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Biostratigraphie des kystes de dinoflagellés de la limite Crétacé-Paléogène à Ellès, Tunisie

Dinoflagellate cyst biostratigraphy from the Cretaceous-Palaeogene boundary at Ellès, Tunisia

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Résumé

L'étude palynologique des dépôts du passage Crétacé-Paléogène (K-Pg) dans la coupe d'Ellès, Nord-Est de la Tunisie, a révélé la présence des assemblages de microfossiles marins à paroi organique, formés essentiellement de kystes de dinoflagellés (dinokystes) qui sont bien conservés. L'interprétation biostratigraphique des assemblages de dinokystes suggère une sédimentation continue dans l'intervalle étudié de la section et permet de situer la limite K-Pg juste au-dessus de l'acmé de *Manumiella seelandica*, marqueur global du Maastrichtien terminal, et de la dernière apparition de rares taxons crétacés comme *Dinogymnium* spp., *Alisogymnium euclaense* et *Pterodinium cretaceum*, et directement au-dessous de la première apparition des espèces marqueurs du Danien basal *Damassadinium californicum*, *Membranilarnacia? tenella*, *Senoniasphaera inornata* et *Carpatella cornuta*. Cette limite reconnue à partir de la biostratigraphie des dinokystes coïncide avec la limite K-Pg tracée antérieurement à l'aide de la lithostratigraphie et de la biostratigraphie des foraminifères planctoniques et nannofossiles calcaires. L'assemblage de dinokystes rencontré (suite de Malloy) suggère un dépôt dans une province tropicale à subtropicale ou téthysienne.

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Mots clés : Limite Crétacé-Paléogène ; Kystes de dinoflagellés ; Stratigraphie ; Ellès ; Tunisie

Abstract

A Palynological study of the Cretaceous-Palaeogene (K-Pg) transition deposits in the Ellès section, northern Tunisia, revealed the presence of marine organic-walled microfossil assemblages formed essentially by well-preserved dinoflagellate cysts (dinocysts). The biostratigraphic interpretation of the dinocyst assemblages suggests a continuous sedimentation in the studied interval of the section and allows to place the K-Pg boundary just above the Latest Maastrichtian global marker acme of *Manumiella seelandica* and the last appearance of few Cretaceous taxa such as *Dinogymnium* spp., *Alisogymnium euclaense* and *Pterodinium cretaceum*, and directly below the first appearance of the basal Danian markers *Damassadinium californicum*, *Membranilarnacia? tenella*, *Senoniasphaera inornata* and *Carpatella cornuta*. This recognized boundary based on dinocyst biostratigraphy coincides with the K-Pg boundary previously known based on lithostratigraphy and planktic foraminiferal and calcareous nannofossil biostratigraphy. The observed dinocyst assemblage (Malloy suite) suggests a deposition in a tropical to subtropical or Tethyan province.

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Keywords: Cretaceous-Palaeogene boundary; Dinoflagellate cysts; Stratigraphy; Ellès; Tunisia

Abridged version

The present work aims to study dinoflagellate cyst biostratigraphy of the Cretaceous-Palaeocene boundary interval at Ellès,

northern Tunisia (Figs. 1, 2). This study concerns only 2 m of marly and clay deposits around the Cretaceous/Palaeogene boundary (Fig. 3). The Ellès section has been proposed to be a K-Pg boundary parastratotype or a new stratotype since it presents a thin layer with the iridium anomaly (cosmic marker of the fallout from the Chicxulub impact event), and holds the most complete record of the K-Pg transition in Tunisia, according to planktic foraminifera (Zaghib-Turki et al., 2000,

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2001; Karoui-Yaakoub et al., 2002). Furthermore, this section has been considered by the latter authors, to be better exposed than the K-Pg boundary stratotype at El Kef. This palynological study of 25 samples from the Cretaceous-Palaeogene (K-Pg) transition deposits, revealed the presence of marine organic-walled microfossil assemblages formed essentially by well preserved dinocysts. The dinocyst assemblages represent 90% of total palynomorphs. Spores, pollen, acritarchs and foraminiferal lignings represent only 10%. A total of 78 species and subspecies of dinocysts have been recognized (Appendix A and Table 1) among which, 5 species are restricted to the Maastrichtian and 12 other species appear in the Danian. The other species recorded in the Maastrichtian (61 species) cross the K-Pg boundary, and persist into the Danian. These findings indicate that dinocysts did not undergo a mass extinction across the Maastrichtian-Danian boundary in this section, in contrast to the mass extinction recorded in the calcareous planktic foraminifer assemblages (Zaghib-Turki et al., 2000, 2001; Karoui-Yaakoub et al., 2002). Dinocysts show however, important changes in the relative abundances of taxa and an enrichment in genera and species characterizing the lower Palaeocene. Important dinocyst species are illustrated in this paper (Plates 1–3). The biostratigraphic interpretation of the dinocyst assemblages, based on dinocyst events (Fig. 3, Table 1), suggests a continuous sedimentation in the studied interval of the section and allows to place the K-Pg boundary just above the uppermost Maastrichtian global marker acme of *Manumiella seelandica* and the last appearance of few Cretaceous taxa such as *Dinogymnium* spp., *Alisogymnium euclaense* and *Pterodinium cretaceum*, and directly below the first appearance of the basal Danian markers *Damassadinium californicum*, *Membranilarnacia? tenella*, *Senoniasphaera inornata* and *Carpatella cornuta*. This recognized boundary based on dinocyst biostratigraphy coincides with the K-Pg boundary previously known based on lithostratigraphy and planktic foraminiferal (Zaghib-Turki et al., 2000, 2001; Karoui-Yaakoub et al., 2002) and calcareous nannofossil biostratigraphy (Gardin, 2002). The dinoflagellate cyst age determinations (upper Maastrichtian-lower Danian) of the studied interval corroborate the planktic foraminifer and calcareous nannofossil biostratigraphic results in the same section by the latter authors (Fig. 3). The dinocyst-dated interval corresponds to the upper Maastrichtian planktic foraminifer *Abathomphalus mayaroensis* (CF1) Zone and the lower Danian *Globoconusa conusa* (P0) and *Parvularugoglobigerina eugubina* (P1a) zones. Moreover, this interval corresponds to the upper Maastrichtian calcareous nannofossil *Nephrolithus frequens* Zone (*Micula prinsii* Subzone [CC26b]) and the lower Danian NP1 Zone (Fig. 3). The gradual succession of dinocyst events in the studied interval, confirms the complete record of the K-Pg boundary transition suggested previously by planktic foraminifera in this section.

The dinocyst assemblages observed in the Ellès section are very similar to those observed in Tunisia at El Kef (Brinkhuis and Zachariasse, 1988; Brinkhuis and Leereveld, 1988) and Aïn Settara sections (Dupuis et al., 2001), and in Morocco at Ouled Haddou (Slimani et al., 2010). The *Damassadinium californicum* Zone of Hansen (1977) characterizing the Danian

in the Northern Hemisphere is recognized in Tunisia, at El Kef (Brinkhuis and Zachariasse, 1988), Aïn Settara (Dupuis et al., 2001), but also in the studied section. The dinocyst events, including the first or/and last appearances of taxa during the upper Maastrichtian and Danian, reinforce the dinocyst events previously known in the Tethyan realm (De Coninck and Smith, 1982; Rauscher and Doubinger, 1982; Brinkhuis and Zachariasse, 1988; Eshet et al., 1992; Slimani et al., 2010; Dupuis et al., 2001) and equatorial realm (Masure et al., 1998; Oboh-Ikuenobe et al., 1998; Yepes, 2001). Many of these events are similar to those observed in the middle latitudes of the Northern Hemisphere in Northern Europe and the USA. The dinocyst *Palynodinium grallator* is the only species that has a last occurrence at the top of the Maastrichtian in northern higher latitudes (Hansen, 1977; Brinkhuis et al., 1998; Slimani et al., 2011), but only occurs for the first time close to the K-Pg boundary in low latitudes (Brinkhuis et al., 1998; Slimani et al., 2010) and in the studied section. These differences in *Palynodinium grallator* records might be due to a southward migration caused by a cooling event in the earliest Danian (Brinkhuis et al., 1998).

The dinocyst species *Cerodinium mediterraneum*, *Damassadinium spinosum*, *Lejeunecysta izerzenensis*, *Impagidinium maghribensis* described for the first time at the K-Pg transition in Morocco (Slimani et al., 2008) and found in the same interval, both in out section and in Austria (Mohamed et al., 2012), may be considered as new markers of the K-Pg boundary in the Tethyan realm.

The observed dinocyst assemblage is dominated by species of *Cerodinium*, *Lejeunecysta*, *Senegalinium*, *Andalusiella*, *Phelodinium* that characterize the Malloy suite (Lentin and Williams, 1980), and thus confirms a deposition in a tropical to subtropical or Tethyan province for the studied interval of the Ellès section.

1. Introduction

À l'échelle mondiale, plusieurs coupes présentant un passage K-Pg continu et complet ont été décrites, soit en affleurements, soit dans des forages. Les affleurements découverts au Texas « Brazos river », en Espagne (Zumaya, Caravaca), Italie (Gubbio), France (Bidart) et Tunisie (El Kef, Ellès, Aïn Settara) sont considérés parmi les plus connus en raison de la continuité de sédimentation et la présence de la couche d'iridium (marqueur cosmique) à la limite K-Pg. En Tunisie septentrionale, non loin du stratotype de la limite K-Pg et Global Stratotype Section and Point (GSSP) à El Kef (Molina et al., 2006), les coupes de Aïn Settara, la coupe de l'Oued El Maleh et la coupe d'Ellès montrent également une transition K-Pg continue avec un enrichissement en iridium à la limite K-Pg. La coupe d'Ellès a déjà fait l'objet de plusieurs travaux d'ordre minéralogique, géochimique (Stüben et al., 2002; Adatte et al., 2002) et biostratigraphique fondés sur les foraminifères planctoniques et benthiques (Saïd, 1978; Karoui-Yaakoub, 1999; Zaghib-Turki et al., 2000, 2001; Karoui-Yaakoub et al., 2002; Coccioni et Marsili, 2007) et les nannofossiles calcaires (Gardin, 2002). Cette coupe a été proposée comme un parastratotype ou même comme un nouveau stratotype de la limite K-Pg (Zaghib-Turki et al., 2000, 2001; Karoui-Yaakoub et al., 2002) puisqu'elle

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