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Mohtadi, M.,

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R/V SONNE Cruise Report SO256

TACTEAC
Temperature And Circulation History of The East Australian Current

Auckland (New Zealand) – Darwin (Australia)
17 April – 09 May 2017

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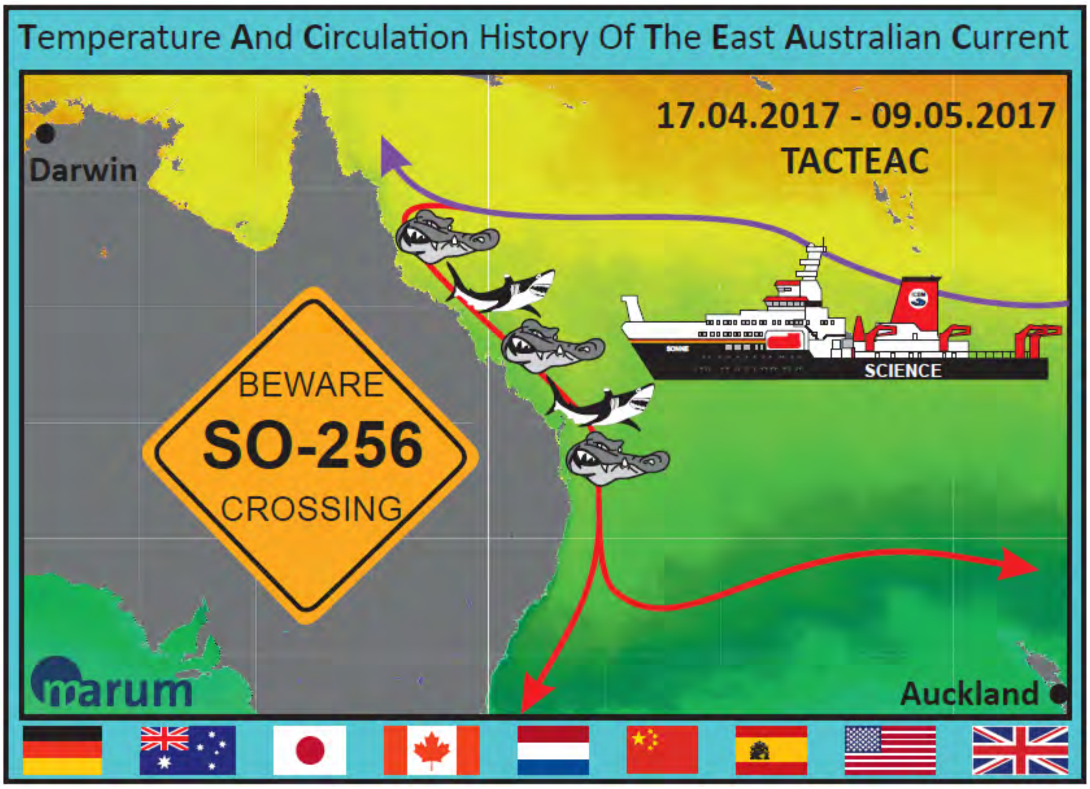
Cruise Report

TACTEAC

R/V SONNE Cruise SO-256



Auckland, New Zealand (17.04.2017) – Darwin, Australia (09.05.2017)

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Content

1 Summary

The R/V SONNE expedition SO-256 (TACTEAC) took place between April 17th and May 9th, 2017. The expedition started in Auckland, New Zealand and ended in Darwin, Australia. The first and the last 4.5 days of the expedition were spent for transit into, and out of, the study area in the Great Barrier Reef (GBR), respectively. The goal of this expedition was to collect water and sediment samples along the GBR in order to reconstruct the history of the East Australian Current (EAC) and its effect of the evolution of the GBR and the continental climate of eastern Australia. The 22 scientist attending this expedition made use of the ship equipment to collect swath bathymetry and sub-bottom profiling data, and water samples by a CTD-rosette water sampler. Sediment samples were collected using a gravity corer, a multiple corer, a chain bag dredge, and a giant box corer.

Samples were collected at 36 stations in 9 study areas off the Fraser Island (~26°S), One Tree Reef and Bunker (~23°S), Capricorn Channel (~22°S) and Swains/Marion Plateau (~21°S), Hydrographer's Passage (~20°S), South Queensland Trough and Gloria Knolls (~17°S), Central Queensland Trough (~16°S), Ribbon Reefs (~15°S) and off Cape York (~12°S). During the 10 working days of the R/V SONNE expedition SO-256, 49 casts including 4 CTD-rosette water sampler casts, 5 chain bag dredge casts, 3 giant box corer casts, 14 multiple corer and 23 gravity corer casts were deployed. More than 100 m of sediment were recovered, described and sub-sampled on board, and about 8 hours of HD images from the seafloor were collected. Samples and data have been shipped to Germany, Australia, Canada, Japan, The Netherlands and China for further processing and will provide clues on the history and fate of the EAC and GBR in the coming months/years.

2 Participants

2.1 Scientific Party SO-256

Name	Discipline	Institute
Mahyar MOHTADI	Chief Scientist	MARUM
Tobias SCHADE	Technical assistance	MARUM
Maximilian DAUMANN	Technical assistance	MARUM
Birgit Inge Gisela MEYER-SCHACK	Technical assistance	MARUM
Martina HOLLSTEIN	Marine geology	MARUM
Vera RODEHUTSCORD	Marine geology	MARUM
Vivien Melina FLOREN	Marine geology	MARUM
Sandy BOEHNERT	Marine geology	MARUM
Stephen Phillip OBROCHTA	Oceanography	AKITA
Yusuke YOKOYAMA	Oceanography	AORI
Shoko HIRABAYASHI	Oceanography	AORI
Andreas LÜCKGE	Marine geology	BGR
Markus KIENAST	Organic geochemistry	DAL
Jessica Laura Annie GOULD	Organic geochemistry	DAL
Robin Jordan BEAMAN	Hydro-acoustic, Bathymetry	JCU-C
Michal Jan WENDERLICH	Hydro-acoustic, Bathymetry	JCU-T
Willem RENEMA	Marine biology	NAT
Jody Michael WEBSTER	Marine geology	USYD
Jodie Rae PALL	Marine geology	USYD
Lena Mary O'TOOLE	Marine geology	USYD
Kelsey Lynne SANBORN	Marine geology	USYD
Stephan STEINKE	Marine geology	XIU

2.2 *Crew List SO-256*

Name	Rank
Oliver MEYER	Master
Nils ADEN	Chief Mate
Tilo BIRNBAUM-FEKETE	2. Officer Navigational Watch
Lars HOFFSOMMER	2. Officer Navigational Watch
Anke WALTHER	Surgeon
Dieter HERMESMEYER	Chief Engineer
Roman HORSEL	2. Engineer
Tim STEGMANN	2. Engineer
Timur OVCHARENKO	Electrician
Hermann PREGLER	Electrician
Jörg LEPPIN	Electron. Eng.
Wolfgang BORCHERT	System Manager
Miriam PLÖGER	System Manager
Volker BLOHM	Fitter
Ralf GIESKE	Motorman
Lothar MÜNCH	Motorman
André GARNITZ	Chief Cook
Frank STÖCKER	2. Cook
Alexander VOGT	Chief Steward
Nina HINZ	Stewardess
Bernardo CAROLINO	Steward
Sven KROEGER	Steward
Torsten BIERSTEDT	Bosun
Oliver EIDAM	Multi-purpose Crew / A.B.
Arnold ERNST	Multi-purpose Crew / A.B.
Stefan KOCH	Multi-purpose Crew / A.B.
Torsten KRUSZONA	Multi-purpose Crew / A.B.
Reno ROß	Multi-purpose Crew / A.B.
Dennis VOGEL	Multi-purpose Crew / A.B.

2.3 Institutions

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Fig. 2.1 Scientific party of SO-256.

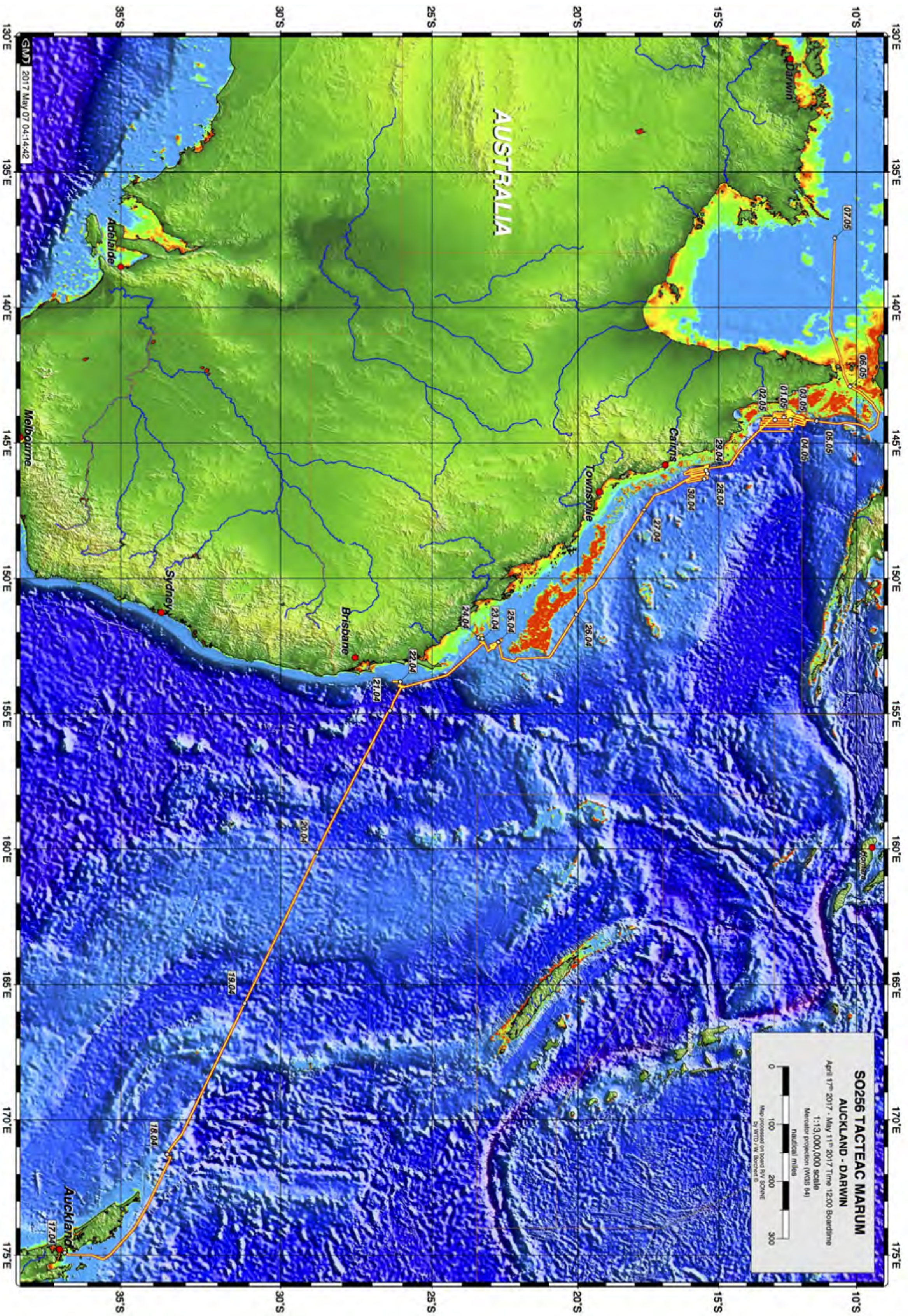


Fig. 2.2 Cruise plot of SO-256.

3 Research Program

The East Australian Current (EAC) is one of the two main western boundary currents of the Pacific that transports large amount of heat out of the Western Pacific Warm Pool into the subtropics and subpolar regions, thereby regulating the global climate. By transporting between 27 Sv and 36 Sv (1 Sv = 10^6 m^3 s^{-1}) of tropical waters poleward, the EAC not only influences the climate of Australia and New Zealand but also plays a crucial role in maintaining the health and vitality of the Great Barrier Reef (GBR) ecosystem. Previously dated and paleo-ecologic data from fossil reef cores taken from the GBR shelf edge show that the drowned reefs at these locations have had a dynamic history, turning on and turning off several times but the precise environmental causes are still unknown. The few existing reconstructions of past changes in transport and temperature of the EAC are contradictory resulting in a knowledge gap in long-term variability of the southwest Pacific currents, which in turn hampers a reliable projection of future tropical and subtropical climate development. The overarching goal of this expedition is to improve our knowledge about past sea surface temperature (SST) variability in the Coral Sea on various timescales, its link to changes in the EAC transport under different boundary conditions and the evolution of the GBR, and its possible forcing factors. To this end, sample material collected during the expedition SO256 along the GBR from 12°S to 26°S will be used to test the following hypotheses:

1. *The EAC is stronger and warmer during generally warmer climate periods*

If glacial boundary conditions and a generally colder climate result in a reduced EAC, then heat accumulation in the equatorial Pacific should be increased, and vice versa during the warm periods. What is mechanistically different than on ENSO timescales, when heat is accumulated in, or removed from, the western Pacific without any significant effect on the EAC?

2. *The export of heat from low to high latitudes is higher during warm periods*

This hypothesis will be tested by comparing SST records from different latitudes along the EAC: a higher (lower) latitudinal SST gradient would suggest a reduced (increased) heat transport.

3. *Australian drought periods are associated with decreased EAC transport*

This hypothesis will be tested by studying past rainfall and runoff variability in the same archives used for SST reconstruction. Periods of higher SST should have been associated with increased runoff and rainfall, decreased salinity and increased nutrient and sediment input.

We make use of CTD-rosette water sampler and multi-corer in order to collect modern data and sediment samples for ground-truthing the proxies that will be applied for reconstructing past SST and circulation. A gravity corer and a rock dredge will be deployed to collect sample material for reconstructing past changes in SST and circulation along the EAC, and the continental climate of eastern Australia. Finally, bathymetric and sub-bottom profiler data will provide useful information on large-scale sedimentary setting and potential transport mechanisms. The collected sediment samples will be XRFscanned for their element composition, cross-correlation and initial age approximations, followed by washing and picking of planktic foraminifera for radiocarbon, oxygen isotope and Mg/Ca measurements at MARUM, University of Bremen and at AORI, University of Tokyo. Additional proxy-based reconstructions will be performed as follows:

BGR: alkenones in sediment samples for SST reconstructions

DAL: alkenones, nitrogen isotopes and nutrients of the water samples for (modern) water mass reconstructions

MARUM: compound-specific isotopes and grain-size analyses in sediment samples for continental climate reconstructions, carbon and oxygen isotopes of the water samples for (modern) water mass reconstruction

XMU: faunal composition of planktic foraminifera in sediment samples for water mass and temperature reconstructions

NAT: faunal composition of benthic foraminifera in sediment samples for paleoproductivity reconstruction

AORI: uranium and carbon isotopes of the water samples for (modern) water mass reconstruction

USYD: sedimentological analyses on sediment and rock samples for reconstructing the GBR history

4 Narrative of the Cruise

Twenty-two scientists from eight different countries boarded the R/V SONNE in Auckland, New Zealand to participate in the R/V SONNE expedition 256. The expedition started on April 17th at 10 AM local time (note that all dates in this section refer to local time). During the transit from Auckland to the southern Queensland margin the EM122 multi-beam and Parasound sub-bottom profiler were started on April 18th once inside Australian waters. On April 19th, the vessel transited over the New Caledonia Basin with a deepest depth of 3300 m then commenced surveying up the western side of Lord Howe Rise. Through April 20th, we passed over the Lord Howe Rise and into the Middleton and Tasman basins lying on the western side of the rise. The vessel continued across the Tasman Basin with depths around 4700 m over a very flat seafloor. On April 21st, we mapped the north flank of the Brisbane Guyot, one of the Tasmantid Seamounts, then crossed the south flank of the Moreton Seamount before passing back over the Tasman Basin. By midday, we started the transit up the continental slope opposite the south end of Fraser Island.

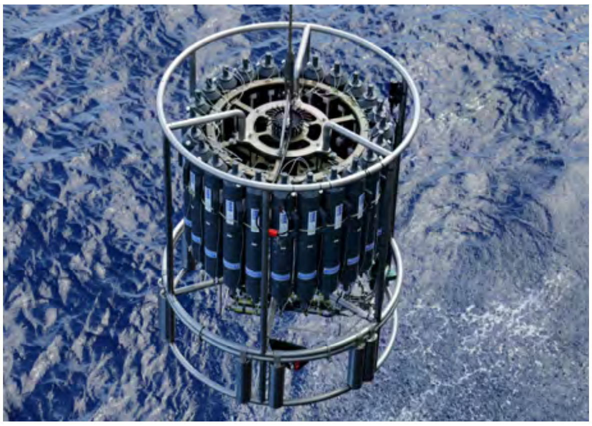


Fig. 4.1 Main sampling tools during the SO-256 expedition. Left: multiple corer, giant box corer, and gravity corer (in the cradle). Right: CTD-rosette water sampler.

After more than 4 days of transit we finally reached the designated working area 1 off Fraser Island in the afternoon of Friday, April 21st, and immediately started the sampling campaign at 154° 3.0' E, 26° 3.0' S with a CTD-rosette cast. At this site (GeoB22201-1), we sampled 2500 m of water column for oxygen, nitrogen and carbon isotopes, nutrients, uranium and radiocarbon at 23 different depths. About 6 nm upslope at 1700 m, sediments were successfully sampled using a Multiple Corer (MUC) and a Gravity Corer (GC). During the MC cast, the new video telemetry system on board R/V SONNE was tested. The overnight swath bathymetry and sub-bottom profiling of the shelf edge were followed by dredging on the paleo-shorelines features between ~110 and 80 m on April 22nd. At GeoB22203-2 dredging operations were successful breaking of fist sized limestones from ~92 m water depth. Preliminary observations reveal the surfaces of the limestones were covered with a patchy veneer of living crustose coralline algae, encrusting bryoazoans, gastropods and worm tubes. Two of the rocks show clear breakage surfaces confirming they were broken off in situ. Lithologically, they are composed of a dense, heavily bioeroded packstone to bindstone facies, with visible bioclasts (e.g. larger benthic forams) and thin crusts of coralline algae. The next Giant Box Corer (GBC) deployment recovered surface sediments rich in benthic biota, mainly coralline algae and benthic foraminifera.

After the GBC site, we returned to site GeoB22201 and sampled the sediment with a GC before leaving for the second working area, where we started with the site survey on Sunday, April 23rd. In accordance with the permit conditions for the Great Barrier Reef Marine Park, we deployed a video telemetry system attached to the Multiple Corer in order to survey the designated dredging areas in advance. The system provided images of extraordinary high quality and enabled us to survey two transects at 120 and 90 m water depths, which revealed an intact live coral reef community growing on top of fossil reef structures. While bathymetric lows are covered by unlithified carbonate sediments, the surface of the “pinnacles” are characterized by a highly complex, honeycomb style outcrop with large cavities with abundant attached biota and fish life.


Fig. 4.2 Left: Members of the science party discussing the benthic biota on surface sediments recovered by the MC at site GeoB22202-1 (153° 59' E, 26° 07' S). Right: Sediment recovered from ~100 m depth by a GBC at site GeoB22204-1 (153° 49' E, 26° 04' S).

On Monday, April 24th, we started with a systematic EM710 multi-beam and Parasound survey over the One Tree shelf lying to the east of the Capricorn-Bunker Group of islands in the southern GBR. The surveyed area was ~109 km^2 with depths ranging from 50 to 200 m revealing the shelf break together with multiple terraces and numerous low pinnacles. On Monday morning, we continued with the video telemetry in the southern part of the third working area (GeoB22209, 152° 11' E, 23° 25' S). We traversed southeast for about 300 m over the top of a ridge (paleo-reef) structure at 90 m water depth. The substrate was mainly covered by soft sediments with isolate patches of limestone outcrop covered by attached biota (e.g. sponges, red coralline algae). More complex pinnacle structures occurred towards the end of the traverse with their sides and tops characterised by rough substrates and abundant attached biota. We continued the survey of the 90 m deep ridge towards the east over the front of the seaward facing, 10 m high cliff. Both the top and the cliff edge were covered by abundant attached biota similar in composition to the preceding transect.

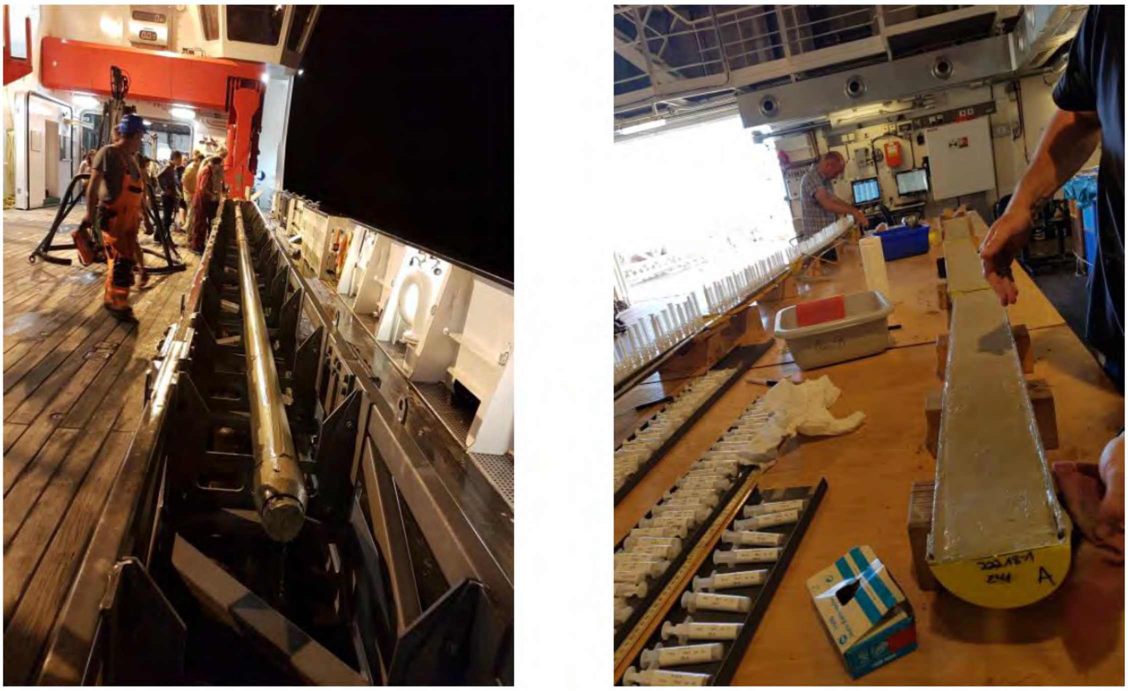


Fig. 4.3 Gravity core GeoB22218-1 being recovered (left) and described/sampled (right) on deck.

We sampled the northern part of the study area with a GBC at 90 m water depth and recovered rather homogenous medium to coarse carbonate sand with few pebbles on top and abundant benthic foraminifera. Sediments were recovered with a GC deployed at 120 m water depth followed by two GC deployments at 200 and 240 m water depth (recovery between 5 and 6 m) on the way to the Capricorn Channel further east. The broad Capricorn Channel separates the outer-shelf Swain Reefs from the inner-shelf. The overnight survey along a scarp rimming the channel in ~200 m revealed drift deposit-like sediments on the downslope side and low pinnacles on the upslope platform. We sampled the southern part of the channel at 340 m water depth with a GC recovering more than 5 m of sandy to clayey mud, and the northern part of the channel with a GBC and two GC at 120 m water depth and recovered clayey sand with patches of ooids.

On Tuesday, April 25th, we transited around the eastern side of the Swain Reefs over the South Marion Plateau, stopping briefly for a camera survey over a previously mapped patch of low pinnacles lying in 100 m. We rounded Elusive Reef at the northeast tip of the Swain Reefs on Wednesday, April 26th and crossed onto the North Marion Plateau in about 350 m. There, we recovered the top ~9 m of sediment at the ODP site 194 (GeoB22218-1, 152°48' E, 20°54' S). We crossed the tail of a large submarine landslide, sourced from the GBR shelf, to the west of Elusive Reef. We continued along the plateau for Hydrographers Passage and the Southern Queensland Trough and deployed one GC in each area before arriving at the Gloria Knolls, which are the remains of large submarine landslide from the GBR margin. The knolls appear as a cluster of eight large debris blocks up to 179 m high lying in depths of ~1200 m. The Parasound revealed lens-like chaotic internal strata within the largest knoll that could be a bioherm and now buried with hemipelagic sediments. We deployed a CTD-rosette water sampler followed by a MUC with the video-telemetry for surveying and recording this sampling technique. With a GC, we recovered the top 6 m of sediments before heading to the Ribbon Reefs. On April 27th and underway in the Central Queensland Trough, we deployed two GCs in order to collect mass wasting deposits and hemipelagic sediments in close vicinity.

From Friday 28th to Sunday 30th April, we conducted extensive swath mapping near the Ribbon Reefs on the northern GBR margin. Depths ranged from 400 m on the upper slope to depths over 2000 m, heavily incised with a submarine canyon system, and draining into the relatively flat Queensland Trough. Unusual findings were trains of small debris blocks stretching across the floor of the trough, presumably sourced from mass wasting at the foot of the canyons. These block trains have moved over 20 km in places from their source. We sampled the Ribbon Reef working area with CTD-rosette, several MUCs and GCs in a depth transect from 800 m to 2200 m.

Fig. 4.4 Deployment of the multiple corer with the video telemetry system (left) and a snapshot of the sampling technique on Gloria Knolls (GeoB22222-2).

On Monday, May 1st, we reached our final study area east of Cape York late in the morning and started a CTD-rosette water sampler cast at ~2800 m water depth. As for the previous deployments, the water column was sampled for radiocarbon and uranium, nutrients and stable N, C, and O isotopes. An extensive swath bathymetry and Parasound survey until May 2nd revealed the inaccuracy of the seafloor maps available for this region. Several deep-cutting canyons reaching from 600 to 2200 m water depth characterize the slope in this area. While the tops and flanks of the canyons appear barren of sediment, seafloor at depths greater than 2200 m contains slump sediments in front of the canyon mouths and rather undisturbed sedimentation further offshore.

We conducted a canyon video survey from ~630 m to >1000m at the Plunge Pool edge and found a rough substrate with a thin dusting of sediments over the top of outcrops. Numerous soft corals, urchins, and cold-water corals were observed on or near the harder outcrops, which were also coated by a dark crust/stain (FeMg oxide?). On the side of the canyon wall, numerous steep cliffs and flatter terraces were observed with very rough scarps and mostly covered by sessile biota (some crinoids). A huge, undercut wall or cliff representing the canyon floor of the upper terraces showed, in addition to planar bedding, clear evidence of sub-vertical joints or fractures in the outcrop that are in a similar orientation (NE/SW) to large, regional structures (faults?) observed in the multi-beam bathymetry. We moved SE transiting over rough, slab-like outcrops with attached biota and finally reached a very steep plunge pool edge that dropped away to >1000 m before terminating the dive. Here, the rough outcrops on the edge were characterised by abundant and large sessile biota (e.g. sea fans).

Gravity corer and MUC deployments on top of a canyon terrace at ~600 m recovered stiff, clayey fine sandy sediments in the rather short cores. After another overnight swath bathymetry and sub-bottom profiling, we sampled the seafloor on May 3rd, at ~2850 m depth with a GC and a MUC and recovered brownish to olive mud with few sandy layers. The site survey continued until the next day, Thursday, May 4th, when we deployed two gravity cores (GeoB22235-1 and 22236-1) in the mass wasting deposits of the canyons at ~2200 m water depth and recovered short sediment cores consisting of foraminifera bearing mud.

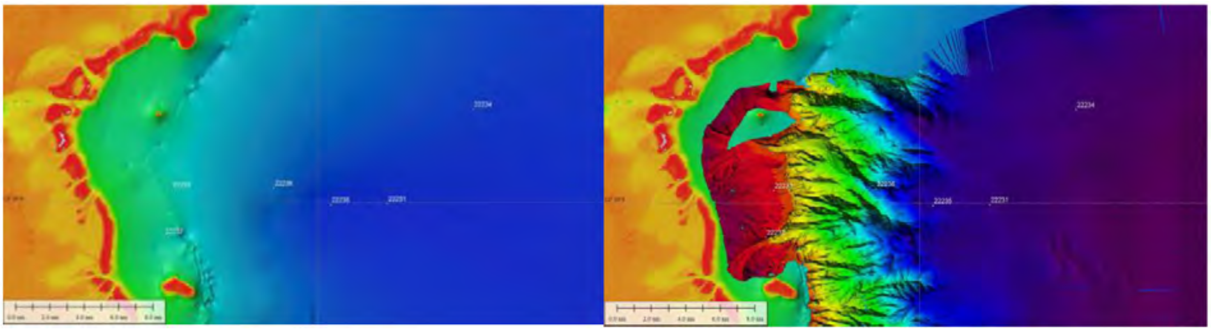


Fig. 4.5 Bathymetry map of the final study area before (left) and after (right) the SO-256 survey. White dots and numbers indicate the position of the sampling sites.

We left the final study area towards the Torres Strait in the early morning of Friday, May 5th, picked up the pilot on the next day at 6 AM and passed the strait by the afternoon. During the transit to Darwin, the scientific crew started to store and pack the samples for shipping, clean up the labs and discuss plans for further processing of the samples onshore. Aside from the IODP drilling campaigns, we obtained the longest sediments in the GBR at all working areas. Combined with the priceless video images that reveal the complex biota and structure of the GBR and the unprecedented high-resolution seafloor maps, we experienced a number of unexpected highlights during this voyage.

5 Preliminary Results

5.1 CTD Profiling and Water Sampling

(Floren, Gould, Hirabayashi, Kienast, Obrochta, Rodehutscord, Yokoyama)

5.1.1 Instrumentation

A CTD equipped with a 24-Niskin bottle rosette was used to measure the physicochemical properties of the water column and to collect water samples at specific depths, respectively. Besides standard CTD sensors, the instrument was also equipped with a Fluorescence sensor to obtain profiles of turbidity and fluorescence, which allowed the identification of the chlorophyll maxima. In addition, an oxygen sensor was installed on the CTD rosette. Because of the significant discrepancies between the downcast and upcast O_2 profiles, however, these profiles are deemed unreliable and were excluded from any further consideration. Based on the T, S, and fluorescence properties, the predominant water masses could be identified for subsequent rosette water sampling (Table 5.1). The water samples will be analysed for stable water and dissolved inorganic carbon (DIC) isotopes ($\delta^{18}O$ and $\delta^{13}C$ at MARUM), for N and O isotopes of nitrate ($\delta^{15}N$ and $\delta^{18}O$ at Dalhousie), for uranium series nuclides measurements and radiocarbon of DIC at the University of Tokyo, and for nutrient concentrations (nitrate, phosphate, silicate) at Dalhousie (Table 5.2).

5.1.2 CTD Profiles and Main Water Masses

Four stations were sampled with the CTD, including at the southern and northern limit of the cruise transect. All stations clearly depict (a) the upper salinity maximum (35.6 - 35.8) centered between 100 and 200 m (Figs 5.1 and 5.2) immediately below the mixed layer, associated with the South Pacific Tropical Water (SPTW; 20-25°C, Grenier et al. 2013), also referred to as the Subtropical Lower Water (SLW; Sukolov & Rintoul 2000), as well as (b) the salinity minimum (34.4 - 34.5) generally associated in the study area with the Antarctic Intermediate Waters (AAIW; 650 - 900 m depth). Only at the southernmost station, GeoB22201-1, is the salinity minimum slightly deeper and broader (700 – 1150 m, Fig. 5.2), consistent with a Tasman Sea origin of

AAIW there (Bostock et al. 2003). At the three stations further north, AAIW is carried by the SEC from the east (Sukolov & Rintoul 2000).

Table 5.1 CTD-Water sampler stations during R/V SONNE expedition SO-256. Geographical coordinates and water depths refer to "station start" in Chapter 7.

GeoB	Latitude (°S)	Longitude (°E)	Water Depth (m)	Instrument Depth (m)	Depth sampled (m)	Samples
22201-1	26°03.039'	154°2.980'	2495	2513	2483, 2230, 2026, 1771, 1516, 1264, 1111, 1009, 908, 807, 756, 601, 502, 402, 278, 199, 150, 111, 93, 83, 73, 43, 12	MARUM, DAL, AORI, AKITA
22221-1	17°17.913'	146°56.256'	1166	1156	1156, 1106, 904, 838, 803, 754, 653, 551, 501, 453, 402, 353, 303, 254, 228, 203, 178, 148, 103, 93, 77, 73, 53, 12	MARUM, DAL, AORI, AKITA
22225-1	15°24.116'	146°7.912'	2228	2177	2177, 2126, 1872, 1822, 1517, 1213, 1162, 858, 777, 707, 404, 353, 303, 253, 203, 178, 153, 128, 103, 78, 53, 12	MARUM, DAL, AORI, AKITA
22231-1	12°30.109'	144°4.080'	2822	2785	2785, 2734, 2174, 1870, 1512, 1156, 1002, 850, 768, 697, 546, 397, 349, 300, 252, 203, 178, 153, 128, 107, 77, 52, 12, 7	MARUM, DAL, AORI, AKITA

Surface ocean salinities decreased from 35.6 in the southern part of the work area to values around 35.3 in the north. Only at the northernmost station, did we observe a 10 m "fresh water" lens at the top of the mixed layer, with salinities of 35.06. This surface layer was sampled at CTD station GeoB22231-1 (Fig. 5.2). Monitoring surface ocean salinities measured by the vessel's thermo-salinograph during the bathymetric profiling suggests that this fresher surface water (salinities as low as 34.7) is restricted to the offshore region to the northeast of GeoB22231, possible indicative of a plume of surface waters advected clockwise from the Fly River in Papua New Guinea to the north. Alternatively, this could be the Tropical Surface Water (TSW) of Lindstrom et al. (1987), which forms a shallow halocline as a result of heavy precipitation associated with the South Pacific Convergence Zone. We observed a clear fluorescence maximum immediately below the mixed layer at all stations except GeoB22221.

Table 5.2 CTD/Water samples for $\delta^{18}O$, $\delta^{13}C$ $\delta^{14}C$, $\delta^{15}N$, Nutrients and U-isotope ratios during R/V SONNE expedition SO-256.

Location	GeoB	Depth of sampling (m)	δ^{18}O	δ^{13}C	δ^{15}N	δ^{14}C	Nutrients	U-isotope
Fraser Slope (110 samples)	22201-1	2483, 2230, 2026, 1771, 1516, 1264, 1111, 1009, 908, 807, 756, 601, 502, 402, 278, 199, 150, 111, 93, 83, 73, 43, 12	x	x				
	22201-1	2483, 2230, 2026, 1771, 1516, 1264, 1111, 1009, 908, 807, 756, 601, 502, 402, 278, 199, 150, 111, 93, 83, 73, 43			x		x	
	22201-1	1264, 1009, 908, 807, 502, 278, 150, 73, 43, 12				x		x
Gloria Knolls (166 samples)	22221-1	1156, 1106, 904, 838, 803, 754, 653, 551, 501, 453, 402, 353, 303, 254, 228, 203, 178, 148, 103, 93, 77, 73, 53, 12	x	x	x		x	
	22221-1	1156, 803, 653, 501, 353, 254, 178, 148, 93, 12				x		
	22221-1	1156, 904, 803, 754, 653, 501, 353, 254, 178, 148, 93, 12						x
Ribbon Reef (151 samples)	22225-1	2177, 2126, 1872, 1822, 1517, 1213, 1162, 858, 777, 707, 404, 353, 303, 253, 203, 178, 153, 128, 103, 78, 53, 12	x	x				
	22225-1	2177, 2126, 1872, 1822, 1517, 1213, 1162, 858, 777, 707, 404, 353, 303, 253, 203, 178, 153, 128, 103, 78, 53, 12			x		x	
	22225-1	2177, 1872, 1213, 777, 404, 303, 178, 153, 103, 12				x		
	22225-1	2177, 1872, 1213, 777, 707, 404, 303, 178, 153, 103, 53, 12						x
Cape York (164 samples)	22231-1	2785, 2734, 2174, 1870, 1512, 1156, 1002, 850, 768, 697, 546, 397, 349, 300, 252, 203, 178, 153, 128, 107, 77, 52, 12, 7	x	x				
	22231-1	2785, 2734, 2174, 1870, 1512, 1156, 1002, 850, 768, 697, 546, 397, 349, 300, 252, 203, 178, 153, 128, 107, 77, 52			x		x	
	22231-1	2785, 1870, 1512, 768, 697, 300, 178, 153, 107, 52, 12, 7				x		x

Subantarctic Mode Water (SAMW) is generally characterized by high oxygen concentration, owing to its formation by deep winter convection north of the Antarctic Circumpolar Current. Delineation of the SAMW between the SPTW and AAIW is difficult because of the non-reproducible oxygen profiles. But the isotope and nutrient analyses to be carried out on the water samples will eventually clearly identify this water mass. Below the AAIW, salinities increased slightly at all stations, indicative of Circumpolar Deep Water (CDW). This cold and saline (34.7) water mass enters the study area through the Tasman Sea.

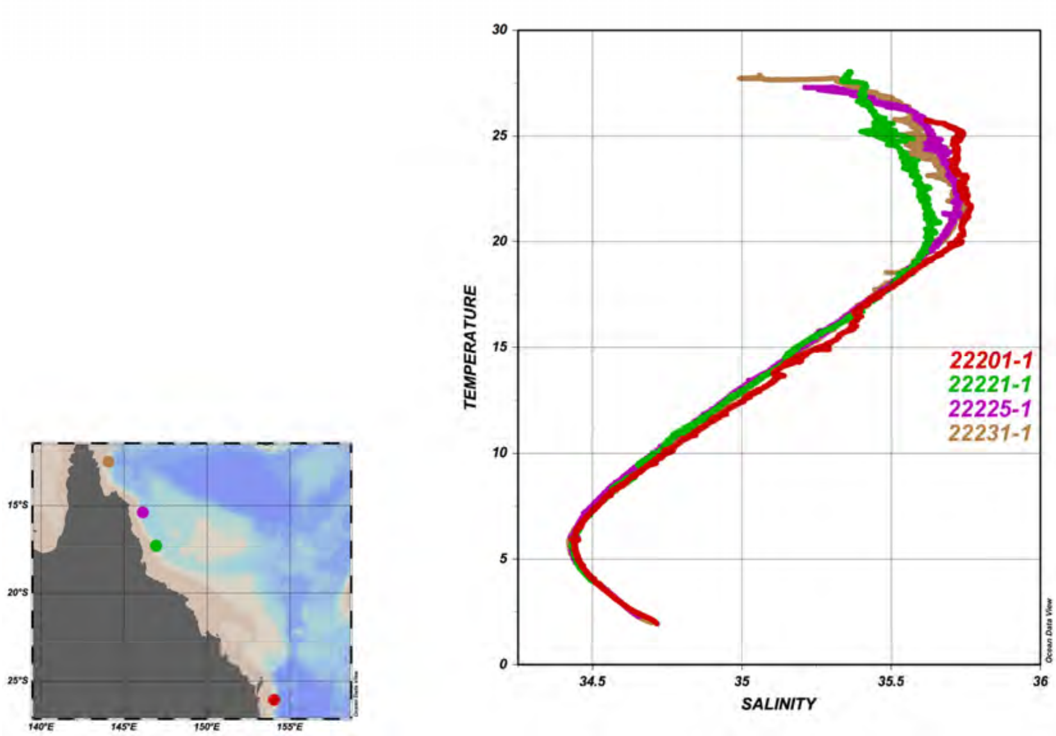


Fig. 5.1 Temperature vs.salinity profiles at the 4 CTD-rosette water sampler stations, indicated by dots (map) and lines (graph).

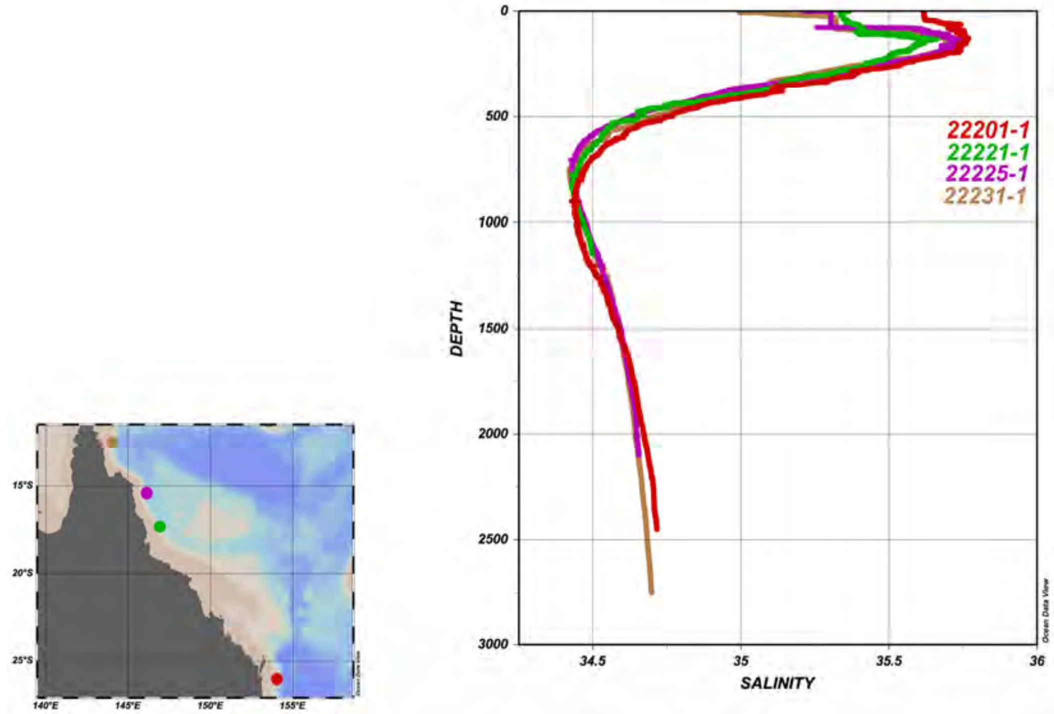


Fig. 5.2 Depth profiles of salinity at the 4 CTD-rosette water sampler stations indicated by dots (map) and lines (graph).

5.1.3 Seawater Nutrient Content

In order to determine the nutrient content of each water mass in the region, selected depths were sampled from 4 CTD casts during the SO-258 expedition (Tables 5.1 and 5.2). 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 were shipped with dry ice upon disembarking in Darwin, Australia. The samples will then be analyzed at Dalhousie University upon reception of the shipment.

5.1.4 Underway Filtration

During transit, seawater was filtered using the ship's contamination-free seawater intake for alkenone analysis (Table 5.3). 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 were shipped in dry ice upon disembarking in Darwin, Australia, while the water samples will travel to Bremen prior to being shipped to Dalhousie University where all analyses will be performed.

Table 5.3 Underway filtration of the sea surface during R/V SONNE expedition SO-256. Latitude (LAT) and longitude (LON) values are given in degree and decimal degree; time and date refer to UTC time.

START					**END**				
Filter	**Date**	**Time**	**LAT (°S)**	**LON (°E)**	**Date**	**Time**	**LAT (°S)**	**LON (°E)**	**volume filtered (l)**
1	18.04.17	10:50:00	32.3649833	168.667567	18.04.17	15:20:00	31.9310833	167.605633	320
2	18.04.17	19:05:00	31.5728	166.732833	18.04.17	23:00:00	31.19205	165.809567	452
3	19.04.17	03:00:00	30.8417833	164.957833	19.04.17	07:00:00	30.4735	164.069933	245
4	19.04.17	10:55:00	30.1044	163.1833	19.04.17	15:04:00	29.6839167	162.17735	251
5	19.04.17	18:50:00	29.28345	161.222867	19.04.17	23:00:00	28.86795	160.23715	252
6	20.04.17	02:59:00	28.4826667	159.327	20.04.17	07:10:00	28.0618167	158.3937	266.5
7	20.04.17	10:55:00	27.6904667	157.5781	20.04.17	15:06:00	27.2807333	156.681533	317.5
8	20.04.17	20:00:00	26.7777	155.5849	20.04.17	23:58:00	26.3843833	154.838367	285.5
9	21.04.17	04:14:00	26.0506	154.04955	21.04.17	10:00:00	26.1302667	153.9894	38.5
10	22.04.17	22:30:00	23.3612333	152.339417	23.04.17	02:31:00	23.3025667	152.130767	328
11	23.04.17	02:38:00	23.3149333	152.140683	23.04.17	06:50:00	23.3122167	152.1263	264
12	24.04.17	11:56:00	22.6824667	152.289317	24.04.17	16:10:00	22.9885667	152.5336	241
13	25.04.17	08:35:00	21.9878167	152.9684	25.04.17	12:00:00	21.3340333	152.938783	211
14	25.04.17	22:00:00	20.22315	151.6322	26.04.17	02:06:00	19.7507333	150.8309	156
15	26.04.17	05:23:00	19.5816667	150.397767	26.04.17	10:55:00	18.9016667	149.433367	266
16	26.04.17	23:14:00	17.6907333	147.51855	27.04.17	04:55:00	17.2979167	146.937033	376.5
17	27.04.17	17:00:00	16.4957167	146.571733	27.04.17	22:08:00	15.4114167	146.13305	213
18	27.04.17	22:17:00	15.4017833	146.131833	28.04.17	04:00:00	15.3996167	145.901767	248
19	29.04.17	07:00:00	15.5701667	145.9095	29.04.17	13:00:00	15.8126167	146.09785	345
20	30.04.17	08:12:00	14.7740333	145.846633	30.04.17	12:25:00	14.2554167	145.299383	270
21	30.04.17	22:20:00	12.8709167	144.019067	01.05.17	03:12:00	12.5018333	144.067933	203
22	02.05.17	04:20:00	12.5333333	143.851783	02.05.17	06:45:00	12.4880167	143.85955	149
23	03.05.17	11:15:00	12.4709333	144.3983	03.05.17	17:13:00	13.4851833	144.562833	472
24	05.05.17	10:16:00	9.6719	144.425567	05.05.17	16:37:00	09.25035	143.8113	367
25	06.05.17	02:31:00	10.5035833	142.262267	06.05.17	03:35:00	10.5657667	142.0376	19

5.2 Swath Bathymetry

(Beaman, O'Toole, Pall, Sanborn)

5.2.1 System Overview and Data Processing

The Kongsberg EM122 multi-beam system was used for bathymetric mapping continuously within Australian waters across the Tasman Sea to the south-east Queensland margin, then northward along the Great Barrier Reef (GBR) margin and Coral Sea towards the Torres Strait. Within the Torres Strait and then westerly towards Darwin across the Arafura and Timor Seas, the relatively shallow waters of <100 m precluded the use of the EM122 system and so was switched off. The hull-mounted Kongsberg multi-beam system EM710 was used for bathymetric mapping at several sampling sites along the GBR margin where water depths were <100 to ~400 m, and then used continuously from the Torres Strait west towards Darwin as the depths were <100 m. The only times that the EM122 multi-beam system was stopped recording along the GBR margin were occasionally during station sampling where the vessel was stationary for long periods. Once moving again, the EM122 system commenced recording. Both the EM122 and EM710 multi-beam systems worked reliably with no obvious data gaps. To calibrate the depth determination, modelled sound velocity profiles were input to both EM122 and EM710 systems using the CSIRO-supplied software program SVP Builder, which relies on climatology models of the physical ocean properties around Australia. Occasional deep CTDs along the GBR margin provided additional observed data to append to the modelled sound velocity profiles. Profiles were regularly input to the systems at least every 6-12 hours to ensure the correct sound velocities were being used for the geographic area being worked in.

The Kongsberg EM122 system allows accurate bathymetric mapping down to full ocean depth. Basic components of the system are two linear transducer arrays hull-mounted in a Mills cross configuration with separate units for transmitting and receiving. The transducer system version on the R/V SONNE has 0.5° transmit x 1° receive arrays. The nominal sonar frequency is 12 kHz with an angular coverage sector of up to 150° and 288 beams/432 soundings per swath. The system was operated in Dual Swath mode, achieving two swaths per ping and resulting in a maximum number of soundings per ping of 864. 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 may be up to 150° and set to vary automatically with depth according to achievable coverage, which maximizes the number of usable beams. For SO-256, the angular coverage was typically set manually at +/-70°, but occasionally to +/-75° to obtain maximum coverage. Equidistant beam spacing was always used during SO-256. In addition to the depth soundings, the EM122 also provides backscatter imagery and water column data. Backscatter and water column data were recorded continuously during R/V SONNE expedition SO-256 whenever the EM122 system was set to record.

The Kongsberg EM710 system allows high-resolution depth bathymetric mapping down to ~1000 m. However for R/V SONNE expedition SO-256, the EM710 was typically only used in relatively shallow water depths <100 m to ~400 m, as there was a tendency for interference from the Parasound sub-bottom profiler for depths greater than 400 m. The EM710 is also hull-mounted with a Mills cross transducer array of separate transmit and receive arrays. The transducer system version on the R/V SONNE has 0.5° transmit x 1° receive arrays. The sonar frequency range operates from 70 to 100 kHz, with an angular coverage sector of up to 140°. Therefore, the swath width on a flat bottom will normally be up to five times the water depth. For R/V SONNE expedition SO-256, the angular coverage was typically set to +/-65°, but occasionally out to +/-70° to obtain maximum coverage. The system can generate 256 beams/400 soundings per swath. The EM710 system was operated in Dual swath mode, achieving two swaths per ping, resulting in a maximum number of soundings per ping of 800. Equidistant beam spacing was always used. The EM710 also provides backscatter imagery and water column data, and these data were recorded simultaneously whenever the EM710 system was set to record, with the exception that water column was turned off during the transit across the Arafura and Timor seas towards Darwin to save on file storage space.

The EM122 and EM710 multi-beam *.all and *.wcd data files were imported into the post-processing software Caris HIPS/SIPS V8.1.10 onboard the R/V SONNE. Bathymetry data were edited for obvious noise spikes and then predicted tidal data applied in several places on the GBR margin for waters ~100 m. Tidal data files were generated from the Australian Hydrographic Service-supplied software AUSTIDES 2017. Refraction corrections were applied to a small number of multi-beam lines where the modelled sound velocity profiles were found to be incorrect (see SO256_2017_MBES_processing_log.xlsx). Overall, the edited bathymetry data from both multi-beam systems were of high quality and valuable for further scientific analysis. The surface grids from the five main study sites along the GBR margin are presented below, after first exporting the grid DEMs from Caris HIPS/SIPS and then importing the DEMs into QPS FLEDERMAUS 3D visualization software. In turn, the FLEDERMAUS SD files were exported as hill-shaded geotif images for import to ESRI ARCMAP, and then overlaid with vector data of the sample positions and ship track line.

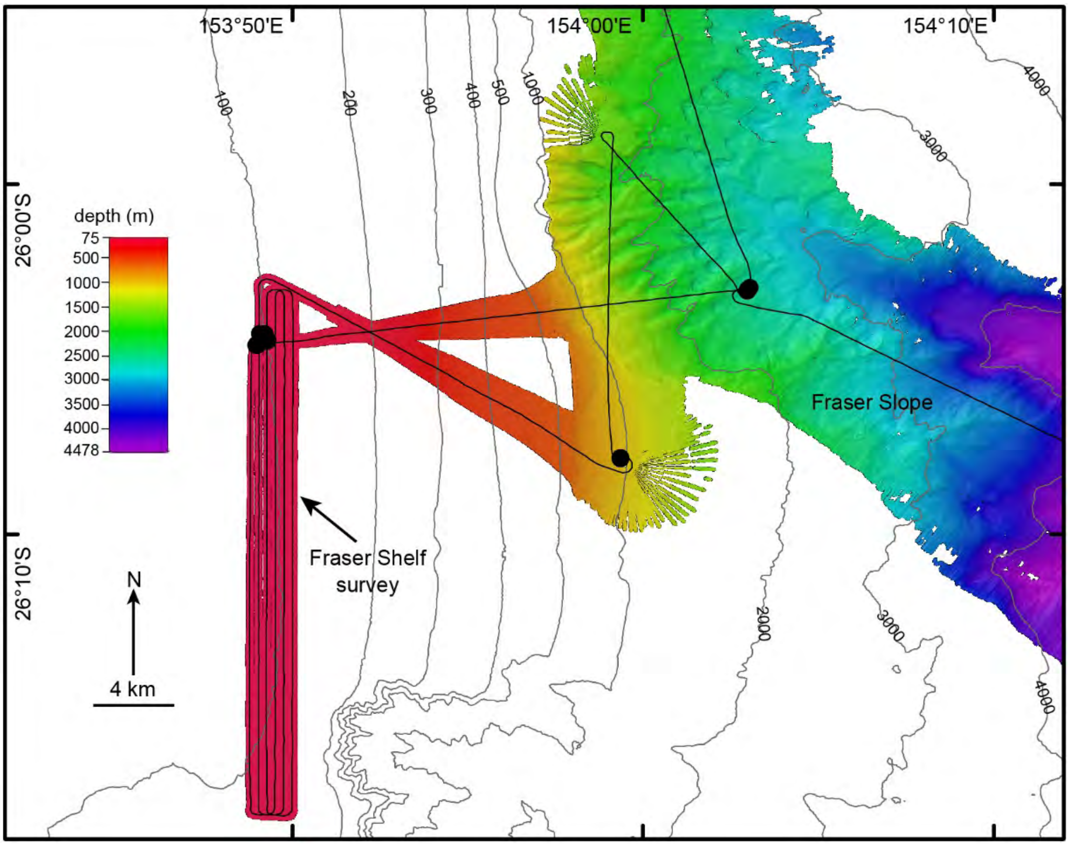


Fig. 5.3 Bathymetric map of the Fraser Shelf and Fraser Slope area. Thin black line is the ship track. Black circles show the location of sampling stations in the north of the Fraser Shelf survey, on the upper- and the lower-Fraser Slope.

5.2.2 Preliminary Results

Fig. 5.3 shows the bathymetric data for the Fraser Shelf and Fraser Slope survey area on the south-east Queensland margin. The depths shown range from 75 to 4458 m. A systematic survey was conducted in the vicinity of the shelfbreak at ~100 m over an area 18.5 km long x 2.4 km wide. Paleo-dune features, 2-3 m high, were revealed lying parallel to and about 400 m to landward of the shelfbreak in depths of ~85 m, which likely reflects a sub-aerial origin during lowstands. To seaward of the shelfbreak, the upper-slope shoulder is relatively smooth with a gentle gradient dropping from ~100 to 500 m over an east-west distance of 12 km. At ~600 m, the gradient increases at the mid-slope with the appearance of undersea landslide scarps and the heads of submarine canyons and gullies. Below ~1000 m, much of the slope is incised with submarine canyons about 700 m wide and cutting 50-200 m into the slope. At the lower-slope below a depth of 2500 m, most of the canyons coalesce towards a much larger canyon, about 2 km wide, which drains in a south-east direction towards the deeper Tasman Basin. The edge of the relatively flat Tasman Basin can be traced around the eastern limit of the study area surveyed below depths of ~4000 m.

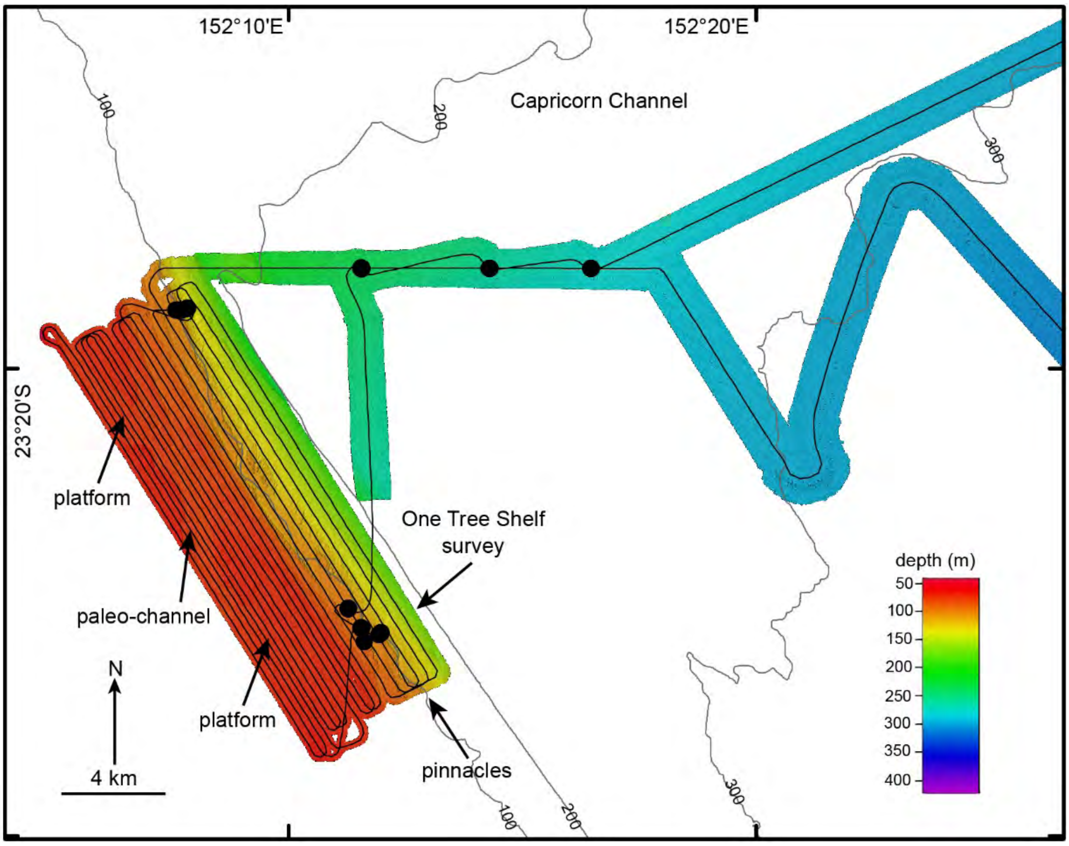


Fig. 5.4 Bathymetric map of the One Tree Shelf area and Capricorn Channel transit. Thin black line is the ship track. Black circles show the location of sampling stations in the south-east and north of the One Tree Shelf study area and along the upper Capricorn Channel.

Heading north 350 km from the Fraser Shelf/Slope study area and opposite the Capricorn-Bunker Group of islands on the southern GBR margin, a systematic survey was conducted on the One Tree Shelf covering an area of 18 km long x 6 km wide (Fig. 5.4). Depths within the One Tree Shelf survey ranged from 40 to 200 m. The shelfbreak is a distinct step of about 10 m near the 100 m contour, and is non-linear due to lobes of sediment and small promontories of drowned reefs and numerous low (<5 m high) pinnacles. These pinnacles continue to about the 120 m contour, over a horizontal distance of between 300 to 1000 m from the shelfbreak. From ~120 m to 400 m, survey data along the upper-slope of the Capricorn Channel reveals the seabed becoming relatively smooth with a gentle gradient. Back on the shelf to landward of the shelfbreak, are at least five distinct steps separated by terraces, which likely represent the integrated response of outer-shelf topography over multiple sea-level lowstands. The uppermost of these steps lies at about 68 m where a broad platform stretches about 2 km wide in ~65 m. In the centre of the One Tree Shelf study area is a 300-1000 m wide paleo-channel running north-south which separates the ~65 m platform from another broad platform to the north-west. Backscatter imagery indicates the paleo-channel has soft sediments compared to the hard-ground platforms either side.

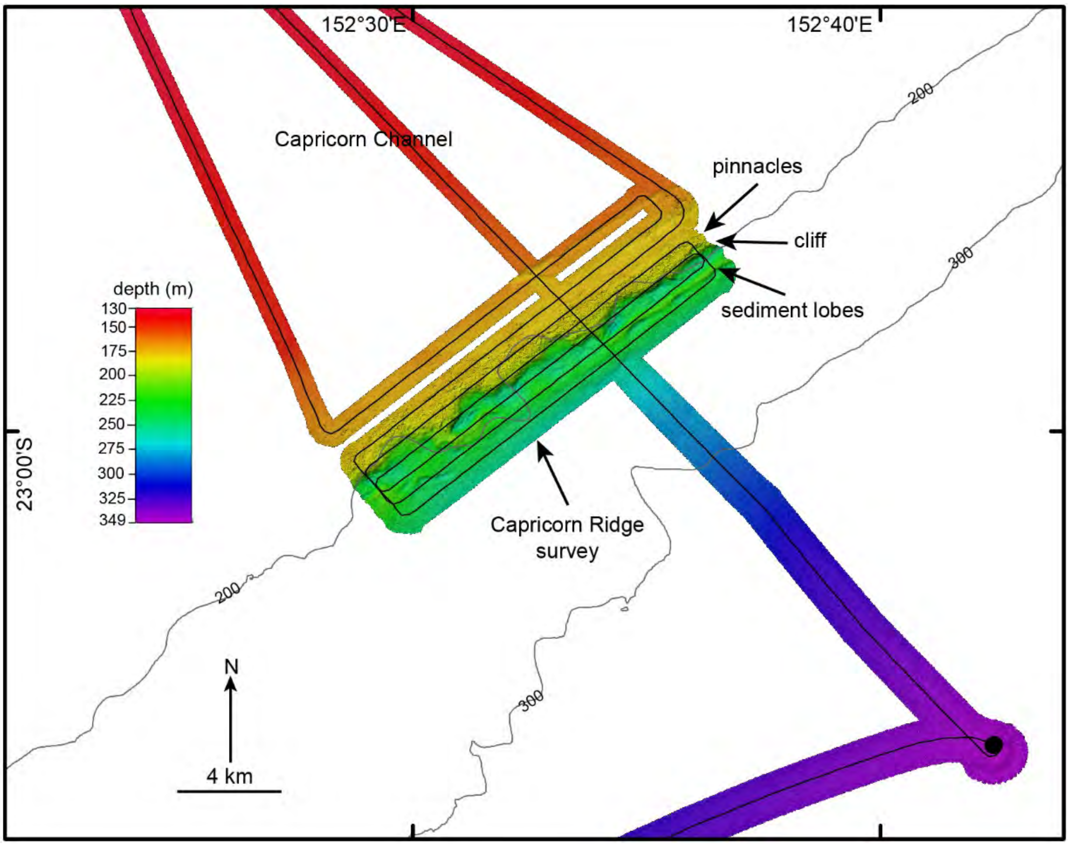


Fig. 5.5 Bathymetric map of the Capricorn Ridge and Capricorn Channel area. Thin black line is the ship track. Black circles show the location of sampling stations in the deeper Capricorn Channel.

About 50 km north-east of the One Tree Shelf study area is the Capricorn Channel study area (Fig. 5.5). Transit lines across the upper-slope between depths of 130 to 349 m revealed a distinct ridge, hereafter called the Capricorn Ridge, around the 200 m contour. A systematic survey parallel to this ridge showed the upper-slope seabed relief remaining smooth with a gentle gradient down to 160 m, then followed by an increase in gradient and dropping about 5-10 m. A broad terrace then extends 2.2 to 2.5 km in width to about 180 m depth where a band of distinct low (<5 m in height) pinnacles appeared. This band of pinnacles is about 500 to 750 m in width, dropping from 180 to 200 m depth before terminating at an undulating cliff edge. The relatively steep cliff drops about 40 m in height to 240 m depth. The base of the cliff appears to have lobes or drift deposits of sediment locally built-up as contour-parallel, smooth ridges for up to one km in width from the base of the steep cliff. Below depths of 250 m, the sediment lobes disappear and the upper-slope of the Capricorn Channel again becomes relatively smooth with no obvious seafloor features.

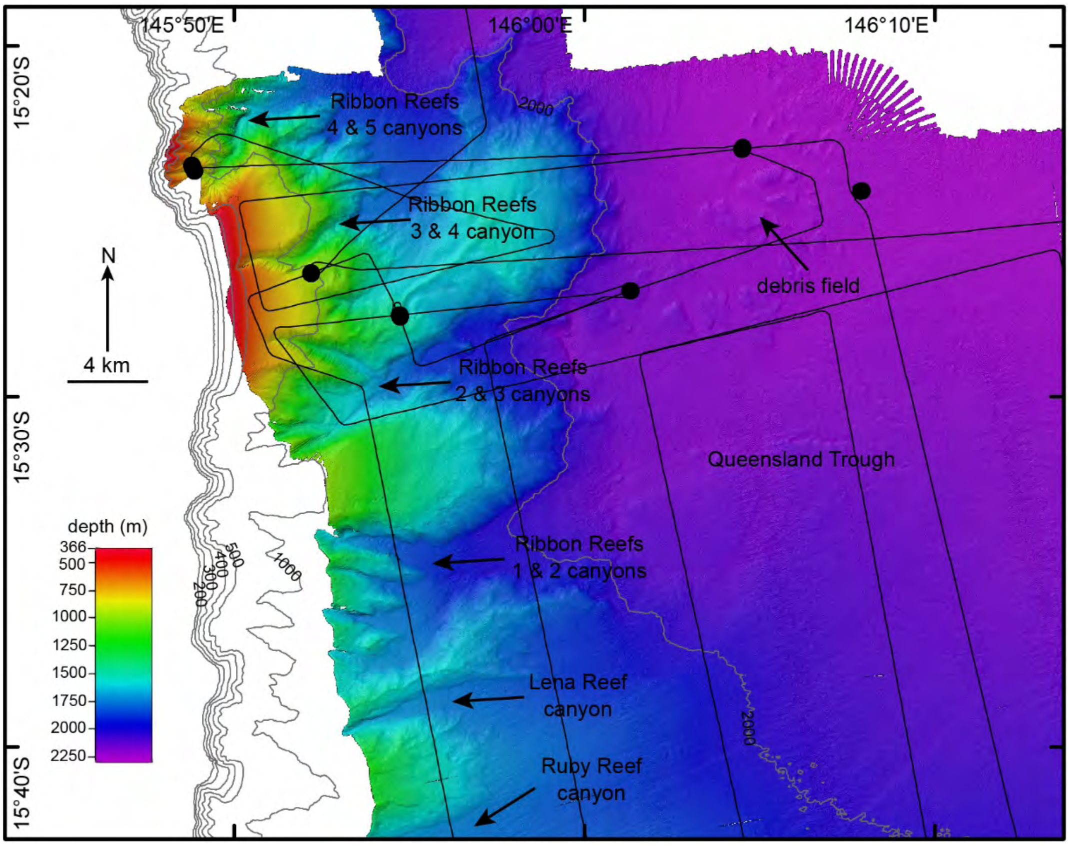


Fig. 5.6 Bathymetric map of the Ribbon Reef study area. Thin black line is the ship track. Black circles show the location of sampling stations in the heads of canyons, the mid-slope and in the deeper Queensland Trough.

On the northern GBR margin, a large area of seafloor was surveyed opposite the Ribbon Reefs (Fig. 5.6). Depths ranged from 366 to 2296 m, from the heads of canyons and across the heavily incised slope, then merging into the deeper Queensland Trough. In the south-west of the study area, the toes of canyons sourced from opposite Ruby and Lena Reefs are 1-3 km wide and separated by broad raised interfluves, then merge with the basin floor at ~1800 m. A narrow, sharp interfluve north of the Lena Reef-sourced canyon is the southern limit of a series of four ~1 km wide canyons sourced from Ribbon Reefs 1 and 2. These four canyons coalesce into a single 2.5 km wide canyon at the base of the slope in ~1800 m, then merge into the basin below ~2000 m. Continuing northward, a broad raised interfluve separates the next group of four canyons sourced from Ribbon Reefs 2 and 3. These four canyons coalesce at 1760 m into a single 1.5 km wide canyon that opens out into a ~3 km wide, bowl-shaped lower-slope. From this bowl at 2150 m, a distinct scarp drops ~100 m to the basin floor to a remarkable mass flow deposit stretching north-easterly over an area 6 km wide and 20 km long. These partially buried blocks may be up to 3 km across and over 50 m in height. To northward, another broad interfluve is the boundary for a solitary sinuous canyon sourced from between Ribbon Reefs 3 and 4. In the far north-west of the study area, a cluster of narrow, gullied canyons sourced from Ribbon Reefs 4 and 5 join below 1200 m into a single 1 km-wide canyon that merges with the basin at ~1900 m.

Fig. 5.7 shows the northern-most study area on the GBR margin opposite Cape York and centred between the Southern and Northern Small Detached Reefs. A large survey was conducted in the vicinity of these detached reefs, across the heavily incised slope and into the Bligh Tough, with depths ranging from 172 to 3053 m. There have been little previous bathymetry data from this area, so the high number and complexity of the canyons incising the margin were surprising. A major discovery was a gently sloping, broad platform that underlies the detached reefs, stretching out over 7 km from under the GBR outer-shelf starting at ~300 m, before coming to a sharp precipice at 700-800 m. There are several 300 to >1000 m wide canyons cutting some 50-120 m into the platform. These platform canyons end at the precipice, which drops 300 m near-vertically into ‘plunge pools’ at ~1000 m. This 300 m high precipice is consistent along the upper-slope platform, and is likely remnant continental crust associated with the Iron Range Province, which outcrops along the nearby Cape York. The ‘plunge pools’ and the sections between them at the base of the precipice, then form the heads of multiple canyons starting around 1000 m and stretching 10 to 15 km away from the precipice, before merging with the relatively flat Bligh Trough at 2600-2700 m.

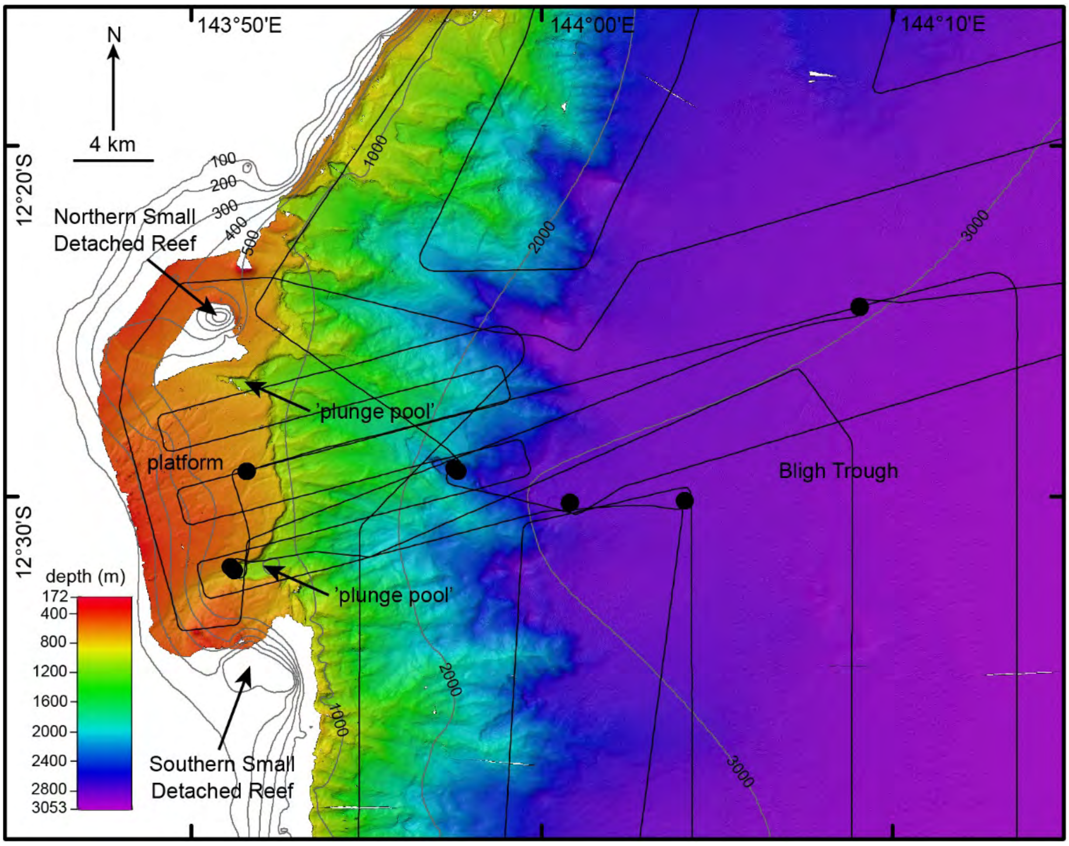


Fig. 5.7 Bathymetric map of the Cape York study area. Thin black line is the ship track. Black circles show the location of sampling stations on the upper-slope platform between the Southern and Northern Small Detached Reefs, on the mid-slope and in the Bligh Trough.

A full copy of the raw *.all and water column *.wcd files, the Caris HIPS/SIPS project (SO256_2017), metadata documents, and post-processing log (SO256_2017_MBES_processing_log.xlsx) have been supplied to the German BSH, Geoscience Australia and the Australian Hydrographic Service for archive.

5.3 PARASOUND Sediment Echosounder

(Wenderlich)

5.3.1 System Overview and Data Processing

Sub-bottom profiler data was used to confirm the suitability of core targets. The system achieved this by providing supporting evidence for the presence of undisturbed sediments. In conjunction with core target selection, buried river channels, sediment drift deposits, shallow gas, mass wasting deposits and faults could also be imaged. Ergonomically, the system was intuitive and largely automatic making it hassle-free to operate. Best results were obtained in deep water or shallow water with low to no prominent angular and/or hard surfaces.

Teledyne-Reson's PARASOUND P70 is a parametric sub-bottom profiler (P-SBP). The system is a hull mounted transducer that can deliver 70 kilowatt transmission power over 18 to 24 kHz for PHF (Primary High Frequency) and 0.5 to 7 kHz for SLF (Secondary Low Frequency). During SO-256 we used both PHF and SLF channels, maintained at 18 and 4 kHz for the PHF and SLF, respectively. Adjustment of the SLF down to 2 kHz was applied to some surveys north of the Osprey Embayment (UTM zone 54S) to increase penetration. Quasi-Equi-Distant (QED) multi-ping with a sample interval of 500 milliseconds was used in deep water terrains such as the Tasman Basin (Fig. 5.8) and Queensland Trough. In these deeper environments, sample interval was adjusted to up to 1500 milliseconds to minimize noise from the water column. Shallow terrains (approximately shallower than -1000 m) were resolved using the 'Single Pulse' setting.

Data was stored in three formats:

- PS3 – PARASOUND 3
- SEG-Y – Society of Exploration Geophysicists Y format
- ASD – Atlas Sound Data

of which the ASD files were routinely backed up. Sub-bottom profiler data acquisition, control, querying, visualisation and processing were facilitated by ATLAS HYDROMAP, PARASTORE-3, SEISEE and OPENDTECT software solutions. Navigation was initially stored as arc degrees in the ASD metadata. PARASTORE converted these ASD files to SEG-Y, making the profiles available for importation to OPENDTECT. Navigation was queried using SEISEE and R was used for coordinate conversions making the data available for GIS applications as well as the query of trace headers and output of seismic maps. Due to variability in shot interval when adjusting settings and vessel movement from deep to shallow environments, shot spacing (trace number) is not a consistent horizontal measure of distance and therefore, horizontal distance has been calculated for each of the following profiles separately with caveats. Some of the first data acquired (Fig. 5.8) exhibited sub-bottom penetration depths of approximately 100 m. In Fig. 5.8 acoustic basement conspicuously interdigitates the overlying sediment packages.

5.3.2 Preliminary Results

Acquisition of sub-bottom profiler data commenced upon entering Australian territorial waters (18th of April 2017). Time interval of the total raw data acquired ranges from 05:21:52 18-APR-2017 to 09:25:13 06-MAY-2017 (UTC). Recording was maintained throughout the voyage, bar some lost data, until it was switched off at approximately 1920 on the 6th of May 2017 (Brisbane UTC). In the shallow Torres Strait, switching off the PARASOUND P70 sub-bottom profiler reduced noise in the multi-beam bathymetry survey.

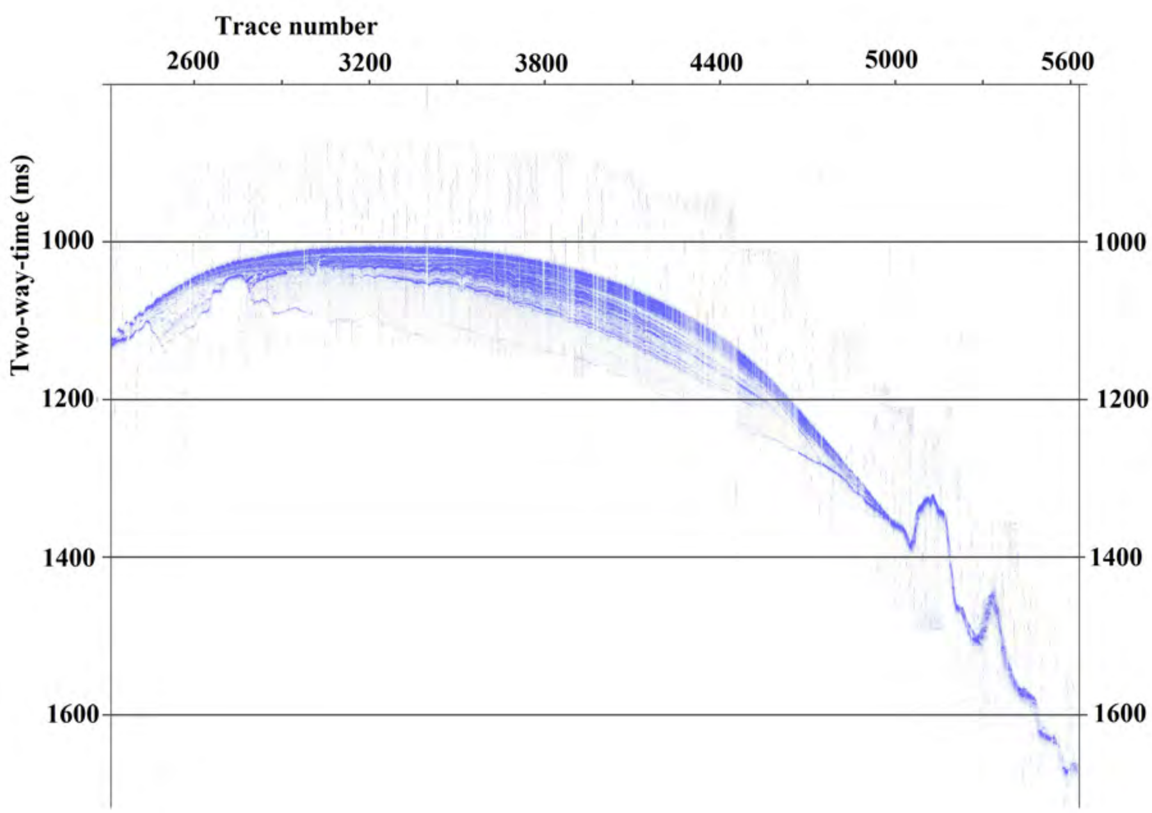


Fig. 5.8 Profile taken during transit to the Fraser Island site from Auckland, New Zealand.

After transiting to the One Tree Reef study site, the vessel surveyed east toward the shelf edge and acquired a profile of the continental slope sediments (Fig. 5.9). Data was imported into OPENDTECT on site while the vessel continued surveying. High resolution sub-bottom profiler revealed several prograding packages approaching an estimated 50 m thickness. Tangential oblique reflectors of the latest progradational phase show moderate amplitude and continuity, consistent with the high frequency alternation of sands and muds associated with delta fans/lobes (Mitchum et al., 1977). This phase overlies a larger sigmoidal prograding package exhibiting homogenous material toward its conspicuous erosional upper contact. Three core targets were collected along the profile (Fig. 5.9).

Gravity core GeoB22220-01 was retrieved on the 26th of April 2017 UTC from a relatively undisturbed interval of sediments, confirmed by PARASOUND data. The profile in Fig. 5.10 reveals the transit route towards the Gloria Knolls study site and spans over 30 kilometres of the central Great Barrier Reef (from southeast to northwest). Approximately eight hours after collecting GeoB22220-01, we detected a buried mound within the southern limit of the largest Gloria Knoll (Fig. 5.11). Upper horizontal seismic reflectors onlap the mound whilst lower reflectors dip beneath its margins. This feature exhibits geometries consistent with a bioherm –typically indicating a buried reef (Bubb & Hatleid, 1977). Sub-bottom profiler data reveals that the bioherm appears attenuated approximately 20 m to the northwest of Fig. 5.11. Furthermore, the extent of profiler coverage over the knoll suggests the bioherm's maximum length is at least approximately 668 m.

The northern Great Barrier Reef Ribbon Reef canyons exhibit relatively small unconsolidated sediment intervals on their shallow interfluves (Fig. 5.12). In this shallow environment, the PARASOUND was able to detect sporadic intervals suitable for coring during the low density reconnaissance survey. Stages of canyon fill were resolved from data collected during an overnight survey south of the Ribbon Reef study site (Fig. 5.13). Canyon fill reflector geometry was enhanced using SeiSee's automatic gain control algorithm. Sediment fill was seismically expressed as discontinuous reflectors separating chatoic and reflection free horizons. Geometries and seismic facies inspected suggest that some of the fill originated from the canyon walls (e.g. cayotic reflectors with an external form of a slump block on the northern wall of the confluence of canyons 18 and 19 – centre canyon in Fig. 5.13).

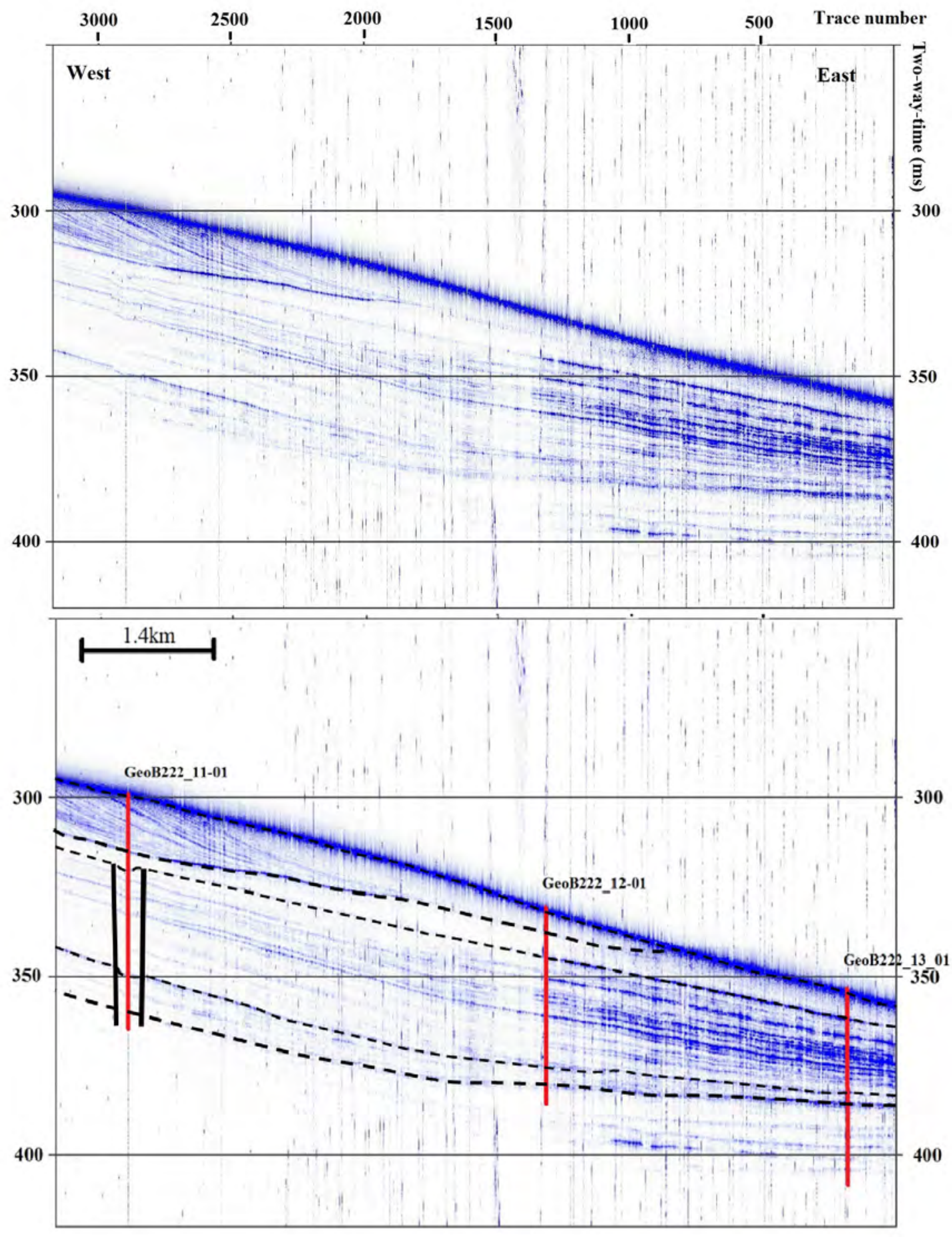


Fig. 5.9 Top: east-west profile taken approximately perpendicular to shelf progradation - South Capricorn Channel, adjacent to One Tree Reef. Bottom: annotated echograph. Several conspicuous progradational packages were resolved (major boundaries delineated by dashed lines) and gravity cores subsequently deployed to sample the upper, middle and lower superficial sediments (locations indicated by red lines). Note that the red line is not a size representation of core length. Solid black vertical lines represent faults (note stratal terminations on interpreted fault plane and approximate offsets of up to 1 m).

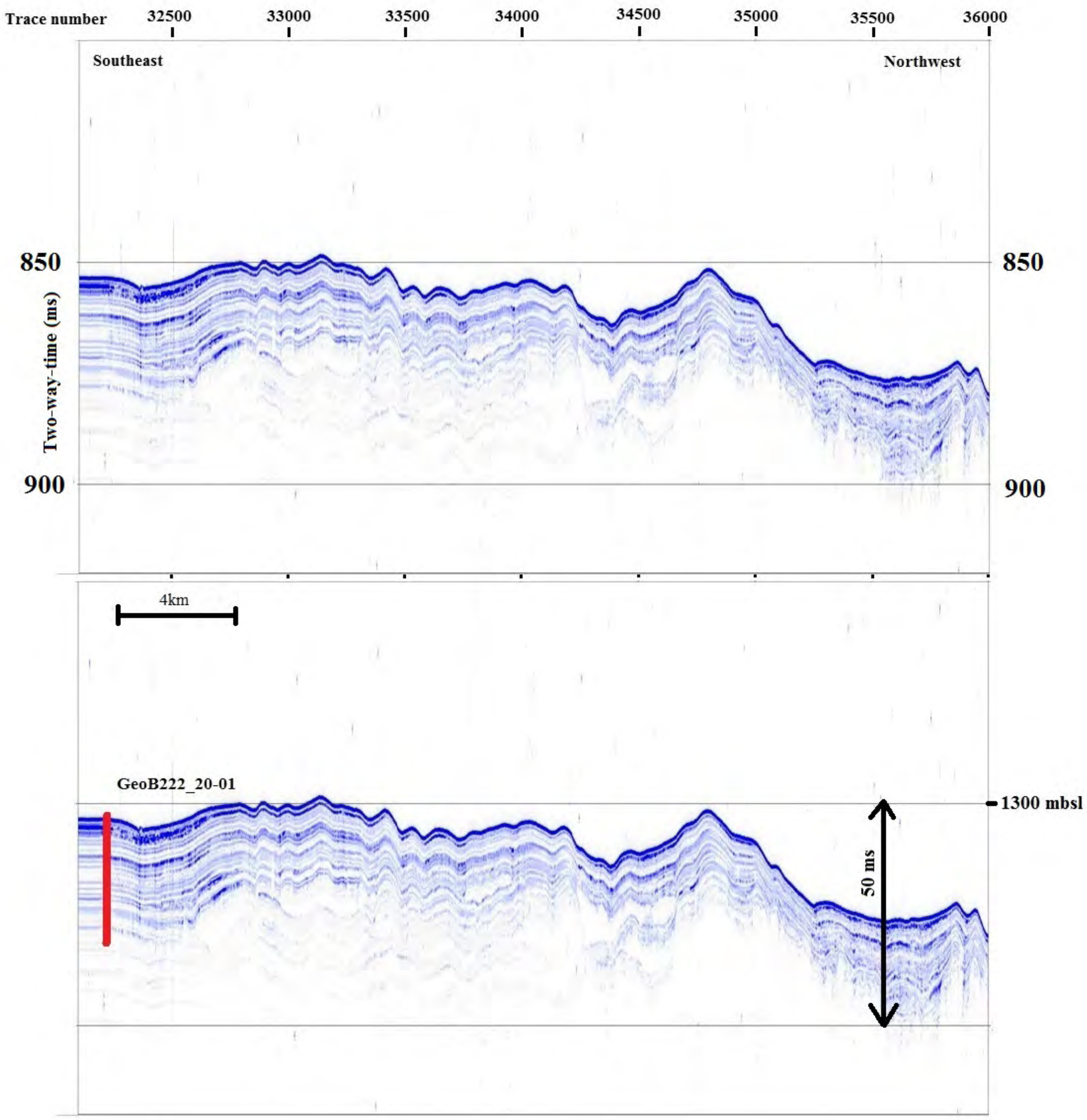


Fig. 5.10 Top: echograph from transit north across the central Great Barrier Reef approaching the Gloria Knolls. Bottom: annotated echograph. GeoB22220-01 core location is indicated by the red line. Note that the red line is not a size representation of core length.

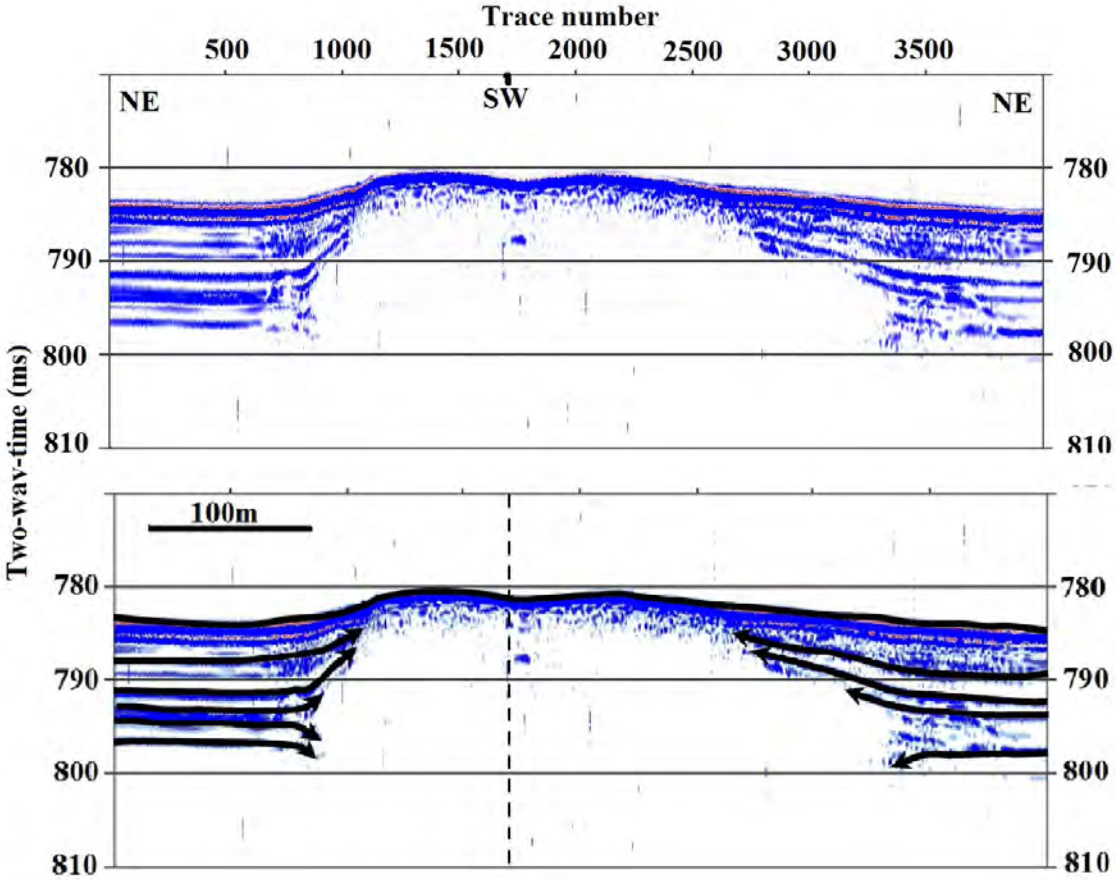


Fig. 5.11 Top: a bioherm within the southern limit of the largest Gloria Knoll's bathymetric expression. Bottom: annotated echograph. Note the indirect indication of the bioherm by ambient reflector terminations (black arrowed lines). Annotated lines are exaggerated to punctuate seismic reflection geometry. Dashed line represents point at which vessel turned approximately 180°, retracing its steps; therefore, sampling the same (northeast) side of the bioherm. Longest feature length is at least 668 m, taken by measuring a northwest strike at an oblique angle intersecting ~4 seismic profiles.

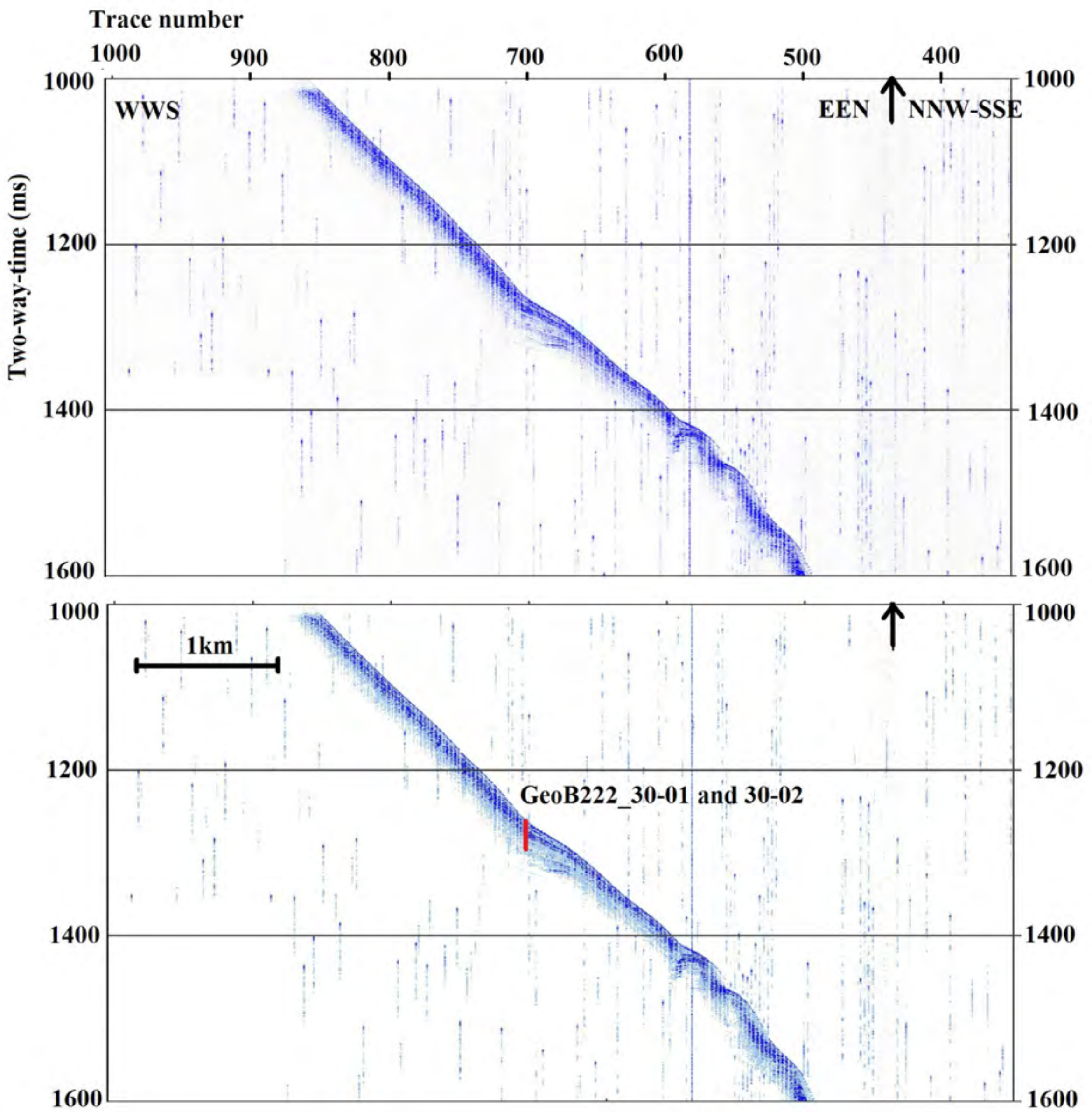


Fig. 5.12 Top: echograph on canyon interfluve. Bottom: annotated echograph. Note that the black arrow indicates a change in profile direction (from right to left) north east-east to south-south east. The location of gravity core GeoB22230-01 and Multi-core GeoB22230-02 is indicated by the red line. Note that the red line is not a size representation of core length.

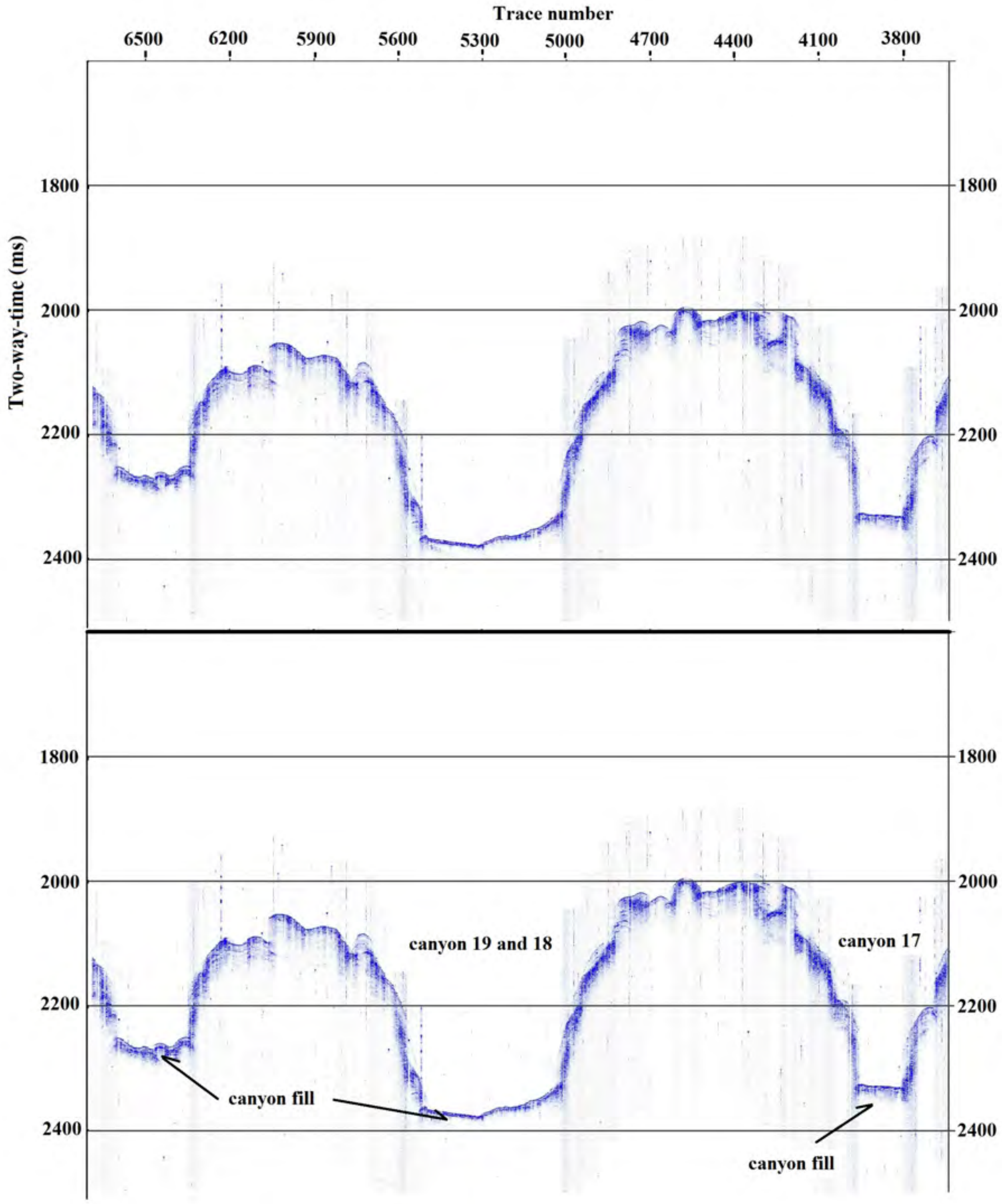


Fig. 5.13 Top: profile (trends ~north-south) showing three shelf incising canyons south of Ribbon Reefs, northern Great Barrier Reef. Canyon 17 (left) confluence of canyons 18 and 19 (Puga-Bernabeua et al., 2011). Resolvable canyon fill approaches 15 m. Bottom: annotated echograph.

5.4 Sediment Sampling

(Boehnert, Daumann, Floren, Gould, Hirabayashi, Hollstein, Lückge, Meyer-Schack, O'Toole, Pall, Renema, Rodehutscord, Sanborn, Schade, Steinke, Webster, Yokoyama)

5.4.1 Multiple Corer Equipped with Video Telemetry System

The main tool for the sampling of undisturbed surface sediments was the multiple corer (MUC) equipped with 12 plastic tubes of 60 cm length and 10 cm diameter. During the expedition SO-256, 8 Multi-corers have been successfully deployed (Table 5.4) and recovered up to 38 cm of undisturbed surface sediment. A new subsea video system manufactured by "Isitec GmbH" in Germany was mounted on the MUC and connected to the vessel via fibre optic cable (Fig. 5.14). The system comprises 1 HD-SDI-subsea camera (10x zoom, angle of view 90°/50°, and day/night modus), 1 subsea transmission unit, 2 LED lights "Sealight Sphere 5150", 1 point laser system for online sea bottom distance evaluation, 1 positioning sensor for horizontal correction, 1 depth sensor for online depth, and 1 subsea positioning sensor for relative position of subsea vehicle to the vessel ("ixblue" posidonia transponder). For the benefit of an unobstructed seafloor image by the video-telemetry system, two tubes were removed in almost all MUC deployments. Besides, in 7 deployments the MUC was used as a video slit in order to survey the seafloor prior to sampling (Table 5.5), in accordance with the permit requirement by the Great Barrier Reef Marine Park Authority (GBRMPA).

Fig. 5.14 Left: the video telemetry system (cyan arrow) mounted on MUC and connected to the vessel via fiber optic cable (white arrow). Right: the HD-SDI-subsea camera (yellow arrow) connected to the video transmission unit (white arrow).

Except for deployment GeoB22222-2, MUC samples were entirely cut in 1 cm slices and packed in Petri dishes or Kautex bottles. At GeoB22233-1, the overlying water in two tubes was murky and therefore, we refrained from sampling the sediment in those tubes. The "standard" distribution of the 10 Multi-corer tubes was as follows (see also Table 5.5):

-3 tubes cut into 1 cm thick slices for archive (MARUM)

-2 tubes cut into 1 cm thick slices for biomarker analysis (MARUM)

-1 tube cut into 1 cm thick slices for planktic foraminiferal studies (MARUM)

-1 tube cut into 1 cm thick slices for benthic foraminiferal studies (NAT)

-1 tube cut into 1 cm thick slices for δ^{15}N analysis (DAL)

-1 tube cut into 1 cm thick slices for alkenone analysis (BGR)

-1 tube cut into 1 cm thick slices for δ^{14}C and ^{10}Be analyses (AORI)

Table 5.4 Multi-corer sampling and sub-sampling during R/V SONNE expedition SO-256. AR: archive, PF: planktic foraminifera, BF: benthic foraminifera, Ni, Nu: nitrate, nutrients, AK: alkenones, BM: biomarker. *: only surface (0-1 cm) was sampled. Geographical coordinates and water depths refer to "on ground" in Chapter 7.

GeoB	Latitude (S)	Longitude (E)	Water Depth (m)	Large tubes (10 cm)										Max. Recovery (cm)
				1	2	3	4	5	6	7	8	9	10	
22202-1	26°07.818'	153°59.366'	965	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	32
22222-1	17°17.698'	146°56.354'	1168	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	19
22222-2	17°17.700'	146°56.348'	1169	AR	AR	AR	AR	AR	AR	AR	AR	AR	BF	0-1*
22227-1	15°22.932'	146°04.499'	2236	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	35
22228-2	15°26.980'	146°01.310'	2123	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	35
22230-2	15°26.473'	145°52.198'	968	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	21
22233-1	12°29.280'	143°51.571'	613	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	-	AR	-	12
22234-1	12°24.589'	144°09.069'	2864	Be, ^{14}C	AR	PF	Ni,Nu	BF	AK	BM	BM	AR	AR	38

Table 5.5 Multi-corer seafloor observation with mounted camera during R/V SONNE expedition SO-256. Geographical coordinates and water depths refer to "station start" in Chapter 7.

GeoB No.	Latitude (S)	Longitude (E)	Water depth (m)	Video
22208-1	23°18.734'	152°07.578'	90	x
22209-1	23°25.553'	152°11.553'	87	x
22217-1	22°04.780'	152°56.713'	98	x
22221-2	17°17.876'	146°56.220'	1179	not working
22222-2	17°17.700'	146°56.348'	1169	x
22226-1	15°23.387'	145°48.789'	731	x
22232-1	12°31.994'	143°51.107'	627	x

5.4.2 Giant Box Corer

At three stations of shallow water depths (Table 5.6), surface sediment was sampled using a giant box corer (GBC) with a box size of 50 x 50 x 60 cm (L x W x H). Surface sediment (0-1 cm) and the entire sediment column recovered by the GBC were distributed to NAT for benthic faunal analyses and MARUM for archiving (Fig. 5.15). While the GBC recovery off Fraser Island contained coarse grained calcareous sand with some large coralline algae nodules and bryozoans (GeoB22204-1, Fig. 5.15), sediment recovered off the One Tree Reef (GeoB22210-1) contained medium to coarse grained sand with large benthic foraminifera. Recovered sediments in the Capricorn Channel (GeoB22215-1) consisted of strongly bioturbated olive gray mud and dark gray clay.

Table 5.6 Giant box corer sampling during R/V SONNE expedition SO-256. Geographical coordinates and water depths refer to "on ground" in Chapter 7.

GeoB	Latitude (S)	Longitude (E)	Water depth (m)	Samples	Sample kind
22204-1	26°04.274'	153°49.203'	99	MARUM, NAT	BF, Archive
22210-1	23°25.135'	152°11.273'	85	MARUM, NAT	BF, Archive
22215-1	22°44.725'	152°21.052'	121	MARUM, NAT, AORI	BF, Archive

Fig. 5.15 Images of surface sediments recovered by the GBC (see sections 5.4.2 and 5.4.5 for details).

5.4.3 Chain Bag Dredge

In the second study area near One Tree Reef, a chain bag dredge was deployed to collect in situ rocks and fossil corals (Table 5.7). At GeoB22203-2 dredging operations were successful breaking of fist sized limestones from ~92 m water depth. Preliminary observations reveal the surfaces of the limestones were covered with a patchy veneer of living crustose coralline algae, encrusting bryoazoans, gastropods and worm tubes. Two of the rocks show clear breakage surfaces confirming they were broken off in situ. Lithologically, they are composed of a dense, heavily bioeroded packstone to bindstone facies, with visible bioclasts (e.g. larger benthic forams) and thin crusts of coralline algae. Dredge samples were shipped to USYD for further analysis.

Table 5.7 Dredge sampling during R/V SONNE expedition SO-256. Geographical coordinates and water depths refer to "station start" in Chapter 7.

GeoB No.	Latitude (S)	Longitude (E)	Water depth (m)	Samples	Sample Kind
22203-1	26°04.464'	153°49.281'	104	-	empty
22203-2	26°04.453'	153°49.288'	103	USYD	carbonate, packstone
22205-1	26°04.278'	153°49.107'	94	-	empty
22206-1	26°04.562'	153°49.002'	80	-	empty
22206-2	26°04.586'	153°48.966'	81	-	empty

5.4.4 Gravity Corer

Longer sediment sequences were obtained by a Gravity corer with a pipe length of 3, 6, 9, and 12 m, respectively, and a weight of 1.5 tons. Once on board, the sediment core was cut into 1 m sections, closed with caps on both ends and labelled. In total, 23 cores were retrieved with recoveries between 0 cm and 845 cm (Table 5.8). Altogether ~91 m of sediment was recovered with the Gravity corer during R/V SONNE Cruise 256.

All of the Gravity cores were cut into an archive and a work half. The archive half was used for core description and color scanning. The work half was routinely sampled with two or three series of syringes (10 ml) at 4 cm intervals for geochemical and faunal studies. At some stations, sediment was sampled by 10 ml syringes at certain depths for sedimentological studies and shipped to USYD upon arrival at Darwin, Australia. All the core halves and the syringe series were shipped to MARUM.

Table 5.8 List of Gravity cores retrieved during R/V SONNE expedition SO-256. Geographical coordinates and water depths refer to "on ground" in Chapter 7.

GeoB	Gear	Latitude (S)	Longitude (E)	Water depth (m)	Recovery (cm)
22202-2	6 m	26°07.806'	153°59.365'	979	426
22207-1	6 m	26°02.997'	154°03.000'	2528	57
22211-1	3 m	23°17.846'	152°11.550'	222	empty
22211-2	3 m	23°17.847'	152°11.550'	221	296
22212-1	6 m	23°17.848'	152°14.292'	248	533
22213-1	6 m	23°17.854'	152°16.463'	268	529
22214-1	6 m	23°06.709'	152°42.433'	339	515
22216-1	9 m	22°44.726'	152°21.053'	121	74
22216-2	6 m	22°44.725'	152°21.052'	121	60
22218-1	9 m	20°54.479'	152°47.896'	356	843
22219-1	6 m	19°44.916'	150°30.880'	236	337
22220-1	9 m	17°41.869'	147°31.287'	1292	642
22222-3	6 m	17°17.702'	146°56.351'	1171	545
22223-1	6 m	16°41.747'	146°42.173'	1565	20
22224-1	6 m	16°39.774'	146°40.507'	1564	577
22227-2	12 m	15°22.927'	146°04.502'	2237	545
22228-1	12 m	15°26.980'	146°01.305'	2124	756
22229-1	12 m	15°27.713'	145°54.741'	1443	742
22230-1	12 m	15°26.471'	145°52.199'	968	648
22233-2	12 m	12°29.271'	143°51.574'	612	296
22234-2	9 m	12°24.592'	144°09.073'	2863	332
22235-1	6 m	12°30.179'	144°00.802'	2759	64
22236-1	6 m	12°29.272'	143°57.591'	2414	188

The core descriptions (Chapter 6) 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 by "smartCIS 1600 Line Scanner", a Schäfter+Kirchhoff Triple Line Scan Camera SK12240GKOC-LB equipped with a APO Rodagon lens 2Dx (1:4.5/f=75 mm) for 500 dpi and 1000 dpi resolution. The line scan software produces visual color images (BMP, TIF and JPG) but also color data in RGB and CIE-L*,a*,b*. During the R/V SONNE expedition SO-256, all gravity cores were scanned with 500 dpi resolution (see Chapter 6 for images).

In the core descriptions the lithological data are based on visual analysis of the core and 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 addition, the intensity of bioturbation together with specific features (turbidites, volcanic ash layers, plant debris, shell fragments, etc.) are indicated. Lightness and red/blue ratio are derived from the line scanning data and displayed next to the core images (see Chapter 6).

5.4.5 Shipboard Results

Working Area Fraser Slope

Stations GeoB 22202, 22204 and 22207

In the first working area Fraser slope, a MUC and two GCs were deployed at 969 and 2535 m water depth. The sediment recovered at station GeoB22202-2 (Fig. 6.2) is mainly a sandy foraminifera bearing mud. Overall, the sediment is moderately to strongly bioturbated. Recovery at station 22207-1 (Fig. 6.3) was only 57 cm because a very stiff mud clast between 4 and 44 cm core depth hampered a deeper penetration of the gravity corer. The sediment recovered with the GBC (GeoB22204-1) consists of coarse grained calcareous sand with some large coralline algae nodules and bryozoans.

Working Area Bunker/One Tree Reef

Stations GeoB 22210, 22211, 22212, and 22213

At the first station of the working area Bunker, a GBC was deployed at 86 m water depth. The recovered sediment consists of medium-to-coarse grained sand. At all three other stations in the working area Bunker, a GC was deployed. Sediments of the sediment cores taken from 211 m (GeoB22211-2, Fig. 6.4), 247 m (GeoB22212-1, Fig. 6.5) and 268 m (GeoB22213-1, Fig. 6.6) water depth are characterized by a high sand content in a dark gray to olive clay matrix, in which foraminifera are absent. Overall, the sediment is strongly bioturbated.

Working Area Capricorn Channel

Stations GeoB 22214, 22215, and 22216

In the working area Capricorn Channel, a GBC and three GCs were deployed. The sediment of the GC recovered from 339m water depth at GeoB22214-1 (Fig. 6.7) consists of 5.15 m sandy mud and fine-to-medium sand. The GBC deployment at GeoB22215 (water depth 121 m) recovered an olive gray mud and dark gray clay. The sediment is strongly bioturbated. The sediment at GeoB22215-1 (Fig. 6.8) is characterized by layers and patches of ooid sand, which were most likely formed in a shallow water environment during the last glacial lowstand in sea-level. GeoB22216-1 (Fig. 6.9) and GeoB22216-2 (Fig. 6.10) contain olive to dark olive nannofossil to foram bearing clayey sand.

Working Area Swains/Marion Plateau

Station GeoB22218

A 843 cm long core has been recovered from a water depth of 356 m. The sediment recovered at GeoB22218-1 (Fig. 6.11) is mainly a homogenous sandy mud with abundant foraminifera. The sediment is moderately bioturbated.

Working Area Hydrographer's Passage

Station GeoB22219

At GeoB22219, a 337 cm (GeoB22219-1, Fig. 6.12) long GC was recovered at 236 m water depth. The sediment is a pale olive to olive gray mud and moderately to strongly bioturbated.

Working Area South Queensland Trough and Gloria Knolls

Stations GeoB 22220 and 22222

In the working area South Queensland Trough and Gloria Knolls, two MUCs and two GCs were deployed. The recovered sediment is mainly composed of foraminifera bearing mud. The total length of Gravity core GeoB22220-1 (water depth 1294 m, Fig. 6.13) and GeoB22222-3 (water depth 1171 m, Fig. 6.14) is 642 cm and 545 cm, respectively. The sediment of GeoB22220-1 is characterized by two layers of olive sand, rich in planktic and benthic foraminifera, pteropods and quartz grains. The sandy layers are most likely turbidites, although no internal structures, such as a fining upward in grain size, are visible.

Working Area Central Queensland Trough

Stations GeoB 22223 and 22224

At GeoB22223-1 (water depth 1565 m) a GC was deployed (Fig. 6.15). The sediment consists of 20 cm olive yellow foraminifera bearing mud. At GeoB22224-1 (water depth 1566 m, Fig. 6.16), a GC deployment recovered 577 cm of sediment, which is mainly composed of pale olive to olive foraminifera bearing mud intercalated by sandy foraminifera bearing layers, most likely representing turbidites.

Working Area Ribbon Reefs

Stations GeoB 22227, 22228, 22229, and 22230

In the working area Ribbon Reefs a total of 3 MUCs and 4 GCs were deployed. At GeoB22227-2 (Fig. 6.17), a 554 cm long sediment core was recovered from a water depth of 2242 m. The sediment is a pale olive to dark olive gray mud intercalated by sandy foraminifera bearing layers, most likely turbidites. The sediment is moderately to strongly bioturbated. A MUC (GeoB22227-1) recovered 35 cm pale olive foraminifera bearing mud. The sediment recovered at GeoB22228-1 (Fig. 6.18) from 2122 m water depth is composed of foraminifera bearing mud with numerous cm-scale sandy intercalations (turbidites). A 742 cm long sediment core (GeoB22229-1, Fig. 6.19) was recovered from 1447 m water depth, mainly composed of olive to olive gray foraminifera bearing mud. The sediment succession recovered at GeoB22230-1 from 970 m water depth (Fig. 6.20) is composed of olive foraminifera bearing mud with few sandy layers.

Working Area Cape York

Stations GeoB 22233, 22234, 22235, and 22236

In the working area Cape York, a total of two MUCs and four GCs were deployed in water depths between 614 m and 2861 m. The sediment in the gravity core GeoB22233-2 (Fig. 6.21) is olive-gray clayey fine sand. Sediment core GeoB22234-2 (Fig. 6.22) consists of 332 cm yellowish brown-olive bearing mud intercalated by a few sandy layers (planktic and benthic foraminifera, pteropods, quartz grains). The recovered sediment of the two gravity cores GeoB22235-1 (Fig. 6.23) and GeoB22236-1 (Fig. 6.24) mainly consist of 64 cm and 188 cm olive foraminifera bearing mud, respectively.

6 Core Descriptions

(Boehnert, Hollstein, Steinke)

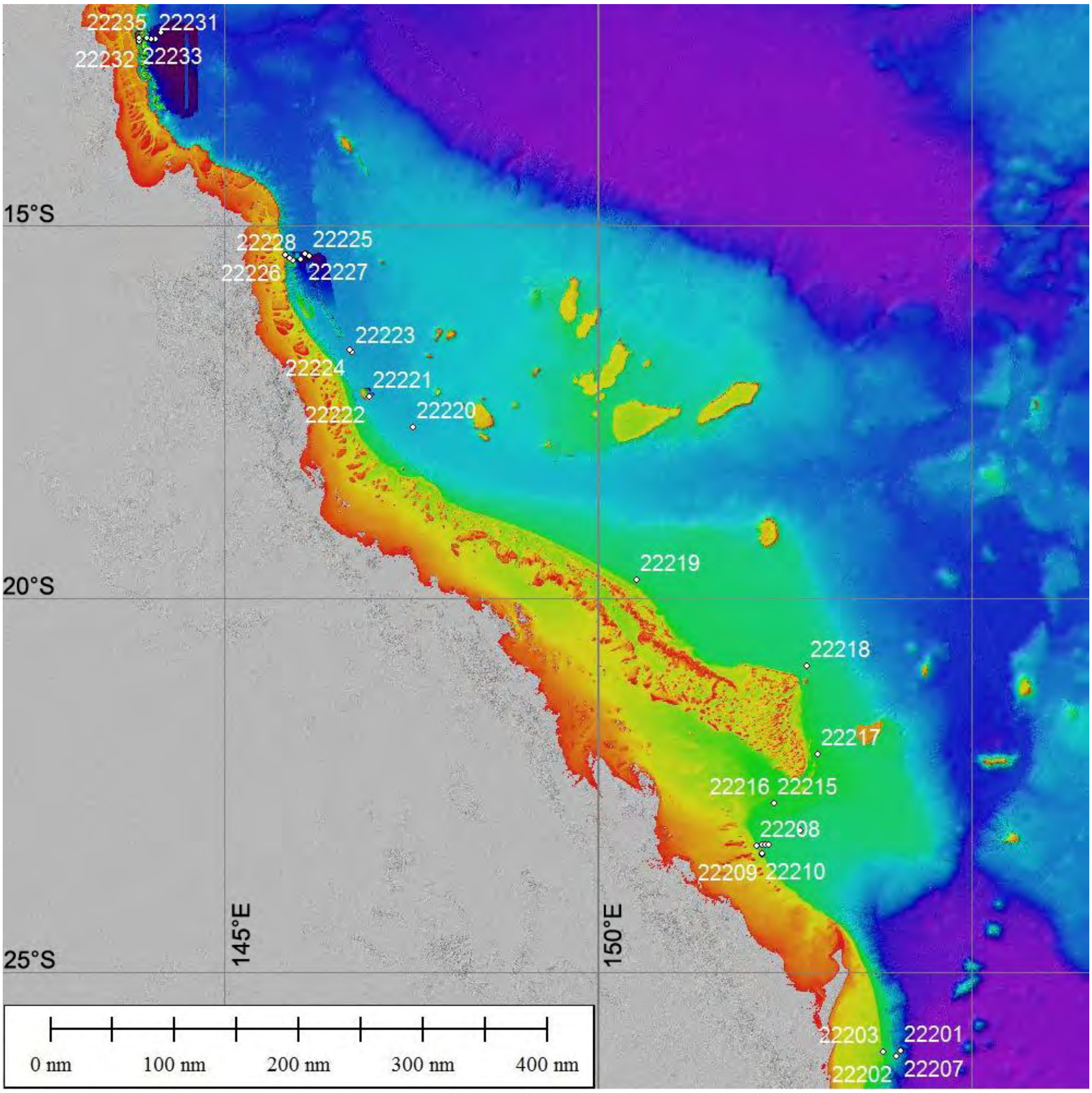
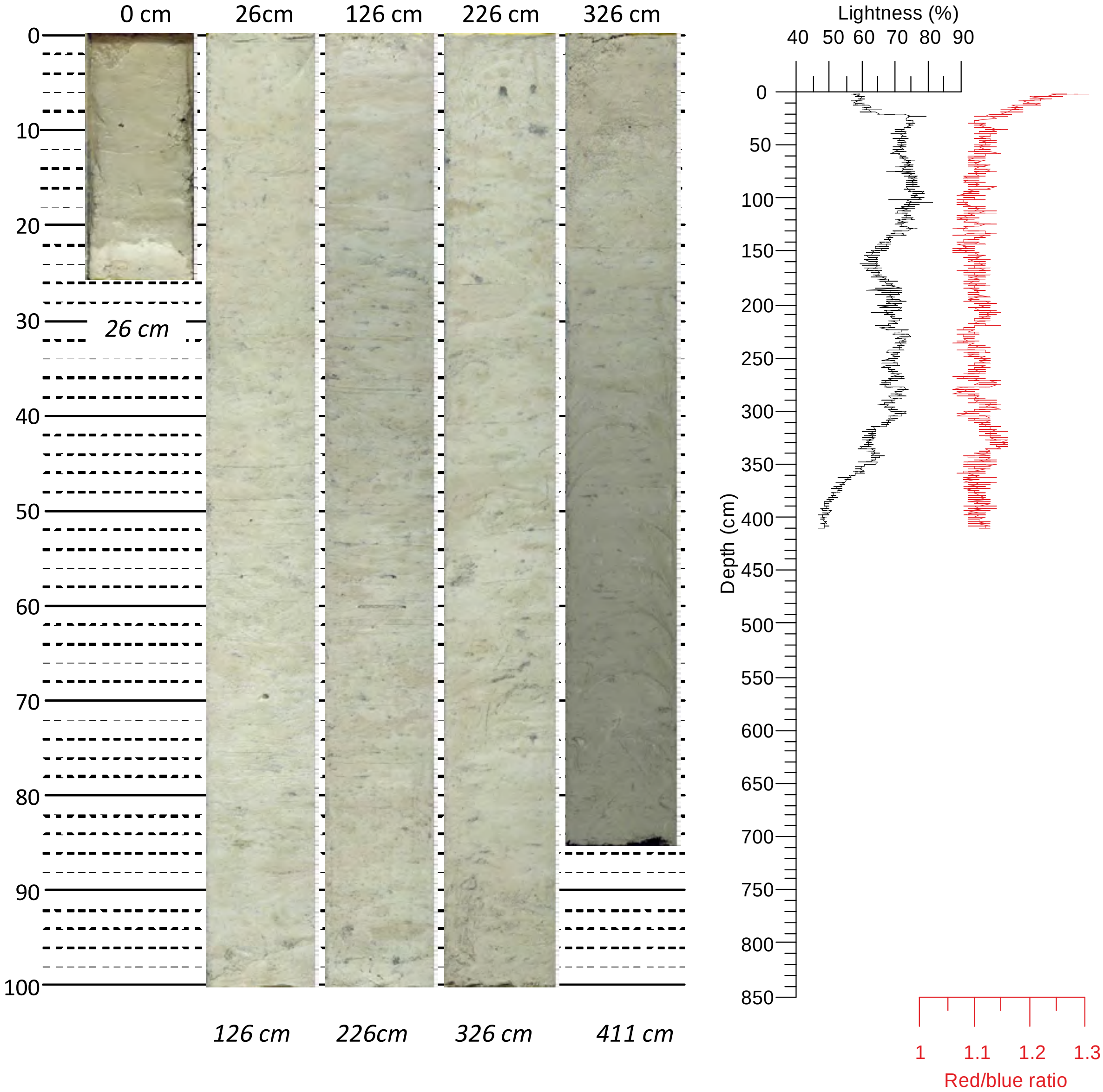


Fig. 6.1 Bathymerty map of the study area with the GeoB stations indicated by white dots.

GeoB 22202-2 Date: 21.04.17 Pos: 26°07.818' S 153°59.366' E
Water Depth: 975 m Core Length: 411 cm

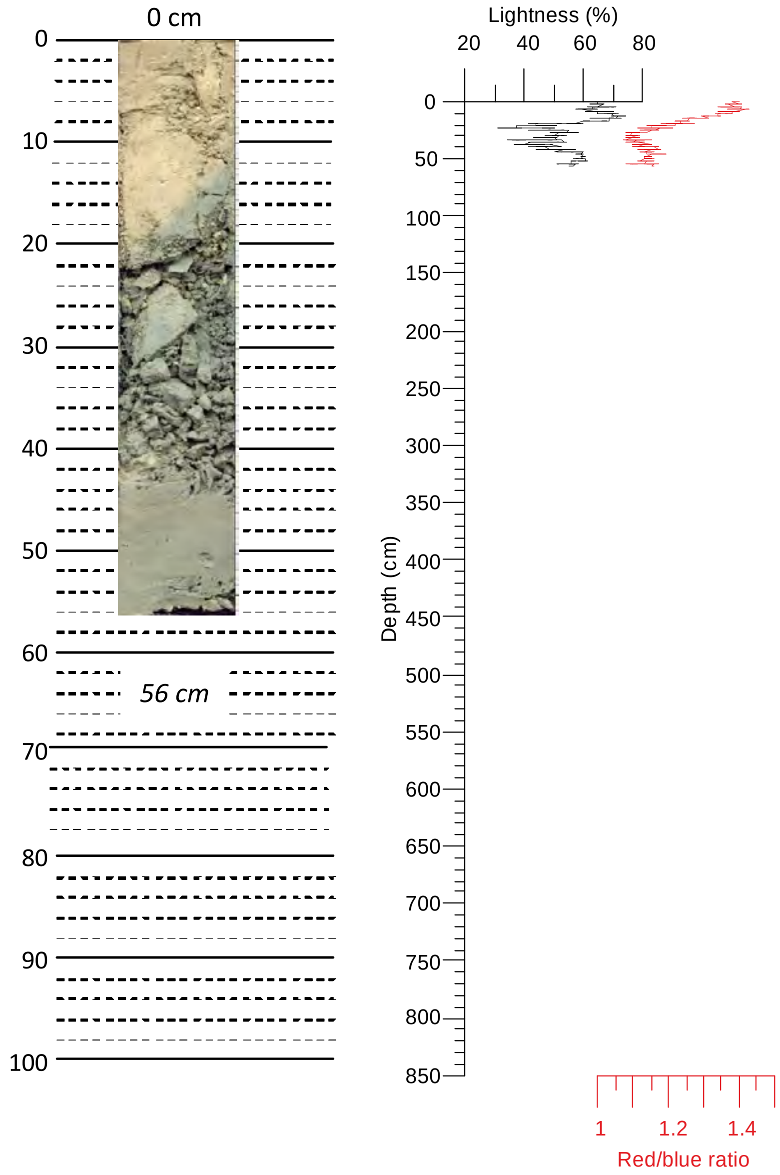


Lithology

0-2 cm: Light olive brown (2.5Y5/6) nannofossil mud rich in plankt. forams and minerals (quartz, feldspar); oxidized top layer
2-22/23 cm: Light olive brown (2.5Y5/3) nannofossil mud rich in plankt. forams and minerals (quartz, feldspar)
22/23-26 cm: Light brownish gray (10YR6/2) nannofossil ooze with abundant plankt. forams
26-126 cm: Light brownish gray (10YR6/2) nannofossil ooze (Mn-precipitates are abundant)
126-226 cm: Light brownish gray (10YR6/2) nannofossil ooze with pockets of sand (plankt. and benthic forams) and ntercalations of light yellowish brown (10YR6/4) nannofossil mud indicative of bioturbation
226-316 cm: Light brownish gray (10YR6/2) nannofossil ooze with intercalations of light yellowish brown (10YR6/4) nannofossil mud indicative of bioturbation
316-348 cm: Olive brown (2.5Y4/3) clayey-silty fine sand consisting of plank. and benthic forams, quartz and feldspar grains, sponge spicules; the fine–grained matrix consists of nannofossils and clay minerals
348-371 cm: Light brownish gray (10YR6/2) nannofossil mud
371-411 cm: Dark gray (2.5Y4/1) nannofossil mud

Fig. 6.2 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22202-2.

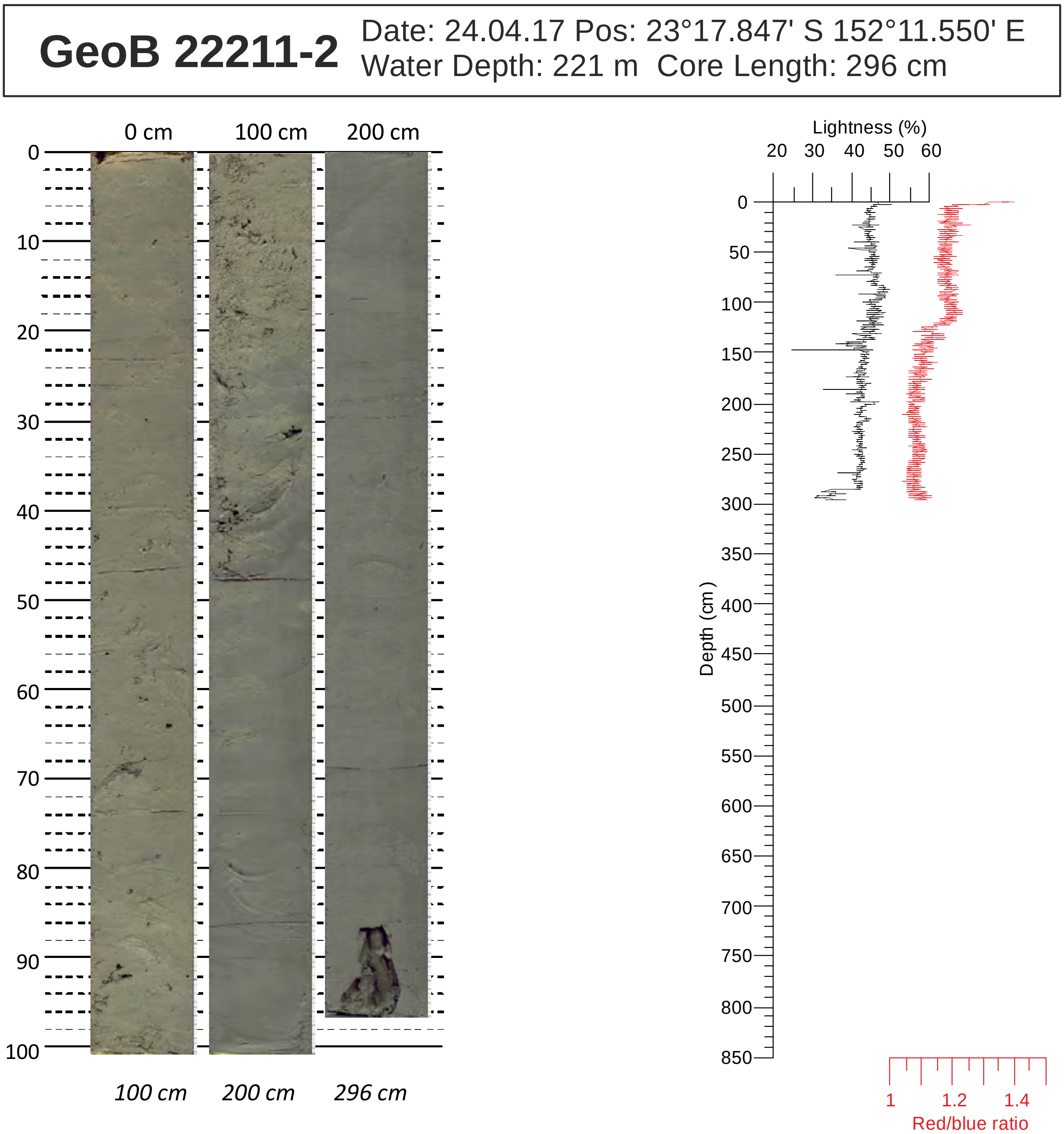
GeoB 22207-1 Date: 22.04.17 Pos: 26°02.997' S 154°03.000' E
Water Depth: 2535 m Core Length: 56 cm



Lithology

0-4 cm: Light brownish gray (10YR6/2) nannofossil mud
4-12/20 cm: Light brownish gray (2.5Y6/2) nannofossil mud - mudclast (very stiff)
12/20-44 cm: Olive (5Y4/3) nannofossil mud – mudclast (very stiff)
44-57 cm: Olive (5Y4/3) nannofossil mud with rare plankt. and benthic forams

Fig. 6.3 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22207-1.

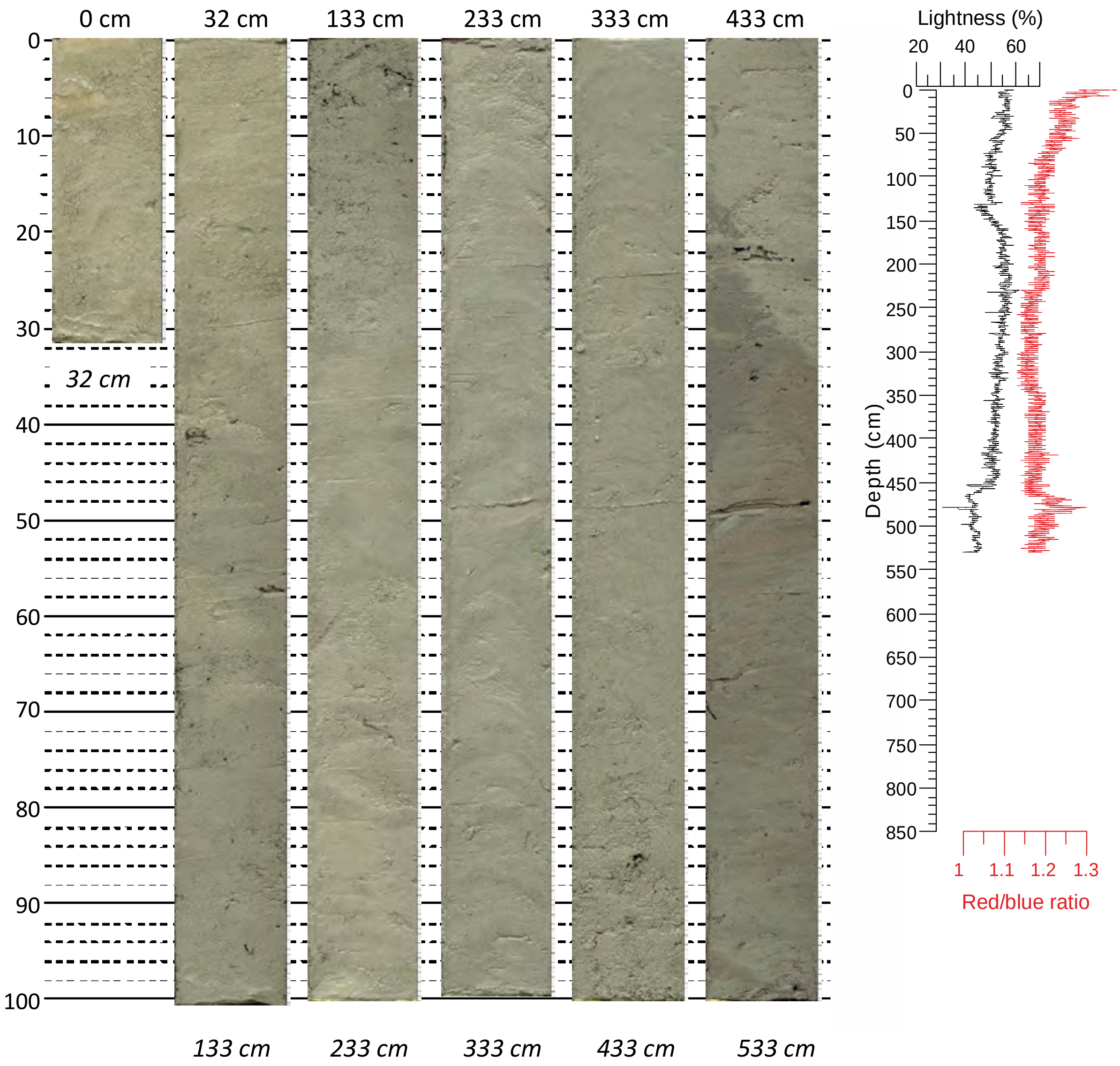


Lithology

0-2 cm: Light olive brown (2.5Y5/4) nannofossil-bearing mud with sandy patches of forams and mineral grains (oxidized top layer)
2-98 cm: Dark gray (5Y4/1) nannofossil-bearing mud with sandy patches of forams and mineral grains (strongly bioturbated); the fine-grained matrix consists of nannofossils and clay minerals
98-122 cm: Dark gray (5Y4/1) clayey-silty sand consisting of plankt. and benthic forams, mineral grains
122-296 cm: Dark gray (5Y4/1) nannofossil-bearing mud
122-181 cm: Dark gray (5Y4/1) nannofossil-bearing mud with abundant sandy patches (strongly bioturbated)
181-296 cm: Dark gray (5Y4/1) nannofossil-bearing mud

Fig. 6.4 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22211-2.

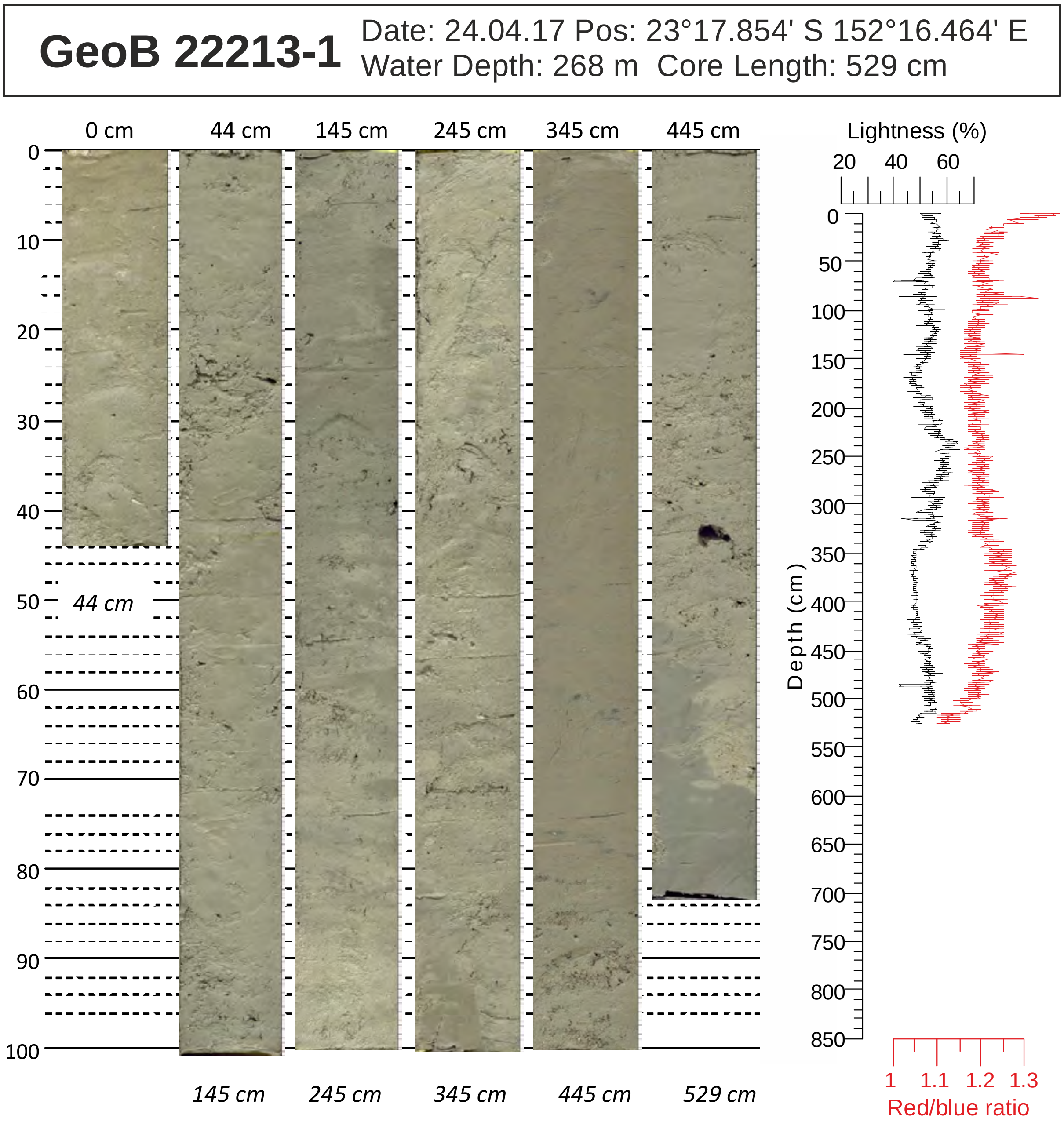
GeoB 22212-1 Date: 24.04.17 Pos: 23°17.848' S 152°14.290' E
Water Depth: 247 m Core Length: 533 cm



Lithology

0-450/465 cm: Olive (5Y4/3) clayey-silty fine-to-medium sand consisting of mineral grains, plankt. and benthic forams; mollusk fragments are common. The fine grained matrix consists of nannofossils and clay minerals.
450/465 cm: erosive contact
450/465-533 cm: Very dark gray (5Y3/1) nannofossil-bearing mud

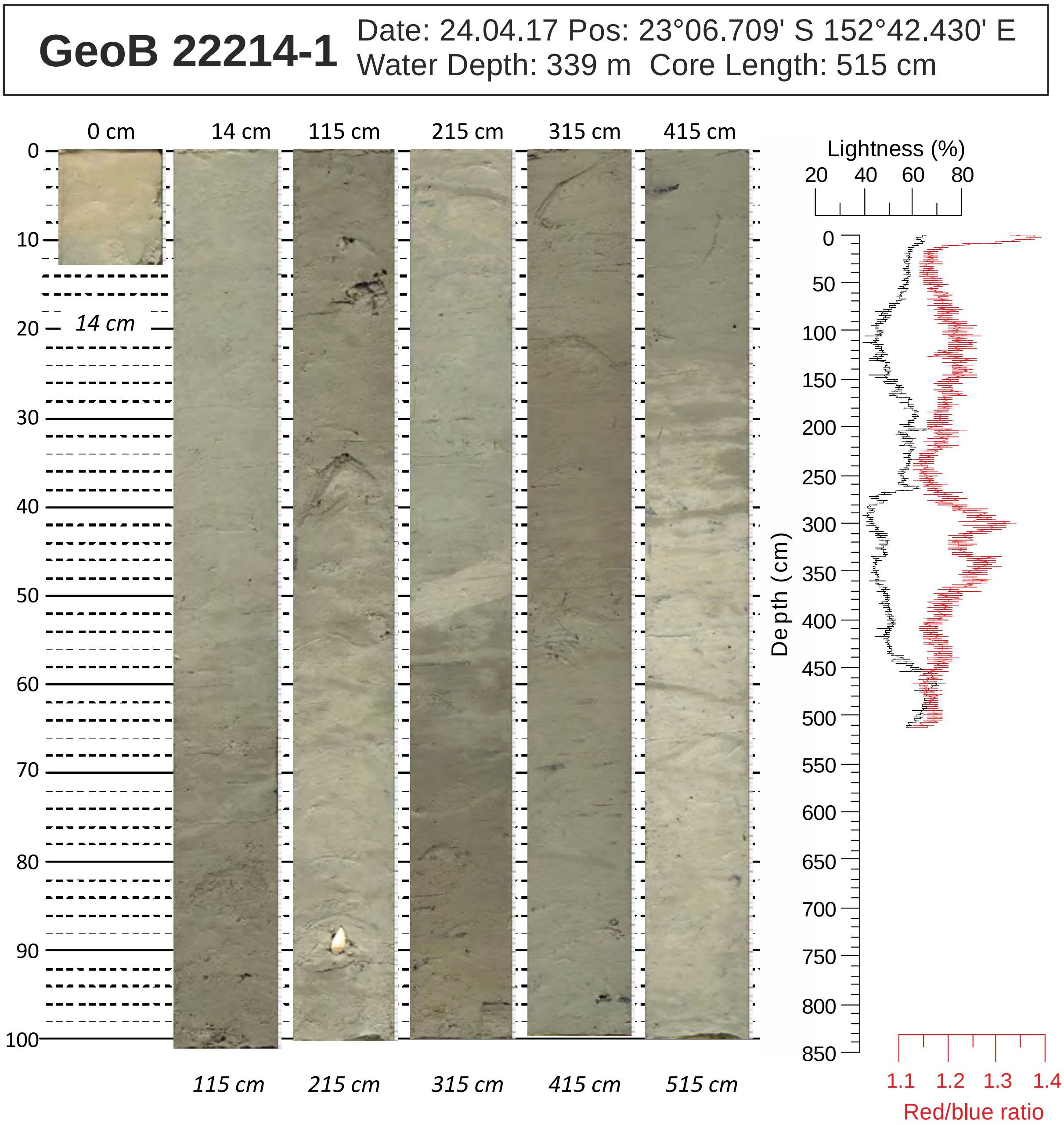
Fig. 6.5 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22212-1.



Lithology

0-145 cm: Olive (5Y4/3) clayey fine-to-medium sand consisting of plankt. and benthic forams and mineral grains (dominantly quartz), mollusk shell fragments are common. The fine grained maxtrix is composed of nannofossils
145-230 cm: Dark olive gray (5Y3/2) nannofossil mud with intercalations of olive clayey sand indicative of strong bioturbation
230-331 cm: Olive (5Y4/3) clayey fine-to-medium sand consisting of of plankt. and benthic forams and mineral grains (dominantly quartz), shell fragments are common, the fine grained maxtrix is composed of nannofossils and clay minerals
331-430 cm: Dark olive gray (5Y3/2) nannofossil ooze
430-498 cm: Dark olive gray (5Y3/2) nannofossil ooze with intercalations/patches of olive clayey sand (dominantly mineral grains)
486-515 cm: Mollusk shell
498-515 cm: Olive (5Y4/3) clayey fine-to-medium sand (plankt. and benthic forams and mineral grains; dominantly quartz)
515-529 cm: Dark olive gray (5Y3/2) nannofossil-bearing mud

Fig. 6.6 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22213-1.

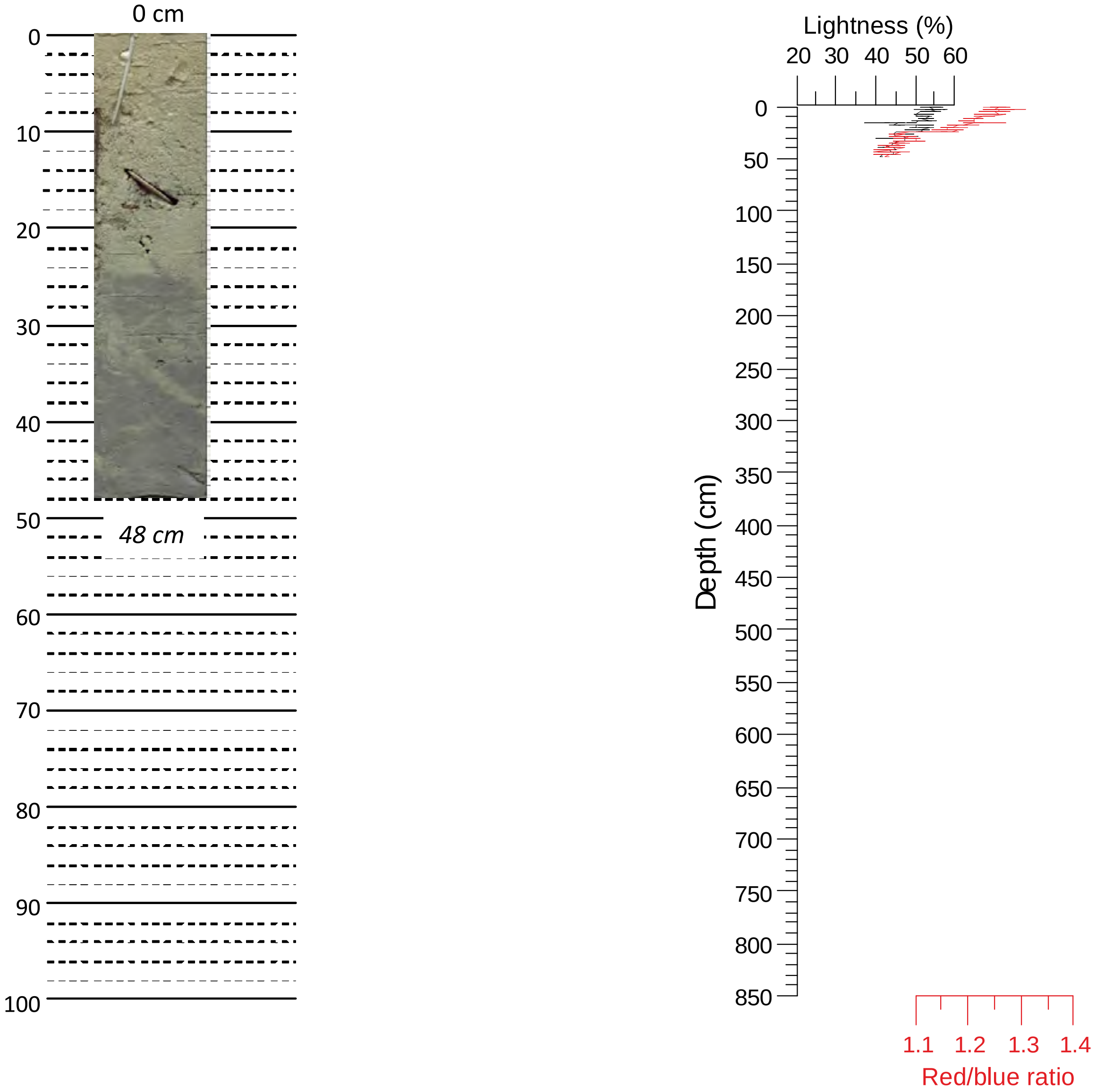


Lithology

0-9 cm: Light olive brown (2.5Y5/4) nannofossil-bearing mud with mineral grains of silt-to-fine sand grain size (oxidized top layer)
9-75 cm: Olive (5Y5/3) nannofossil-bearing mud with mineral grains of fine sand grain size
75-150 cm: Dark gray (5Y4/1) nannofossil-bearing mud with abundant mineral grains and plankt. forams; mollusk fragments at 125 cm and 131 cm
150-259 cm: Olive (5Y5/3) nannofossil-bearing mud with intercalations of dark gray clay consisting of nannofossils and clay minerals
160/165-163/168 cm: Light olive brown (2.5Y5/4) clayey fine sand (burrow); the fine grained matrix is dominantly composed of nannofossils
259-442 cm: Dark gray (5Y4/1) nannofossil-bearing mud with mineral grains of silt-to-fine sand grain size
442-515 cm: Olive (5Y5/3) nannofossil-bearing mud with mineral grains of silt-to-fine sand grain size

Fig. 6.7 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22214-1.

GeoB 22215-1 Date: 24.04.17 Pos: 22°44.727' S 152°21.055' E
Water Depth: 121 m Core Length: 48 cm

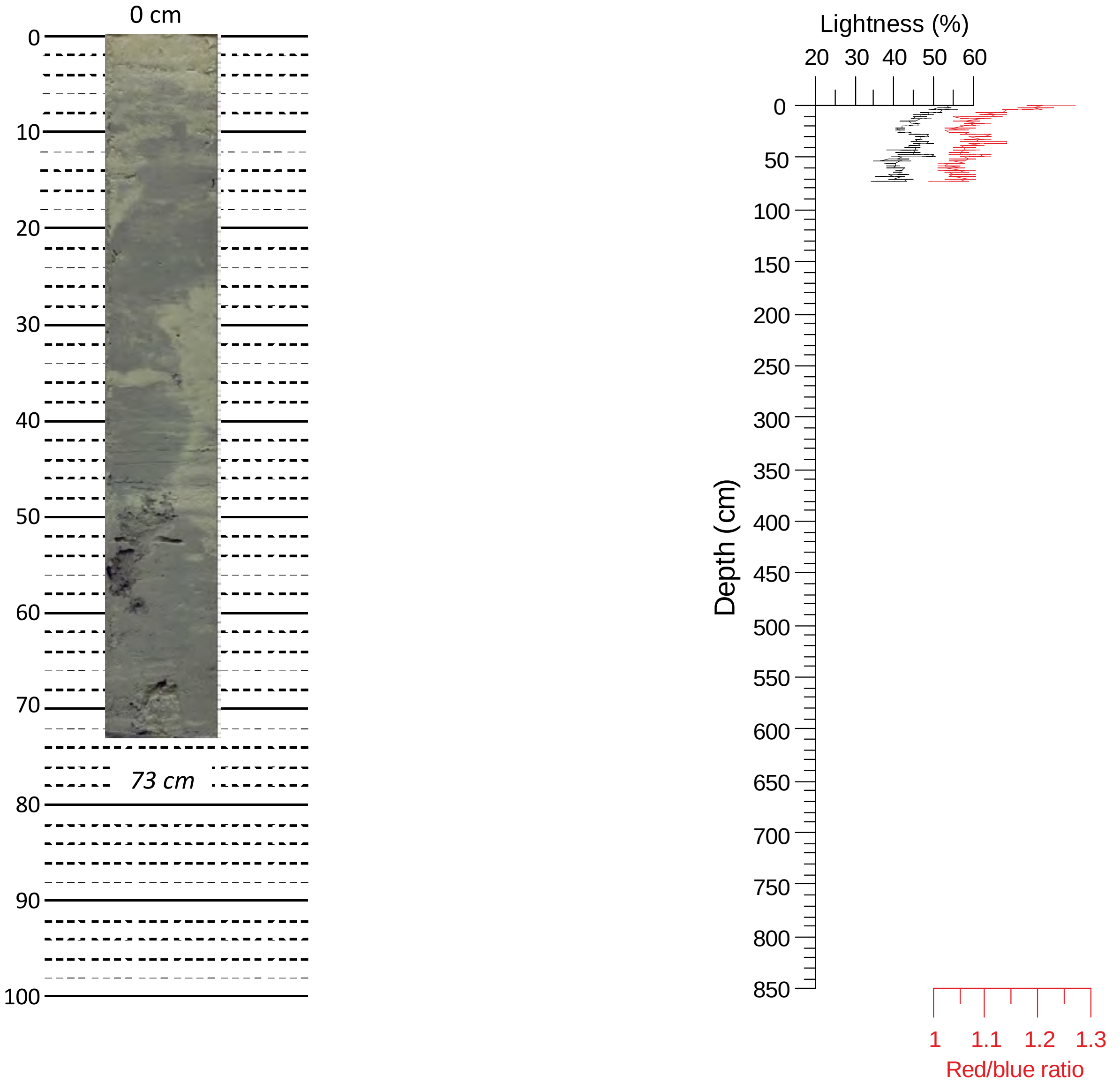


Lithology

0-26 cm: Olive gray (5Y5/3) nannofossil-bearing mud with abundant mineral grains
0-10 cm: Scaphopoda covered by a barnacle
15-18 cm: Urchin (“sand dollar”)
26-48 cm: Dark gray (5Y4/1) nannofossil-bearing mud with bioturbation traces of olive gray (5Y5/2) clay

Fig. 6.8 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22215-1.

GeoB 22216-1 Date: 24.04.17 Pos: 22°44.725' S 152°21.051' E
Water Depth: 121 m Core Length: 73 cm

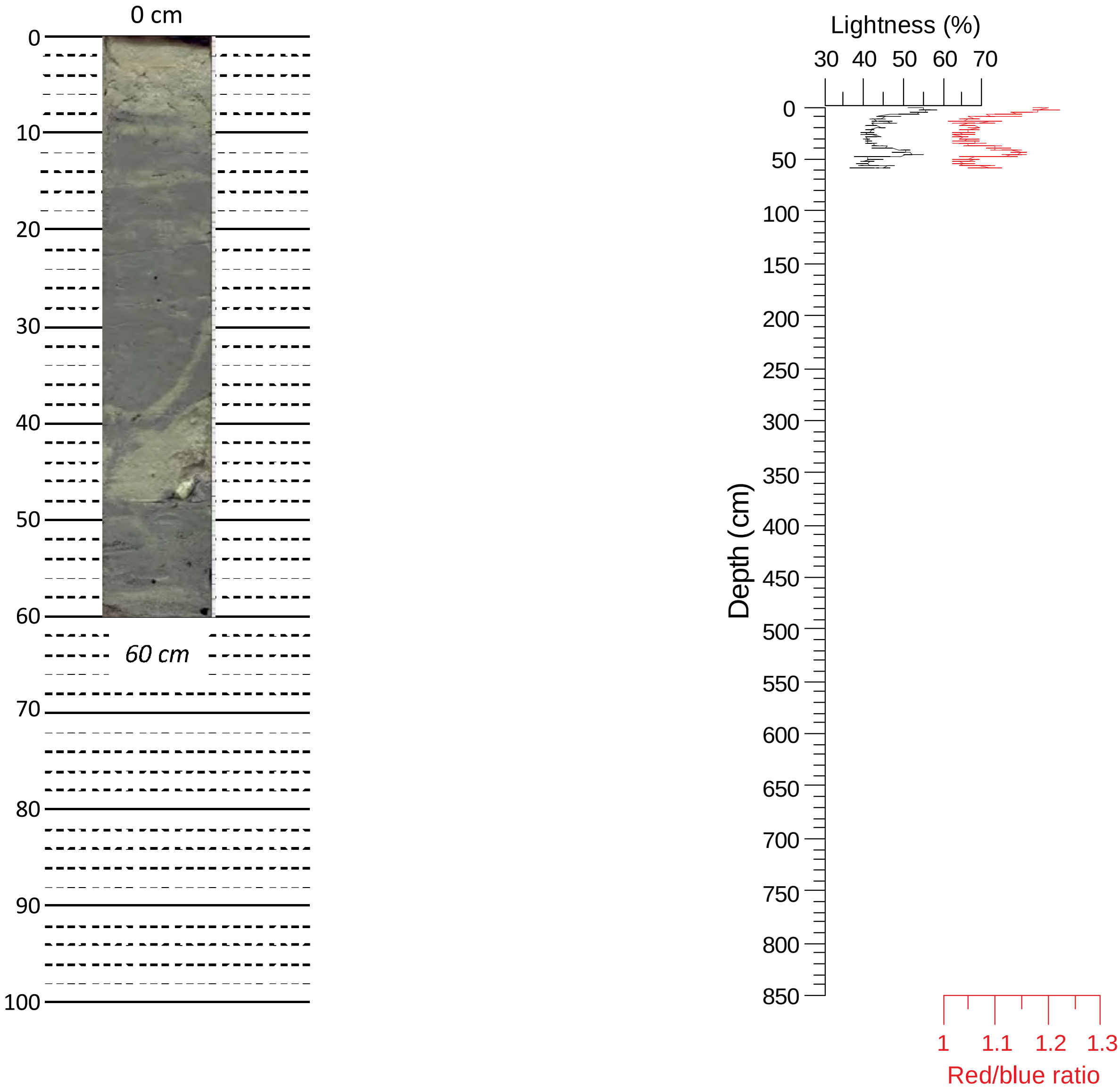


Lithology

0-6 cm: Olive (5Y5/3) clayey sand rich in benthic forams, calcareous debris and sponge spicules. The fine grained matrix consists of nannofossils.
3.5-4 cm: Dark sandy layer rich in benthic forams and calcareous debris
6-74 cm: Dark olive gray (5Y3/2) nannofossil-bearing mud with patches of olive (5Y5/3) clayey sand rich in calcareous fragments and olive (5Y5/3) sandy clay indicative of strong bioturbation and very dark gray (5Y3/1) patches of ooid sand.
55-59 cm: Mollusk fragment covered by barnacles

Fig. 6.9 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22216-1.

GeoB 22216-2 Date: 24.04.17 Pos: 22°44.725' S 152°21.052' E
Water Depth: 121 m Core Length: 60 cm

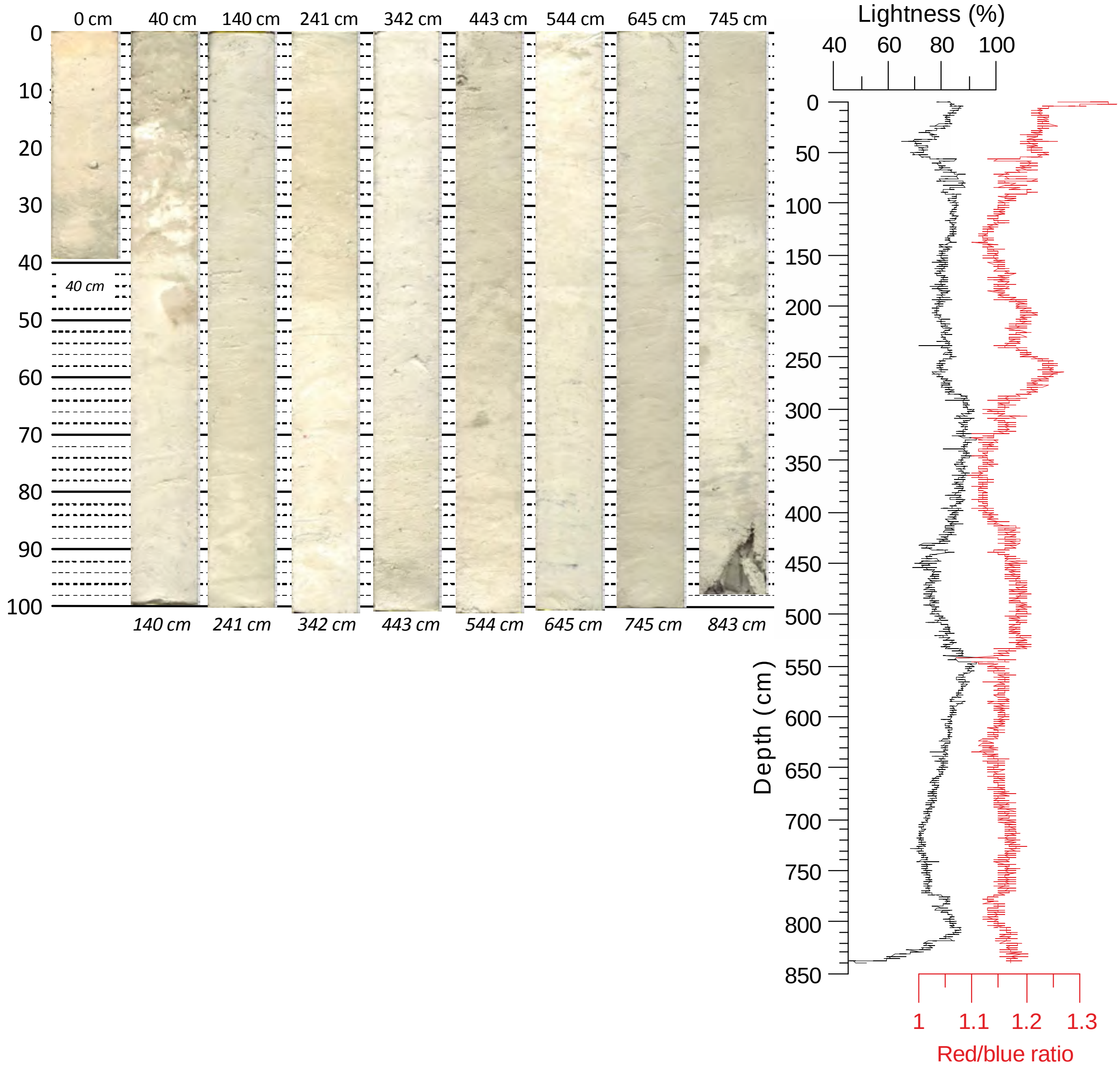


Lithology

0-8 cm: Olive (5Y5/3) clayey sand rich in plankt. and benthic forams and siliciclastic components; quartz grains are dominant. The fine grained matrix consists of nannofossils
8-10 cm: Dark layers of ooid sand
10-37/45 cm: Dark olive gray (5Y3/2) nannofossil-bearing mud, strongly bioturbated
37/45-48 cm: Mollusk fragment
48-60 cm: Dark olive gray (5Y3/2) clayey sand consisting of quartz and feldspar mineral grains, bryozoans, plankt. and benthic forams and patches of ooid sand

Fig. 6.10 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22216-2.

GeoB 22218-1	Date: 25.04.17 Pos: 20°54.479' S 152°47.898' E Water Depth: 356 m Core Length: 843 cm

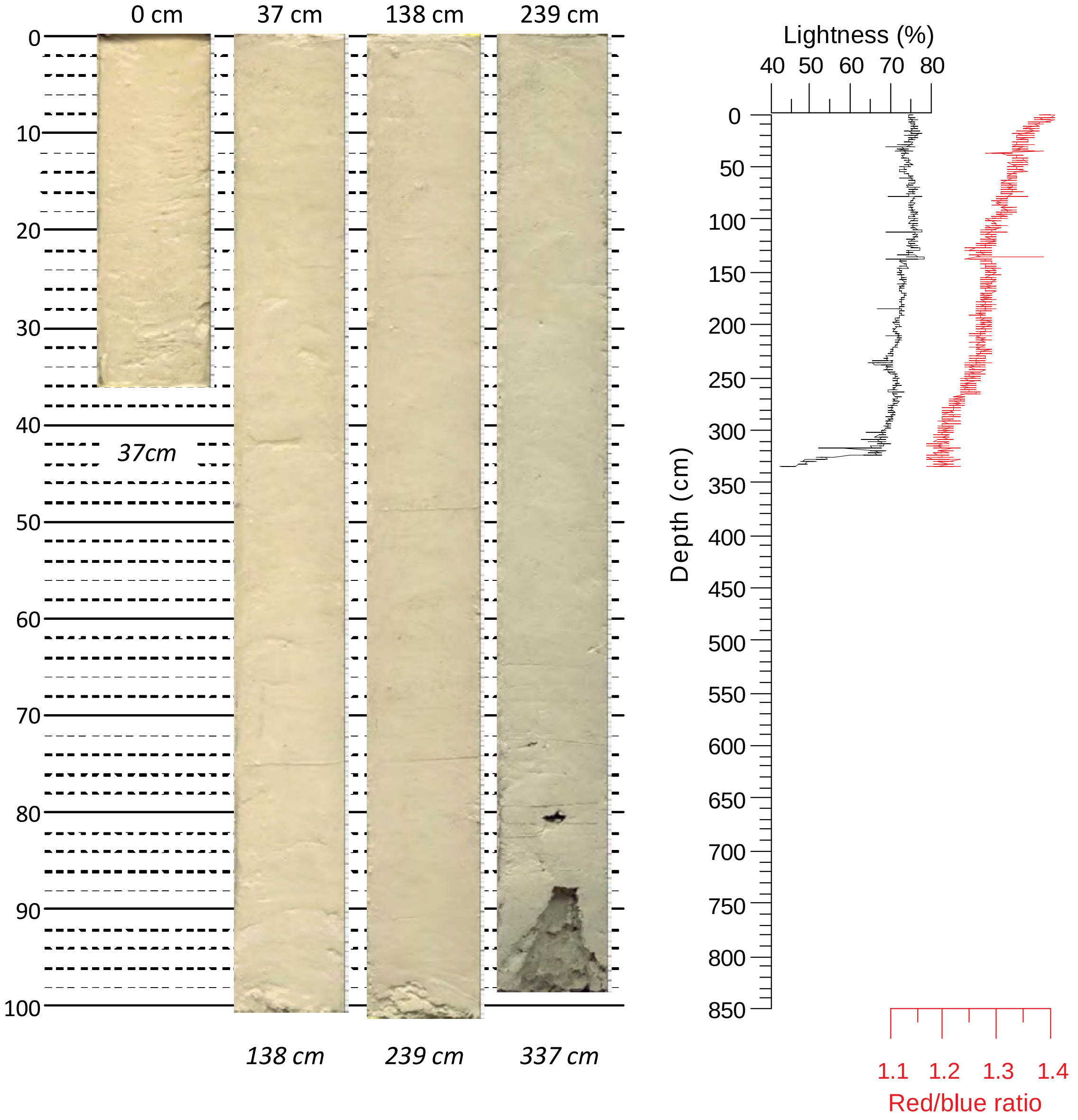


Lithology

0-3 cm: Light olive brown (2.5Y5/4) nannofoosil ooze (oxidized top layer)
3-28 cm: Pale olive (5Y6/3) nannofossil-bearing mud rich in plankt. forams
28-56 cm: Olive gray (5Y4/2) nannofossil-bearing mud with abundant plankt. forams and calcareous debris.Traces of bioturbation at 29-40 cm and 58-90 cm
56-435 cm: Pale olive (5Y6/3) nannofossil ooze rich in plankt. forams
435-535 cm: Olive gray (5Y5/2) nannofossil ooze rich in plankt. forams with clayey-to-sandy patches of plankt. forams (fine grained matrix consists of nannofossils)
535-794 cm: Pale olive (5Y6/3) nannofossil ooze rich in plankt. forams
794-843 cm: Pale yellow (5Y7/3) nannofossil ooze rich in plankt. forams with intercalations of pale olive (5Y6/3) plankt. forams-bearing nannofossil ooze

Fig. 6.11 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22218-1.

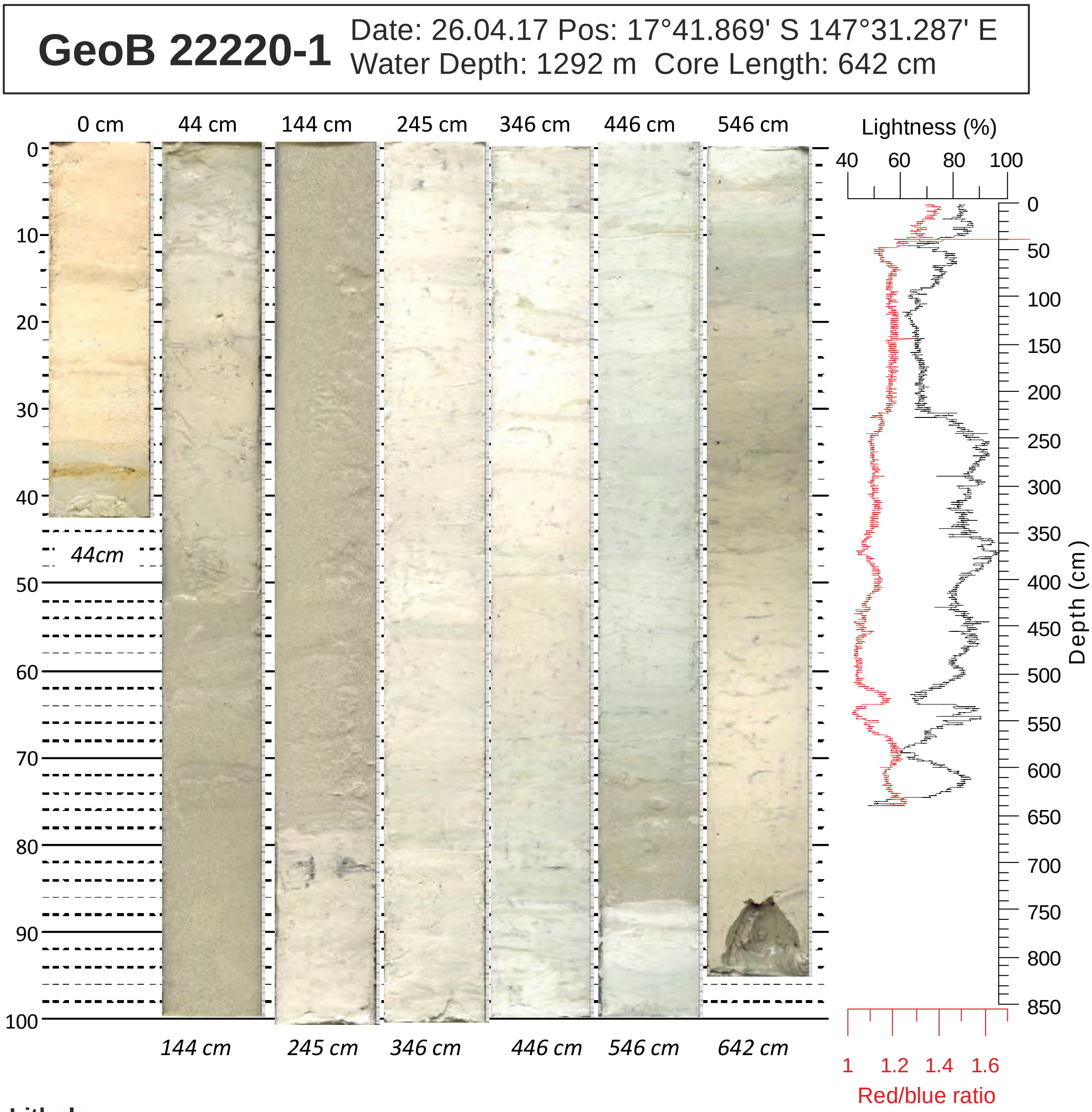
GeoB 22219-1 Date: 26.04.17 Pos: 19°44.916' S 150°30.880' E
Water Depth: 236 m Core Length: 337 cm



Lithology

0-285/300 cm: Pale olive (5Y6/3) nannofossil ooze rich in plankt. forams and mineral grains
285-300 cm: Gradual transition from pale olive (5Y6/3) to olive gray (5Y5/2) nannofossil ooze
285/300-337 cm: Olive gray (5Y5/2) nannofossil ooze rich in plankt. forams
319-321 cm: Undefined calcareous concretion

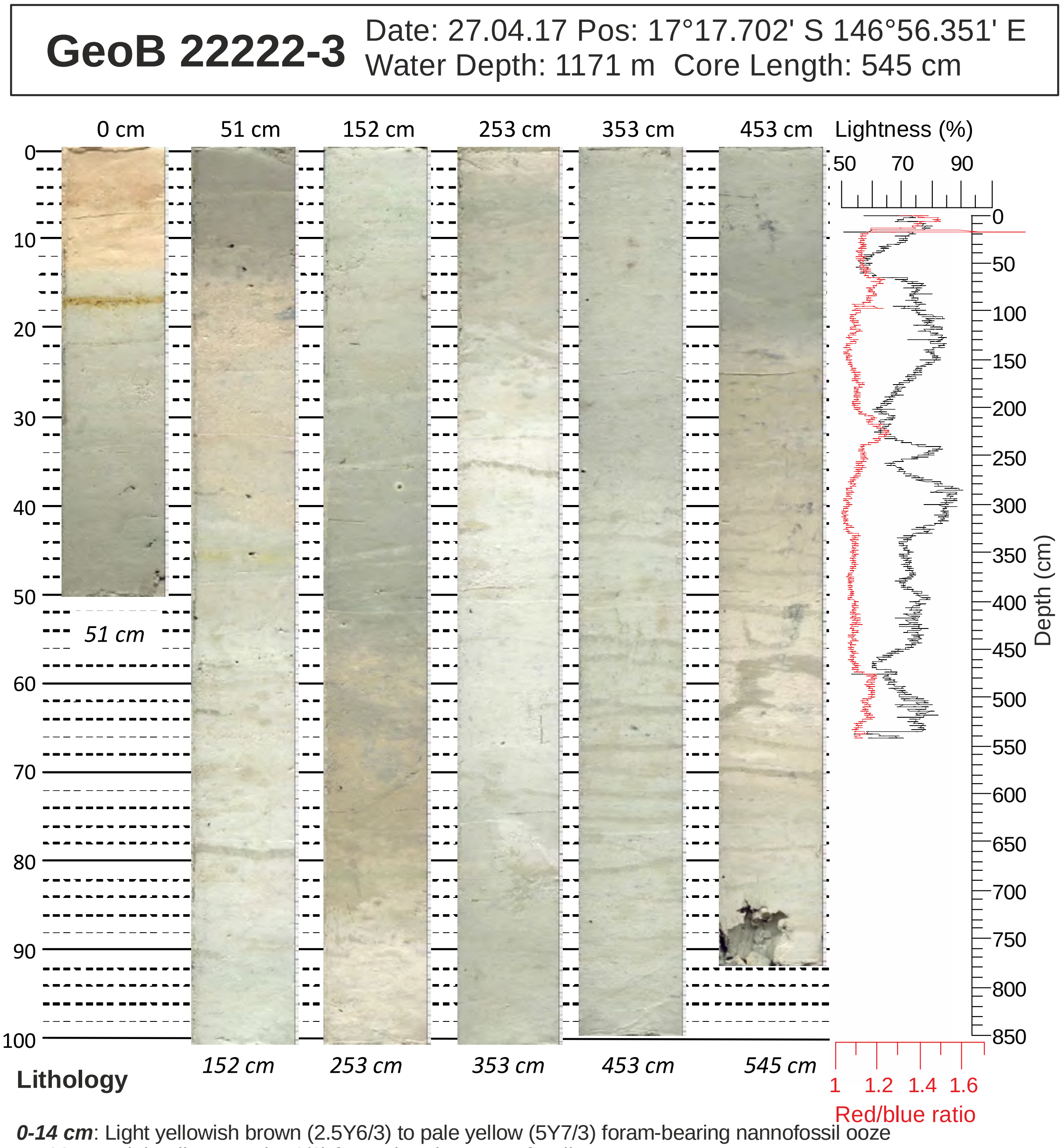
Fig. 6.12 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22219-1.



Lithology

0-15 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil ooze
15-17 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
17-35 cm: Pale yellow (2.5Y7/3) foram-bearing nannofossil ooze
25.5-26 cm** and **27-28 cm: Layers of olive (5Y5/4) mud
35-51 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
38-39 cm: Yellowish brown nannofossil ooze rich in plankt. forams
51-96 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
96-213 cm: Olive sand (plankt. and benthic forams, pteropods, quartz grains)
213 cm: erosive contact
213-519 cm: Light olive gray (5Y6/3) foraminifera-bearing nannofossil ooze
519-533 cm: Olive sand (plankt. and benthic forams, pterpods, quartz grains)
533-555 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
555-563 cm: Olive gray (5Y5/2) foram-bearing nannofossil ooze
563-592 cm: Olive (5Y4/2) foram-bearing nannofossil ooze
592-642 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze

Fig. 6.13 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22220-1.

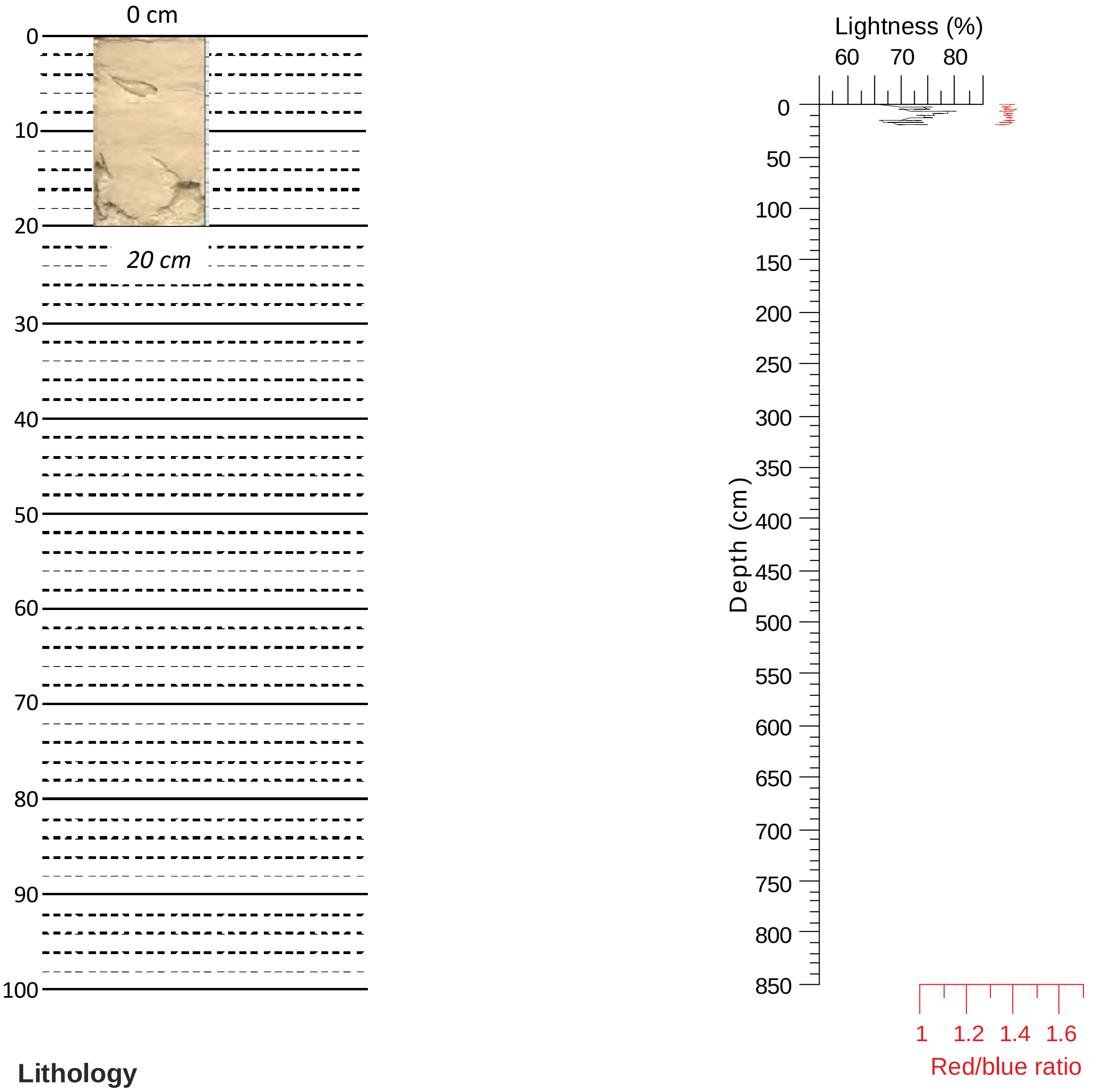


Lithology

0-14 cm: Light yellowish brown (2.5Y6/3) to pale yellow (5Y7/3) foram-bearing nannofossil ooze
14-33 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
17-18 cm: Yellowish brown (10YR5/6) layer of mud
33-62 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
62-93 cm: Pale yellow (2.5Y7/4) foram-bearing nannofossil ooze
93-183 cm: Light gray (5Y7/1) foram-bearing nannofossil ooze
183-210 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
210-240 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil ooze
240-254 cm: Light gray (5Y7/1) foram-bearing nannofossil ooze
254-274 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
274-326 cm: Light gray (5Y7/1) foram-bearing nannofossil ooze
326-390 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
390-450 cm: Light gray (5Y7/1) foram-bearing nannofossil ooze
450-474 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
474-504 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
504-525 cm: Light gray (5Y7/1) foram-bearing nannofossil ooze
525-545 cm: Light olive gray (5Y6/3) foram-bearing nannofossil ooze
Sedimentary succession is strongly bioturbated

Fig. 6.14 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22222-3.

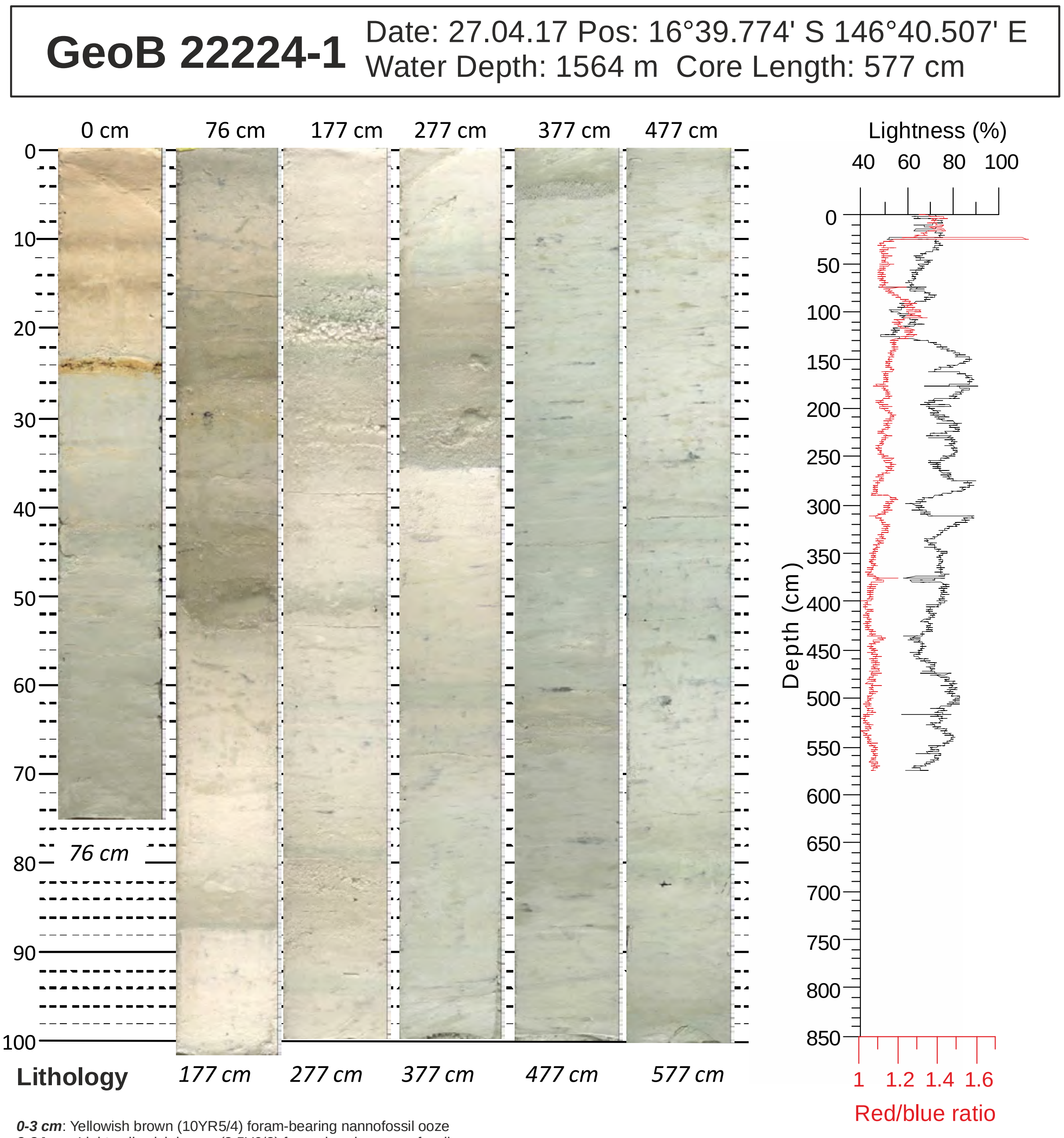
GeoB 22223-1 Date: 27.04.17 Pos: 16°41.747' S 146°42.173' E
Water Depth: 1565 m Core Length: 20 cm



Lithology

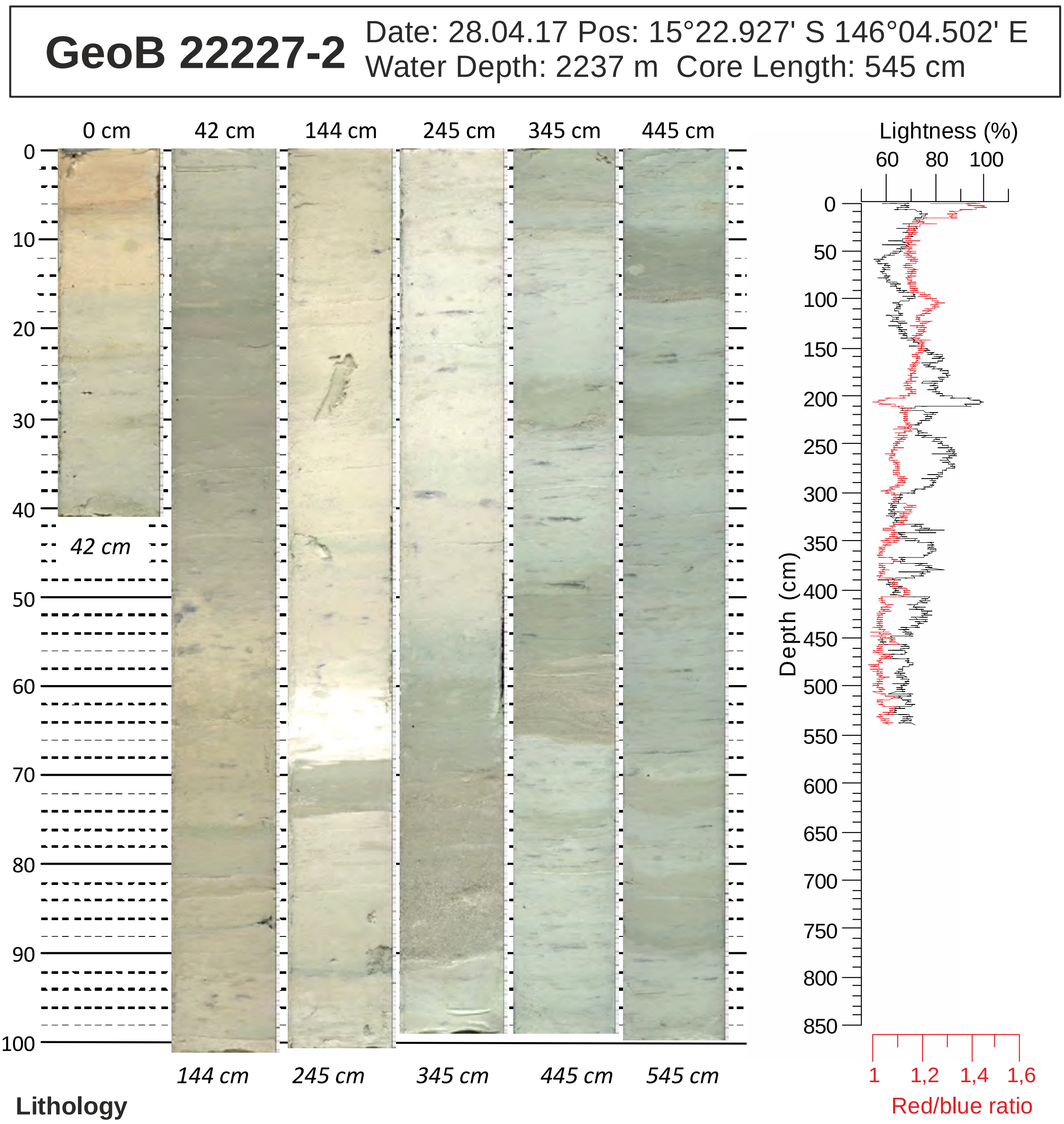
0-20 cm: Olive yellow (2.5Y6/6) foram-bearing nannofossil ooze

Fig. 6.15 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22223-1.



0-3 cm: Yellowish brown (10YR5/4) foram-bearing nannofossil ooze
3-24 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil ooze
Layers of dark grayish brown (10YR5/8) foram-bearing nannofossil ooze at 10-11.5 cm and 15-17 cm
24-26 cm: Yellowish brown (10YR5/4) nannofossil-bearing mud with abundant yellowish brown unidentified mineral particles (Fe-oxydes?)
26-79 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
79-93 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
93-103 cm: Olive (5Y5/3) sandy layer of dominantly forams, pteropods, quartz and feldspar mineral grains
103-106 cm: Light olive gray (5Y6/3) sandy layer of forams, pteropods, quartz and feldspar mineral grains
106-118/119 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
118/119-130 cm: Olive (5Y5/3) sandy layer of dominantly forams and pteropods
130-157/159 cm: Pale yellow (5Y7/3) foram-bearing nannofossil ooze
157/159-163 cm: Olive (5Y5/3) sandy layer of dominantly forams and pteropods
163-188/189 cm: Light gray (5Y6/2) foram-bearing nannofossil ooze
188/189-214 cm: Light olive gray (5Y6/2) sandy layer of dominantly forams and pteropods
196-200 cm: Layer rich in pteropods
214-257 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
257-265 cm: Olive (5Y5/3) sandy layer of dominantly forams and pteropod
265-293 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
293-313 cm: Olive (5Y5/3) sandy layer rich in forams and mineral grains (graded, turbidite?)
313-330 cm: ca. 330 cm transition from light olive gray (5Y6/2) to olive (5Y5/4) foram-bearing nannofossil ooze
330-381 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
381-383 cm: Olive (5Y5/3) sandy layer rich in forams and mineral grains
383-441 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
441-443 cm: Olive (5Y5/3) silty-to-sandy layer rich in forams and mineral grains
443-557 cm: Olive (5Y5/3) foram-bearing nannofossil ooze

Fig. 6.16 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22224-1.

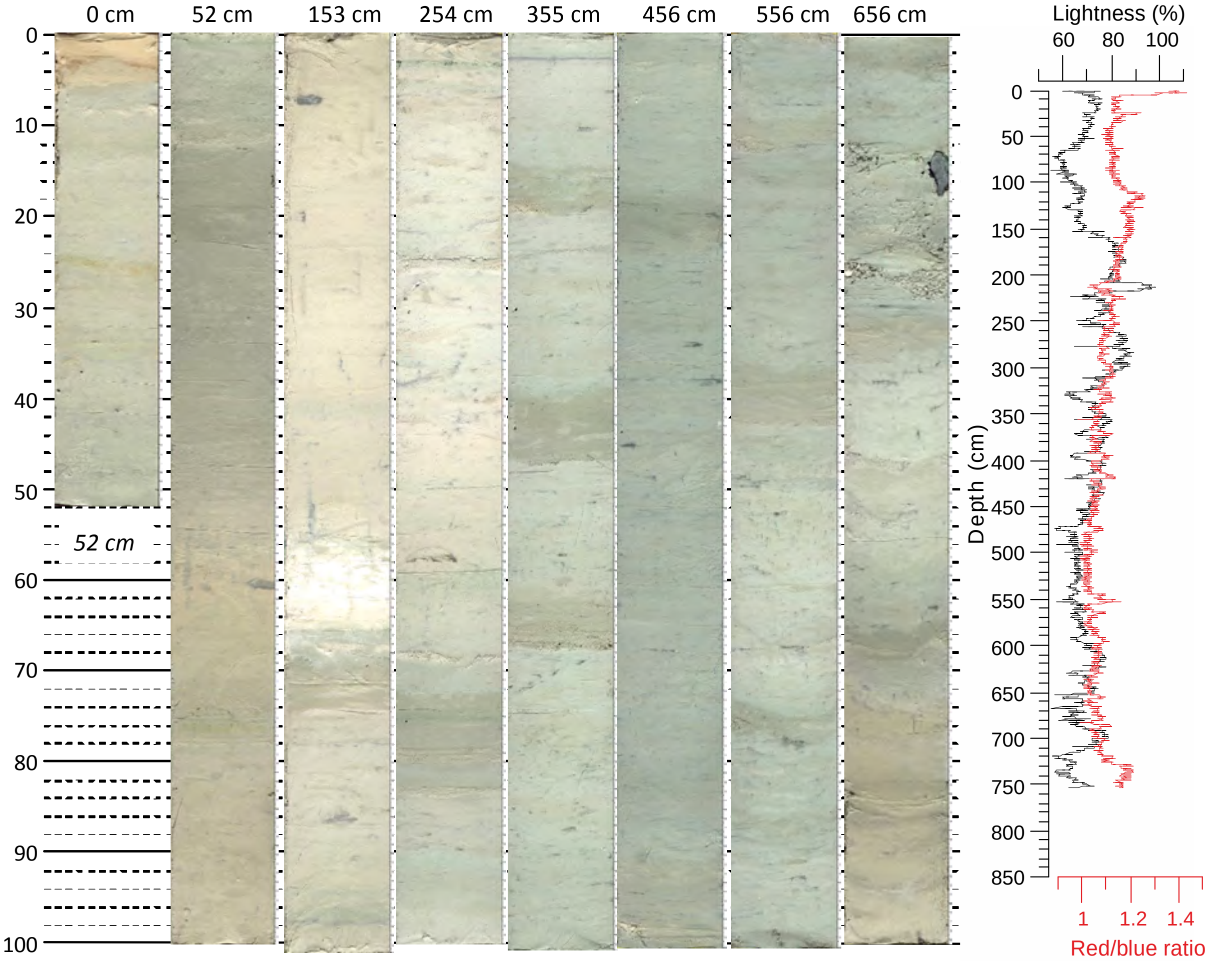


Lithology

0-17 cm: Light yellowish brown (2.5Y6/4: 0-6 cm, 2.5Y6/3: 6-17 cm) foram-bearing nannofossil ooze
17-91 cm: Olive (5Y5/4, 17-53 cm) to olive gray (5Y5/2, 53-91 cm) foram-bearing nannofossil ooze
91-118 cm: Light olive gray (5Y6/2, 91-105 cm) to olive (5Y5/3, 105-118 cm) foram-bearing nannofossil ooze
118-204 cm: Olive (5Y5/4, 118-143 cm) to light gray (5Y7/2, 143-204 cm) foram-bearing nannofossil ooze
204-213 cm: Pale yellow (5Y8/2) foram-bearing nannofossil ooze
213-219 cm: Dark olive gray (5Y3/2) nannofossil mud (sharp contact)
219-300 cm: Olive (5Y5/4, 219-257 cm) to pale olive (257-300 cm) foram-bearing nannofossil ooze
300-316 cm: Dark olive gray (5Y3/2) nannofossil mud
316-336/337 cm: Olive (5Y5/3) sandy layer (plankt. and benthic forams, pteropods, bryozoans; graded)
336/337-345 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
345-355 cm: Dark olive gray (5Y3/2) nannofossil mud (fine sandy layers of dominantly plankt. forams and mineral grains at 350-352 cm and 354-355 cm
355-377 cm: Pale olive (5Y6/3, 355-370 cm) to dark olive gray (5Y3/2, 370-377 cm) foram-bearing nannofossil ooze
377-402 cm: Pale olive (5Y6/3, 377-395 cm) to dark olive gray (5Y3/2, 395-402 cm) foram-bearing nannofossil ooze
402-411 cm: Olive (5Y5/3) sandy layer of calcareous fragments/debris
411-454 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
454-461 cm: Dark olive gray (5Y3/2) foram-bearing nannofossil ooze
461-462.5 cm: Olive (5Y5/3) sandy layer of dominantly calcareous fragments/debris
462.5-473 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
473-477 cm: Dark olive gray (5Y3/2) foram-bearing nannofossil ooze
477-515 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze

Fig. 6.17 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22227-2.

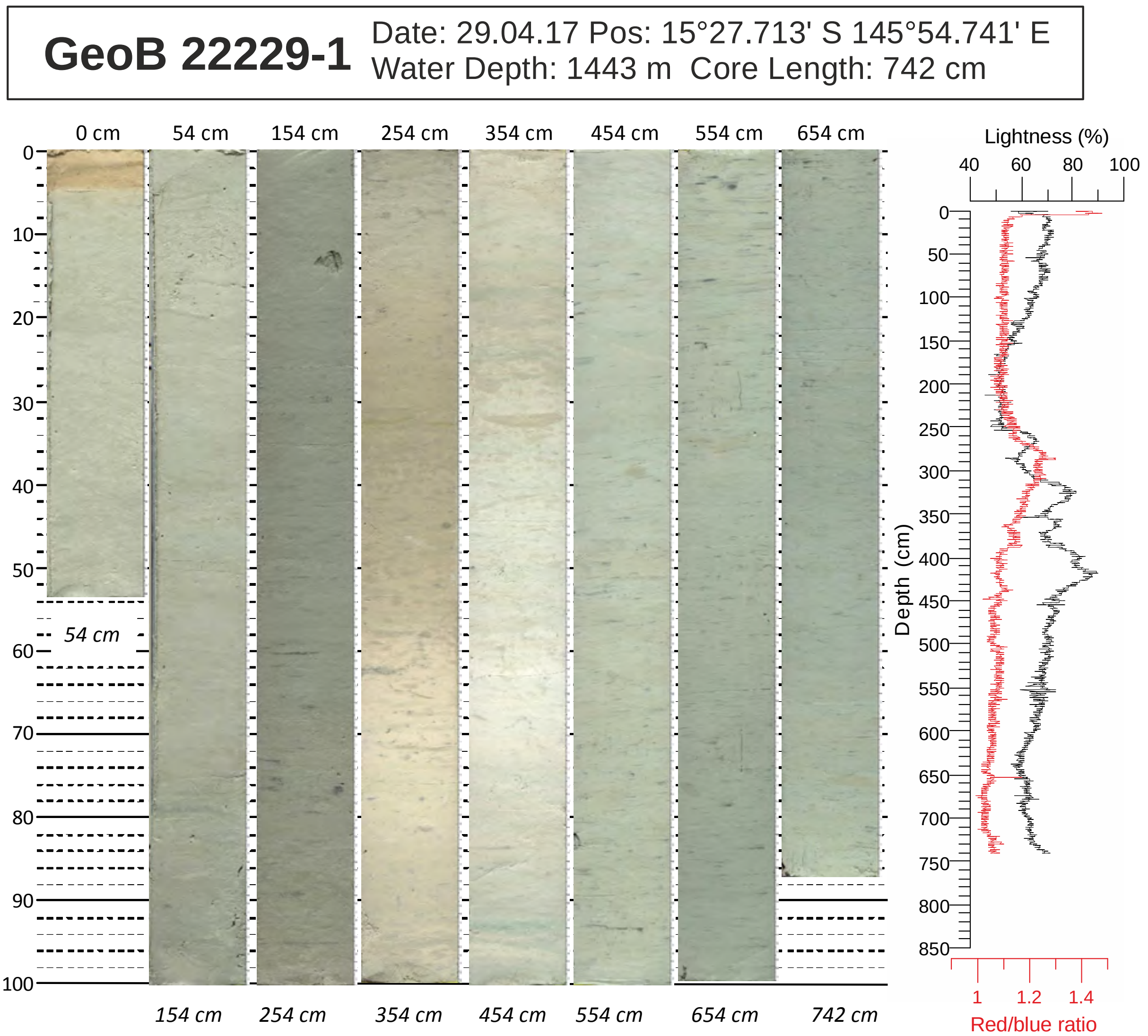
GeoB 22228-1 Date: 28.04.17 Pos: 15°26.980' S 146°01.305' E
Water Depth: 2124 m Core Length: 756 cm



Lithology

0-4 cm: Yellowish brown (10YR5/6) foram-bearing nannofossil ooze (oxidized top layer)
4-60 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
60-64 cm: Olive (5Y5/4) foram-bearing nannofossil ooze with sandy layers at 61-62 cm and 63-64 cm
64-108 cm: Olive gray (5Y4/2) nannofossil ooze rare in foraminifera
108-209 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
209-224 cm: Pale yellow (5Y7/3, 209-219) to olive (5Y4/3, 219-224 cm) foram-bearing nannofossil ooze
224-227 cm: Layer of olive (5Y4/3) foram-bearing nannofossil ooze
227-327 cm: Light olive gray (5Y6/2) nannofossil ooze with sandy layers consisting of plankt. and benthic forams and pteropods at 278-280 cm and 322-327 cm
327-333 cm: Olive (5Y5/3) nannofossil ooze rare in plankt. and benthic forams (in the following as unit 1)
333-335 cm: Olive (5Y5/3) sandy layer of dominantly plankt. and benthic forams (in the following as unit 2)
335-338 cm: Olive (5Y5/3) unit 1 (335-337 cm) to unit 2 (337-338 cm)
338-370 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
370-374 cm: Olive (5Y5/3) foram-bearing nannofossil ooze with patch of sand
374-394 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
394-401 cm: Olive (5Y5/3) unit 1 (394-401 cm) to unit 2 (401-402 cm)
402-421 cm: Light olive gray (5Y6/2, 402-417 cm) to olive (5Y5/3, 417-421 cm) foram-bearing nannofossil ooze
421-423 cm: Olive (5Y5/3) unit 2
423-474 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
474-478 cm: Olive (5Y5/3) unit 1
478-555 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
555-557 cm: Pale yellow (5Y7/3) layer of silt and fine sand
557-568 cm: Light olive gray (5Y6/2, 557-566 cm) to olive (5Y5/3, 566-568 cm) foram-bearing nannofossil ooze
568-569 cm: Olive (5Y5/3) unit 2
569-630 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze
630-633 cm: Olive (5Y5/3) foram-bearing nannofossil ooze with patch of sand
633-656 cm: Light olive gray (5Y6/2) unit 1
656-720 cm: Olive (5Y5/3, 656-660 cm) to light olive gray (5Y6/2, 660-720 cm) unit 1
669-673 cm: Pebble (Quarzite)
669-685 cm: Layer of shell fragments (large benthic forams, Halimeda, platform derived calcareous material)
702-743 cm: Olive (5Y5/3) unit 2 (702-720 cm) to unit 1 (720-743 cm)
743-756 cm: Light olive gray (5Y6/2) foram-bearing nannofossil ooze

Fig. 6.18 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22228-1.

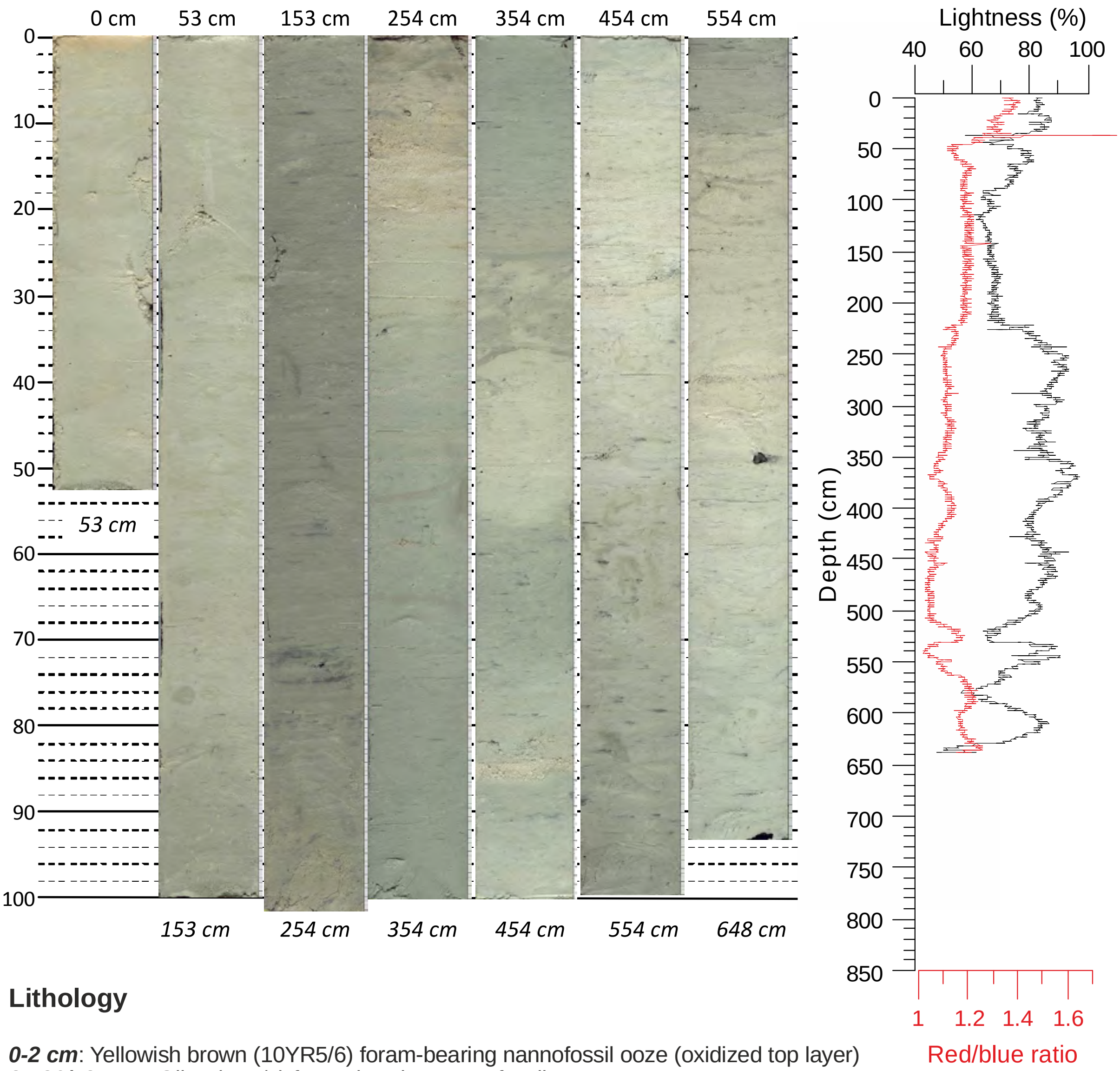


Lithology

0-5 cm: Yellowish brown (10YR5/4) foram-bearing nannofossil ooze (oxidized top layer)
5-102 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
102 cm: sediment is getting darker
102-255 cm: Olive gray (5Y4/2) nannofossil ooze (rare in forams)
255-272 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
272-313 cm: Light olive brown (2.5Y5/3) foram-bearing nannofossil ooze
313-338 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
338-381 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
381-443 cm: Light gray (5Y7/2) foram-bearing nannofossil ooze transition to olive gray mud (5Y5/2)
443-742 cm: olive gray mud (5Y5/2) foram-bearing nannofossil ooze

Fig. 6.19 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22229-1.

GeoB 22230-1 Date: 30.04.17 Pos: 15°26.471' S 145°52.199' E
Water Depth: 968 m Core Length: 648 cm

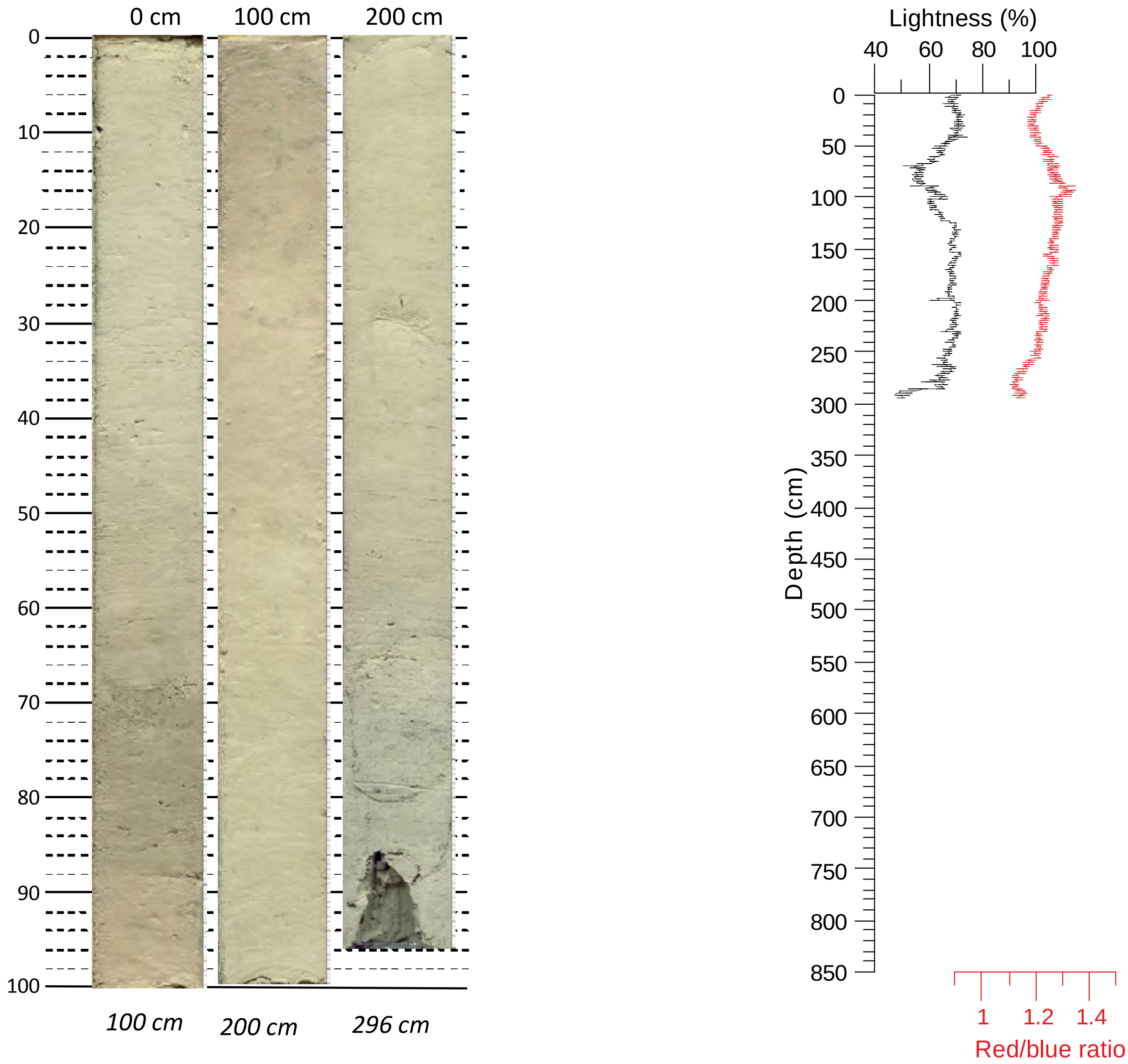


Lithology

0-2 cm: Yellowish brown (10YR5/6) foram-bearing nannofossil ooze (oxidized top layer)
2-136/137 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
73-79 cm: Patches rich in pteropods and forams
136/137-264 cm: Olive gray (5Y4/2) nannofossil ooze (rare in forams)
264-273 cm: Olive (5Y5/3) clayey sand (mainly plankt. and benthic forams). The matrix consists of nannofossils
273-287 cm: Olive (5Y5/1) foram-bearing nannofossil ooze
287-380 cm: Olive gray (5Y4/2) nannofossil ooze (rare in forams) with a sandy patch of forams at 313 cm
380-410 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
410-457 cm: Olive gray (5Y4/2) nannofossil ooze (rare in forams)
436-440 cm: Olive (5Y5/3) sandy layer (mainly plankt. forams and calcareous debris/fragments)
457-515 cm: Olive (5Y5/1) foram-bearing nannofossil ooze with a piece of pumice at 503-504 cm
515-565 cm: Olive gray (5Y4/2) nannofossil ooze (rare in forams)
565-648 cm: Olive (5Y5/4) foram-bearing nannofossil ooze with a sandy layer at 593-594 cm

Fig. 6.20 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22230-1.

GeoB 22233-2 Date: 02.05.17 Pos: 12°29.271' S 143°51.574' E
Water Depth: 612 m Core Length: 296 cm



Lithology

Disturbed surface due to kinked liner

0-69 cm: Pale olive (5Y6/3) fine-to-medium sand consisting of plankt. and benthic forams and mineral grains; shell fragment at 11-13 cm

69-89 cm: Olive gray (5Y4/2) clayey fine sand consisting of plankt. and benthic forams and mineral grains

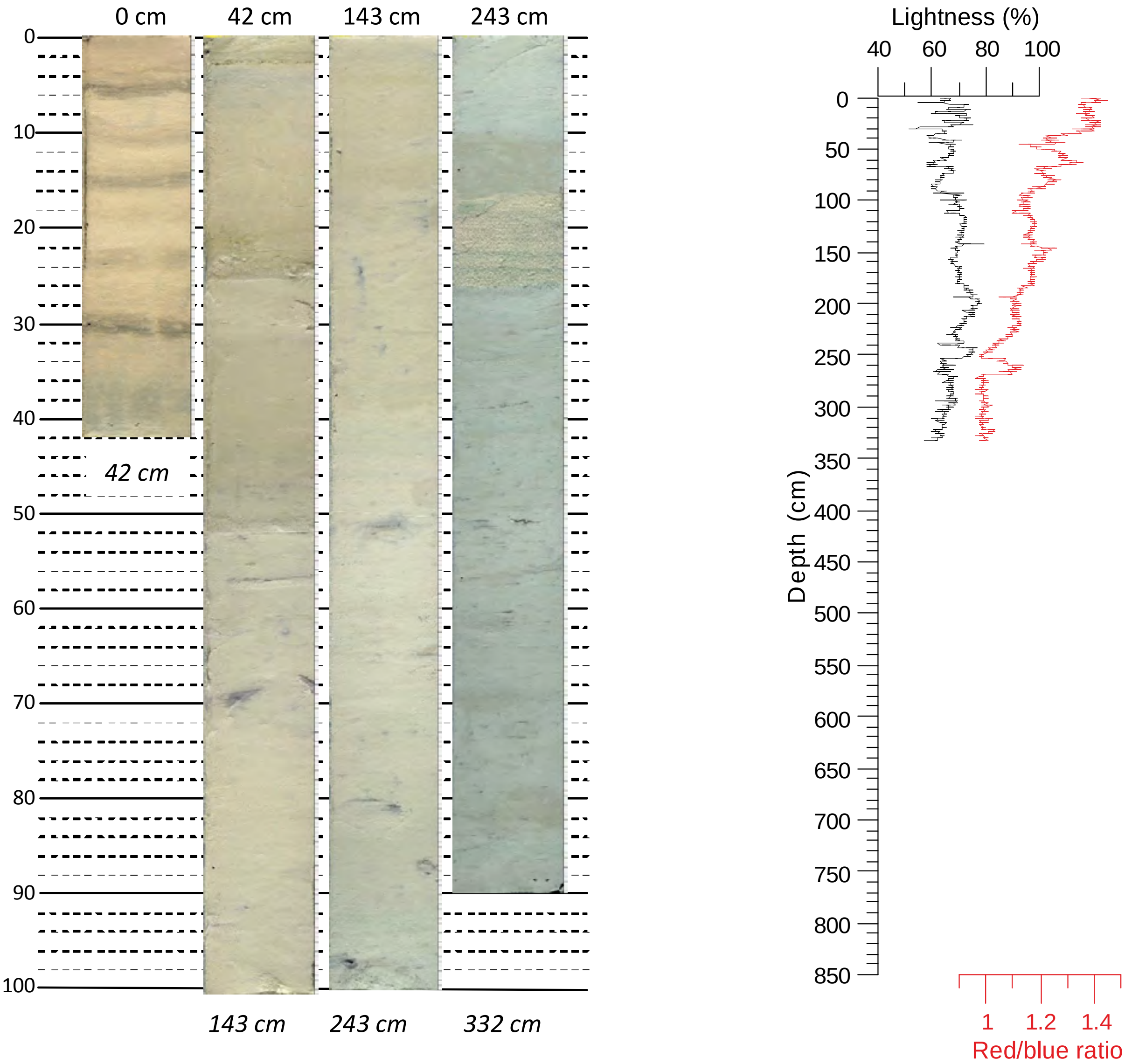
89-153 cm: Gray (5Y5/1) clayey fine sand consisting of plankt. and benthic forams and mineral grains

153-257 cm: Olive (5Y5/3) clayey fine sand consisting of plankt. and benthic forams and mineral grains

257-296 cm: Olive gray (5Y5/2) clayey fine sand with mud clast (consolidated; very stiff) at 263-281 cm

Fig. 6.21 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22233-2.

GeoB 22234-2 Date: 03.05.17 Pos: 12°24.592' S 144°09.073' E
Water Depth: 2863 m Core Length: 332 cm

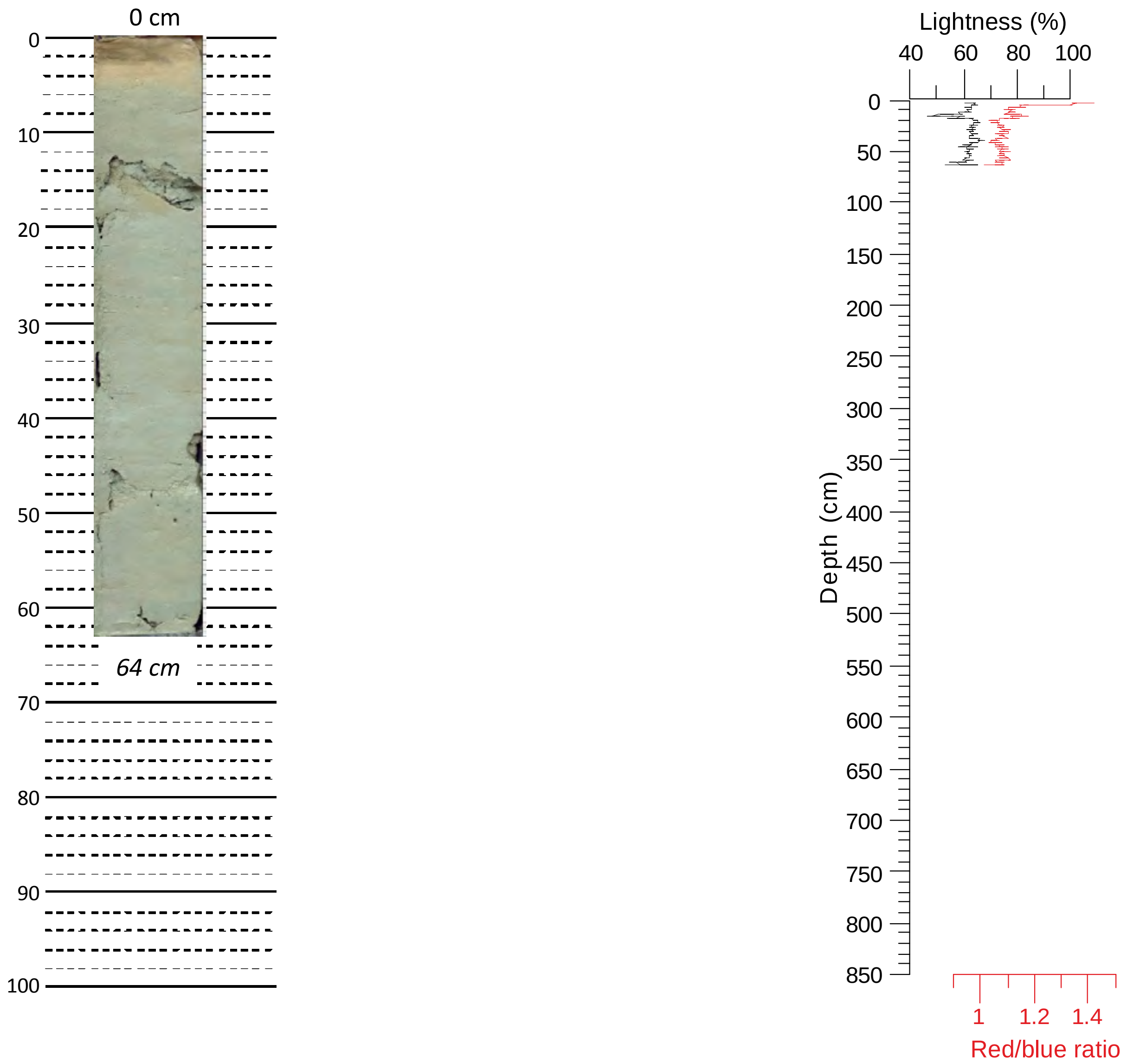


Lithology

0-4 cm: Yellowish brown (10YR5/6) foram-bearing nannofossil mud (oxidized top layer)
4-36 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil mud with layers of dark grayish brown (10YR4/2) forami-bearing nannofossil mud at 5-7 cm, 10.5-11.5 cm, 15-16 cm and 29-31 cm and a layer of light olive brown (2.5Y5/2) foram-bearing nannofossil mud at 29-31 cm containing numerous grains of ?Fe-oxides
36-47 cm: Olive (5Y5/3) foram-bearing nannofossil mud
47-65 cm: Light yellowish brown (2.5Y6/3) foram-bearing mud with a layer of nannofossil ooze at 44.5-45 cm
65-68 cm: Olive (5Y5/3) sandy layer rich in plankt. and benthic forams, pteropod fragments and quartz grains
68-74 cm: Pale olive (5Y6/4) nannofossil mud
74-93 cm: Olive (5Y5/4) nannofossil mud
93-95 cm: Olive (5Y5/3) sandy layer rich in plankt. and benthic forams, pteropod fragments and quartz grains
95-253 cm: Pale olive (5Y6/3) foram-bearing nannofossil ooze
253-260 cm: Olive (5Y5/3) nannofossil ooze
260-269 cm: Olive (5Y5/3) sandy layer rich in plankt. and benthic forams, pteropod fragments and quartz grains
269-332 cm: Olive gray (5Y5/2) foram-bearing nannofossil ooze

Fig. 6.22 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22234-2.

GeoB 22235-1	Date: 04.05.17 Pos: 12°30.179' S 144°00.802' E Water Depth: 2759 m Core Length: 64 cm

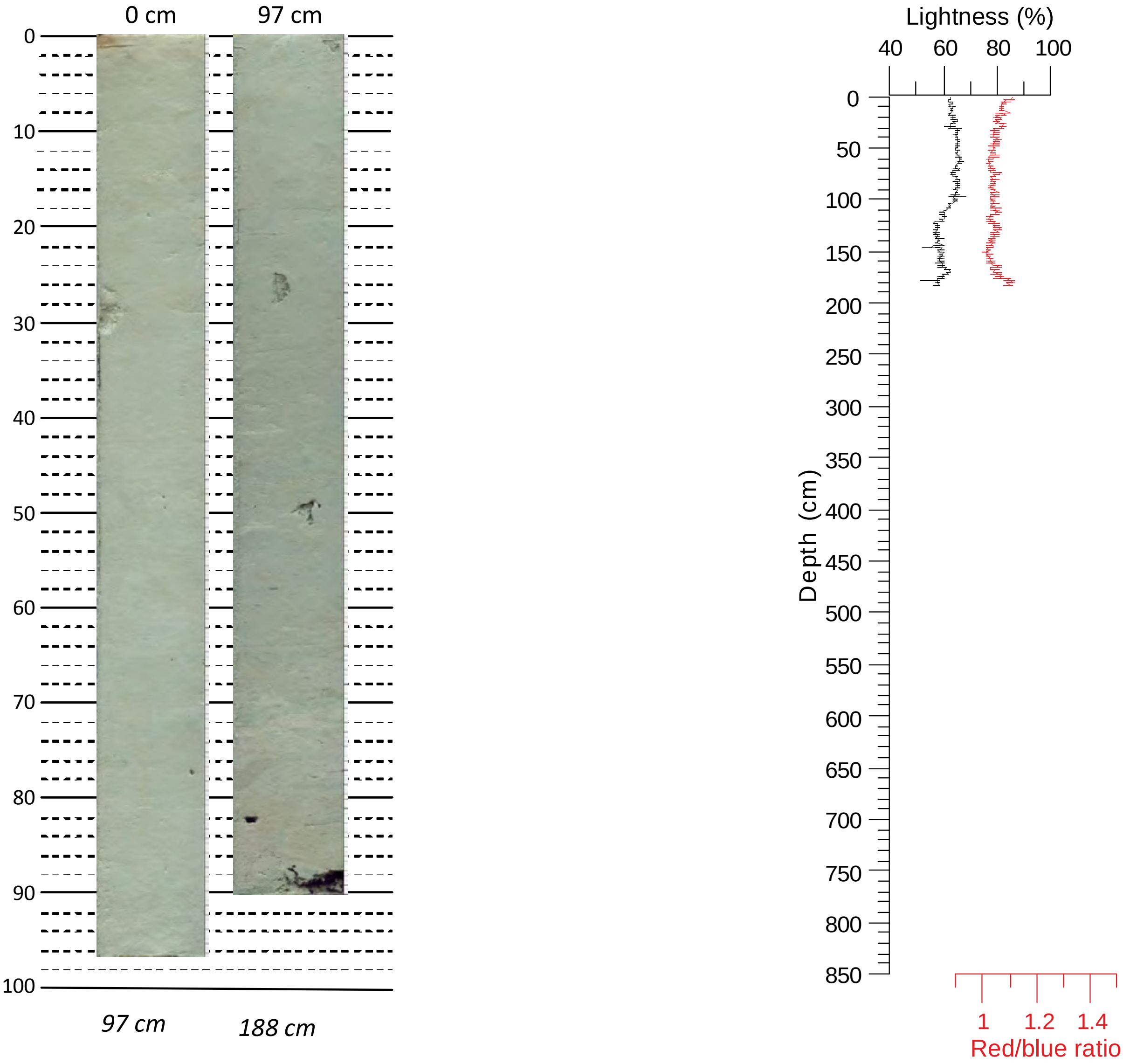


Lithology

0-5 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil ooze with dark olive brown (2.5Y3/3) intercalations of foram-bearing nannofossil ooze
5-64 cm: Olive (5Y5/4) foram-bearing nannofossil ooze

Fig. 6.23 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22235-1.

GeoB 22236-1	Date: 04.05.17 Pos: 12°29.272' S 143°57.591' E Water Depth: 2414 m Core Length: 188 cm



Lithology

0-1 cm: Light yellowish brown (2.5Y6/3) foram-bearing nannofossil ooze (oxidized top layer)
1-163 cm: Olive (5Y5/4) foram-bearing nannofossil ooze
163-186 cm: Olive (5Y5/3) foram-bearing nannofossil ooze
186-188 cm: Sandy layer rich in benthic forams, quartz, biotite, muscovite, and pteropod fragments

Fig. 6.24 Line-scan images, lightness, red/blue ratio, and core description of GeoB 22236-1.

7 Station List SO-256

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22201-1	21.04.2017 03:56:00	CTD	station start	26°3.039'	154°2.980'	2495	0.3	159
22201-1	21.04.2017 04:02:20	CTD	in the water	26°3.042'	154°2.977'	2508	0.5	62
22201-1	21.04.2017 05:08:20	CTD	on ground	26°3.030'	154°2.980'	2505	0.9	42
22201-1	21.04.2017 05:09:00	CTD	hoisting	26°3.030'	154°2.981'	2511	0.2	343
22201-1	21.04.2017 06:24:15	CTD	on deck	26°3.037'	154°2.977'	2509	0.9	228
22201-1	21.04.2017 06:26:12	CTD	station end	26°3.037'	154°2.980'	2519	0.3	71
22202-1	21.04.2017 08:22:03	MUC	station start	26°7.810'	153°59.365'	975	0.7	258
22202-1	21.04.2017 08:23:29	MUC	in the water	26°7.806'	153°59.360'	963	0.4	22
22202-1	21.04.2017 08:27:09	MUC	information	26°7.812'	153°59.365'	977	0.4	135
22202-1	21.04.2017 09:13:43	MUC	on ground	26°7.818'	153°59.366'	965	0.2	83
22202-1	21.04.2017 09:36:31	MUC	on deck	26°7.807'	153°59.366'	973	0.1	255
22202-1	21.04.2017 10:27:48	MUC	station end	26°7.818'	153°59.366'	977	0.1	21
22202-2	21.04.2017 10:28:51	GC	station start	26°7.818'	153°59.366'	975	0.7	13
22202-2	21.04.2017 10:30:23	GC	in the water	26°7.818'	153°59.366'	975	0.1	115
22202-2	21.04.2017 10:50:30	GC	on ground	26°7.806'	153°59.365'	979	0.5	347
22202-2	21.04.2017 10:50:52	GC	hoisting	26°7.806'	153°59.365'	974	0.0	161
22202-2	21.04.2017 11:15:58	GC	on deck	26°7.812'	153°59.364'	975	0.9	285
22202-2	21.04.2017 11:17:33	GC	station end	26°7.811'	153°59.360'	973	0.1	206
22203-1	21.04.2017 22:08:57	DRG	station start	26°4.464'	153°49.281'	104	1.8	326
22203-1	21.04.2017 22:09:39	DRG	in the water	26°4.461'	153°49.280'	102	0.5	113
22203-1	21.04.2017 22:26:10	DRG	information	26°4.451'	153°49.289'	104	1.0	318
22203-1	21.04.2017 22:37:23	DRG	in the water	26°4.454'	153°49.291'	104	0.4	343
22203-1	21.04.2017 22:41:27	DRG	on ground	26°4.449'	153°49.295'	103	0.3	356
22203-1	21.04.2017 22:42:55	DRG	profile start	26°4.447'	153°49.293'	103	0.5	300
22203-1	21.04.2017 22:47:39	DRG	hoisting	26°4.448'	153°49.260'	99	0.2	357
22203-1	21.04.2017 22:53:31	DRG	information	26°4.442'	153°49.263'	100	1.1	197
22203-1	21.04.2017 22:58:06	DRG	on deck	26°4.451'	153°49.266'	102	1.4	164
22203-2	21.04.2017 23:29:18	DRG	station start	26°4.453'	153°49.288'	103	0.6	178
22203-2	21.04.2017 23:29:25	DRG	in the water	26°4.453'	153°49.288'	103	0.3	158
22203-2	21.04.2017 23:33:48	DRG	on ground	26°4.451'	153°49.289'	103	0.1	65
22203-2	21.04.2017 23:35:20	DRG	profile start	26°4.452'	153°49.283'	102	0.6	241

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22203-2	21.04.2017 23:40:27	DRG	profile end	26°4.454'	153°49.240'	91	1.0	125
22203-2	21.04.2017 23:40:56	DRG	hoisting	26°4.453'	153°49.244'	91	0.8	160
22203-2	21.04.2017 23:48:35	DRG	information	26°4.454'	153°49.240'	91	0.2	236
22203-2	21.04.2017 23:55:00	DRG	on deck	26°4.453'	153°49.241'	92	0.8	342
22203-2	21.04.2017 23:57:01	DRG	station end	26°4.453'	153°49.239'	93	0.6	318
22204-1	22.04.2017 00:14:54	GKG	station start	26°4.272'	153°49.205'	99	0.4	54
22204-1	22.04.2017 00:26:04	GKG	in the water	26°4.273'	153°49.200'	97	0.5	282
22204-1	22.04.2017 00:30:32	GKG	on ground	26°4.274'	153°49.203'	99	0.5	316
22204-1	22.04.2017 00:30:49	GKG	hoisting	26°4.274'	153°49.201'	98	0.4	201
22204-1	22.04.2017 00:39:24	GKG	on deck	26°4.271'	153°49.201'	100	0.9	40
22204-1	22.04.2017 01:00:18	GKG	station end	26°4.274'	153°49.204'	100	0.8	28
22204-1	22.04.2017 01:04:16	DRG	profile start	26°4.276'	153°49.149'	96	0.7	279
22205-1	22.04.2017 01:07:26	DRG	station start	26°4.278'	153°49.107'	94	0.5	319
22205-1	22.04.2017 01:10:27	DRG	in the water	26°4.276'	153°49.107'	95	1.1	353
22205-1	22.04.2017 01:13:26	DRG	on ground	26°4.270'	153°49.101'	93	0.6	37
22205-1	22.04.2017 01:19:20	DRG	profile end	26°4.260'	153°49.064'	83	1.1	189
22205-1	22.04.2017 01:19:29	DRG	hoisting	26°4.260'	153°49.063'	84	1.2	237
22205-1	22.04.2017 01:24:34	DRG	information	26°4.262'	153°49.060'	84	0.1	242
22205-1	22.04.2017 01:33:34	DRG	information	26°4.262'	153°49.062'	89	0.7	347
22205-1	22.04.2017 01:51:05	DRG	information	26°4.267'	153°49.086'	91	0.3	157
22205-1	22.04.2017 01:55:41	DRG	on deck	26°4.268'	153°49.085'	89	0.4	332
22205-1	22.04.2017 02:00:25	DRG	station end	26°4.266'	153°49.085'	89	0.9	152
22206-1	22.04.2017 02:22:30	DRG	station start	26°4.562'	153°49.002'	80	1.7	171
22206-1	22.04.2017 02:24:07	DRG	in the water	26°4.565'	153°48.998'	81	0.5	58
22206-1	22.04.2017 02:36:26	DRG	on ground	26°4.583'	153°48.971'	80	0.3	66
22206-1	22.04.2017 02:37:56	DRG	profile start	26°4.582'	153°48.971'	81	0.3	299
22206-1	22.04.2017 02:42:48	DRG	hoisting	26°4.564'	153°49.004'	81	0.1	271
22206-1	22.04.2017 02:49:47	DRG	information	26°4.565'	153°49.005'	81	0.4	191
22206-1	22.04.2017 02:56:36	DRG	on deck	26°4.565'	153°49.002'	81	1.2	28
22206-1	22.04.2017 02:58:17	DRG	station end	26°4.563'	153°49.005'	81	1.2	32
22206-2	22.04.2017 03:03:32	DRG	station start	26°4.586'	153°48.966'	81	1.1	176
22206-2	22.04.2017 03:05:14	DRG	in the water	26°4.585'	153°48.967'	81	1.3	20
22206-2	22.04.2017 03:09:12	DRG	on ground	26°4.585'	153°48.970'	85	0.8	120

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	**UTC**			**(°S)**	**(°E)**	**(m)**	**(kn)**	**(°)**
22206-2	22.04.2017 03:09:55	DRG	profile start	26°4.586'	153°48.971'	81	0.4	295
22206-2	22.04.2017 03:15:17	DRG	hoisting	26°4.563'	153°49.005'	80	0.3	148
22206-2	22.04.2017 03:26:31	DRG	information	26°4.564'	153°49.007'	80	0.1	252
22206-2	22.04.2017 03:32:58	DRG	on deck	26°4.565'	153°49.010'	81	0.4	140
22206-2	22.04.2017 03:35:17	DRG	station end	26°4.565'	153°49.016'	80	1.2	127
22207-1	22.04.2017 04:55:24	GC	station start	26°2.995'	154°3.004'	2541	0.6	15
22207-1	22.04.2017 04:57:55	GC	in the water	26°2.999'	154°2.999'	2545	0.9	351
22207-1	22.04.2017 05:43:50	GC	on ground	26°2.997'	154°3.000'	2528	1.0	345
22207-1	22.04.2017 05:44:03	GC	hoisting	26°2.997'	154°3.000'	2543	0.5	34
22207-1	22.04.2017 06:35:40	GC	on deck	26°3.003'	154°3.002'	2536	0.3	183
22207-1	22.04.2017 06:40:38	GC	station end	26°2.946'	154°3.051'	2525	4.4	36
22208-1	23.04.2017 06:49:49	MUC	station start	23°18.734'	152°7.578'	90	0.0	56
22208-1	23.04.2017 06:51:13	MUC	in the water	23°18.733'	152°7.578'	90	0.2	216
22208-1	23.04.2017 06:53:50	MUC	information	23°18.734'	152°7.588'	92	0.6	42
22208-1	23.04.2017 06:58:16	MUC	information	23°18.736'	152°7.613'	94	0.6	18
22208-1	23.04.2017 07:09:17	MUC	information	23°18.742'	152°7.671'	106	0.2	96
22208-1	23.04.2017 07:26:17	MUC	information	23°18.741'	152°7.704'	110	0.5	354
22208-1	23.04.2017 07:50:07	MUC	hoisting	23°18.707'	152°7.814'	129	0.5	121
22208-1	23.04.2017 08:00:17	MUC	on deck	23°18.700'	152°7.824'	125	0.2	270
22208-1	23.04.2017 08:00:52	MUC	station end	23°18.700'	152°7.824'	125	0.1	162
22209-1	23.04.2017 22:10:18	MUC	station start	23°25.553'	152°11.553'	87	0.1	242
22209-1	23.04.2017 22:10:30	MUC	in the water	23°25.553'	152°11.554'	87	0.2	82
22209-1	23.04.2017 22:13:05	MUC	information	23°25.553'	152°11.556'	87	0.2	151
22209-1	23.04.2017 22:18:20	MUC	information	23°25.546'	152°11.548'	87	0.2	142
22209-1	23.04.2017 22:22:41	MUC	profile start	23°25.547'	152°11.548'	86	0.2	314
22209-1	23.04.2017 23:20:09	MUC	information	23°25.835'	152°11.605'	77	0.3	146
22209-1	23.04.2017 23:50:58	MUC	information	23°25.688'	152°11.919'	89	0.5	58
22209-1	23.04.2017 23:51:44	MUC	information	23°25.686'	152°11.922'	90	0.2	89
22209-1	23.04.2017 23:53:45	MUC	information	23°25.685'	152°11.924'	91	0.0	118
22209-1	24.04.2017 00:06:09	MUC	profile end	23°25.647'	152°11.965'	104	0.5	50
22209-1	24.04.2017 00:06:20	MUC	hoisting	23°25.647'	152°11.965'	105	0.3	45
22209-1	24.04.2017 00:12:37	MUC	information	23°25.647'	152°11.966'	105	0.2	172
22209-1	24.04.2017 00:15:22	MUC	on deck	23°25.646'	152°11.965'	105	0.2	115

Station	**Date / Time**	**Tool**	**Action**	**Latitude**	**Longitude**	**Depth**	**Speed**	**Course**
GeoB	**UTC**			**(°S)**	**(°E)**	**(m)**	**(kn)**	**(°)**
22209-1	24.04.2017 00:20:43	MUC	station end	23°25.647'	152°11.966'	104	0.4	223
22210-1	24.04.2017 00:50:03	GKG	station start	23°25.134'	152°11.272'	86	0.4	195
22210-1	24.04.2017 00:56:05	GKG	in the water	23°25.134'	152°11.271'	85	0.2	350
22210-1	24.04.2017 00:58:37	GKG	on ground	23°25.135'	152°11.273'	85	0.6	48
22210-1	24.04.2017 00:59:18	GKG	hoisting	23°25.134'	152°11.271'	86	0.5	299
22210-1	24.04.2017 01:08:39	GKG	on deck	23°25.134'	152°11.272'	86	0.3	337
22210-1	24.04.2017 01:10:54	GKG	station end	23°25.134'	152°11.271'	86	0.3	237
22211-1	24.04.2017 02:03:54	GC	station start	23°17.830'	152°11.545'	222	0.6	214
22211-1	24.04.2017 02:06:15	GC	in the water	23°17.843'	152°11.546'	221	0.3	223
22211-1	24.04.2017 02:11:49	GC	on ground	23°17.846'	152°11.550'	222	0.4	250
22211-1	24.04.2017 02:11:57	GC	hoisting	23°17.846'	152°11.550'	222	0.3	234
22211-1	24.04.2017 02:24:06	GC	on deck	23°17.846'	152°11.549'	221	0.1	24
22211-1	24.04.2017 02:26:58	GC	station end	23°17.865'	152°11.550'	222	1.1	179
22211-2	24.04.2017 02:32:41	GC	station start	23°17.847'	152°11.548'	221	0.2	228
22211-2	24.04.2017 02:37:43	GC	in the water	23°17.846'	152°11.550'	222	0.2	111
22211-2	24.04.2017 02:44:39	GC	on ground	23°17.847'	152°11.550'	221	0.3	60
22211-2	24.04.2017 02:44:42	GC	hoisting	23°17.847'	152°11.550'	222	0.5	260
22211-2	24.04.2017 02:55:24	GC	on deck	23°17.847'	152°11.550'	221	0.1	303
22211-2	24.04.2017 02:56:27	GC	station end	23°17.847'	152°11.550'	222	0.3	241
22212-1	24.04.2017 03:28:36	GC	station start	23°17.846'	152°14.291'	261	0.1	212
22212-1	24.04.2017 03:31:00	GC	in the water	23°17.848'	152°14.290'	247	0.1	338
22212-1	24.04.2017 03:38:12	GC	on ground	23°17.848'	152°14.292'	248	0.2	220
22212-1	24.04.2017 03:38:31	GC	hoisting	23°17.848'	152°14.290'	248	0.3	269
22212-1	24.04.2017 03:50:49	GC	on deck	23°17.847'	152°14.291'	248	0.1	54.5
22212-1	24.04.2017 03:51:52	GC	station end	23°17.848'	152°14.291'	248	0.1	248
22213-1	24.04.2017 04:23:30	GC	station start	23°17.853'	152°16.460'	268	0.2	135
22213-1	24.04.2017 04:25:46	GC	in the water	23°17.854'	152°16.464'	267	0.2	130
22213-1	24.04.2017 04:33:55	GC	on ground	23°17.854'	152°16.463'	268	0.2	39
22213-1	24.04.2017 04:34:05	GC	hoisting	23°17.854'	152°16.463'	268	0.3	34
22213-1	24.04.2017 04:47:45	GC	on deck	23°17.854'	152°16.464'	268	0.2	138
22213-1	24.04.2017 04:47:59	GC	station end	23°17.854'	152°16.464'	268	0.2	222

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22214-1	24.04.2017 07:22:24	GC	station start	23°6.707'	152°42.444'	340	0.3	174
22214-1	24.04.2017 07:26:19	GC	in the water	23°6.709'	152°42.430'	338	0.6	272
22214-1	24.04.2017 07:36:31	GC	on ground	23°6.709'	152°42.433'	339	0.3	19
22214-1	24.04.2017 07:50:14	GC	on deck	23°6.712'	152°42.425'	339	0.1	163
22214-1	24.04.2017 07:50:28	GC	station end	23°6.712'	152°42.425'	339	0.3	33
22215-1	24.04.2017 10:34:19	GKG	station start	22°44.727'	152°21.055'	120	0.2	201
22215-1	24.04.2017 10:34:50	GKG	in the water	22°44.726'	152°21.055'	121	0.3	272
22215-1	24.04.2017 10:39:28	GKG	on ground	22°44.725'	152°21.052'	121	0.1	157
22215-1	24.04.2017 10:39:57	GKG	hoisting	22°44.726'	152°21.052'	120	0.1	200
22215-1	24.04.2017 10:50:50	GKG	on deck	22°44.730'	152°21.051'	121	0.4	258
22215-1	24.04.2017 11:13:29	GKG	station end	22°44.731'	152°21.052'	120	0.1	292
22216-1	24.04.2017 22:42:15	GC	station start	22°44.728'	152°21.046'	121	0.0	235
22216-1	24.04.2017 22:56:10	GC	in the water	22°44.725'	152°21.051'	121	0.4	244
22216-1	24.04.2017 23:00:32	GC	on ground	22°44.726'	152°21.053'	121	0.1	199
22216-1	24.04.2017 23:00:59	GC	hoisting	22°44.727'	152°21.053'	121	0.1	71.6
22216-1	24.04.2017 23:12:11	GC	on deck	22°44.725'	152°21.047'	121	0.2	178
22216-1	24.04.2017 23:16:45	GC	station end	22°44.726'	152°21.048'	121	0.0	293
22216-2	24.04.2017 23:26:36	GC	station start	22°44.723'	152°21.049'	121	0.1	168
22216-2	24.04.2017 23:27:24	GC	in the water	22°44.723'	152°21.049'	121	0.1	313
22216-2	24.04.2017 23:31:50	GC	on ground	22°44.725'	152°21.052'	121	0.2	219
22216-2	24.04.2017 23:32:34	GC	hoisting	22°44.725'	152°21.051'	120	0.2	25
22216-2	24.04.2017 23:41:46	GC	on deck	22°44.726'	152°21.052'	121	0.3	197
22216-2	24.04.2017 23:47:05	GC	station end	22°44.724'	152°21.053'	121	0.1	227
22217-1	25.04.2017 06:23:03	MUC	station start	22°4.780'	152°56.713'	98	0.1	177
22217-1	25.04.2017 06:26:42	MUC	in the water	22°4.777'	152°56.714'	98	0.3	180
22217-1	25.04.2017 06:34:18	MUC	information	22°4.793'	152°56.710'	94	0.2	73
22217-1	25.04.2017 06:40:42	MUC	information	22°4.795'	152°56.711'	94	0.3	49
22217-1	25.04.2017 07:44:53	MUC	hoisting	22°4.821'	152°57.244'	116	0.5	36
22217-1	25.04.2017 07:56:03	MUC	on deck	22°4.821'	152°57.245'	116	0.4	226
22217-1	25.04.2017 08:06:05	MUC	station end	22°4.817'	152°57.247'	115	0.4	196
22218-1	25.04.2017 15:00:46	GC	station start	20°54.480'	152°47.898'	356	0.8	321
22218-1	25.04.2017 15:08:50	GC	in the water	20°54.479'	152°47.897'	356	0.1	216

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22218-1	25.04.2017 15:17:25	GC	on ground	20°54.479'	152°47.896'	356	0.7	275
22218-1	25.04.2017 15:17:34	GC	hoisting	20°54.479'	152°47.896'	355	0.2	12.3
22218-1	25.04.2017 15:37:52	GC	on deck	20°54.475'	152°47.896'	351	0.2	25
22218-1	25.04.2017 15:38:51	GC	station end	20°54.475'	152°47.896'	365	0.1	348
22219-1	26.04.2017 03:47:46	GC	station start	19°44.913'	150°30.906'	236	0.4	272
22219-1	26.04.2017 03:51:38	GC	in the water	19°44.917'	150°30.884'	236	0.4	94
22219-1	26.04.2017 04:00:04	GC	on ground	19°44.916'	150°30.880'	236	0.1	78
22219-1	26.04.2017 04:00:19	GC	hoisting	19°44.916'	150°30.881'	236	0.1	258
22219-1	26.04.2017 04:16:31	GC	on deck	19°44.917'	150°30.881'	236	0.2	59
22219-1	26.04.2017 04:17:09	GC	station end	19°44.917'	150°30.881'	235	0.2	348
22220-1	26.04.2017 21:55:38	GC	station start	17°41.867'	147°31.291'	1295	0.5	273
22220-1	26.04.2017 21:57:28	GC	in the water	17°41.866'	147°31.291'	1293	0.2	347
22220-1	26.04.2017 22:26:15	GC	on ground	17°41.869'	147°31.287'	1292	0.1	274
22220-1	26.04.2017 22:26:40	GC	hoisting	17°41.869'	147°31.287'	1292	0.1	300
22220-1	26.04.2017 23:04:20	GC	on deck	17°41.867'	147°31.289'	1295	0.4	100
22220-1	26.04.2017 23:08:46	GC	station end	17°41.866'	147°31.288'	1295	0.5	2
22221-1	27.04.2017 02:20:33	CTD	station start	17°17.913'	146°56.256'	1166	0.8	325
22221-1	27.04.2017 02:23:02	CTD	in the water	17°17.901'	146°56.245'	1168	0.8	288
22221-1	27.04.2017 02:58:58	CTD	on ground	17°17.880'	146°56.219'	1185	0.2	10
22221-1	27.04.2017 03:00:00	CTD	hoisting	17°17.879'	146°56.219'	1185	0.1	147
22221-1	27.04.2017 04:04:54	CTD	on deck	17°17.876'	146°56.220'	1183	0.0	106
22221-1	27.04.2017 04:07:13	CTD	station end	17°17.877'	146°56.220'	1184	0.1	210
22221-2	27.04.2017 04:08:55	MUC	station start	17°17.876'	146°56.220'	1179	0.1	149
22221-2	27.04.2017 04:46:26	MUC	in the water	17°17.877'	146°56.222'	1184	0.0	259
22221-2	27.04.2017 05:17:13	MUC	hoisting	17°17.876'	146°56.219'	1182	0.0	284
22221-2	27.04.2017 05:34:31	MUC	station end	17°17.880'	146°56.220'	1183	0.3	113
22222-1	27.04.2017 05:52:56	MUC	station start	17°17.695'	146°56.356'	1169	0.8	192
22222-1	27.04.2017 05:53:06	MUC	lowering	17°17.697'	146°56.355'	1168	1.0	225
22222-1	27.04.2017 06:16:52	MUC	on ground	17°17.698'	146°56.354'	1168	0.2	138
22222-1	27.04.2017 06:17:30	MUC	hoisting	17°17.699'	146°56.354'	1169	0.1	295
22222-1	27.04.2017 06:42:34	MUC	on deck	17°17.699'	146°56.349'	1168	0.2	100
22222-1	27.04.2017 06:48:01	MUC	station end	17°17.701'	146°56.353'	1171	0.1	155

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22222-2	27.04.2017 06:57:11	MUC	station start	17°17.702'	146°56.352'	1169	0.2	120
22222-2	27.04.2017 07:03:28	MUC	in the water	17°17.702'	146°56.348'	1167	0.1	90
22222-2	27.04.2017 07:31:51	MUC	information	17°17.701'	146°56.349'	1168	0.4	80
22222-2	27.04.2017 07:32:54	MUC	on ground	17°17.700'	146°56.348'	1169	0.3	288
22222-2	27.04.2017 07:33:26	MUC	hoisting	17°17.700'	146°56.348'	1168	0.0	13
22222-2	27.04.2017 08:20:09	MUC	on deck	17°17.751'	146°56.315'	1168	0.4	49
22222-2	27.04.2017 08:22:51	MUC	station end	17°17.739'	146°56.324'	1169	0.4	62
22222-3	27.04.2017 08:55:01	GC	station start	17°17.700'	146°56.351'	1171	0.0	101
22222-3	27.04.2017 08:57:21	GC	in the water	17°17.701'	146°56.351'	1170	0.1	74
22222-3	27.04.2017 09:23:42	GC	on ground	17°17.702'	146°56.351'	1171	0.1	266
22222-3	27.04.2017 09:55:41	GC	on deck	17°17.703'	146°56.353'	1174	0.1	239
22222-3	27.04.2017 09:58:02	GC	station end	17°17.703'	146°56.354'	1171	0.2	74
22223-1	27.04.2017 13:03:36	GC	station start	16°41.746'	146°42.173'	1566	0.2	212
22223-1	27.04.2017 13:06:30	GC	in the water	16°41.746'	146°42.173'	1566	0.1	353
22223-1	27.04.2017 13:37:27	GC	on ground	16°41.747'	146°42.173'	1565	0.3	169
22223-1	27.04.2017 13:37:47	GC	hoisting	16°41.747'	146°42.173'	1566	0.1	45
22223-1	27.04.2017 14:17:25	GC	on deck	16°41.743'	146°42.176'	1566	0.1	325
22223-1	27.04.2017 14:18:04	GC	station end	16°41.743'	146°42.176'	1566	0.0	47
22224-1	27.04.2017 14:55:52	GC	station start	16°39.786'	146°40.464'	1565	0.6	69
22224-1	27.04.2017 15:01:58	GC	in the water	16°39.777'	146°40.505'	1567	0.3	149
22224-1	27.04.2017 15:31:27	GC	on ground	16°39.774'	146°40.507'	1564	0.1	142
22224-1	27.04.2017 15:32:06	GC	hoisting	16°39.774'	146°40.507'	1565	0.1	196
22224-1	27.04.2017 16:09:30	GC	on deck	16°39.780'	146°40.509'	1568	0.1	256
22224-1	27.04.2017 16:09:45	GC	station end	16°39.780'	146°40.509'	1568	0.1	351
22225-1	27.04.2017 22:18:46	CTD	station start	15°24.116'	146°7.912'	2228	0.2	115
22225-1	27.04.2017 22:19:58	CTD	in the water	15°24.113'	146°7.912'	2224	0.3	353
22225-1	27.04.2017 23:15:10	CTD	on ground	15°24.119'	146°7.909'	2229	0.0	85
22225-1	28.04.2017 00:23:59	CTD	on deck	15°24.114'	146°7.917'	2226	0.1	60
22225-1	28.04.2017 00:25:39	CTD	station end	15°24.116'	146°7.918'	2223	0.2	65
22226-1	28.04.2017 04:52:07	MUC	station start	15°23.387'	145°48.789'	731	0.8	145
22226-1	28.04.2017 04:53:36	MUC	in the water	15°23.390'	145°48.790'	737	0.2	317
22226-1	28.04.2017 04:57:05	MUC	information	15°23.395'	145°48.792'	740	0.1	240

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22226-1	28.04.2017 05:12:59	MUC	information	15°23.391'	145°48.795'	739	0.1	194
22226-1	28.04.2017 05:17:03	MUC	profile start	15°23.392'	145°48.797'	741	0.1	273
22226-1	28.04.2017 05:31:19	MUC	information	15°23.453'	145°48.821'	794	0.2	224
22226-1	28.04.2017 05:35:00	MUC	information	15°23.456'	145°48.820'	797	0.2	240
22226-1	28.04.2017 05:37:02	MUC	information	15°23.452'	145°48.816'	791	0.1	285
22226-1	28.04.2017 05:59:15	MUC	hoisting	15°23.551'	145°48.860'	888	0.3	162
22226-1	28.04.2017 06:21:03	MUC	on deck	15°23.555'	145°48.862'	893	0.2	291
22226-1	28.04.2017 06:23:31	MUC	station end	15°23.550'	145°48.874'	910	1.9	63
22227-1	28.04.2017 08:04:52	MUC	station start	15°22.880'	146°4.514'	2238	0.1	190
22227-1	28.04.2017 08:06:41	MUC	in the water	15°22.889'	146°4.511'	2236	0.6	230
22227-1	28.04.2017 08:57:42	MUC	on ground	15°22.932'	146°4.499'	2236	0.3	314
22227-1	28.04.2017 08:58:07	MUC	hoisting	15°22.932'	146°4.498'	2237	0.1	231
22227-1	28.04.2017 09:39:56	MUC	on deck	15°22.926'	146°4.503'	2240	0.1	275
22227-1	28.04.2017 09:40:41	MUC	station end	15°22.925'	146°4.503'	2235	0.3	324
22227-2	28.04.2017 09:48:30	GC	station start	15°22.926'	146°4.503'	2242	0.1	316
22227-2	28.04.2017 09:53:37	GC	in the water	15°22.925'	146°4.500'	2238	0.3	127
22227-2	28.04.2017 10:36:31	GC	on ground	15°22.927'	146°4.502'	2237	0.1	81
22227-2	28.04.2017 10:36:52	GC	hoisting	15°22.927'	146°4.502'	2241	0.3	1
22227-2	28.04.2017 11:27:59	GC	on deck	15°22.926'	146°4.503'	2241	0.3	184
22227-2	28.04.2017 11:29:57	GC	station end	15°22.926'	146°4.502'	2238	0.3	169
22228-1	28.04.2017 23:06:52	GC	station start	15°26.974'	146°1.310'	2122	0.5	42
22228-1	28.04.2017 23:17:15	GC	in the water	15°26.978'	146°1.306'	2122	0.2	291
22228-1	28.04.2017 23:59:04	GC	on ground	15°26.980'	146°1.305'	2124	0.1	118
22228-1	29.04.2017 00:00:27	GC	hoisting	15°26.978'	146°1.304'	2124	0.1	251
22228-1	29.04.2017 00:50:39	GC	on deck	15°26.979'	146°1.305'	2122	0.2	126
22228-1	29.04.2017 00:52:12	GC	station end	15°26.979'	146°1.303'	2126	0.1	252
22228-2	29.04.2017 00:56:44	MUC	station start	15°26.980'	146°1.307'	2122	0.2	157
22228-2	29.04.2017 00:57:02	MUC	in the water	15°26.980'	146°1.307'	2124	0.1	153
22228-2	29.04.2017 01:46:20	MUC	on ground	15°26.980'	146°1.310'	2123	0.1	241
22228-2	29.04.2017 01:46:40	MUC	hoisting	15°26.980'	146°1.309'	2125	0.4	311
22228-2	29.04.2017 02:29:28	MUC	on deck	15°26.976'	146°1.310'	2122	0.1	49
22228-2	29.04.2017 02:32:45	MUC	station end	15°26.979'	146°1.307'	2123	0.2	163
22229-1	29.04.2017 03:48:06	GC	station start	15°27.666'	145°54.721'	1445	0.6	143

Station	**Date / Time**	**Tool**	**Action**	**Latitude**	**Longitude**	**Depth**	**Speed**	**Course**
GeoB	**UTC**			**(°S)**	**(°E)**	**(m)**	**(kn)**	**(°)**
22229-1	29.04.2017 03:55:30	GC	in the water	15°27.677'	145°54.723'	1445	0.1	257
22229-1	29.04.2017 04:19:04	GC	information	15°27.672'	145°54.729'	1445	0.1	67
22229-1	29.04.2017 04:45:44	GC	on ground	15°27.713'	145°54.741'	1443	0.3	281
22229-1	29.04.2017 04:46:09	GC	hoisting	15°27.713'	145°54.741'	1445	0.1	315
22229-1	29.04.2017 05:16:02	GC	information	15°27.712'	145°54.744'	1446	0.0	145
22229-1	29.04.2017 05:25:02	GC	on deck	15°27.716'	145°54.740'	1442	0.2	100
22229-1	29.04.2017 05:26:08	GC	station end	15°27.716'	145°54.740'	1444	0.1	161
22230-1	30.04.2017 02:41:43	GC	station start	15°26.454'	145°52.195'	970	0.6	194
22230-1	30.04.2017 02:47:52	GC	in the water	15°26.470'	145°52.196'	970	0.2	268
22230-1	30.04.2017 03:07:08	GC	on ground	15°26.471'	145°52.199'	968	0.1	309
22230-1	30.04.2017 03:07:30	GC	hoisting	15°26.471'	145°52.199'	965	0.1	306
22230-1	30.04.2017 03:36:31	GC	on deck	15°26.472'	145°52.192'	967	0.0	262
22230-1	30.04.2017 03:37:03	GC	station end	15°26.472'	145°52.192'	965	0.2	260
22230-2	30.04.2017 03:41:20	MUC	station start	15°26.472'	145°52.196'	967	0.1	351
22230-2	30.04.2017 03:42:49	MUC	in the water	15°26.471'	145°52.197'	968	0.2	56
22230-2	30.04.2017 04:08:12	MUC	on ground	15°26.473'	145°52.198'	968	0.1	80
22230-2	30.04.2017 04:08:26	MUC	hoisting	15°26.473'	145°52.198'	967	0.0	54
22230-2	30.04.2017 04:30:34	MUC	on deck	15°26.471'	145°52.193'	969	0.1	39
22230-2	30.04.2017 04:31:12	MUC	station end	15°26.470'	145°52.193'	967	0.1	44
22231-1	01.05.2017 00:24:15	CTD	station start	12°30.109'	144°4.080'	2822	0.2	343
22231-1	01.05.2017 00:24:54	CTD	in the water	12°30.109'	144°4.080'	2819	0.3	302
22231-1	01.05.2017 01:36:27	CTD	on ground	12°30.110'	144°4.076'	2819	0.1	273
22231-1	01.05.2017 03:12:00	CTD	on deck	12°30.110'	144°4.076'	2818	0.1	245
22231-1	01.05.2017 03:16:45	CTD	station end	12°30.110'	144°4.075'	2822	0.1	72
22232-1	02.05.2017 04:08:31	MUC	station start	12°31.994'	143°51.107'	627	0.7	148
22232-1	02.05.2017 04:20:06	MUC	in the water	12°31.999'	143°51.108'	632	0.3	240
22232-1	02.05.2017 04:23:13	MUC	information	12°32.000'	143°51.109'	630	0.0	102
22232-1	02.05.2017 04:39:20	MUC	information	12°32.000'	143°51.110'	633	0.1	75
22232-1	02.05.2017 05:14:18	MUC	hoisting	12°32.105'	143°51.216'	803	0.3	104
22232-1	02.05.2017 05:31:12	MUC	information	12°32.107'	143°51.222'	809	0.2	320
22232-1	02.05.2017 05:35:13	MUC	on deck	12°32.106'	143°51.220'	809	0.1	251
22232-1	02.05.2017 05:36:02	MUC	station end	12°32.107'	143°51.220'	819	0.1	110

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	**UTC**			**(°S)**	**(°E)**	**(m)**	**(kn)**	**(°)**
22233-1	02.05.2017 06:11:11	MUC	station start	12°29.284'	143°51.566'	618	0.6	45
22233-1	02.05.2017 06:12:48	MUC	in the water	12°29.278'	143°51.571'	620	0.2	153
22233-1	02.05.2017 06:27:58	MUC	on ground	12°29.280'	143°51.571'	613	0.1	344
22233-1	02.05.2017 06:43:19	MUC	on deck	12°29.279'	143°51.576'	613	0.2	176
22233-1	02.05.2017 06:44:12	MUC	station end	12°29.280'	143°51.575'	614	0.1	179
22233-2	02.05.2017 06:48:54	GC	station start	12°29.278'	143°51.572'	616	0.1	48
22233-2	02.05.2017 06:51:54	GC	in the water	12°29.273'	143°51.577'	612	0.1	124
22233-2	02.05.2017 07:05:17	GC	on ground	12°29.271'	143°51.574'	612	0.2	241
22233-2	02.05.2017 07:05:51	GC	hoisting	12°29.272'	143°51.574'	612	0.1	202
22233-2	02.05.2017 07:24:56	GC	on deck	12°29.271'	143°51.579'	615	0.1	166
22233-2	02.05.2017 07:26:06	GC	station end	12°29.272'	143°51.580'	615	0.2	278
22234-1	02.05.2017 21:55:27	MUC	station start	12°24.574'	144°9.065'	2867	1.0	23
22234-1	02.05.2017 21:56:59	MUC	in the water	12°24.563'	144°9.065'	2866	0.7	348
22234-1	02.05.2017 23:04:21	MUC	on ground	12°24.589'	144°9.069'	2864	0.2	115
22234-1	02.05.2017 23:04:40	MUC	hoisting	12°24.589'	144°9.069'	2866	0.2	206
22234-1	03.05.2017 00:00:41	MUC	on deck	12°24.590'	144°9.073'	2870	0.2	248
22234-1	03.05.2017 00:00:57	MUC	station end	12°24.591'	144°9.072'	2861	0.3	260
22234-2	03.05.2017 00:05:37	GC	station start	12°24.586'	144°9.071'	2864	0.2	308
22234-2	03.05.2017 00:06:50	GC	in the water	12°24.586'	144°9.069'	2860	0.2	235
22234-2	03.05.2017 01:01:24	GC	on ground	12°24.592'	144°9.073'	2863	0.1	321
22234-2	03.05.2017 01:02:06	GC	hoisting	12°24.593'	144°9.072'	2864	0.2	302
22234-2	03.05.2017 02:01:49	GC	on deck	12°24.588'	144°9.076'	2866	0.2	288
22234-2	03.05.2017 02:04:52	GC	station end	12°24.585'	144°9.073'	2864	0.0	54
22235-1	04.05.2017 01:56:26	GC	station start	12°30.161'	144°0.794'	2759	0.5	83
22235-1	04.05.2017 02:00:44	GC	in the water	12°30.173'	144°0.806'	2759	0.6	147
22235-1	04.05.2017 02:51:11	GC	on ground	12°30.179'	144°0.802'	2759	0.3	88
22235-1	04.05.2017 02:51:31	GC	hoisting	12°30.179'	144°0.802'	2760	0.1	215
22235-1	04.05.2017 03:49:39	GC	on deck	12°30.174'	144°0.809'	2765	0.1	195
22235-1	04.05.2017 03:51:00	GC	station end	12°30.175'	144°0.809'	2762	0.3	303
22236-1	04.05.2017 04:25:31	GC	station start	12°29.191'	143°57.486'	2358	1.0	120
22236-1	04.05.2017 04:29:26	GC	in the water	12°29.218'	143°57.519'	2379	0.6	120
22236-1	04.05.2017 05:12:40	GC	on ground	12°29.272'	143°57.591'	2414	0.2	132
22236-1	04.05.2017 05:12:44	GC	hoisting	12°29.272'	143°57.591'	2414	0.1	70

Station	Date / Time	Tool	Action	Latitude	Longitude	Depth	Speed	Course
GeoB	UTC			(°S)	(°E)	(m)	(kn)	(°)
22236-1	04.05.2017 06:03:42	GC	on deck	12°29.273'	143°57.596'	2412	0.1	272
22236-1	04.05.2017 06:05:16	GC	station end	12°29.273'	143°57.597'	2414	0.1	21

8. Data and Sample Storage Availability

All data obtained during the R/V SONNE expedition SO-256 are stored at PANGAEA (www.pangaea.de) except for the video material. All samples are stored at MARUM core repository in Bremen, Germany, at the University of Sydney in Australia, at the Atmosphere and Ocean Research Institute in Tokyo, Japan, and at Dalhousie University in Halifax, Canada (see tables in chapter 5 for details). Sample request should be sent to MARUM core repository and Dr. Mahyar Mohtadi (mmohtadi@marum.de)

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