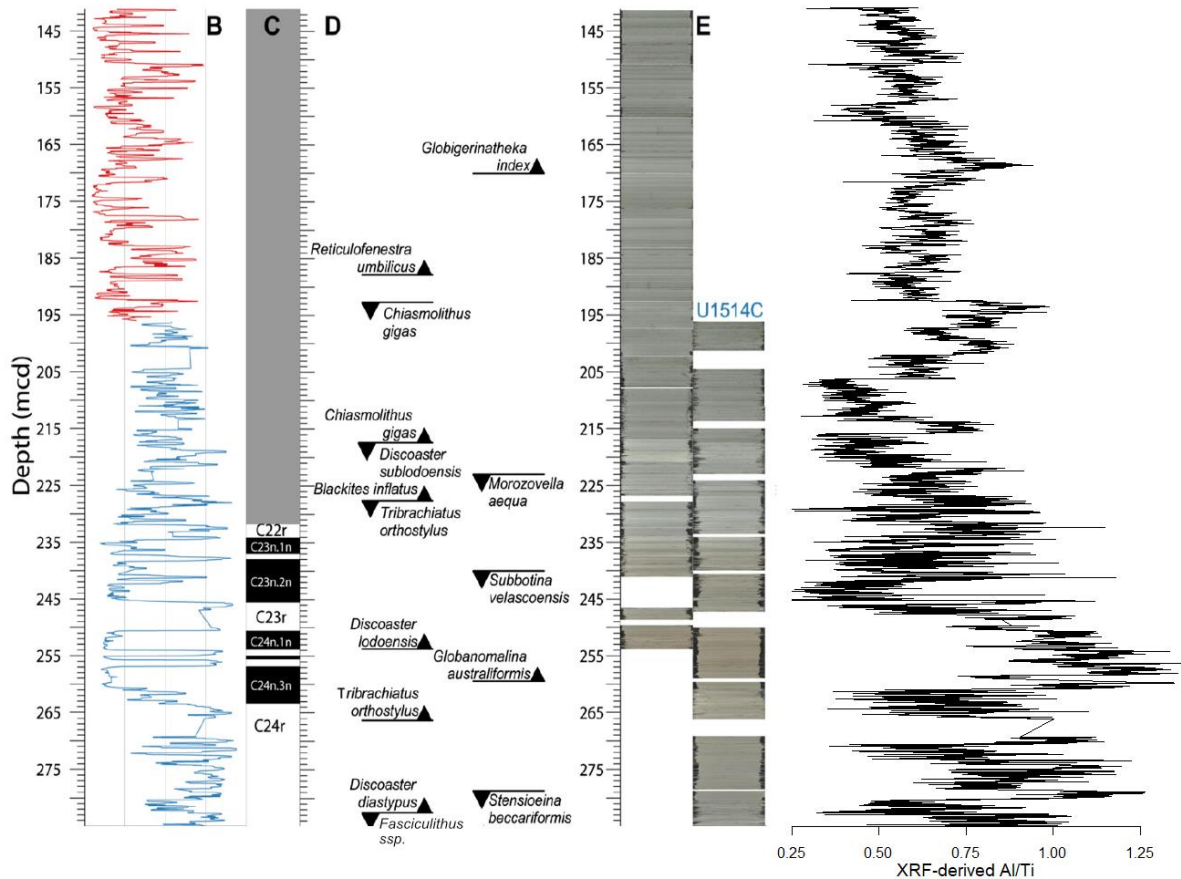


Cyclostratigraphy Intercomparison Project 2.0

Case 1: The Eocene of the Mentelle Basin

The scientific party of International Ocean Discovery Program (IODP) Expedition 369 cored Site U1514 in the Mentelle Basin in the southeastern Indian Ocean (U1514 Site Report). The Eocene-Paleocene sequence of this site consists of light greenish gray clayey nannofossil ooze, sponge spicule-rich clay, nannofossil-rich clay, clayey nannofossil chalk and nannofossil-rich claystone. The Site was XRF-core scanned at cm-scale resolution and the XRF-derived Ca/Fe ratio was used by Vahlenkamp et al. (2020, EPSL) to construct an astrochronology for the lower to middle Eocene portion of this Site.

For this CIP 2.0 case study, we imagine a situation in which the cyclostratigraphic interpretation has been put into question by sceptics. The sceptics request an independent re-analysis of the dataset on an element ratio that is more resistant to diagenesis and post-depositional element redistribution. They would like to see a cyclostratigraphic analysis using Al/Ti. It is your task (1) to test whether you can discern an astronomical imprint in the Al/Ti dataset, (2) to attempt a floating astrochronology for the lower – middle Eocene interval of the site (roughly 140 – 285 mcd), and (3) explore whether the floating astrochronology can be anchored in numerical time.



To do so, you have several resources at your disposition: [DATA DOWNLOAD](#)

- The spliced (two-hole composite) Al/Ti XRF-dataset is provided here in **IODP_Site_U1514_splice_ALTi.xlsx**
- In case you would like to look into other datasets, you have the possibility to consult XRF-derived depth-series of all other measured elements: raw datafiles available as **369_U1514A_10kV.xlsx**, **369_U1514C_10kV.xlsx**, **369_U1514_AC_splice.sit.csv**. Other physical properties (magnetic susceptibility, density, color, ...), high-resolution core pictures, and shipboard sedimentological descriptions are available for download from <https://web.iodp.tamu.edu/LORE/>
- Importantly, magnetostratigraphic and biostratigraphic constraints exist for the site, and are available from the Site report: **IODP_Site_U1514_Report.pdf**. For your convenience, they are summarized in the file **IODP_Site_U1514_biostrat_datums.xlsx**

In the [Google Forms](#), you will be asked following questions

Q1: Can you discern an astronomical imprint in this dataset? When yes, how clear would you describe the precession imprint on a scale from 1 (Not at all) to 5 (precession-dominated)? Same questions for obliquity and eccentricity. Did you notice a hiatus?

Q2: An anchored or floating age model for following stratigraphic levels: 150.0, 160.0, 170.0, 180.0, 190.0, 200.0, 210.0, 220.0, 230.0, 240.0, 250.0, 260.0, 270.0, 280.0 m. Output is asked in absolute age (in million of years ago). If you only made a floating age model, please use 140 m = 0 Myr. What are the uncertainties on these astrochronologic ages?

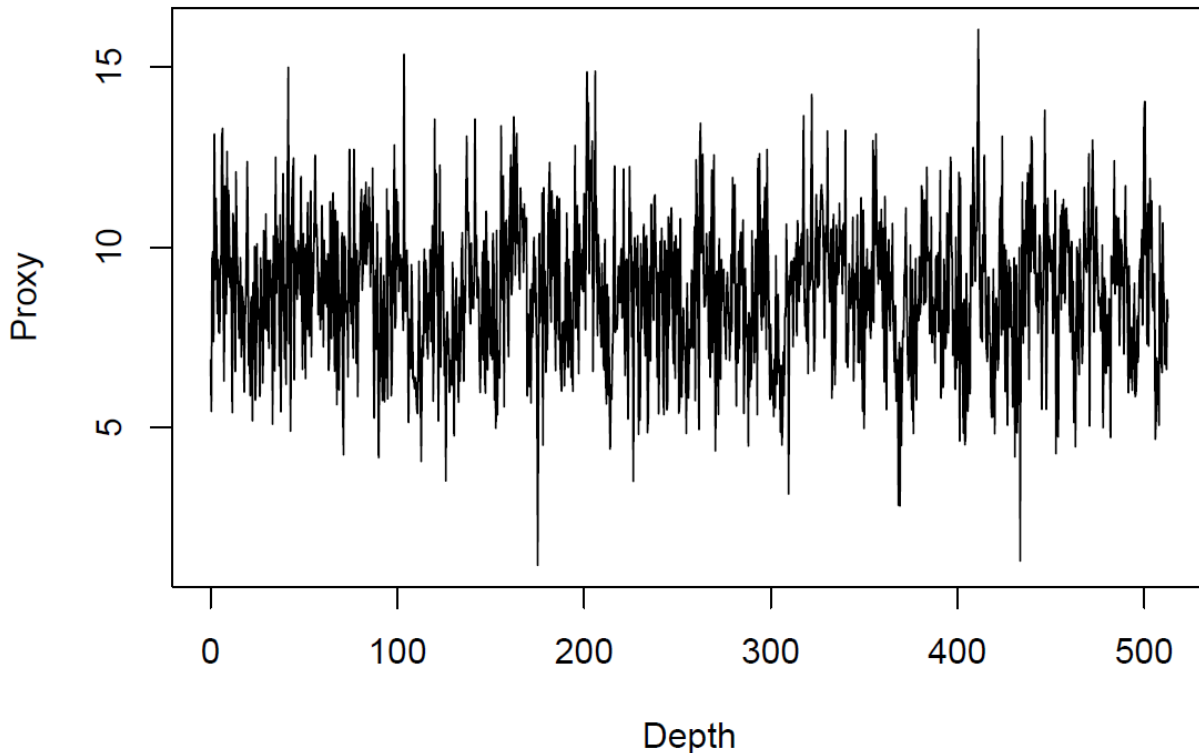
Q3: What is the duration of magnetochron C23r in U1514? Can you provide an uncertainty estimate?

Q4: Some extra questions for those who can't get enough: Do you see any evidence for hyperthermals between 225 – 245 m? If yes, briefly describe how they appear in the Al/Ti record. Were you able to extract an eccentricity signal (an eccentricity waveform) from the data? If yes, please email it as a csv-file to Matthias. Were you able to reconstruct g-terms, s-terms and/or the precession constant from this dataset? If yes, please email it as a csv-file to Matthias.

Case 2: A Quaternary proxy dataset

IODP expedition *999* recovers a core in Southeast Asia offshore the Philippines. A colleague thinks to see 'Milankovitch' cycles in a magnetic susceptibility dataset of the unopened cores. The colleague asks you to assess if there may be cycles in the Quaternary part, which is placed by Magnetostratigraphy into the Brunhes Chron. Can you refine the rough estimate of the duration of the record?

The dataset can be found [HERE](#).



In the [Google Forms](#), you will be asked following questions

Q1: Can you discern an astronomical imprint in this dataset? If so, how clear would you describe the orbital imprint on a scale from 1 (Not present) to 5 (Clear)?

Q2: How much time is present in the record in your opinion? Can you identify eccentricity, obliquity, and precession in this dataset?

Q3: Please establish a 'floating chronology' based on cycle counting and/or statistical analysis. What is the relative age difference to the top at 100, 200, 300, 400, 500 cm, and for the profile base?

Q4: Would you dare to do a tuning? If so, what is the age at the top and at depths of 100, 200, 300, 400, 500 cm, and at the base?

One-page Essay: Significance testing and uncertainty in cyclostratigraphy

Statistical significance testing in power spectra is a commonly used tool in cyclostratigraphy used to interpret cyclicity in a given data set. There are various ways of performing spectral analyses, constructing noise models and estimating significance levels, or confidence limits. However, standard community practices are sometimes criticized, as recently highlighted by two review papers by Weedon (2022) and Smith (2023). There is discussion and confusion within (part of) the community on how to deal (or not) with this problem. Therefore, we suggest a debate centered on this topic and the broader question *'The quality of a cyclostratigraphic interpretation'* at this second CIP workshop. In order to prepare for this debate, we ask every participant to write a short 1-page essay with their view on *"The do's and don'ts of statistical testing in cyclostratigraphy"* (loose guideline). Other relevant reflections can also be related to the broader question of the robustness of cyclostratigraphic interpretations, uncertainty formulation and how to bring this topic further.

This essay should be emailed to Matthias Sinnesael before May 24th, 2024.

Smith, D.G., 2023. The Orbital Cycle Factory: Sixty cyclostratigraphic spectra in need of re-evaluation. *Palaeogeography Palaeoecology Palaeoclimatology*, 628, 111733, doi:10.1016/j.palaeo.2023.111744.

Weedon, G.P., 2022. Problems with the current practice of spectral analysis in cyclostratigraphy: avoiding false detection of regular cyclicity. *Earth-Science Reviews*, 235, doi:10.1016/j.earscirev.2022.104261.