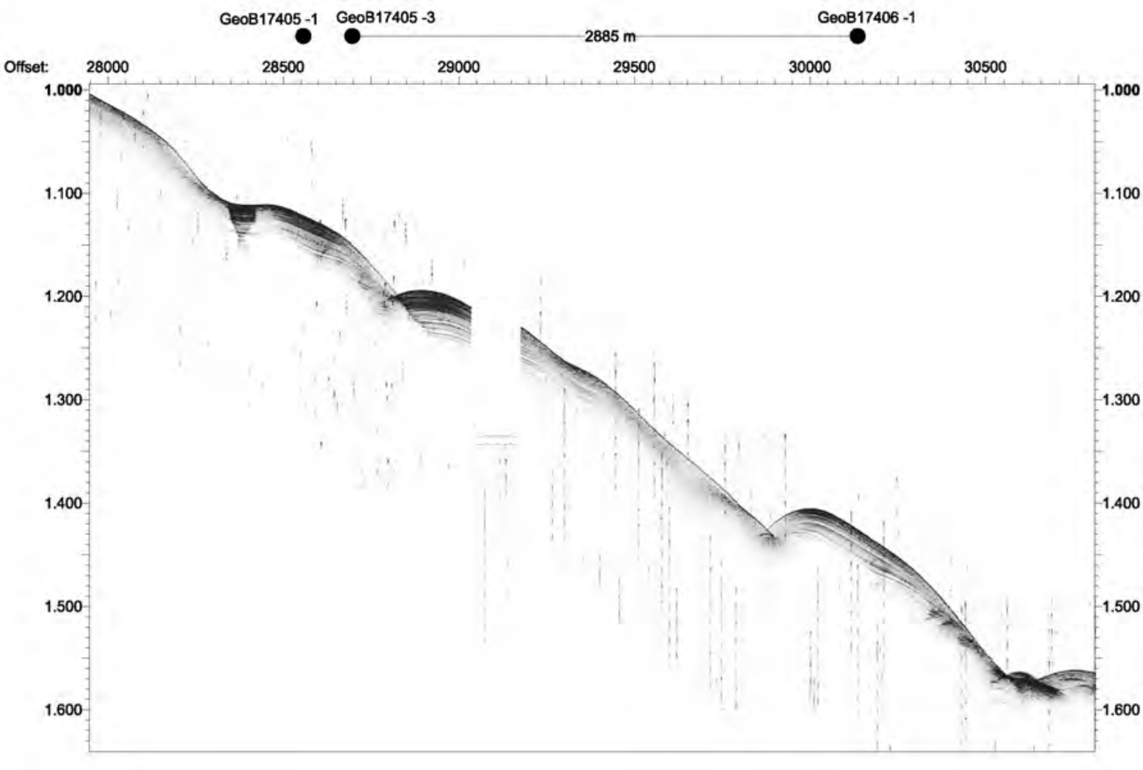
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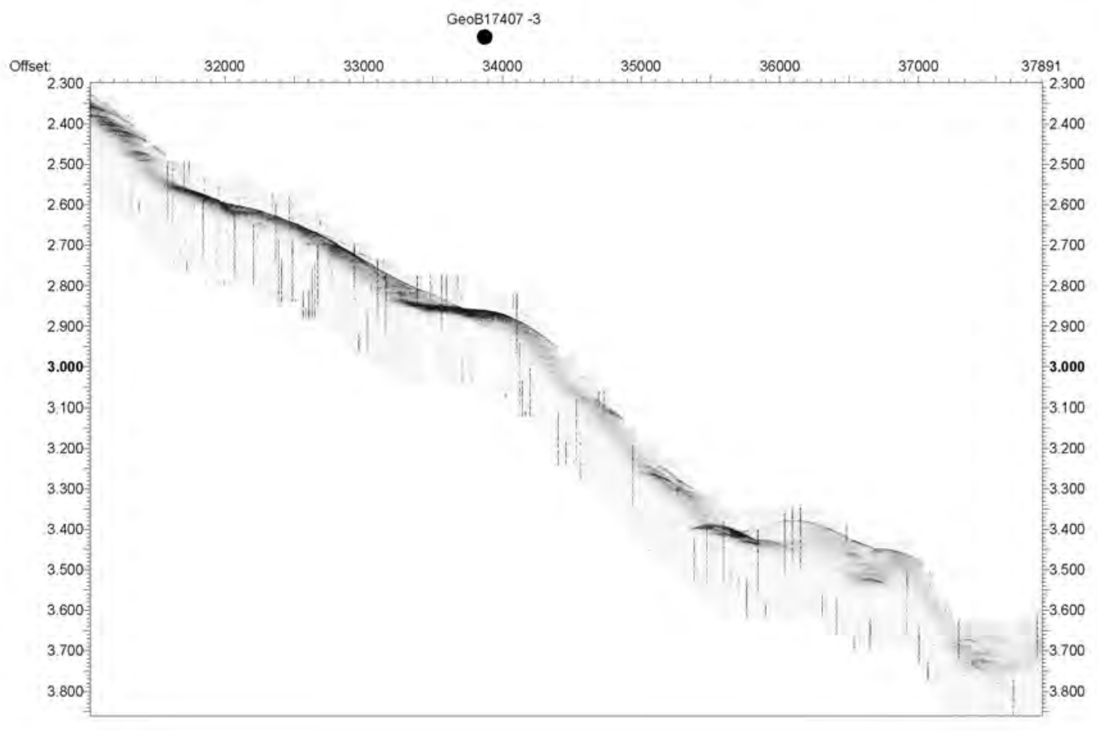
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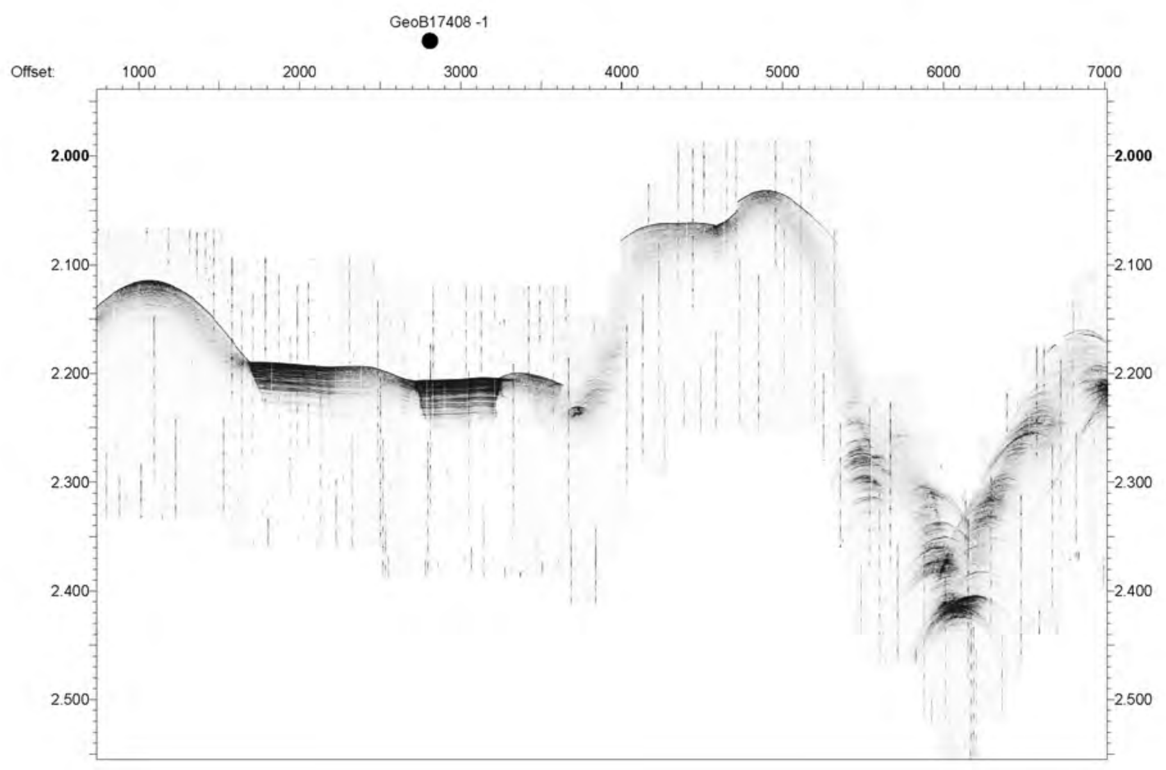
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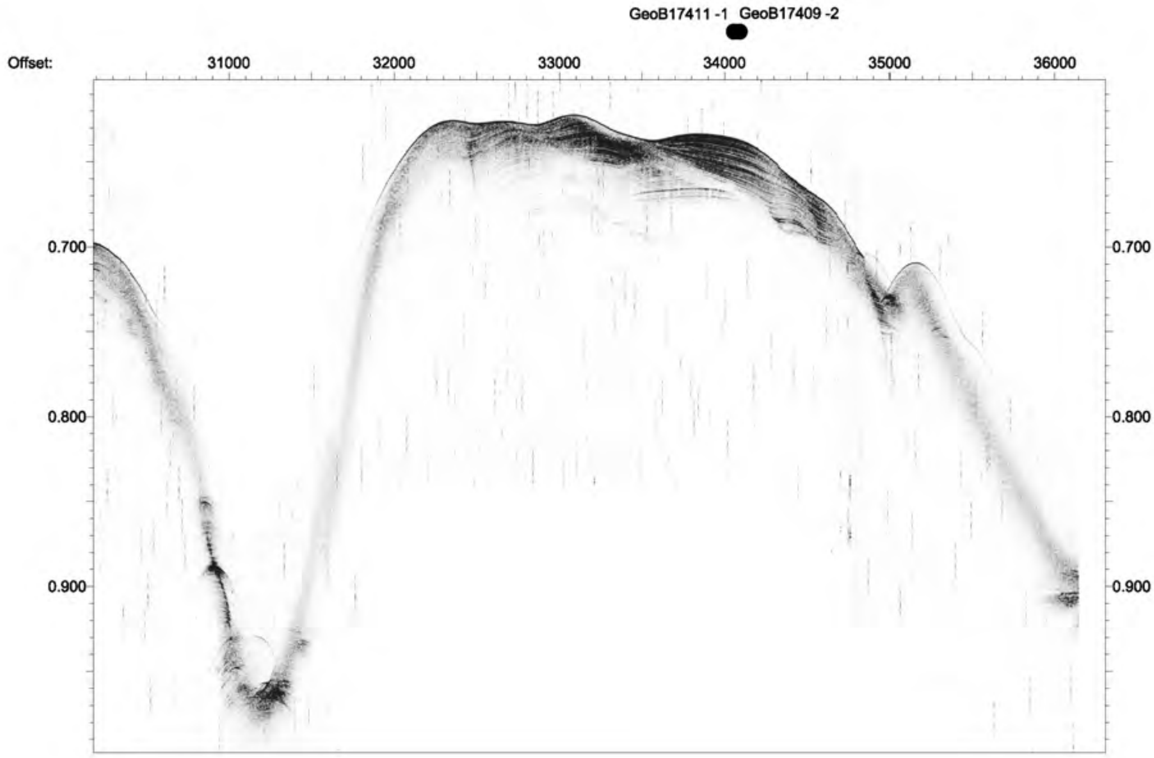

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33000
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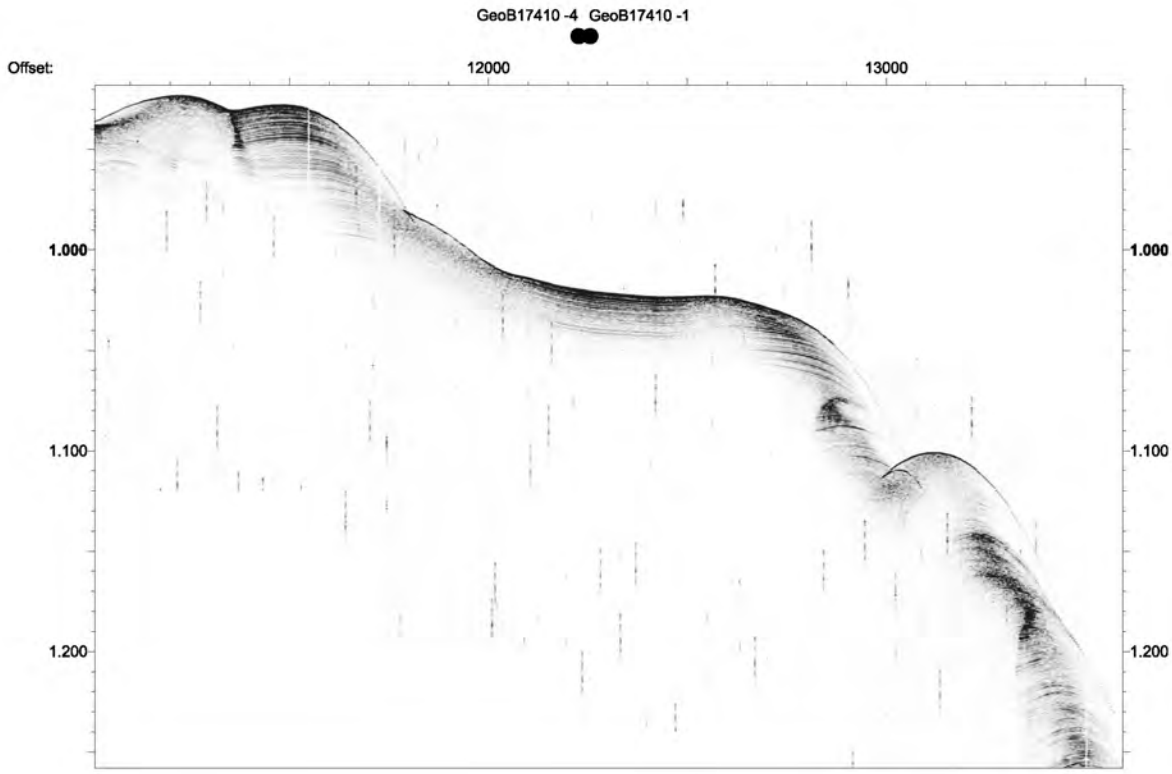

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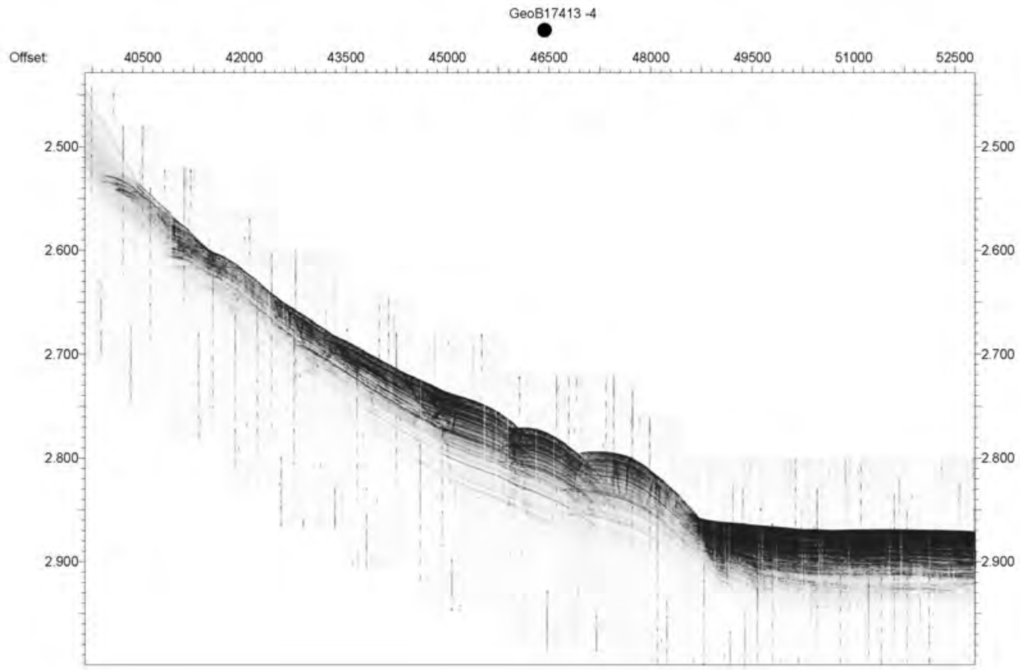
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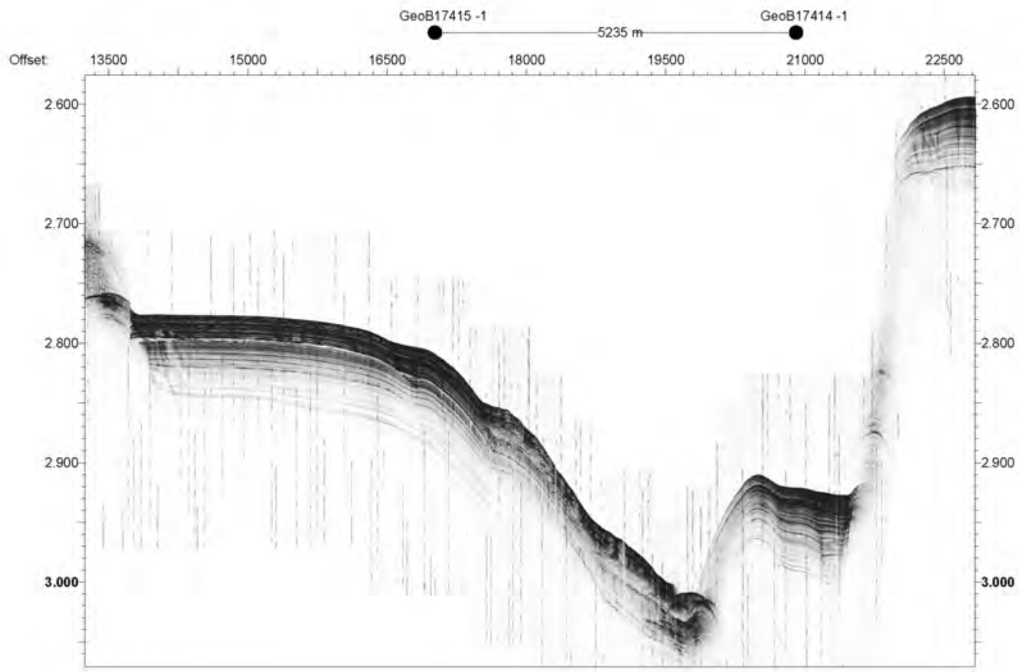
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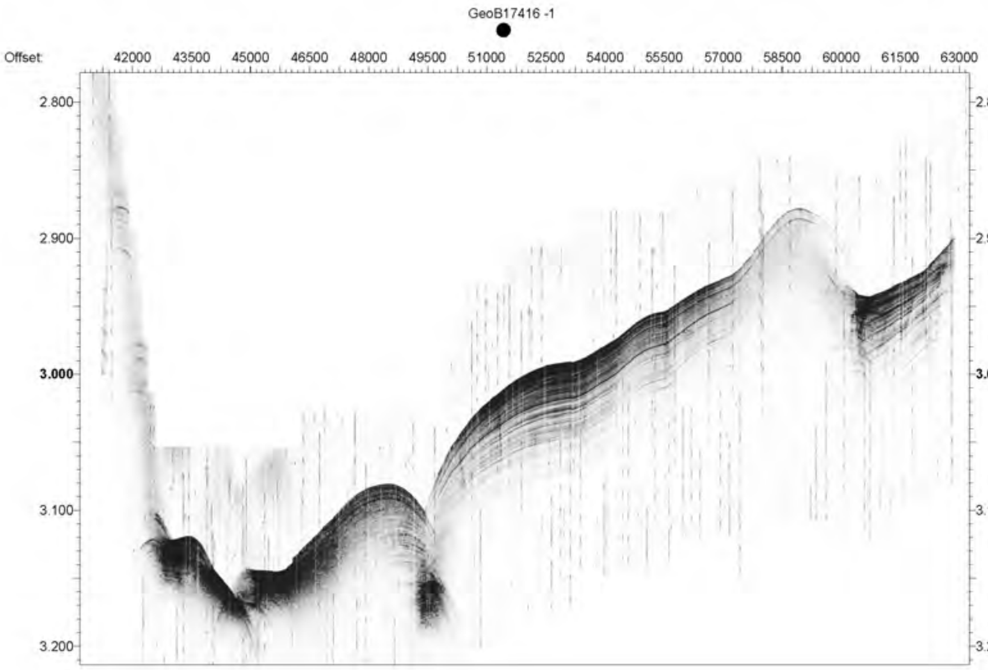
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3.000
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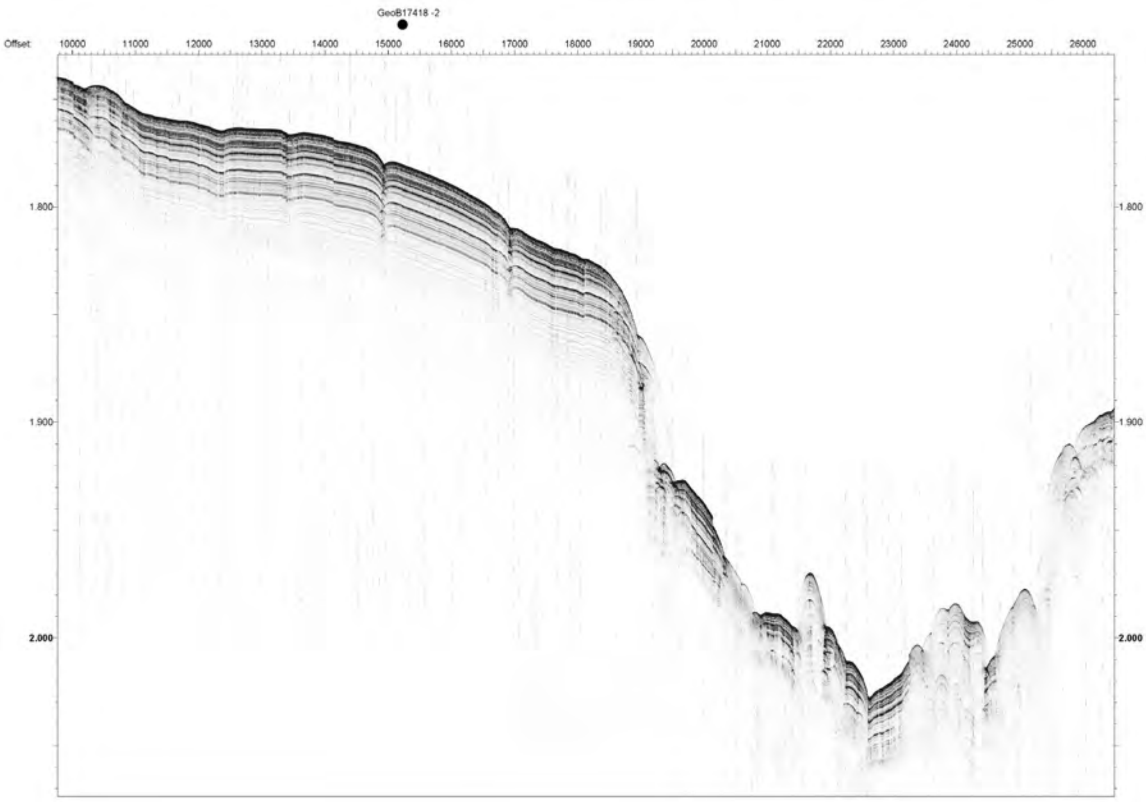
3.200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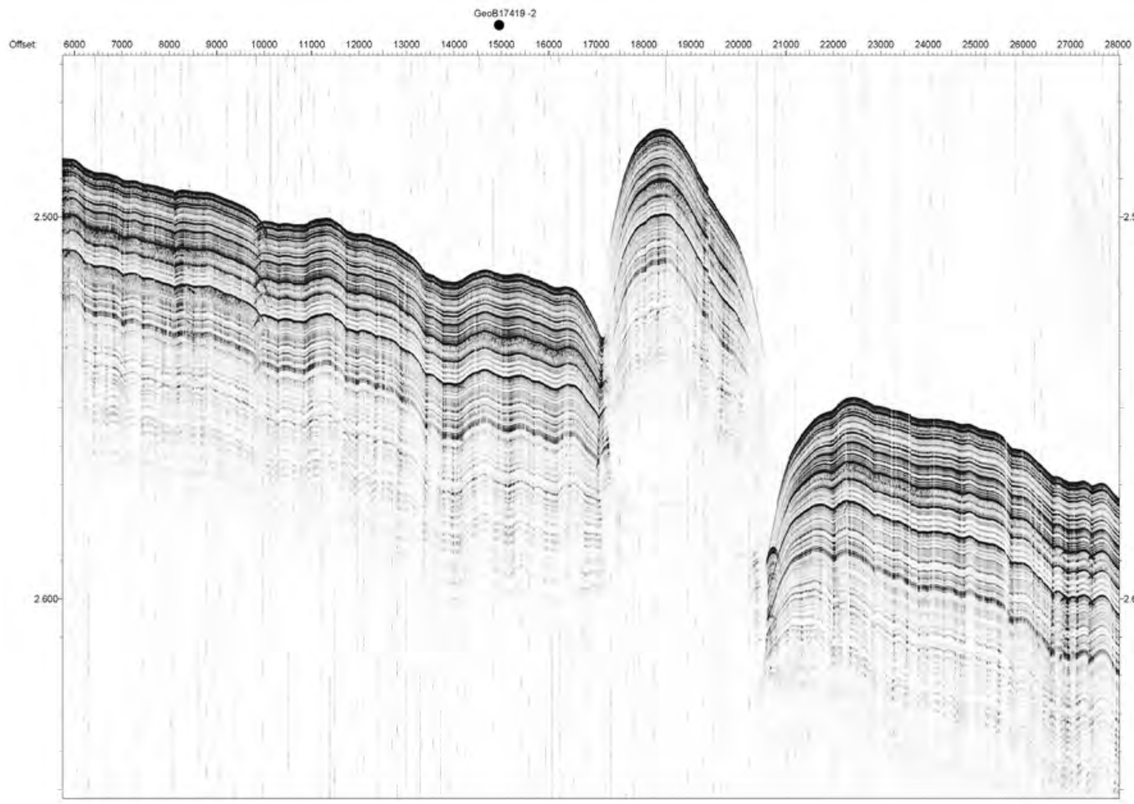
2.000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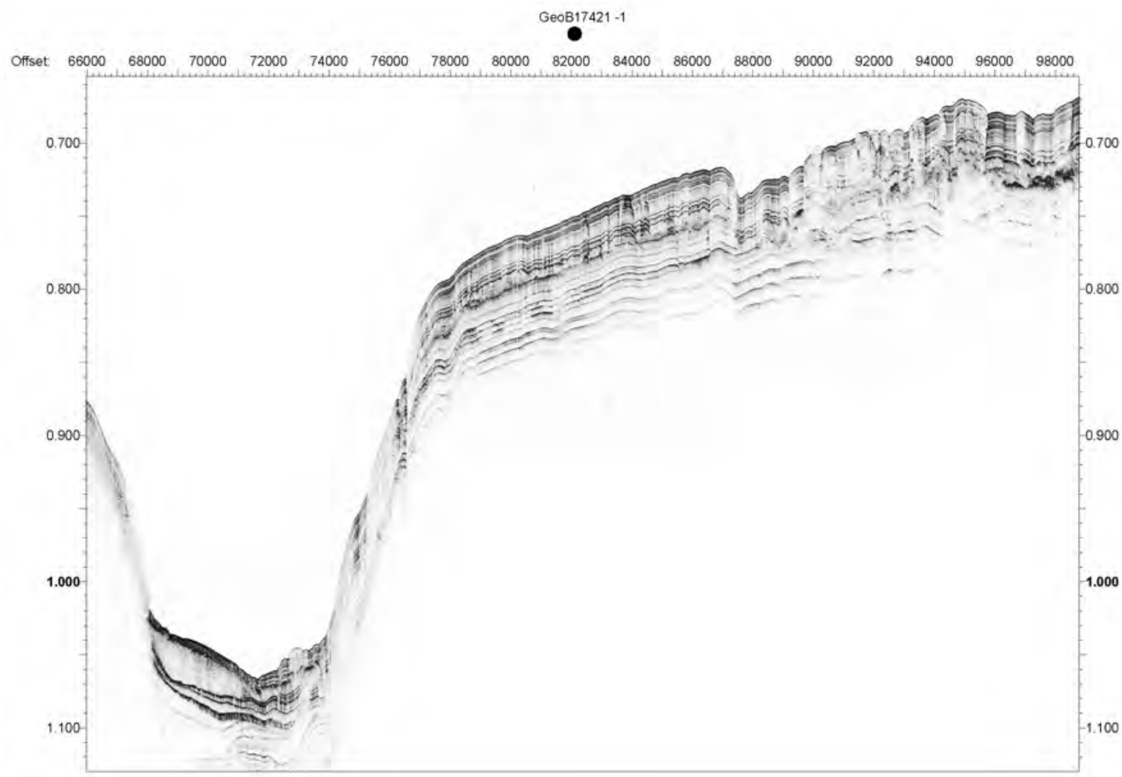
2.600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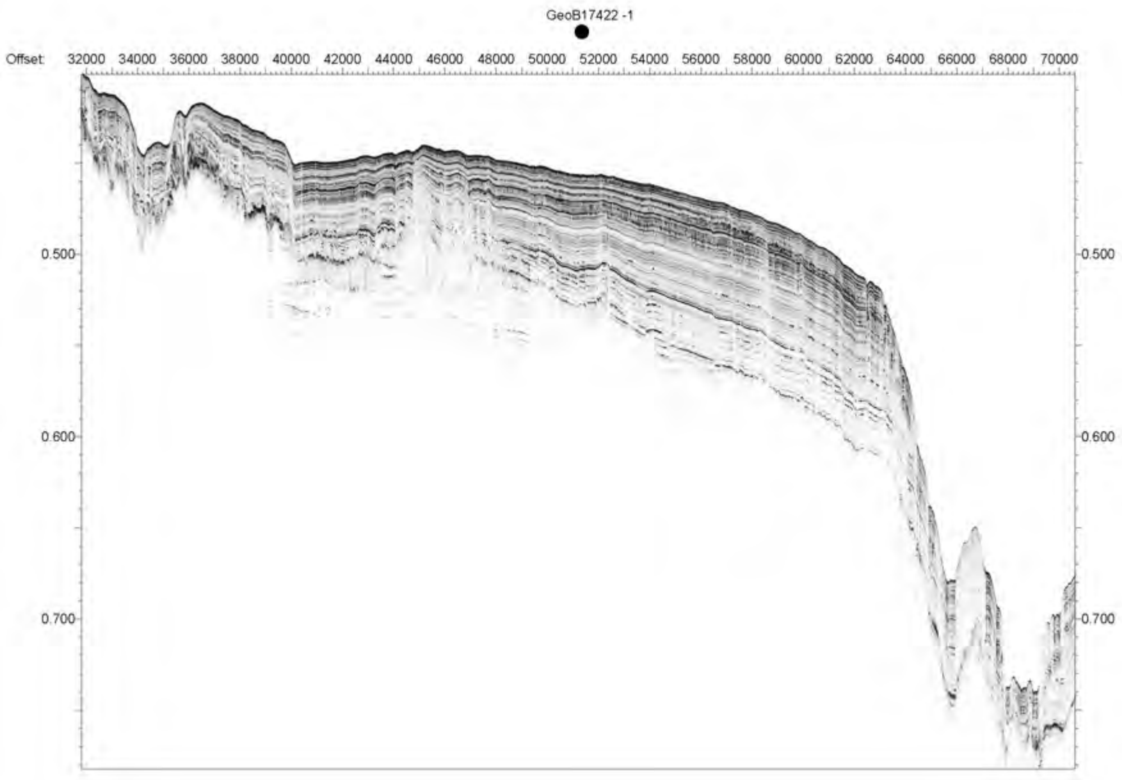
1.100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64000
66000
68000
70000
0.500
0.600
0.700

6 Sediment sampling

(Blanquera, Buleka, Carag, Carriére-Garwood, Dassié, Fernando, Ghasemifard, Groeneveld, Hathorne, Huang, Huang, Janßen, Kerrigan, Kienast, Kremer, Kwiatkowski, Lehnen, Lückge, Mai, Martínez-Méndez, Meyer-Schack, Nishibayashi, Plaß, Quevedo, Rincon, Seeba, Setiawan, Steinke, Tevlone, Yu)

6.1 Multi-corer

The main tool for the sampling of undisturbed surface sediments was the Multi-corer (MUC) equipped with eight large (diameter of 10 cm) and four smaller (diameter of 6 cm) plastic tubes of 60 cm length. During the SO-228 cruise, 29 Multi-corers have been deployed (Table 6.1). All but one of them were successful and recovered up to 55 cm of undisturbed surface sediment.

Fig. 6.1: Undisturbed sediment surface in multi-corer tubes.

6.1.1 Sub-sampling of the Multi-corer

Depending on the availability of filled tubes, the “standard” sampling of the Multi-corer was distributed as follows:
-2 large tubes cut into 1 cm thick slices for planktic foraminiferal studies (MARUM)
-2 large tubes cut into 1 cm thick slices for benthic foraminiferal studies (MARUM)

-1 large tube cut into 1 cm thick slices for $\delta^{15}N$ analysis (DAL)
-2 large tubes cut into 1 cm thick slices for nannofossil studies (UP, 1st leg)
-1 large tube cut into 1 cm thick slices for TEX86 studies (TORI, 1st leg)
-1 large tube cut into 1 cm thick slices for biomarker studies (MARUM, 2nd leg)
-1 large tube cut into 1 cm thick slices for pteropod studies (LDEO, 2nd leg)
-1 large tube cut into 1 cm thick slices for micropaleontological studies (UPNG, 2nd leg)
-1 small tube cut into 1 cm thick slices for $\delta^{14}C$ analysis (MARUM)
-2 small tubes cut into 1 cm thick slices for archive (MARUM), or radionuclides (IUP, only at 4 Stations, see Tables 6.1 and 6.2).
-1 small tube cut into 1 cm thick slices for archive (MARUM)

Table 6.1: Multi-corer sampling and sub-sampling during R/V SONNE Cruise SO-228

GeoB No.	Latitude (+N, -S)	Longitude (E)	Water Depth (m)	Large tube (10 cm)								Small tube (6 cm)				Core Length (cm)
				#1	#2	#3	#4	#5	#6	#7	#8	#1	#2	#3	#4	
17402-1	8°00.002‘	126°34.507‘	553	δN	NF	NF	TX	PF	PF	BF	BF	AR	RN	RN	RC	18-20
17403-3	7°49.472‘	126°40.713‘	1318	δN	NF	NF	TX	PF	PF	BF	BF	AR	AR	AR	RC	25-33
17404-2	7°53.889‘	126°32.554‘	404	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	29-37
17405-2	7°59.934‘	126°37.023‘	848	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	16-33
17407-2	7°54.697‘	126°46.153‘	2178	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	26-30
17408-2	7°50.881‘	126°42.280‘	1683	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	28-35
17409-1	7°51.503‘	126°33.278‘	503	δN	NF	NF	TX	BF	BF	PF	PF	AR	RN	RN	RC	36-42
17410-2	7°52.014‘	126°35.553‘	771	-	-	-	-	-	-	-	-	-	-	-	-	-
17410-3	7°52.014‘	126°35.553‘	771	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	34-45
17413-3	6°20.848‘	125°50.900‘	2077	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	35-39
17414-2	6°15.606‘	125°49.945‘	2188	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	40-46
17418-1	-2°22.270‘	144°36.024‘	1338	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	23-27
17419-2	-2°48.891‘	144°29.969‘	1887	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	25-30
17421-2	-3°32.996‘	144°11.854‘	588	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	37-55
17422-2	-3°37.218‘	144°13.418‘	366	δN	NF	NF	TX	BF	BF	PF	PF	AR	AR	AR	RC	29-49
17424-2	-1°22.828‘	147°10.455‘	2210	δN	OC	MM	PP	BF	BF	PF	PF	AR	AR	AR	RC	24-49
17425-2	-1°32.662‘	146°46.547‘	1621	δN	OC	MM	PP	BF	BF	PF	PF	AR	AR	AR	RC	20-21
17426-2	-2°11.214‘	150°51.667‘	1365	δN	OC	MM	PP	BF	BF	PF	PF	AR	AR	AR	RC	27-30
17427-2	-2°9.793‘	150°30.016‘	970	δN	OC	MM	PP	-	-	PF	-	AR	-	-	RC	13-19
17428-4	-3°27.541‘	144°9.153‘	1058	δN	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	46-50
17429-1	-4°6.032‘	145°12.029‘	1604	δN	OC	MM	PP	BF	BF	PF	PF	AR	AR	AR	RC	27-37
17430-2	-4°13.037‘	145°1.625‘	1160	δN	OC	MM	PP	BF	BF	PF	PF	RN	RN	AR	RC	29-41
17431-1	-5°18.805‘	146°2.488‘	1164	δN	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	30-40
17432-3	-5°20.675‘	146°11.983‘	1388	δN	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	33-39
17433-2	-5°37.232‘	147°8.024‘	1384	δN	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	45-51
17434-2	-6°35.656‘	148°16.157‘	4208	δN	OC	-	PP	BF	BF	PF	PF	AR	AR	AR	RC	29-35
17435-2	-7°16.224‘	147°20.401‘	1001	δN	OC	MM	PP	BF	BF	PF	PF	AR	AR	AR	RC	28-31
17436-4	-7°53.388‘	148°12.170‘	845	δN	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	15-23
17437-2	-9°59.371‘	145°10.541‘	1776	AR	OC	AR	PP	BF	BF	PF	PF	AR	AR	AR	RC	11-22

PF	Planktic foraminifera	MARUM
BF	Benthic foraminifera	MARUM
NF	Nannofossils	UP
δN	$\delta^{15}N$	DAL
MM	Micropaleontology	UPNG
OC	Organic Carbon	MARUM

RN	Radionuclides	IUP
TX	TEX86	TORI
RC	Radiocarbon	MARUM
AR	Archive	MARUM
PP	Pteropods	LDEO

6.1.2. Radionuclides

The study on artificial radionuclides as tracers for sources of radioactive fallout in the study area contains the activity concentrations of ^{137}Cs (half-life: 30 yrs.) and ^{241}Am (half-life: 141 yrs.) and their ratios that are measured by gamma spectrometry. Furthermore, ^{238}Pu (half-life: 87 yrs.) and ^{239}Pu,^{240}Pu (half-life: 24,100 yrs. and 6563 yrs.) activity concentrations and ratios will be measured by alpha spectrometry. Finally, $^{240}Pu/^{239}Pu$ atom ratios will be measured by mass spectrometry. Natural radionuclides detected simultaneously in gamma spectra can be

used as tracers of sedimentation or mixing processes, such as ^{228}Th (half-life: 1.9 yrs.), ^{228}Ra (half –life: 5.8 yrs.), ^{210}Pb (half-life: 22.2 yrs.) and ^{226}Ra (half –life: 1600 yrs.).
According to Table 6.2. four stations have been selected to collect Multi-corer samples for Radioactivity measurements at the laboratory of the Institute for Environmental Physics (IUP), University of Bremen.

Table 6.2: Radionuclides Multi-corer samples collected during the SO-228 expedition.

Station (GeoB)	Latitude (+N, -S)	Longitude (E)	From-To (cm)	Water depth (m)
17402-1	+ 8° 0.033'	126° 34.50'	0-18	553
17409-1	+7° 51.503'	126° 33.278'	0-33	503
17421-2	- 3° 32.996'	144° 11.854'	0-53	588
17430-2	- 4° 13.037'	145° 01.625'	0-30	1160

6.2 Gravity Corer

Longer sediment sequences were obtained by a Gravity corer with a pipe length of 6m/12m and a weight of 2 tons. Before using the coring tools, the liners had been marked lengthwise with a straight line in order to retain the orientation of the core for later paleomagnetic analyses. Once on board, the sediment core was cut into 1 m sections, closed with caps on both ends and labelled. In total, 44 cores were retrieved with recoveries between 0 cm and 1031 cm (Table 6.3). From the Gravity corers taken during SO-228 six brought no sediments on deck. Altogether ~200m of sediment was recovered with the Gravity corer during R/V SONNE Cruise 228.

6.2.1. Sampling of the Gravity corers

All of the Gravity cores except for the last two stations were cut into an archive and work half. The archive half was used for core description and color scanning. The work half was sampled with two series of syringes (10 ml) for geochemical and faunal studies, both at 4 cm intervals.

6.2.2 Core description and color scanning

The core descriptions (chapter 7) summarize the most important results of the analysis of each sediment core following procedures applied during ODP/IODP expeditions. All cores were opened, described, and color-scanned.

In the core descriptions the first column displays the lithological data that are based on visual analysis of the core and are supplemented by information from binocular and smear slide analyses. The sediment classification largely follows ODP/IODP convention. Lithological names consist of a principal name based on composition, degree of lithification, and/or texture as determined from visual description and microscopic observations.
In the structure column the intensity of bioturbation together with individual or special features (turbidites, volcanic ash layers, plant debris, shell fragments, etc.) is shown. The hue and chroma attributes of color were determined by comparison with the Munsell soil color charts and are given in the color column in the Munsell notation. A GretagMacbeth™ *Spectrolino* spectrophotometer was used to measure percent reflectance values of sediment color at 36 wavelength channels over the visible light range (380-730 nm) on all of the cores. The digital reflectance data of the spectrophotometer readings were routinely obtained from the surface (measured in 1 cm steps) of the split cores (archive half). The *Spectrolino* is equipped with a measuring aperture with folding mechanism allowing an exact positioning on the split core and is connected to a portable computer. The data are directly displayed within the software package Excel and can be controlled simultaneously. From all the color measurements, for each core the red/blue ratio (700 nm/450 nm) and the lightness are shown together with the visual core description. The reflectance of individual wavelengths is

often significantly affected by the presence of minor amounts of oxyhydroxides or sulphides. To eliminate these effects, we used the red/blue ratio and lightness.

Table 6.3: List of Gravity cores retrieved during R/V SONNE Cruise SO-218.

GeoB No.	Gear	Latitude (+N, -S)	Longitude (E)	Water Depth (m)	Recovery (cm)
17402-2	6 m tube	8°00.002‘	126°34.507‘	553	536
17403-2	6 m tube	7°49.472‘	126°40.713‘	1318	412
17404-3	6 m tube	7°53.889‘	126°32.554‘	404	519
17404-4	9 m tube	7°53.889‘	126°32.554‘	404	empty
17405-1	9 m tube	7°59.934‘	126°37.023‘	848	177
17405-3	6 m tube	7°59.934‘	126°37.023‘	848	500
17406-1	6 m tube	8°00.478’	126°38.648’	1155	548
17407-3	6 m tube	7°54.697‘	126°46.153‘	2178	203
17408-1	6 m tube	7°50.881‘	126°42.280‘	1683	457
17409-2	6 m tube	7°51.503‘	126°33.278‘	503	empty
17410-1	6 m tube	7°52.014‘	126°35.553‘	771	527
17410-4	6 m tube	7°52.014‘	126°35.553‘	771	495
17411-1	6 m tube	7°51.365’	126°33.294’	485	563
17413-4	12 m tube	6°20.848‘	125°50.900‘	2077	244
17414-1	12 m tube	6°15.606‘	125°49.945‘	2188	714
17415-1	12 m tube	6°15.139’	125°52.786’	2102	780
17416-1	12 m tube	6°12.407’	125°51.229’	2253	empty
17418-2	12 m tube	-2°22.270‘	144°36.024‘	1338	570
17419-1	12 m tube	-2°48.891‘	144°29.969‘	1887	914
17421-1	12 m tube	-3°32.996‘	144°11.854‘	588	758
17421-3	12 m tube	-3°32.996‘	144°11.854‘	588	906
17422-1	12 m tube	-3°37.218‘	144°13.418‘	366	698
17422-3	12 m tube	-3°37.218‘	144°13.418‘	366	692
17423-1	6 m tube	-0°35.921’	142°53.775’	3105	577
17424-3	12 m tube	-1°22.828‘	147°10.455‘	2210	472
17425-1	12 m tube	-1°32.662‘	146°46.547‘	1621	864
17426-3	12 m tube	-2°11.214‘	150°51.667‘	1365	1031
17427-1	12 m tube	-2°9.793‘	150°30.016‘	970	empty (tube bent)
17428-3	12 m tube	-3°27.541‘	144°9.153‘	1058	674
17428-5	12 m tube	-3°27.541‘	144°9.153‘	1058	empty (tube bent)
17429-2	12 m tube	-4°6.032‘	145°12.029‘	1604	590
17430-1	12 m tube	-4°13.037‘	145°1.625‘	1160	496 (tube bent)
17430-3	6 m tube	-4°13.037‘	145°1.625‘	1160	123
17431-2	12 m tube	-5°18.805‘	146°2.488‘	1164	393
17432-3	12 m tube	-5°20.675‘	146°11.983‘	1388	458
17433-3	6 m tube	-5°37.232‘	147°8.024‘	1384	empty (tube bent)
17434-3	6 m tube	-6°35.656‘	148°16.157‘	4208	158
17435-1	12 m tube	-7°16.224‘	147°20.401‘	1001	432
17435-3	12 m tube	-7°16.224‘	147°20.401‘	1001	282
17436-3	12 m tube	-7°53.388‘	148°12.170‘	845	226
17436-5	12 m tube	-7°53.388‘	148°12.170‘	845	576
17437-1	12 m tube	-9°59.371‘	145°10.541‘	1776	518
17437-3	12 m tube	-9°59.371‘	145°10.541‘	1776	520
17438-1	12 m tube	-16°47,92'	146°33,69'	1290	70 (tube bent)

6.2.3 Shipboard results

Working area East off Mindanao (Philippines)

Stations GeoB 17402, 17403, 17404, 17405, 17406, 17407, 17408, 17409, 17410, and 17411

In our working area East off Mindanao, a total of eight Multi-corer and eleven Gravity corer were deployed at water depths between 402 m and 2136 m. The sediment recovered at station 17402 (556 m water depth), 17403 (1295 m water depth), 17404 (402 m water depth), 17406 (1074 m water depth), 17407 (2136 m water depth), 17408 (1650 m water depth), and 17411 (485 m water depth) is mainly a dark gray nannofossil-bearing mud which is covered by an olive gray homogenous nannofossil-bearing mud or olive gray nannofossil mud. The dark gray nannofossil-bearing mud is coarser grained (silt sized grain-size) than the overlying olive gray homogenous nannofossil-bearing mud or olive gray nannofossil mud. Foraminifera are more abundant in the olive gray homogenous nannofossil-bearing mud. The transition between the two types of sediment is gradual. Overall, the sediment is moderately to strongly bioturbated.The two cores recovered at station GeoB 17405 (840 m and 880 m water depth) mainly consist of olive gray homogenous nannofossil mud.The same type of sediment has been also observed in the cores GeoB 17410-1 and GeoB 17410-4.

Working Area Davao Gulf (Philippines)

Stations GeoB 17413, 17414, and 17415

At station GeoB 17413, a Multi-corer (GeoB 17413-3) and a Gravity corer (GeoB 17413-4) were deployed. The sediment of the Multi-core GeoB 17413-3 and Gravity core GeoB 17413-4 is an olive-gray homogenous nannofossil-bearing mud. The recovered sediment of the two Gravity cores GeoB 17414-1 and GeoB 17415-1 consisted of 7.14 m and 7.80 m olive gray nannofossil ooze, respectively. The Multi-corer (GeoB 17414-2) deployed at station GeoB 17414 consisted of ~0.38 m olive gray nannofossil ooze covered by a 6 cm thick olive brown nannofossil ooze (oxidized top layer). A 3 cm thick ash layer occurs at 4.74-4.77 m depth in core of Gravity corerGeoB 17415-1. This prominent and distinct ash layer has been not found in core GeoB 17414-1. A detailed core description is given in chapter 7.

Working Area Bismarck Sea (Papua New Guinea)

Stations GeoB 17418, 17419, 17429, and 17430

The sediment of the two Gravity cores recovered at station GeoB17418 (water depth 1338 m) and 17419 (water depth 1887 m) consist of a 5.70 m and 9.14 m olive gray nannofossil ooze rich in planktonic foraminifera, respectively. The sediment at both stations is homogenous due to strong bioturbation. The sediment at the two stations GeoB 17429 (1604 m water depth) and 17430 (1160 m water depth) in the Bismarck Sea is a dark olive gray nannofossil-bearing mud with numerous dark gray sandy layers/intercalations. Ash layers have been found only in cores GeoB 17429-2 and GeoB 17430-1.

Working Area off Sepik River (Papua New Guinea)

Stations GeoB 17421, 17422, 17428

At all three stations off the Sepik River, a Multi-corer and two Gravity corer were deployed.Two Gravity corers were deployed because the carbonate content was expected to be low due to the high terrigenous supply by the Sepik River. Sediments of the Gravity cores taken from a water depth of 570 m (GeoB17421-1 and GeoB 17421-3) and 366 m (GeoB 17422-1 and GeoB 17422-3) are composed of very dark gray homogenous clay. Foraminifera are rare in these sediments. In contrast, the sediment of the deeper station GeoB 17428 (water depth 1059 m) is a dark gray nannofossil-bearing mud with numerous intercalations of very dark gray nannofossil-bearing mud. All cores contain numerous prominent and distinct ash layers. However, Gravity core GeoB 17428-5 was empty.

Working Area West and East Carolina Basin (Papua New Guinea)

Stations GeoB 17423, 17424, 17425, 17426 and 17427

At station GeoB 17423 (water depth 3103 m), a Gravity corer was deployed. The sediment consisted of 5.77 m olive gray nannofossil ooze rich in foraminifera.The sediment is homogenous due to strong bioturbation. At the other stations, a Multi-corer and a Gravity corer were deployed. The Gravity core GeoB 17424-3 (water depth 2218 m) has a total length of 4.72 m and is mainly composed of pale olive nannofossil ooze rich in foraminifera interrupted by a very dark olive grey layer of nannofossil ooze (core depth 1.17 – 1.25 m). The Gravity core GeoB 17425-1 (water depth 1620 m) mainly consists of 8.64 m pale olive and olive grey foraminifera bearing nannofossil ooze intercalated by sandy foraminifera-bearing layers and ash layers. The sediments of Gravity core GeoB 17426-1 (water depth 1368 m) are composed of 10.31 m light olive grey foraminifera bearing nannofossil ooze. The sediment is homogenous due to strong bioturbation and intercalated by ash layers.

Working Area Astrolabe Bay (Papua New Guinea)

Stations GeoB17431 and 17432

In the Astrolabe Bay, the recovered sediment is composed of olive gray nannofossil-bearing mud. The total length of Gravity core GeoB 17431-2 and GeoB17432-2 is 3.93 m and 4.58 m. The sediment is homogenous due to strong bioturbation and characterized by numerous cm-scale sandy intercalations. A turbidite with a typical fining upward cycle has been found in core GeoB 17431-2.Both cores contain numerous distinct ash layers.

Working Area Solomon Sea off Huon (Papua New Guinea)

Stations GeoB17434

At station GeoB 17434, a Multi-corer (GeoB 17434-2) and Gravity corer (GeoB 17434-3) were deployed. With a water depth of 4208 m, station GeoB 17434 represents our deepest station of our cruise. However, an only 1.58 m long Gravity core had been recovered. The sediment is a dark gray homogenous nannofossil mud. A distinct ash layer occurs at 1.11-1.15 m core depth. A 12 cm thick sandy layer most likely is a turbidite. However, this sandy layer shows no internal structures, such as a fining upward in grain size.

Working Area Huon Gulf (Papua New Guinea)

Station GeoB17435

At station GeoB 17435, a Multi-corer (GeoB 17435-2) and two Gravity corers (GeoB 17435-1 and GeoB 17435-3) were deployed. The sediment consisted of 4.32 m (GeoB 17435-1) and 2.82 m (GeoB 17435-3) olive gray nannofossil mud. The sediment is homogenous due to strong bioturbation and contains foraminifera. A 3 cm thick ash layer occurs at 3.10-3.13 m in core GeoB 17435-1 and at 0.52-0.55 m in core GeoB 17435-3.

Working Area Hercules Bay – Solomon Sea

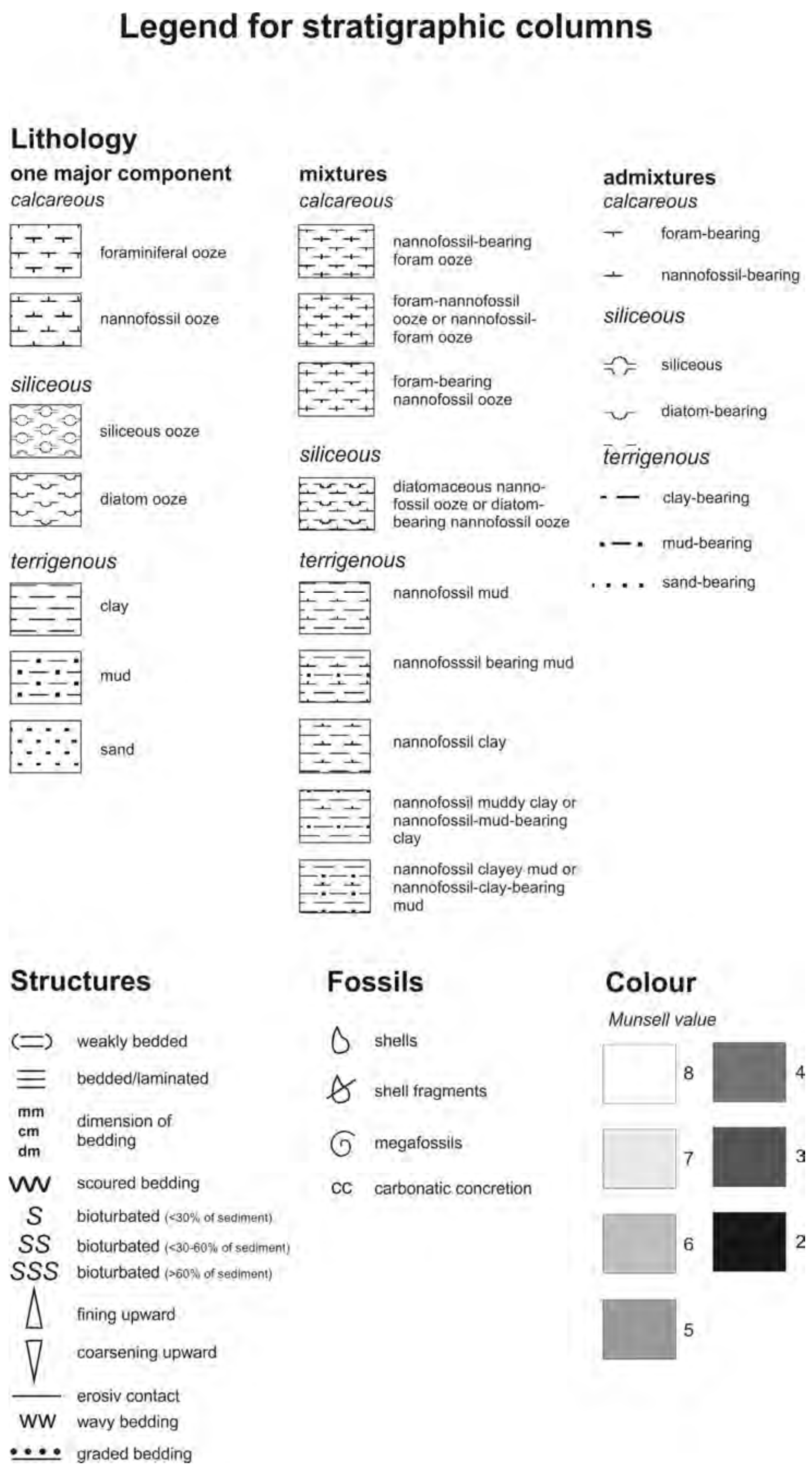
Station GeoB17436

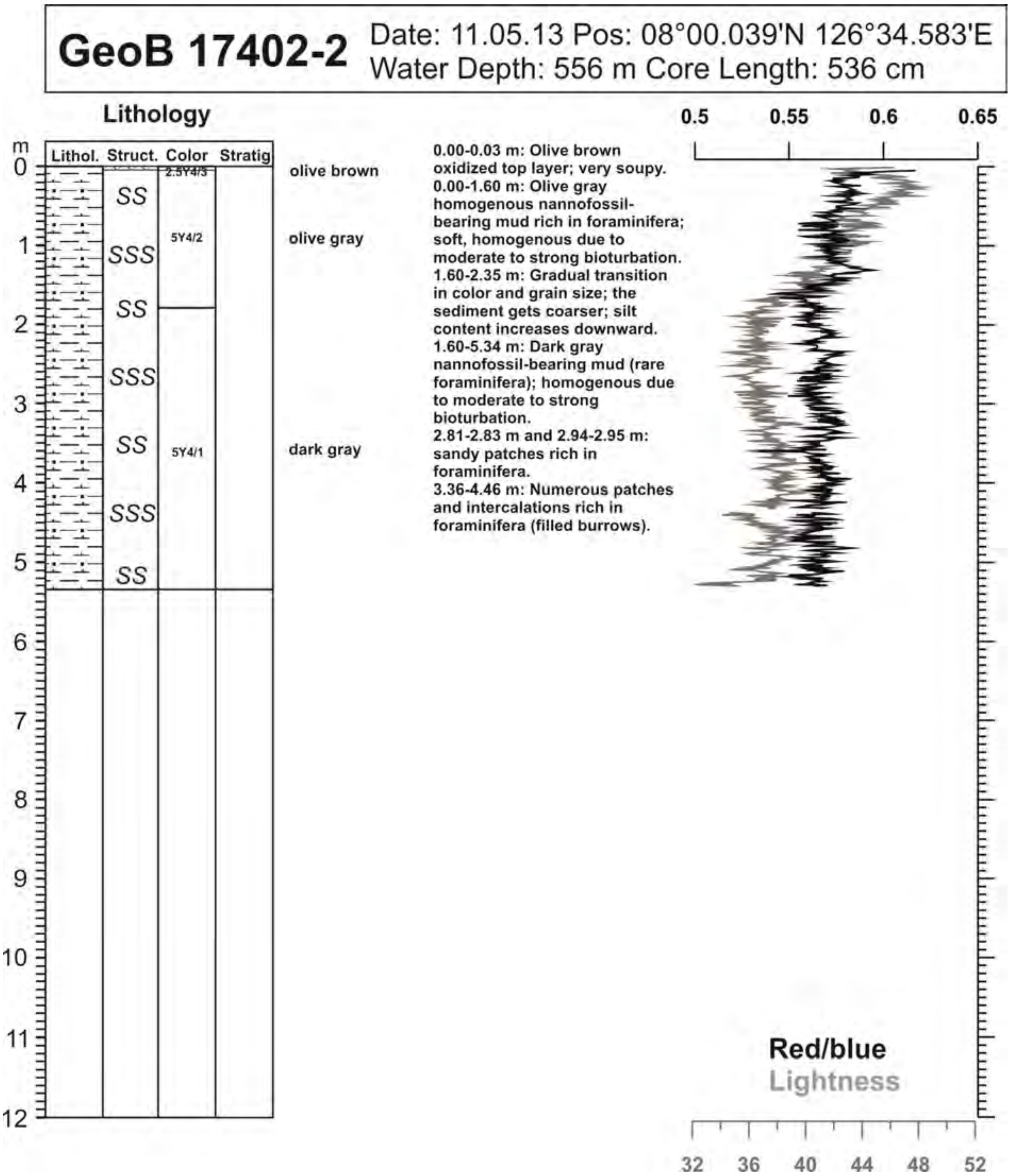
At station GeoB 17436, a 2.26 m (GeoB 17436-3) and a 5.76 cm (GeoB 17436-5) long Gravity had been recovered. The sediment of both deployments is a homogenous foraminifera bearing nannofossil mud. The sediment is strongly bioturbated. A gradual change in color (from 5Y5/2 to 5Y4/2) of core GeoB 17436-3 occurs at around 0.66 m. The same change in color is seen around 0.55 m in core GeoB 17436-5. The sediment of core GeoB 17436-5 is getting gradual lighter at around 3.57 m (from 5Y4/2 to 5Y5/2). Both contain numerous distinct ash layers and patches of volcanic ash.

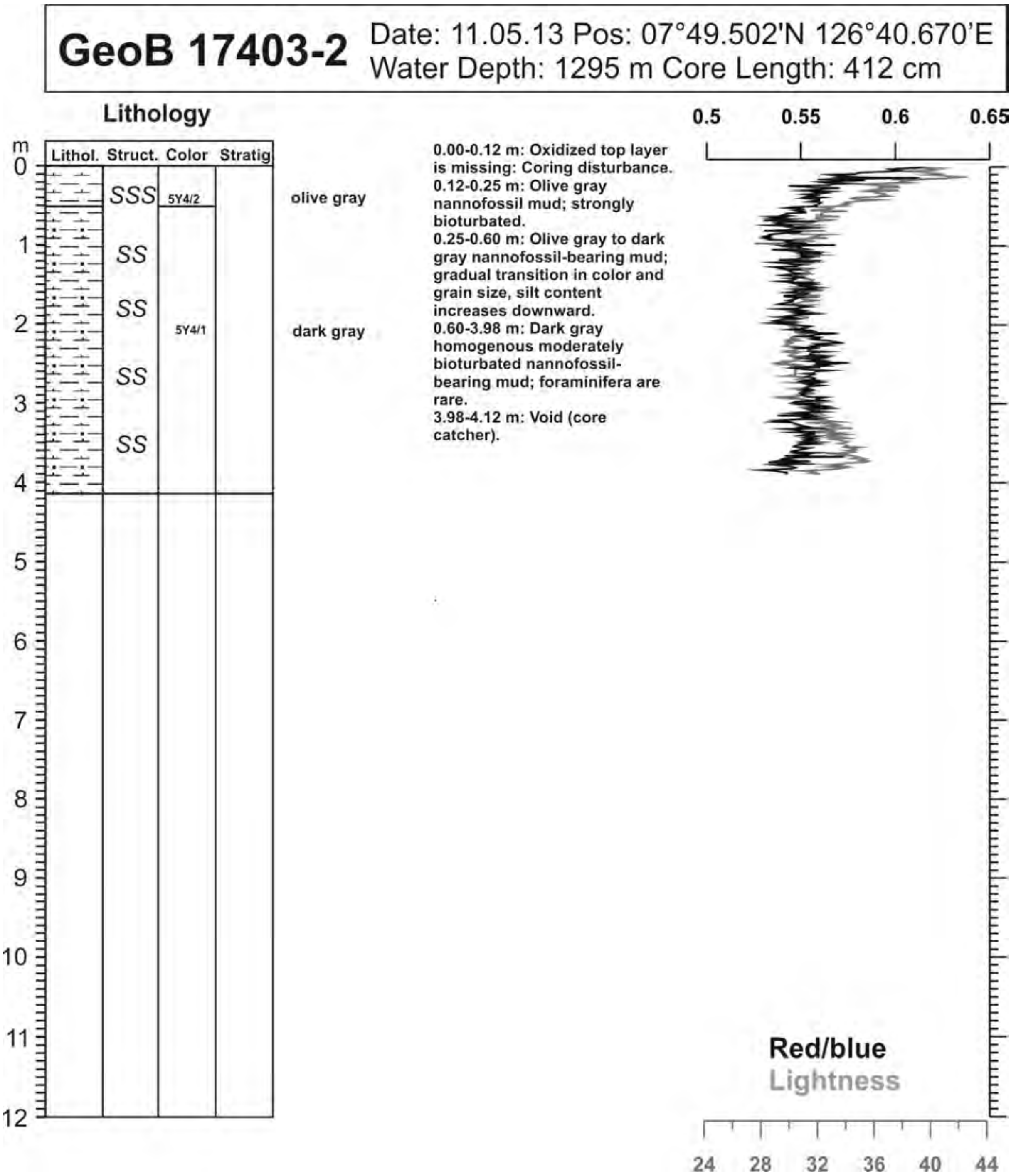
Working Area Coral Sea off Fly River (Papua New Guinea)
Station GeoB 17437

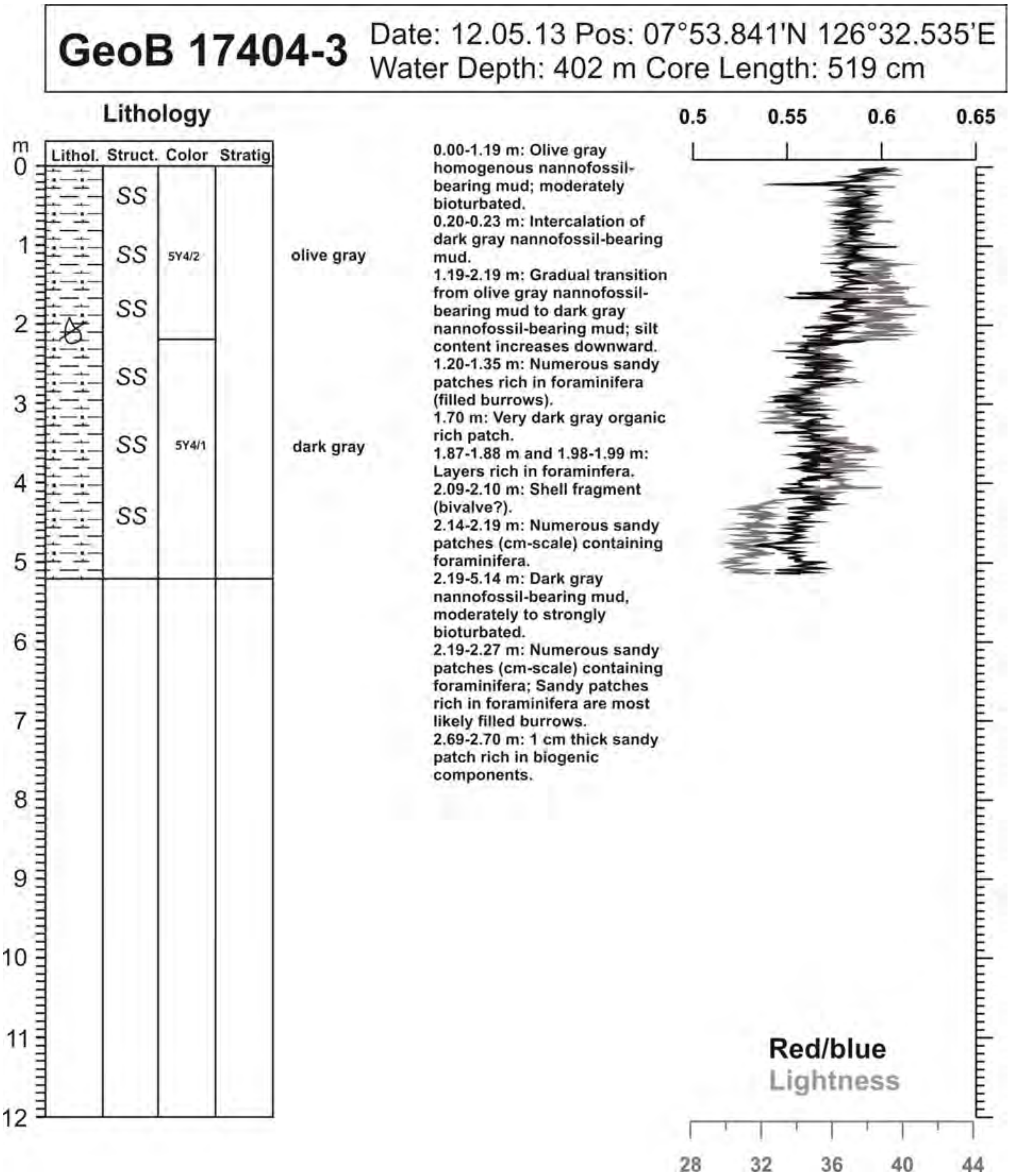
The Multi-corer (GeoB 17437-3) deployed at this station consisted of ~0.14 m light olive gray nannofossil mud covered by a 8 cm thick yellowish brown nannofossil mud. Planktic foraminifera are abundant. The sediment of the two Gravity cores (GeoB 17437-1 and GeoB 17437-3) is a light olive gray nannofossil mud in the upper ~1.2 m. Several turbidites occur between ~1.2- 2.3 m. The recovered sediment of the two Gravity cores below ~2.3 m represents an alternate succession (cm-scale; interbedding) of olive nannofossil/nannofossil-bearing mud and gray clay. Planktic foraminifera are rather rare. Numerous cm-scale dark gray sandy intercalations and/or patches occur in this succession.

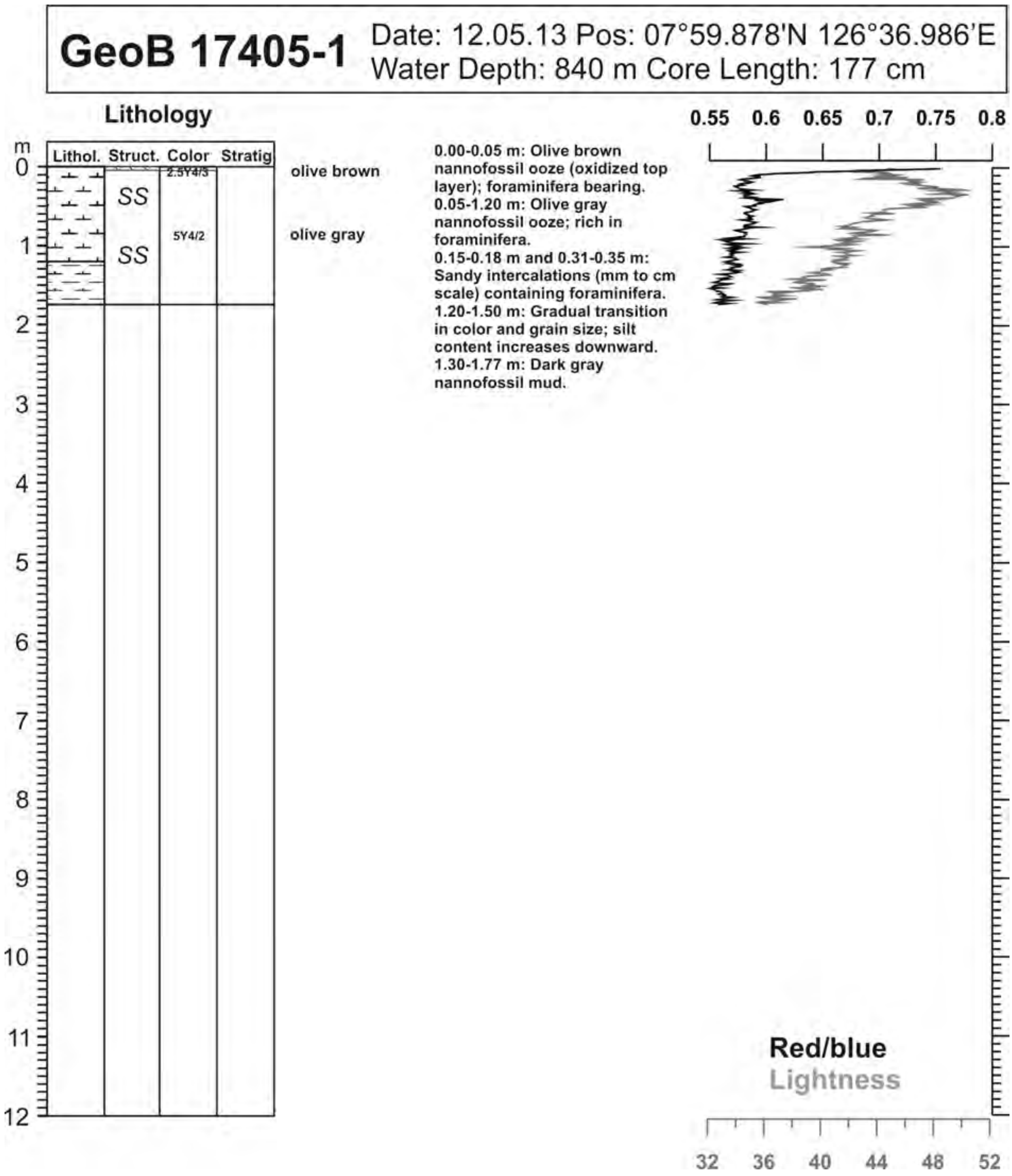
7 Core descriptions

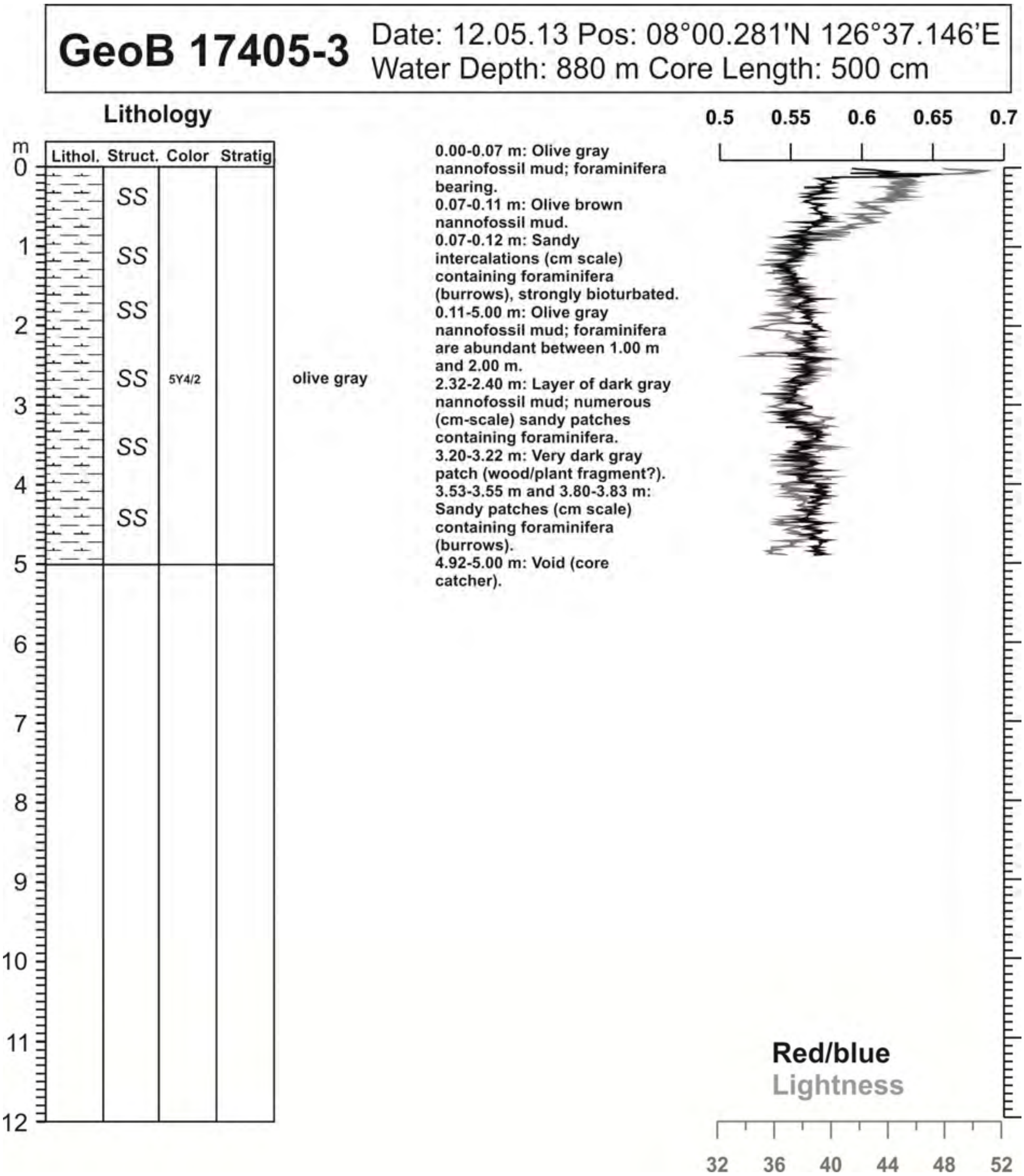


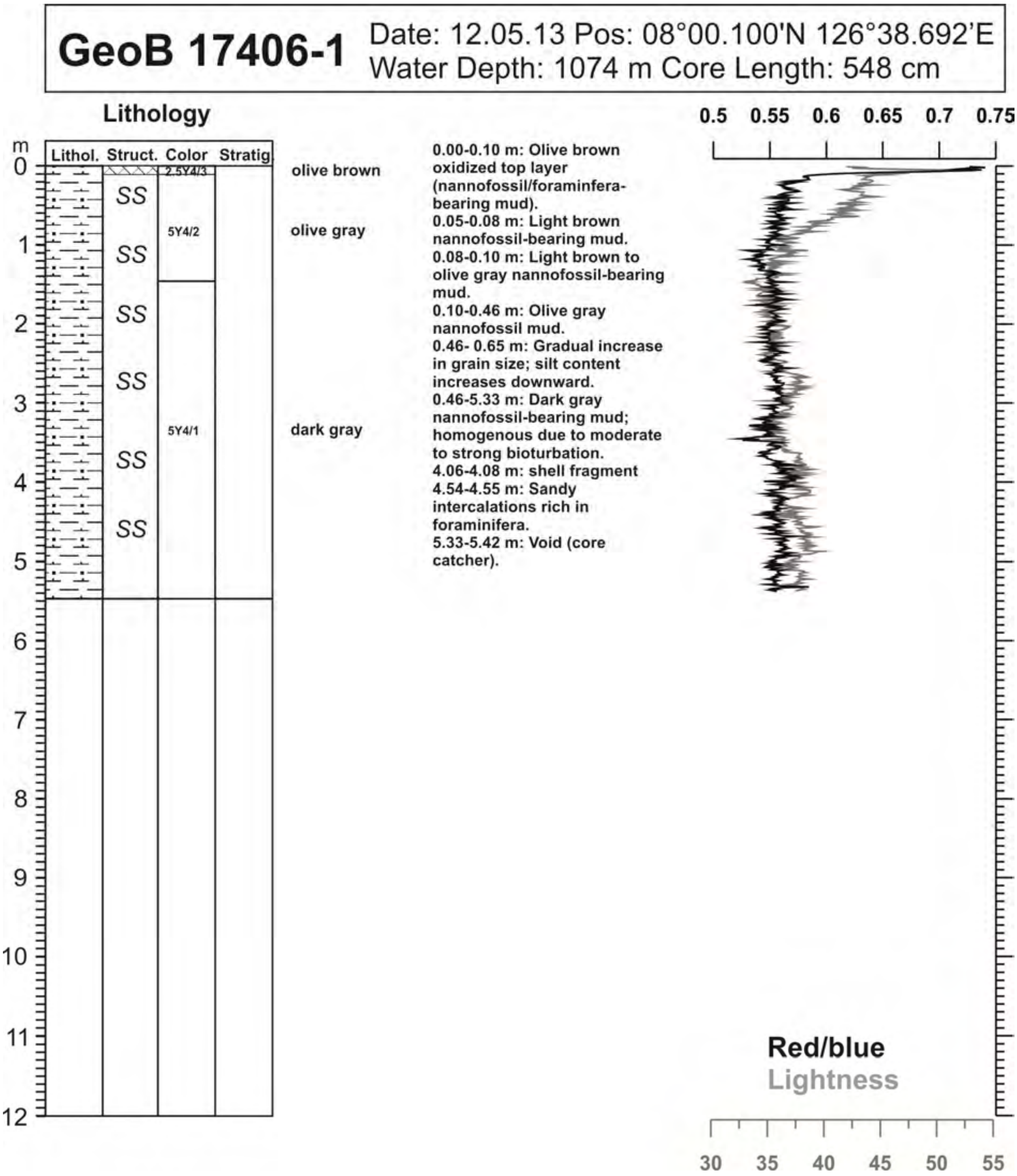

GeoB 17402-2
Date: 11.05.13 Pos: 08°00.039'N 126°34.583'E
Water Depth: 556 m Core Length: 536 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SS
SSS
SS
SSS
SS
SSS
SS
2.5Y4/3
5Y4/2
5Y4/1
olive brown
olive gray
dark gray
0.00-0.03 m: Olive brown oxidized top layer; very soupy.
0.00-1.60 m: Olive gray homogenous nannofossil-bearing mud rich in foraminifera; soft, homogenous due to moderate to strong bioturbation.
1.60-2.35 m: Gradual transition in color and grain size; the sediment gets coarser; silt content increases downward.
1.60-5.34 m: Dark gray nannofossil-bearing mud (rare foraminifera); homogenous due to moderate to strong bioturbation.
2.81-2.83 m and 2.94-2.95 m: sandy patches rich in foraminifera.
3.36-4.46 m: Numerous patches and intercalations rich in foraminifera (filled burrows).
0.5
0.55
0.6
0.65
Red/blue
Lightness
32
36
40
44
48
52


GeoB 17403-2
Date: 11.05.13 Pos: 07°49.502'N 126°40.670'E
Water Depth: 1295 m Core Length: 412 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
5Y4/2
olive gray
SS
SS
5Y4/1
dark gray
SS
SS
0.00-0.12 m: Oxidized top layer is missing: Coring disturbance.
0.12-0.25 m: Olive gray nannofossil mud; strongly bioturbated.
0.25-0.60 m: Olive gray to dark gray nannofossil-bearing mud; gradual transition in color and grain size, silt content increases downward.
0.60-3.98 m: Dark gray homogenous moderately bioturbated nannofossil-bearing mud; foraminifera are rare.
3.98-4.12 m: Void (core catcher).
0.5 0.55 0.6 0.65
Red/blue
Lightness
24 28 32 36 40 44

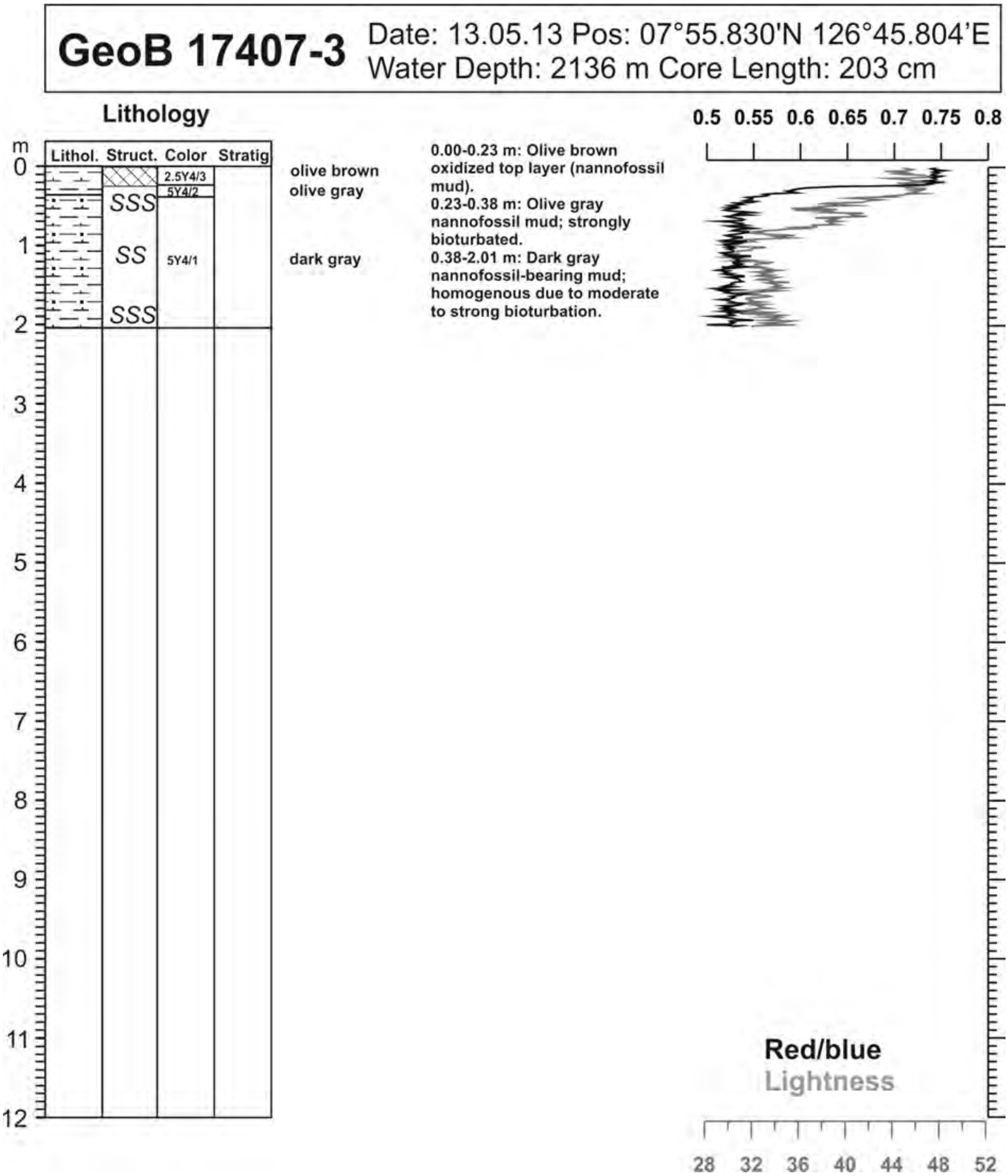

GeoB 17404-3
Date: 12.05.13 Pos: 07°53.841'N 126°32.535'E
Water Depth: 402 m Core Length: 519 cm
Lithology
m
Lithol. Struct. Color Stratig
SS
5Y4/2
olive gray
5Y4/1
dark gray
0
1
2
3
4
5
6
7
8
9
10
11
12
0.00-1.19 m: Olive gray homogenous nannofossil-bearing mud; moderately bioturbated.
0.20-0.23 m: Intercalation of dark gray nannofossil-bearing mud.
1.19-2.19 m: Gradual transition from olive gray nannofossil-bearing mud to dark gray nannofossil-bearing mud; silt content increases downward.
1.20-1.35 m: Numerous sandy patches rich in foraminifera (filled burrows).
1.70 m: Very dark gray organic rich patch.
1.87-1.88 m and 1.98-1.99 m: Layers rich in foraminfera.
2.09-2.10 m: Shell fragment (bivalve?).
2.14-2.19 m: Numerous sandy patches (cm-scale) containing foraminifera.
2.19-5.14 m: Dark gray nannofossil-bearing mud, moderately to strongly bioturbated.
2.19-2.27 m: Numerous sandy patches (cm-scale) containing foraminifera; Sandy patches rich in foraminifera are most likely filled burrows.
2.69-2.70 m: 1 cm thick sandy patch rich in biogenic components.
0.5
0.55
0.6
0.65
Red/blue
Lightness
28
32
36
40
44

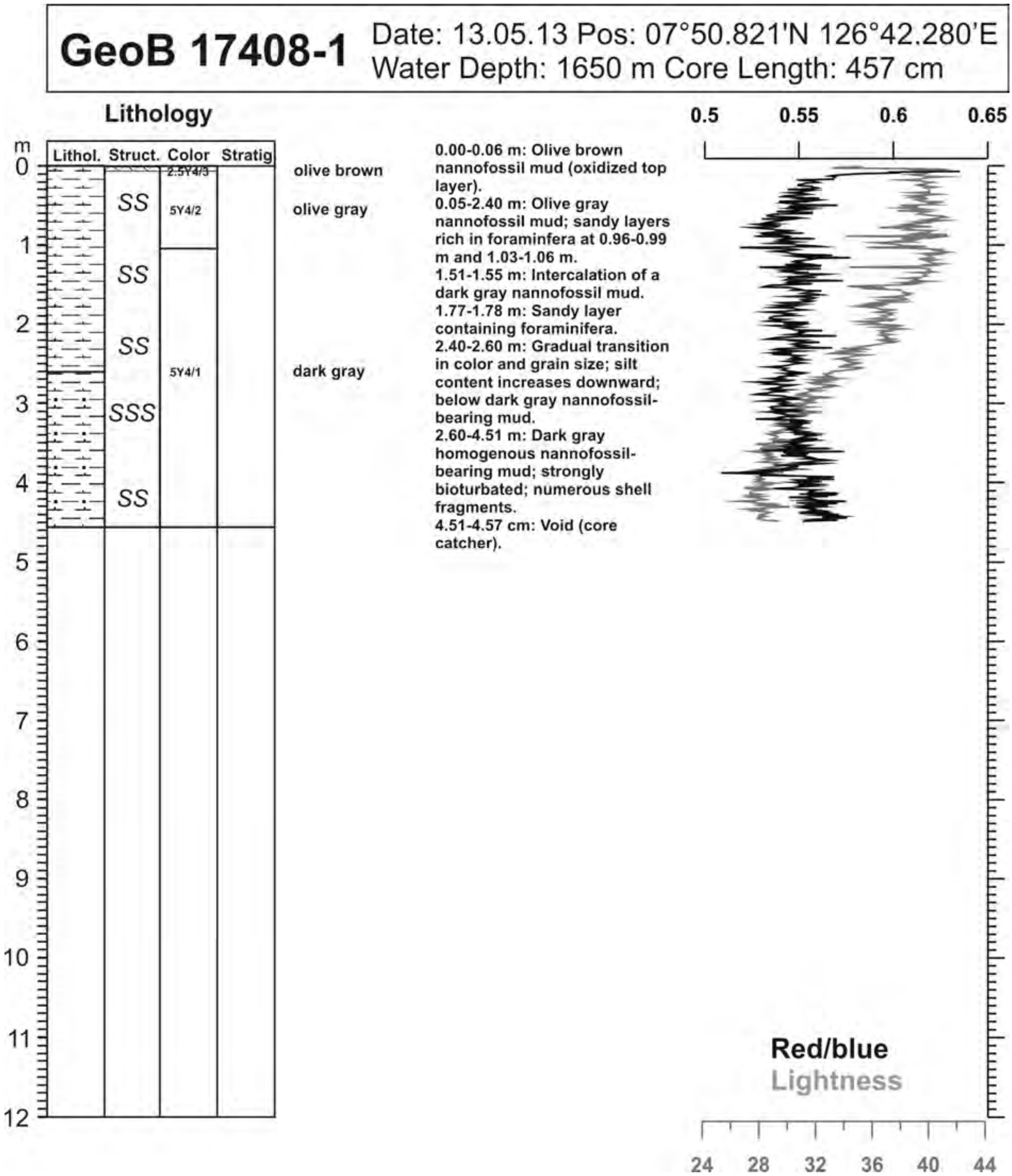

GeoB 17405-1
Date: 12.05.13 Pos: 07°59.878'N 126°36.986'E
Water Depth: 840 m Core Length: 177 cm
Lithology
m
Lithol. Struct. Color Stratig
2.5Y4/3
5Y4/2
SS
SS
olive brown
olive gray
0.00-0.05 m: Olive brown nannofossil ooze (oxidized top layer); foraminifera bearing.
0.05-1.20 m: Olive gray nannofossil ooze; rich in foraminifera.
0.15-0.18 m and 0.31-0.35 m: Sandy intercalations (mm to cm scale) containing foraminifera.
1.20-1.50 m: Gradual transition in color and grain size; silt content increases downward.
1.30-1.77 m: Dark gray nannofossil mud.
0.55 0.6 0.65 0.7 0.75 0.8
Red/blue
Lightness
32 36 40 44 48 52
0 1 2 3 4 5 6 7 8 9 10 11 12

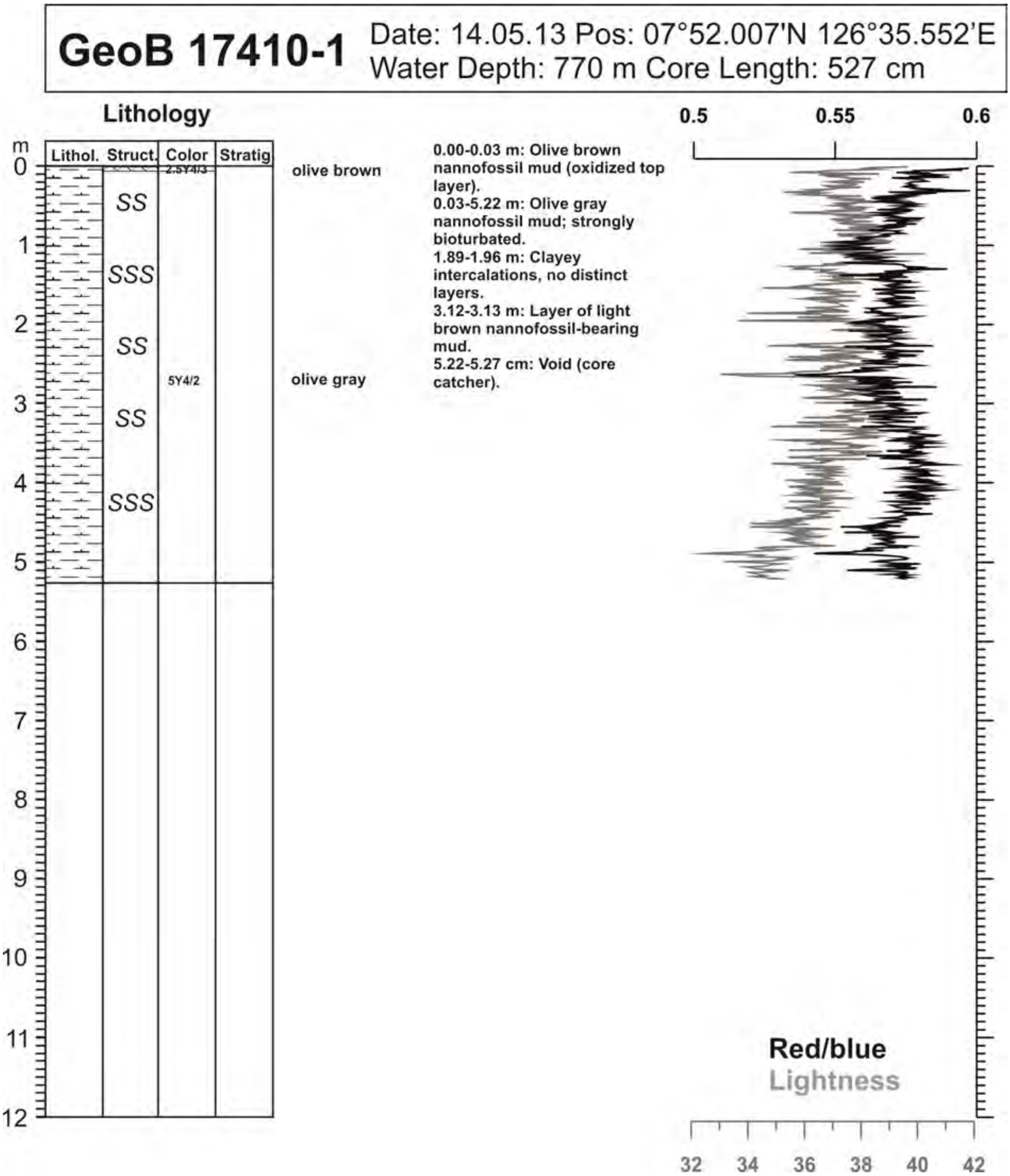

GeoB 17405-3
Date: 12.05.13 Pos: 08°00.281'N 126°37.146'E
Water Depth: 880 m Core Length: 500 cm
Lithology
m
Lithol. Struct. Color Stratig
SS
5Y4/2
olive gray
0.00-0.07 m: Olive gray nannofossil mud; foraminifera bearing.
0.07-0.11 m: Olive brown nannofossil mud.
0.07-0.12 m: Sandy intercalations (cm scale) containing foraminifera (burrows), strongly bioturbated.
0.11-5.00 m: Olive gray nannofossil mud; foraminifera are abundant between 1.00 m and 2.00 m.
2.32-2.40 m: Layer of dark gray nannofossil mud; numerous (cm-scale) sandy patches containing foraminifera.
3.20-3.22 m: Very dark gray patch (wood/plant fragment?).
3.53-3.55 m and 3.80-3.83 m: Sandy patches (cm scale) containing foraminifera (burrows).
4.92-5.00 m: Void (core catcher).
0.5 0.55 0.6 0.65 0.7
Red/blue
Lightness
32 36 40 44 48 52



GeoB 17406-1
Date: 12.05.13 Pos: 08°00.100'N 126°38.692'E
Water Depth: 1074 m Core Length: 548 cm
Lithology
m
Lithol. Struct. Color Stratig.
SS
2.5Y4/3
5Y4/2
5Y4/1
olive brown
olive gray
dark gray
0.00-0.10 m: Olive brown oxidized top layer (nannofossil/foraminifera-bearing mud).
0.05-0.08 m: Light brown nannofossil-bearing mud.
0.08-0.10 m: Light brown to olive gray nannofossil-bearing mud.
0.10-0.46 m: Olive gray nannofossil mud.
0.46- 0.65 m: Gradual increase in grain size; silt content increases downward.
0.46-5.33 m: Dark gray nannofossil-bearing mud; homogenous due to moderate to strong bioturbation.
4.06-4.08 m: shell fragment
4.54-4.55 m: Sandy intercalations rich in foraminifera.
5.33-5.42 m: Void (core catcher).
0.5 0.55 0.6 0.65 0.7 0.75
Red/blue
Lightness
30 35 40 45 50 55

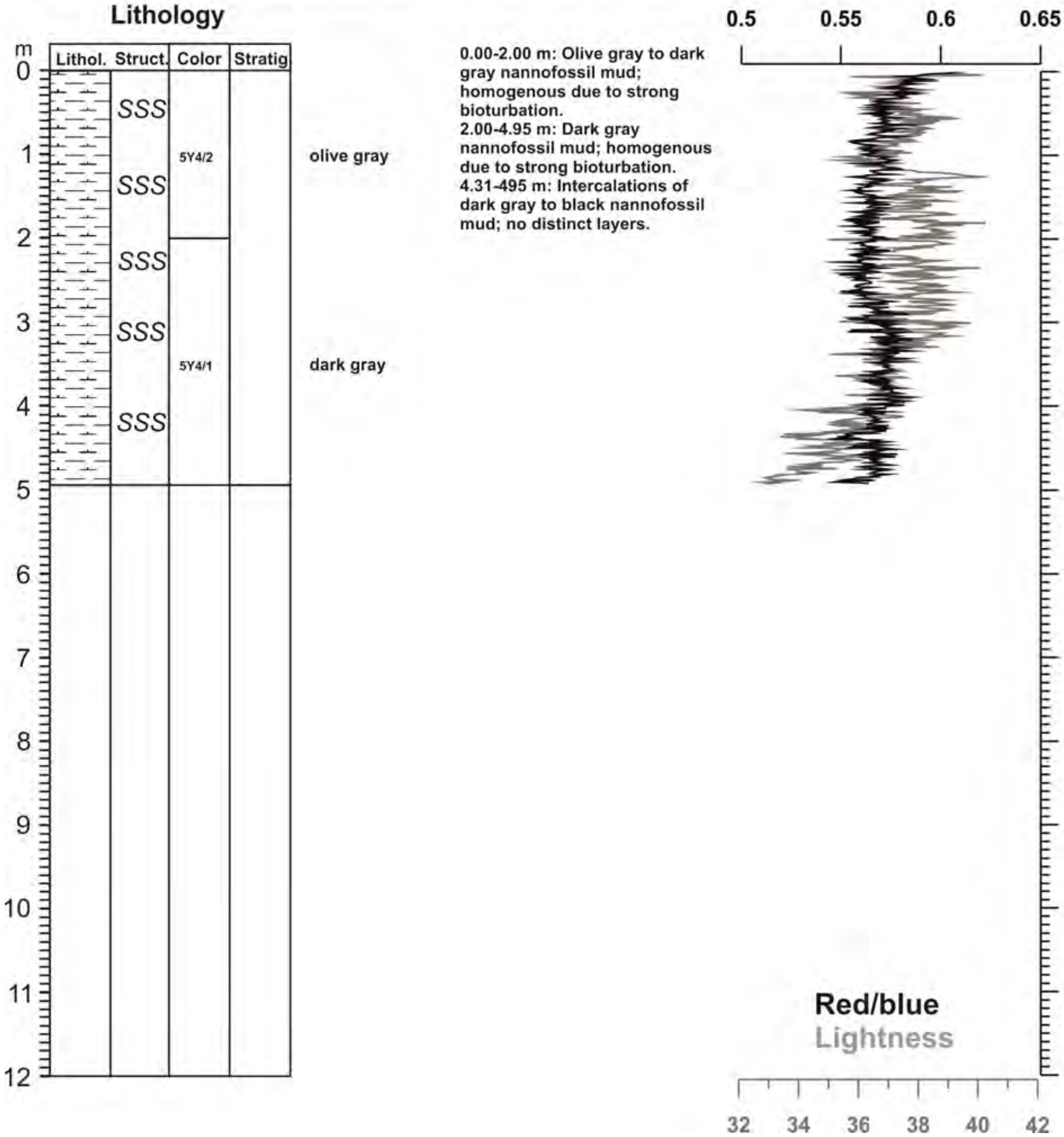

GeoB 17407-3
Date: 13.05.13 Pos: 07°55.830'N 126°45.804'E
Water Depth: 2136 m Core Length: 203 cm
Lithology
m
Lithol. Struct. Color Stratig
2.5Y4/3
5Y4/2
5Y4/1
SSS
SS
SSS
olive brown
olive gray
dark gray
0.00-0.23 m: Olive brown oxidized top layer (nannofossil mud).
0.23-0.38 m: Olive gray nannofossil mud; strongly bioturbated.
0.38-2.01 m: Dark gray nannofossil-bearing mud; homogenous due to moderate to strong bioturbation.
0.5 0.55 0.6 0.65 0.7 0.75 0.8
Red/blue
Lightness
28 32 36 40 44 48 52
0 1 2 3 4 5 6 7 8 9 10 11 12

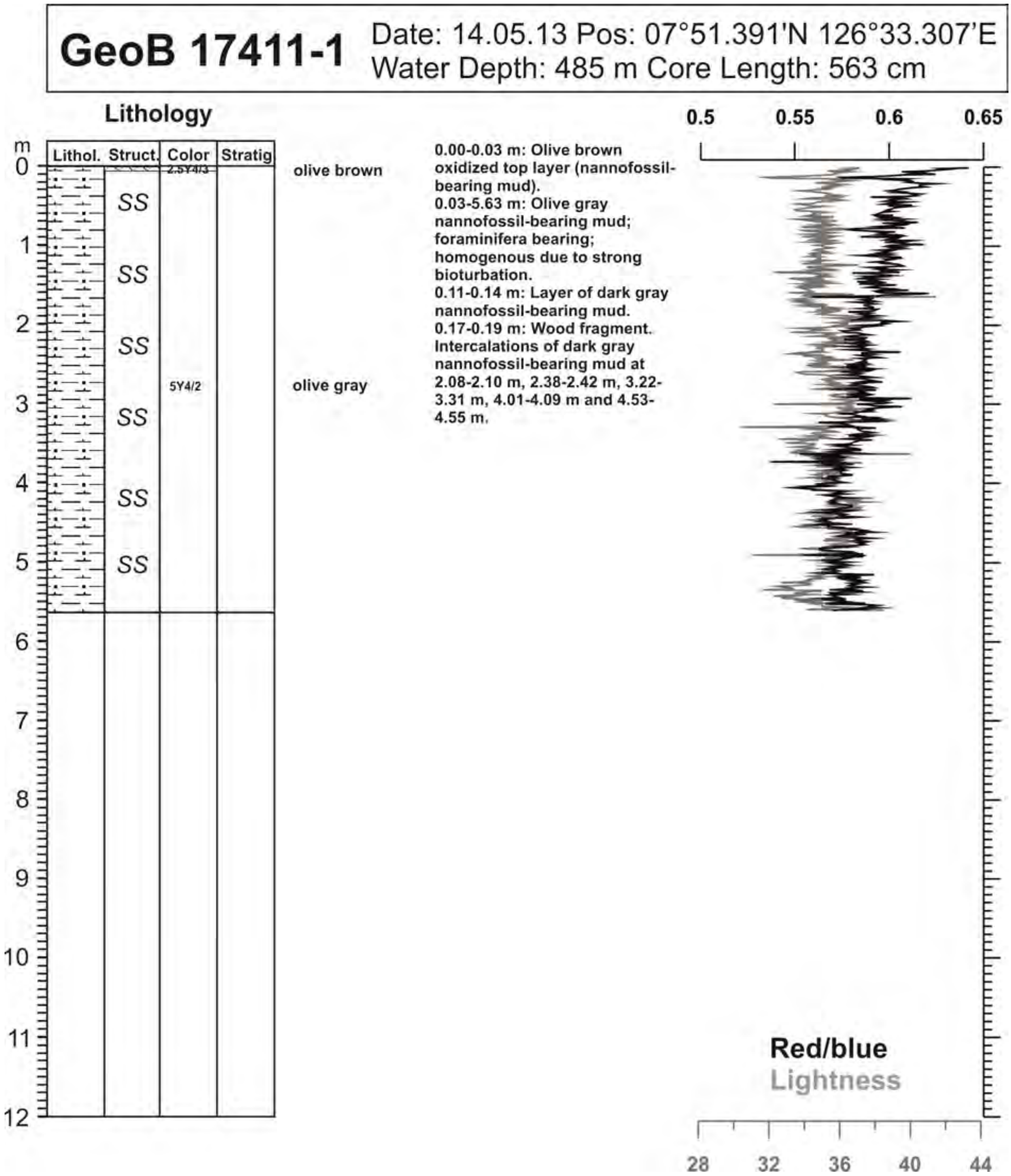

GeoB 17408-1
Date: 13.05.13 Pos: 07°50.821'N 126°42.280'E
Water Depth: 1650 m Core Length: 457 cm
Lithology
m
Lithol. Struct. Color Stratig
0
1
2
3
4
5
6
7
8
9
10
11
12
SS
SS
SS
SSS
SS
2.5Y4/3
5Y4/2
5Y4/1
olive brown
olive gray
dark gray
0.00-0.06 m: Olive brown nannofossil mud (oxidized top layer).
0.05-2.40 m: Olive gray nannofossil mud; sandy layers rich in foraminfera at 0.96-0.99 m and 1.03-1.06 m.
1.51-1.55 m: Intercalation of a dark gray nannofossil mud.
1.77-1.78 m: Sandy layer containing foraminifera.
2.40-2.60 m: Gradual transition in color and grain size; silt content increases downward; below dark gray nannofossil-bearing mud.
2.60-4.51 m: Dark gray homogenous nannofossil-bearing mud; strongly bioturbated; numerous shell fragments.
4.51-4.57 cm: Void (core catcher).
0.5
0.55
0.6
0.65
Red/blue
Lightness
24
28
32
36
40
44

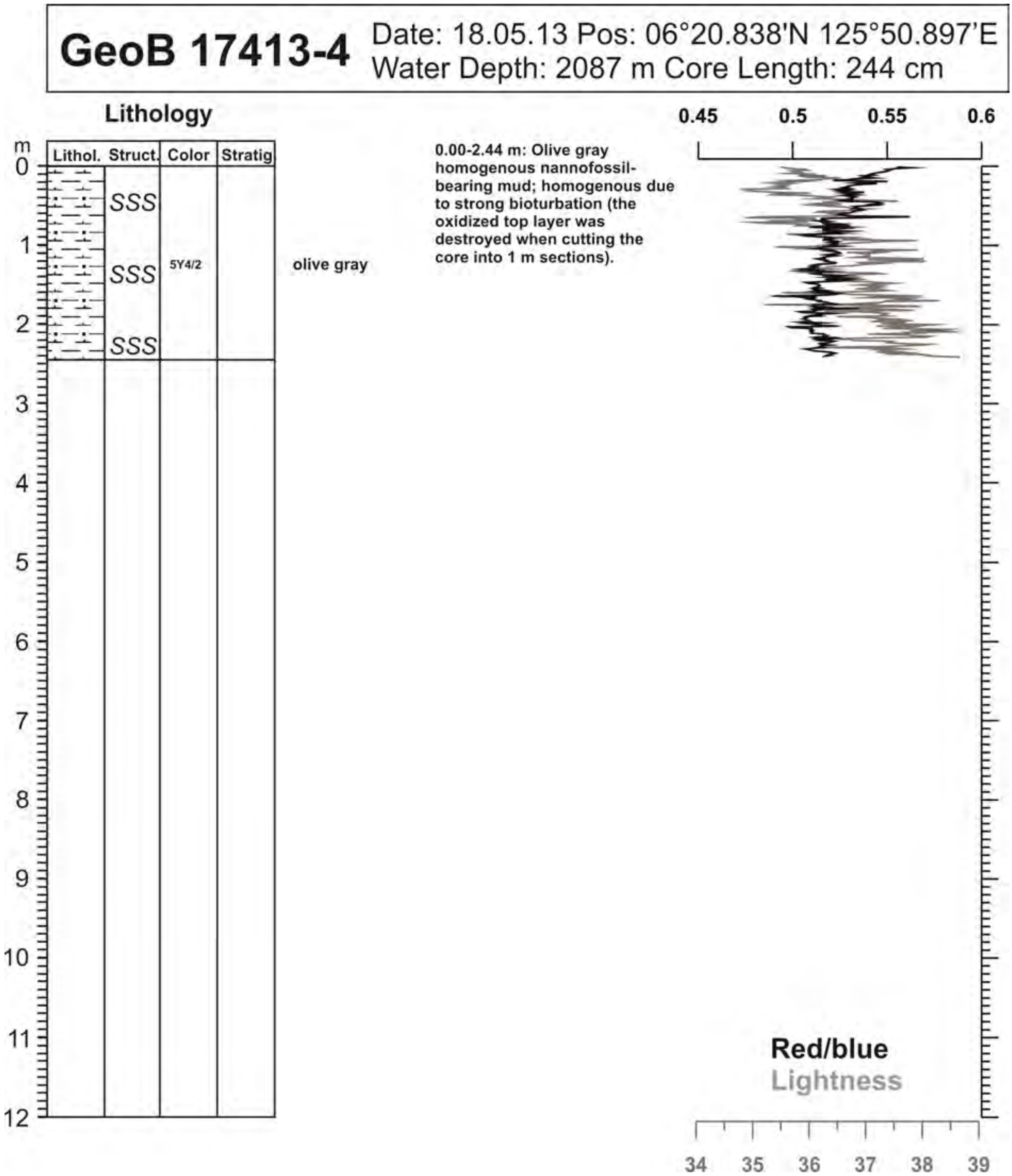

GeoB 17410-1
Date: 14.05.13 Pos: 07°52.007'N 126°35.552'E
Water Depth: 770 m Core Length: 527 cm
Lithology
m
Lithol. Struct. Color Stratig
0 1 2 3 4 5 6 7 8 9 10 11 12
SS
SSS
SS
SS
SSS
2.5Y4/3
5Y4/2
olive brown
olive gray
0.00-0.03 m: Olive brown nannofossil mud (oxidized top layer).
0.03-5.22 m: Olive gray nannofossil mud; strongly bioturbated.
1.89-1.96 m: Clayey intercalations, no distinct layers.
3.12-3.13 m: Layer of light brown nannofossil-bearing mud.
5.22-5.27 cm: Void (core catcher).
0.5 0.55 0.6
Red/blue
Lightness
32 34 36 38 40 42

GeoB 17410-4

Date: 14.05.13 Pos: 07°52.024'N 126°35.544'E
Water Depth: 767 m Core Length: 495 cm

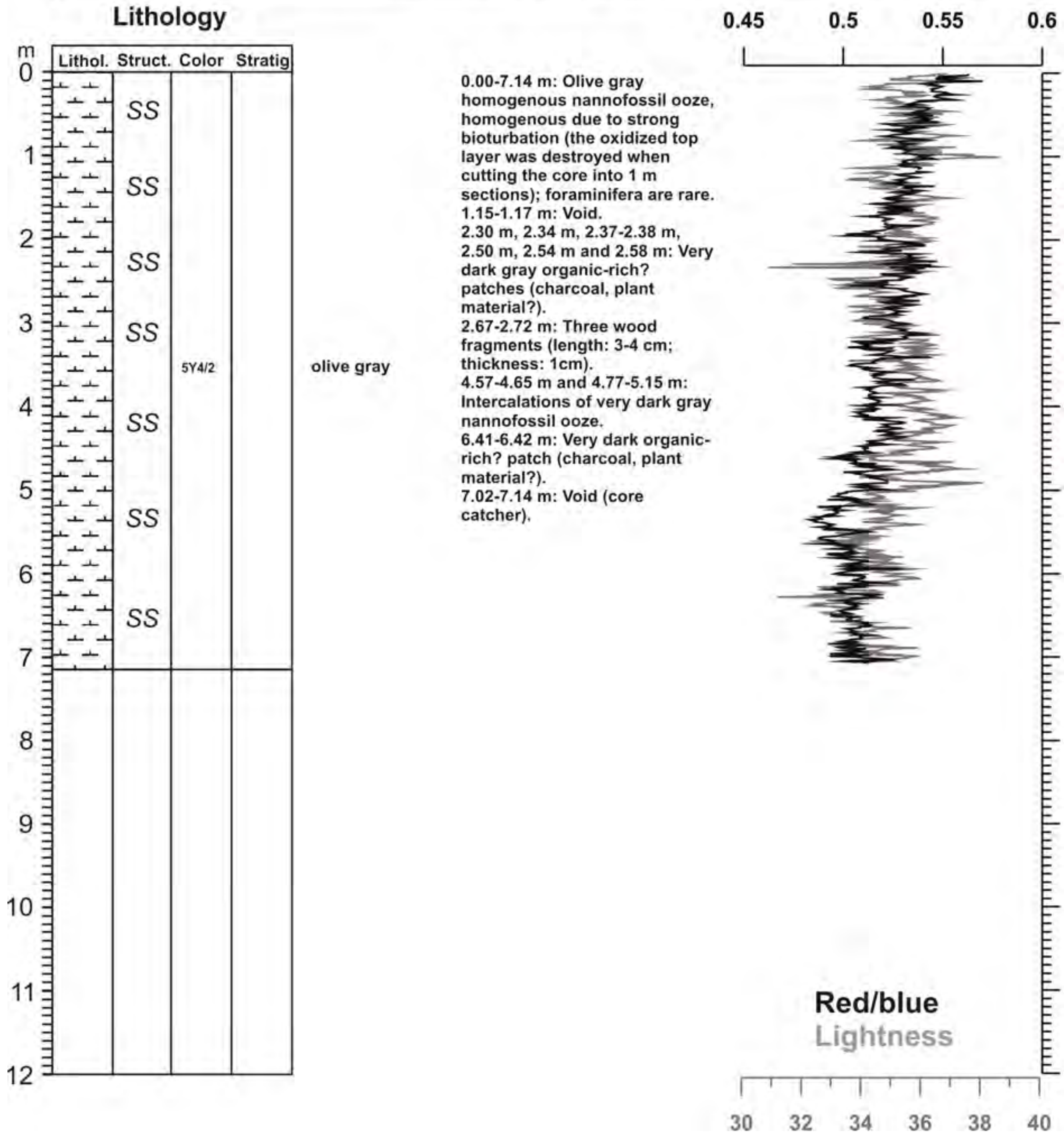


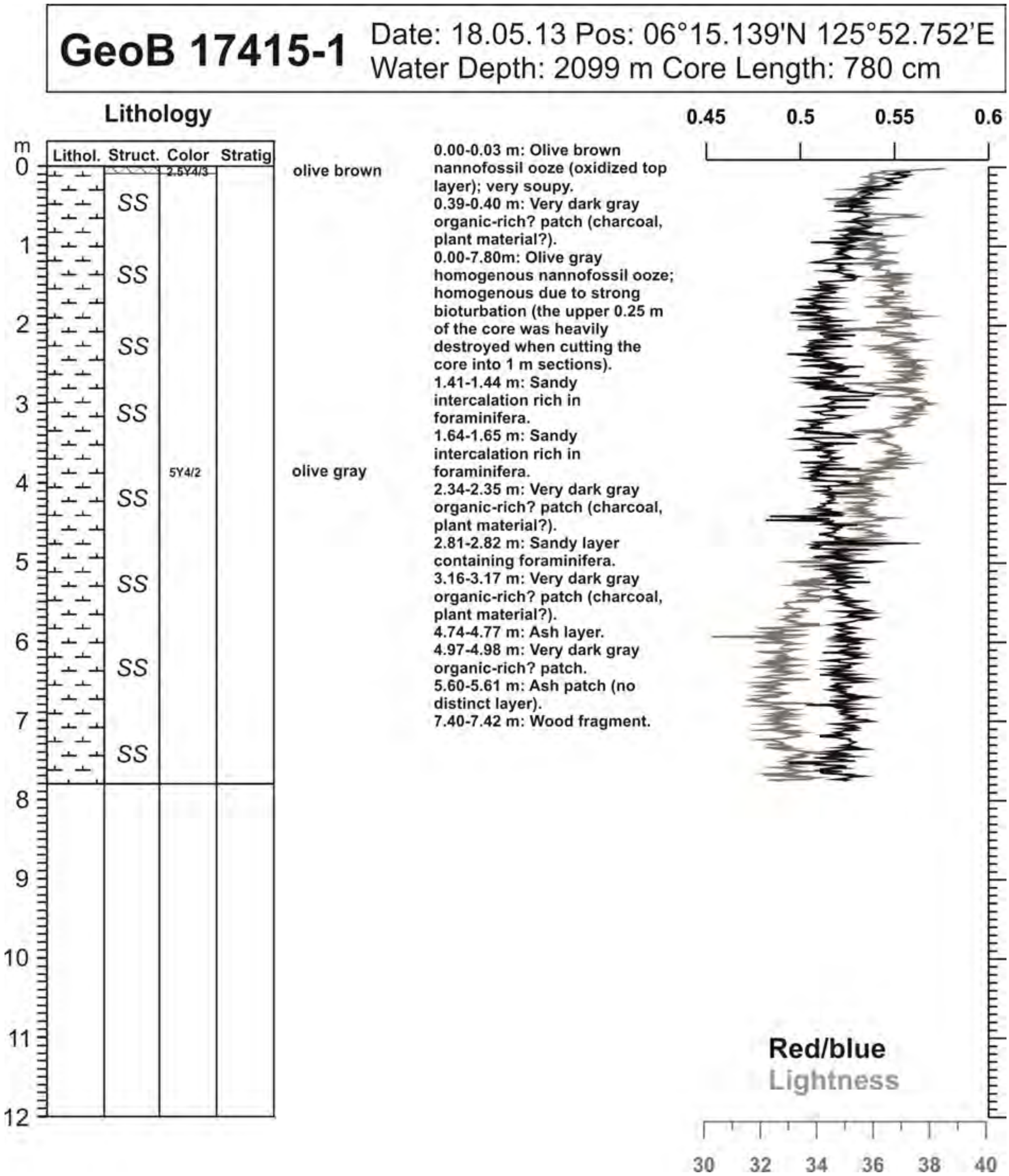

GeoB 17411-1
Date: 14.05.13 Pos: 07°51.391'N 126°33.307'E
Water Depth: 485 m Core Length: 563 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SS
2.5Y4/3
5Y4/2
olive brown
olive gray
0.00-0.03 m: Olive brown oxidized top layer (nannofossil-bearing mud).
0.03-5.63 m: Olive gray nannofossil-bearing mud; foraminifera bearing; homogenous due to strong bioturbation.
0.11-0.14 m: Layer of dark gray nannofossil-bearing mud.
0.17-0.19 m: Wood fragment.
Intercalations of dark gray nannofossil-bearing mud at 2.08-2.10 m, 2.38-2.42 m, 3.22-3.31 m, 4.01-4.09 m and 4.53-4.55 m.
0.5
0.55
0.6
0.65
Red/blue
Lightness
28
32
36
40
44
0
1
2
3
4
5
6
7
8
9
10
11
12

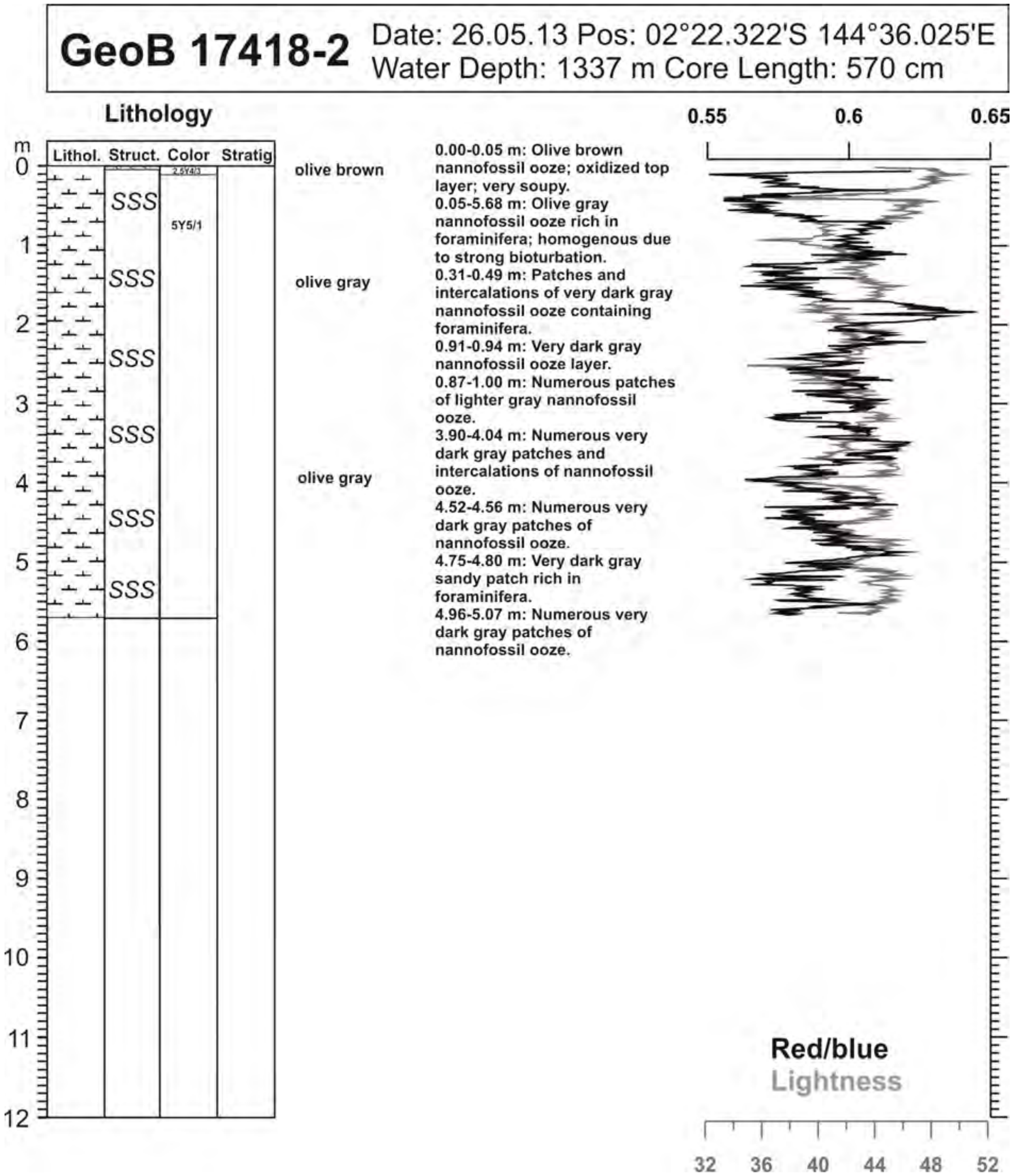

GeoB 17413-4
Date: 18.05.13 Pos: 06°20.838'N 125°50.897'E
Water Depth: 2087 m Core Length: 244 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SSS
SSS
SSS
5Y4/2
olive gray
0.00-2.44 m: Olive gray homogenous nannofossil-bearing mud; homogenous due to strong bioturbation (the oxidized top layer was destroyed when cutting the core into 1 m sections).
0.45
0.5
0.55
0.6
Red/blue
Lightness
34
35
36
37
38
39

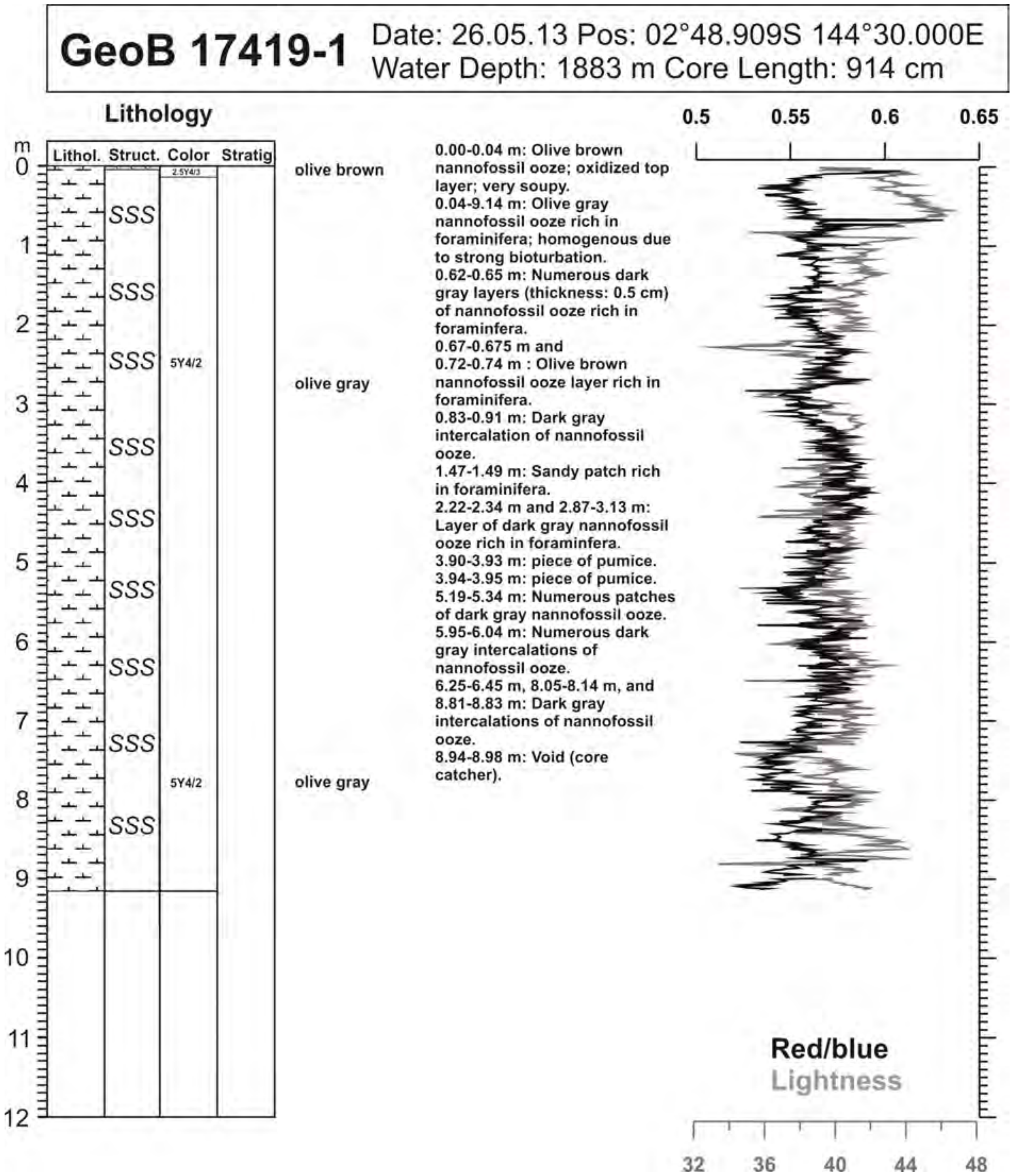
GeoB 17414-1

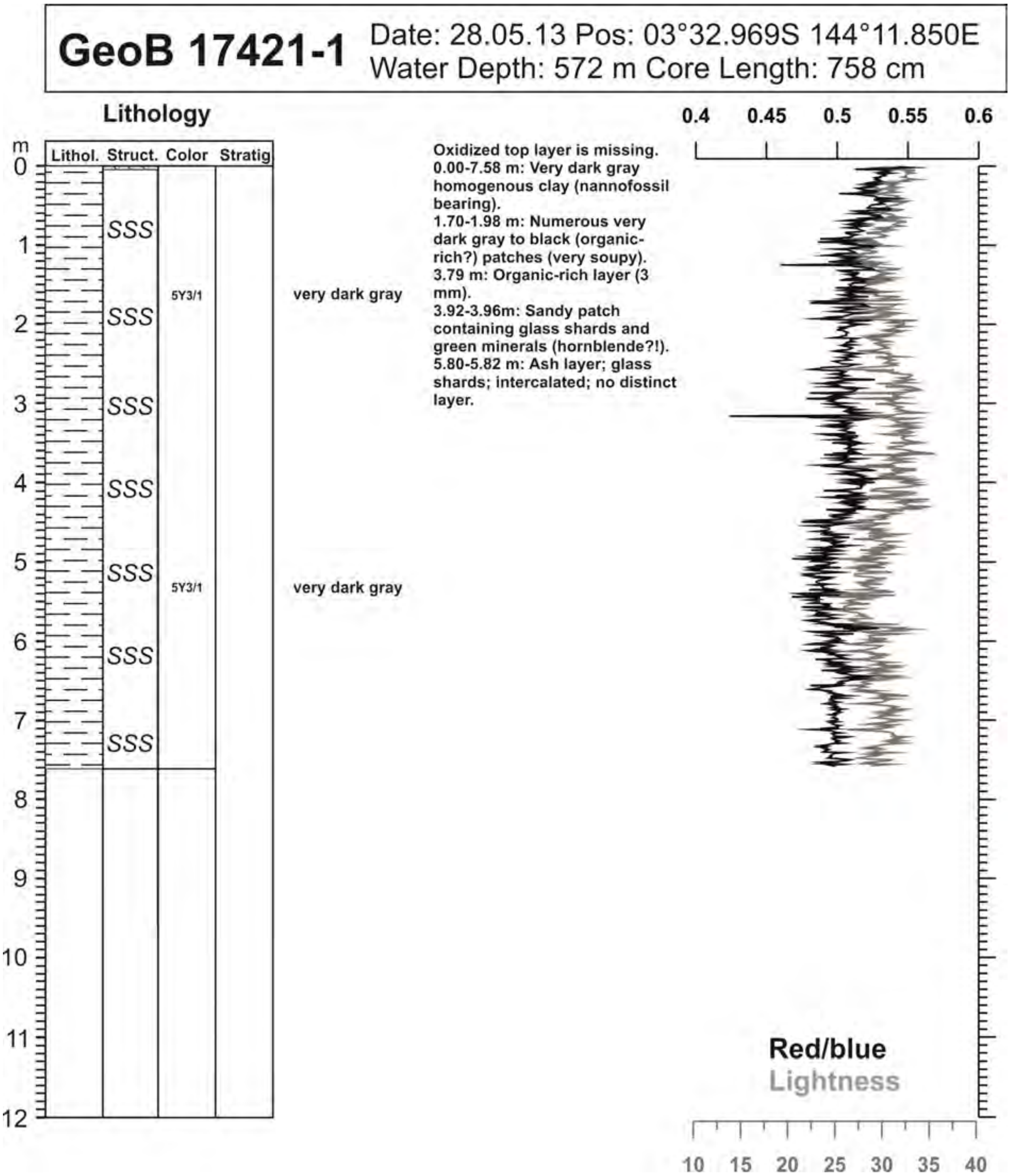
Date: 18.05.13 Pos: 06°15.570'N 125°49.951'E
Water Depth: 2190 m Core Length: 714 cm

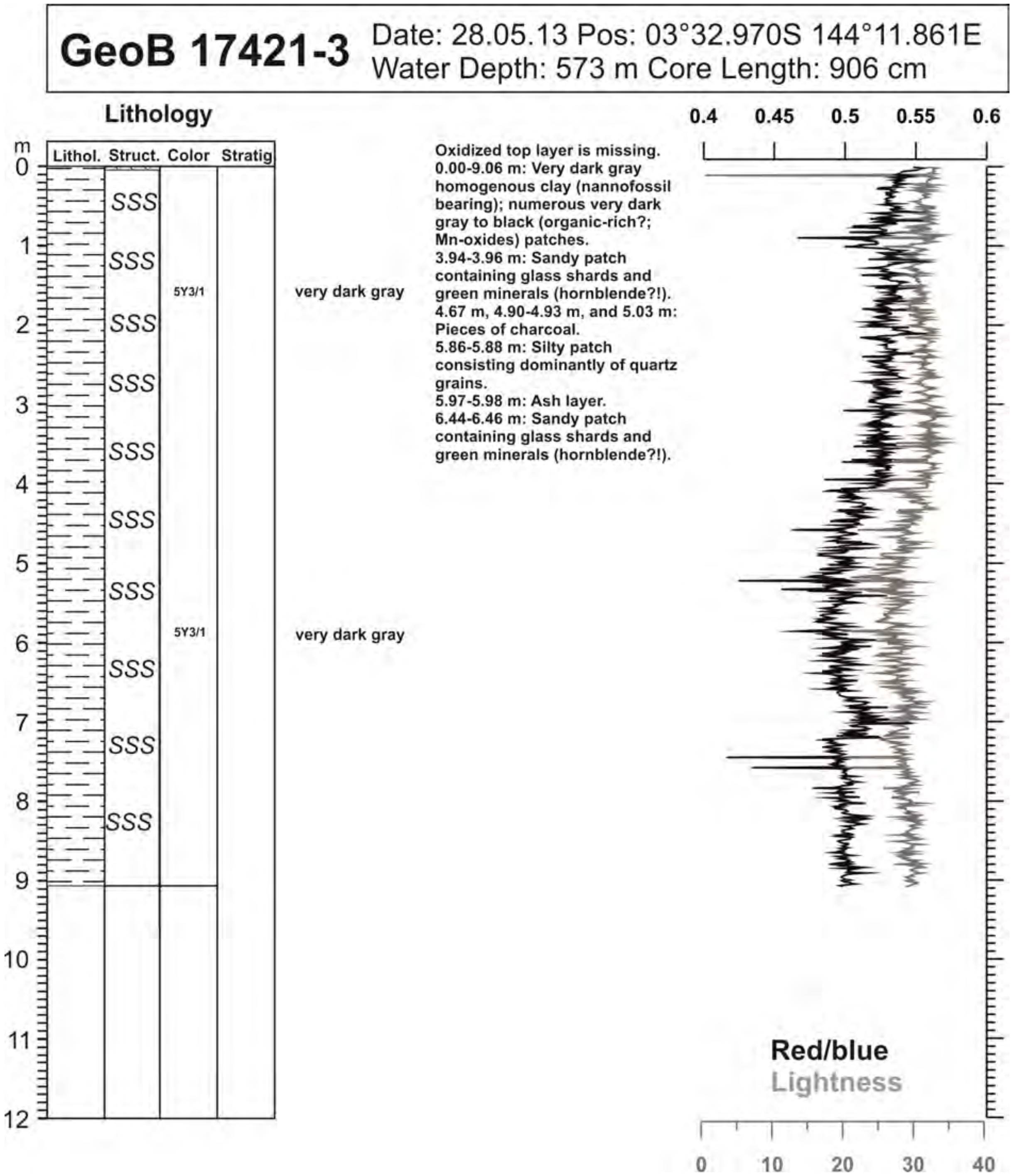


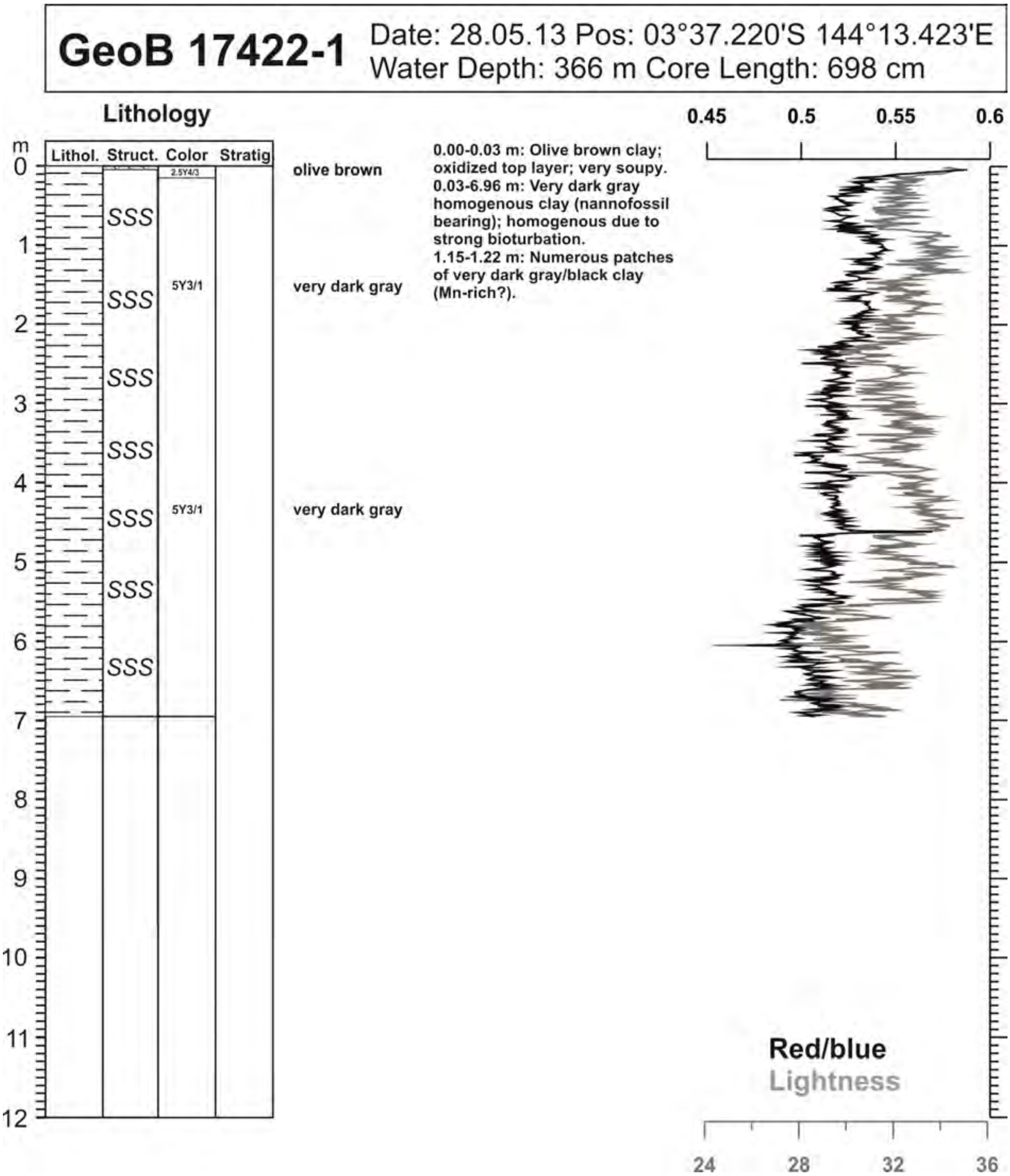

GeoB 17415-1
Date: 18.05.13 Pos: 06°15.139'N 125°52.752'E
Water Depth: 2099 m Core Length: 780 cm
Lithology
m
Lithol. Struct. Color Stratig
2.5Y4/3
olive brown
SS
5Y4/2
olive gray
0 1 2 3 4 5 6 7 8 9 10 11 12
0.00-0.03 m: Olive brown nannofossil ooze (oxidized top layer); very soupy.
0.39-0.40 m: Very dark gray organic-rich? patch (charcoal, plant material?).
0.00-7.80m: Olive gray homogenous nannofossil ooze; homogenous due to strong bioturbation (the upper 0.25 m of the core was heavily destroyed when cutting the core into 1 m sections).
1.41-1.44 m: Sandy intercalation rich in foraminifera.
1.64-1.65 m: Sandy intercalation rich in foraminifera.
2.34-2.35 m: Very dark gray organic-rich? patch (charcoal, plant material?).
2.81-2.82 m: Sandy layer containing foraminifera.
3.16-3.17 m: Very dark gray organic-rich? patch (charcoal, plant material?).
4.74-4.77 m: Ash layer.
4.97-4.98 m: Very dark gray organic-rich? patch.
5.60-5.61 m: Ash patch (no distinct layer).
7.40-7.42 m: Wood fragment.
0.45 0.5 0.55 0.6
Red/blue
Lightness
30 32 34 36 38 40

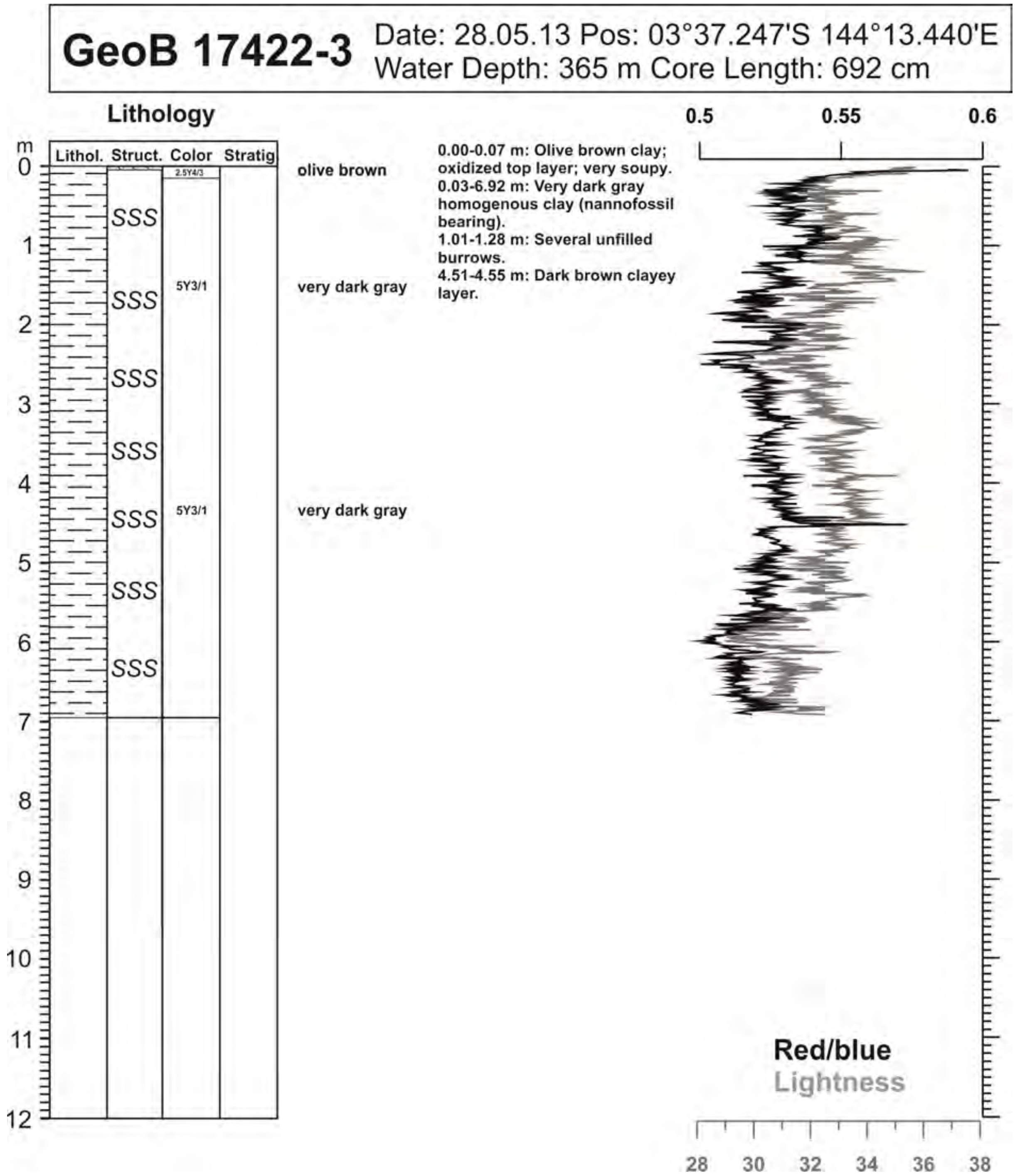

GeoB 17418-2
Date: 26.05.13 Pos: 02°22.322'S 144°36.025'E
Water Depth: 1337 m Core Length: 570 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SSS
5Y5/1
olive brown
olive gray
olive gray
0.00-0.05 m: Olive brown nannofossil ooze; oxidized top layer; very soupy.
0.05-5.68 m: Olive gray nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
0.31-0.49 m: Patches and intercalations of very dark gray nannofossil ooze containing foraminifera.
0.91-0.94 m: Very dark gray nannofossil ooze layer.
0.87-1.00 m: Numerous patches of lighter gray nannofossil ooze.
3.90-4.04 m: Numerous very dark gray patches and intercalations of nannofossil ooze.
4.52-4.56 m: Numerous very dark gray patches of nannofossil ooze.
4.75-4.80 m: Very dark gray sandy patch rich in foraminifera.
4.96-5.07 m: Numerous very dark gray patches of nannofossil ooze.
0.55
0.6
0.65
Red/blue
Lightness
32
36
40
44
48
52

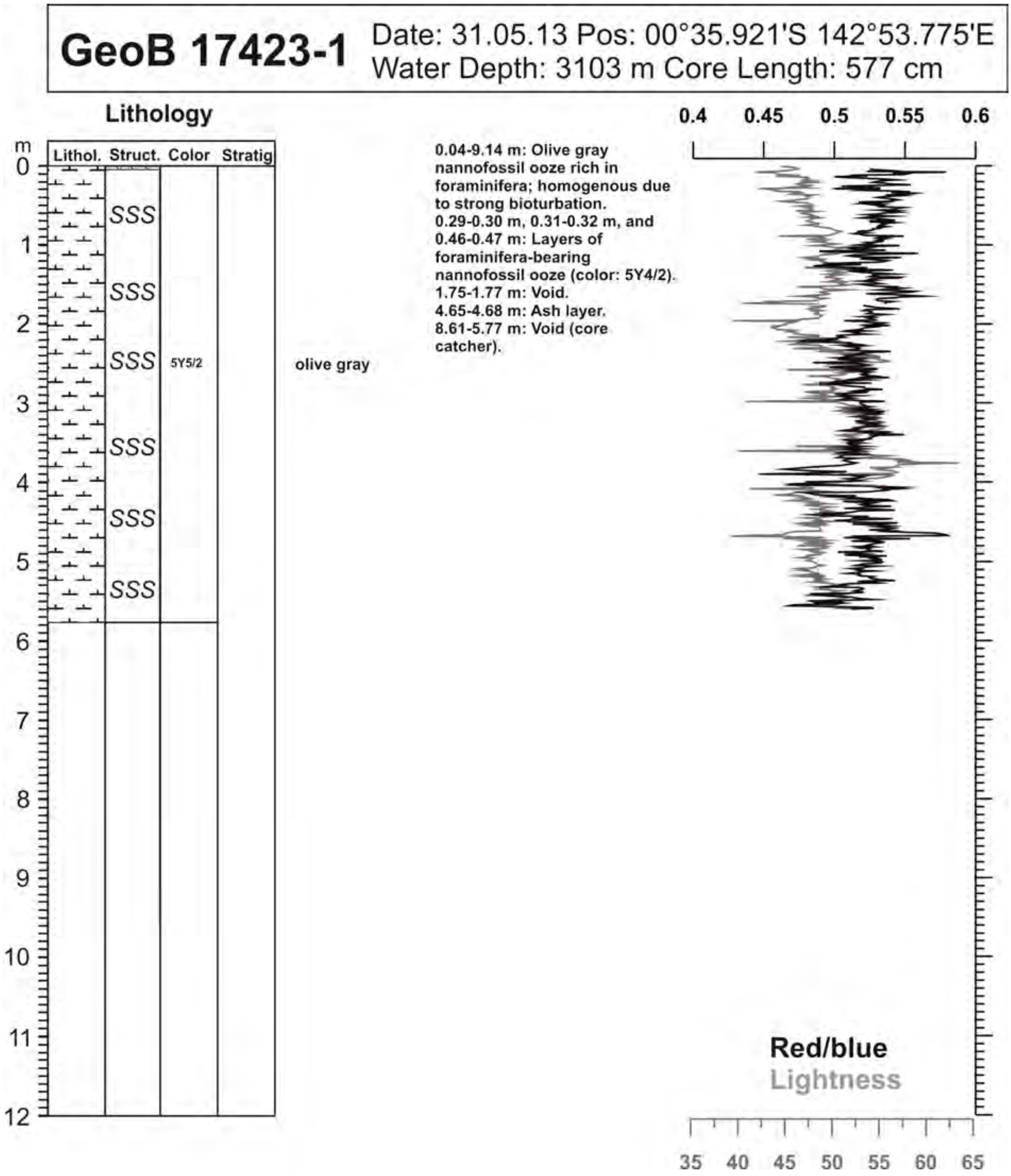

GeoB 17419-1
Date: 26.05.13 Pos: 02°48.909S 144°30.000E
Water Depth: 1883 m Core Length: 914 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SSS
2.5Y4/3
5Y4/2
5Y4/2
olive brown
olive gray
olive gray
0.00-0.04 m: Olive brown nannofossil ooze; oxidized top layer; very soupy.
0.04-9.14 m: Olive gray nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
0.62-0.65 m: Numerous dark gray layers (thickness: 0.5 cm) of nannofossil ooze rich in foraminfera.
0.67-0.675 m and
0.72-0.74 m : Olive brown nannofossil ooze layer rich in foraminifera.
0.83-0.91 m: Dark gray intercalation of nannofossil ooze.
1.47-1.49 m: Sandy patch rich in foraminifera.
2.22-2.34 m and 2.87-3.13 m: Layer of dark gray nannofossil ooze rich in foraminfera.
3.90-3.93 m: piece of pumice.
3.94-3.95 m: piece of pumice.
5.19-5.34 m: Numerous patches of dark gray nannofossil ooze.
5.95-6.04 m: Numerous dark gray intercalations of nannofossil ooze.
6.25-6.45 m, 8.05-8.14 m, and 8.81-8.83 m: Dark gray intercalations of nannofossil ooze.
8.94-8.98 m: Void (core catcher).
0.5
0.55
0.6
0.65
Red/blue
Lightness
32
36
40
44
48


GeoB 17421-1
Date: 28.05.13 Pos: 03°32.969S 144°11.850E
Water Depth: 572 m Core Length: 758 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SSS
5Y3/1
very dark gray
5Y3/1
very dark gray
0
1
2
3
4
5
6
7
8
9
10
11
12
Oxidized top layer is missing.
0.00-7.58 m: Very dark gray homogenous clay (nannofossil bearing).
1.70-1.98 m: Numerous very dark gray to black (organic-rich?) patches (very soupy).
3.79 m: Organic-rich layer (3 mm).
3.92-3.96m: Sandy patch containing glass shards and green minerals (hornblende?!).
5.80-5.82 m: Ash layer; glass shards; intercalated; no distinct layer.
0.4
0.45
0.5
0.55
0.6
Red/blue
Lightness
10
15
20
25
30
35
40

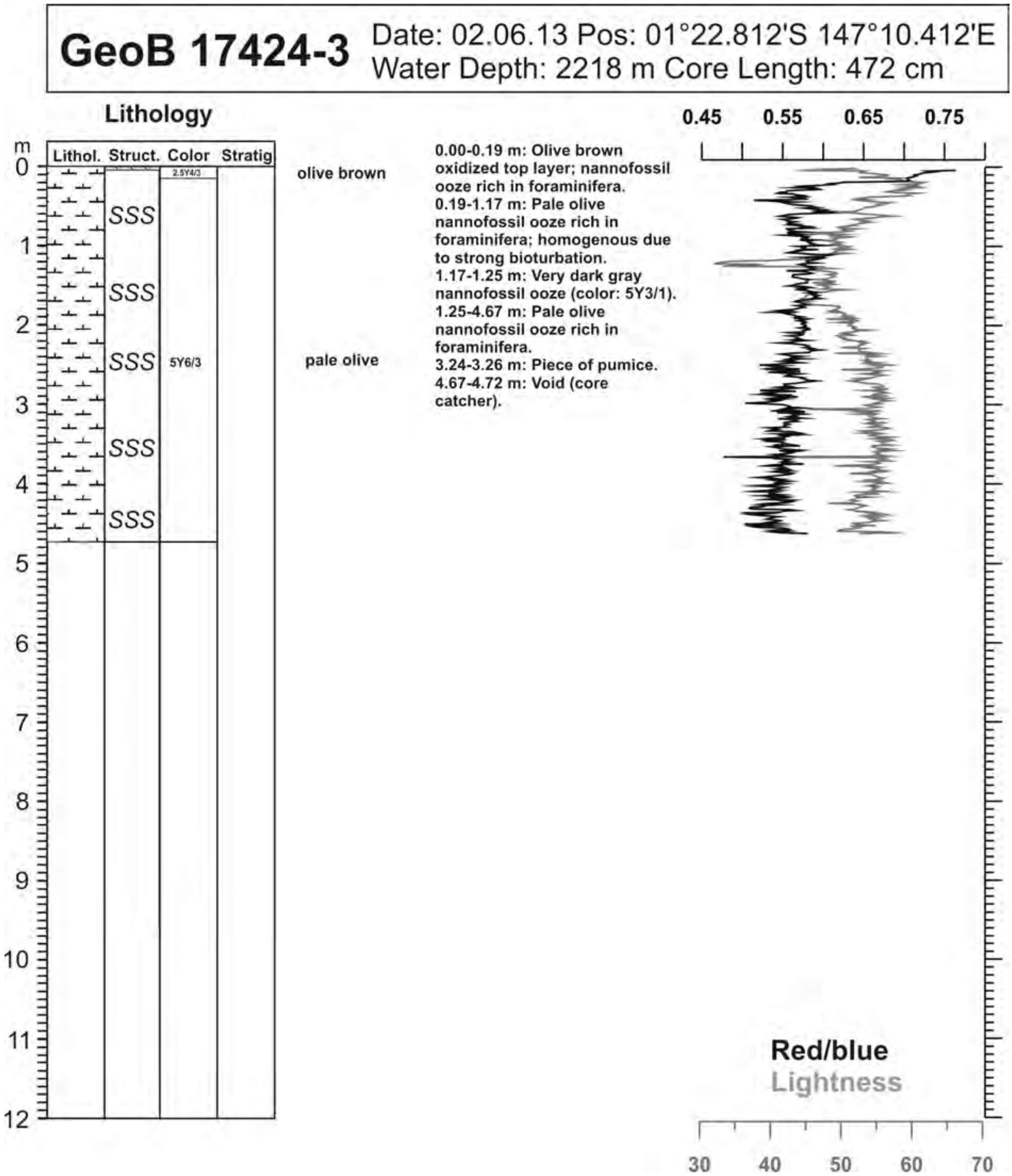

GeoB 17421-3
Date: 28.05.13 Pos: 03°32.970S 144°11.861E
Water Depth: 573 m Core Length: 906 cm
Lithology
Lithol. Struct. Color Stratig
m
SSS
5Y3/1
very dark gray
Oxidized top layer is missing.
0.00-9.06 m: Very dark gray homogenous clay (nannofossil bearing); numerous very dark gray to black (organic-rich?; Mn-oxides) patches.
3.94-3.96 m: Sandy patch containing glass shards and green minerals (hornblende?!).
4.67 m, 4.90-4.93 m, and 5.03 m: Pieces of charcoal.
5.86-5.88 m: Silty patch consisting dominantly of quartz grains.
5.97-5.98 m: Ash layer.
6.44-6.46 m: Sandy patch containing glass shards and green minerals (hornblende?!).
Red/blue
Lightness
0.4 0.45 0.5 0.55 0.6
0 10 20 30 40


GeoB 17422-1
Date: 28.05.13 Pos: 03°37.220'S 144°13.423'E
Water Depth: 366 m Core Length: 698 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
2.5Y4/3
5Y3/1
olive brown
very dark gray
very dark gray
0.00-0.03 m: Olive brown clay; oxidized top layer; very soupy.
0.03-6.96 m: Very dark gray homogenous clay (nannofossil bearing); homogenous due to strong bioturbation.
1.15-1.22 m: Numerous patches of very dark gray/black clay (Mn-rich?).
0.45 0.5 0.55 0.6
Red/blue
Lightness
24 28 32 36
0 1 2 3 4 5 6 7 8 9 10 11 12

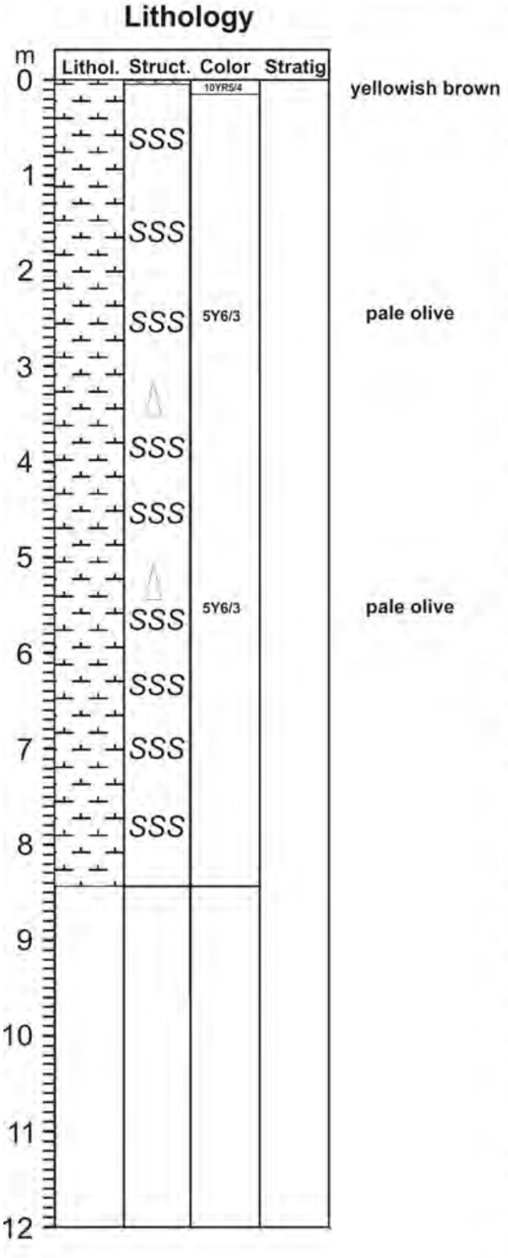

GeoB 17422-3
Date: 28.05.13 Pos: 03°37.247'S 144°13.440'E
Water Depth: 365 m Core Length: 692 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
2.5Y4/3
5Y3/1
5Y3/1
olive brown
very dark gray
very dark gray
0.00-0.07 m: Olive brown clay; oxidized top layer; very soupy.
0.03-6.92 m: Very dark gray homogenous clay (nannofossil bearing).
1.01-1.28 m: Several unfilled burrows.
4.51-4.55 m: Dark brown clayey layer.
0.5
0.55
0.6
Red/blue
Lightness
28
30
32
34
36
38



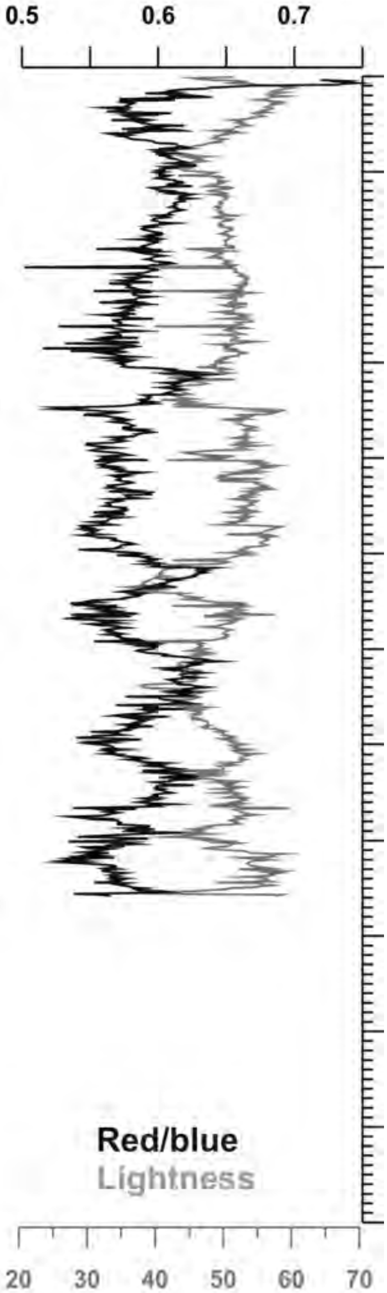
GeoB 17423-1
Date: 31.05.13 Pos: 00°35.921'S 142°53.775'E
Water Depth: 3103 m Core Length: 577 cm
Lithology
Lithol. Struct. Color Stratig
m
SSS
5Y5/2
olive gray
0.04-9.14 m: Olive gray nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
0.29-0.30 m, 0.31-0.32 m, and 0.46-0.47 m: Layers of foraminifera-bearing nannofossil ooze (color: 5Y4/2).
1.75-1.77 m: Void.
4.65-4.68 m: Ash layer.
8.61-5.77 m: Void (core catcher).
0.4 0.45 0.5 0.55 0.6
Red/blue
Lightness
35 40 45 50 55 60 65

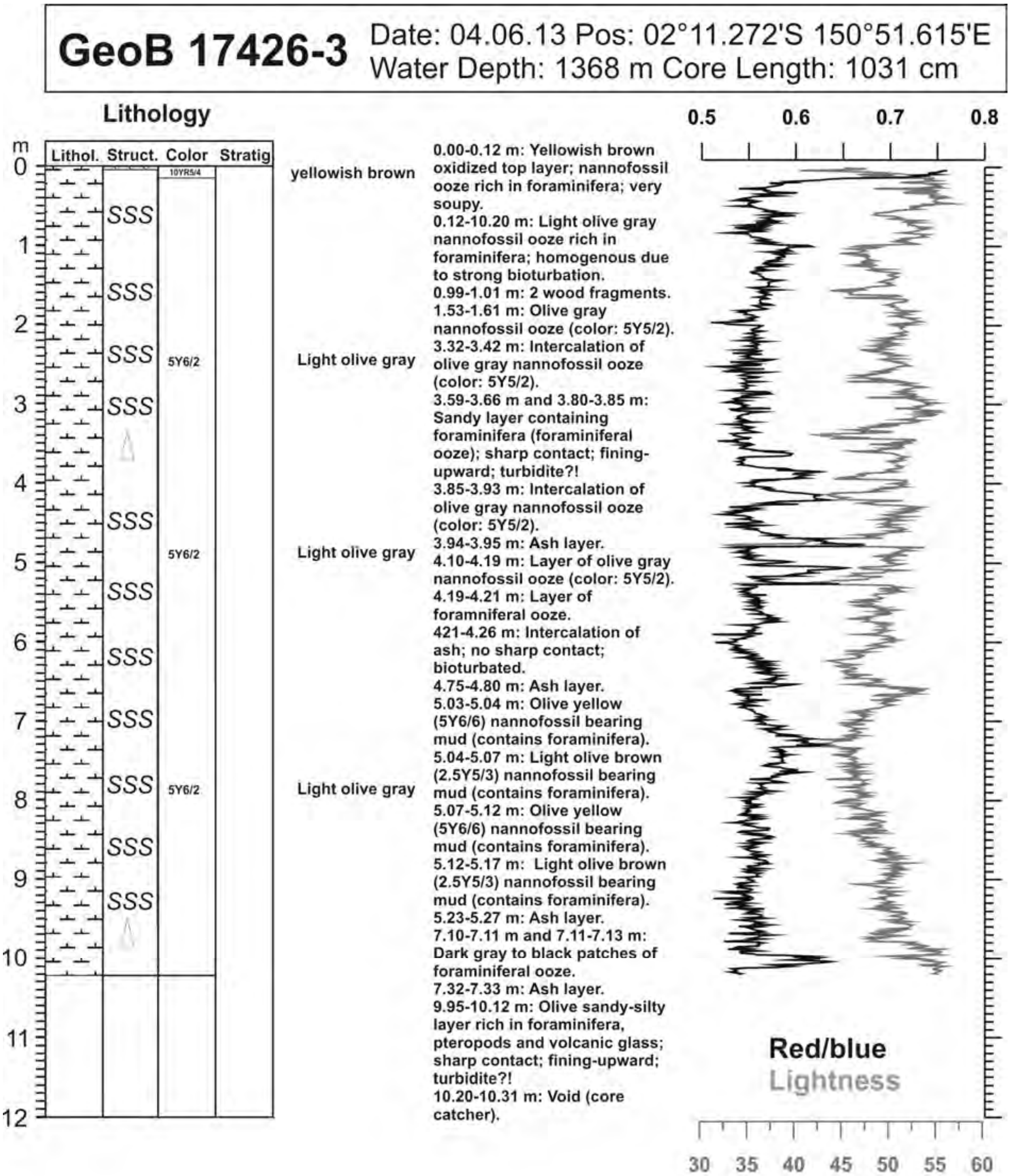

GeoB 17424-3
Date: 02.06.13 Pos: 01°22.812'S 147°10.412'E
Water Depth: 2218 m Core Length: 472 cm
Lithology
Lithol. Struct. Color Stratig
m
SSS
2.5Y4/3
5Y6/3
olive brown
pale olive
0.00-0.19 m: Olive brown oxidized top layer; nannofossil ooze rich in foraminifera.
0.19-1.17 m: Pale olive nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
1.17-1.25 m: Very dark gray nannofossil ooze (color: 5Y3/1).
1.25-4.67 m: Pale olive nannofossil ooze rich in foraminifera.
3.24-3.26 m: Piece of pumice.
4.67-4.72 m: Void (core catcher).
0.45 0.55 0.65 0.75
Red/blue
Lightness
30 40 50 60 70

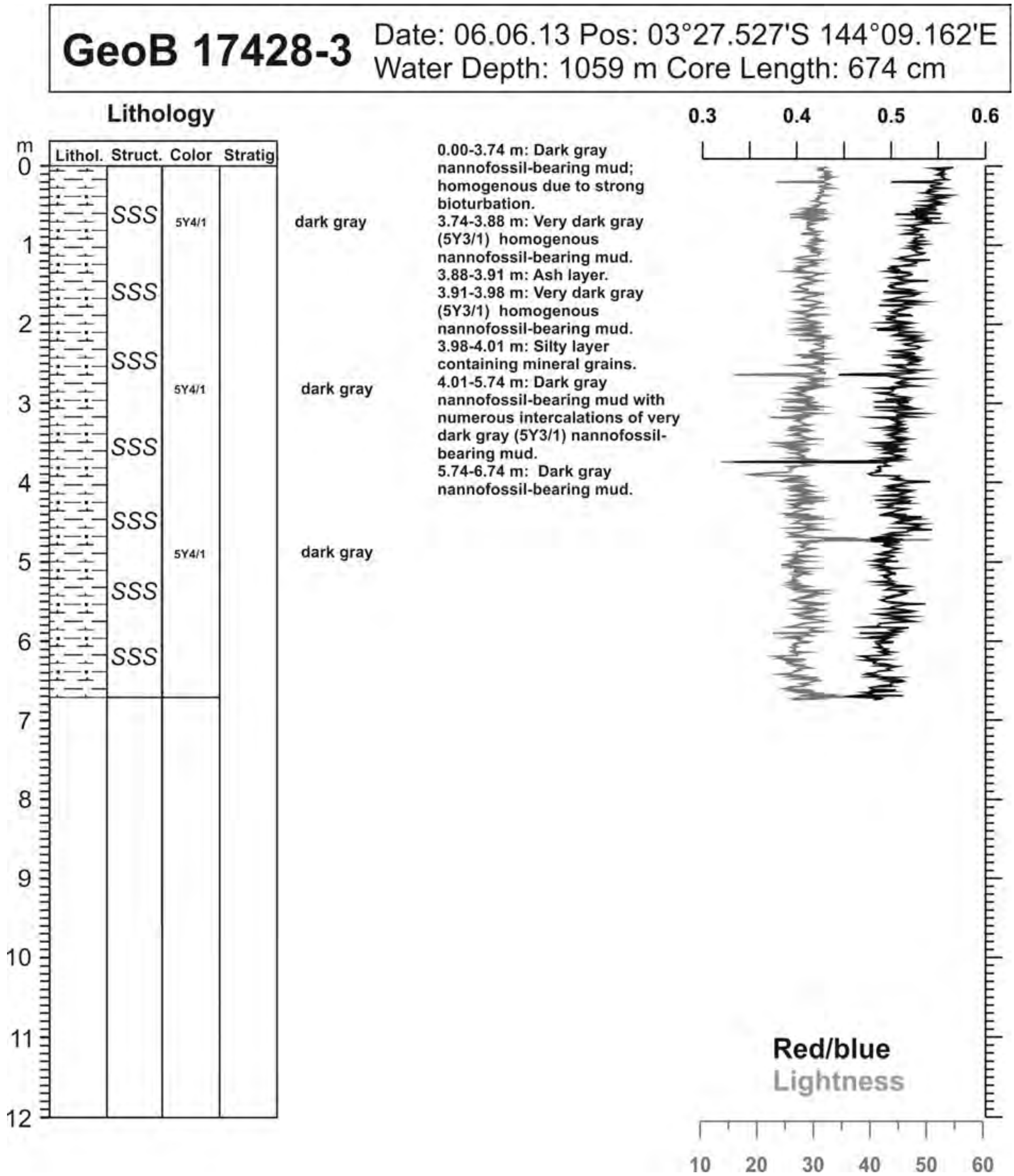
GeoB 17425-1 Date: 02.06.13 Pos: 01°32.652'S 146°46.567'E
Water Depth: 1620 m Core Length: 864 cm

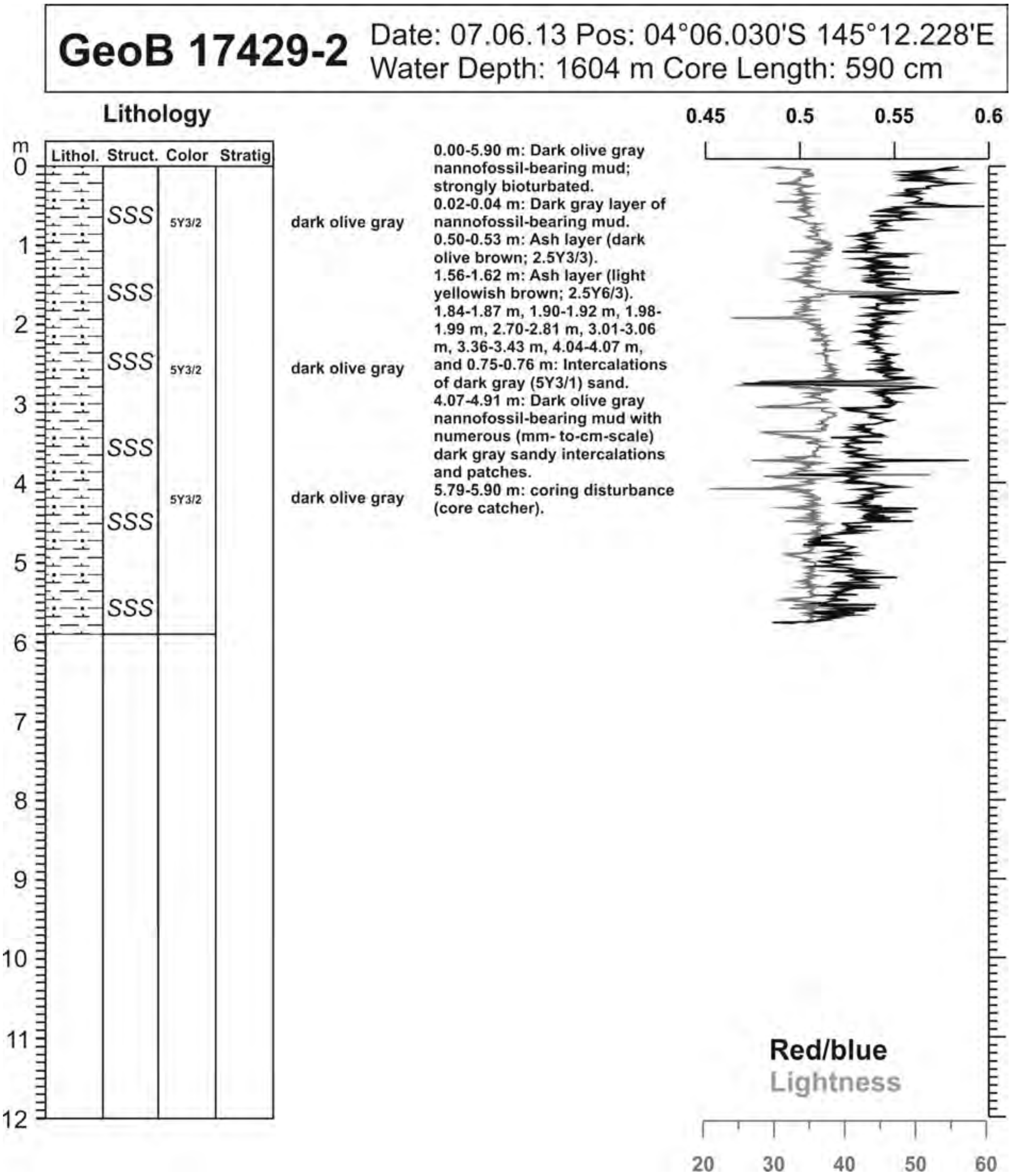


0.00-0.09 m: Yellowish brown oxidized top layer; nannofossil ooze rich in foraminifera; very soupy.
0.09-0.70 m: Pale olive nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
0.70-1.03 m: Olive gray nannofossil ooze (color: 5Y5/2).
1.03-3.03: Pale olive nannofossil ooze rich in foraminifera.
3.03-3.12 m: Sandy layer rich in foraminifera.
3.12-3.23 m: Olive gray nannofossil ooze (color: 5Y5/2).
3.23-3.33 m: Olive gray nannofossil ooze rich in foraminifera (color: 5Y5/2).
3.33-3.50 m: Sandy layer containing foraminifera (foraminiferal ooze); sharp contact; fining-upward; turbidite?!
3.50-3.92 m: Pale olive nannofossil ooze rich in foraminifera.
3.92-3.96 m: Olive gray nannofossil ooze rich in foraminifera (color: 5Y5/2).
3.96-5.12 m: Pale olive nannofossil ooze rich in foraminifera.
5.12-5.25 m: Olive gray nannofossil ooze rich in foraminifera (color: 5Y5/2).
5.25-5.49 m: Sandy layer containing foraminifera (quartz and feldspar bearing); sharp contact; fining-upward; turbidite?!
5.49-5.64 m: Pale olive nannofossil ooze rich in foraminifera.
5.64-5.67 m: Layer of forminferal ooze.
5.67-6.35 m: Pale olive nannofossil ooze rich in foraminifera.
6.35-6.43 m: Pale olive nannofossil ooze rich in foraminifera.
6.43-7.87 m: Pale olive nannofossil ooze rich in foraminifera; 6.50 m, 6.52 m and 6.59 m: Very dark gray patches of foraminifera ooze; pyritized.
7.87-7.99 m: Ash layer
7.99-8.52 m: Pale olive nannofossil ooze rich in foraminifera.
8.52-8.58 m: Ash layer.
8.55-8.58 m: Pale olive nannofossil ooze rich in foraminifera.
8.58-8.64 m: Void (core catcher).

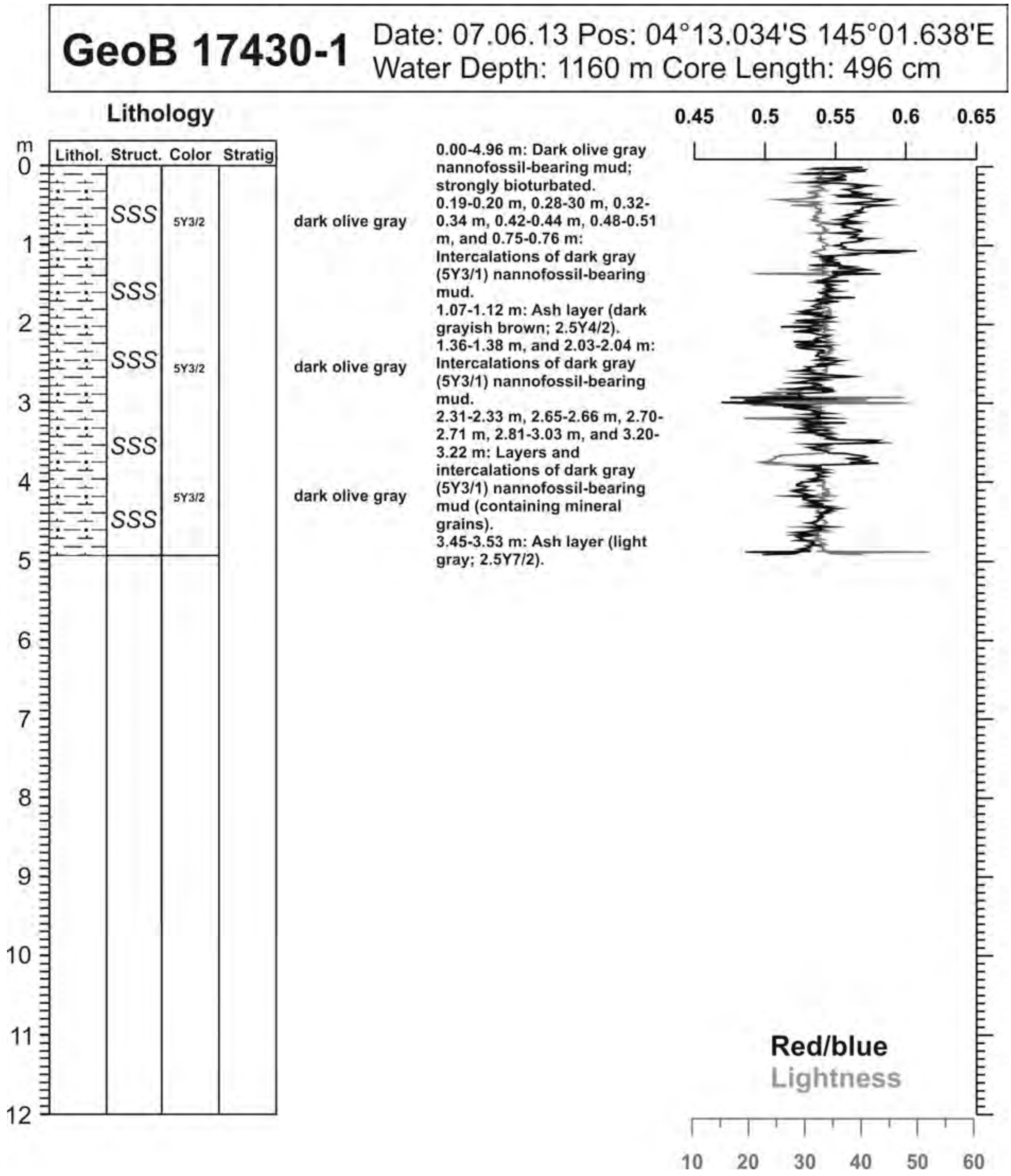


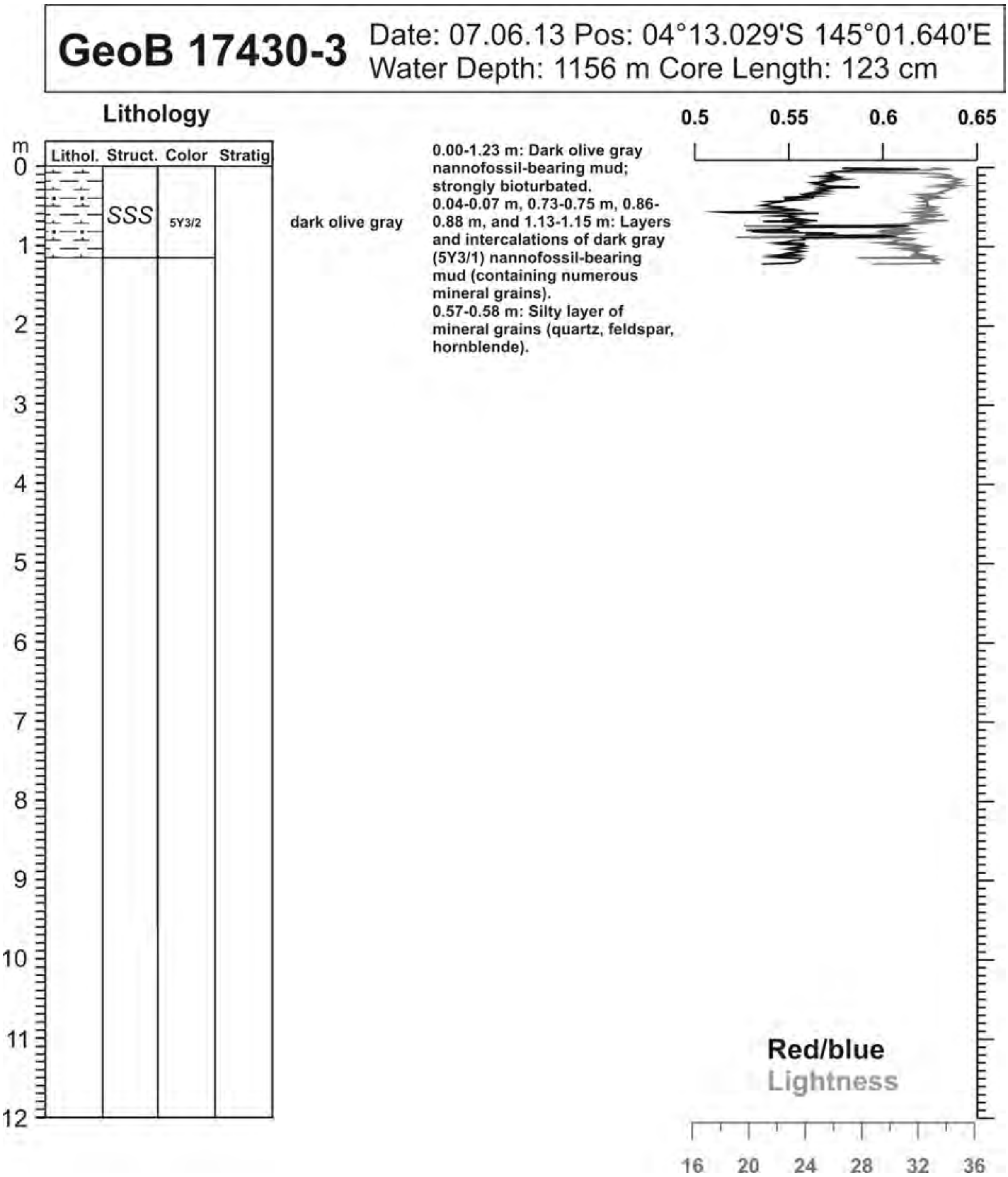

GeoB 17426-3
Date: 04.06.13 Pos: 02°11.272'S 150°51.615'E
Water Depth: 1368 m Core Length: 1031 cm
Lithology
m
Lithol. Struct. Color Stratig
0 1 2 3 4 5 6 7 8 9 10 11 12
SSS
10YR5/4
5Y6/2
yellowish brown
Light olive gray
Light olive gray
Light olive gray
0.00-0.12 m: Yellowish brown oxidized top layer; nannofossil ooze rich in foraminifera; very soupy.
0.12-10.20 m: Light olive gray nannofossil ooze rich in foraminifera; homogenous due to strong bioturbation.
0.99-1.01 m: 2 wood fragments.
1.53-1.61 m: Olive gray nannofossil ooze (color: 5Y5/2).
3.32-3.42 m: Intercalation of olive gray nannofossil ooze (color: 5Y5/2).
3.59-3.66 m and 3.80-3.85 m: Sandy layer containing foraminifera (foraminiferal ooze); sharp contact; fining-upward; turbidite?!
3.85-3.93 m: Intercalation of olive gray nannofossil ooze (color: 5Y5/2).
3.94-3.95 m: Ash layer.
4.10-4.19 m: Layer of olive gray nannofossil ooze (color: 5Y5/2).
4.19-4.21 m: Layer of foramniferal ooze.
421-4.26 m: Intercalation of ash; no sharp contact; bioturbated.
4.75-4.80 m: Ash layer.
5.03-5.04 m: Olive yellow (5Y6/6) nannofossil bearing mud (contains foraminifera).
5.04-5.07 m: Light olive brown (2.5Y5/3) nannofossil bearing mud (contains foraminifera).
5.07-5.12 m: Olive yellow (5Y6/6) nannofossil bearing mud (contains foraminifera).
5.12-5.17 m: Light olive brown (2.5Y5/3) nannofossil bearing mud (contains foraminifera).
5.23-5.27 m: Ash layer.
7.10-7.11 m and 7.11-7.13 m: Dark gray to black patches of foraminiferal ooze.
7.32-7.33 m: Ash layer.
9.95-10.12 m: Olive sandy-silty layer rich in foraminifera, pteropods and volcanic glass; sharp contact; fining-upward; turbidite?!
10.20-10.31 m: Void (core catcher).
0.5 0.6 0.7 0.8
Red/blue
Lightness
30 35 40 45 50 55 60

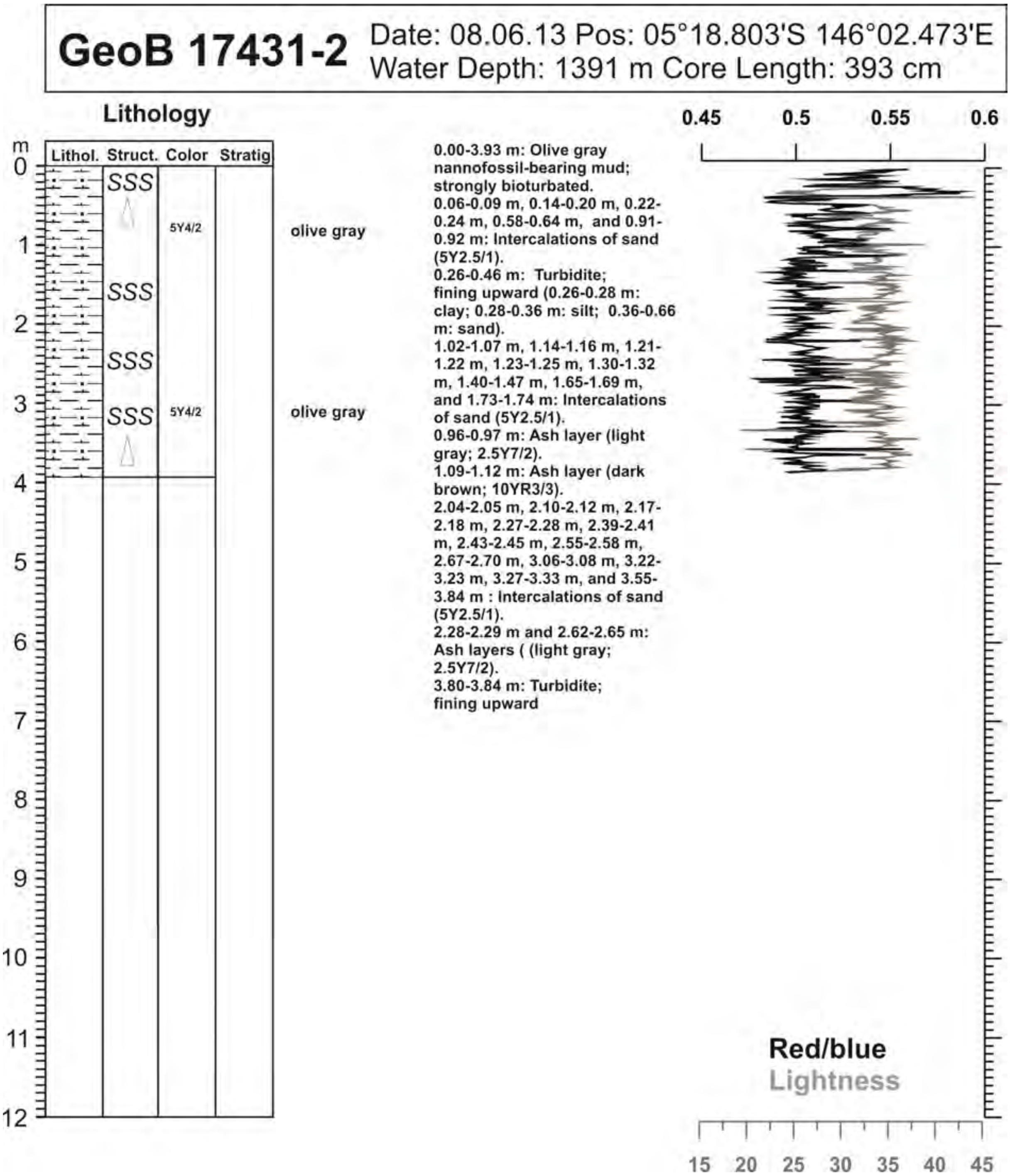

GeoB 17428-3
Date: 06.06.13 Pos: 03°27.527'S 144°09.162'E
Water Depth: 1059 m Core Length: 674 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
5Y4/1
dark gray
0.00-3.74 m: Dark gray nannofossil-bearing mud; homogenous due to strong bioturbation.
3.74-3.88 m: Very dark gray (5Y3/1) homogenous nannofossil-bearing mud.
3.88-3.91 m: Ash layer.
3.91-3.98 m: Very dark gray (5Y3/1) homogenous nannofossil-bearing mud.
3.98-4.01 m: Silty layer containing mineral grains.
4.01-5.74 m: Dark gray nannofossil-bearing mud with numerous intercalations of very dark gray (5Y3/1) nannofossil-bearing mud.
5.74-6.74 m: Dark gray nannofossil-bearing mud.
0.3 0.4 0.5 0.6
Red/blue
Lightness
10 20 30 40 50 60

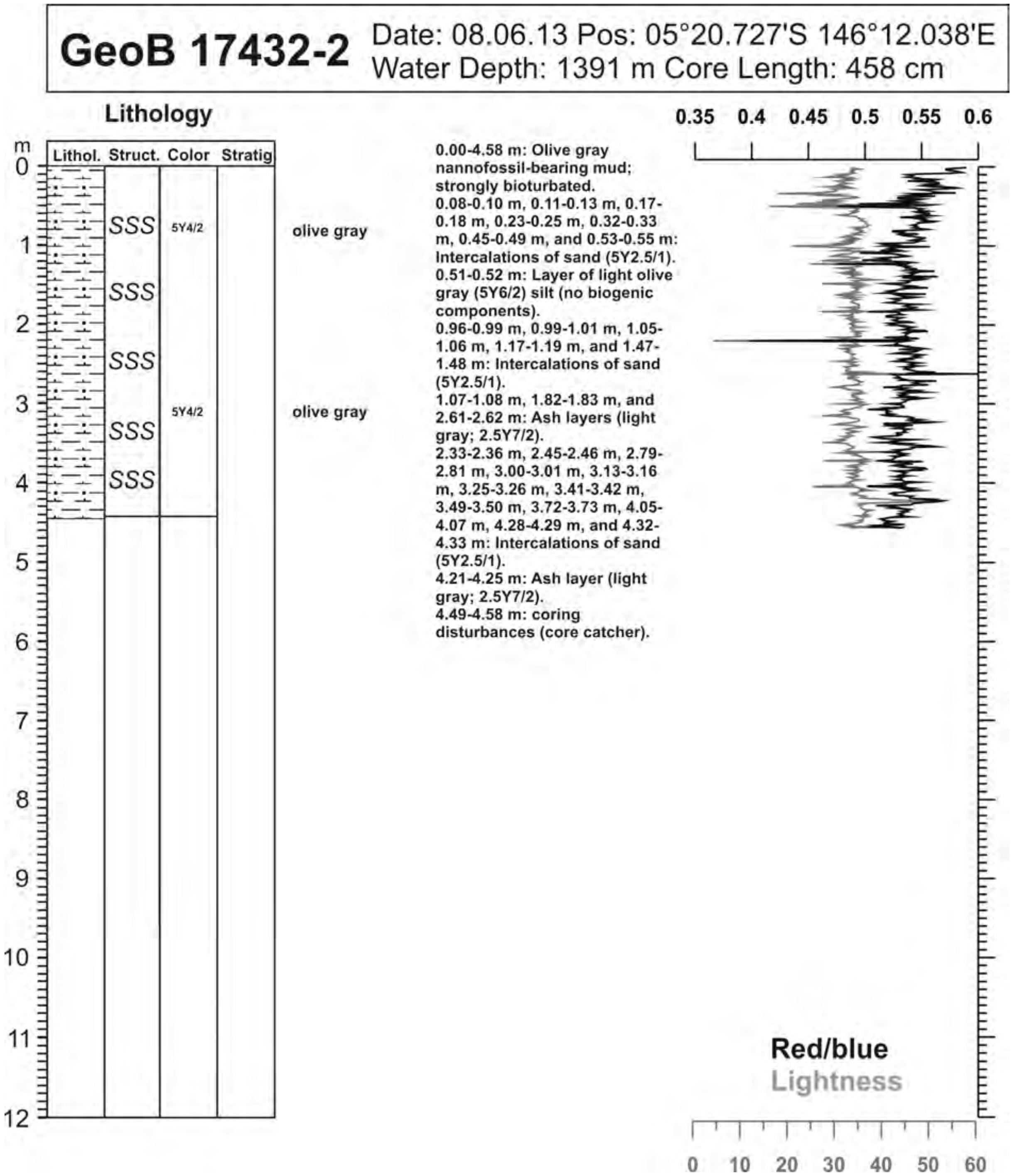


GeoB 17429-2
Date: 07.06.13 Pos: 04°06.030'S 145°12.228'E
Water Depth: 1604 m Core Length: 590 cm
Lithology
Lithol. Struct. Color Stratig
m
SSS
5Y3/2
dark olive gray
0.00-5.90 m: Dark olive gray nannofossil-bearing mud; strongly bioturbated.
0.02-0.04 m: Dark gray layer of nannofossil-bearing mud.
0.50-0.53 m: Ash layer (dark olive brown; 2.5Y3/3).
1.56-1.62 m: Ash layer (light yellowish brown; 2.5Y6/3).
1.84-1.87 m, 1.90-1.92 m, 1.98-1.99 m, 2.70-2.81 m, 3.01-3.06 m, 3.36-3.43 m, 4.04-4.07 m, and 0.75-0.76 m: Intercalations of dark gray (5Y3/1) sand.
4.07-4.91 m: Dark olive gray nannofossil-bearing mud with numerous (mm- to-cm-scale) dark gray sandy intercalations and patches.
5.79-5.90 m: coring disturbance (core catcher).
0.45 0.5 0.55 0.6
Red/blue
Lightness
20 30 40 50 60

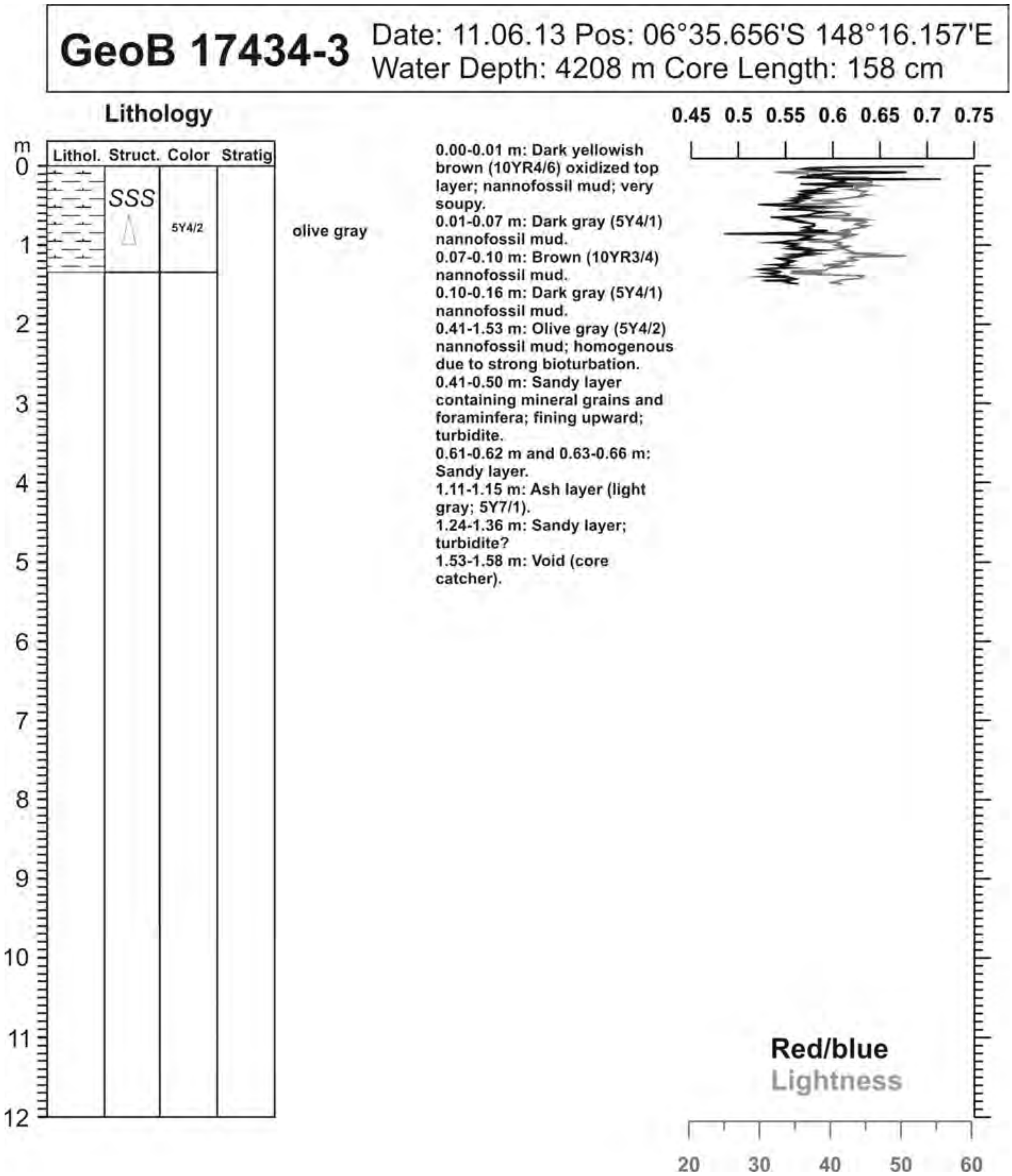

GeoB 17430-1
Date: 07.06.13 Pos: 04°13.034'S 145°01.638'E
Water Depth: 1160 m Core Length: 496 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
0
1
2
3
4
5
6
7
8
9
10
11
12
SSS
SSS
SSS
SSS
SSS
5Y3/2
5Y3/2
5Y3/2
dark olive gray
dark olive gray
dark olive gray
0.00-4.96 m: Dark olive gray nannofossil-bearing mud; strongly bioturbated.
0.19-0.20 m, 0.28-30 m, 0.32-0.34 m, 0.42-0.44 m, 0.48-0.51 m, and 0.75-0.76 m: Intercalations of dark gray (5Y3/1) nannofossil-bearing mud.
1.07-1.12 m: Ash layer (dark grayish brown; 2.5Y4/2).
1.36-1.38 m, and 2.03-2.04 m: Intercalations of dark gray (5Y3/1) nannofossil-bearing mud.
2.31-2.33 m, 2.65-2.66 m, 2.70-2.71 m, 2.81-3.03 m, and 3.20-3.22 m: Layers and intercalations of dark gray (5Y3/1) nannofossil-bearing mud (containing mineral grains).
3.45-3.53 m: Ash layer (light gray; 2.5Y7/2).
0.45
0.5
0.55
0.6
0.65
Red/blue
Lightness
10
20
30
40
50
60

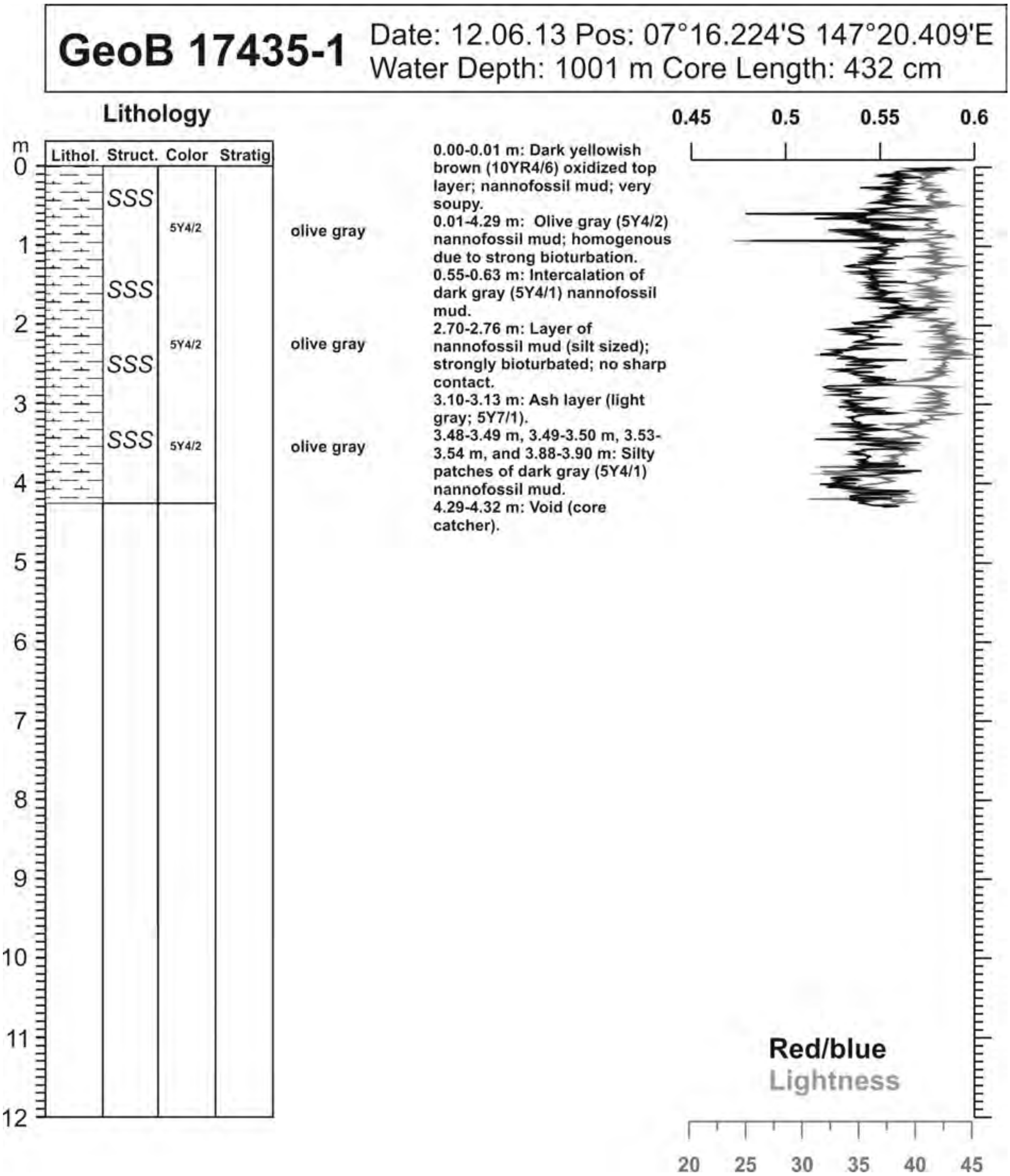

GeoB 17430-3
Date: 07.06.13 Pos: 04°13.029'S 145°01.640'E
Water Depth: 1156 m Core Length: 123 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
5Y3/2
dark olive gray
0.00-1.23 m: Dark olive gray nannofossil-bearing mud; strongly bioturbated.
0.04-0.07 m, 0.73-0.75 m, 0.86-0.88 m, and 1.13-1.15 m: Layers and intercalations of dark gray (5Y3/1) nannofossil-bearing mud (containing numerous mineral grains).
0.57-0.58 m: Silty layer of mineral grains (quartz, feldspar, hornblende).
0.5 0.55 0.6 0.65
0 1 2 3 4 5 6 7 8 9 10 11 12
Red/blue
Lightness
16 20 24 28 32 36

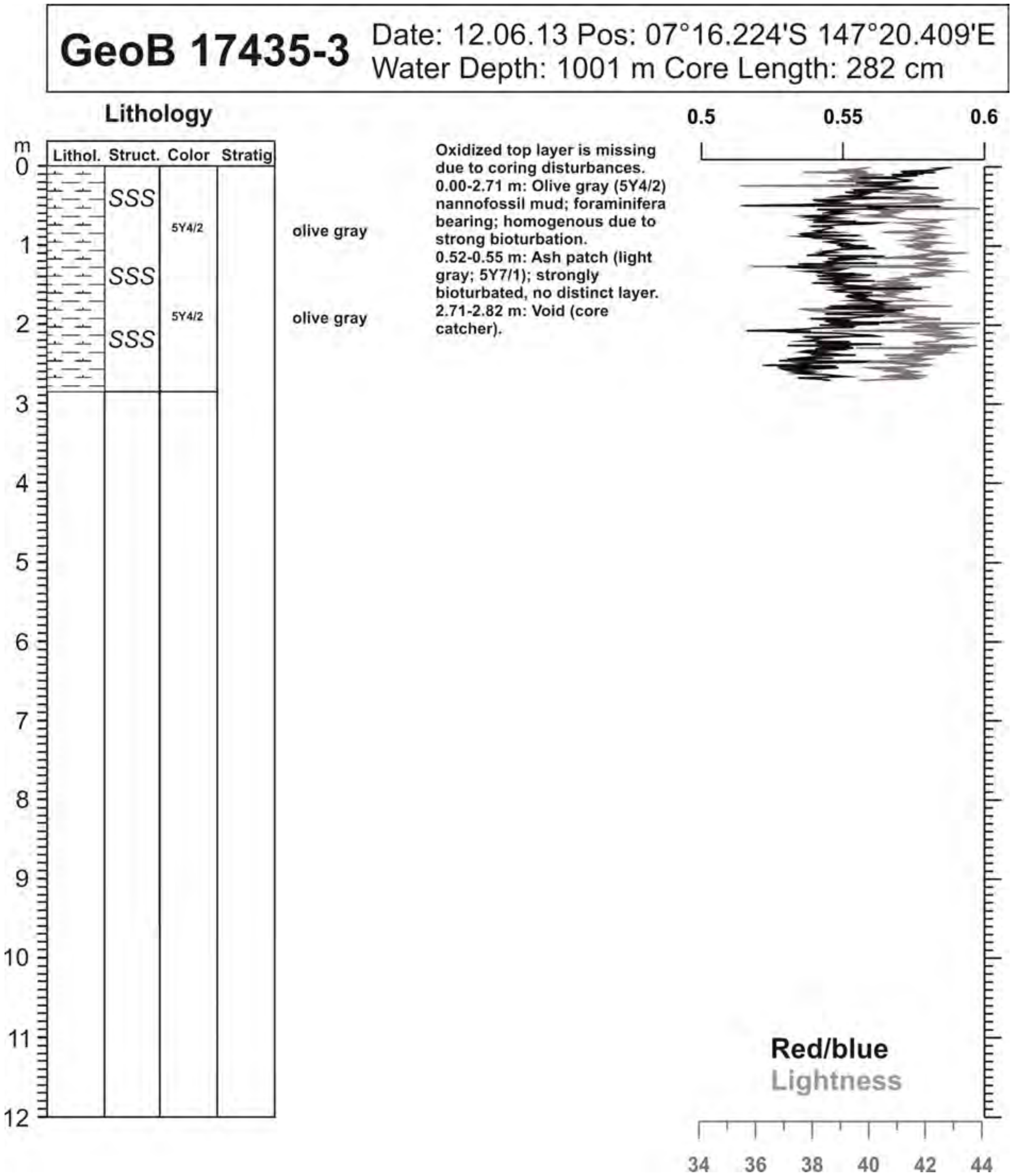

GeoB 17431-2
Date: 08.06.13 Pos: 05°18.803'S 146°02.473'E
Water Depth: 1391 m Core Length: 393 cm
Lithology
m
Lithol.
Struct.
Color
Stratig
SSS
5Y4/2
olive gray
0.00-3.93 m: Olive gray nannofossil-bearing mud; strongly bioturbated.
0.06-0.09 m, 0.14-0.20 m, 0.22-0.24 m, 0.58-0.64 m, and 0.91-0.92 m: Intercalations of sand (5Y2.5/1).
0.26-0.46 m: Turbidite; fining upward (0.26-0.28 m: clay; 0.28-0.36 m: silt; 0.36-0.66 m: sand).
1.02-1.07 m, 1.14-1.16 m, 1.21-1.22 m, 1.23-1.25 m, 1.30-1.32 m, 1.40-1.47 m, 1.65-1.69 m, and 1.73-1.74 m: Intercalations of sand (5Y2.5/1).
0.96-0.97 m: Ash layer (light gray; 2.5Y7/2).
1.09-1.12 m: Ash layer (dark brown; 10YR3/3).
2.04-2.05 m, 2.10-2.12 m, 2.17-2.18 m, 2.27-2.28 m, 2.39-2.41 m, 2.43-2.45 m, 2.55-2.58 m, 2.67-2.70 m, 3.06-3.08 m, 3.22-3.23 m, 3.27-3.33 m, and 3.55-3.84 m : Intercalations of sand (5Y2.5/1).
2.28-2.29 m and 2.62-2.65 m: Ash layers ((light gray; 2.5Y7/2).
3.80-3.84 m: Turbidite; fining upward
0.45
0.5
0.55
0.6
Red/blue
Lightness
15
20
25
30
35
40
45

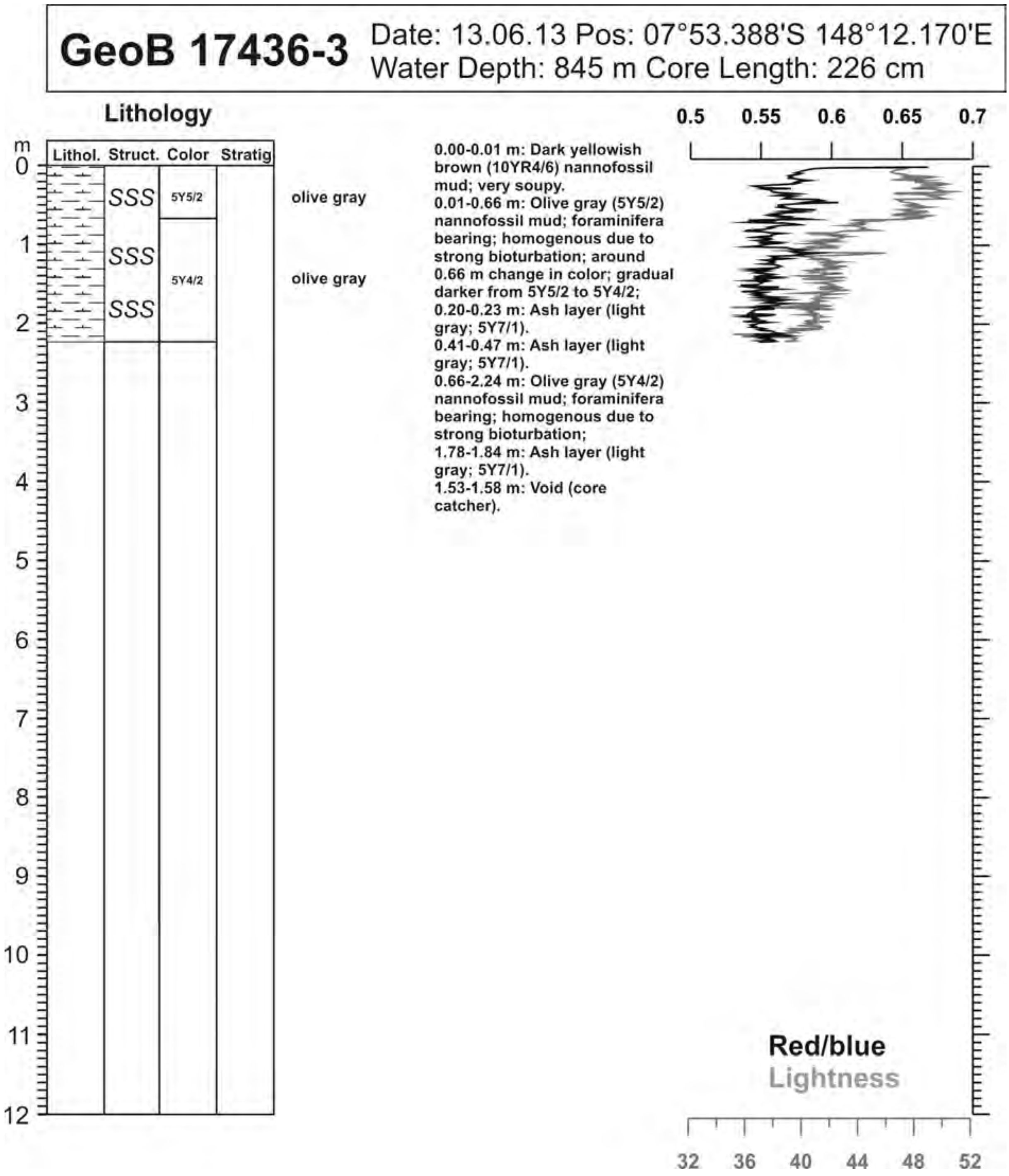


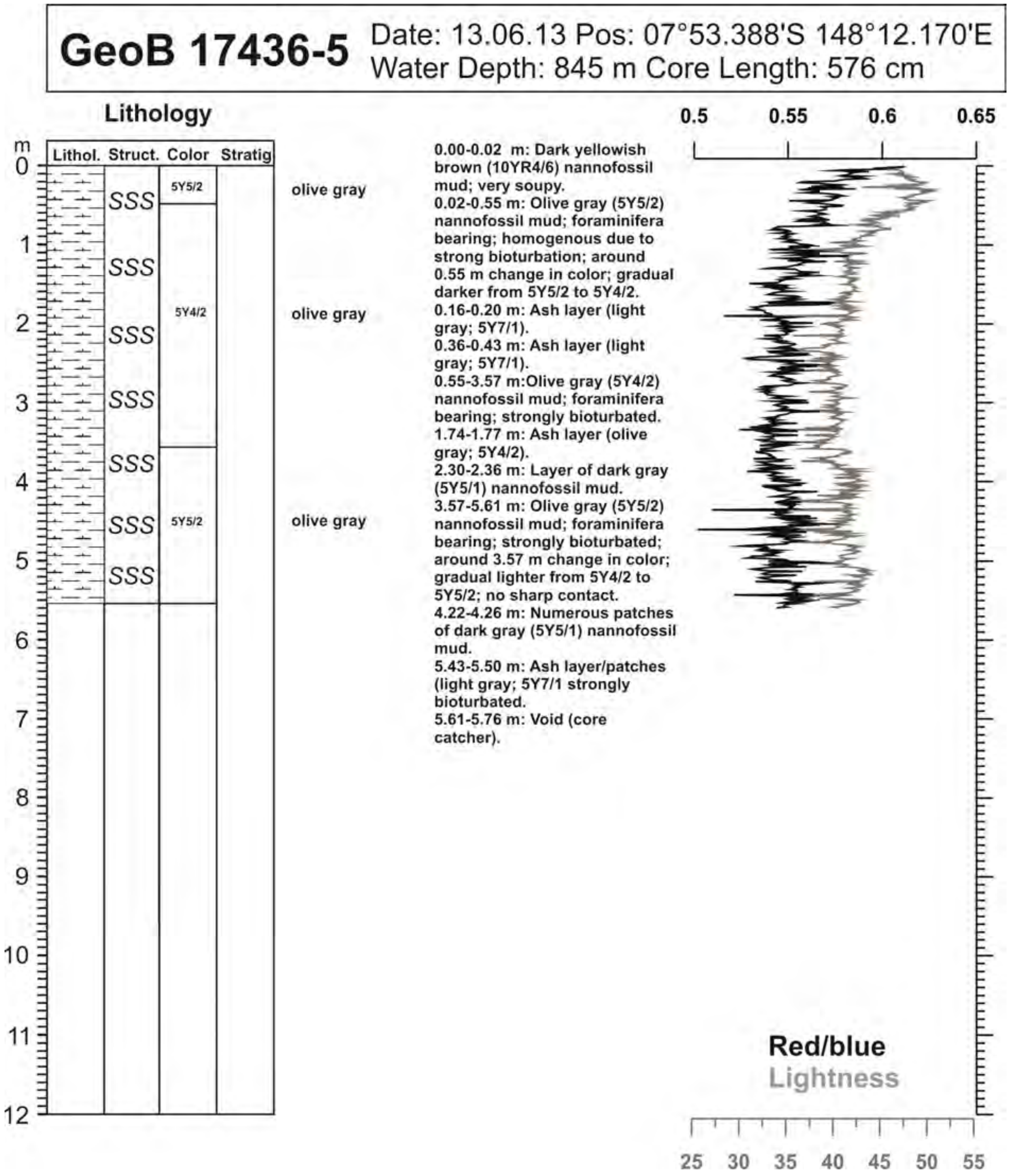
GeoB 17432-2
Date: 08.06.13 Pos: 05°20.727'S 146°12.038'E
Water Depth: 1391 m Core Length: 458 cm
Lithology
m
Lithol. Struct. Color Stratig
0
1
2
3
4
5
6
7
8
9
10
11
12
SSS
SSS
SSS
SSS
SSS
5Y4/2
5Y4/2
olive gray
olive gray
0.00-4.58 m: Olive gray nannofossil-bearing mud; strongly bioturbated.
0.08-0.10 m, 0.11-0.13 m, 0.17-0.18 m, 0.23-0.25 m, 0.32-0.33 m, 0.45-0.49 m, and 0.53-0.55 m: Intercalations of sand (5Y2.5/1).
0.51-0.52 m: Layer of light olive gray (5Y6/2) silt (no biogenic components).
0.96-0.99 m, 0.99-1.01 m, 1.05-1.06 m, 1.17-1.19 m, and 1.47-1.48 m: Intercalations of sand (5Y2.5/1).
1.07-1.08 m, 1.82-1.83 m, and 2.61-2.62 m: Ash layers (light gray; 2.5Y7/2).
2.33-2.36 m, 2.45-2.46 m, 2.79-2.81 m, 3.00-3.01 m, 3.13-3.16 m, 3.25-3.26 m, 3.41-3.42 m, 3.49-3.50 m, 3.72-3.73 m, 4.05-4.07 m, 4.28-4.29 m, and 4.32-4.33 m: Intercalations of sand (5Y2.5/1).
4.21-4.25 m: Ash layer (light gray; 2.5Y7/2).
4.49-4.58 m: coring disturbances (core catcher).
0.35 0.4 0.45 0.5 0.55 0.6
Red/blue
Lightness
0 10 20 30 40 50 60


GeoB 17434-3
Date: 11.06.13 Pos: 06°35.656'S 148°16.157'E
Water Depth: 4208 m Core Length: 158 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
5Y4/2
olive gray
0 1 2 3 4 5 6 7 8 9 10 11 12
0.00-0.01 m: Dark yellowish brown (10YR4/6) oxidized top layer; nannofossil mud; very soupy.
0.01-0.07 m: Dark gray (5Y4/1) nannofossil mud.
0.07-0.10 m: Brown (10YR3/4) nannofossil mud.
0.10-0.16 m: Dark gray (5Y4/1) nannofossil mud.
0.41-1.53 m: Olive gray (5Y4/2) nannofossil mud; homogenous due to strong bioturbation.
0.41-0.50 m: Sandy layer containing mineral grains and foraminfera; fining upward; turbidite.
0.61-0.62 m and 0.63-0.66 m: Sandy layer.
1.11-1.15 m: Ash layer (light gray; 5Y7/1).
1.24-1.36 m: Sandy layer; turbidite?
1.53-1.58 m: Void (core catcher).
0.45 0.5 0.55 0.6 0.65 0.7 0.75
Red/blue
Lightness
20 30 40 50 60

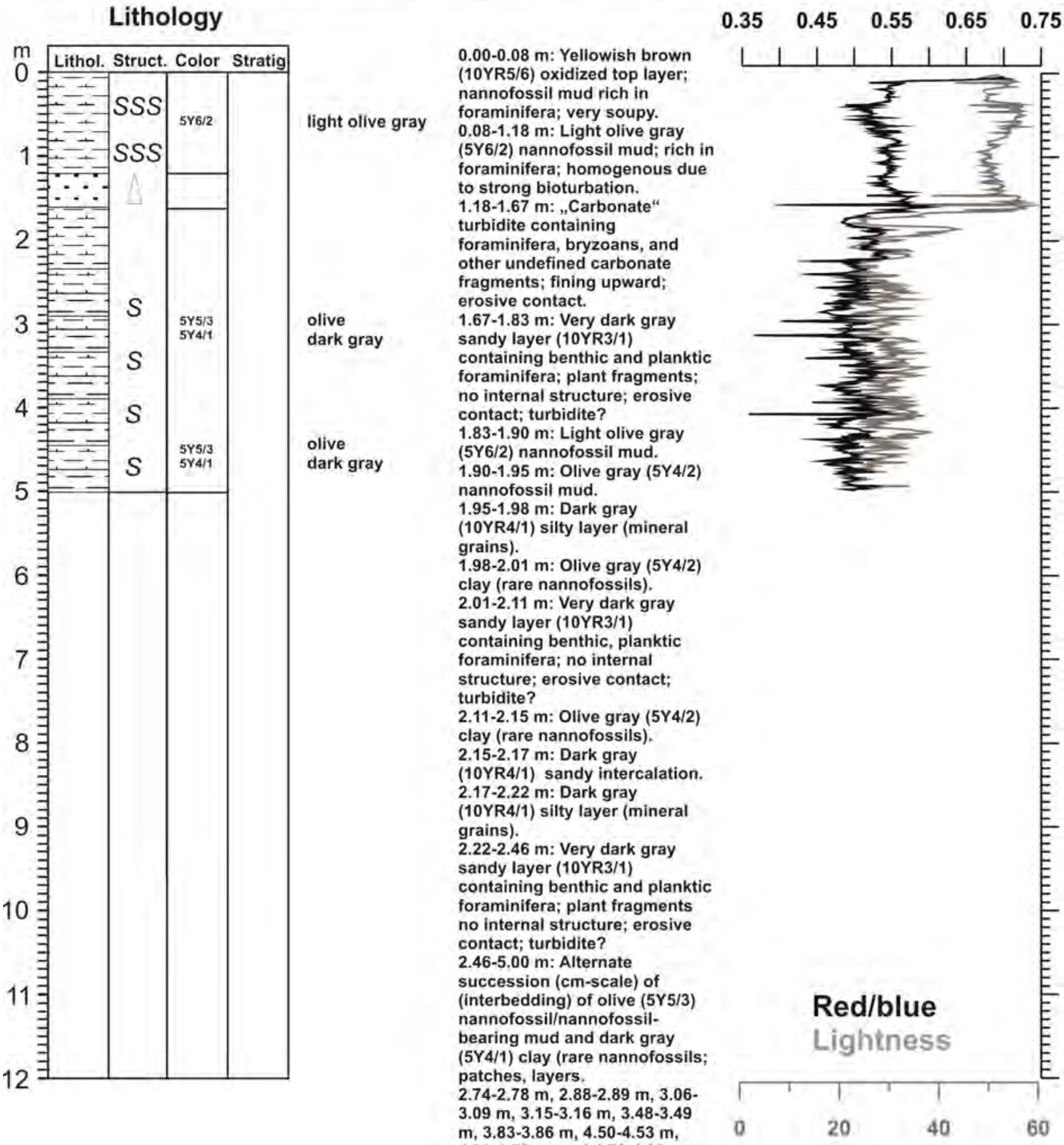

GeoB 17435-1
Date: 12.06.13 Pos: 07°16.224'S 147°20.409'E
Water Depth: 1001 m Core Length: 432 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
SSS
SSS
SSS
5Y4/2
5Y4/2
5Y4/2
olive gray
olive gray
olive gray
0.00-0.01 m: Dark yellowish brown (10YR4/6) oxidized top layer; nannofossil mud; very soupy.
0.01-4.29 m: Olive gray (5Y4/2) nannofossil mud; homogenous due to strong bioturbation.
0.55-0.63 m: Intercalation of dark gray (5Y4/1) nannofossil mud.
2.70-2.76 m: Layer of nannofossil mud (silt sized); strongly bioturbated; no sharp contact.
3.10-3.13 m: Ash layer (light gray; 5Y7/1).
3.48-3.49 m, 3.49-3.50 m, 3.53-3.54 m, and 3.88-3.90 m: Silty patches of dark gray (5Y4/1) nannofossil mud.
4.29-4.32 m: Void (core catcher).
0.45 0.5 0.55 0.6
Red/blue
Lightness
20 25 30 35 40 45
0 1 2 3 4 5 6 7 8 9 10 11 12


GeoB 17435-3
Date: 12.06.13 Pos: 07°16.224'S 147°20.409'E
Water Depth: 1001 m Core Length: 282 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
SSS
SSS
5Y4/2
5Y4/2
olive gray
olive gray
Oxidized top layer is missing due to coring disturbances.
0.00-2.71 m: Olive gray (5Y4/2) nannofossil mud; foraminifera bearing; homogenous due to strong bioturbation.
0.52-0.55 m: Ash patch (light gray; 5Y7/1); strongly bioturbated, no distinct layer.
2.71-2.82 m: Void (core catcher).
0.5 0.55 0.6
Red/blue
Lightness
34 36 38 40 42 44
0 1 2 3 4 5 6 7 8 9 10 11 12


GeoB 17436-3
Date: 13.06.13 Pos: 07°53.388'S 148°12.170'E
Water Depth: 845 m Core Length: 226 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
SSS
SSS
5Y5/2
5Y4/2
olive gray
olive gray
0.00-0.01 m: Dark yellowish brown (10YR4/6) nannofossil mud; very soupy.
0.01-0.66 m: Olive gray (5Y5/2) nannofossil mud; foraminifera bearing; homogenous due to strong bioturbation; around 0.66 m change in color; gradual darker from 5Y5/2 to 5Y4/2;
0.20-0.23 m: Ash layer (light gray; 5Y7/1).
0.41-0.47 m: Ash layer (light gray; 5Y7/1).
0.66-2.24 m: Olive gray (5Y4/2) nannofossil mud; foraminifera bearing; homogenous due to strong bioturbation;
1.78-1.84 m: Ash layer (light gray; 5Y7/1).
1.53-1.58 m: Void (core catcher).
0.5 0.55 0.6 0.65 0.7
Red/blue
Lightness
32 36 40 44 48 52


GeoB 17436-5
Date: 13.06.13 Pos: 07°53.388'S 148°12.170'E
Water Depth: 845 m Core Length: 576 cm
Lithology
m
Lithol. Struct. Color Stratig
SSS
5Y5/2
5Y4/2
5Y5/2
olive gray
olive gray
olive gray
0.00-0.02 m: Dark yellowish brown (10YR4/6) nannofossil mud; very soupy.
0.02-0.55 m: Olive gray (5Y5/2) nannofossil mud; foraminifera bearing; homogenous due to strong bioturbation; around 0.55 m change in color; gradual darker from 5Y5/2 to 5Y4/2.
0.16-0.20 m: Ash layer (light gray; 5Y7/1).
0.36-0.43 m: Ash layer (light gray; 5Y7/1).
0.55-3.57 m:Olive gray (5Y4/2) nannofossil mud; foraminifera bearing; strongly bioturbated.
1.74-1.77 m: Ash layer (olive gray; 5Y4/2).
2.30-2.36 m: Layer of dark gray (5Y5/1) nannofossil mud.
3.57-5.61 m: Olive gray (5Y5/2) nannofossil mud; foraminifera bearing; strongly bioturbated; around 3.57 m change in color; gradual lighter from 5Y4/2 to 5Y5/2; no sharp contact.
4.22-4.26 m: Numerous patches of dark gray (5Y5/1) nannofossil mud.
5.43-5.50 m: Ash layer/patches (light gray; 5Y7/1 strongly bioturbated.
5.61-5.76 m: Void (core catcher).
0.5 0.55 0.6 0.65
Red/blue
Lightness
25 30 35 40 45 50 55

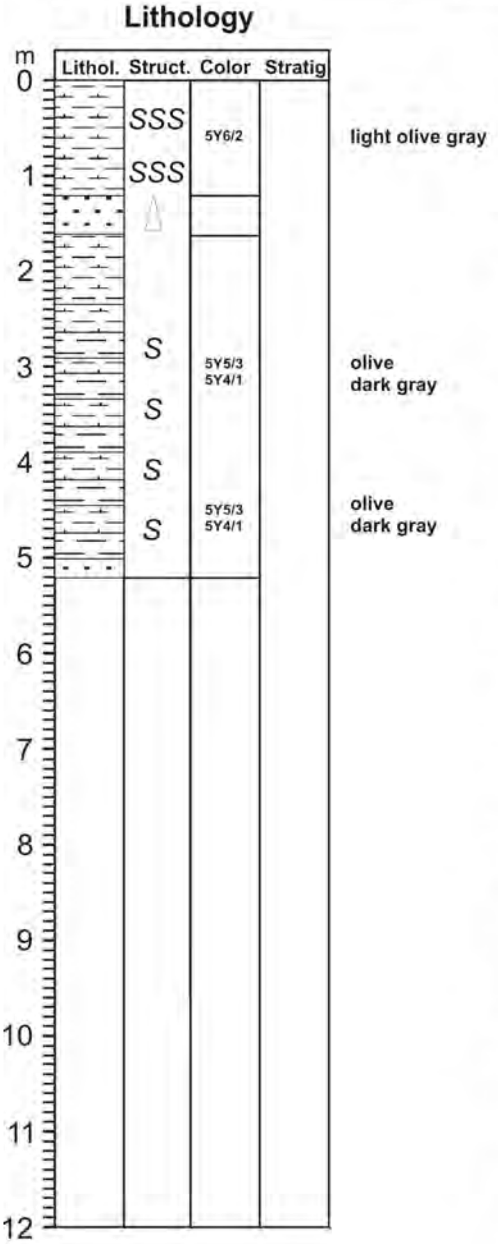
GeoB 17437-1 Date: 17.06.13 Pos: 09°59.371'S 145°10.514'E
Water Depth: 1776 m Core Length: 518 cm



0.00-0.08 m: Yellowish brown (10YR5/6) oxidized top layer; nannofossil mud rich in foraminifera; very soupy.
0.08-1.18 m: Light olive gray (5Y6/2) nannofossil mud; rich in foraminifera; homogenous due to strong bioturbation.
1.18-1.67 m: „Carbonate“ turbidite containing foraminifera, bryzoans, and other undefined carbonate fragments; fining upward; erosive contact.
1.67-1.83 m: Very dark gray sandy layer (10YR3/1) containing benthic and planktic foraminifera; plant fragments; no internal structure; erosive contact; turbidite?
1.83-1.90 m: Light olive gray (5Y6/2) nannofossil mud.
1.90-1.95 m: Olive gray (5Y4/2) nannofossil mud.
1.95-1.98 m: Dark gray (10YR4/1) silty layer (mineral grains).
1.98-2.01 m: Olive gray (5Y4/2) clay (rare nannofossils).
2.01-2.11 m: Very dark gray sandy layer (10YR3/1) containing benthic, planktic foraminifera; no internal structure; erosive contact; turbidite?
2.11-2.15 m: Olive gray (5Y4/2) clay (rare nannofossils).
2.15-2.17 m: Dark gray (10YR4/1) sandy intercalation.
2.17-2.22 m: Dark gray (10YR4/1) silty layer (mineral grains).
2.22-2.46 m: Very dark gray sandy layer (10YR3/1) containing benthic and planktic foraminifera; plant fragments no internal structure; erosive contact; turbidite?
2.46-5.00 m: Alternate succession (cm-scale) of (interbedding) of olive (5Y5/3) nannofossil/nannofossil-bearing mud and dark gray (5Y4/1) clay (rare nannofossils; patches, layers.
2.74-2.78 m, 2.88-2.89 m, 3.06-3.09 m, 3.15-3.16 m, 3.48-3.49 m, 3.83-3.86 m, 4.50-4.53 m, 4.69-4.75 m, and 4.78-4.93 m: Dark gray (10YR4/1) silty layers and patches (mineral grains); turbidites?
5.07-5.20 m: Void (core catcher).

GeoB 17437-3

Date: 17.06.13 Pos: 09°59.371'S 145°10.514'E
Water Depth: 1776 m Core Length: 520 cm



0.00-0.09 m: Yellowish brown (10YR5/6) oxidized top layer; nannofossil mud rich in foraminifera; very soupy.
0.09-1.22 m: Light olive gray (5Y6/2) nannofossil mud; rich in foraminifera; homogenous due to strong bioturbation.
0.76-0.78 m: Ash layer; reworked.
1.22-1.64 m: „Carbonate" turbidite containing foraminifera, bryzoans, and other undefined carbonate fragments; fining upward; erosive contact.
1.64-1.71 m: Very dark gray sandy layer (10YR3/1) containing benthic and planktic foraminifera; plant fragments; no internal structure; erosive contact; turbidite?
1.71-1.81 m: Light olive gray (5Y6/2) nannofossil mud.
1.71-1.87 m: Olive gray (5Y4/2) nannofossil mud.
1.87-1.90 m: Dark gray (10YR4/1) silty layer (mineral grains).
1.90-1.93 m: Olive gray (5Y4/2) clay (rare nannofossils).
1.93-2.01 m: Dark gray (10YR4/1) silty layer (mineral grains).
2.01-2.11 m: Dark gray (10YR4/1) silty layer (mineral grains).
2.11-2.34 m: Very dark gray sandy layer (10YR3/1) containing benthic and planktic foraminifera; no internal structure; erosive contact; turbidite?
2.34-5.07 m: Alternate succession (cm-scale) of (interbedding) of olive (5Y5/3) nannofossil/nannofossil-bearing mud and dark gray (5Y4/1) clay (rare nannofossils; patches, layers.
2.61-2.62 m, 2.70-2.71 m, 3.05-3.08 m, 3.16-3.18 m, 3.32-3.36 m, 3.41-3.43 m, 3.77-3.78 m, 4.10-4.12 m, 4.48-4.50 m, 4.58-4.62 m, 4.85-4.90 m, and 4.94-5.07 m: Dark gray (10YR4/1) silty layers and patches (mineral grains); turbidites?
5.07-5.20 m: Void (core catcher).

8 Station list SO-228

CTD	CTD and rosette water sampler	MUC	Multi-corer	GC	Gravity corer

Station (GeoB)	Gear	Date	UTC	Latitude	Longitude (°E)	Depth [m]	Remarks
17401-1	CTD	09.05.13	00:00	8° 19,58' N	126° 54,58'	5155	
17402-1	MUC	11.05.13	04:40	7° 59,98' N	126° 34,49'	15	
17402-2	GC 6	11.05.13	05:57	8° 00,07' N	126° 34,54'	555	
17403-1	CTD	11.05.13	07:55	7° 49,47' N	126° 40,71'	1438	
17403-2	GC 6	11.05.13	09:36	7° 49,59' N	126° 40,66'	1413	
17403-3	MUC	11.05.13	10:58	7° 49,98' N	126° 40,62'	1247	
17404-1	CTD	12.05.13	00:12	7° 54,02' N	126° 32,60'	407	
17404-2	MUC	12.05.13	00:52	7° 53,83' N	126° 32,54'	402	
17404-3	GC 6	12.05.13	01:32	7° 53,83' N	126° 32,52'	401	
17404-4	GC 9	12.05.13	02:31	7° 53,82' N	126° 32,53'	401	empty
17405-1	GC 9	12.05.13	04:53	7° 59,94' N	126° 36,95'	838	
17405-2	MUC	12.05.13	05:51	8° 0,04' N	126° 36,96'	840	
17405-3	GC 6	12.05.13	07:00	8° 0,18' N	126° 37,10'	866	
17406-1	GC 6	12.05.13	08:20	8° 0,45' N	126° 38,64'	1144	
17407-1	CTD	12.05.13	22:05	7° 56,29' N	126° 45,73'	2116	
17407-2	MUC	13.05.13	00:52	7° 56,49' N	126° 45,75'	2118	
17407-3	GC 6	13.05.13	03:10	7° 56,24' N	126° 45,81'	2118	
17408-1	GC 6	13.05.13	05:36	7° 50,87' N	126° 42,27'	1660	
17408-2	MUC	13.05.13	07:50	7° 50,98' N	126° 42,22'	1688	
17409-1	MUC	14.05.13	00:00	7° 51,50' N	126° 33,28'	501	
17409-2	GC 6	14.05.13	00:51	7° 51,41' N	126° 33,31'	486	empty
17410-1	GC 6	14.05.13	02:18	7° 52,03' N	126° 35,56'	770	
17410-2	MUC	14.05.13	03:37	7° 52,24' N	126° 35,60'	741	not released
17410-3	MUC	14.05.13	04:36	7° 52,26' N	126° 35,54'	745	
17410-4	GC 6	14.05.13	05:42	7° 52,27' N	126° 35,54'	740	
17411-1	GC 6	14.05.13	07:04	7° 51,35' N	126° 33,29'	484	
17412-1	CTD	14.05.13	23:19	5° 55,91' N	126° 4,15'	2986	
17413-1	CTD	18.05.13	02:18	6° 20,85' N	125° 50,90'	2075	
17413-2	CTD	18.05.13	02:58	6° 20,81' N	125° 50,89'	2079	
17413-3	MUC	18.05.13	05:08	6° 20,84' N	125° 50,90'	2075	
17413-4	GC 12	18.05.13	07:03	6° 20,79' N	125° 50,88'	2079	
17414-1	GC 12	18.05.13	09:45	6° 15,61' N	125° 49,94'	2191	

Station (GeoB)	Gear	Date	UTC	Latitude	Longitude (°E)	Depth [m]	Remarks
17414-2	MUC	18.05.13	11:31	6° 15,56' N	125° 49,94'	2194	
17415-1	GC 12	18.05.13	22:57	6° 15,15' N	125° 52,79'	2103	
17416-1	GC 12	19.05.13	01:36	6° 12,40' N	125° 51,23'	2253	empty
17417-1	CTD	24.05.13	21:15	2° 24,98' S	144° 29,95'	1634	
17418-1	MUC	26.05.13	10:19	2° 22,27' S	144° 36,02'	1335	
17418-2	GC 12	26.05.13	11:45	2° 22,31' S	144° 36,02'	1337	
17419-1	GC 12	26.05.13	16:11	2° 48,88' S	144° 29,98'	1883	
17419-2	MUC	26.05.13	17:48	2° 48,87' S	144° 29,95'	1883	
17420-1	CTD	27.05.13	07:00	3° 38,45' S	144° 29,00'	722	
17421-1	GC 12	28.05.13	00:40	3° 33,00' S	144° 11,86'	588	
17421-2	MUC	28.05.13	01:28	3° 32,96' S	144° 11,83'	590	
17421-3	GC 12	28.05.13	02:12	3° 32,96' S	144° 11,85'	574	
17422-1	GC 12	28.05.13	03:52	3° 37,20' S	144° 13,37'	367	
17422-2	MUC	28.05.13	04:32	3° 37,23' S	144° 13,39'	363	
17422-3	GC 12	28.05.13	05:12	3° 37,23' S	144° 13,41'	366	
17423-1	GC 6	31.05.13	07:00	0° 35,94' S	142° 53,68'	3105	
17424-1	CTD	01.06.13	23:42	1° 22,82' S	147° 10,46'	2220	
17424-2	MUC	02.06.13	02:00	1° 22,81' S	147° 10,43'	2217	
17424-3	GC 12	02.06.13	03:57	1° 22,81' S	147° 10,41'	2219	
17425-1	GC 12	02.06.13	08:21	1° 32,66' S	146° 46,54'	1621	
17425-2	MUC	02.06.13	09:44	1° 32,64' S	146° 46,50'	1620	
17426-1	CTD	03.06.13	23:10	2° 11,23' S	150° 51,68'	1364	
17426-2	MUC	04.06.13	00:49	2° 11,32' S	150° 51,65'	1366	
17426-3	GC 12	04.06.13	02:03	2° 11,27' S	150° 51,63'	1367	
17427-1	GC 12	04.06.13	05:35	2° 9,78' S	150° 30,03'	969	empty (bent)
17427-2	MUC	04.06.13	06:29	2° 9,76' S	150° 30,05'	971	
17428-1	CTD	05.06.13	23:33	3° 27,55' S	144° 9,16'	1057	
17428-2	CTD	06.06.13	00:07	3° 27,53' S	144° 9,16'	1058	
17428-3	GC 12	06.06.13	01:30	3° 27,54' S	144° 9,17'	1057	
17428-4	MUC	06.06.13	02:38	3° 27,53' S	144° 9,15'	1063	
17428-5	GC 12	06.06.13	03:38	3° 27,53' S	144° 9,14'	1060	empty (bent)
17429-1	MUC	06.06.13	23:12	4° 6,02' S	145° 12,04'	1606	
17429-2	GC 12	07.06.13	00:41	4° 6,03' S	145° 12,03'	1606	
17430-1	GC 12	07.06.13	03:35	4° 13,03' S	145° 1,62'	1155	tube bent
17430-2	MUC	07.06.13	04:41	4° 13,05' S	145° 1,64'	1158	
17430-3	GC 6	07.06.13	05:50	4° 13,04' S	145° 1,64'	1153	
17431-1	MUC	08.06.13	05:13	5° 18,81' S	146° 2,48'	1164	

Station (GeoB)	Gear	Date	UTC	Latitude	Longitude (°E)	Depth [m]	Remarks
17431-2	GC 12	08.06.13	06:18	5° 18,82' S	146° 2,49'	1164	
17432-1	CTD	08.06.13	08:32	5° 20,67' S	146° 11,99'	1388	
17432-2	GC 12	08.06.13	09:54	5° 20,69' S	146° 12,01'	1391	
17432-3	MUC	08.06.13	11:16	5° 20,67' S	146° 12,02'	1390	
17433-1	CTD	09.06.13	00:00	5° 37,23' S	147° 8,03'	1384	
17433-2	MUC	09.06.13	02:22	5° 37,53' S	147° 8,70'	1386	
17433-3	GC 6	09.06.13	04:01	5° 37,07' S	147° 7,87'	1381	empty (bent)
17434-1	CTD	11.06.13	03:17	6° 35,65' S	148° 16,15'	4206	
17434-2	MUC	11.06.13	06:42	6° 35,68' S	148° 16,26'	4208	
17434-3	GC 6	11.06.13	10:00	6° 35,72' S	148° 16,27'	4208	
17435-1	GC 12	12.06.13	05:20	7° 16,23' S	147° 20,41'	1001	
17435-2	MUC	12.06.13	06:16	7° 16,19' S	147° 20,38'	1001	
17435-3	GC 12	12.06.13	07:12	7° 16,18' S	147° 20,36'	1004	
17436-1	CTD	13.06.13	00:06	7° 53,39' S	148° 12,18'	849	
17436-2	CTD	13.06.13	00:45	7° 53,35' S	148° 12,15'	849	
17436-3	GC 12	13.06.13	01:49	7° 53,34' S	148° 12,19'	849	
17436-4	MUC	13.06.13	03:01	7° 53,35' S	148° 12,15'	842	
17436-5	GC 12	13.06.13	03:51	7° 53,38' S	148° 12,15'	847	
17437-1	GC 12	16.06.13	22:43	9° 59,38' S	145° 10,52'	1781	
17437-2	MUC	17.06.13	00:21	9° 59,35' S	145° 10,52'	1779	
17437-3	GC 12	17.06.13	01:51	9° 59,36' S	145° 10,52'	1780	
17438-1	GC 12	19.06.13	05:00	16° 47,92' S	146° 33,69'	1290	tube bent

9 Appendix

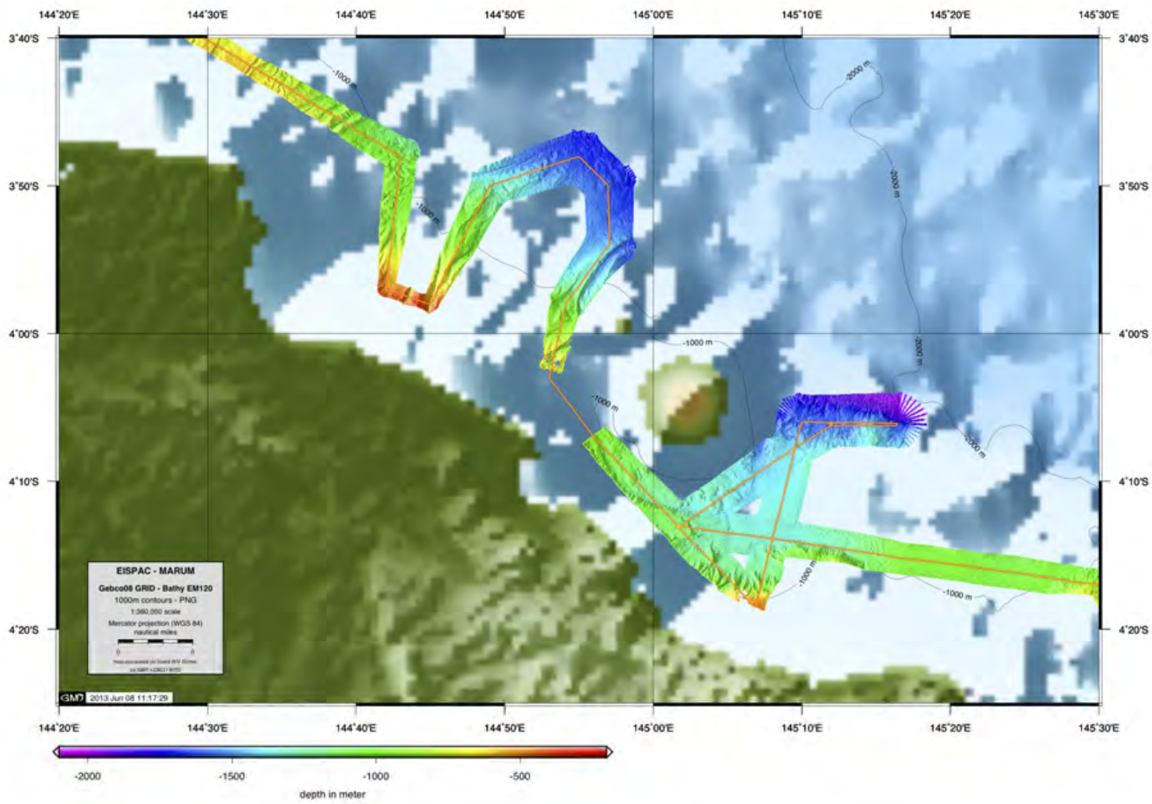


Fig. A1. Bathymetric map of N Papua New Guinea around Manam Island.

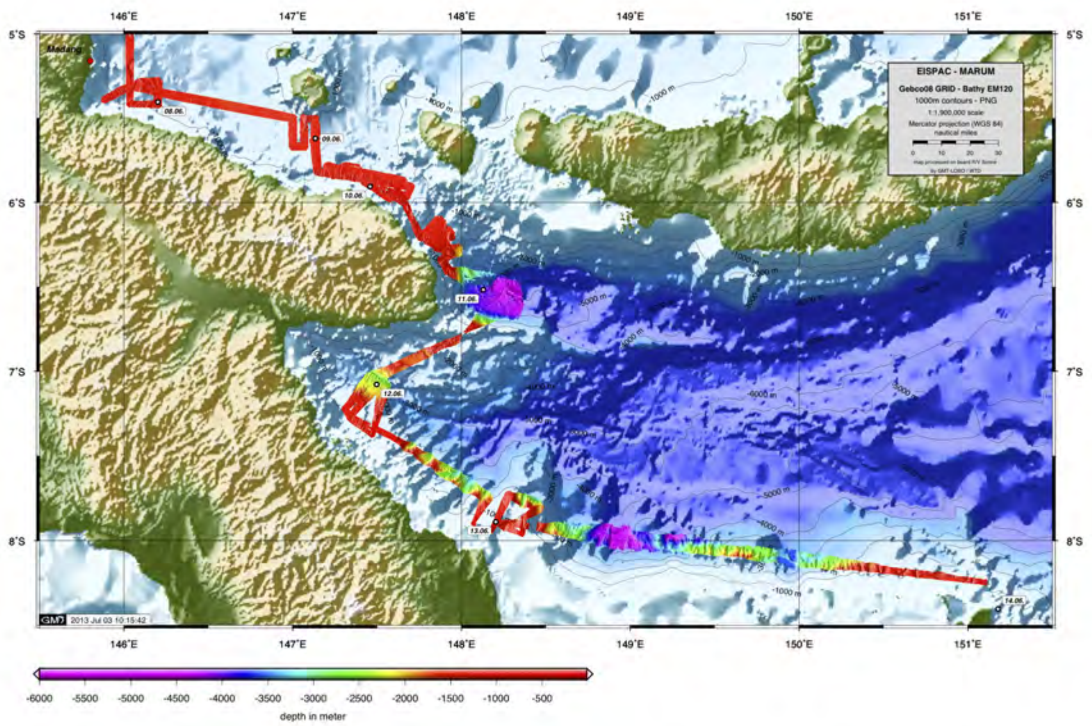


Fig. A2. Bathymetric map of Papua New Guinea from S of Karkar Island to the Solomon Sea.

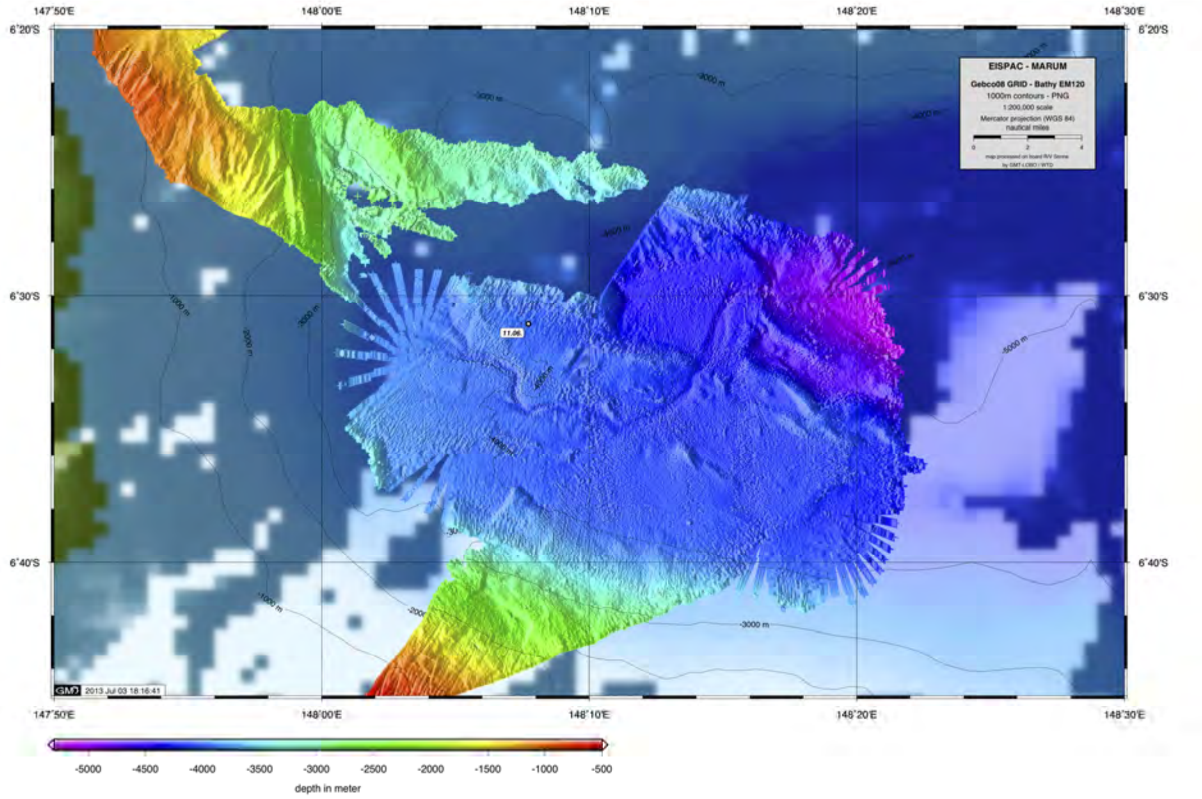


Fig. A3. Bathymetric map of the Solomon Sea E of the Huon Peninsula.

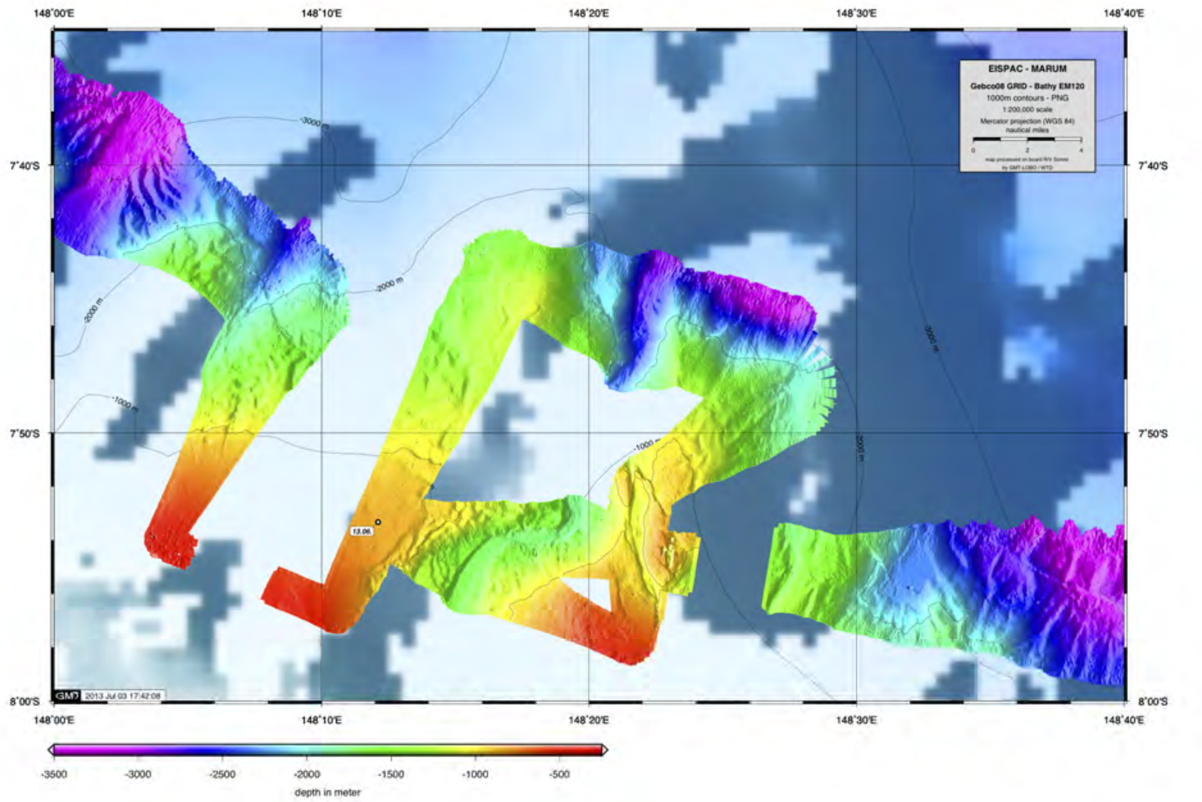


Fig. A4. Bathymetric map of the Solomon Sea N of the Hercules Bay.

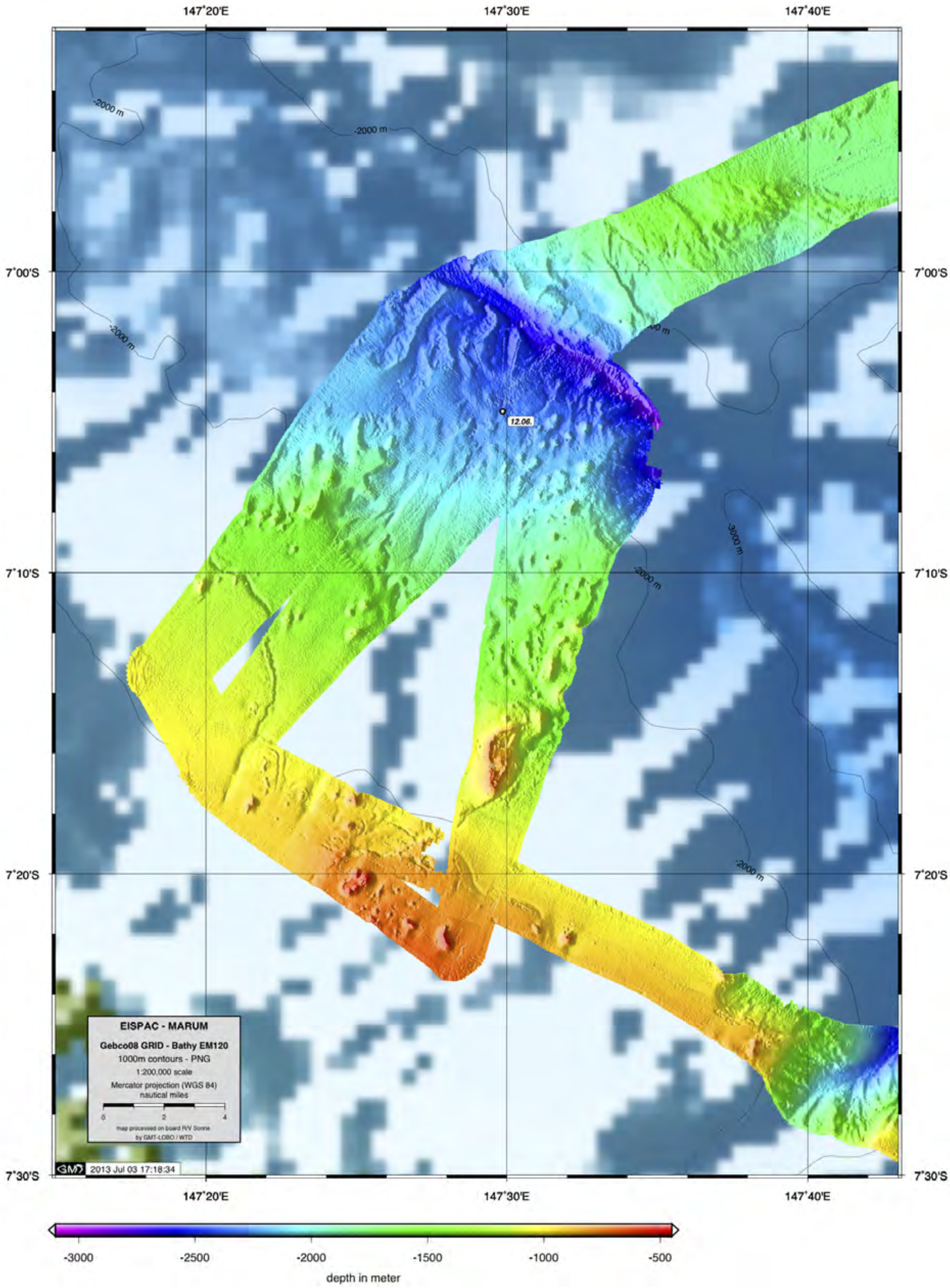


Fig. A5. Bathymetric map of the Solomon Sea S of the Huon Peninsula.

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