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Fault-controlled stratigraphy of the Late Cretaceous Abiod Formation at Ain Medheker (Northeast Tunisia)

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ABSTRACT

The palaeogeographic setting of the studied Ain Medheker section represents an Early Campanian to Early Maastrichtian moderately deep carbonate shelf to distal ramp position with high rates of hemipelagic carbonate production, periodically triggered by mass-flow processes. Syndepositional extensional tectonic processes are confirmed to the Early Campanian. Planktonic foraminifera identified in thin sections and calcareous nannofossils allow the identification of the following biozones: *Globotruncanita elevata, Contusotruncana plummerae* (replacing former *Globotruncana ventricosa* Zone), *Radotruncana calcarata, Globotruncana falsostuarti*, and *Gansserina gansseri*. The following stable C-isotope events were identified: the Santonian/Campanian boundary Event, the Mid-Campanian Event, and the Late Campanian Event. Together with further four minor isotopic events, they allow for correlation between the western and eastern realms of Tunisia. Frequently occurring turbidites were studied in detail and discussed in comparison with contourites.

1. Introduction

Northeast and east Central Tunisia was located on the southwestern shelf of the Tethyan Ocean during the Cretaceous Period. It forms the western part of the Pelagian Shelf, a geological province that includes mainly the Tunisian offshore areas (as far as Malta and northwestern Libya; Klett, 2001). During the Late Cretaceous to Neogene interval, periods of extensional tectonics were followed by structural inversion, reverse or thrust faulting, whereby Triassic evaporites provided a "décollement surface" (Guiraud, 1998). In Late Cretaceous times, a shallow submarine swell ran nearly parallel to a major tectonic element, the "North–South Axis", separating the Tunisian Trough (west of the swell) from the Pelagian Shelf to the east (Fig. 1A).

The "North–South Axis"-tectonic element represents a 100-km-long deformation front of the Atlas Mountains in central Tunisia and consists of NE–SW to NNE–SSW-trending tight folds and thrusts, reactivated during the African–European collision in Middle Miocene time (Anderson, 1996). Adjacent to the Pelagian Platform, thrust structures are affected later by strike-slip faults (Fig. 1B). The complex structural evolution of the "North–South Axis"-tectonic element was interpreted by Ouali et al. (1987) and Boccaletti et al. (1988) as a transpressive 'flower' structure, generated during sinistral strike-slip on an inferred N–S-trending basement fault. These authors have proposed a Late Miocene to Early Pliocene age for the faulting and folding and therefore interpreted the "North–South Axis"-tectonic element as a post-collisional structure. Bouaziz et al. (2002) interpreted the "North–South Axis"-tectonic element as resulting from the polyphase reactivation of an inherited Pan-African or Palaeozoic lineament. A major extensional stage with WNW–ESE striking direction was described from the Campanian–Early Maastrichtian, documented by a NW–SE to NNW–SSE conjugate normal fault system that cut the Campanian carbonates and form syndepositional features of the Abiod Formation in the folded Atlasic domain (Bouaziz et al., 2002).

The studied Abiod succession at Ain Medheker is situated at the eastern flank near the northern termination of the "North–South Axis"-tectonic element (Fig. 1B). A major syndepositional normal fault was discovered in the lower part of the outcrop, indicating Early Campanian extensional tectonic movements. They are comparable to similar extensional processes that affected the whole North African margin, originating from NW–SE to NNW–SSE striking basins, as described by Baird et al. (1996). In defined alternating intervals of the whole succession, slumpings and turbidites reflect

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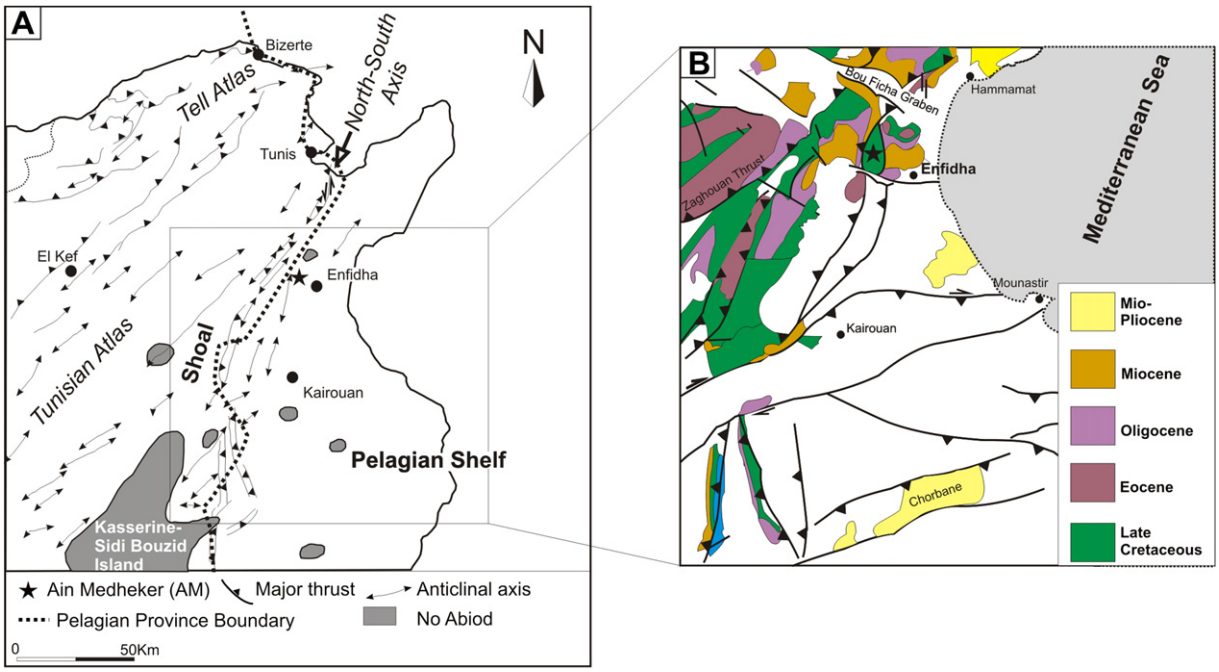

Fig. 1. A, major tectonic units of northeast Tunisia (after Anderson, 1996) and thickness distribution of the Abiod Formation (after Hennebert et al., 2009). Asterisk indicates the position of the studied section at Ain Medheker. B, simplified geological map (after Khomsi et al., 2009) around Enfidha with the studied section of Ain Medheker (asterisk).

imprints of syndepositional reworking of (hemi) pelagic carbonaceous sediments on a palaeo-slope. The analysis of planktonic foraminifera allows for a high-resolution biostratigraphic framework, supported by stable isotope-geochemistry data. The latter have been widely used as in important tool for stratigraphic correlation in Late Cretaceous pelagic and hemipelagic settings (Scholle and Arthur, 1980; Jarvis et al., 2002, 2006; Jacobs et al., 2005) and enable us to refine the stratigraphic concepts of the studied section.

The main goals of this paper are to: (1) describe the characteristics of the stratigraphic record of a Late Cretaceous submarine fault-controlled half-graben and the corresponding downcurrent mass-flow processes; (2) analyze the stratigraphic architecture of the Abiod Formation at Ain Medheker; (3) date the main events recorded in it; (4) to identify the processes controlling turbidite sedimentation; and (5) to integrate all data into a regional and supraregional stratigraphic framework.

These data will provide a deeper understanding of the stratigraphic evolution of the Late Cretaceous Abiod Formation, syndepositional tectonic movements that are related to stages of extensional tectonics, and will contribute to interpretations on the evolution of the Late Cretaceous Pelagian Shelf. The ultimate objective of this study is to integrate outcrop geological data and descriptions from similar areas to develop a tectono-sedimentary model explaining depositional processes during the Campanian–Early Maastrichtian period.

2. Geological setting

The Abiod Formation (Early Campanian–Early Maastrichtian) of Tunisia exhibits varying thicknesses and facies from the south to the north. In the Kasserine area (central Tunisia), the thickness is highly reduced and the Abiod Formation includes conglomeratic gravity flow deposits (Negra, 1994) and local rudist-bearing limestones (Khessibi, 1978; M'Rabet et al., 1986; Negra, 1986, 1995; Negra and Purser, 1989, 1995; Ben Ferjani et al., 1990; Negra et al., 1995; Negra and Gili, 2004), or is even missing in the Kasserine-Sidi Bouzid Island (Negra et al., 1995; Fig. 1A). Further to the south (Gafsa area), the Abiod Formation consists of bioclastic limestones, intercalated with sandy, dolomitic and evaporitic intervals (Abdallah, 1987; Negra and M'Rabet, 1994; Chaabani, 1994), indicating the proximity to the southern Saharan Platform. In the southernmost areas (Chotts), the Abiod facies becomes more proximal with lagoonal to intertidal–subtidal environments.

Based on thickness variations of the Abiod Formation, Hennebert et al. (2009) proposed two elongated shoals in central East Tunisia (Fig. 1A): the first runs along the northern prolongation of the Kasserine Island, nearly parallel to the "North–South Axis"-tectonic element, with a subsiding basin (Tunisian Trough) to the west, where the Abiod Formation exceeds 600 m of pelagic and hemipelagic chalks and marls (Burollet and Ellouz, 1984; Ben Ferjani et al., 1990); the second is situated to the east of Kasserine Island, extending over the Pelagian Shelf. Both shoals exhibit several highs that are indicated by circular areas without Abiod Formation (Fig. 1A).

The studied section AM (Ain Medheker) is located to the west of an active quarry at the village of Ain Medheker (ca.10 km west of Enfidha). It is near the eastern boundary of the "North–South Axis"-tectonic element, therefore representing also the eastern flank of the first shoal (Fig. 1A,B).

3. Material and methods

The studied section AM comprises a 115-m-thick succession of limestones and marly or argillaceous limestones. The Abiod Formation (105 m) is sandwiched between the upper Aleg Formation (below) and the El Haria Formation (above; Fig. 2). Our detailed microfacies, biostratigraphy and chemostratigraphy studies were carried out on 130 samples that were collected bed-by-bed; moreover, the textures of both, hemipelagic carbonates and intercalated turbiditic layers of the Abiod Formation (including the transition to the underlying/overlying formations) was documented. A total of 72 thin sections were prepared from limestones to determine the microfossils and the microfacies characteristics. The percentages of the main components were estimated by means of point counting (see Fig. 2). Planktonic foraminifera are the most