Data report: a revised biomagnetostratigraphic age model for Site U1338, IODP Expedition 320/321¹

Jan Backman,² Jack G. Baldauf,³ Marina Ciummelli,⁴ and Isabella Raffi⁵

Chapter contents

Abstract
Introduction1
Methods
Results and discussion
Conclusions
Acknowledgments5
References
Figures
Tables

Abstract

The development of late middle Miocene through recent sedimentation rates was determined for Integrated Ocean Drilling Program Site U1338 in the eastern equatorial Pacific using available geomagnetic chron boundaries and biostratigraphic biohorizons provided by calcareous nannofossils and diatoms. These data were set in a revised depth splice of the three holes at Site U1338 and provide a lower resolution image of the sedimentation rate history in the region of Site U1338 through relatively long linear interpolations between 11 chosen age-depth control points encompassing 18 My. The resulting sedimentation rates depict the movement of Site U1338 from just south of the Equator with modest sedimentation rates starting at 11 m/My to tripling of these rates near 13 Ma, when the site moved onto the Equator and into the equatorial high-productivity belt. High sedimentation rates continued into the earliest Pliocene (5 Ma) except for a 50% decrease during the so-called "carbonate crash" centered around 9.6 Ma \pm 0.4 My. The site's movement north, away from the equatorial high-productivity belt, began between 5.0 and 4.2 Ma, when the site was located ~75–90 nmi north of the Equator, and resulted in a series of successively decreasing sedimentation rates to the present rate of 11 m/My, identical to the rate when sedimentation began at Site U1338 at nearly 18 Ma, when the site was located ~100 nmi south of the Equator.

Introduction

A key goal of Integrated Ocean Drilling Program (IODP) Expedition 320/321 (Pacific Equatorial Age Transect [PEAT]) was to recover a series of sediment sections from the Pacific paleoequator region preserving critical intervals of Cenozoic paleoceanographic and paleoclimatic conditions and development (see the "Expedition 320/321 summary" chapter [Pälike et al., 2010]). The age transect, or flow-line concept, of Pälike et al. (2010) made use of Pacific plate motion and placed sites close to the Pacific paleoequator for carefully selected time intervals that would ensure near-continuous recovery of optimally preserved early Eocene through recent sediment sections. Eight sites were drilled (Sites U1331–U1338) with present locations along an oblique northsouth transect from 12°4'N, 142°10'W (old end-member Site U1331; 5116 m water depth), to 2°30'N, 117°58'W (young end-

¹Backman, J., Baldauf, J.G., Ciummelli, M., and Raffi, I., 2016. Data report: a revised biomagnetostratigraphic age model for Site U1338, IODP Expedition 320/321. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). doi:10.2204/iodp.proc.320321.219.2016 ²Department of Geological Sciences, Stockholm University, SE-10691 Stockholm, Sweden. backman@geo.su.se ³Department of Oceanography, Texas A&M

University, College Station TX 77843, USA. ⁴Petrostrat Ltd., Tan-Y-Graig, Parc Caer Seion, LL32 8FA Conwy, United Kingdom.

⁵Dipartimento di Ingegneria e Geologia, Università "G. d'Annunzio" di Chieti-Pescara, I-66013 Chieti Scalo, Italy.



member Site U1338; 4200 m water depth). Establishing an age model for each site was a crucial component of the expedition objectives.

Sediment sections recovered from three holes at Site U1338 represent the interval from the late early Miocene at ~18 Ma to the recent. These three holes were spliced onboard using physical property data into a single continuous section with coherent depth progression from the water/sediment interface to the sediment-basalt transition, permitting determination of linear sedimentation rates from biomagnetostratigraphic data (see Fig. F14 in the "Site U1338" chapter [Expedition 320/321 Scientists, 2010b]).

IODP employs three different core depth concepts for recovered sediments. The baseline depth is in meters below seafloor (mbsf), or core depth below seafloor (CSF-A, in meters). When splicing a single continuous section from multiple holes at a single drill site, a second set of depths are assigned to the cores: composite depth below seafloor (CCSF-A, in meters). Empirically, we have learned that CCSF-A depths lie deeper than CSF-A depths and that the spliced section typically has grown in length by about 10%. In the case of Site U1338, this value was 11%, calculated by linear regression of CSF-A versus CCSF-A for all Site U1338 cores (see Fig. F44 in the "Site U1338" chapter [Expedition 320/321 Scientists, 2010b]). This growth factor distorts sedimentation and mass accumulation rates. To compensate for this distortion, CCSF-A depths for Site U1338 were divided by a growth factor of 1.11, resulting in a third set of depths, the corrected composite depths (CCSF-B, in meters) (see Table T23 in the "Site U1338" chapter [Expedition 320/321 Scientists, 2010b]). Subsequently, CCSF-A depth data from Site U1338 were revised by Wilkens et al. (2013), who also provide a discussion of IODP depth scale terminology.

Here, we combine revised diatom and partly revised calcareous nannofossil biostratigraphic data with shipboard magnetostratigraphic data to produce a biomagnetostratigraphic age model for Site U1338 using the Wilkens et al. (2013) revised depth data.

Methods

Shipboard calcareous nannofossil biostratigraphic and magnetostratigraphic data were acquired from all three holes at Site U1338 (see Tables T4 and T15 in the "Site U1338" chapter [Expedition 320/321 Scientists, 2010b]). Ciummelli (2013) provided additional higher resolution calcareous nannofossil biostratigraphic data for the late middle through earliest Pliocene interval that were partly published by Backman et al. (2013). Baldauf (2013) provided higher resolution diatom biostratigraphic data. See above references for methods of data acquisition. Age estimates and nomenclatures for geomagnetic chron boundaries follow the timescale of Lourens et al. (2004). Age estimates for equatorial Pacific diatom biohorizons were synthesized by Barron (1992) and are here converted from the timescale by Berggren et al. (1985) to that by Lourens et al. (2004). Age estimates for calcareous nannofossils mainly represent astronomically tuned calibrations from the western equatorial Atlantic (Backman et al., 2012).

Results and discussion

Revised CCSF-A depths for both biostratigraphic and magnetostratigraphic data were calculated by adding an offset depth to the CSF-A depth for each core, according to Table T5 in Wilkens et al. (2013). They further refined depths within cores from all three holes at Site U1338 caused by intracore stretching or squeezing and referred to these depths as "Adjusted CCSF." In Tables AT47, AT52, and AT57, Wilkens et al. (2013) adjusted depths for a total of 843 samples. Of these samples, 232 show no adjustment (0 cm), 281 show an average adjustment of +16 cm, and 330 show an average adjustment of -17 cm. These adjusted depths within cores are generally small but are useful for exceptionally detailed work in need of centimeter precision. Considering the uncertainties involved in the underlying data sets, we did not employ the "Adjusted CCSF" by Wilkens et al. (2013).

Growth factors for each hole are calculated by linear regression (Fig. F1) of CSF-A versus CCSF-A, following the approach from the "Site U1338" chapter (Expedition 320/321 Scientists, 2010b). The CCSF-A depth is divided by the hole-specific growth factor to obtain the corrected composite CCSF-B depth for each biomagnetostratigraphic age-depth indicator from each hole.

Site U1338 biomagnetostratigraphic age-depth data are presented in Tables T1 (calcareous nannofossils), T2 (diatoms), and T3 (magnetostratigraphy). Many individual biohorizons and magnetostratigraphic chron boundaries have been determined from two or all three Site U1338 holes (see the "Site U1338" chapter [Expedition 320/321 Scientists, 2010b]; Baldauf, 2013; Ciummelli, 2013; Backman et al., 2013). It is difficult to determine which hole provides the true or most accurate depth information for individual age-depth indicators. Hence, the midpoint of the deepest and shallowest CCSF-B depths are used for individual chron boundaries and biohorizons in the sedimentation rate plots, taking into account one, two, or all three holes from Site U1338. These midpoint CCSF-B depths show average uncertainties of ± 1.23 m (maximum ± 3.54 m) for calcareous nanno-



fossils, ± 0.86 m (maximum ± 8.23 m) for diatoms, and ± 0.57 m (maximum ± 2.32 m) for magnetostratigraphic chron boundaries.

The entire age-depth data set is presented in Figure **F2**. These data are composed of 33 geomagnetic chron boundaries, 33 calcareous nannofossil biohorizons, and 57 diatom biohorizons. Magnetostratigraphy is available in three different yet coherent intervals: Pliocene–Pleistocene (3.596–0.781 Ma), early late Miocene (9.987–9.098 Ma), and late middle Miocene (15.160–12.730 Ma).

Age calibrations of diatom biohorizons represent lower resolution equatorial Pacific data generated 23 years ago, which may suggest potential room for improvement (as always in biochronology). Still, the diatom biohorizons generally align well with magnetostratigraphic chron boundaries and calcareous nannofossil biohorizons, presumably because 75% of the diatom biohorizons (Table T2) have been directly calibrated with geomagnetic polarity stratigraphies from the equatorial Pacific (Barron, 1992) in depositional settings similar to that of Site U1338. In the 9.0 through 12.9 Ma interval, however, only 23% (3 of 13) of the diatom biohorizons are directly calibrated with magnetostratigraphy.

In order to show details of the different parts of the sedimentation rate history at Site U1338, the record is divided into three parts: 0–5.2 Ma (Fig. F3), 5–10.2 Ma (Fig. F4), and 9.9–18 Ma (Fig. F5). The proposed rate-determining age-depth indicators, or control points (CPs), and the resulting linear sedimentation rates (LSRs) are presented in Table T4.

It appears clearly from Figure F2 that the 123 agedepth indicators fall into coherent linear intervals, albeit with some minor scatter. Minor variations in sedimentation rates presumably occurred in the presented linear intervals between the nearest chosen age-depth CP couplets. It is beyond the scope of this data report to accommodate for such minor variations, which would require highly resolved cyclostratigraphic or stable isotopic data correlated to sites with independent (magnetostratigraphic) age control to resolve properly. When allowing for minor scatter in these biomagnetostratigraphic data, the suggested LSRs become uniform over relatively long intervals. This is considered preferable in comparison to, for example, placing CPs at each progressively deeper age-depth indicator, which would still result in scatter but also cause artificial extremes in sedimentation rates between closely spaced agedepth indicator couplets.

Age estimates of late early Miocene through Pleistocene geomagnetic chron boundaries are considered well constrained (Lourens et al., 2004), yet we have permitted a few such boundaries in the older/deeper part of the record to fall slightly off the proposed interpolated rate lines (Fig. F5) so as to not introduce extreme, shorter variations in sedimentation rates caused by less well constrained depths or age estimates of a few chron boundaries.

With these caveats, this data report may be taken to provide a basic biomagnetostratigraphic reference framework for future attempts to develop highly resolved age models for Site U1338 based on, for example, carbon isotope stratigraphy or astronomically tuned cyclostratigraphy.

We are fully aware of that the relatively few (11) interpolated linear sedimentation rate intervals encompassing the past 18 My at Site U1338 may be drawn differently, yet we consider that the proposed sedimentation rate history represents a reasonable interpretation of the age-depth distribution of available magnetostratigraphic, diatom, and calcareous nannofossil data. All depths below are on the CCSF-B scale.

Sedimentation rate lines between 0 and 5 Ma

Pliocene–Pleistocene sedimentation rates are shown in Figure F3. The youngest rate line is determined by the top of the Site U1338 sediment sequence, placed at 0.00 m and 0.00 Ma, and the Chron C1n/C1r boundary (base Brunhes; CP1).

CP2 is the Chron C2n/C2r.1r boundary (base Olduvai), and CP3 is the Chron C2An.3n/C2Ar boundary (base Gauss). There are two diatom and three calcareous nannofossil biohorizons clearly falling to the left of the proposed rate line between CP2 and CP3, suggesting that these represent paleoecologically driven disappearances prior to their genuine extinctions.

The three nannofossil extinctions represent *Discoaster* species, two of which have known problematic abundance histories toward the end of their ranges in the equatorial Pacific (Backman and Shackleton, 1983). It remains uncertain why the diatom biohorizons at 4.7 Ma (top *Fragilariopsis cylindrica*) and 4.9 Ma (base *Nitzschia jouseae*) deviate from the proposed interpolated line controlled by CP4 (base *Asteromphalus elegans* at 4.2 Ma) and CP5 (top *Ceratolithus acutus* at 5.04 Ma).

Sedimentation rate lines between 5 and 10 Ma

A constant sedimentation rate is suggested over 4 My from CP5 in the earliest Pliocene to CP6 (base Chron CAn) in the early late Miocene (Fig. F4). Two nannofossil biohorizons are clearly off the line, one being



the top of the absence interval (paracme) of Reticulofenestra pseudoumbilicus (7.09 Ma) and the other the base of Amaurolithus spp. (7.39 Ma). Both biohorizons appear unproblematic in terms of abundance patterns (Backman et al., 2013). The former biohorizon does not represent the evolutionary first appearance of the species but rather its reappearance after having been virtually absent from the assemblages for about 1.7 My for reasons unknown. Its position suggests a reduced absence interval of about 0.4 My at its upper end in the region of Site U1338, as the proposed interpolated line suggests a reappearance at 7.5 Ma rather than 7.1 Ma. Base Amaurolithus spp. seems to appear at ~0.3 My earlier (7.7 Ma rather than 7.4 Ma) to the Site U1338 region compared with its calibrated first appearance from both the western equatorial Atlantic and two sites in the eastern equatorial Pacific (Backman et al., 2012). In Monte dei Corvi section on the Adriatic Sea coast, base Amaurolithus spp. occurs in the middle part of Chron C4n.1n at an estimated age of 7.57 Ma (Di Stefano et al., 2010), which would bring this biohorizon to within 0.1 My from the proposed interpolated line. These data suggest that this biohorizon is diachronous, perhaps up to 0.3 My, as suggested at Site U1338.

The interval between CP6 and CP7 is controlled by geomagnetic chron boundaries, one of which only marginally fits the proposed rate line. Top *Catinaster coalitus* at 9.70 Ma disappeared from the Site U1338 region well prior to its calibrated extinction. Not surprisingly, the final part of its range is characterized by low and discontinuous abundances (Backman et al., 2013).

Sedimentation rate lines between 10 and 18 Ma

The interval between geomagnetic chron boundaries CP7 and CP8 encompasses 3.2 My (Fig. F5). Even if this interval is divided using one or two intermediate biostratigraphic CPs, biohorizons will still be scattered around the shorter interpolation alternative.

Between CP8 and CP9, four geomagnetic chron boundaries do not fit the proposed linear interpolation. Less good core conditions began to affect the splice and composite section toward the deep end of the sequence (see **"Site U1338"** in the "Expedition 320/321 summary" chapter [Pälike et al., 2010]), which presumably affected the positions of some of the deepest geomagnetic chron boundaries. For example, in Holes U1338B and U1338C (Table T3), the series of successively older geomagnetic chron boundaries shows a corresponding successive increase in depth. When combining the data from the two holes to calculate midpoint depths of individual chron boundaries from their lowermost and uppermost occurrences, the obvious progression of depth in the individual holes dissolves, suggesting that the two holes are not perfectly correlated in their deepest parts. The position of, for example, the C5ADr/ C5Bn.1n boundary in Hole U1338B at 14.781 Ma occurs above (354.00 m) the younger (14.581 Ma) C5ADn/C5ADr boundary at 356.44 m in Hole U1338C (Table T3). We therefore used only data from Hole U1338C for the four deepest geomagnetic chron boundaries in order to maintain a logical depth progression of each successive chron boundary.

The lowermost part of the Site U1338 sedimentation rate history is based on nannofossil biostratigraphy. The short overlap between two nannofossil biohorizons at 15.69 Ma (*Discoaster deflandrei* decreases to <30% of the total *Discoaster assemblage*) and 15.73 Ma (base *Discoaster signus*) indicates that CP10 can be confidently placed at the latter biohorizon. The base of common *Sphenolithus heteromorphus* provides CP11, which has a consistent first common occurrence in Chron C5Dr in the Indian Ocean, Atlantic Ocean, and Mediterranean Sea (Backman et al., 1990, 2012; Di Stefano et al., 2015).

Sedimentation rates versus age

The sedimentation rate history at Site U1338 shows distinct variability and some general trends (Fig. F6; Table T4). When plotting the sedimentation rate history using linear interpolation between specific age-depth indicators, rates change stepwise at the CPs. We assume that the rate history was more smooth than depicted in Figure F6 and that the changes did not generally occur at the CPs but more likely as transitions between the CPs.

Rates were modest (11 m/My) during the first 2 My of sedimentation at Site U1338, when the site was located ~100 nmi south of the Equator (see Fig. F5 in the "Expedition 320/321 summary" chapter [Pälike et al., 2010]). Sedimentation rates thereafter increased to 34 m/My by ~13.2 Ma, when the site began to approach the Equator from the south. This high rate was maintained for about 3 My until the rate was halved to 17 m/My between 10.0 and 9.1 Ma.

This major yet temporary decrease in sedimentation rate coincides with intense carbonate dissolution at Site U1338, also known as the "carbonate crash," in the eastern equatorial Pacific (Farrell et al., 1995; Lyle et al., 1995). The most intense dissolution occurs over a 0.72 m thick interval within Section 321-U1338B-22H-2, with a minimum carbonate content of 5% and an average of 12% between 198.85 and 199.57 m (Lyle and Backman, 2013) corresponding



to a 42 ky long interval according to the present age model, beginning at 9.618 Ma and ending at 9.576 Ma.

Carbonate content and the sedimentation rate increased after this early late Miocene carbonate crash at ~9.6 Ma to 30 m/My for a 4.1 My long interval lasting into the earliest Pliocene. This late Miocene rate regime changed in the early Pliocene between 5.0 and 4.2 Ma into a new Pliocene–Pleistocene sedimentation rate regime with an average of 14 m/My representing a decrease of 56% compared with the late Miocene regime. Exactly when this major decrease occurs is unclear. If extrapolating the late Miocene regime downward, these will meet at ~4.8 Ma, when the site was located ~80 nmi north of the Equator (see Fig. F5 in the "Expedition 320/321 summary" chapter [Pä-like et al., 2010]).

Pliocene–Pleistocene sedimentation rates are, however, not uniform, but they show a stepwise decrease from 18 m/My (5.0–4.2 Ma) to 15 m/My (4.2–3.6 Ma), followed by 13 m/My (3.6–1.9 Ma) to 12 m/My (1.9–0.8 Ma) and finally 11 m/My (0.8–0.0 Ma), as Site U1338 is slowly moving away from the Equatorial high productivity region.

Conclusions

Late middle Miocene through recent linear sedimentation rates were calculated for IODP Site U1338 in the eastern equatorial Pacific using available geomagnetic chron boundary data together with calcareous nannofossil and diatom biochronologic data. Rather than attempting to use every age-depth indicator for estimates of sedimentation rates, we selected 11 key control points to describe a low-resolution sedimentation history, thus permitting for scatter around the proposed interpolated rate lines.

The sedimentation rate history at Site U1338 mirrors the movement of the site from ~2°45'S of the Pacific Equator to its present location at 2°30'N of the Equator, crossing a high-productivity zone during the late middle Miocene through earliest Pliocene times and resulting in sedimentation rates on the order of 30-34 m/My. Sedimentation rates started at a modest rate (11 m/My) when the Site U1338 basalt crust was formed, ramped up in three steps to a tripling at ~13.2 Ma to 34 m/My, and decreased by 50% during the so-called carbonate crash between 10.0 and 9.1 Ma. The crash was followed by an increase to 30 m/My that lasted for ~4 My into the earliest Pliocene (5.0 Ma). Thereafter, sedimentation rates decreased successively in five steps to its present rate of 11 m/My.

Acknowledgments

This research used data and samples provided by the Integrated Ocean Drilling Program (IODP). J. Backman acknowledges financial support from the Swedish Research Council and Stockholm University. Reviews by Samantha Gibbs and Anna Joy Drury helped improve the manuscript.

References

- Backman, J., Raffi, I., Ciummelli, M., and Baldauf, J., 2013. Species-specific responses of late Miocene *Discoaster* spp. to enhanced biosilica productivity conditions in the equatorial Pacific and the Mediterranean. *Geo-Marine Letters*, 33(4):285–298. http://dx.doi.org/10.1007/s00367-013-0328-0
- Backman, J., Raffi, I., Rio, D., Fornaciari, E., and Pälike, H., 2012. Biozonation and biochronology of Miocene through Pleistocene calcareous nannofossils from low and middle latitudes. *Newsletters on Stratigraphy*, 45(3):221–244.

http://dx.doi.org/10.1127/0078-0421/2012/0022

Backman, J., Schneider, D.A., Rio, D., and Okada, H., 1990. Neogene low-latitude magnetostratigraphy from Site 710 and revised age estimates of Miocene nannofossil datum events. *In* Duncan, R.A., Backman, J., Peterson, L.C., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 115: College Station, TX (Ocean Drilling Program), 271–276.

http://dx.doi.org/10.2973/odp.proc.sr.115.209.1990

- Backman, J., and Shackleton, N.J., 1983. Quantitative biochronology of Pliocene and early Pleistocene calcareous nannofossils from the Atlantic, Indian and Pacific Oceans. *Marine Micropaleontology*, 8(2):141–170. http://dx.doi.org/10.1016/0377-8398(83)90009-9
- Baldauf, J.G., 2013. Data report: diatoms from Sites U1334 and U1338, Expedition 320/321. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http://dx.doi.org/10.2204/ iodp.proc.320321.215.2013
- Barron, J.A., 1992. Neogene diatom datum levels in the equatorial and North Pacific. *In* Ishizaki, K., and Saito, T. (Eds.), *Centenary of Japanese Micropaleontology:* Tokyo (Terra Scientific Publishing Company), 413–425. http:// www.terrapub.co.jp/e-library/cjm/pdf/0413.pdf
- Berggren, W.A., Kent, D.V., and Van Couvering, J.A., 1985. The Neogene, Part 2. Neogene geochronology and chronostratigraphy. *In* Snelling, N.J. (Ed.), *The Chronology of the Geological Record*. Memoir—Geological Society of London, 10:211–260.

http://dx.doi.org/10.1144/GSL.MEM.1985.010.01.18

Ciummelli, M., 2013. Morphometry, evolution, biostratigraphy and paleoecology of the genus *Discoaster* in the Miocene using material from Site U1338, IODP Exp. 321 [Ph.D. dissertation]. University of Chieti-Pescara, Italy.



- Di Stefano, A., Baldassini, N., Maniscalco, R., Speranza, F., Maffione, M., Cascella, A., and Foresi, L.M., 2015. New bio-magnetostratigraphic data on the Miocene Moria section (Northern Apennines, Italy): connections between the Mediterranean region and the North Atlantic Ocean. *Newsletters on Stratigraphy*, 48(2):135–152. http://dx.doi.org/10.1127/nos/2015/0057
- Di Stefano, A., Verducci, M., Lirer, F., Ferraro, L., Iaccarino, S.M., Hüsing, S.K., and Hilgen, F.J., 2010. Paleoenvironmental conditions preceding the Messinian Salinity Crisis in the central Mediterranean: integrated data from the upper Miocene Trave section (Italy). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 297(1):37–53. http://dx.doi.org/10.1016/j.palaeo.2010.07.012
- Expedition 320/321 Scientists, 2010a. Methods. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http://dx.doi.org/10.2204/ iodp.proc.320321.102.2010
- Expedition 320/321 Scientists, 2010b. Site U1338. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http://dx.doi.org/10.2204/ iodp.proc.320321.110.2010
- Farrell, J.W., Raffi, I., Janecek, T.R., Murray, D.W., Levitan, M., Dadey, K.A., Emeis, K.-C., Lyle, M., Flores, J.-A., and Hovan, S., 1995. Late Neogene sedimentation patterns in the eastern equatorial Pacific Ocean. *In* Pisias, N.G., Mayer, L.A., Janecek, T.R., Palmer-Julson, A., and van Andel, T.H. (Eds.), *Proceedings of the Ocean Drilling Program, Scientific Results*, 138: College Station, TX (Ocean Drilling Program), 717–756.

http://dx.doi.org/10.2973/odp.proc.sr.138.143.1995

- Lourens, L.J., Hilgen, F.J., Shackleton, N.J., Laskar, J., and Wilson, D., 2004. The Neogene period. *In* Gradstein, F.M., Ogg, J.G., and Smith, A.G. (Eds.), *A Geological Time Scale 2004*. Cambridge, UK (Cambridge Univ. Press), 409–440.
- Lyle, M., and Backman, J., 2013. Data report: calibration of XRF-estimated CaCO₃ along the Site U1338 splice. *In*

Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http://dx.doi.org/10.2204/ iodp.proc.320321.205.2013

Lyle, M., Dadey, K.A., and Farrell, J.W., 1995. The late Miocene (11–8 Ma) eastern Pacific carbonate crash: evidence for reorganization of deep-water circulation by the closure of the Panama gateway. *In* Pisias, N.G., Mayer, L.A., Janecek, T.R., Palmer-Julson, A., and van Andel, T.H. (Eds.), *Proceedings of the Ocean Drilling Program, Scientific Results*, 138: College Station, TX (Ocean Drilling Program), 821–838.

http://dx.doi.org/10.2973/odp.proc.sr.138.157.1995

- Pälike, H., Nishi, H., Lyle, M., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, 2010. Expedition 320/321 summary. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/ 321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http:// dx.doi.org/10.2204/iodp.proc.320321.101.2010
- Raffi, I., Backman, J., Fornaciari, E., Pälike, H., Rio, D., Lourens, L., and Hilgen, F., 2006. A review of calcareous nannofossil astrobiochronology encompassing the past 25 million years. *Quaternary Science Reviews*, 25(23– 24):3113–3137. http://dx.doi.org/10.1016/j.quascirev.2006.07.007
- Wilkens, R.H., Dickens, G.R., Tian, J., Backman, J., and the Expedition 320/321 Scientists, 2013. Data report: revised composite depth scales for Sites U1336, U1337, and U1338. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., and the Expedition 320/321 Scientists, *Proceedings of the Integrated Ocean Drilling Program*, 320/321: Tokyo (Integrated Ocean Drilling Program Management International, Inc.). http://dx.doi.org/10.2204/iodp.proc.320321.209.2013

Initial receipt: 8 September 2015 Acceptance: 5 November 2015 Publication: 11 February 2016 MS 320321-219





Figure F1. CSF-A versus CCSF-A depths for tops of cores, Site U1338. Growth factors = slope of the regression line for each hole.



Figure F2. Biomagnetostratigraphic indicators, 0–18 Ma, Site U1338. Symbols are shown with error bars in the depth domain, representing the lowermost and uppermost depths of biohorizons and chron boundaries (Tables T1, T2, T3).





Figure F3. Biomagnetostratigraphic indicators, 0–5.2 Ma, Site U1338. See Table **T4** for CPs and LSRs. Symbols are shown with error bars in the depth domain, representing the lowermost and uppermost depths of biohorizons and chron boundaries (Tables **T1**, **T2**, **T3**).





Figure F4. Biomagnetostratigraphic indicators, 5.0–10.2 Ma, Site U1338. See Table **T4** for CPs and LSRs. Symbols are shown with error bars in the depth domain, representing the lowermost and uppermost depths of biohorizons and chron boundaries (Tables **T1**, **T2**, **T3**).





Figure F5. Biomagnetostratigraphic indicators, 10–18 Ma, Site U1338. See Table **T4** for CPs and LSRs. Site U1338 terminal depth = 413.6 m CCSF-B at 18.4 Ma. Symbols are shown with error bars in the depth domain, representing the lowermost and uppermost depths of biohorizons and chron boundaries (Tables **T1**, **T2**, **T3**).





Figure F6. Linear sedimentation rate versus age. CP numbers in plot refer to Table **T4.** Estimated paleolatitude positions of Site U1338 are from Figure **F5** in the "Expedition 320/321 summary" chapter (Pälike et al., 2010).





Table T1. Biomagnetostratigraphic age-depth data for calcareous nannofossils, Site U1338. This table is available in oversized format.



 Table T2. Biomagnetostratigraphic age-depth data for diatoms, Site U1338.

bate Date Display and production Index Status Top depth Top depth Exclusine dep									D 1 1 1		
Datam bioloxian Thermal (cm) CBA (m) CBA (m) CCBA (m) <thccba (m)<="" th=""> <thccba (m)<="" th=""> CCBA (m)</thccba></thccba>		Age	Lop hole core section	Bottom hole core section	Top depth	Bottom depth	Top depth	Bottom depth	(midpoint)	Uncertainty	Calibrated with
121- 221- 221- 521- 533 7.25 8.39 7.22 0.39 Yes Inglingent foulit 0.72 0.3384.274-3.120 0.3384.274-4.51 0.75 11.39 12.13 10.41 0.38 No Micascher martugmaria 1.2 0.3386.271-3102 0.3386.274-4.50 0.3386.274-4.51 0.3386.274-4.50 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.274-4.51 0.3386.272-51 0.338 1.53 0.338 1.53 0.338.274-51 0.338 1.34 0.3386.22 0.38 Yes Micasching paradegraphic run- obtabal 1.1 0.3386.541, 20 0.35.54 1.30 0.36 Yes 0.38 Yes Micasching paradegraphic run-obtabal 1.1 0.3386.541, 20 0.35.54 0.30 1.34.1 0.36 Yes	Diatom biohorizon	(Ma)	interval (cm)	interval (cm)	CSF-A (m)	CSF-A (m)	CCSF-A (m)	CCSF-A (m)	CCSF-B (m)	(± m)	stratigraphy
321- 321- <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<>											
Singlengen in with windlif 0.70 0.1380. JH 3, 4 J, 4 (J) 0.1380. JH 3, 1 JD 4.13 6.30 7.31 8.38 7.22 0.18 Yes Microbine matrix mannel 1.2 0.1380. JH 3, 1 JD 1.180 1.2.5 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.44 1.3.0 1.3.0 1.3.4 1.3.0 1.3.4 1.3.0 1.3.4 1.3.0 1.3.4 1.3.0 </td <td></td> <td></td> <td>321-</td> <td>321-</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>			321-	321-							
magnengan transm magnengan tr	T Fragilariopsis reinholdii	0.70	U1338A-2H-3, 45	U1338A-2H-3, 120	6.15	6.90	7.63	8.38	7.22	0.38	Yes
 https://www.international.org/particle/international.org/parti	T Fragilariopsis fossilis	0.92	U1338A-2H-5, 120	U1338A-2H-6, 45	9.90	10.65	11.38	12.13	10.61	0.38	No
Intracedure productional 1.2 01388-214-1, 4.5 01388-214-1, 120 12.33 13.30 13.44 13.30 13.45 13.50 13.45 13.50 13.45 13.50 13.45 13.50 13.45 13.50 13.45 13.50 13.45 13.45 13.45 13.45 13.45 13.40 13.45 13.40 13.46 13.45 13.40 13.46 13.45 13.40 13.45<	T Rhizosolenia matuyamai	1.02	U1338B-2H-3, 120	U1338B-2H-4, 45	11.80	12.55	13.09	13.84	12.10	0.38	Yes
 Microadem prodecegonal var. Roburda I. 1388-14-2, 12 U. 1388-14-2, 12 U. 1388-14-4, 14 U. 1388-14-14, 14 U. 13	B Rhizosolenia matuyamai	1.2	U1338B-2H-4, 45	U1338B-2H-4, 120	12.55	13.30	13.84	14.59	12.77	0.38	Yes
Imaginary and adults 19 UII 3388-3145, 120 UI 3388-3145, 420 UI 3388-3145, 420 UI 3386-315, 425 UI 3386-315, 426	T Rhizosolenia praebergonii var. robusta	1.66	U1338B-3H-2, 120	U1338B-3H-3, 45	19.80	20.55	21.87	22.62	19.99	0.38	Yes
The data converse and converse	B Fragilariopsis doliolus	1.9	U1338B-3H-5, 120	U1338B-3H-6, 45	24.30	25.05	26.37	27.12	24.03	0.38	Yes
Mitschein growene 2.7 U1338-A3H-1, 20 1338-A3H-1, 20 31.63 32.46 32.765 32.775 32.866 32.765 32.775 32.866 32.765 32.775 32.866 32.765 32.775 32.866 32.775 32.866 32.775 32.867 32.867 32.867 32.867 32.867 32.867 32.867 32.867 32.867 32.867 32.867 </td <td>T Thalassiosira convexa var. convexa</td> <td>2.2</td> <td>U1338A-4H-4, 45</td> <td>U1338A-4H-4, 120</td> <td>26.65</td> <td>27.40</td> <td>30.27</td> <td>31.02</td> <td>27.66</td> <td>0.38</td> <td>Yes</td>	T Thalassiosira convexa var. convexa	2.2	U1338A-4H-4, 45	U1338A-4H-4, 120	26.65	27.40	30.27	31.02	27.66	0.38	Yes
Initial production production production production of production production production production production of the production of th	ר Nitzschia jouseae	2.7	U1338A-5H-1, 45	U1338A-5H-1, 120	31.65	32.40	37.05	37.80	33.78	0.38	Yes
Arthocycki allphica: Lanceoluta 3.4 U1338-614-7, 45 U1338-614-7, 45 U1338-614-7, 45 U1338-614-7, 45 U1338-714-7, 120 22.15 52.90 53.64 47.68 0.38 Yes Arthocychalc elgens 4.2 U1338-714-7, 120 22.15 52.90 53.64 61.35 53.04 0.38 Yes Arthocychalc elgens 4.2 U1338-714-7, 120 52.15 52.90 53.64 61.35 53.04 0.38 Yes Mitching contrapil 5.7 U1338-114-1, 45 U1338-114-1, 45 90.05 88.65 99.05 88.32 0.44 Yes Artenologing concilicha 6.28 U1338-114-1, 45 90.05 87.30 116.14 116.89 105.14 0.38 Yes Mitcschin micromica 6.40 U1338-124-1, 120 101.55 105.30 116.14 116.89 104.49 0.38 Yes Mitcschin micromica 6.40 U1338-124-1, 120 101.38-144 122.01 122.50 138.20 139.70 124.84 0.75 Yes Mitcschin micromica 6.9 U13388-144-1, 20 11388-144-1, 20 <td>3 Rhizosolenia praebergonii var. robusta</td> <td>3.1</td> <td>U1338A-5H-4, 120</td> <td>U1338A-5H-5, 45</td> <td>36.90</td> <td>37.65</td> <td>42.30</td> <td>43.05</td> <td>38.52</td> <td>0.38</td> <td>Yes</td>	3 Rhizosolenia praebergonii var. robusta	3.1	U1338A-5H-4, 120	U1338A-5H-5, 45	36.90	37.65	42.30	43.05	38.52	0.38	Yes
The description convexar var. convexar 3.8 U13388-ht-2, 45 U13386-ht-2, 120 47.55 44.30 52.69 53.44 47.66 0.38 Yes intercompliant convexar 4.7 U13387.774.43 52.00 53.64 50.11 53.00 0.38 Yes intercompliant convexar 4.7 U13387.774.43 52.00 53.64 50.01 50 57.04 0.38 Yes intercompliant convexar 4.7 U13387.774.43 52.00 53.64 50.01 50 57.04 0.38 Yes intercompliant convexar 4.7 U13387.174.43 52.00 53.64 50.01 50 57.04 0.38 Yes intercompliant convexar 4.7 U13387.174.43 52.00 53.84 50.01 50 57.04 0.38 Yes intercompliant convexar 4.7 U13387.174.43 50.01 57	Actinocyclus ellipticus f. lanceolata	3.4	U1338B-5H-5, 45	U1338B-5H-5, 120	42.55	43.30	46.85	47.60	42.43	0.38	No
Asternorphalis eligens 4.2 U1338A.7H-2, 120 52.15 52.01 53.36 59.11 53.01 0.38 Yes Nitschin guinens 4.9 U1338A.7H-2, 120 1238A.7H-4, 120 72.15 70.01 79.85 71.38 0.36 Yes Nitschin guinens 5.7 U1338A.7H-4, 120 U1338A.7H-14, 120 72.15 70.01 79.85 71.88 0.38 Yes Thalassonin micricito 5.7 U138B.1H-14, 45 U1338A.1H-14, 54 81.370 70.01 88.92 79.42 70.42 80.49 80.49 70.42 80.49 80.49 70.42 80.49	3 Thalassiosira convexa var. convexa	3.8	U1338B-6H-2, 45	U1338B-6H-2, 120	47.55	48.30	52.69	53.44	47.68	0.38	Yes
Insiglic system 4.7 U 338A-7H-1, 45 S 4.40 S 5.40 C 1.3 S 5.04 O.38 Yes Shaneadcas cetrupii 7.7 U 338A-7H-1, 45 U 338A-7H-1, 45 U 338A-7H-1, 45 VisaA-7H-1, 47	3 Asteromphalus elegans	4.2	U1338A-7H-2, 45	U1338A-7H-2, 120	52.15	52.90	58.36	59.11	53.01	0.38	Yes
Nitschin procence 4.9 U13388-104-6, 45 U13388-101-6, 45 U13388-111-1, 120 U13388-1111-1, 120 U13388-111-1, 120	Fragilariopsis cylindrica	4.7	U1338A-7H-3, 120	U1338A-7H-4, 45	54.40	55.15	60.61	61.36	55.04	0.38	Yes
Shahondixuz aentunpii 5.7 U13388-10H-4, 45 U13388-10H-5, 45 88.55 90.55 97.55 99.05 88.32 0.75 Yes Attacediampra carcillable 6.03 U13388-11H-1, 45 U13388-11H-1, 42 U13388-11H-1, 120 01.15 101.90 11.6.14 10.6.67 107.42 96.18 0.38 Yes Mitarchia maccenico var. dengrata 6.40 U13388-11H-1, 120 10.31 10.190 11.6.14 116.69 104.62 10.32 0.27 Yes Mitarchia maccenico var. dengrata 6.6 U13388-14H-1, 120 10.31 10.190 11.6.14 116.69 10.442 0.75 Yes Mitarchian maccenico var. dengrata 6.6 U13388-14H-1, 120 124.50 124.60 126.50 114.62 10.144 0.75 Yes Mitarchian protein 7.5 U13388-14H-1, 120 123.40 126.50 114.62 131.66 0.38 Yes Mitarchian protein 7.5 U13388-14H-5, 120 U13388-14H-3, 120 124.55 150.15 165.56 165	3 Nitzschia jouseae	4.9	U1338B-8H-6, 45	U1338A-9H-1, 120	72.55	70.40	79.13	79.85	71.58	0.36	Yes
Thalassian aniocenica 5.7 U13388-110-5, 45 U13388-111-1, 45 90.05 88.5 99.05 99.93 89.59 0.44 Yes Frequisition micenitia 6.30 U13388-111-1, 32 U13388-111-1, 32 90.05 88.53 99.05 99.03 80.59 0.44 Yes Inclusion micenitia 0.43 U13388-111-1, 32 U13388-111-1, 32 <	s Shionodiscus oestrupii	5.7	U1338B-10H-4, 45	U1338B-10H-5, 45	88.55	90.05	97.55	99.05	88.32	0.75	Yes
Asterolampica curiloba 6.03 U13388-11H-3, 45 U13388-11H-3, 120 96.55 97.30 106.67 107.42 96.18 0.38 Yes Nitzschin micernica var., elongata 6.40 U13388-12H-4, 45 U13388-12H-4, 12 10.15 10.15 10.8, 30 116.14 116.85 10.14 0.38 Yes Nitzschin micernica var., elongata 6.6 U13388-12H-4, 120 U13381-11-12 110.55 108.40 122.14 126.26 10.23 0.27 Yes Rosisble propagalence 6.8 U13386-14H-3, 122 U13381-14H-3, 120 122.40 122.80 138.20 139.70 124.84 0.75 Yes Indicasiosiar processore 7.1 U13388-14H-3, 120 U13381-14H-3, 120 124.30 125.80 138.20 139.70 124.84 0.75 Yes Indicasiosiar processore 7.1 U13388-14H-3, 120 U13388-14H-3, 120 124.30 147.50 146.25 136.40 167.80 166.20 0.38 Yes Indicasiosiar processore 7.6 U13388-14H-3, 120 U13388-14H-3, 120 171.80 172.85 10.40 191.15 <	Thalassiosira miocenica	5.7	U1338B-10H-5, 45	U1338A-11H-1, 45	90.05	88.65	99.05	99.93	89.59	0.44	Yes
fragilariopics miccanica6.28U1338A-12H-3, 45U1338A-12H-3, 12010.1, 1510.1, 90114, 65103.140.38YesMicaschin aronentear6.6U1338B-12H-6, 45U1338B-12H-7, 120110.55105.30116.14112.67110.230.27YesRossella pragulacear6.6U1338B-12H-6, 45U1338B-14H-1, 20122.20122.77135.60136.33124.840.75YesTholassissiar ancennea6.9U1338B-14H-3, 120U1338B-14H-3, 120124.80125.80138.20139.70124.840.75YesTholassissiar ancennea6.9U1338B-14H-3, 120129.65148.53164.33146.25133.660.38YesVilschin parterin7.5U1338A-13H-3, 45U1338A-11H-3, 120129.65164.33164.53164.35164.35164.35164.35164.35164.35165.06147.222.56YesFragiloripsi raincenica7.6U1338A-13H-3, 45U1338A-13H-3, 45173.80178.03178.78161.020.38YesTholassiar barcenica7.7U1338A-13H-3, 45U1338A-13H-3, 45U1338A-13H-3, 45172.55190.40191.15171.410.38YesHaces marina8.3U1338A-13H-5, 45U1338A-13H-5, 120176.65171.40172.55190.40191.51171.410.38YesHaces marina8.3U1338A-13H-5, 120U1338B-13H-5, 120176.60184.61185.36166.200.38 <td< td=""><td>Γ Asterolampra acutiloba</td><td>6.03</td><td>U1338B-11H-3, 45</td><td>U1338B-11H-3, 120</td><td>96.55</td><td>97.30</td><td>106.67</td><td>107.42</td><td>96.18</td><td>0.38</td><td>Yes</td></td<>	Γ Asterolampra acutiloba	6.03	U1338B-11H-3, 45	U1338B-11H-3, 120	96.55	97.30	106.67	107.42	96.18	0.38	Yes
Nitzschian micenica var. elongata6.60U13388-12H-2, 4.5U13388-12H-2, 120104.55105.30105.14116.14116.89104.690.88YesRossella procepilencen6.8U13386-14H-3, 122U13386-14H-4, 7112.0212.2713.80.0138.0138.00.75YesRolarskian funcenica6.9U13388-14H-2, 120U13388-14H-3, 120124.30125.80138.20139.70124.840.75YesThalanskian funcenica7.60U13388-14H-2, 120U13388-14H-3, 120124.51146.55146.55146.55146.55146.55146.55146.55146.55147.80138.6150.15158.15158.90158.0158.15158.15158.15158.0158.15	۲ Fragilariopsis miocenica	6.28	U1338A-12H-3, 45	U1338A-12H-3, 120	101.15	101.90	113.90	114.65	103.14	0.38	Yes
Tholassisia praeconvexa6.6U1338-12H-6, 4.5U1338-13H-1, 120110.5108.40122.14122.67110.230.27VesBossiello progendence6.8U1338-14H-3, 12011338-14H-3, 120122.02122.07135.60136.20130.70124.840.75VesThalassisiar convexa6.9U1338-14H-3, 12011338-14H-3, 120124.30125.80138.20139.70124.840.75VesThalassisiar convexa6.9U1338-14H-3, 12011338-14H-3, 120124.30128.60145.50146.25131.660.38VesThalassisiar praeconvexa7.7U1338-14H-4, 51U1338-14H-3, 120158.15164.35166.56151.560.75VesStapillor pist miccenica7.7U1338-14H-4, 54U1338-17H-4, 54148.65150.15167.18166.200.38VesThalassisiar backlina du lationa8.2U1338-18H-5, 120158.15158.70178.03178.03178.03172.400.38VesThalassisiar backlina du lationa8.3U1338-18H-5, 120166.50171.40193.50172.400.38VesThalassisiar publica var. jovanica8.3U1338-19H-5, 45U1338-19H-5, 45171.80172.55190.40191.15172.400.38VesThalassisiar publica var. jovanica8.40U1338-19H-5, 120U1338-19H-5, 120171.80172.55190.40191.15172.400.38Ves <trr< tr="">Thalassisiar publica var. j</trr<>	🖥 Nitzschia miocenica var. elongata	6.40	U1338B-12H-2, 45	U1338B-12H-2, 120	104.55	105.30	116.14	116.89	104.69	0.38	Yes
Basiella progenilacea 6.8 U1386-14H-3, 122 U1386-14H-4, 212 U1386-14H-3, 120 U1388-14H-3, 120 U24.30 125.01 136.03 137.00 124.84 0.75 Yes Tholassioiar convexa 7.9 U13388-14H-5, 120 U13388-14H-5, 120 124.80 138.20 137.00 124.84 0.75 Yes Tholassioiar prozenvexa 7.10 U13388-16H-5, 120 U13388-16H-5, 120 U13388-16H-5, 120 124.55 164.33 165.08 147.92 2.56 Yes Topolaropism sincenica 7.6 U1338A-17H-4, 45 143.65 167.18 166.86 151.56 0.75 Yes Topolaropism sincholdi 8.2 U1338B-19H-3, 45 173.80 172.55 190.40 191.15 171.41 0.38 Yes Topolaropism sincholdi 8.43 U1338B-19H-5, 45 U1338B-19H-5, 120 176.60 166.05 166.01 184.11 185.30 162.00 0.88 Yes Topolaropism sincholdi 8.43 U1338A-19H-5, 45 U1338A-19H-5, 120 171.40 189.20 <td>۲ Thalassiosira praeconvexa</td> <td>6.6</td> <td>U1338B-12H-6, 45</td> <td>U1338A-13H-1, 120</td> <td>110.55</td> <td>108.40</td> <td>122.14</td> <td>122.67</td> <td>110.23</td> <td>0.27</td> <td>Yes</td>	۲ Thalassiosira praeconvexa	6.6	U1338B-12H-6, 45	U1338A-13H-1, 120	110.55	108.40	122.14	122.67	110.23	0.27	Yes
Thalaxsoiar micenka6.9U13388-14+2, 120U13388-14+3, 120124, 30125.80138.20139.70124.840.75YesThalaxsoiar oncovexa6.9U13388-14+2, 120U13388-14+3, 120124.30125.00138.00147.92124.840.75YesThalaxsoiar oncovexa7.1U1338A-15+2, 45U1338A-15+2, 45147.80145.50146.25146.26147.222.56YesForgilariopist micenka7.60U1338A-16+6, 45U1338A-17+4, 45148.65150.16165.68147.222.56YesFragilariopist micenka7.7U1338A-18+2, 45U1338A-17+4, 45148.65150.16166.10167.10178.78161.020.38YesFragilariopist micholdi8.2U1338B-18+2, 120U1338B-19+3, 120166.05166.80184.61185.36166.200.38YesAlvacs marinus8.3U1338B-19+5, 45U1338B-18+5, 120176.05166.80184.61185.36166.200.38YesFragilariopis cylindrica8.43U1338A-19+5, 45U1338B-19+5, 120177.15177.55192.00191.15177.410.38YesFragilariopis cylindrica9.0U1338A-20+3, 45U1338A-19+5, 120177.15177.55192.00194.14178.760.88NoFragilariopis cylindrica9.0U1338A-20+3, 45U1338A-20+3, 45178.40177.15197.09198.44178.760.88NoFragilariopis cylindrica <td>r Rossiella praepaleacea</td> <td>6.8</td> <td>U1338C-14H-3, 122</td> <td>U1338C-14H-4, 47</td> <td>122.02</td> <td>122.77</td> <td>135.60</td> <td>136.35</td> <td>123.61</td> <td>0.38</td> <td>Yes</td>	r Rossiella praepaleacea	6.8	U1338C-14H-3, 122	U1338C-14H-4, 47	122.02	122.77	135.60	136.35	123.61	0.38	Yes
Thalaxisoiar convexa6.9U1338A-14H-2, 120U133BA-14H-3, 12012.9, 6.0138.20139.7012.8, 4.8(.7.5(.7.5)Thalaxisoiar pareanvexa7.1U133BA-14H-3, 5U133BA-14H-4, 5129, 6.5144, 6.5164, 3.3165, 0.8147, 9.80.3.8(.7.6)Nitzschin porteri7.6U133BA-14H-4, 6.5U133BA-14H-4, 4.5143, 6.5164, 7.8165, 0.8147, 9.80.3.8(.7.6)(.7.6)Rossiella paleacea7.7U133BA-14H-4, 6.5U133BA-14H-4, 4.5148, 6.5150.15167, 1.8188, 6.8151, 6.60.3.8(.7.6)Thalaxisoiar barckiana8.2U133BA-14H-4, 5U133BA-14H-4, 5171, 8.0172, 5.5190, 00191, 1.5171, 4.10.3.8(.7.6)Rogilanopis rainfoldi8.2U133BA-14H-5, 1.20U133BA-14H-5, 1.20166, 20166, 80184, 61185, 36166, 200.3.8(.7.6)Rogilanopis rainfoldi8.43U133BA-14H-5, 1.20170, 65171, 40191, 00194, 15174, 410.3.8(.7.6)Thalaxisoiar public9.0U133BA-24H-5, 120U133BA-14H-5, 120170, 65177, 15190, 00194, 15174, 220.600.8(.7.6)Thalaxisoiar public9.0U133BA-24H-5, 120U133BA-24H-5, 120177, 15190, 00194, 15174, 150.8NoThalaxisoiar public9.0U133BA-24H-5, 120U133BA-24H-5, 120177, 15190, 00194, 14202, 02180, 79 <td< td=""><td>3 Thalassiosira miocenica</td><td>6.9</td><td>U1338B-14H-2, 120</td><td>U1338B-14H-3, 120</td><td>124.30</td><td>125.80</td><td>138.20</td><td>139.70</td><td>124.84</td><td>0.75</td><td>Yes</td></td<>	3 Thalassiosira miocenica	6.9	U1338B-14H-2, 120	U1338B-14H-3, 120	124.30	125.80	138.20	139.70	124.84	0.75	Yes
Thalassisir praeconvexa7.1U1338A-15H-3, 45U1338A-15H-3, 120120, 120, 120, 145, 130146, 25147, 28147, 28146, 25147, 28147, 28146, 25147, 28 <th< td=""><td>3 Thalassiosira convexa</td><td>6.9</td><td>U1338B-14H-2, 120</td><td>U1338B-14H-3, 120</td><td>124.30</td><td>125.80</td><td>138.20</td><td>139.70</td><td>124.84</td><td>0.75</td><td>Yes</td></th<>	3 Thalassiosira convexa	6.9	U1338B-14H-2, 120	U1338B-14H-3, 120	124.30	125.80	138.20	139.70	124.84	0.75	Yes
Nitzschia porteri7.5U13388-16H-5, 12U13388-16H-6, 45U13388-17H-4, 45143, 65144, 55160, 56165, 68147, 222.56YesRoussilla poleocea7.7U1338A-17H-3, 45U1338A-17H-4, 45143, 65150, 15167, 18166, 56167, 220.38YesTaclassivia bunchlan7.8U1338A-17H-3, 45U1338A-17H-3, 45171, 80172, 55190, 40191, 15171, 410.38YesTaclassivia bunchlan8.2U1338B-18H-3, 45U1338B-18H-3, 45171, 80172, 55190, 40191, 15171, 410.38YesAteus marina8.3U1338B-18H-3, 45U1338B-18H-3, 45171, 80172, 55190, 40191, 15171, 410.38YesTalassici pubei8.43U1338B-19H-5, 45U1338B-19H-5, 45173, 80166, 20191, 15174, 220.67YesTalassici pubei var. elliptica9.0U1338A-20H-5, 120170, 65171, 40191, 30192, 50172, 290.38YesTalassici pubei var. elliptica9.0U1338A-20H-2, 120U1338A-20H-3, 120177, 15175, 50192, 40198, 44178, 760.38NoTalassici pubei var. elliptica9.0U1338A-20H-2, 120U1338A-20H-3, 120177, 15196, 90198, 44178, 760.38NoTalassici pubei var. elliptica9.0U1338A-20H-4, 120U1338A-20H-4, 120177, 15196, 90198, 44178, 760.38NoT	3 Thalassiosira praeconvexa	7.1	U1338A-15H-3, 45	U1338A-15H-3, 120	129.65	130.40	145.50	146.25	131.66	0.38	Yes
Incigliariys insciencica7.60U1338A-16H-6, 4SU1338A-17H-2, 4SU1338A-17H-2, 4S148, 6S147.15160.60165.68147.222.56YesRescillar polarosia fairboldii7.8U1338A-18H-3, 4SU1338A-18H-3, 120158.15159.05178.03178.78161.020.38YesTradissiosiara burcklana7.8U1338A-18H-3, 4SU1338B-18H-3, 120158.15159.00178.03178.78161.020.38YesAltonocyclus ellipticus var. joranica8.2U1338B-18H-5, 4SU1338B-18H-5, 120166.05166.80184.61185.36166.200.38YesIndiassiosiry apolei8.43U1338A-19H-5, 4SU1338A-19H-5, 120176.05171.40191.15171.410.38YesFragilariopsis cylindrica8.43U1338A-19H-5, 4SU1338A-19H-5, 120176.65171.40191.30192.05172.990.38YesFragilariopsis cylindrica8.43U1338A-19H-5, 4SU1338A-20H-5, 120177.15180.90198.44102.19180.791.88NoThalassiosir burcklana9.0U1338A-20H-5, 120177.15180.90198.44102.19180.791.88NoThalassiosir burcklana9.1U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoCarloadsing bigs var. diorana11.0U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoCarloadsica bigs var. dior	Nitzschia porteri	7.5	U1338B-16H-5, 120	U1338B-16H-6, 45	147.80	148.55	164.33	165.08	147.98	0.38	Yes
Roiselli polencea7.7U1338A-17H-3, 45U1338A-17H-4, 45U48.6515.1516.7.18166.8615.1.660.7.5YesTradisosior burcheding8.2U1338B-19H-2, 120U1338B-19H-3, 120178.18178.25190.40191.15171.410.38YesActinocyclus ellipticus var. javanica8.3U1338B-19H-2, 120U1338B-19H-3, 150166.05166.60184.61185.36166.200.38YesThalessiosiar vabei8.43U1338B-19H-5, 45U1338B-19H-5, 120170.65171.40191.15171.420.67YesTradisosiosiar vabei8.43U1338B-19H-5, 45U1338B-19H-5, 120170.65171.40191.30192.05172.990.38YesAcpeiton adulifera var. cyclopa8.6U1338A-20H-3, 150177.15175.55192.80194.15174.220.67YesThalessiosiar burckinan9.0U1338A-20H-3, 150177.15175.05192.80194.15174.220.67YesThalessiosiar burckinan9.0U1338A-20H-3, 450177.15175.05192.80198.44202.19188.760.38NoThalessiosiar burckinan9.0U1338A-20H-4, 120U1338A-20H-4, 120177.15180.90198.44202.19188.760.38NoCavitar burckinan9.0U1338A-20H-5, 120U1338A-20H-2, 120177.15180.90198.44202.19188.760.38NoCavitar burckinan10.0U1338B-22H-6, 70 <td>3 Fragilariopsis miocenica</td> <td>7.60</td> <td>U1338A-16H-6, 45</td> <td>U1338A-17H-2, 45</td> <td>143.65</td> <td>147.15</td> <td>160.56</td> <td>165.68</td> <td>147.22</td> <td>2.56</td> <td>Yes</td>	3 Fragilariopsis miocenica	7.60	U1338A-16H-6, 45	U1338A-17H-2, 45	143.65	147.15	160.56	165.68	147.22	2.56	Yes
Thalassisiry buckliona7.8U1338A-18H-3, 42U1338A-18H-3, 120158, 15158, 9017.0317.87.8161.020.38YesActinocyclus ellipticus var. javanica8.25U1338B-19H-2, 120U1338B-19H-3, 45171.80172.55190.40191.15171.410.38YesAleus marinus8.3U1338B-19H-5, 45U1338B-19H-5, 45U1338B-19H-5, 4510133B-19H-5, 4510138B-19H-5, 45172.15190.40191.15171.410.38YesFragilariopsis cylindrica8.43U1338B-19H-5, 45U1338B-19H-5, 45172.15174.05174.40191.30192.05172.990.38YesFragilariopsis cylindrica9.0U1338A-20H-5, 45172.15175.05171.40191.30192.05172.990.84NoThalassiosira buckliara9.0U1338A-20H-5, 45172.15175.05198.44201.9180.791.88NoThalassiosira buckliara9.0U1338A-20H-5, 120173.84276.40271.5189.69198.44201.9180.791.88NoThalassiosira buckliara9.0U1338A-22H-6, 70U1338A-22H-2, 120173.5190.40191.41210.956.85YesCavitatus jouseana10.0U1338B-22H-6, 70U1338A-22H-2, 120173.15180.90198.44201.9180.791.88NoCavitatus jouseana11.0U1338B-22H-6, 70U1338A-22H-2, 24241.12210.956.85YesCavitatus jousea	Rossiella paleacea	7.7	U1338A-17H-3, 45	U1338A-17H-4, 45	148.65	150.15	167.18	168.68	151.56	0.75	Yes
froglaropsix reinholdii8.2U13388-19H-2, 120U13388-19H-3, 45171.80172.55190.40191.15171.410.38YesActinocyclus ellipticus var. javanica8.25U13388-19H-2, 120U13388-19H-3, 45171.80172.55190.40191.15171.410.38YesThalassoisria vabei8.3U13388-19H-5, 45U13388-19H-5, 120166.05166.80184.61185.36166.200.38YesTrajalaropsis cylindra8.43U13388-19H-5, 45U13388-19H-5, 120170.65171.40191.10192.05172.290.38YesTaglaropsis cylindra8.64U1338A-19H-6, 45U1338A-19H-5, 120172.15175.55192.80194.15174.220.67YesTrajalaropsis fosilis9.0U1338A-20H-3, 51U1338A-20H-3, 120177.15180.90198.44202.19180.791.88NoThalossiosira burcklinan9.1U1338A-20H-3, 45U1338A-20H-2, 120177.15180.90198.44202.19180.791.88YesCantorcus contromensis10.0U1338B-22H-6, 70U1338A-20H-2, 120177.15180.90198.44202.19180.796.85YesCantorcus contromensis11.0U1338B-22H-6, 70U1338A-20H-2, 120248.77275.48276.23250.780.38NoCantorcus contromensis11.0U1338C-28H-1, 120U1338C-28H-1, 72248.02248.77275.48276.23250.780.38No	Thalassiosira burckliana	7.8	U1338A-18H-3, 45	U1338A-18H-3, 120	158.15	158.90	178.03	178.78	161.02	0.38	Yes
Actinocyclus ellipticus var. javanica8.25U13388-18H-5, 45U13388-18H-5, 120166.05166.80184.61185.36166.200.38YesAlkeus marinus8.3U13388-19H-2, 120U13388-19H-3, 45171.80172.55190.40191.15171.410.38YesFragilariopsis cylindrica8.43U1338A-19H-5, 45U1338A-19H-5, 120160.5166.80184.61185.36166.200.38YesFragilariopsis cylindrica8.43U1338A-19H-5, 45U1338A-19H-5, 45172.15175.55192.05172.290.38YesFragilariopsis fosilis9.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoThalassiosira vabei var. elliptica9.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoThalassiosira vabei var. elliptica9.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88YesActinocyclus moronensis10.0U1338A-22H-4, 70U1338A-20H-2, 120177.15180.90198.44202.19180.791.88NoCoscinadiscus gias var. diorama11.3U1338C-28H-1, 122U1338C-28H-2, 47255.2222.62260.3223.6780.83NoCascinadiscus gias var. diorama11.3U1338C-28H-1, 47U1338C-28H-1, 47255.5222.8228.9510.88NoCascinad	3 Fragilariopsis reinholdii	8.2	U1338B-19H-2, 120	U1338B-19H-3, 45	171.80	172.55	190.40	191.15	171.41	0.38	Yes
Akeus marinus 8.3 U1338B-19H-2, 120 U1338B-19H-3, 45 171.80 172.55 190.40 191.15 171.41 0.38 Yes Thalassiosira yabei 8.43 U1338B-18H-5, 45 U1338B-19H-5, 120 170.65 171.40 191.30 192.05 172.99 0.38 Yes Azpeitin ondulifera var. cyclopa 8.6 U1338A-19H-5, 45 U1338A-19H-5, 120 177.65 170.65 171.40 191.30 192.05 172.99 0.38 Yes Thalossiosi sysics vicindica 8.6 U1338A-20H-3, 45 U1338A-20H-5, 120 177.15 180.90 198.44 108.79 1.88 No Thalossiosiro yabei var. elliptica 9.0 U1338A-20H-3, 45 U1338A-20H-3, 45 103.84.20H-5, 120 177.15 180.90 198.44 178.76 0.38 No Thalossiosiro wabei var. elliptica 9.0 U1338A-20H-4, 47 248.02 248.27 254.21 241.11 210.95 6.85 Yes Thalossiosiro wabei var. elliptica 11.0 U1338C-28H-1, 122 U1338C-28H-2, 47 248.02 248.77 275.48 276.23 250.78 0.38 No <td>Actinocyclus ellipticus var. javanica</td> <td>8.25</td> <td>U1338B-18H-5, 45</td> <td>U1338B-18H-5, 120</td> <td>166.05</td> <td>166.80</td> <td>184.61</td> <td>185.36</td> <td>166.20</td> <td>0.38</td> <td>Yes</td>	Actinocyclus ellipticus var. javanica	8.25	U1338B-18H-5, 45	U1338B-18H-5, 120	166.05	166.80	184.61	185.36	166.20	0.38	Yes
Thalassiosira yabei8.43U13388-18H-5, 45U13388-18H-5, 120166.05166.80184.61185.36166.200.38Yesfragilariopsis cylindrica8.43U1338A-19H-5, 45U1338A-19H-5, 45U1338A-19H-5, 45172.15172.900.38Yesfragilariopsis fosilis9.0U1338A-20H-3, 45U1338A-20H-3, 45U1338A-20H-3, 45177.15180.90198.44202.19180.791.88NoThalassiosi yabei var. elliptica9.0U1338A-20H-3, 45U1338A-20H-3, 45177.16177.15180.90198.44202.19180.791.88YesThalassiosi yabei var. elliptica9.1U1338A-20H-3, 45U1338A-20H-3, 45177.15180.90198.44202.19180.791.88YesActinocyclus moronensis10.0U1338B-23H-5, 45U1338A-20H-2, 45232.5523.65259.26260.93234.210.83NoCraspedoliscus coscinodiscus11.2U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCoscinodiccus gigs var. diorama11.6U1338C-28H-1, 122U1338C-28H-4, 45258.30262.05286.35290.10258.961.88YesActinocyclus nigens11.6U1338C-28H-4, 47U1338C-28H-4, 45258.27256.77287.33234.210.38NoCracidenticula nicobaria12.5U1338C-28H-1, 47U1338C-28H-1, 47292.67292.67286.35290.10258.96 <td< td=""><td>Alveus marinus</td><td>8.3</td><td>U1338B-19H-2, 120</td><td>U1338B-19H-3, 45</td><td>171.80</td><td>172.55</td><td>190.40</td><td>191.15</td><td>171.41</td><td>0.38</td><td>Yes</td></td<>	Alveus marinus	8.3	U1338B-19H-2, 120	U1338B-19H-3, 45	171.80	172.55	190.40	191.15	171.41	0.38	Yes
Fragilariopsis cylindrica8.43U1338A-19H-5, 45U1338A-19H-5, 120170.65171.40191.30192.05172.990.38YesAzpeitin andulifera var. cyclopa8.6U1338A-19H-5, 45U1338A-19H-5, 120177.15175.55192.80194.15174.220.67YesFragilariopsis fossilis9.0U1338A-20H-3, 120U1338A-20H-3, 45U1338A-20H-3, 45176.40177.15197.69198.44178.760.38NoThalassiosira burckliana9.1U1338A-20H-3, 45U1338A-20H-4, 120177.15180.90198.44202.19180.791.88YesCavitatus jouseana11.0U1338B-22H-6, 70U1338A-20H-4, 120205.80214.28227.42241.11210.956.85YesCostendoliscus gigas var. diorama11.2U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCosciendoliscus gigas var. diorama11.3U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCosciendoliscus gigas var. diorama11.3U1338C-28H-1, 47288.02248.77275.48276.23250.780.38NoCosciendoliscus gigas var. diorama11.3U1338C-28H-1, 47248.02248.77275.48276.23250.780.38NoCosciendoliscus gigas var. diorama12.0U1338C-28H-2, 47248.02248.77275.48276.23250.780.38N	Thalassiosira vabei	8.43	U1338B-18H-5, 45	U1338B-18H-5, 120	166.05	166.80	184.61	185.36	166.20	0.38	Yes
Azpeitia nodulífera var. cyclopa8.6U1338A-19H-6, 45U1338A-19H-5, 45172.15175.55192.80194.15174.220.67YesFragilariopsis fossilis9.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoThalassiosira burckliana9.1U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88YesActinocyclus moronensis10.0U1338A-22H-6, 70U1338A-24H-2, 108205.80214.28227.42241.11210.956.85YesCovitatus jouseana11.0U1338C-28H-4, 54U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCascinodiscus gigas var. diorama11.3U1338C-28H-4, 47U1338C-28H-6, 122248.77275.48276.23250.780.38NoActinocyclus lipticus var. spiralis11.3U1338C-28H-6, 122248.77255.52282.25282.59259.601.88NoActinocyclus lipticus var. spiralis11.6U1338C-28H-6, 122248.77255.48276.23250.780.38NoActinocyclus lipticus var. spiralis11.6U1338C-28H-6, 122248.77255.48276.23280.661.88YesActinocyclus lipticus var. spiralis11.6U1338C-28H-7, 47U1338C-28H-6, 122248.77255.48290.10258.961.88YesActinocyclus lipticus var. spiralis11.6U1338B	B Fraailariopsis cylindrica	8.43	U1338A-19H-5, 45	U1338A-19H-5, 120	170.65	171.40	191.30	192.05	172.99	0.38	Yes
Fragilariopsis fossilis9.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88NoThalassiosiar yabei var. elliptica9.0U1338A-20H-2, 120U1338A-20H-3, 45176.40177.15197.69198.44178.760.38NoThalassiosiar burckliana9.1U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88YesActinocyclus moronensis10.0U1338A-20H-5, 45U1338A-20H-2, 108205.80214.28227.42241.11210.956.85YesCarspedoliscus coscinadiscus11.2U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCoscinadiscus gigas var. diorama11.3U1338C-28H-6, 47U1338C-28H-6, 122254.77255.52282.23282.98256.910.38NoActinocyclus ellipticus var. spiralis11.6U1338B-28H-4, 45258.20266.07283.73284.23258.160.25NoCardentotian incobarica12.0U1338B-23H-7, 47U1338C-28H-6, 122256.77283.73284.23258.160.25NoCardentotian incobarica12.0U1338B-33H-5, 120U1338B-33H-7, 45299.60300.3530.73331.05297.510.38NoCascinadiscus gigas var. diorama12.0U1338B-34H-4, 45292.87292.35322.91322.97291.860.03NoCardentoti	Azpeitia nodulifera var. cvclopa	8.6	U1338A-19H-6, 45	U1338B-19H-5, 45	172.15	175.55	192.80	194.15	174.22	0.67	Yes
Thalassiosira yabei var. elliptica 9.0 U1338A-20H-2, 120 U1338A-20H-3, 45 176.40 177.15 197.69 198.44 178.76 0.38 No Thalassiosira burckliana 9.1 U1338A-20H-3, 45 U1338A-24H-5, 120 177.15 180.90 198.44 202.19 180.79 1.88 Yes Actinocyclus moronensis 10.0 U1338A-24H-2, 102 202.55 232.65 259.26 260.93 234.21 0.83 No Cavitatus jouseana 11.0 U1338C-28H-1, 122 U1338C-28H-2, 47 248.02 248.77 275.48 276.23 250.78 0.38 No Coscindiscus coscinodiscus gigas var. diorama 11.3 U1338C-28H-6, 47 U1338C-28H-4, 45 258.30 262.05 286.35 290.10 258.96 1.88 Yes Actinocyclus ellipticus var. spiralis 11.3 U1338C-28H-4, 45 298.00 300.35 330.75 331.50 297.51 0.38 No Cavitadus ingens 12.6 U1338B-28H-1, 120 U1338B-28H-4, 45 299.60 300.35 330.75 331.50 297.51 0.38 No Cavitadu	3 Fragilarionsis fossilis	9.0	U1338A-20H-3, 45	U1338A-20H-5, 120	177.15	180.90	198.44	202.19	180.79	1.88	No
Thalassis in turbupted1.0U1338A-20H-3, 45U1338A-20H-5, 120177.15180.90198.44202.19180.791.88YesActinocyclus moronensis10.0U1338B-22H-6, 70U1338A-24H-2, 108205.80214.28227.42241.11210.956.85YesCavitatus jouseana11.0U1338B-25H-5, 45U1338A-26H-2, 45232.55232.65259.26260.93234.210.83NoCoscinodiscus gigas var. diorama11.3U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoActinocyclus gilgas var. diorama11.3U1338C-28H-4, 7U1338C-28H-4, 52254.77255.52282.23282.98256.910.38NoActinocyclus ellipticus var. spiralis11.6U1338B-28H-4, 45258.30262.05286.35290.10258.961.88YesActinocyclus ingens12.0U1338C-28H-7, 47U1338C-29H-1, 47256.27256.77283.73284.23258.160.25NoCrucidenticula nicobarica12.5U1338B-23H-5, 120U1338B-23H-4, 45299.60300.35330.75331.50297.510.38NoArnellus califormicas12.7U1338B-23H-4, 45U1338B-23H-1, 47306.85307.37339.28340.50307.180.61NoAranleus elipticus var. spiralis13.0U1338B-34H-1, 45U1338B-34H-2, 12.01338B-34H-2, 12.0135.84336.24314.250.38Yes <td>3 Thalassiosira vahei var. ellintica</td> <td>9.0</td> <td>U1338A-20H-2, 120</td> <td>U1338A-20H-3, 45</td> <td>176.40</td> <td>177.15</td> <td>197.69</td> <td>198 44</td> <td>178.76</td> <td>0.38</td> <td>No</td>	3 Thalassiosira vahei var. ellintica	9.0	U1338A-20H-2, 120	U1338A-20H-3, 45	176.40	177.15	197.69	198 44	178.76	0.38	No
Actinocyclus moronensis10.0U13388-22H-6, 70U1338A-24H-2, 108205.80214.28227.42241.11210.956.85YesCavitatus jouseana11.0U1338B-22H-6, 70U1338A-24H-2, 108205.80214.28227.42241.11210.956.85YesCavitatus jouseana11.0U1338B-23H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCoscinodiscus gigas var. diorama11.3U1338C-28H-4, 122U1338C-28H-4, 47248.02248.77275.48276.23250.780.38NoActinocyclus ellipticus var. spiralis11.3U1338C-28H-4, 47U1338C-28H-4, 45258.30262.05288.23282.98256.910.38NoActinocyclus ingens12.0U1338B-28H-1, 120U1338B-28H-1, 45256.27256.77283.73284.23258.160.25NoCrucidenticula nicobarica12.5U1338B-33H-5, 120U1338B-32H-7, 45292.87292.35322.91332.97291.860.03NoCoscinodiscus gigas var. diorama12.9U1338B-34H-4, 45U1338B-32H-7, 45292.87292.35322.91336.28301.460.75YesCoscinodiscus gigas var. diorama12.9U1338B-34H-1, 45U1338B-34H-1, 120313.85344.83336.28301.460.75YesCascindoviscus gigas var. diorama12.9U1338B-34H-1, 45U1338B-35H-4, 45315.60316.35349.38336.28301.46 <t< td=""><td>3 Thalassiosira burckliana</td><td>9.1</td><td>U1338A-20H-3, 45</td><td>U1338A-20H-5, 120</td><td>177.15</td><td>180.90</td><td>198.44</td><td>202.19</td><td>180.79</td><td>1.88</td><td>Yes</td></t<>	3 Thalassiosira burckliana	9.1	U1338A-20H-3, 45	U1338A-20H-5, 120	177.15	180.90	198.44	202.19	180.79	1.88	Yes
Construction </td <td>Actinocyclus moronensis</td> <td>10.0</td> <td>U1338B-22H-6 70</td> <td>U1338A-24H-2, 108</td> <td>205 80</td> <td>214 28</td> <td>227.42</td> <td>241.11</td> <td>210.95</td> <td>6 85</td> <td>Yes</td>	Actinocyclus moronensis	10.0	U1338B-22H-6 70	U1338A-24H-2, 108	205 80	214 28	227.42	241.11	210.95	6 85	Yes
CraspedoliscusConstructionConstructionConstructionConstructionConstructionConstructionCraspedoliscuscoscinodiscusgigas var. diorama11.3U1338C-28H-1, 122U1338C-28H-2, 47248.02248.77275.48276.23250.780.38NoCoscinodiscusgigas var. diorama11.3U1338C-28H-6, 47U1338C-28H-6, 122254.77255.52282.23282.98256.910.38NoHemidiscuscureiformis11.6U1338C-28H-7, 47U1338C-28H-6, 122254.77255.52286.35290.10258.961.88YesActinocyclus ingens12.0U1338C-28H-7, 47U1338C-28H-6, 45299.60300.35330.75331.50297.510.38NoCrucidenticula nicobarica12.5U1338C-28H-1, 47U1338C-39H-7, 45292.87292.35322.91322.97291.860.03NoCoscinodiscus gigas var. diorama12.9U1338B-34H-2, 45306.85307.37339.28340.50307.180.61NoAraniscus lewisianus13.0U1338B-34H-1, 45U1338B-35H-4, 45315.60316.35349.38350.13314.250.38YesAztinocyclus ellipticus var. spiralis14.2U1338C-36H-4, 47U1338B-35H-4, 45315.60316.35349.38350.13314.250.38YesCestodiscus peplum13.5U1338C-36H-4, 47U1338B-35H-4, 45315.60316.35349.38350.13314.250.38Yes <td>Cavitatus iouseana</td> <td>11.0</td> <td>U1338B-25H-5, 45</td> <td>U1338A-26H-2, 45</td> <td>232.55</td> <td>232.65</td> <td>259.26</td> <td>260.93</td> <td>234.21</td> <td>0.83</td> <td>No</td>	Cavitatus iouseana	11.0	U1338B-25H-5, 45	U1338A-26H-2, 45	232.55	232.65	259.26	260.93	234.21	0.83	No
CarbonCostinuityC	Craspedodiscus coscinodiscus	11.0	U1338C-28H-1 122	U1338C-28H-2 47	248 02	248 77	275 48	276.23	250 78	0.38	No
Character gigst van strand11.5013362 (28H-6, 4701338C (28H-7, 4701338C	Coscinodiscus aigas var diorama	11.3	U1338C-28H-1 122	U1338C-28H-2 47	248 02	248 77	275 48	276.23	250.78	0.38	No
Name years11.501.5 yee years21.723.72202.25202.25202.25202.25201.710.38NoHemidiscus cuneiformis11.6U13388-28H-7, 47U1338E-29H-1, 47256.27256.77283.73284.23258.160.25NoCrucidenticula nicobarica12.5U1338E-33H-5, 120U1338E-29H-1, 47256.27256.77283.73331.50297.510.38NoAnnellus californicus12.7U1338E-33H-5, 120U1338B-33H-6, 45299.60300.35330.75331.50297.510.38NoCoscinodiscus gigs var. diorama12.9U1338E-33H-1, 47U1338E-32H-7, 45292.87292.35322.91322.97291.860.03NoAraniscus lewisianus13.0U1338B-33H-5, 120U1338E-35H-1, 47306.85307.37339.28340.50307.180.61NoAraniscus lewisianus13.0U1338B-33H-5, 120U1338B-35H-1, 47302.35303.85334.78336.28301.460.75YesAzpeitia nodulifera13.41U1338B-34H-2, 45302.35303.85344.78356.24321.820.15YesCestodiscus peplum14.2U1338C-38H-2, 122U1338C-38H-3, 47338.12338.87374.91375.66341.170.38YesActinocyclus ellipticus var. spiralis14.2U1338C-38H-3, 47U1338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos<	Actinocyclus ellinticus var sniralis	11 3	111338C-28H-6 47	U1338C_28H_6 122	254 77	255 52	282 23	282.98	256.91	0.30	No
Actinocyclus ingens11.00.1336C 281+7, 470.1338C-291+1, 47256.27256.77283.73284.23258.160.25NoCrucidenticula nicobarica12.50.1338C-281+7, 470.1338C-391+1, 47256.27256.77283.73284.23258.160.25NoCrucidenticula nicobarica12.50.1338C-331+1, 470.1338C-351+1, 47256.27292.85322.91322.97291.860.03NoCoscinodiscus gigas var. diorama12.90.1338B-34H-4, 450.1338C-351+1, 47306.85307.37339.28340.50307.180.61NoAraniscus lewisianus13.00.1338B-34H-4, 450.1338B-34H-2, 45302.35303.85334.78336.28301.460.75YesThalassiosira tappanae13.410.1338B-36H-1, 1200.1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peplum14.20.1338C-38H-2, 1220.1338C-38H-3, 47338.12338.87374.91375.66377.16342.190.75NoThalassiosira tappanae14.50.1338C-38H-3, 470.1338C-38H-4338.87340.37375.66377.16342.190.75NoThalassiosira tappanae14.50.1338C-38H-3, 470.1338C-38H-4338.87340.37375.66377.16342.190.75NoThalassiosira tappanae14.50.1338C-38H-3, 470.1338C-38H-4338.87340.37375.66377.16342.190.75 <td>R Hemidiscus cuneiformis</td> <td>11.5</td> <td>11338B-28H-1 120</td> <td>111338B-28H-4 45</td> <td>258 30</td> <td>262.05</td> <td>286 35</td> <td>290.10</td> <td>258.96</td> <td>1 88</td> <td>Yes</td>	R Hemidiscus cuneiformis	11.5	11338B-28H-1 120	111338B-28H-4 45	258 30	262.05	286 35	290.10	258.96	1 88	Yes
InclusionI2.0OT 30C-2017/7OT 30C-2017/7I2037/7I20	- Actinocyclus ingens	12.0	111338C_28H_7 /7	111338C_20H_1 /7	256.50	256 77	200.33	220.10	250.70	0.25	No
Clauterine and incounted12.30.13360-33H-1, 1200.13360-33H-0, 125272.00300.33300.33310.0277.110.1380.136NoAnnellus californicus12.7U1338C-33H-1, 47U1338B-32H-7, 45292.87292.35322.91322.97291.860.03NoCoscinodiscus gigas var. diorama12.9U1338B-34H-4, 45U1338C-35H-1, 47306.85307.77339.28340.50307.180.61NoAraniscus lewisianus13.0U1338B-34H-1, 45U1338B-35H-4, 45315.60316.35349.38350.13314.250.38YesThalassiosira tappanae13.41U1338C-36H-4, 47U1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peljum14.2U1338C-38H-2, 122U1338C-38H-3, 47338.12338.87374.91375.66341.170.38YesActinocyclus ellipticus var. spiralis14.2U1338C-38H-3, 47U1338C-38H-4, 47338.87340.37375.66341.170.38YesThalassiosira tappanae14.5U1338C-39H-1, 122U1338C-38H-4, 47338.87340.37375.66341.170.38YesCoscinodiscus plytoms14.5U1338C-38H-5, 122U1338C-39H-1, 122346.12346.55383.42384.15348.900.36YesCoscinodiscus plysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.740.00No <td>Crucidenticula nicobarica</td> <td>12.0</td> <td>111338R_32H_5 120</td> <td>111338R_33H_6 //5</td> <td>290.27</td> <td>200.77</td> <td>203.75</td> <td>231 50</td> <td>200.10</td> <td>0.25</td> <td>No</td>	Crucidenticula nicobarica	12.0	111338R_32H_5 120	111338R_33H_6 //5	290.27	200.77	203.75	231 50	200.10	0.25	No
Conscinuous Cuinomicus12.701336C-33H-1, 4701336C-32H-7, 45292.67292.53322.91522.97291.600.05NoCoscinodiscus gigas var. diorama12.9U1338B-34H-1, 45U1338C-35H-1, 47306.85307.37339.28340.50307.180.61NoAraniscus lewisianus13.0U1338B-34H-1, 45U1338C-35H-1, 47306.85302.35303.85334.78336.28301.460.75YesThalassiosira tappanae13.41U1338B-36H-4, 47U1338B-36H-4, 45315.60316.35349.38350.13314.250.38YesAzpeitia nodulifera13.5U1338C-36H-4, 47U1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peplum14.2U1338C-38H-2, 122U1338C-38H-4, 47338.87340.37375.66377.16342.190.75NoThalassiosira tappanae14.5U1338C-38H-3, 47U1338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-39H-1, 122U1338C-39H-2, 45346.12379.10401.55418.01372.538.23NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCestodiscus peplum16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13Yes <td></td> <td>12.3</td> <td>11238C-32L 1 17</td> <td>112288-220 7 15</td> <td>277.00</td> <td>200.22</td> <td>330.73</td> <td>331.30</td> <td>277.31</td> <td>0.30</td> <td>No</td>		12.3	11238C-32L 1 17	112288-220 7 15	277.00	200.22	330.73	331.30	277.31	0.30	No
Costentionistics gigas var. biologram12.2013380-34H-1, 4.5013380-34H-2, 4.5300.35307.57339.20340.30507.100.01NoAraniscus lewisianus13.0U1338B-34H-1, 4.5U1338B-34H-2, 4.5302.35303.85334.78336.28301.460.75YesThalassiosira tappanae13.41U1338B-35H-4, 4.7U1338B-35H-4, 4.5315.60316.35349.38350.13314.250.38YesAzpeitia nodulifera13.5U1338C-36H-4, 4.7U1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peplum14.2U1338C-38H-2, 122U1338C-38H-3, 4.7338.12338.87374.91375.66371.16342.190.75NoThalassiosira tappanae14.5U1338C-38H-3, 4.7U1338C-39H-2, 4.5346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 4.7U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 4.5U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75	Annenus cumornicus Coscinadiscus aigas var diarama	12./	11238B-34U / //	11228C-25U 1 43	272.01	272.33	320.20	340 50	271.00	0.05	No
Indiasta remains13.0013380-35H-1, 12013380-35H-2, 45502.53502.53534.76530.26501.400.75HesThalassiosira tappanae13.41U1338B-35H-4, 47U1338B-35H-4, 45315.60316.35349.38350.13314.250.38YesAzpeitia nodulifera13.5U1338C-36H-4, 47U1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peplum14.2U1338C-38H-2, 122U1338C-38H-3, 47338.12338.7340.37375.66377.16342.190.75NoThalassiosira tappanae14.5U1338C-39H-1, 122U1338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75Yes	Araniscus lewisianus	12.7	112288-211 1 15	112288-214 2 15	300.03	302.82	337.20	336 20	307.10	0.01	Vos
Industriant dupunde15.41015300-5361-4, 47015300-5361-4, 45513.00510.55349.58530.15514.250.38YesAzpeitia nodulifera13.5U1338C-36H-4, 47U1338B-36H-1, 120321.37322.10355.94356.24321.820.15YesCestodiscus peplum14.2U1338C-38H-2, 122U1338C-38H-3, 47338.12338.87374.91375.66377.16342.190.75NoThalassiosira tappanae14.5U1338C-39H-1, 122U1338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75Yes	Thalassiosira tanpanaa	13.0	UI330D-341-1,43	UI330D-3417-2, 43	215 20	216 25	224./0 240.20	220.20 220 12	21/ 25	0.75	Voc
Acpende nodulineral15.501536C-30F+4,4701536D-30F-1,120321.57322.10355.94356.24521.820.15YesCestodiscus peplum14.2U1338C-38H-2,122U1338C-38H-3,47338.12338.87374.91375.66341.170.38YesActinocyclus ellipticus var. spiralis14.2U1338C-38H-3,47U1338C-38H-4,47338.87340.37375.66377.16342.190.75NoThalassiosira tappanae14.5U1338C-39H-1,122U1338C-39H-2,45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5,122U1338C-39H-1,122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7,47U1338C-42H-4,120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1,45U1338C-45H-1,120394.60398.10435.81439.31397.781.75Yes	Anaitia nodulifora	13.41	UI3300-330-3, 120	UI330D-330-4, 43	213.0U	210.33	247.30	256.24	214.23 221 02	0.30	Vec
Cestodiscus peplium14.201330C-30H-2,12201330C-30H-2,12201330C-30H-2,47338.12338.7340.37375.66371.10.38YesActinocyclus ellipticus var. spiralis14.2U1338C-39H-1,122U1338C-38H-4,47338.87340.37375.66377.16342.190.75NoThalassiosira tappanae14.5U1338C-39H-1,122U1338C-39H-2,45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5,122U1338C-39H-1,122342.62346.12379.11388.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7,47U1338C-42H-4,120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1,45U1338C-44H-2,120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5,120U1338C-45H-1,120394.60398.10435.81439.31397.781.75Yes	Azpenia noaumera	13.5	UI330C-30H-4, 4/	UI330D-30H-1, 120	3∠1.3/ 220.12	322.1U	333.94	330.24	3∠1.8∠ 241.17	0.15	Tes
Actinocyclus emplicus var. spirans14.201338C-38H-3, 4/01338C-38H-4, 4/338.8/340.3/375.66577.16342.190.75NoThalassiosira tappanae14.5U1338C-39H-1, 122U1338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75Yes	Cesioalscus pepium	14.2	UI338C-38H-2, 122	UI338C-38H-3, 4/	338.12	338.8/	3/4.91	5/5.66	341.17	0.38	res
Indiassiosira tappanae14.501338C-39H-1, 12201338C-39H-2, 45346.12346.85383.42384.15348.900.36YesCoscinodiscus blysmos14.5U1338C-39H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75Yes	Actinocyclus ellipticus var. spiralis	14.2	UI338C-38H-3, 47	UI338C-38H-4, 47	338.8/	340.37	3/5.66	3//.16	342.19	0.75	NO
Coscinoaliscus plysmos14.5U1338C-38H-5, 122U1338C-39H-1, 122342.62346.12379.41383.42346.742.00NoActinocyclus ingens15.4U1338C-40H-7, 47U1338C-42H-4, 120363.87379.10401.55418.01372.538.23NoCrucidenticula kanayae16.6U1338C-44H-1, 45U1338C-44H-2, 120387.85390.10429.06431.31391.081.13YesCestodiscus peplum16.2U1338C-44H-5, 120U1338C-45H-1, 120394.60398.10435.81439.31397.781.75Yes	i naiassiosira tappanae	14.5	UI338C-39H-1, 122	UI338C-39H-2, 45	346.12	346.85	383.42	384.15	348.90	0.36	Yes
Actinocyclus ingens 15.4 U1338C-40H-/, 4/ U1338C-42H-4, 120 363.87 379.10 401.55 418.01 372.53 8.23 No Crucidenticula kanayae 16.6 U1338C-44H-1, 45 U1338C-44H-2, 120 387.85 390.10 429.06 431.31 391.08 1.13 Yes Cestodiscus peplum 16.2 U1338C-44H-5, 120 U1338C-45H-1, 120 394.60 398.10 435.81 439.31 397.78 1.75 Yes	Coscinodiscus blysmos	14.5	UI338C-38H-5, 122	UT338C-39H-1, 122	342.62	346.12	3/9.41	383.42	346.74	2.00	No
Crucidenticula kanayae 16.6 U1338C-44H-1, 45 U1338C-44H-2, 120 387.85 390.10 429.06 431.31 391.08 1.13 Yes Cestodiscus peplum 16.2 U1338C-44H-5, 120 U1338C-45H-1, 120 394.60 398.10 435.81 439.31 397.78 1.75 Yes	s Actinocyclus ingens	15.4	UI338C-40H-7, 47	U1338C-42H-4, 120	363.87	3/9.10	401.55	418.01	3/2.53	8.23	No
Cestoaiscus pepium 16.2 U1338C-44H-5, 120 U1338C-45H-1, 120 394.60 398.10 435.81 439.31 397.78 1.75 Yes	B Crucidenticula kanayae	16.6	UI 338C-44H-1, 45	UT338C-44H-2, 120	387.85	390.10	429.06	431.31	391.08	1.13	Yes
	B Cestodiscus peplum	16.2	U1338C-44H-5, 120	U1338C-45H-1, 120	394.60	398.10	435.81	439.31	397.78	1.75	Yes

Age column data are from Barron (1992; table 1, including decimal precision) converted to Lourens et al. (2004) timescale. Top and bottom hole, core, section, interval measurements are from Table T3 in Baldauf (2013). Top and bottom CSF-A and CCSF-A depths are from Table T5 in Wilkens et al. (2013). Revised depth = midpoint CCSF-A (m)/site growth factor (Fig. F1). Calibration data are from Barron (1992). Bold = shallowest and deepest depths of individual biohorizons.

Data report: a revised biomagnetostratigraphic age model

-
BS
ĩc
Ĥ
an
e
. t
a

Table T3. Biom	agnetostratigraphic	c age-depth data ba	ased on magnetostrat	tigraphy, Site U1338.
	- 0 - F			0 F //

Geomagnetic polarity chron boundary	Age (Ma)	Core, section, interval (cm)	Depth CSF-A (m)	Depth CCSF-A (m)	Revised depth CCSF-B (m)	Core, section, interval (cm)	Depth CSF-A (m)	Depth CCSF-A (m)	Revised depth CCSF-B (m)	Core, section, interval (cm)	Depth CSF-A (m)	Depth CCSF-A (m)	Revised depth CCSF-B (m)	Top depth Site U1338 CCSF-B (m)	Bottom depth Site U1338 CCSF-B (m)	Depth (midpoint) CCSF-B (m)	Depth uncertainty (± m)
								()						()		()	· · /
/		321-U1338A-				321-U1338B-				321-U1338C-							
C1n/C1r.1r	0.781	2H-4, 122	8.42	9.90	8.94	2H-1, 115	8.75	10.04	9.02	2H-4, 105	9.38	9.93	9.03	8.94	9.03	8.98	0.05
Clr.1r/Clr.1n	0.988	2H-6, 92	11.12	12.60	11.37	2H-3, 85	11.45	12.74	11.45	2H-6, 87	12.17	12.72	11.56	11.37	11.56	11.47	0.10
C1r.1n/C1r.2r	1.072	2H-7, 42	12.12	13.60	12.27	2H-4, 27	12.37	13.66	12.27	2H-7, 40	13.20	13.75	12.50	12.27	12.50	12.39	0.11
C1r.3r/C2n	1.778	3H-7, 0	21.20	23.43	21.15	3H-3, 120	21.30	23.37	21.00	3H-6, 40	21.20	23.51	21.37	21.00	21.37	21.19	0.19
C2n/C2r.1r	1.945					3H-5, 37	23.47	25.54	22.95	3H-7, 67	22.97	25.28	22.98	22.95	22.98	22.96	0.02
C2r.2r/C2An.1n	2.581	4H-7, 48	31.18	34.80	31.41	4H-4, 112	32.22	34.88	31.34					31.34	31.41	31.37	0.03
C2An.1n/C2An.1r	3.032	5H-3, 130	35.50	40.90	36.91	5H-1, 75	36.85	41.15	36.97	5H-3, 47	35.77	41.03	37.30	36.91	37.30	37.11	0.19
C2An.1r/C2An.2n	3.116	5H-5, 0	37.20	42.60	38.45	5H-2, 40	38.00	42.30	38.01	5H-4, 17	36.97	42.23	38.39	38.01	38.45	38.23	0.22
C2An.2n/C2An.2r	3.207	511 <i>4</i> 4 40				5H-3, 18	39.28	43.58	39.16	5H-5, 10	38.40	43.66	39.69	39.16	39.69	39.42	0.27
C2An.2r/C2An.3	3.330	5H-6, 140	40.10	45.50	41.06	5H-4, 32	40.92	45.22	40.63	5H-6, 30	40.10	45.36	41.24	40.63	41.24	40.93	0.30
C2An.3n/C2Ar	3.596	6H-2, 140	43.60	49.16	44.37	5H-6, 120	44.80	49.10	44.12					44.12	44.37	44.24	0.13
C4An/C4Ar.1r	9.098									21H-6, 15	187.95	209.66	190.60	190.60	190.60	190.60	0.00
C4Ar.1r/C4Ar.1n	9.312	21H-6, 10	190.80	213.29	192.50	21H-4, 0	192.60	213.35	191.69	22H-1, 140	191.20	213.33	193.94	191.69	193.94	192.81	1.12
C4Ar.1n/C4Ar.2r	9.409	22H-1, 10	192.80	216.70	195.58	21H-5, 110	195.20	215.95	194.03	22H-3, 112	193.92	216.05	196.41	194.03	196.41	195.22	1.19
C4Ar.2r/C4Ar.2n	9.656	22H-3, 122	196.92	220.82	199.30	22H-2, 22	199.32	220.94	198.51	22H-7, 50	199.30	221.43	201.30	198.51	201.30	199.90	1.40
C4Ar.2n/C4Ar.3r	9.717	22H-5, 10	198.80	222.70	200.99	22H-3, 60	201.20	222.82	200.20	23H-1, 125	200.55	222.53	202.30	200.99	202.30	201.65	0.65
C4Ar.3r/C5n.1n	9.779					22H-4, 22	202.32	223.94	201.20	23H-2, 105	201.85	223.83	203.48	201.20	203.48	202.34	1.14
C5n.1n/ C5n.1r	9.934	23H-1, 15	202.35	227.54	205.36									205.36	205.36	205.36	0.00
C5n.1r/C5n.2n	9.987					22H-6, 117	206.27	227.89	204.75	23H-5, 57	205.87	227.85	207.14	204.75	207.14	205.94	1.19
C5Ar.1r/C5Ar.1n	12.730					33H-6, 87	300.77	331.92	298.22	34H-2, 95	304.35	333.14	302.85	298.22	302.85	300.54	2.32
C5Ar.2n/C5Ar.3r	12.878					34H-3, 67	305.57	338.00	303.68	34H-6, 17	309.57	338.36	307.60	303.68	307.60	305.64	1.96
C5Ar.3r/C5AAn	13.015					34H-6, 90	310.30	342.73	307.93	35H-2, 125	309.65	342.78	311.62	307.93	311.62	309.78	1.84
C5AAn/C5AAr	13.183					35H-3, 117	315.57	349.35	313.88	35H-7, 35	316.25	349.38	317.62	313.88	317.62	315.75	1.87
C5AAr/C5ABn	13.369					35H-6, 110	320.00	353.78	317.86	36H-2, 140	319.30	353.87	321.70	317.86	321.70	319.78	1.92
C5ABn/C5ABr	13.605					36H-6, 15	328.59	362.73	325.90					325.90	325.90	325.90	0.00
C5ABr/C5ACn	13.734					36H-7, 65	330.55	364.69	327.66					327.66	327.66	327.66	0.00
C5ACn/C5ACr	14.095									38H-4, 0	339.90	376.69	342.45	342.45	342.45	342.45	0.00
C5ACr/C5ADn	14.194									38H-6, 0	342.90	379.69	345.17	345.17	345.17	345.17	0.00
C5ADn/C5ADr	14.581									40H-1, 0	354.40	392.08	356.44	356.44	356.44	356.44	0.00
C5ADr/C5Bn.1n	14.784					39H-2, 87*	351.77	394.00	354.00	40H-2, 72	356.62	394.30	358.45	358.45	358.45	358.45	0.00
C5Bn.1n/C5Bn.1r	14.877					39H-3, 77*	353.17	395.40	355.26	40H-3, 37	357.77	395.45	359.50	359.50	359.50	359.50	0.00
C5Bn.1r/C5Bn.2n	15.032									41H-3, 40	367.30	405.59	368.72	368.72	368.72	368.72	0.00
C5Bn.2n/C5Br	15.160					40H-6, 0*	366.40	408.80	367.30	41H-5, 80	370.70	408.99	371.81	371.81	371.81	371.81	0.00

* = data from Hole U1338B not used (see text). Age column data are from Table T6 in the "Methods" chapter (Expedition 320/321 Scientists, 2010a). Core, section, interval measurements are from Table T15 in the "Site U1338" chapter (Expedition 320/321 Scientists, 2010b). CSF-A and CCSF-A depths are from Table T5 in Wilkens et al. (2013). Revised depth = CCSF-A (m)/hole growth factor (Fig. F1). Bold = shallowest and deepest depths of individual biohorizons.

15

Table T4. Age-depth control points (CPs) and linear sedimentation rates (LSRs), Site U1338.

СР	Biohorizons and geomagnetic chron boundaries	Age (Ma)	Depth CCSF-B (m)	LSR (m/My)	Figure
	Top Site U1338 sediment section	0.00	0.00		F3
1	C1n/C1r (Bruhnes/Matuyama)	0.781	8.98	11	F3
2	C2n/C2r.1r (Olduvai/Matuyama)	1.945	22.96	12	F3
3	C2An.3n/C2Ar (Gauss/Gilbert)	3.596	44.24	13	F3
4	Base Asteromphalus elegans (D)	4.2	53.11	15	F3
5	Top Ceratolithus acutus (N)	5.04	68.63	18	F3/F4
6	C4An/C4Ar.1r	9.098	190.60	30	F4
7	C5n.1r/C5n.2n	9.987	205.94	17	F4/F5
8	C5AAn/C5AAr	13.183	315.75	34	F5
9	C5Bn.2n/C5Br	15.160	371.81	28	F5
10	Base Discoaster signus (N)	15.73	384.56	22	F5
11	Base common Sphenolithus heteromorphus (N)	17.74	406.43	11	F5
	Hole U1338B terminal depth	18.4	413.6		

D = diatom, N = nannofossil.

