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Preliminary magnetostratigraphy for Jurassic/Cretaceous transition in Porto da Calada, Portugal

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Abstract

We will present a stratigraphic log supporting a preliminary magnetostratigraphy of Tithonian-Berriasian section in the Porto da Calada (Portugal). Based on biostratigraphy and reversed and normal magnetostartigraphy the location of Tithonian-Berriasian boundary is tentatively located at ca. 52 m, not in conflict with former proposals. Due to later remagnetizations (diagenesis) an unsuccessful study for magnetostratigraphy of Tithonian-Berriasian section at the Cabo Espichel (Portugal) location is reported here.

1. INTRODUCTION

The Jurassic/Cretaceous boundary is still poorly understood and is the last system boundary without a GPSS. Furthermore, biostratigraphical correlations among paleobiogeographic provinces are hampered by barriers to faunal exchange (e.g. Ogg et al. 2012). Dating by magnetostratigraphy coupled with regional correlations and biostratigraphy has been successfully used to large-scale correlations. Earlier studies have placed the Tithonian-Berriasian boundary in different position, but currently the base of Chron M18r is admitted, and is even a candidate as a correlation event marking the boundary (Ogg et al. 2012).

The onshore uppermost Jurassic to lowermost Cretaceous of the Lusitanian Basin (Western Portugal) has been the subject of numerous articles and thesis (Ramalho, 1971; Rey, 1972, 1993; Mateus, 2006; Dinis et al. 2008; Myers et al. 2012). It includes several good exposures of the Jurassic/Cretaceous (J/K) transitions (e.g. Porto da Calada, Sintra-Cascais region, and Praia dos Lagosteiros - Cabo Espichel). Despite that, the exact position of the boundary in the series is poorly known, due to the lack of good biostratigraphic markers in a complex stratigraphy, recording important variations in a coastal landscape still under the influence of the Late Oxfordian to Early Kimmeridgian rifting.

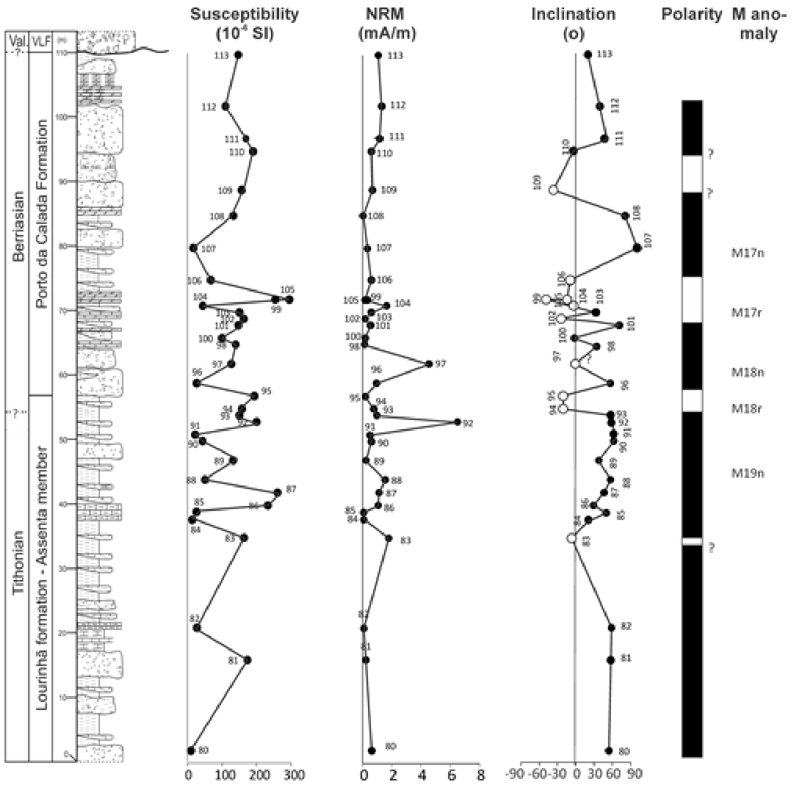

Figure 1: Stratigraphy of the Porto da Calada section (Portugal): variation of magnetic susceptibility, intensity, inclination of ChRM, polarity column and M-anomalies. Black (white) indicates normal (reversed) polarity.

2. SAMPLING AND METHODS

We collected 102 standard cores from the Porto da Calada section (39.04° N; 9.41° E), and 72 standard cores and four oriented block samples from the Cabo Espichel section (38.42° N; 350.78 ° E). A portable field drill was used and cores were oriented using both sun and magnetic compasses.

Paleomagnetic measurements for magnetostartigraphy were conducted in the magnetically shielded room of the paleomagnetic laboratory of the Department of Geology and Geophysics at the Yale University, USA. After measurement of natural remanent magnetization (NRM), samples were placed into liquid nitrogen in a null field to demagnetize viscous remanent magnetization (Borradaile et al. 2004). Thereafter to separate the characteristic remanent magnetization (ChRM) component the samples were stepwise thermally demagnetized in a nitrogen-atmosphere using ASC Scientific model TD-48SC furnace. Remanent magnetization was measured using an automated sample-changing system attached to a 2G cryogenic magnetometer (Kirschvink et al. 2008). Results were analyzed using principal component analysis (Jones, 2002). Sister specimens from the same cores were stepwise demagnetized using the alternating field (AF) method and a 2G cryogenic magnetometer in the Solid Earth Geophysics laboratory of the University of Helsinki. Due to high coercivity minerals in some of the samples the thermal method was more effective.

3. RESULTS OF MAGNETIC STUDIES

The natural remanent magnetization (NRM) intensity was generally in order of 10^{-3} A/m and magnetic susceptibility in order of 10^{-4} SI being typical for sedimentary rocks. NRM and susceptibility values depend on lithology and limestone show lowest values (Figure 1). Based on thermomagnetic (Curie point measurements) and thermal demagnetization main ferrimagnetic minerals in these samples are magnetite and pyrhhotite. Many of the samples were totally cleaned during the thermal demagnetization and vectors decayed to origin indicating that ChRM was successfully obtained and no higher coercivity/unblocking temperature component were present. Normal and reversed ChRM directions were obtained.

We sampled a 65 meters thick section at Cabo Espichel for magnetostratigraphy but it was almost totally remagnetized by later processes. Samples were losing most of their magnetization at 180-240°C during thermal cleaning. AF method was not able to demagnetize samples indicating presence of high coercivity ferrimagnetic minerals (goethite).

4. STRATIGRAPHY

Since the results from Cabo Espichel cannot be used for sin-sedimentary stratigraphic purposes, this outcrop is not discussed here.

Concerning the Porto da Calada section, the Assenta member of the Lourinhã Fm. is Tithonian in age. The Lourinhã Fm. is Kimmeridgian-Tithonian in age, confidently biostratigraphically dated by numerous invertebrates and vertebrates (see Mateus, 2006; Ribeiro and Mateus, 2012) and by strontium stable isotope curves (Schneider et al. 2009). The foraminifera, namely Anchispirocyclina lusitanica (Egger, 1902), and ostracods of the 37-40 m limestone level (Figure 1, Rey, 1972) are similar to the regional Tithonian assemblages (Ramalho, 1971). Dinocysts of the 65-73 m interval are considered as representing early to middle Berriasian boundary (Berthou and Leereveld, 1990). The unconformity between the Porto da Calada and Vale de Lobos formations is dated by regional tectono-stratigraphic correlation as Late Berriasian (Dinis et al. 2008). In this section, two dinosaurs were identified: axial and postcrania of Ankylosauria below the J/K limit, and one tail spine of Stegosauridae above it, both chronologically consistent with the magnetostratigraphy.

5. DISCUSSION AND CONCLUSIONS

Based on these we correlate the reversed magnetozone at 33 m in log with M19r1 anomaly and normal magnetozone between 35 and 51 m with M19n1 (Fig. 1). Following the (Ogg et al. 2012) scale, we place the J/K Tithonian-Berriasian boundary at the base of magnetozone M18r, around 52 m of our log in Porto da Calada section.This position is an improvement of previous proposals for this outcrop, namely by Rey (1993), that tentatively located the J/K boundary at the base of the Porto da Calada Formation (our 60 m) as a best fit between available biostratigraphy and regional correlations. However, it must be stressed that the proposed position of the J/K boundary is tentative, due to scarcity and uncertainties in the age significance of fossils in the studied series.

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