Development and occurrence of *Emiliania huxleyi* morphotypes in the North Atlantic Ocean during the last 270,000 years

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The currently-accepted morphotype classification for *Emiliania huxleyi* is based entirely on modern samples, and the stratigraphic range of distinct morphotypes is unknown. Therefore, the main objective of this study was to investigate the occurrence of known *E. huxleyi* morphotypes in the fossil record and to study chronological and geographic changes in the composition of E. *huxleyi* assemblages in the North Atlantic Ocean during the last 270,000 years.

In total, four sediment cores, aligned along a N–S transect covering the equatorial to subpolar North Atlantic Ocean, were investigated. Counts of morphometric coccolith parameters were conducted using an SEM, and measurements of these parameters on SEM images were analysed using statistical methods. Three normally-calcified morphotypes (Types A, B/C and O) and one heavily-calcified morphotype (here named Type T) could be distinguished in the fossil record. In addition, a morphotype (Type R*) characterised by extensive distal shield calcification, was observed. All records show a similar, but diachronous, size evolution of *E. huxleyi* coccoliths, with the largest coccolith sizes occurring during MIS 4 and MIS 3. A size increase at higher latitudes, with up to 30% larger coccoliths, was also observed. In addition, a dominance of *E. huxleyi* Type O was observed at low latitudes, although this morphotype has previously been considered to be a cold-water type.

Constraining the Fantangisña serpentinite mud volcano (Mariana Forearc) episodicity using calcareous nannofossils

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In 2016, sediments were collected during IODP Expedition 366 from the Mariana Convergent Margin and analysed to address key questions regarding the age and episodicity of the eruption of the Fantangisña serpentinite mud volcano (SMV), one of three mud volcanoes (MVs) in the Mariana Forearc. Here, we used the calcareous nannofossils in the pelagic sediments collected from the MV summit and flank to estimate the age of the MV edifice, supplementing this with planktonic foraminifera in some coarse-grained intervals. Because of their deep origin, most of the MV sediments were barren of nannofossils, although some contained rare to very rare, poorly-preserved specimens, hence making them unreliable biostratigraphic markers. On the other hand, the pelagic sediments draping the MV or beneath the edifice contained abundant, well-preserved nannofossils, and thus provided a rather precise age estimate. Results from this study show that the biostratigraphic age of the Fantangisña SMV can be well constrained. The pelagic cover on top of the serpentinite mudflows yielded an age of ~0.44 Ma (Late Pleistocene), marked by the top of *Pseudoemiliania lacunosa*. The forearc sediments were dated at ~11.21 Ma (Late Miocene), based on the last occurrence of *Calcidiscus premacintyrei*. This indicates that the timespan for the build-up of the entire Fantangisña edifice at the Mariana Forearc is ~10.77 Myr, and was consequently actively erupting mud up until ~0.44 Myr ago. The occurrence of reworked Late Oligocene to Early Miocene nannofossil taxa (*Triquetrorhabdulus carinatus* and *Reticulofenestra bisecta*) in the investigated samples from the flanks of the SMV also suggests the presence of older pelagic sediments in the Mariana Forearc region.

Biogenic carbonate composition throughout the last 140 kyr in pelagic sediments of the western South Atlantic

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This study evaluated the variation in total calcium carbonate ($CaCO_3$) content over time, as well as whether calcareous nannofossils or foraminifera contributed more to the composition of the total $CaCO_3$ content. For this study, 57 samples from a marine piston core (GL-1090), located in the western South Atlantic, were analysed for the last 140 kyr (last glacial/interglacial cycle). For this purpose, the $CaCO_3$ content was calculated in different size fractions – bulk, sand (>63 μm), coarse and medium silt (63–20 μm) and fine silt to clay (<20 μm). The observed variations were typical for the Atlantic Ocean, with higher $CaCO_3$ values during interglacial periods and lower values during glacial periods. Observing the different sediment fractions, it was noted that calcareous nannofossils were the most important contributors to carbonate deposits in the region throughout the entire studied period, but the percentages of their contribution were higher in glacial periods than interglacial intervals. This is probably due to the effects of regional preservation, which are related mainly to differences in the carbonate chemistry of the water-masses and dilution by terrigenous sediments. In addition, the calcareous nannofossil contribution showed a synchronicity with other dissolution proxies, allowing the conclusion that dissolution is the main factor controlling the contribution of each organismal group to $CaCO_3$ content. These variations revealed alternating modes of high and low carbonate preservation that were influenced by circulation-induced changes in water-masses. The lower-volume preservation events are probably related to a more corrosive, southern-sourced water-mass during a glacial at the depth where the core was collected (2225 m).

MicroRange, a tool for determining the stratigraphic distribution and geologic age of microfossils

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MicroRange is a software program that processes biostratigraphic information to provide a faster and more efficient method for making age calculations of microfossil samples. This software was created using the multi-paradigm programming language Python 3.6.5. Its algorithm was fashioned to calculate ages by taking into account the existing micropalaeontological associations in a sample, as well as the base and top occurrences of some microfossil species. To construct this software, we took into account the databases available on the Internet (i.e. Mikrotax.org of Young et al., 2017a, b) and papers with biostratigraphic and biochronological data (i.e. Lourens et al., 2004; Raffi et al., 2006; Jaramillo et al., 2011; Wade et al., 2011; Backman et al., 2012; Agnini et al., 2014). The database created from this software currently summarises the biostratigraphic distribution and bioevents of more than 1500 Cenozoic microfossil events of calcareous nannofossils, planktonic foraminifera and palynomorphs in northwestern South America.

The MicroRange operation calculates the numerical age range of a sample by means of its micropalaeontological content. In order to input information, the software only needs a micropalaeontological count table in Excel. The software can display results as a graphic of taxon distribution based on the Geologic Time Scale 2102 (Gradstein et al., 2012) and as a table with the biostratigraphic information presented by species (age range and author of the biostratigraphic datum) for each sample. This tool may be of benefit to the entire micropalaeontology community, and can be used both for academic and industrial purposes.

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Coccolithophore and silicoflagellate assemblages in the East China Sea and Japan Sea

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Satellite imagery can provide regional and seasonal distribution patterns of living phytoplankton by the remote sensing of chlorophyll-*a* concentrations, while surface-water physicochemical parameters (e.g. temperature, salinity, nutrients and light) often determine their horizontal and vertical distributions. However, species-specific details of these assemblages still require in-situ collection and shipboard/land-based analyses. Nowadays, the average sea-surface temperature (SST) is increasing, and phytoplankton distributions are migrating. Therefore, this study focuses on: 1) absolute phytoplankton abundances (notably of coccolithophores and silicoflagellates) along a transect from Nagasaki to Tsuruga or Toyama Bays, central Japan via the East China Sea and the Tsushima Strait (southwestern Kyushu) during the May, August and October 2018 cruises of the T/S *Nagasaki-Maru* of Nagasaki University; and 2) their relationship to records of SST, salinity and chlorophyll-*a* obtained by the ship's recorder.

The species assemblages identified in the summer of 2018 in the East China Sea and the central/coastal area of the Japan Sea are nearly identical. There are three common coccolithophores (*Emiliania huxleyi*, *Gephyrocapsa oceanica* and *Umbilicosphaera sibogae*) and three common silicoflagellates (*Dictyocha stapedia*, which is often misidentified as the fossil species *D. fibula, D.* cf. *D. subclinata* and *Octactis pulchra*). The main diatom contributors include the genera *Chaetoceros, Guinardia*, *Rhizosolenia*, *Bacteriastrum* and *Cocconeis*. Our results show that: 1) geographic boundaries of phytoplankton assemblages could be recognised in the Kanmon Strait (northern Kyushu), the northeastern area of Oki Islands and the Noto Peninsula; 2) the SST in the Japan Sea is steadily increasing, with similar assemblages seen in the East China Sea and Japan Sea in summer 2018; and 3) the symbiotic relationship between *Reticulofenestra sessilis* and *Thalassiosira* sp., normally found in offshore deep-photic waters, was observed in the coastal area of Tsuruga or Toyama Bays of northern central Japan.

Albian–Cenomanian (Cretaceous) calcareous nannofossils from DSDP Site 364, Bacia de Kwanza, Angola

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The fragmentation of Gondwana resulted in the creation of the Atlantic Ocean through the separation of the South American and African tectonic plates. This palaeogeographic occurrence favoured the diversification and geographic distribution of marine organisms throughout the sedimentary basins of the South Atlantic. Many studies using DSDP/ODP sites have revealed a biostratigraphic unconformity in the Upper Albian–Turonian interval (Bolli et al., 1978). DSDP Site 364 was drilled in the offshore portion of the Kwanza Basin (Angolan coast), where this biostratigraphic unconformity was observed. However, the zonation scheme that was applied to it is out of date when compared to current biozonations. The biostratigraphic zones for calcareous nannofossils in the Albian–Turonian interval that were proposed by Burnett et al. (1998) were likely to be present in the sedimentary section of Site 364. With the aim of identifying these biozones, and analysing the distribution and composition of their nannofossil assemblages, 11 samples from between the depths of 672 and 715 mbsf were prepared using the smear-slide method. The first results show that all studied samples contained diverse and abundant Cretaceous nannofossil assemblages, with distinct degrees of dissolution and recrystallisation in all samples. Species such as *Eiffellithus turriseiffelii*, *Axopodorhabdus biramiculatus*, *Helenea chiastia* and *Rhagodiscus asper* are typical of the Upper Albian–Cenomanian interval. Future studies with more precise nannofossil identifications and designation of biostratigraphic events at Site 364 will confirm this. This study was supported by IODP/CAPES grant 8888.091703/2014-01.

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Quaternary silicoflagellate assemblages from the subarctic Pacific

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Quaternary sediments from the subarctic Pacific Ocean and Bering Sea have been studied using diatoms, radiolarians and other siliceous microfossils (silicoflagellates and ebridians). However, there is little information on the skeletal morphometrics and morphological variation in silicoflagellates, which has led to identification difficulties.

Two recent studies of water samples from the Southern Ocean have demonstrated a wide morphological variation within *Stephanocha speculum* using morphometrics (Tsutsui et al., 2009; Malinverno, 2010). These studies have suggested that there may be a number of pseudocryptic species within the *S. speculum* complex.

Piston cores and/or multiple Ashura cores (three-tubed multiple cores) were collected from six sites in the subarctic Pacific Ocean and Bering Sea in 1999. The silicoflagellates in these cores were observed, photographed and measured using the light microscope and scanning electron microscope. The data show that there is a relatively high species diversity, including three *Dictyocha* species (*D. aculeata*, *D. stapedia* and *D. subarctios*) and six *Stephanocha* species (*S.* cf. *S. boliviensis*, *S. medianoctisol*, *S. octangulatus*, *S. octonarius*, *S. quinquangulatus* and *S.* cf. *S. speculum*). Observations on the *S. speculum* complex revealed a wide variation in pike morphology and portal shape, which could be useful as separation criteria. All specimens of *Dictyocha* and *Stephanocha* in this study bore pikes. The coastal species *Octactis pulchra* was not present in our core samples, although another study recorded it in a subarctic Pacific sediment trap.

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Estimating the origins of submarine landslide deposits by means of calcareous nannofossil assemblages: An example from the Pleistocene forearc basin, central Japan

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Submarine landslides and the resulting downslope deposits (mass-transport deposits or MTDs) have received a great deal of attention because they are associated with large amounts of sediment flux into the deep sea and geohazards, such as tsunamis, and because they have the potential to destroy nearshore infrastructure. I introduce an example named MTD1 from the Pleistocene forearc basin, central Japan, which has already been reported on by Utsunomiya (2018). MTD1 can be traced laterally for more than several tens of kilometres, and its overall thickness ranges from ~20–100 m. MTD1 consists of folded blocks that range from tens of centimetres to more than tens of metres in width and thickness, in a sandy mud matrix that commonly contains volcaniclastics. Some of the tephra beds in the blocks contain glass shards and unique mineral compositions, and so can be distinguished from the underlying (i.e. older) tephra beds. In addition, *Gephyrocapsa* spp. in the underlying strata show an upward increase in maximum size from <3.5 μm to >5.5 μm. Although the MTDs are intercalated in the horizon characterised by the large (>5.5 μm) *Gephyrocapsa* spp. zone, the blocks containing *Gephyrocapsa* spp. show a wide variety of maximum sizes (<4 to >5.5 μm). These assemblages are typically found in the older strata, down to 250 m below MTD1, which suggests that the blocks may have originated from a deeply excavated slope failure. A combination of studies on MTD textures, tephrostratigraphy and biostratigraphy has the great advantage of being able to determine the spatial distribution, the original stratigraphic position that the MTDs originated from, and the mechanism that generates the variable occurrences of MTDs.

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Morphological variation in the genus Umbilicosphaera from the Pliocene through Pleistocene of ODP 709C (western Indian Ocean) and 994C (northwestern Atlantic) cores

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The present study examined the calcareous nannofossil biostratigraphy of, and the morphological variation in, the genus *Umbilicosphaera* from the Pliocene through Pleistocene in ODP cores 709C (western Indian Ocean) and 994C (northwestern Atlantic). An unreported morphotype was identified from Okada and Bukry's (1980) Zone CN12 through Subzone CN10b. The first occurrence (>5 Ma) of this morphotype is much older than those of *U. sibogae* and *U. foliosa*. This morphotype is similar to *U. sibogae* in having a wide (>1 μm) central opening and monocyclic, imbricated elements in both shields, but differs in having the proximal shield smaller than the distal shield. The difference between the central-area diameter and the central-opening diameter is less than 0.7 µm in the new morphotype, which is due to the steeper surface of the tube elements around the central opening, while *U. sibogae* has a larger central-area ratio to the central opening. This new morphotype is referred to as *Umbilicosphaera* sp. A. *Umbilicosphaera sibogae* became dominant over *Umbilicosphaera* sp. A in subzones CN11b–CN12a. The presence of intermediate forms of *U. sibogae* and *Umbilicosphaera* sp. A suggests that *U. sibogae* evolved from *Umbilicosphaera* sp. A, rather than from either *U. rotula* or *U. jafari*. These results suggest that evolution in the *Umbilicosphaera* spp. occurred simultaneously with the evolution in eutrophic taxa (*Gephyrocapsa* spp.) as part of the floral turnover during the Pliocene–Pleistocene transition.

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Upper Cretaceous–Cenozoic calcareous nannofossil biostratigraphy of northwestern Colombian basins

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After several decades of reliance on palynology and foraminifera as the primary biostratigraphic tools in Colombia, this is the first report on the calcareous nannofossil biostratigraphy through the Upper Cretaceous–Cenozoic sedimentary record from six basins in northwestern Colombia. More than 3000 samples were prepared and analysed from these basins. A discontinuous Upper Mesozoic–Cenozoic sedimentary record was interpreted from the nannofossil biostratigraphy, allowing us to solve some stratigraphic problems in the northwestern Andes. Our micropalaeontological dataset can be grouped into eight biostratigraphic intervals – Campanian–Maastrichtian, Selandian–Thanetian, Ypresian, Bartonian–Priabonian, Rupelian–Chattian, Aquitanian–Burdigalian, Tortonian–Pliocene and Pleistocene. Our results are comparable to the major oceanic pulses previously documented by sedimentological, palynological and foraminiferal studies. This work, which is based on nannofossil biostratigraphy, also reveals episodes of high influxes of reworked microfossils into Upper Miocene and Pliocene formations. This is associated with the erosion of Oligocene and Lower Miocene marine rocks that were uplifted by tectonic readjustment during the most recent northern Andean Orogeny.

Taxonomic revision of selected Early Turonian holococcoliths

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Early Turonian nannofossils and microfossils were examined from various shallow core samples collected from the Cauvery Basin, eastern India. The nannofossil assemblages were extremely diverse and well preserved. The unique character of these nannofossil assemblages are exemplified by the atypically high abundance of holococcoliths found in the samples, with the holococcolith group comprised about 15-42% of the total assemblages.

We utilised a mobile-mounting technique to identify, and gain an understanding of, several new holococcolith species from this section. This technique makes it possible to map all views (sides) of the various species, and it proved to be an especially useful tool during our taxonomic study of the holococcoliths. We mapped the different profiles of the holococcoliths and were able to place the species into two main groups based on the presence or absence of a distal structure. The group that contains species with a distal process include *Isocrystallithus compactus, I. maghredaswampensis, Isocrystallithus* sp., *Owenia hillii, Pharus* sp., *Paulpearsonia ecclesiata* and several unpublished species. This group of holococcolith species (i.e. possessing distal processes) were often observed in both plan and side view. The group that contains species without a distal process, or that possess a vestigial distal process, include *Zebrashapka alta*, several unpublished species and various species of *Russellia* and *Ottavianus*. This group of holococcoliths (i.e. not possessing distal processes) were often observed only in plan view.

In addition, we used the mobile-mounting technique to capture definitive evidence that *Isocrystallithus* and *Owenia* are two distinct genera, and to provide refined biostratigraphic ranges for *Varolia cistula* and *Varolia gracilimura*. Finally, an analysis of the foraminiferal assemblages was able to identify well-oxygenated distal ramp settings (e.g. 150–300 m deep) and restricted open-marine conditions, in spite of the low abundances of planktonic foraminifera. This evidence proves that abundant and diverse holococcolith assemblages can thrive in deep-water settings.

Calcareous nannofossils across the Eocene–Oligocene transition at ODP Site 756 (Ninetyeast Ridge, Indian Ocean): Implications for biostratigraphy and palaeoceanographic clues

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The Eocene–Oligocene transition (EOT; ca. 34–33.5 Ma) represents a key point in Cenozoic climatic evolution, marking the onset of a semipermanent ice sheet on Antarctica and a major step from a greenhouse to icehouse climate state (e.g. Coxall & Pearson, 2007). The timing and modalities of the nannoplankton response to this climatic phase are still poorly understood, and only a few nannofossil biohorizons are considered to be globally synchronous and reliable.

In this study, the calcareous nannofossil response to the EOT was investigated in ODP Hole 756C (27°21.25'S, 87°35.89'E) that was drilled on the Ninetyeast Ridge (eastern Indian Ocean) during Leg 121 (Peirce et al., 1989). Quantitative and semiquantitative analyses were carried out on 102 samples and showed no evidence for dramatic extinctions in the calcareous nannofossil assemblages at the Eocene–Oligocene boundary (EOB, 33.89 Ma). However, significant bioevents occurred short distances below this boundary, such as the successive disappearance of the rosette-shaped *Discoaster barbadiensis* and *D. saipanensis* and, a short distance above, there is an acme of *Clausiococcus subdistichus*. Based on the abundance patterns of the standard and additional marker species, the study section extends from nannofossil Zones NP19–NP20 to NP23 (Martini, 1971), which is equivalent to the CNE20–CNO4 interval of Agnini et al. (2014), and has an estimated duration of ca. 5.6 Myr.

High-resolution analyses allowed us to monitor new, potentially useful and reliable calcareous nannofossil biohorizons, and changes affecting the calcareous nannofossil communities across the EOT. In particular, our data suggest that during the EOT, trophic conditions were likely more important than temperature in controlling the variations observed in the relative abundances of the taxa. Of notable interest were the acme intervals of *C. subdistichus* and the holococcolith *Lanternithus minutus,* both of which are possibly related to episodic increased food supply during the earliest Oligocene.

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Taxonomic revision of the genus Carinolithus (Early–Middle Jurassic) based on morphometric analyses and diagenesis observations: Implications for biostratigraphy and evolutionary trends

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A total of 100 specimens of the genus *Carinolithus* were selected from published papers and new sampling of sections in the Tethys Ocean (Sogno Core and Breggia sections, Lombardy Basin). The species *C. poulnabronei* and *C. cantaluppii* have diagnostic characters that cannot be confused with other those of species and, consequently, were not considered for morphometric analysis. Size measurements were performed for the following parameters: total height, height without proximal and distal shields, stem width (SW), proximal shield width, distal shield width (DS) and thickness of the distal shield (TDS). Only three (DS, TDS and SW) were diagnostic for taxon discrimination. Based on the DS, two groups were distinguished – >7.8 μm and <6.8 μm. Two groups were distinguished based on the TDS – >1.8 μm and <1.5 μm. Analogously, based on the SW, two groups of specimens were identified – >1.3 μm and <1.0 μm.

Our results provide a revised subdivision of *C. superbus* and *C. magharensis* based on a simple, but effective, morphometry that can be seen with a polarising-light microscope. An additional 50 specimens of *C. cantaluppii* were qualitatively investigated to assess the potential role of diagenesis on its morphology. Four pictures were taken for each specimen – with and without a quartz-plate, and at 0° and 45° to the polarisers. All investigated specimens revealed that *C. cantaluppii* is a diagenetic artifact that is produced through different degrees of overgrowth on specimens of *C. poulnabronei, C. superbus* and *C. magharensis*. Using a quartz-plate at 45° to the polarisers allows: 1) recognition of the species that have undergone the diagenetic modification; and 2) the degree of diagenetic change. This impacts the taxonomy and correct identification of this species, and suggests a method for the evaluation of nannofossil/sediment preservation. The morphometry-based revised taxonomy of the genus *Carinolithus* has the potential for improving the biostratigraphic resolution of the Toarcian–Aalenian interval, and has implications for the reconstruction of evolutionary trends.

Preliminary nannofossil biostratigraphic results from the Mariakani Formation, onshore Lamu Basin (SE Kenya)

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During the mid-Jurassic, eastern Gondwana experienced a drastic tectonic and palaeogeomorphological reorganisation that was characterised by a shift from the continental depositional environments of the Karoo Superformation to the marine incursions of the transgressive Kambe Formation. There is a faulted contact between the lacustrine Mariakani and Mazeras Formations (both Triassic) and the marine Kambe Formation (Jurassic) in the Mombasa Basin (Caswell, 1953, 1956; Karanja et al., 1993).

Two samples (60 and 61) were collected from an exposure located about 15 km from the Kinango-Kwale junction, mapped as the Mariakani Formation (Caswell, 1953, 1956). The samples consist of a light grey, weathered, soft shale (Sample 60) and a heavily-jointed and fractured, light greyish, fine-grained sandstone with minor cross-bedding (Sample 61). Only Sample 61 contained moderately-preserved, rare nannofossil remains, including *Watznaueria barnesiae*, *W. britannica*?, *Thoracosphaera* sp., *Lotharingius* cf. *L. contractus, Discorhabdus striatus*? and *Triscutum sullivani*?. The age of this assemblage was identified as uppermost Bajocian–lowermost Bathonian or Zone NJ9 (*Watznaueria britannica*) to lower Zone NJ11 (*Pseudoconus enigma*), based on the bases of *W. britannica* and *W. barnesiae* (Bown & Cooper, 1998). This interval corresponds to the *laeviuscula-garantiana*/*parkinsoni* Ammonite Zones. Thus, the obtained results biostratigraphically correlate Sample 61 with the upper shaly member of the lower Kambe Formation (Chiocchini et al., 2005) and the Upper Bajocian ammonite zones (*Strenoceras niortense* and *Garantiana garantiana*) of Galasz (2017) from the Mwache River area (25 km to the NE), and also re-evaluates the age of the Mariakani Formation at this location. These data also continue the discussion of how far west the Jurassic marine sequences overlap the Karoo/Duruma sandstone series, first discussed by E. Fraas (see Caswell, 1953).

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Importance of coccolithophores in the ocean deep biomass

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The deep biomass (DB), which is located in the lowest part of the euphotic zone (approximately 80–300 m deep) and occurs primarily in the subtropical gyres, is an unexplored part of primary production (PP). It is one of the largest biomes on our planet, considering that subtropical regions occupy 60% of the total ocean. Observations indicate that the major oceanic gyres have expanded recently by 15%, a phenomenon attributed to global warming. As the gyres expand and warm, they become more stratified, which could be expected to favour coccolithophores. The biological community in the DB, however, is not well known, and their contribution to export production has never been quantified. Productivity estimates for oceanic net primary production show that regions with oligotrophic surface-waters contribute significantly to global productivity due to their deep phytoplankton communities. Some model estimates indicate that there has been a recent increase in net oceanic primary production in oligotrophic ocean gyres. If we consider: 1) the total area covered by the DB; 2) the expansion of the ocean gyres; 3) the PP that occurs throughout the year; and 4) the global depth-integrated NPP of the mixed layer in the tropics and subtropical gyres that displays very small seasonal variability, it is reasonable to assume that the DB ecosystem is likely to be as important for productivity and chemical recycling as seasonally-active upwelling areas. The role in PP of this enigmatic biome cannot be easily determined using chlorophyll because organisms in the deep photic zone, particularly coccolithophores, do not possess much chlorophyll per biomass. It is thus probable that carbon export from the DB is underestimated in models. With the upper euphotic zone of the oceans already impacted by acidification, the DB can arguably be considered to be the last refuge for marine organisms. We need to determine how anthropogenic activity is affecting the phytoplankton that comprise the DBM and the ensuing biogeochemical cycling of carbon.

Nannotax and mikrotax, an evolving system for paleoinformatics

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The Nannotax project has been running since 2007, with the objective of providing high-quality online data on nannoplankton taxonomy and biodiversity. The current version was launched in 2013 at the INA13 conference in Reston VA, USA. Since then, the system has been continuously maintained, expanded and updated, and is now a prime resource for anyone interested in extant or fossil nannoplankton. It currently holds original descriptions and illustrations of >4000 taxa, descriptions and range data on >3000 currently-recognised taxa, 25,000 images and, via the Neptune database (MFN Berlin), access to >250,000 occurrence records of nannofossils.

Recent improvements, which have included developing new tools to access the Neptune database, make it possible to investigate the palaeobiogeographical distributions of species and to reconstruct occurrence tables for DSDP and ODP sites held in the database. Mesozoic and Cenozoic nannofossil information has been continuously updated. Notably, the new synthesis of Neogene taxonomy from the BP group, as published in the JNR (e.g. Bergen et al., 2017; Browning et al., 2017) has been reviewed and incorporated. However, this type of taxonomic revision does present some problems for the system, as will be discussed.

Equally important, the system underlying Nannotax is now a demonstrably robust solution to providing a database of online microfossil taxonomy and for integrating taxon-related data. We have used the system to provide a similar level of coverage of planktonic foraminifera (Huber et al., 2017), and we are now actively developing applications for acritarchs and radiolarians. This expansion of coverage has necessitated the development of new capabilities, such as plotting evolutionary trees and improving the underlying software and web-editing tools. It has also led to the system being recognised as a prime example of effective modern palaeoinformatics.

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The trigger for the mid-Brunhes coccolithophore bloom: New evidence from coccolith assemblages and geochemical and morphological data

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Several coccolithophore bloom events have been discovered in the Pleistocene. Among these events, the mid-Brunhes *Gephyrocapsa caribbeanica* bloom can be recognised globally. During this event, the coccolith calcium carbonate accumulation rate increased to approximately 5–10 times greater than in the period above and below this event, and this may have altered the ocean carbon cycle dramatically (e.g. Barker et al., 2006). However, the trigger for this event is still undetermined. Moreover, most previous studies have focused on the mid- or high latitudes.

In this study, we measured coccolith geochemical and morphological data from four cores from both the high and low latitudes during the last 800 kyr, and reviewed published data from another 14 cores, to try to determine the mechanism driving coccolithophore blooms, especially any processes other than glacial-åinterglacial effects. Significant coccolithophore bloom events were identified in 15 cores during the period 600–350 ka, but the timing of these blooms was different in different regions. Generally, the blooms first occurred at high latitudes and in the East Pacific upwelling and then spread to low latitudes, such as the East Pacific warm pool. It appears that the bloom events were not globally synchronous, which may challenge the previous insolation-driven hypothesis. Instead, we suggest that coccolithophore blooms were triggered by nutrient patterns in the ocean. For regions where the nutrient level is controlled by ocean circulation, there may be a rapid response time for changes in the dynamics of Earth's boundary conditions, while for regions in which nutrient content is controlled by weathering and river input, the response time may be longer than one glacial-interglacial cycle.

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Primary productivity dynamics in the northeastern Indian Ocean since the Last Glacial Maximum: Toward a better understanding of tropical climate changes

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Ocean primary productivity (PP) is regulated by atmospheric and oceanic circulation, which may control upper seawater stratification and mixing, and thus impact nutrient distribution in the euphotic zone. While several reconstructions of PP variations have been obtained for the tropical Indian Ocean (TIO) to document oceanic and climatic changes in the past, PP records in the northeastern Indian Ocean (NEIO), including the Bay of Bengal and the Andaman Sea, are relatively scarce. The aim of this study was to reconstruct PP changes in the NEIO since the Last Glacial Maximum (LGM) in order to understand their dynamics, identify the forcing factors behind them, and get a clearer picture of climate evolution during this time interval.

We reconstructed two palaeoproductivity records over the last 26,000 years, using two sediment cores from the northeastern Bay of Bengal (NE-BoB) and northwest of Sumatra (NWoS). The palaeoproductivity was derived from the coccolith assemblages and, more particularly, the relative abundance of *Florisphaera profunda*. These two variations showed diverse patterns at both the millennial and orbital scales. In the NE-BoB, there was no significant difference in PP between the LGM and the Late Holocene, but peaks occurred around 17–15 ka BP and 12–9 ka BP. In contrast, the NWoS record shows that PP was about 15% higher during the LGM than during the Late Holocene, and a significant decrease was observed during deglaciation. Comparisons with other published PP records and a new climate model output (IPSL-CM5A-LR) suggest that the NE-BoB PP record is most probably associated with changes in Indian Monsoon dynamics, while TIO Walker circulation might play a more important role in PP variations in the NWoS.

notes

We hope you enjoyed INA17 in Santos...

See you in 2021 in another nanno-tastic location!