

## Cenomanian–Turonian ammonite successions in the Tinrhert Basin (Southeastern Algeria): Revision and new data



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### ABSTRACT

The Cenomanian–Turonian succession (C–T) outcropping in the Tinrhert Basin, in the southeastern part of Algeria, has been the focus of many studies since the turn of the 19th century. In the present research, new C–T sections have been scrutinized over a distance of approximately 300 km, from Gour Ben Houilet in the west to Oued In Adaoui in the east. More than 1.700 ammonites and nautilids were collected bed-by-bed and 30 taxa subsequently identified; these are systematically described and illustrated herein. Thirteen of them [*Placentoceras* cf. *kaffrarium* Etheridge, *Metengonoceras dumbli* (Cragin), *Calycoceras* (*Proeucalycoceras*) sp., *Pseudaspidoceras pseudonodosoides* (Choffat), *Vascoceras* aff. *glabrum* (Barber), *Rubroceras burroense* Cobban, Hook and Kennedy, *Fagesia peroni* Pervinquier, *Eotissotia simplex* Barber, *Hoplitoides wohlmanni* (Von Koenen), *Kamerunoceras turoniense* (d'Orbigny), *Choffaticeras* sp., *Choffaticeras meslei* (Peron), and *Choffaticeras sinaiticum* Douvillé] are recorded from the Tinrhert area for the first time. This study also evidences that both subspecies *Neolobites vibrayeanus vibrayeanus* (d'Orbigny) and *Neolobites vibrayeanus brancai* Eck are associated in the same section and in the same level.

In the Tinrhert area, the biostratigraphic ammonite successions are subdivided into nine bio-events that are easily correlatable with the upper Cenomanian–lower Turonian standard zonation. The paleo-biogeographic affinities of the recorded taxa characterize these ammonoid assemblages as part of the southern Tethyan Province during the early Late Cretaceous.

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### 1. Introduction

Sahara, especially the Tinrhert Basin, has been the focus of much geological attention since the turn of the 19th century. The first lithological and paleontological study of the Tinrhert Basin is Collignon's (1957).

In 1955–1956 the prospection-BRP-Tinrhert project was launched, results of which lead to the printing of the first geological map (scale 1: 200.000) of part of the “Hamada de Tinrhert”.

In 1957, Rumeau et al. subdivided the upper Cenomanian–lower Turonian succession of the Tinrhert Basin into three

lithostratigraphic formations (‘Lower limestones’, ‘Middle marls’ and ‘Upper limestones’). The research of Busson (1960, 1964, 1965, 1969, and 1972) refined the lithology of the basin, and led to the publication of the geological map (scale 1:500.000) of Fort Flatters. This succession was then the core of several paleontological and biostratigraphical studies: bivalves and gastropods (Collignon, 1971; Amard et al., 1981); echinoids (Néraudeau et al., 1993), and ammonites (Collignon, 1957, 1965; Amédéo et al., 1996; Busson et al., 1999), which provided some stratigraphic precision within the upper Cenomanian–lower Turonian interval in the Tinrhert Basin.

The Cretaceous ledges are displaying a fine-detailed succession of the upper Cenomanian–lower Turonian carbonates over great distances, especially to the west of Tinrhert and Tademaït, which was the concern of the stratigraphical and paleontological study of Amard et al. (1981). These outcrops are noteworthy, spectacular and allow the elucidation of a detailed zonation.

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Recently, the successive works of [Grosheny et al. \(2013\)](#), [Tchenar et al. \(2015\)](#) and [Ferré et al. \(2016\)](#) brought some new light to the position of the upper Cenomanian–lower Turonian boundary. The present study introduces the results of new collecting from six sections of the Tinrhert Basin along a W-E transect of roughly 260 km: three sections in the western part of the basin (Gour Ben Houilet, Gour Belkhouilled and Bordj Omar Driss) and three others in the eastern part (Oued Takouazet, Oued Ountalek and Oued In Adaoui) ([Fig. 1](#)).

Our study intends to complement the systematics and occurrence range of the Cenomanian–Turonian ammonites in the Tinrhert Basin.

## 2. Geographical and geological setting

The studied region occupies the southeast part of Algeria and corresponds to the eastern part of the “Hamada de Tinrhert”. The Cretaceous deposits analyzed in the present study extend for more than 260 km from Gour Ben Houilet in the west to Oued In Adaoui in the east. It is delimited by the Grand Erg Oriental in the north and by the Erg Isaouane and Illizi Basin in the south. It contains one of the most spectacular Upper Cretaceous succession of the south margin of the Tethys; they form parallel carbonate ledges ([Fig. 1](#)), from the south to the north, in the stratigraphic order, we distinguish: Cenomanian ledge, Turonian ledge, Santonian–Campanian ledge, and Maastrichtian ledge.

## 3. Brief lithostratigraphic framework

The description of the Cenomanian–Turonian succession of the “Hamada de Tinrhert” is based on the analysis of six sections along

the limits of exposure between Gour Ben Houilet in the west and Oued In Adaoui in the east ([Fig. 1](#)). To describe this series, the terminology of [Busson \(1972\)](#) is applied to large identified lithologic sets.

The upper Cenomanian–Turonian succession of the Tinrhert Basin comprises three lithostratigraphic formations, which are described below, from base to top ([Figs. 2, 3](#)).

### 3.1. ‘Lower limestones’ Formation

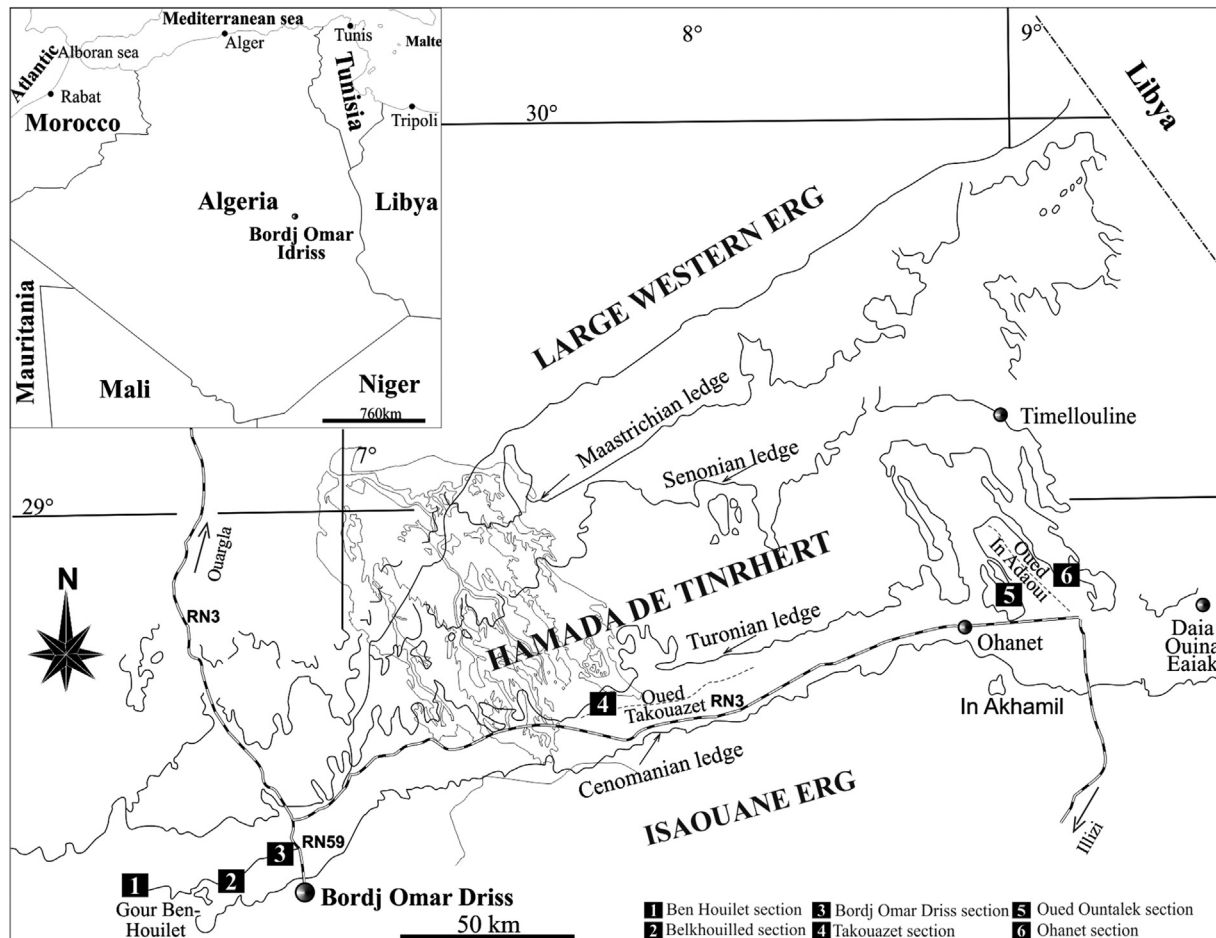
This formation corresponds to the Cenomanian ledge of former authors. It overlies the Gypsum-clay Formation (upper to middle Cenomanian) and underlies the ‘Middle marls’ Formation (lower to middle? Turonian). According to the position of the *Neolobites* beds, the ‘Lower limestones’ Formation can be divided into four informal units ([Zaoui et al., 2016](#)):

#### 3.1.1. ‘Pre-Neolobites limestones’ unit

The unit consists of pseudonodular bioclastic limestone containing oyster and gastropod remains, followed by an alternation of marl and thin algal limestone beds. The uppermost part of the unit consists of a decimetric, strongly bioturbated limestone bed, grey to brown in color.

#### 3.1.2. ‘Limestones with Neolobites’ unit

This unit corresponds to the *Neolobites* deposits ([Ernst et al., 1996](#); [Cavin et al., 2010](#); [Meister and Piuz, 2013](#); [Benyoucef and Meister, 2015](#)), reckoned on the southern margin of the Tethys, from Morocco in the west to Oman in the east ([Cavin et al., 2010](#); [Meister](#)



**Fig. 1.** Geographic position of the “Hamada de Tinrhert” in Algeria and localization of the six studied outcrops.

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