Journal of African Earth Sciences 140 (2018) 267–281

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Late Paleogene-early Neogene dinoflagellate cyst biostratigraphy of the eastern Equatorial Atlantic

Walaa K. Awad*, Francisca E. Oboh-Ikuenobe

Geology and Geophysics Program, Department of Geosciences and Geological and Petroleum Engineering, Missouri University of Science and Technology, 129 McNutt Hall, Rolla, MO 65409-0410, USA

ARTICLE INFO

Article history:
Received 14 September 2017
Received in revised form
17 January 2018
Accepted 19 January 2018
Available online 3 February 2018

Keywords:
Dinoflagellate cysts
Late Paleogene-early Neogene
Biostratigraphy
West Africa

ABSTRACT

Six dinoflagellate cyst biozones (zone 1-zone 5, subzones 1a and 1b) are recognized in the late Paleogene-early Neogene interval of the Ocean Drilling Program (ODP) Site 959 (Hole 959 A), Côte d'Ivoire-Ghana Transform Margin in the eastern Equatorial Atlantic. The biozones are based on palynological analysis of 30 samples covering a 273.2-m interval with generally fair preservation and good to poor recovery. We propose a new age of Late Eocene (Priabonian) for subunit IIB as opposed to the previously published mid-Early Oligocene age (middle Rupelian). This age assignment is mainly based on the presence of Late Eocene marker taxa, such as *Hemiplacophora semilunifera* and *Schematophora speciosa* in the lower part of the studied interval. We also document for the first time a hiatus event within dinoflagellate cyst zone 3, based on the last occurrences of several taxa. This interval is assigned to an Early Miocene age and is barren of other microfossils. Furthermore, we propose new last occurrences for two species. The last occurrence of *Cerebrocysta bartonensis* is observed in the late Aquitanian-early Burdigalian in this study vs. Priabonian-early Rupelian in mid and high latitude regions. Also, the last occurrence of *Chiropteridium galea* extends to the latest Early Miocene (Burdigalian) in ODP Hole 959 A; this event was previously identified in other studies as Chattian in equatorial regions, and Aquitanian in the Northern Hemisphere mid-latitudes. We suspect that these differences are due to physical (offshore vs. nearshore) and latitudinal locations of the areas studied.

1. Introduction

The Paleogene-Neogene is considered a very important and significant time in Earth's history because of its natural climate change. The Paleocene-Early Eocene climate is considered the warmest during the Cenozoic Era with CO_2 levels five times more than the present levels (Sluijs et al., 2007; Zachos et al., 2008; Stassen et al., 2012; McNeil and Parsons, 2013). Subsequent cooling conditions throughout the Middle-Late Eocene to Early Oligocene culminated in a significant drop in sea level during the Oligocene that is characterized by low carbonate sedimentation rates, planktonic diversity and productivity (Zachos et al., 2008). The global climatic cooling during the Late Eocene-Oligocene forced several organisms to migrate from high latitude to low latitude regions. This has led to problems with biostratigraphic calibrations due to the diachronous events between latitudes (Van Simaeys et al., 2004, 2005). While Van Simaeys et al. (2005) proposed factors other than climate that made the Oligocene more complicated and problematic in the North Sea Basin, these factors were more widespread and include: a) the rarity of calcareous nannoplankton due to the siliciclastic nature of most deposits; b) weak paleomagnetic signals; and c) most importantly, hiatus events that were very common and globally widespread.

In the present study, 30 samples (S1–S30, 193.25–466.45 mbsf) from the Priabonian to the Burdigalian interval in ODP Hole 959 A, Côte d'Ivoire-Ghana Transform Margin, West Africa were analyzed for their palynological contents. Previous palynological studies by Oboh-Ikuenobe et al. (1997, 1999) on more than 100 samples from ODP sites 959, 960, 961 and 962 focused mostly on palynofacies analysis to better understand the depositional environment, paleobathymetry of the basin, and thermal evolution of the sediments. In addition, Oboh-Ikuenobe et al. (1998, 1999) studied palynomorph contents (dinoflagellate cysts, pollen and spores) to assist in the age assignment for some intervals in these ODP sites. Shafik et al. (1998a, 1998b) used calcareous nannoplankton to establish the age of the Oligocene-Early Miocene interval for ODP Hole 959 A,

* Corresponding author.
E-mail address: wka9tb@mst.edu (W.K. Awad).

https://doi.org/10.1016/j.jafrearsci.2018.01.014
1464-343X/

and erected biozonations for this part of the interval and determined the Oligocene-Miocene boundary.

Although most biostratigraphic data on the Oligocene-Early Miocene are mainly for nearshore sediments in mid-high latitudes (e.g., Brinkhuis et al., 1992; Van Simaeys et al., 2005; Soliman, 2012; Soliman et al., 2012), few studies have been published on low latitudes (e.g., Helenes and Cabrera, 2003; Williams et al., 2004; Willumsen et al., 2014). Helenes and Cabrera (2003) indicated that the low diversity of dinoflagellate cysts in equatorial regions vs. high diversity in higher latitudes plays an important role in the sparse information about equatorial region zonations. Therefore, the main objective of the present study is to erect dinoflagellate cyst zonations for an offshore location (ODP Hole 959 A) near the equator and calibrate the (sub)zones with the calcareous nannoplankton (sub)zones of Shafik et al. (1998a, 1998b) using the first and last occurrence events of dinoflagellate cysts. Furthermore, we discuss the transition between the Eocene-Oligocene and the Oligocene-Miocene boundaries, and compare the proposed zonations with studies from other areas (e.g., Zevenboom, 1995; de Verteuil and Norris, 1996; Munsterman and Brinkhuis, 2004; Pross et al., 2010).

2. Geologic setting

Four ODP sites (959–962) were drilled on the Côte d'Ivoire-Ghana Transform Margin in the eastern Equatorial Atlantic, West Africa (January–February 1995). Site 959 (959 A, 959 B, 959C, 959D) has the most complete stratigraphic sequence with a maximum penetration in Hole 959D at 1158.9 m below sea floor (mbsf). The maximum depths at the other holes are 480.7 mbsf in Hole 959 A, 184.4 mbsf in Hole 959 B, and 179.6 mbsf in Hole 959C (Fig. 1). Cretaceous to Pleistocene strata were recorded at sites 959–962 and provided very important information about the sedimentology, stratigraphy and structure of the region. This information was used to better understand the thermal evolution, sedimentary processes, tectonics, deformation history, and paleoceanography of the eastern Equatorial Atlantic (Mascle et al., 1996; Hisada et al., 1998).

2.1. Tectonics

The Côte d'Ivoire-Ghana Margin Ridge (CIGMR) was initiated during an initial continental rifting phase between Africa and South America during the Early Cretaceous. Thereafter, during a syn-transform stage, an oceanic crust formed in the course of the separation of the two continents in Aptian-Cenomanian times. Next, the Cenomanian was characterized by an intensive deformation of the top of the CIGMR. Finally, the passive margin post-Cenomanian stage experienced very little tectonic activities (Benkhelil et al., 1998; Pickett and Allerton, 1998). Carbonate sediments dominated the Late Cretaceous interval, and the deposition of the sediments became more stable during the Paleogene period with more pelagic sedimentation. Some extensional structures affected the Cenozoic sediments, and strong submarine erosions represented by canyon and wide submarine valleys occurred during major lowstands (Shipboard Scientific Party, 1996).

2.2. Lithostratigraphy

Shipboard Scientific Party (1996) divided the sediments into five lithological units (I to V downsection) described in Table 1 (see also Fig. 2). Alternation from darker to lighter color of the calcareous sediments down unit has been used to subdivide Unit I into subunits IA and IB. Unit II is predominantly comprised of siliceous phases and subdivided into three subunits based on the dominance of diagenetic sediments as follows: diatomite (IIA), chert (IIB), and porcellanite (IIC). Unit III is characterized by deep shelf claystone with slight to moderate bioturbation. Unit IV, which has two subunits IVA and IVB, comprises calcareous sediments indicative of shallow marine deposition. Thin, well sorted and laminated and cross-laminated sand beds of Unit V are indicative of deep-water lacustrine setting.

3. Material and methods

The 30 samples selected for this study (S1–S30) were processed from subunits IIA and IIB and lower part of subunit IB of ODP Hole 959 A (Fig. 2; Tables 1 and 2). Standard palynological processing methods (Traverse, 2007) were used to extract the organic fraction of the samples by digesting the sediments in HCL and HF, and separation of the organic matter in heavy liquid ($ZnBr_2$). The organic residues were oxidized using Schultze solution ($KClO_3$ plus HNO_3), and screened through 10 μm sieves. Half of the oxidized residues were stained with safranin red. A minimum of 300

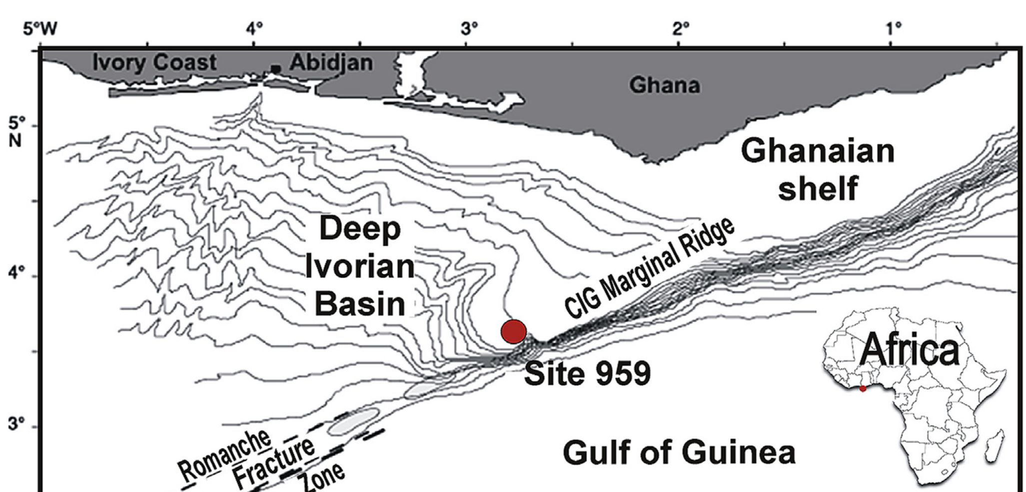

Fig. 1. Map showing the location of ODP Site 959 (indicated by red circle) in the Côte d'Ivoire-Ghana (CIG) Transform Margin in the eastern Equatorial Atlantic, West Africa (modified from Frieling et al., 2018). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)