HIGH-RESOLUTION INTEGRATED MAGNETOBIOSTRATIGRAPHY OF A NEW MIDDLE EOCENE SECTION FROM THE SOUTHERN BRANCH OF THE NEO-TETHYS: ELAZIG BASIN (ELAZIG PROVINCE, TURKEY)

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ABSTRACT

We present a new marine middle Eocene section, from the Elazığ Province, Central Turkey. The high sedimentation rate of the section, its continuity and lack of apparent tectonic disturbances could be a new reference for the study of the “Middle Eocene Climatic Optimum” (MECO) in a shelf margin. Paleomagnetism and biostratigraphy were used to build a solid, high-resolution magnetostratigraphy of the section, that spans from C19n to C17n, thus encompassing the whole Bathonian stage. The magnetostratigraphy here presented will form base to new paleoenvironmental analysis, namely environmental magnetism and geochemistry, in order to give new insights on the paleoclimatic events that characterized de middle Eocene.

Key words: Paleomagnetism, Eocene, MECO

RESUMO

Vai ser presentada uma nova seção marina do Eoceno médio, aflorante na província de Elazığ, Turquia Central. A seção mostra uma elevada taxa de sedimentação, continuidade estratigráfica e falda de deformações tectônicas, resultando uma possível nova referência para o estudo do “Middle Eocene Climatic Optimum” (MECO) em um ambiente de *peri*-plataforma. Tecnicas de paleomagnetismo e bioestratigrafia foram usadas juntas para construir uma magnetoestratigrafia de alta resolução da seção, resultando definida entre os Chrons C19n e C17n, representando então o inteiro Bartoniano. A Magnetoestratigrafia aqui presentada representa a base de futuras analises, tendo como objetifo final obter um melhor conhecimento dos eventos climáticos do Eoceno médio.

Palavras chave: Paleomagnetismo, Eoceno, MECO

Introduction

The middle Eocene represents an important period in the palaeoclimatic history of the Earth. In this epoch, the climate system experienced a cooling from the Early Eocene Climatic Optimum (EECO, 50-52 Ma) as revealed by deep-sea oxygen isotope records, to the end of the Eocene epoch (*e.g.* Zachos *et al*., 2001). Superimposed to this long-term cooling trend fluctuations occurred, with cooling and warming events (*e.g.* Bohaty *et al*., 2009). In this view, the most relevant event is the Middle Eocene Climatic Optimum (MECO, *e.g.* Jovane *et al*., 2010, and refereces therein).

In order to provide new insights and to understand the MECO conundrum, here we present a detailed and

integrated magneto-biostratigraphical framework of a new marine sedimentary section from the Elazığ basin area located near the town of Baskil (Turkey). This section is representative of the portion of the Southern branch of Neo-Tethys that connected the Indian Ocean to the Atlantic Ocean. The stratigraphic continuity of the section and the high sedimentation rate represent an important opportunity to provide a robust integrated magnetobiostratigraphic framework over which calibrates paleoclimatic and major biotic events.

Geological setting, Materials and Methods

The studied section outcrops near the town of Baskil, Elazığ Province (38°36'30.34'' N 38°36'03.46'' E) (Turkey). It is composed by a succession of argillites and calcareous marls, with intercalations of several calci-turbidites several centimeters to couple of meters in thickness. The section spans a total of 357 meters.

Oriented hand sized samples were collected during different fieldtrips and cut in cubes of roughly 8 cm^3, leading to a total of 233 samples. The resolution in most part of the section is one sample every meter. Samples were also collected in order to perform biostratigraphic analysis.

In order to isolate the magnetic directions of the primary component, samples were demagnetized in an alternated field (AF), with a total of 13 steps, up to 1000 mT. Principal component analysis (Kirschvink, 1980) was used to determine the directions of the primary component, in order to distinguish between positive and negative inclined directions, and thus define the magnetozones of the section.

Selected samples were used to measure the magnetic properties of the rocks, using a Vibrating Sample Magnetometer (VSM) to measure hysteresis cycles, IRM acquisition curves, and (on a few samples), create First order reversal curves (FORCs.).

Biostratigraphy was focused on: calcareous nannofossils, plantonic foraminifera and large benthic foraminifera.

Results

The magnetozones recognized analyzing the inclination of the primary magnetic component were correlated to the Geomagnetic Polarity Time Scale (GPTS) by Ogg *et al*. (2012), and calibrated with the biostratigraphic zonations. The studied section spans from the top part of C19n.1r to the top of C17n.1r. The high resolution sampling strategy enabled us to recognize even short period subchrones, namely the C17n subchrones, in total the section spans from the topmost part of the Lutetian, to the Bartonian-Priabonian Boundary, for a total of *ca*. 3.6 Ma.

Sedimentation rates calculated for each magnetozone are quite high, with a minimum of 43 m/Ma to a maximum of 98 m/Ma in the central and lower part, with a decreasing trend from bottom to top.

Mean directions of positive (+34.6°) and negative (-35.5°) inclination samples passed the reversal test (McFadden and Lowes, 1981) (Data resumed in Fig.1)

The magnetic minerals present in the selected samples are magnetite and hematite, with magnetite possibly coming in at least two different forms, terrigenous and biogenic, implying the presence of magnetotactic bacteria in the environment at the time of deposition. The very low abundance of magnetic minerals in the samples resulted in very poor quality FORCs, thus precluding the possibility to confirm the presence of biogenic magnetite.

Fossil content gave insight on the paleobathimetry during the deposition, with many taxa occur with an upper bathyal upper depth limit or are common at bathyal depths, *e.g*., *Cibicidoides eocaenus, C. micrus, C. mexicanus, C. bradyi, Bulimina tuxpamensis, B. alazanensis*., on the basis of their distribution and abundance, a likely upper-bathyal (300-600 m) depositional depth was inferred. The abundance of calcareous taxa and the preservacion of foraminiferal test suggest that the deposition occurred well above the Calcite Compensation Depth (CCD).

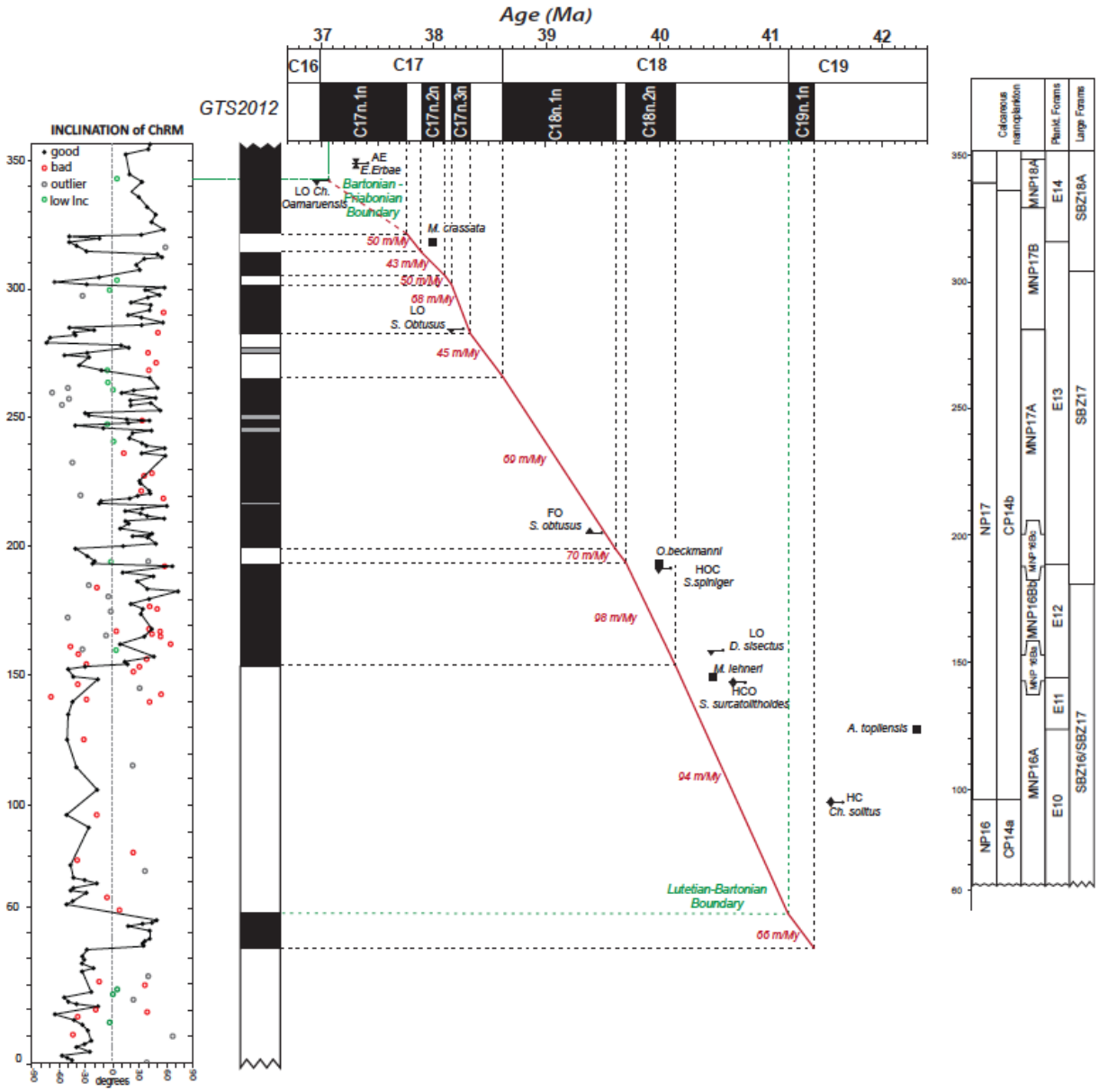

Figure 1. Inclination of ChRM and age vs. depth plot with correlation to the geomagnetic polarity time scale (GPTS) by Ogg (2012). Calcareous nannofossils and planktonic foraminiferal data are used to constrain the interpretation. The red line represent the mean sedimentation rate for each magnetozone. Green lines represent stage boundaries. Legend in the inclination of ChRM graph as follows: GOOD: MAD3 of the data lower than 12°; BAD: MAD3 higher than 12°, OUTLIER: one sample with an inclination value opposite of those of the previous and following samples, LOW INC: inclination value lower than 5°.

Integration with environmental magnetism, sedimentological, stratigraphical and geochemical data is ongoing, and this, together with the quality of the data at our disposition and the very characteristics of the section (namely, the high sedimentation rate, continuity and lack of apparent tectonic disturbances) can represent a starting point to study the middle Eocene climatic history with an (possibly) unparalleled resolution.

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