POS 272

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REPORT AND PRELIMINARY RESULTS OF
POSEIDON CRUISE POS 272
LAS PALMAS - LAS PALMAS; 01.04.2001 - 14.04.2001

1. Research objectives

Upwelling areas are particularly well suited for a combination of oceanographic, satellite and paleoceanographic observations of related processes, because upwelling produces large gradients of temperature and pigment concentrations at the sea surface, which is also mirrored in underlying sediments (Fig. 1). Therefore satellite SST data and chlorophyll-like pigment concentrations are normally used as indicators for upwelling and eastern boundary circulation in combination with historical wind data. Particularly striking in historical pictures are several giant filaments of cool, pigment rich waters between 20°N and 31°N between Cape Blanc and Cape Ghir extending several hundred kilometres offshore (Fig. 1).

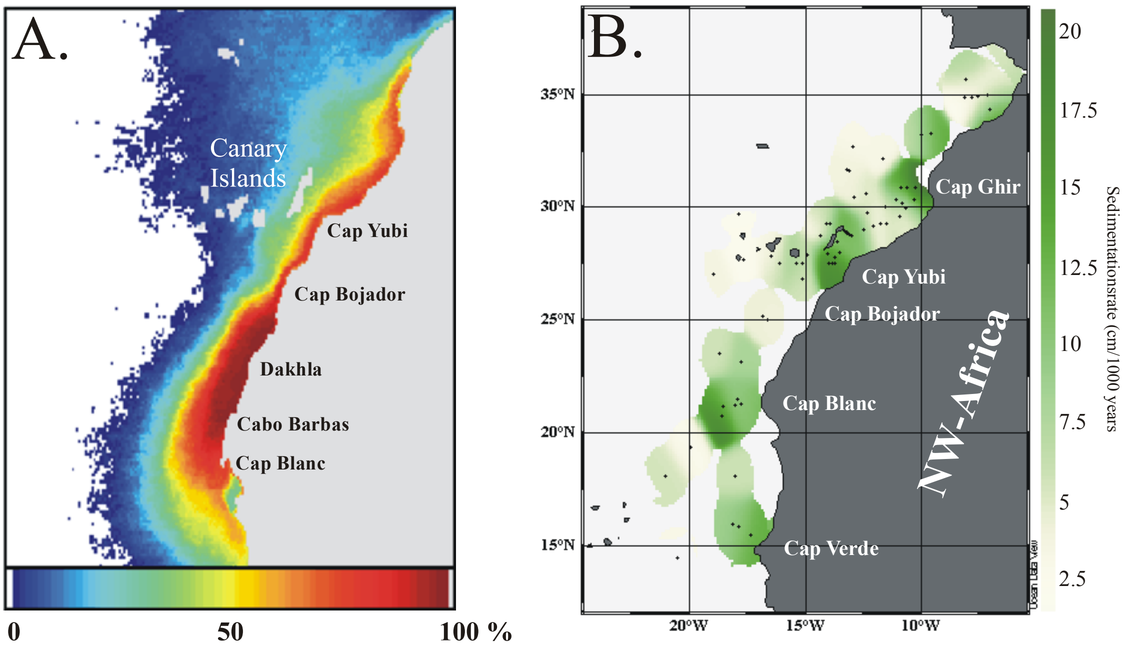

Fig. 1: **A**. Filament abundance in percent during the years 1988 to 1999 (data are calculated from AVHRR-data sets by P. Helmcke, University of Bremen); **B**. Holocene sedimentation rates from the NW-African margin (data from H. Kuhlmann, unpublished, Winn et al., 1991; Marret and Turon, 1994, Martinez et al., 1999, Freudenthal et al., in press and Henderiks et al., in press).

These filament areas are key-areas for climatic studies where oceanographic and paleoceanographic conditions could be registered with a global relevance. Filaments are characterized by high nutrient content, high productivity and an associated particle loading. They transport "upwelling finger prints" into the open oligotrophic ocean. This upwelling characteristic particles were registered in the water column and could be investigated by sediment trap moorings and by analysing the in-situ particle distribution with camera systems.

During this cruise particle flux work will be carried out in the area off Cap Blanc, since the particle flux in this region particularly well reflects the intense upwelling and filament production throughout the year. Climate oscillations will therefore be recorded well in time-series at this location. The one-dimension time-series at the Cap Blanc sediment trap mooring station will be supplemented by a two-dimension data set from remote sensing (SeaWiFS). Finally, the documentation of the particle content in the water column with a particle camera system (including transmissiometer and CTD) on various sites on and around the mooring station and on a zonal profile towards the coastal upwelling area will be used as a three-dimension data set to understand the pathways of the particles in the water-column. These biogeochemical studies are a first step and a basis for actualistic approaches to understand both the present-day conditions and, consequently, past climatic variations.

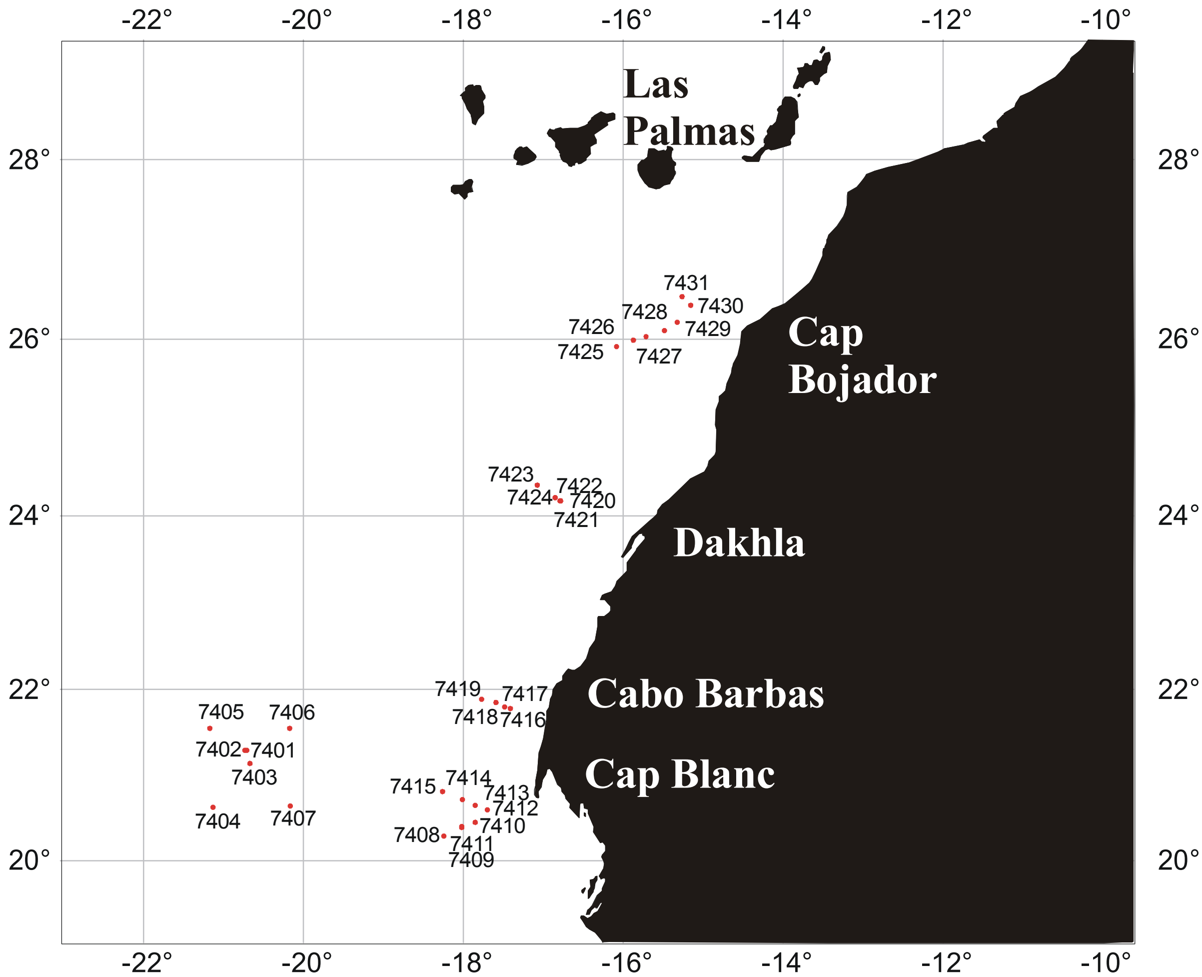

Figure 2: GeoB stations during POSEIDON-cruise POS 272 from Las Palmas to Las Palmas (01 April – 14 April 2001).

On geological time-scales, higher productivity has been proposed to explain lower atmospheric carbon dioxide levels during the last glacial episodes. Accordingly the NW-African upwelling area has been cited as a type-example of a glacial high productivity region (Sarnthein et al., 1988). Although several hypotheses have been proposed during the last few years to explain atmospheric CO_2 changes through glacial-interglacial episodes, one major difficulty remains the assessment of the regional ecosystem as sources or sinks of carbon and their quantitative contributions to the global carbon cycle (Martinez et al., 1999). Systems are very heterogeneous due to complex continental-ocean interactions (wind stress, topography, sea-level changes). Thus the intensive investigation of filaments by taking sediment cores will help to characterize the significance of filaments and related upwelling to the global CO_2 budget and global climate change.

Questions, which were planed to solve with this cruise:

- How are filaments responsible for particle transport to the open oligotrophic ocean?
- How do the regional climate, SST, the upwelling history and the filament activity change in the past?
- How do the past circulation patterns change the productivity in the upwelling area and in the filament during past climatic cycles?

2. Participants

Tab. 1: Participants of POSEIDON cruise no. 272

POS 272

Name	Subject	Institution
Meggers, Helge, Dr. (Chief Scientist)	Sedimentology	GeoB
Bergenthal, Markus, Dipl.-Phys.	Particle Flux	GeoB
Freudenthal, Tim, Dr.	Sedimentology	GeoB
Hamady, Ould, Bambaye	Observer	Mauretania
Held, Matthias, Student	Sedimentology	GeoB
Hofmann, Daniela, Dipl. Geophys.	Sedimentology	GeoB
Kuhlmann, Holger, Dipl.-Geol.	Sedimentology	GeoB
Nowald, Nicolas, Dipl.-Geol.	Particle Flux	GeoB
Ratmeyer, Volker, Dr.	Particle Flux	GeoB
Zizah, Soukaina.	Observer	Morocco

GeoB: Fachbereich 5 - Geowissenschaften, Universität Bremen, Klagenfurter Str., D-28359 Bremen, Germany

3. Research program

The main purpose of the cruise was the investigation of biogeochemical processes and fluxes on different spatial and temporal scales in relation to water mass circulation. Due to its unique location, the NW African margin occupies a key position with respect to the biogeochemical cycles in the region and is a prime location to study environmental parameters sensitive to climate change. During the POSEIDON 272 cruise it is planned to do both particle flux investigations and paleoceanographic studies to better understand the filament characteristic, the production, its relevance for a nutrient and particle transport to the open ocean and its Holocene/Pleistocene history during glacial to interglacial time periods.

The following was and will be done:

1. Studying the particle flux by recovering and deploying a sediment trap mooring (Cap Blanc (CB11/12)). The particulate material collected will be analysed to determine total flux, particulate flux, particulate organic carbon, particulate nitrogen, biogenic opal, carbonate and carbon isotopes of organic matter, and lithogenic material. The trapped material will further be investigated for species composition of the planktonic organisms (pteropods, foraminifera, radiolaria, coccolithophorids, and diatoms), together with the chemical and isotopic compositions of these organisms and the composition of the organic and terrigenous material.

2. Determining the standing stock of particles (marine snow) in the water column. The abundance of particles in the water column will be determined on photographs taken with a particle camera system from several continuous profiles through the water column.

3. Studying the amplitudes and rates of long-term environmental variability exemplified by the flux variability of environmental tracers and atmospheric dust through the last glacial-interglacial cycle along a transect from the high-productivity coastal zone to more open ocean conditions by taking sediment cores. Climate-sensitive parameters (organisms, geochemistry) will be analysed within surface sediments and sediment cores in a paleoceanographic context. For high-resolution work the sedimentological group requires high sedimentation areas to find suitable cores. Accordingly, work was focused on near shore sites with possible high sedimentation rates. Helpful tools in taking sediment cores were the 12 KHZ and the 18 kHz shipboard echo sounder systems. Suitable locations were sampled with conventional wire line coring techniques (multicorer and gravity corer with 3/6 m pipe length).

4. Narrative of the Cruise

The POSEIDON left the harbour of Las Palmas on schedule Sunday, April 01, 2001 at 9:00 a.m. Onboard were 7 colleagues from the Geosciences Department of Bremen University, 1 observer from the Institute National de Recherche Halieutique in Casablanca, Morocco and 1 observer from the Centre National de Recherches Oceanographique et des Peches in Nouadhibou, Mauretania.

The cruise to the Cap Blanc mooring station about 500 nm southwest of Gran Canaria provided the chance for fixing the geological devices and the particle camera equipment. The station work at Cap Blanc began on 03. April with the exchange of the sediment trap mooring CB11. All the instruments (two sediment traps and two current meters) were brought on board in good condition. Unfortunately, the lower sediment trap has not functioned. In the afternoon, another mooring of similar construction (CB12) was deployed at the same position. After mooring work a net of particle camera deployments on mooring site and on a squared grid (60* 60 nm) around the mooring position was carried out from April 03 to 05.

On April 08, the POSEIDON departed the mooring position north off Cap Blanc to begin working at the near shore area off Cap Blanc. On the way to the NW African coast the echo sounder systems (12 and 18 kHz) were switched on and were used to record continuous high resolution bathymetric and sediment echo sounding profiles as a tool to find suitable positions for sediment sampling. The first profile west of Cap Blanc was reached about 1 day later. After surveys with the echo sounder systems sediments were sampled at 3 stations with multicorer and gravity corer in water depths between 1900 and 600 m. In addition the particle camera system was used during the night on 2 stations. After finishing the scientific program on that profile on April 06, POSEIDON steamed northwards to continue scientific work on a second-transect perpendicular off Cap Blanc with again 3 geological stations off Cape Blanc. During the night the particle camera system was used three times from 250 m to 1200 m water-depth. With the morning the geological work was continued with 3 stations in water-depths between 500 m and 1900 m. On the last station the multicorer was equipped with the video camera system to get an impression of the surface sediment at station GeoB 7415. After 2 days the sampling program off Cape Blanc was terminated in the evening of April 07, and POSEIDON took course on another E-W profile west off Cabo Barbas. In the morning of April 08, we started this profile with the use of an underwater-video camera system on the shelf-edge. The system was used twice and the ship drifted over the shelf edge from 99 m to 102 m water-depth respectively from 126 m to 190 m water-depth. In the following geological work on three stations between 700 m and 1600 m water-depth were carried out with multicorer and gravity-corer. During the night POSEIDON steamed towards the oceanographic area west of Dakhla to obtain sediment material and photographs from a non-cape area. This material should be compared to the results that were achieved west of Cape Blanc and Cabo Barbas. On the Dakhla profile on the near shore site in 700 m water-depth we retrieved living sponges with the multicorer. Next to the sedimentological material we also get a video from the sampling procedure. On the Dakhla transect the particle camera and the geological devices were both used twice in greater water-depths between 1000 m and 1600 m. In the afternoon after finishing the Dakhla profile POSEIDON steamed northwards to Cap Bojador, which is in comparison to the other profiles characterized by a lot of submarine channels and small canyons. We started to work in the Cap Bojador area in the early morning of April 10, and started a V-shaped profile with 4 particle-camera profiles in water-depths between 900 m and 1800 m and 6 geological stations in water-depths between 900 m and 2000 m. On site GeoB 7429 we use the particle camera system in one of the submarine canyons to compare the particle content in the water column of a canyon to that of other stations outside the canyon. This profile was finished in the early morning of April 11.. After terminating the geological/camera work on April 12, 2001, POSEIDON took course towards Gran Canaria and the scientific personal fixed and packed their equipment. After completion of all the work and after a great barbecue in the wind shadow of Gran Canaria, POSEIDON continued to Las Palmas, arriving in the early morning of. April 14, ending the cruise POS 272.

5. Preliminary Results

5.1 Particle flux measurements with moored particle traps

(V. Ratmeyer, M. Bergenthal, N. Nowald)

Particle flux measurements off Cape Blanc were carried out since spring of 1988 and show seasonal and short-term variability due to varying productivity and hydrographic conditions.

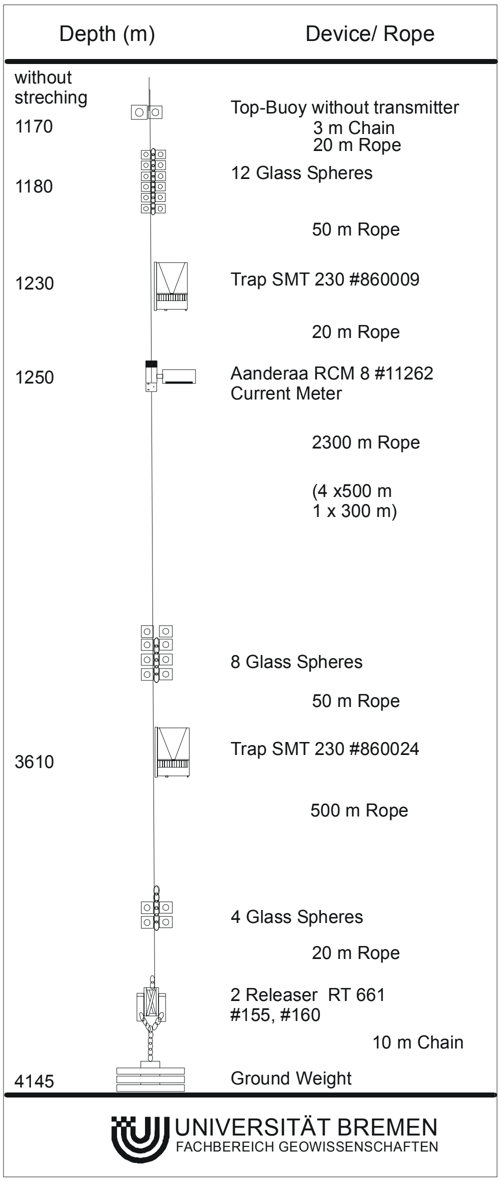

Fig. 3: Sediment trap mooring CB 12 deployed off Cape Blanc

During POS 272 the mooring CB was exchanged. The CB11 sediment trap mooring was recovered on April. 3, 2001. It carried two traps and 2 current meters. All instruments functioned properly with the exception of the lower trap in 3600 m water-depth that did not turned. The mooring was re-deployed on April. 3, with the same devices as the recovered one (CB 12, see Fig. 3). CB 12 will be exchanged in April 2001 on RV METEOR cruise M 53/1.

5.2 Particle camera system

(V. Ratmeyer, N. Nowald)

In-situ particle camera system (ParCa)

The photographic particle camera system ParCa (Ratmeyer and Wefer 1996), was deployed at 22 sites for the in-situ measurement of the vertical size distribution and concentration of particulate matter in the ocean. The system was designed and improved in consideration of similar systems used by Honjo et al. (1984), Asper (1987) and Lampitt (1985). This method provides *in situ* information on the origin and abundance of particles and aggregates (marine snow). In addition to the use of sediment traps, particle flux can be measured even in areas or depths with high lateral transport.

Tab. 2: ParCa profiling stations during POS 272

Station	Water depth	Profile depth
7403	4081	4050
7404	4060	4060
7405	4313	4170
7406	4020	4001
7407	3791	3800
7408	1860	1820
7410	635	620
7411	1213	1180
7412	241	241
7413	509	480
7415	1933	1930
7421	618	618
7422	1061	1061
7423	1632	1632
7425	1813	1813
7428	873	873
7429	858	858
7430	1160	1150

The aim of the deployments was to obtain data of particle abundances in a defined area. Therefore, ParCa was deployed on a station-matrix around the sediment trap site CB at 5 stations. Additionally, ParCa was deployed on three transects along the Mauritanian and Morroconian coast. (Tab. 2). The intention was to compare the particle abundance of the coastal environments within the upwelling system with those off Cape Blanc further offshore.

First observations of the pictures show a distinct difference in the concentration and the size distribution between the CB site and the coastal near profiles. The concentrations on the shelf are much higher than further offshore. Large "stringers" of marine snow aggregates of approximately 40cm in length are common in the upper 200m of the water column along the shelf (GeoB 7410). Aggregates of similar size are seldom found in the Cape Blanc profiles. Various species of plankton and makroplankton are also common in the upper water column. A SeaBird SBE 19 CTD provided data on oceanographic parameters and an optical transmissiometer was used to measure the beam attenuation of the water column. These CTD datasets are useful, to correlate particle maxima or minima with different water layers. Due to the optical resolution limits of the camera, the beam attenuation is useful to measure smallest, suspended particles, which cannot be obtained with a photographic system. The exact quantitative analysis of concentration, shape and size particles in the optical profiles will be performed using a PC-based image analysis system at the University of Bremen.

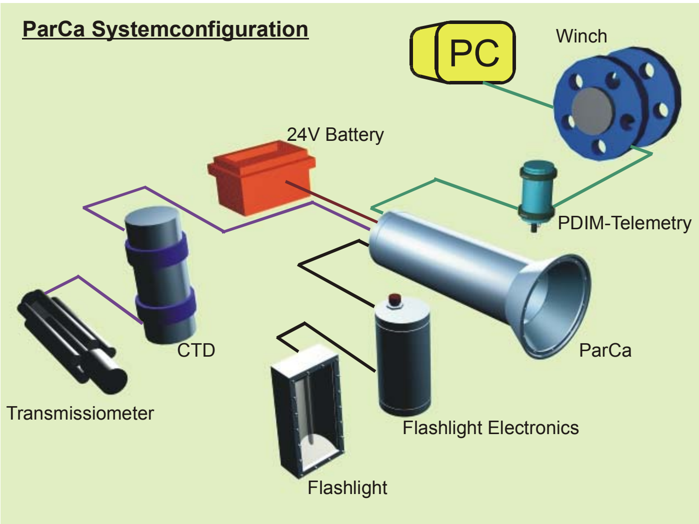

Fig. 4: ParCa: system components and setup

ParCa consists of a 70 mm deep-sea camera (PHOTOSEA 70) with max. 30.5 m film capacity. Two strobes, constructed at the University of Bremen, were installed as light sources. The strobes provide a collimated light beam of 12 cm width and illuminate a total volume of 0.025 m^3. Power Source is a 24V/38 Ah rechargeable lead battery designed for the use to full ocean depth. ParCa can operate in depths up to 6000 m. All devices are mounted in a 200kg galvanised frame (Fig. 4).

Communication with the ship is done by a microcontroller and adapted software. An additionally installed SeaBird PDIM telemetry provided full control of the entire system, via the ships coaxial wire. ParCa was triggered by the CTD´s depth sensor and CTD data were delivered in real time to the ships computer. Pictures were exposed while lowering the system with a speed of 0.5 m/sec at each 10 m of depth.

Video Camera System

In addition to ParCa, a video camera system was used to facilitate the decision if a gravity corer could be deployed at a site or not. Furthermore, the camera system provided video sequences of particle concentrations, abundances and sinking behaviour in the water column and above the sea floor. The video system was attached to the Multicorer or to the ParCa frame.

Tab. 3: VideoCamera System stations during POS 272

Station	Waterdepth	Profile depth
7421	618	618
7422	1061	1061
7423	1632	1632
7425	1813	1813
7428	873	873
7429	858	858

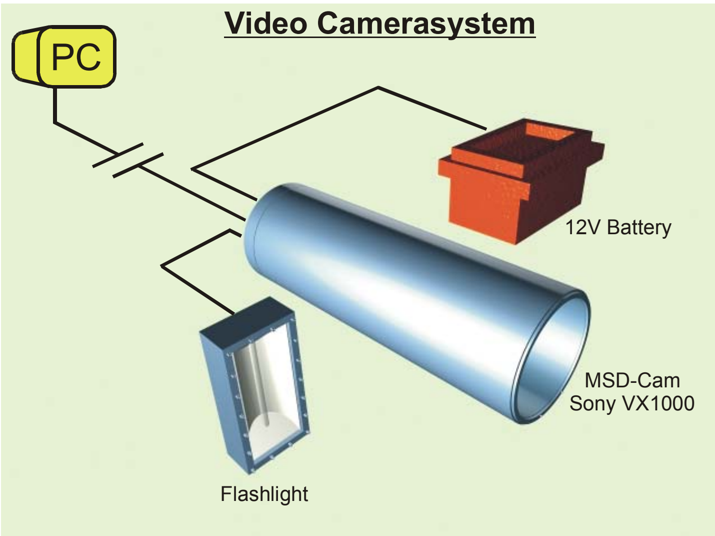

Fig. 5 Underwater video system: components and setup

Video profiles have been obtained on the coastal stations. In all video profiles, the particle concentrations were extremely high. As a first observation, differences have been found in the sinking velocities between the Dakhla and the Cape Bojador stations. Off

Dakhla, the particulate matter seemed to hover above the sea floor, whereas off Cap Bojador the particulate matter sank continiously to the sea floor.

The video system consists of a modified SONY VX 1000 digital 3-chip CCD camera controlled by two PIC microprocessors. The illumination was provided through 2 50 W/12 V halogen lamps, installed into a special housing (Fig. 5). Power source was a 12V lead battery. The camera was programmed via PC to make video sequences of about 20min in a specified time window after the deployment.

5.3 Sediment Sampling

(M. Bergenthal, T. Freudenthal, B. Hamady, M. Held, D. Hofmann, H. Meggers, S. Zizah)

Sediments were recovered at 18 stations on six profiles perpendicular to the NW African margin between 20^{o} and 27^{o} N between Cap Blanc and Cap Bojador. Surface sediments were generally recovered with a multicorer (Tab. 2). A gravity corer with different pipe lengths (3 and 6 m) and a weight of 1.5 tons on top was used at 16 stations to be able to recover deeper sediment sequences.

5.3.1 Sediment surface sampling with multicorer

The main tool for the recovery of undisturbed sediment surfaces and the overlying bottom water was the multicorer equipped with 8 tubes of 10 cm and 4 smaller tubes of 5 cm in diameter. The multicorer was used at 18 stations and mostly the core recovery was good, typically 10 to 12 tubes were filled, and cores of very good quality reaching 34 cm of sediment were recovered from station GeoB 7408 to station GeoB 7431.

At each multicorer station, the overlying bottom water of one of the large tubes was sampled for stable isotope measurements (δ^{13}C and δ^{18}O) at Bremen University. Mostly 4 of the large tubes and 1 of the smaller tubes were usually sampled in 1 cm slices for analysis of C_{org}, benthic and planktic foraminifera and diatoms. Benthic foraminifera samples (down to 5 cm) were stained with a solution of 1g of rose bengal in 1 l ethanol. The other large and small tubes were sampled in 1 cm slices as archives (Tab.4).

Tab. 4. Multicorer sampling, POSEIDON cruise 272

A. Large tubes

GeoB No.	Depth (m)	Recovery (cm)	Corg.	Benthic Forams	Planktic Forams.	Diatoms	Archive
7408-2	1935	28	1	-	-	-	-
7409-1	1216	20	1	2	1	-	3
7410-1	643	28	1	2	1	-	3
7413-2	508	20	1	2	1	-	3
7414-1	1014	20	1	2	1	-	3
7415-1	1906	31	1	2	1	-	2
7417-1	726	24	1	2	1	-	3
7418-1	1150	23	1	2	1	-	3
7419-1	1537	34	1	2	1	-	3
7420-1	676	9	1	-	1	-	1
7423-2	1624	19	1	2	1	-	4
7424-1	1063	9	1	-	-	-	-
7425-2	1810	21	1	2	1	-	2
7426-1	1487	5	1	-	-	-	-
7427-1	1101	15	1	2	1	-	2
7428-1	918	13	1	2	1	-	2
7430-2	1170	13	1	2	1	-	2
7431-1	1951	34	1	2	1	-	3

Tab. 4 continued - Multicorer sampling, POSEIDON cruise 272

B. Small tubes

GeoB No.	Depth (m)	Recovery (cm)	Corg.	Benthic Forams	Planktic Forams.	Diatoms	Archive
7408-2	1935	28	-	-	1	1	2
7409-1	1216	20	-	-	-	1	2
7410-1	643	28	-	-	-	1	1
7413-2	508	20	-	-	-	1	1
7414-1	1014	20	-	-	-	1	1
7415-1	1906	31	-	-	-	1	1
7417-1	726	24	-	-	-	1	-
7418-1	1150	23	-	-	-	1	1
7419-1	1537	34	-	-	-	1	-
7420-1	676	9	-	-	-	1	-
7423-2	1624	19	-	-	-	1	1
7424-1	1063	9	-	-	-	-	-
7425-2	1810	21	-	-	-	1	1
7426-1	1487	5	-	-	-	-	-
7427-1	1101	15	-	-	-	1	1
7428-1	918	13	-	-	-	1	1
7430-2	1170	13	-	-	-	1	1
7431-1	1951	34	-	-	-	1	1

5.3.2 Sediment sampling with gravity corer

15 gravity- cores, in a total of 55 m of sediment were recovered from 16 stations with recoveries, which vary between 0.23 m and 5.75 m. Gravity coring was unsuccessful at station GeoB 7413, were only some material was recovered within the core-catcher. At two stations we obtained an overpenetration of the gravity corer of 30 cm at GeoB 7408-3 and 20 cm at GeoB 7419-2, which hopefully could be compensated by the good recovery of the respective multicorer.

Due to time restrictions, no cores were opened and sampled on board. This will be done at the University of Bremen.

5.3.3 First shipboard results

Unfortunately, the sediment cores taken during POS 272 were not opened onboard. According to this, we did not have a lot of information about the quality of the sediment cores. However, the descriptions of the sediments from the surface sediment and the core catcher allow a first assessment of the time-resolution and the quality of the recovered sediments. From this it is obvious that the research area could be subdivided into two realms. The sediment characteristics off Cape Blanc and Cabo Barbas in both the surface and the core catcher are very similar for all cores, and consisted mostly of overall homogeneous, foraminfera bearing nannofossil oozes and clayey mud. The most distinct feature for all cores at Cape Blanc and Cabo Barbas was the olive green sediment colour. It is speculated that this uniform sediments are reflecting no glacial to interglacial transitions, and thus are promising high Holocene sedimentation rates (>20 cm/1000 years). High resolution paleoclimatic studies off NW-Africa are restricted until now on the ODP site 658 that is located more offshore at 20°45`N; 18°35`W than the recovered cores. This core has a Holocene sedimentation rate of 17 cm/1000 years and allows the reconstruction of the Holocene climate in detail (Zhao et al., 1995; Harris et al., 1996; de Menocal et al., 2000). However, from this studies it is not understand, if the observed Holocene variability in productivity and surface water temperature is caused by the variability of the upwelling-intensity or by the changing intensity of the cold Canary current. With the recovery of the POS 272 sediment cores we hope to contribute to that topic. Comparative geochemical and paleontological analyses on sediment cores from POS 272 and from previous METEOR cruises in the Canary Islands region will give the potential to reconstruct the history of the NW African upwelling and the Eastern Boundary Current circulation in detail (compare with Freudenthal et al., in press; Henderiks et al., in press; Meggers et al., in press).

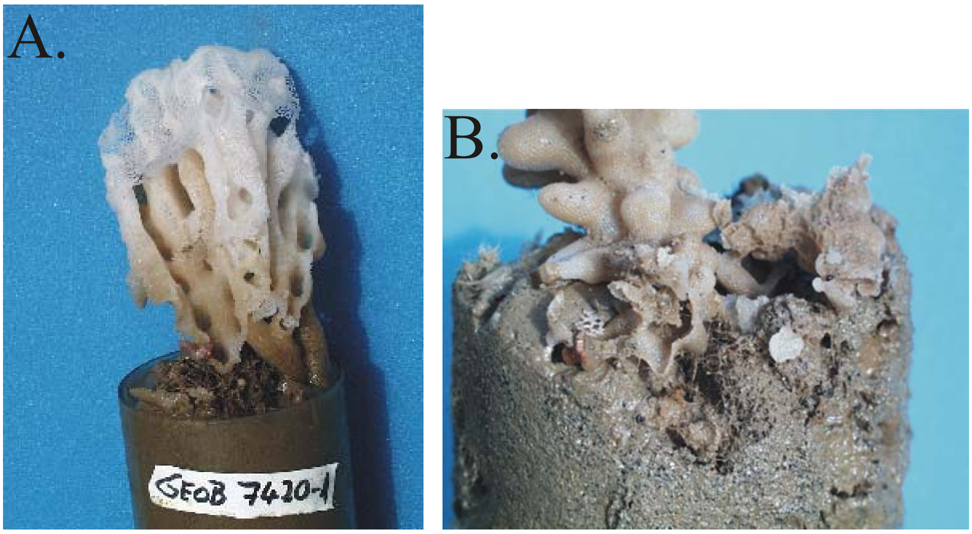

Fig. 6: Living sponges on corals from GeoB station 7420-1 off Dakhla, NW-Africa (A. Sponge (15 cm high), B. Detail picture of the basis of another sponge that is grown on coral fragments, black coarse grains indicate volcanic particles in the underlying sediment).

In contrast to the southern part of the investigated NW African margin during POS 272 the profiles off Dakhla and Cap Bojador are characterized by bioturbated, brown foraminifera-bearing nannofossil muds with distinct intervals of coarser sandy sections. In these cores changes in the sediment colour are obvious reflecting the transitions between glacial and interglacial. Thus, the sedimentation rates in these cores are lower than off Cap Blanc and Cabo Barbas. At Dakhla we found living sponges within four tubes of the multicorer (Fig. 6). Surprisingly, the video of the sampling procedure with the multicorer shows that this feature is a very local one, since the surrounding of the sampling site is free of sponge/coral structures.

Since the NE Atlantic continental margin displays also a wide range of sediment transport systems with both along-slope and down-slope processes, the Cap Bojador area is in comparison to the profiles off Dakhla, Cabo Barbas and Cap Blanc subject to infrequent but large-scale mass movements, giving rise to debris flows and turbidity currents. Thus, Cap Bojador is characterized by various submarine channels and larger canyons (Weaver et al., 2000) and the sediments are characterized by more sandy sediments.

6. References

Asper, V.L. 1987. Measuring the flux and sinking speed of marine snow aggregates. *Deep-Sea Research I.*, 34, 1-17.

Freudenthal, T., H. Meggers, A. Moreno, J. Henderiks and G. Wefer in press. Variability of upwelling intensity and filament activity during the last 250 kyr. *Deep-Sea Research II* (CANIGO Special. Issue).

Harris, P.G., M. Zhao, A. Rosell-Melé, R. Tiedemann, M. Sarnthein and J.R. Maxwell 1996. Chlorin accumulation rate as a proxy for Quaternary marine primary productivity. *Nature*, 383, 63-65.

Henderiks, J., T. Freudenthal, H. Meggers, F. Abrantes, S. Nave, E. Salqueiro, P. Freitas, J. Bollmann and H. Thierstein in press. Glacial-interglacial variability of particle accumulation in the Canary Basin: A time-slice approach. *Deep-Sea Research II* (CANIGO special issue).

Honjo, S., K.W. Doherty, Y.C. Agrawal and V.L.Asper 1984. Direct optical assessment of large amorphous aggregates (marine snow) in the deep ocean. *Deep-Sea Research I*, 31, 67-76.

Lampitt, R.S 1985. Evidence for the seasonal deposition of detritus to the deep-sea floor and its subsequent resuspension. *Deep-Sea Research I*, 31, 885-897.

Marret, F. and J.-L.Turon 1994. Paleohydrology and paleoclimatology off Northwest Africa during the last glacial-interglacial transition and the Holocene: Palynological evidences. *Marine Geology*, 118, 107-117.

Martinez, P., P. Bertrand, G.B. Shimmield, K. Cochrane, F.J. Jorissen, J. Foster and M. Dignan 1999. Upwelling intensity and ocean productivity changes off Cape Blanc (northwest Africa) during the last 70,000 years: geochemical and micropalaeontological evidence. *Marine Geology*, 158, 57-74.

Meggers, H., T. Freudenthal, S. Nave, J. Targarona, F. Abrantes and P. Helmke in press. Assessment of geochemical and micropaleontological sedimentary parameters as proxies of surface water properties in the Canary Islands region. *Deep-Sea Research II* (CANIGO Special Issue).

de Menocal, P., J. Ortiz, T. Guilderson and M. Sarnthein 2000. Coherent high- and low-latitude climate variability during the Holocene warm period. *Science*, 288, 2198-2202.

Ratmeyer, V. and G. Wefer 1996. A high resolution camera system (ParCa) for imaging particles in the ocean: System design and results from profiles and a three-month deployment. *Journal of Marine Research*, 54, 589-603.

Sarnthein, M., K. Winn, J.-C. Duplessy and M.R. Fontugne 1988. Global variations of surface ocean productivity in low and mid latitudes: influence of CO_2 reservoirs of the deep ocean and atmosphere during the last 21,000 years. *Paleoceanography* 3, 361-399.

Weaver, P.P.E., R.B. Wynn, N.H. Kenyon and J. Evans 2000. Continental margin sedimentation, with special reference to the north-east Atlantic margin. *Sedimentology*, 47, 239-256.

Winn, K., M. Sarnthein and H. Erlenkeuser 1991. $\delta^{18}O$ stratigraphy and chronology of Kiel sediment cores from the East Atlantic. *Berichte – Reports, Geologisch-Paläontologisches Institut der Universität Kiel*, 45.

Zhao, M., N.A.S. Beveridge, N.J. Shackleton,, M. Sarnthein and G. Eglington 1995. Molecular stratigraphy of cores off north-west Africa: Sea surface temperatures history over the last 80 ka. *Paleoceanography*, 10; 661-675.

7. Stationlist

GeoB #	Ships #	Date 2001	Device	Time seafloor/ max. wire -length [UTC]	Latitude	Longitude	Water depth [m]	Recovery	Remarks
7401-1	208	03.04.	CB11	07:05	21°16.8'N	20°43.0'W	4216		recovery of mooring CB11, lower trap failed
7402-1	209	03.04.	CB12	13:02	21°16.0'N	20°46.5'W	4145		deployment of mooring CB12
7403-1	210	03.04.	PARCA	17:00	21°08.2'N	20°40.0'W	4081		max. wire length 808 m, CTD failed
7403-2			PARCA	22:34	21°08.8'N	20°40.1'W	4080		max. wire length 4000 m
7404-1	211	04.04.	PARCA	06:37	20°38.0'N	21°10.0'W	4060		max. wire length 4000 m
7405-1	212	04.04.	PARCA	17:49	21°33.0'N	21°10.0'W	4313		max. wire length 4100 m
7406-1	213	05.04.	PARCA	05:32	21°38.0'N	20°10.0'W	4020		max. wire length 3950 m
7407-1	214	05.04.	PARCA	14:09	20°38.0'N	20°09.8'W	3791		max. wire length 3745 m
7408-1	215	06.04.	PARCA	06:55	20°17.2'N	18°15.0'W	1872		max. wire length 1840 m
7408-2			MUC	08:32	20°17.5'N	18°14.9'W	1935	28 cm	
7408-3			SL6	10:09	20°17.9'N	18°15.2'W	1840	574 cm	overpenetration , ca. 30 cm lost (Top), Core Catcher
7409-1	216	06.04.	MUC	14:07	20°23.6'N	18°01.1'W	1216	20 cm	
7409-2			SL6	15:15	20°23.6'N	18°01.1'W	1216	155 cm	tube bended
7410-1	217	06.04.	MUC	18:25	20°27.0'N	17°51.0'W	643	28 cm	
7410-2			SL3	19:06	20°26.9'N	17°51.1'W	641	274 cm	
7410-3			PARCA	20:01	20°27.0'N	17°51.0'W	635		max. wire length 620 m
7411-1	218	06.04.	PARCA	21:56	20°23.6'N	18°01.1'W	1220		max. wire length 1180 m
7412-1	219	07.04.	PARCA	01:43	20°35.7'N	17°41.8'W	241		max. wire length 235 m
7413-1	220	07.04.	PARCA	05:53	20°38.8'N	17°50.7'W	508		
7413-2			MUC	07:03	20°38.8'N	17°50.7'W	508	20 cm	
7413-3			SL3	08:40	20°38.9'N	17°50.6'W	509		Mollusk shill in the core catcher
7414-1	221	07.04.	MUC	10:36	20°43.1'N	18°00.0'W	1014	20 cm	
7414-2			SL6	11:34	20°43.2'N	18°00.0'W	1010	439 cm	
7415-1	222	07.04.	MUC/ CAM	15:30	20°48.3'N	18°15.7'W	1906	31 cm	
7415-2			SL6	16:28	20°48.3'N	18°15.7'W	1911	575 cm	overpenetration, ca. 40 cm lost

GeoB #	Ships #	Date 2001	Device	Time seafloor/ max. wire -length [UTC]	Latitude	Longitude	Water depth [m]	Recovery	Remarks
									(Top), Core Catcher
7415-3			PARCA	19:02	20°48.6'N	18°15.7'W	1906		max. wire length 1925 m
7416-1	223	08.04.	UWV	07:00	21°46.4'N	17°24.1'W	100		drifted between 99 and 102 m water depth
7416-2			UWV		21°47.6'N	17°26.2'W	236		drifted between 190 and 126 m water depth
7417-1	224	08.04.	MUC	11:37	21°47.8'N	17°28.7'W	726	24 cm	
7417-2			SL3	12:23	21°47.6'N	17°28.3'W	657	100 cm	
7418-1	225	08.04.	MUC	14:24	21°50.6'N	17°35.2'W	1150	23 cm	
7418-2			SL6	15:29	21°50.8'N	17°35.2'W	1150	267 cm	
7419-1	226	08.04.	MUC	17:25	21°53.1'N	17°46.3'W	1537	34 cm	
7419-2			SL6	18:50	21°53.1'N	17°46.3'W	1537	575 cm	overpenetration, ca. 20 cm lost (Top), Core Catcher
7420-1	227	09.04.	MUC/ CAM	16:39	24°09.9'N	16°47.3'W	676	9 cm	living sponges on corals in tubes,
7421-1	228	10.04.	PARCA/ CAM	00:27	24°09.9'N	16°46.6'W	618		sea floor drifting profile with MSD camera
7422-1	229	10.04.	PARCA/ CAM	02:24	24°12.4'N	16°50.7'W	1067		max. wire length 1056 m, sea floor drifting profile with MSD camera
7423-1	230	10.04.	PARCA/ CAM	05:45	24°20.2'N	17°04.1'W	1623		max. wire length 1673 m, sea floor drifting profile with MSD camera
7423-2			MUC	07:41	24°20.3'N	17°04.2'W	1624	19 cm	
7423-3			SL6	08:55	24°20.3'N	17°04.1'W	1625	555 cm	Core Catcher
7424-1	231	10.04.	MUC	12:17	24°12.6'N	16°50.6'W	1063	9 cm	
7424-2			SL3	13:15	24°12.8'N	16°50.6'W	1066	23 cm	
7425-1	232	11.04.	PARCA/ CAM	06:21	25°55.2'N	16°04.9'W	1814		max. wire length 1810 m
7425-2			MUC	08:03	25°55.2'N	16°05.1'W	1810	21 cm	
7425-3			SL6	09:21	25°55.1'N	16°05.2'W	1814	433 cm	Core Catcher
7426-1	233	11.04.	MUC	12:24	25°59.2'N	15°52.0'W	1487	5 cm	only one tube filled
7427-1	234	11.04.	MUC	14:24	26°01.9'N	15°42.2'W	1101	15 cm	
7427-2			SL6	15:37	26°01.8'N	15°41.9'W	1109	473 cm	Core Catcher

GeoB #	Ships #	Date 2001	Device	Time seafloor/ max. wire -length [UTC]	Latitude	Longitude	Water depth [m]	Recovery	Remarks
7428-1	235	11.04.	MUC	18:04	26°06.3'N	15°28.6'W	918	13 cm	
7428-2			SL6	18:44	26°06.3'N	15°28.6'W	917	424 cm	Core Catcher
7428-3			PARCA/ CAM	20:51	26°06.3'N	15°28.6'W	875		max. wire length 874 m
7429-1	236	11.04.	PARCA/ CAM	23:19	26°11.4'N	15°19.4'W	858		drifting profile within a Canyon, max. wire length 1012 m
7430-1	237	12.04.	PARCA/ CAM	06:08	26°22.9'N	15°09.1'W	1170		max. wire length 1150 m
7430-2			MUC	07:32	26°23.0'N	15°09.0'W	1170	13 cm	
7430-3			SL6	08:28	26°23.0'N	15°09.0'W	1165	547 cm	Core Catcher
7431-1	238	12.04.	MUC	11:11	26°28.6'N	15°15.5'W	1951	34 cm	
7431-2			SL6	12:03	26°28.6'N	15°15.5'W	2016	61 cm	

CAM – Video camera
CB – Cape Blanc mooring
MUC – Multicorer
PARCA – Particle camera system
SL – gravity corer
UWV – Under water video

9. Acknowledgements

The scientific crew of cruise POS 272 gratefully acknowledges the very good co-operation and technical assistance of Capitain Klaaßen, the officers and crew, who substantially contributed to the overall success of this expedition.

We also like to address our thanks to the IfM Kiel in person Prof. G. Kortum for his help in the planning and realisation of the cruise.

We acknowledge the financial support of the Deutsche Forschungsgemeinschaft (grant no. WE 992/33-1).

Appendix

(Core Descriptions, which were done after the cruise at the University of Bremen)

Legend for stratigraphic columns

Lithology

one major component

calcareous

- foraminiferal ooze
- nannofossil ooze

siliceous

- siliceous ooze
- diatom ooze

terrigenous

- clay
- mud
- sand

mixtures

calcareous

- nannofossil-bearing foram ooze
- foram-nannofossil ooze or nannofossil-foram ooze
- foram-bearing nannofossil ooze

siliceous

- diatomaceous nannofossil ooze or diatom-bearing nannofossil ooze

terrigenous

- clayey nannofossil ooze or clay-bearing nannofossil ooze
- clayey muddy nannofossil ooze or clay-mud-bearing nannofossil ooze
- nannofossil clay
- nannofossil muddy clay or nannofossil-mud-bearing clay
- nannofossil clayey mud or nannofossil-clay-bearing mud

admixtures

calcareous

- foram-bearing
- nannofossil-bearing

siliceous

- siliceous
- diatom-bearing

terrigenous

- clay-bearing
- mud-bearing
- sand-bearing

Structures

- weakly bedded
- bedded/laminated
- mm / cm / dm — dimension of bedding
- scoured bedding
- S — bioturbated (<30% of sediment)
- SS — bioturbated (<30-60% of sediment)
- SSS — bioturbated (>60% of sediment)
- fining upward
- coarsening upward
- erosiv contact
- WW — wavy bedding
- graded bedding

Fossils

- shells
- shell fragments
- megafossils
- cc — carbonatic concretion

Colour

Munsell value

8, 7, 6, 5, 4, 3, 2

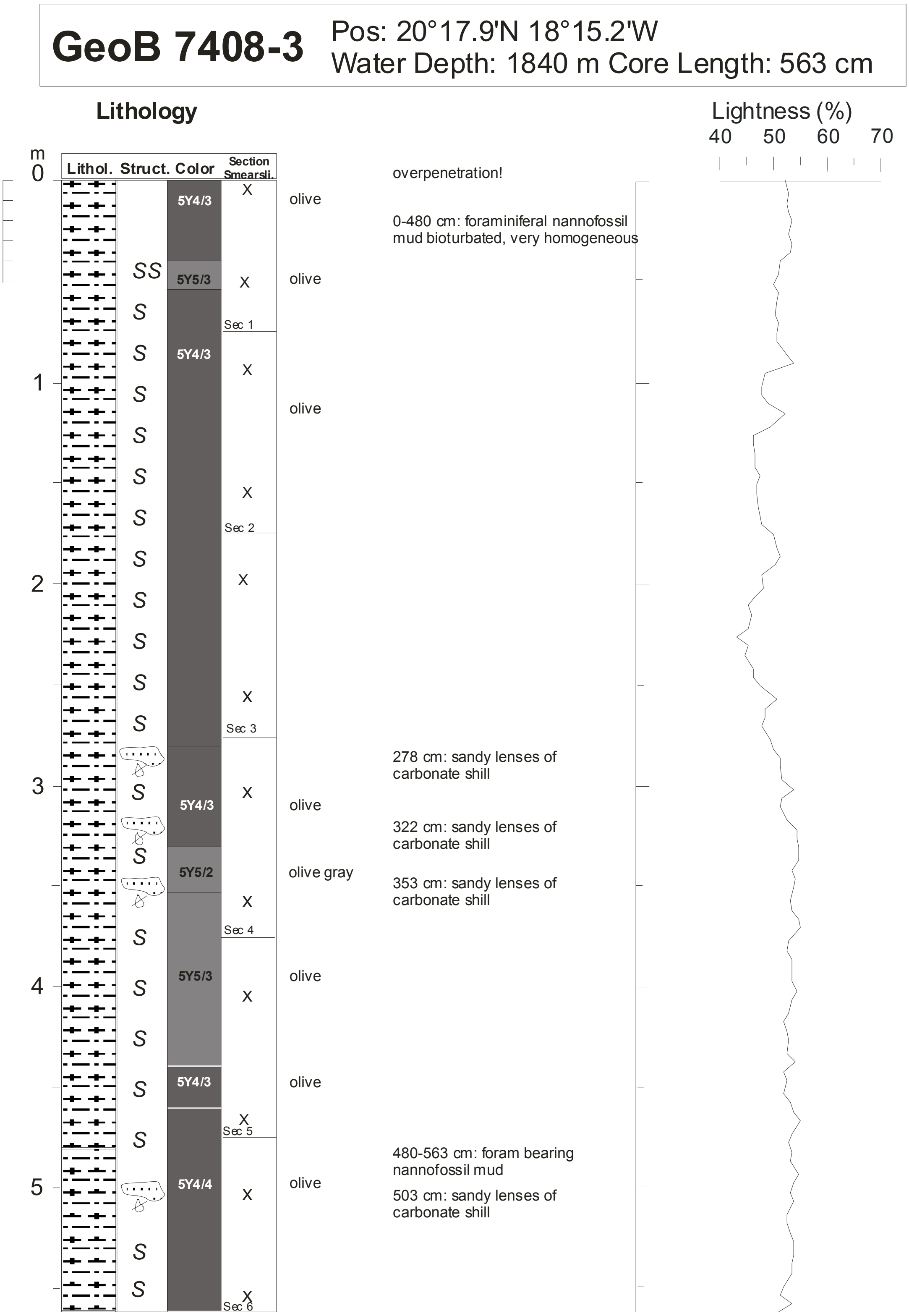

Fig. A1: Core description and lightness of core GeoB 7408-3

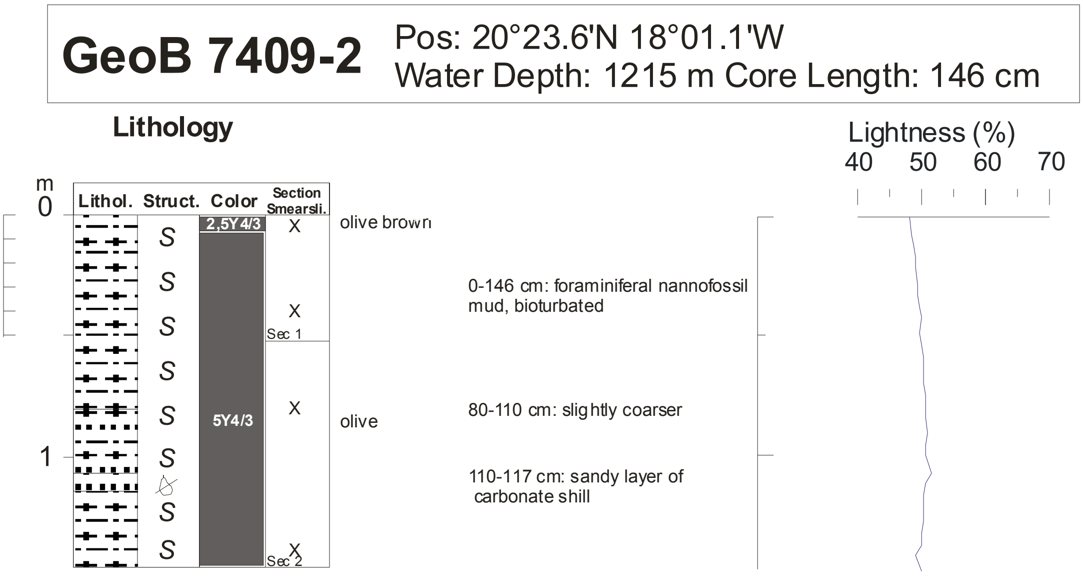

Fig. A2: Core description and lightness of core GeoB 7409-2

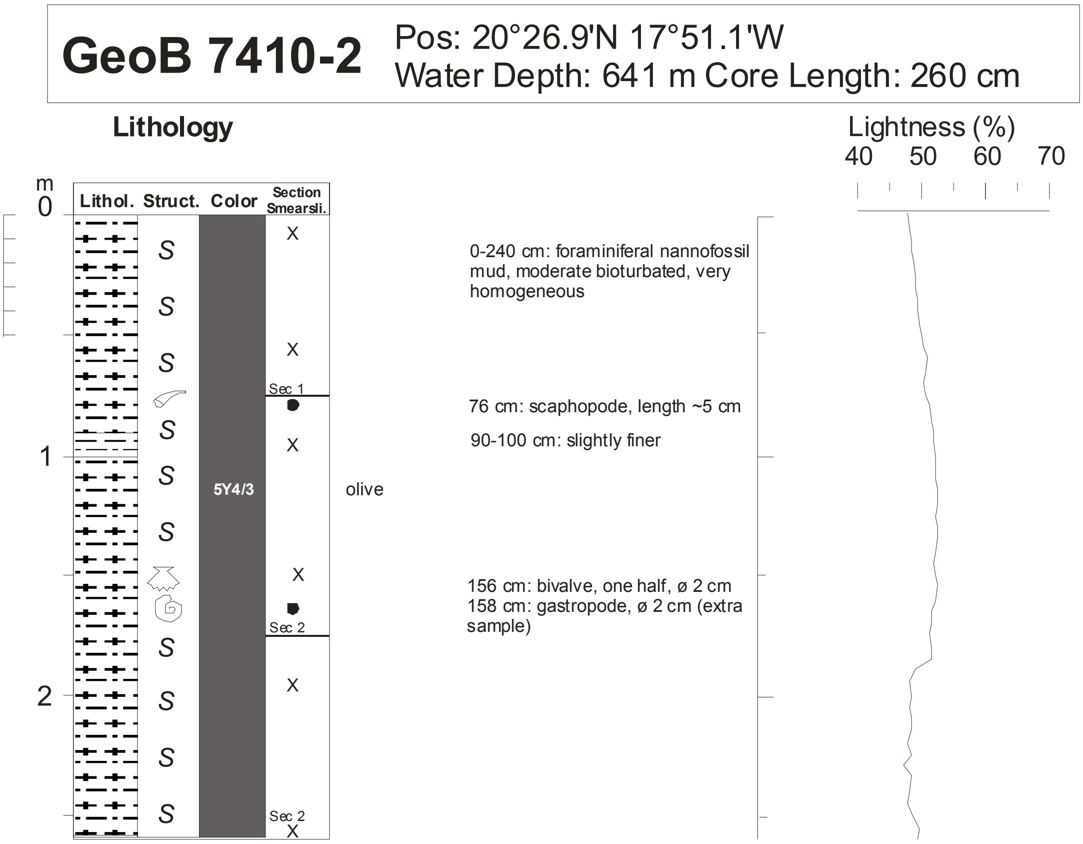

Fig. A3: Core description and lightness of core GeoB 7410-2

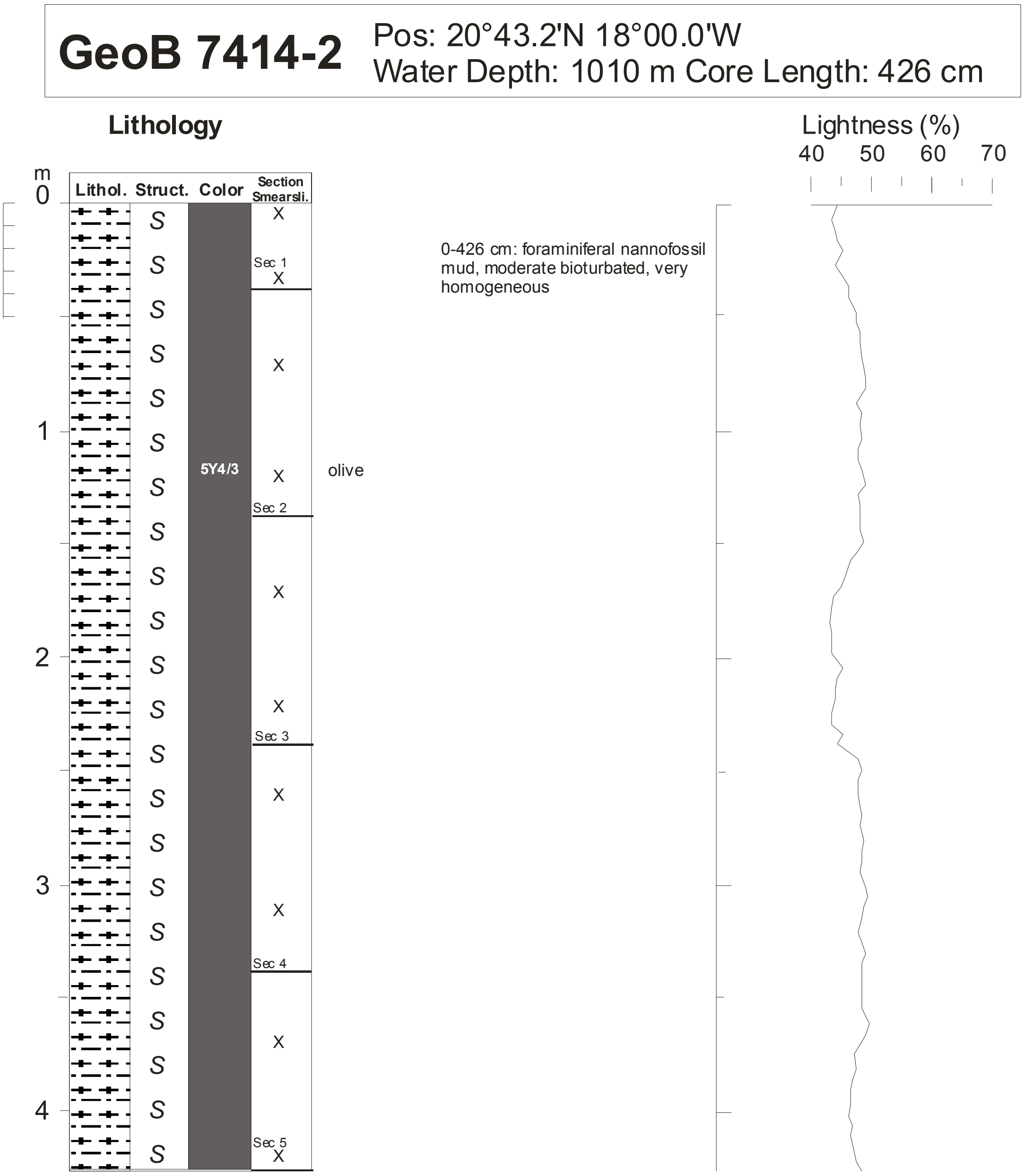

Fig. A4: Core description and lightness of core GeoB 7414-2

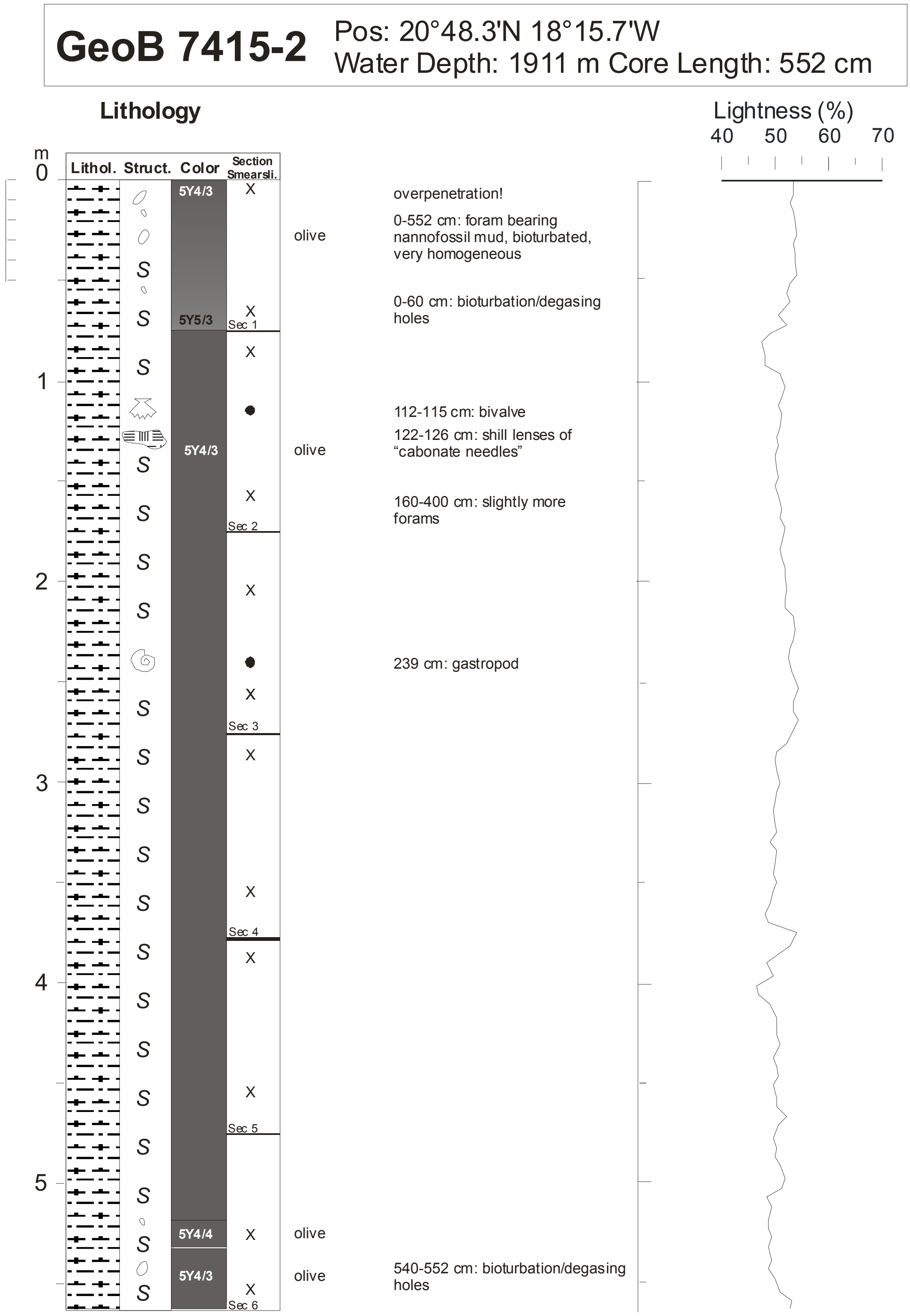

Fig. A5: Core description and lightness of core GeoB 7415-2

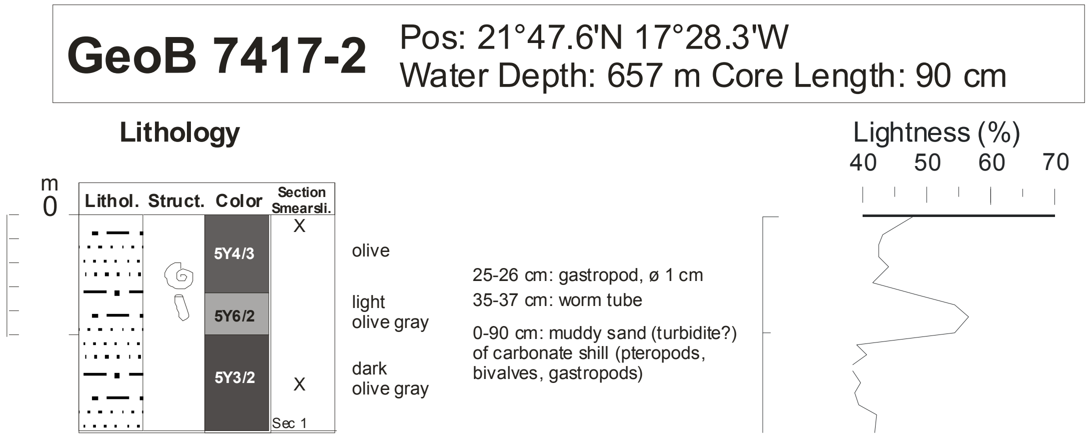

Fig. A6: Core description and lightness of core GeoB 7417-2

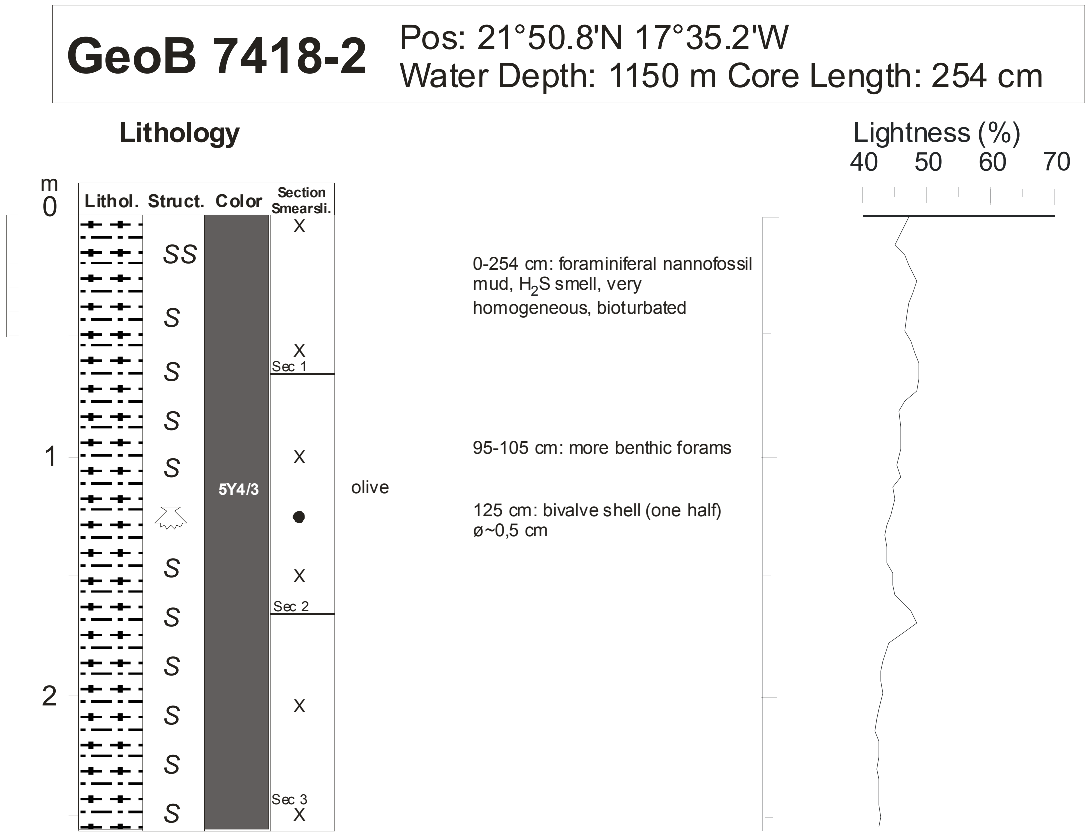

Fig. A7: Core description and lightness of core GeoB 7418-2

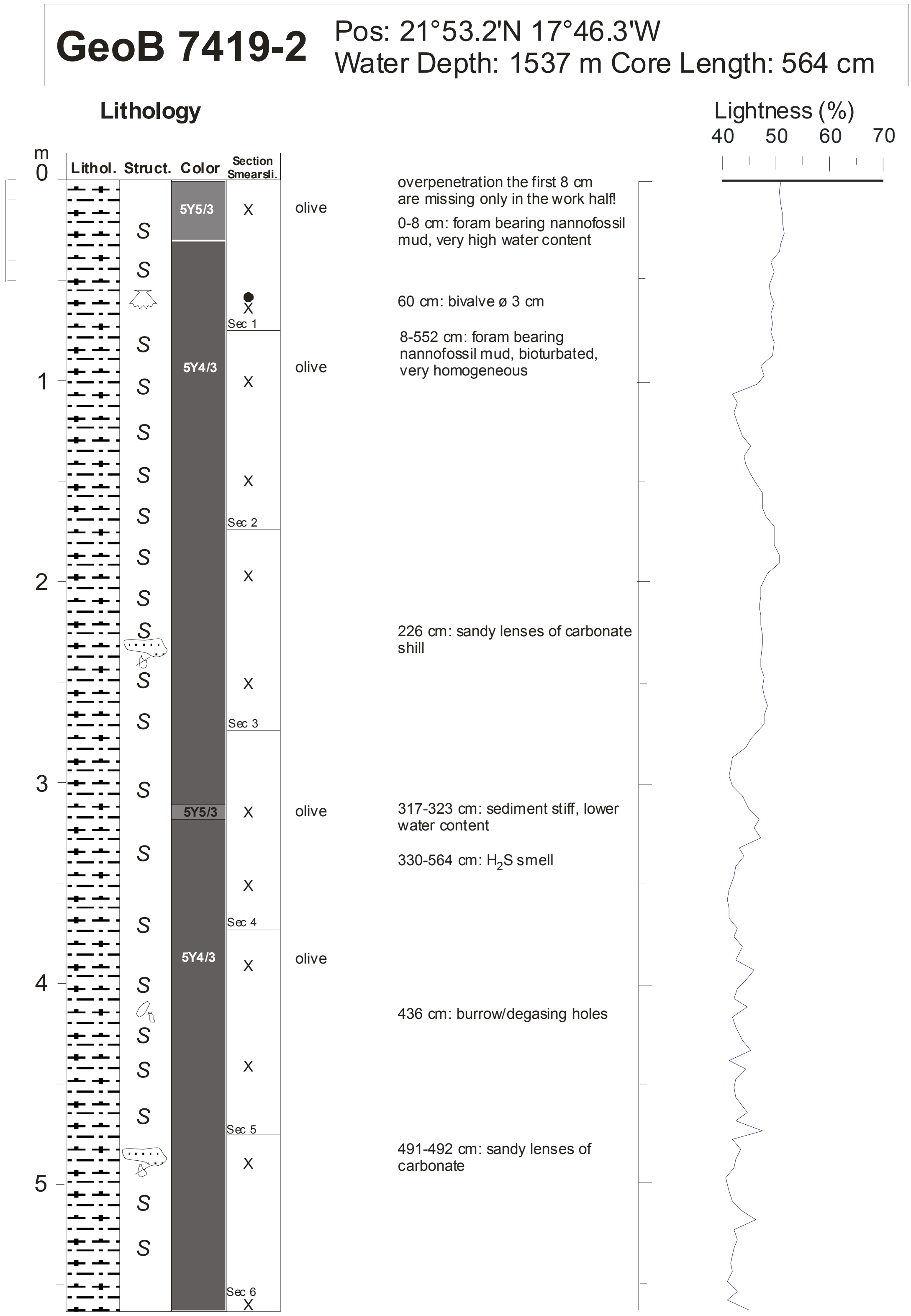

Fig. A8: Core description and lightness of core GeoB 7419-2

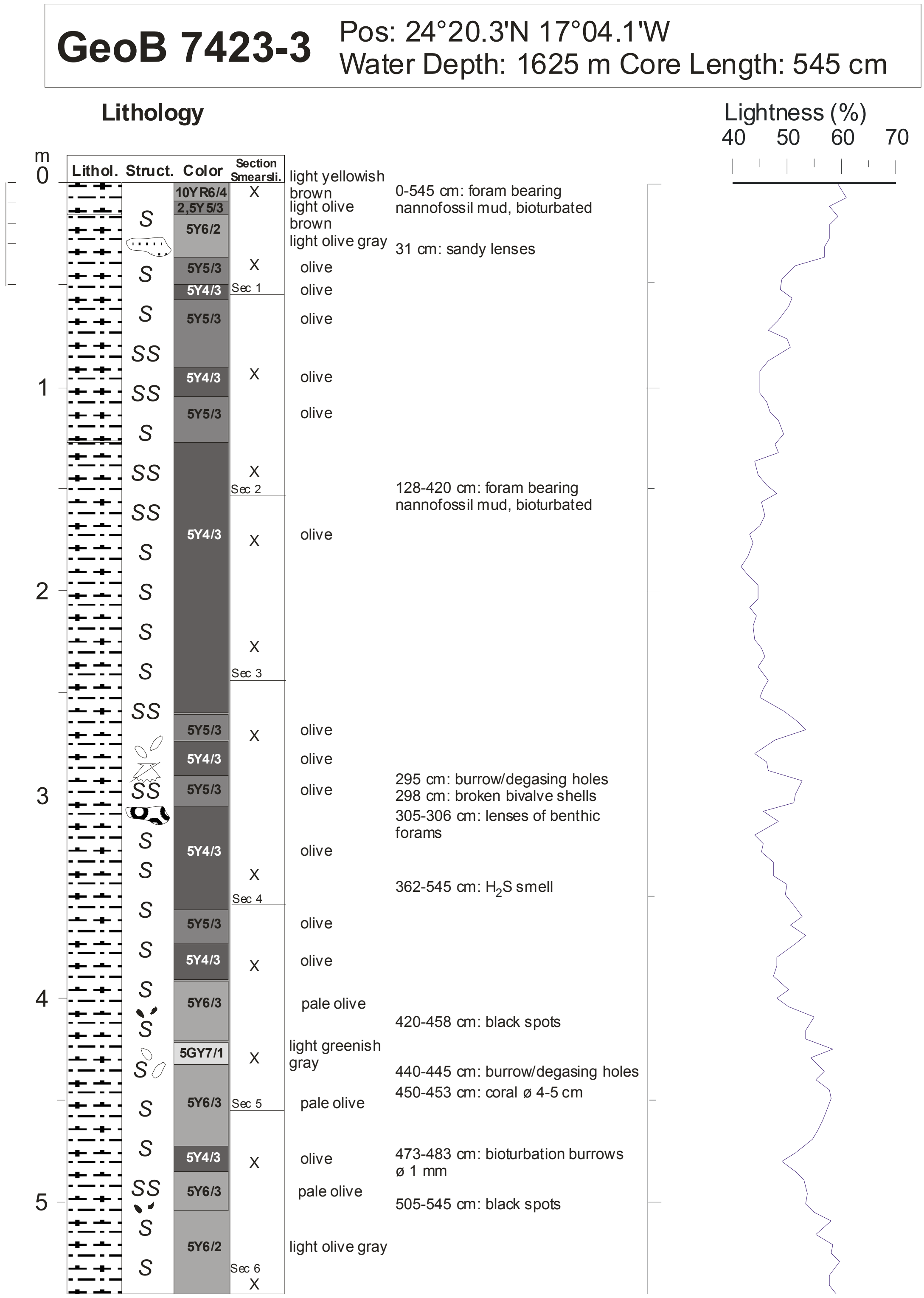

Fig. A9: Core description and lightness of core GeoB 7423-3

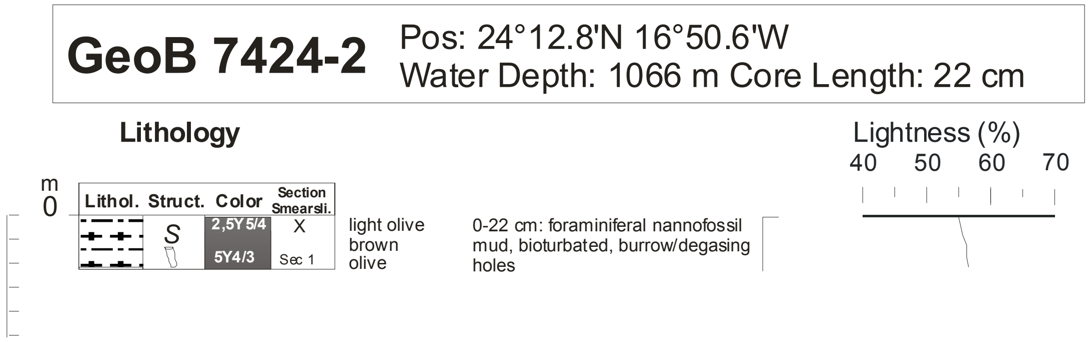

Fig. A10: Core description and lightness of core GeoB 7424-2

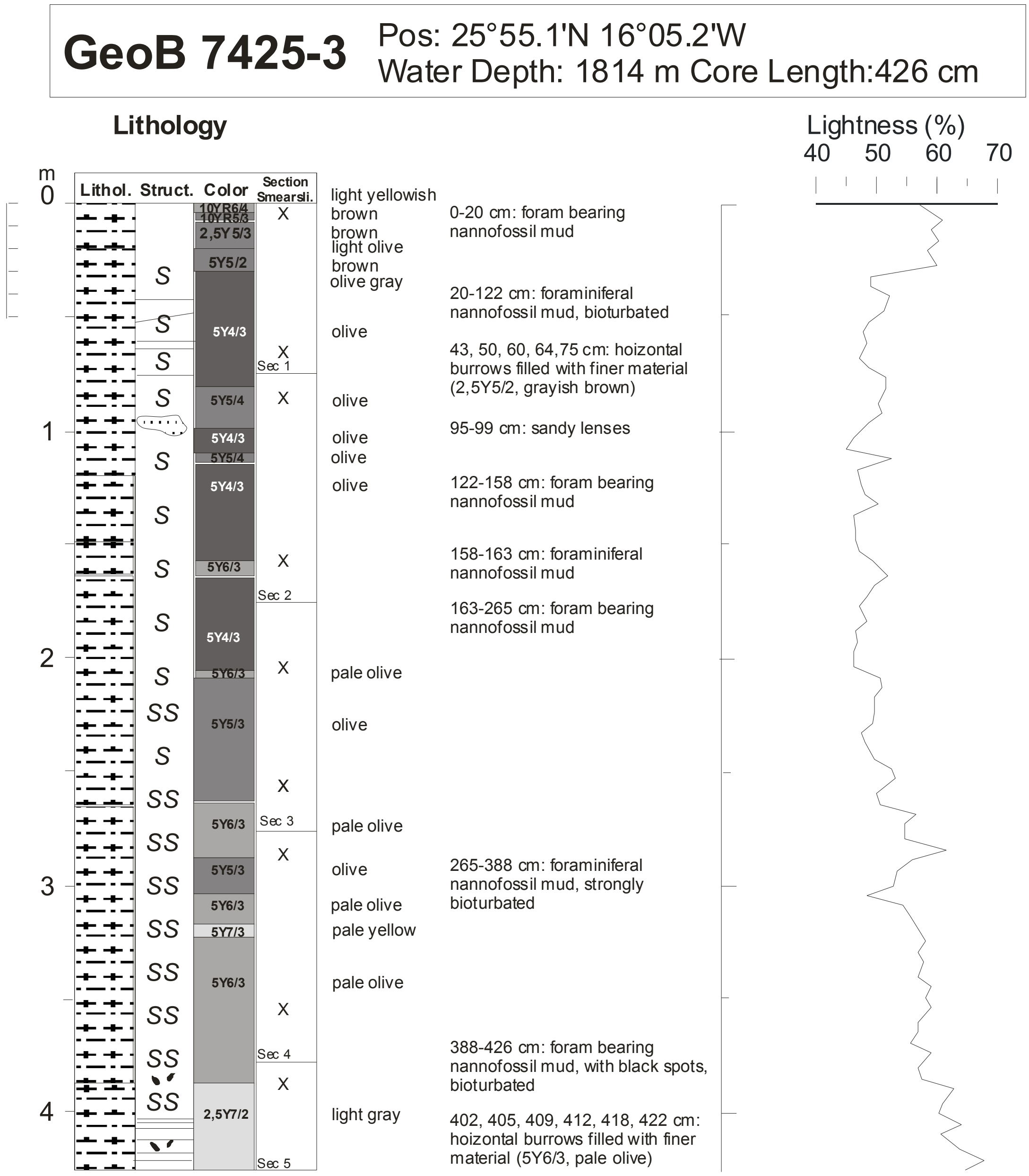

Fig. A11: Core description and lightness of core GeoB 7425-3

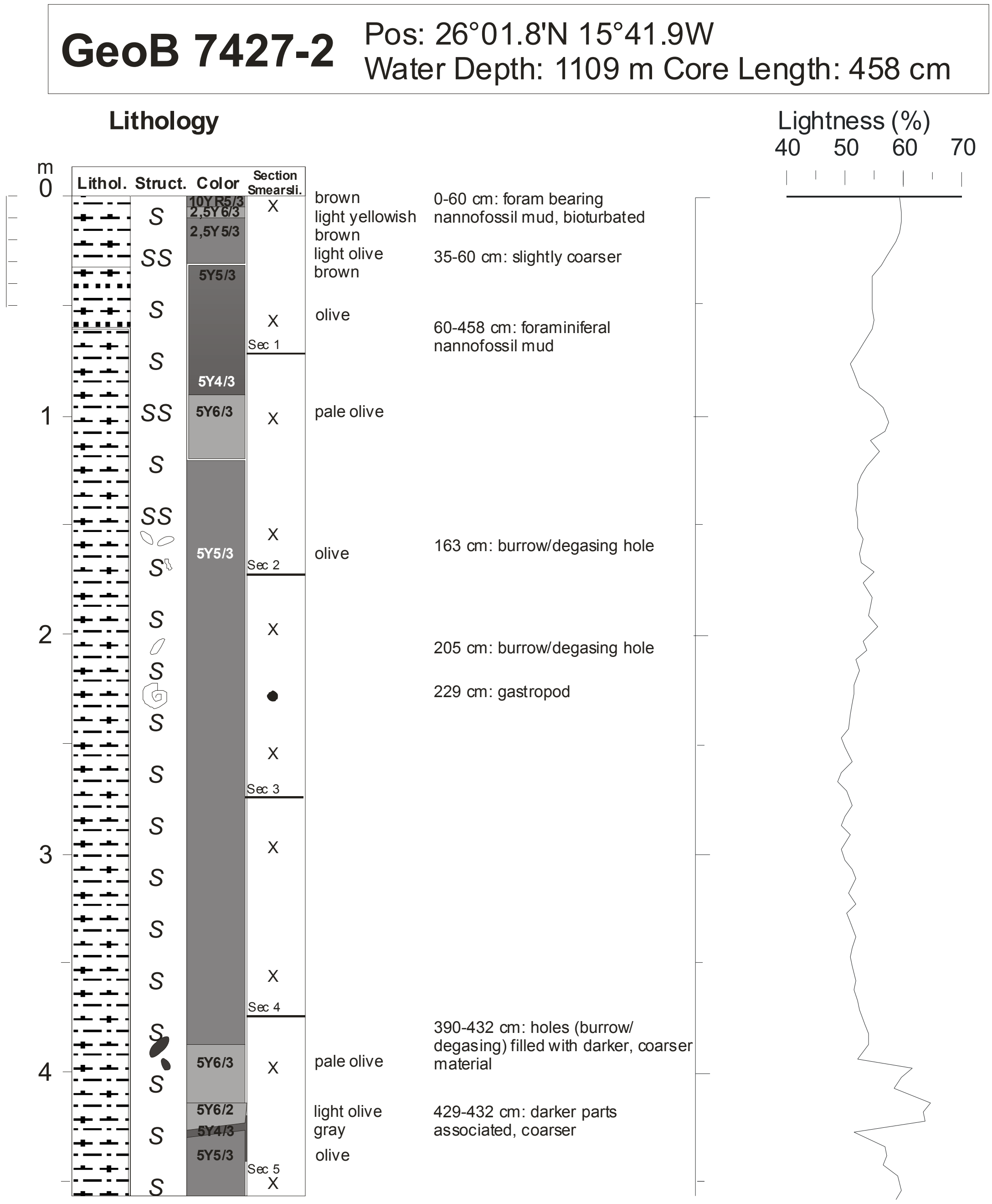

Fig. A12: Core description and lightness of core GeoB 7427-2

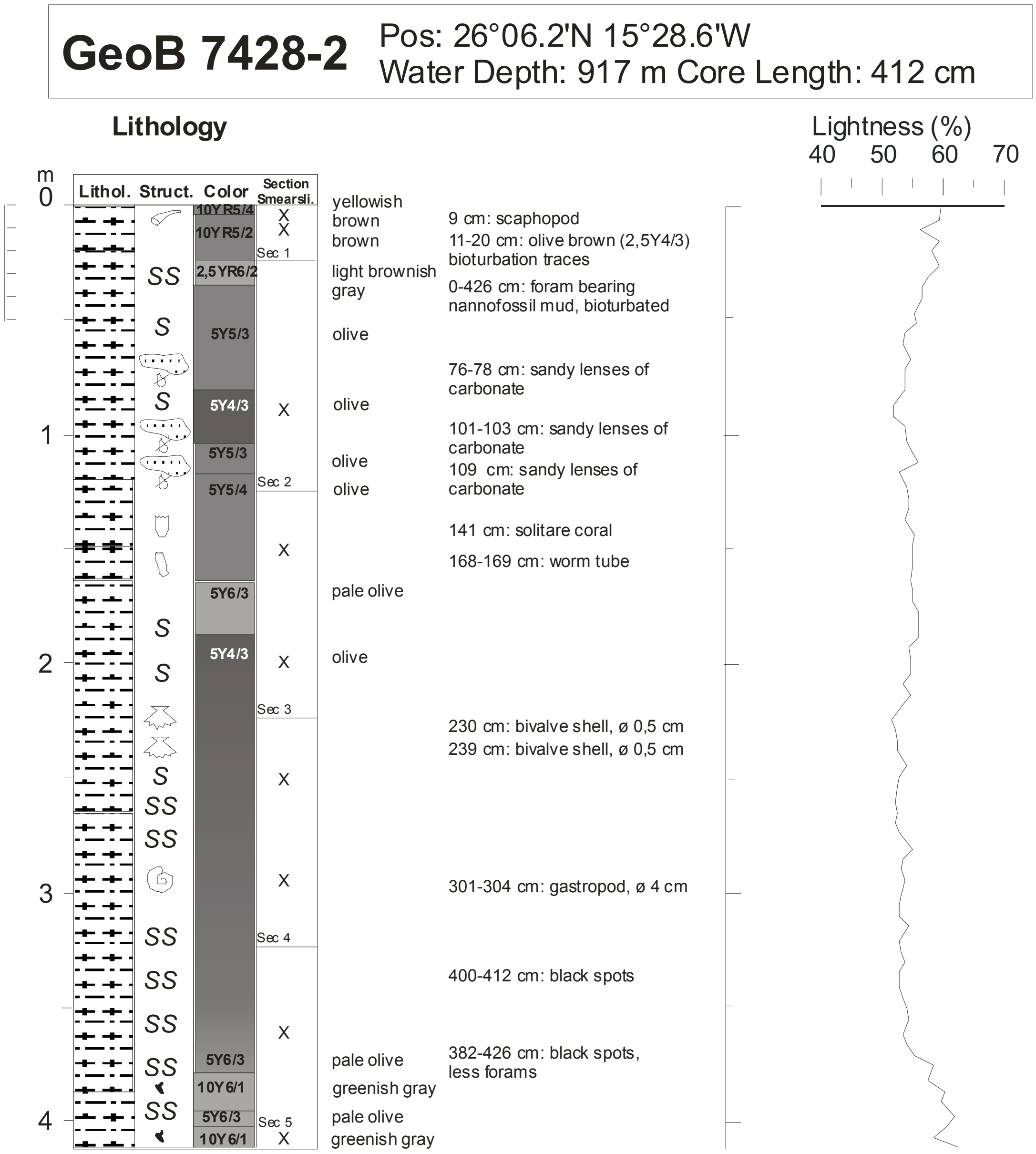

Fig. A13: Core description and lightness of core GeoB 7428-2

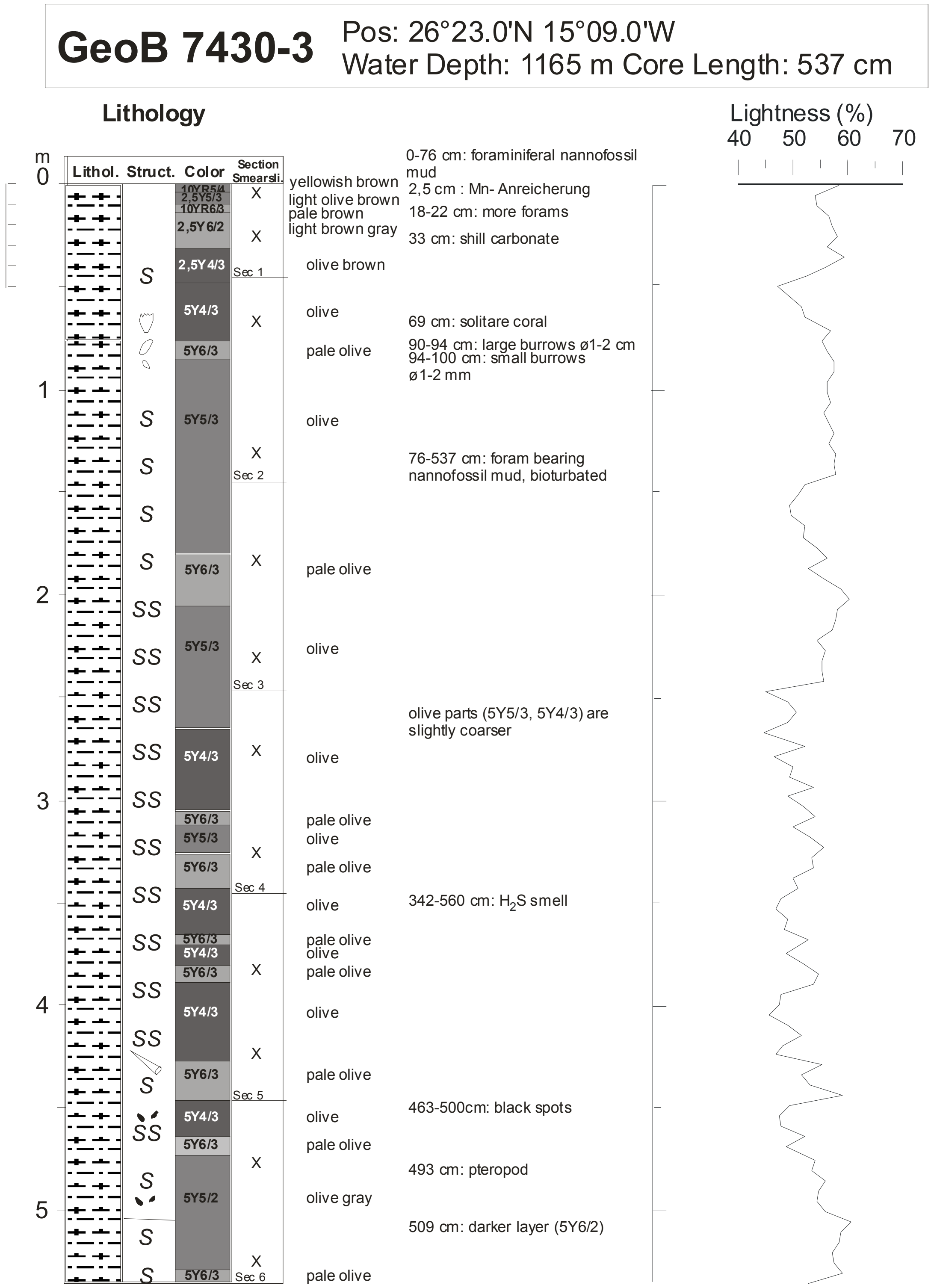

Fig. A14: Core description and lightness of core GeoB 7430-3

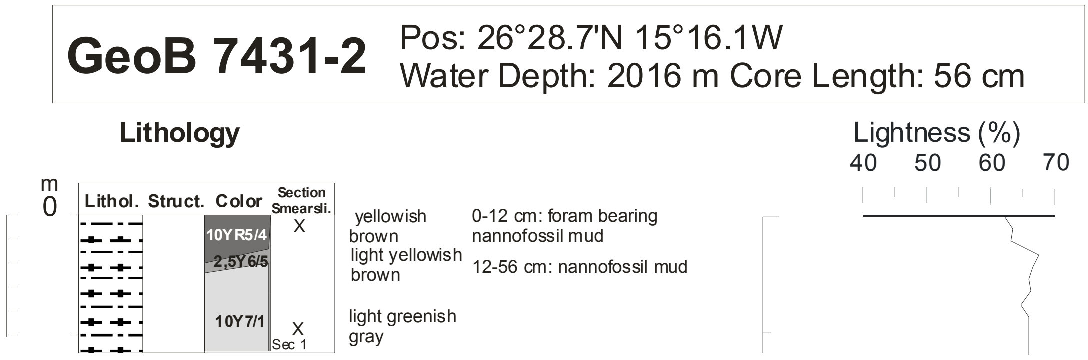

Fig. A15: Core description and lightness of core GeoB 7431-2