Journal of African Earth Sciences 113 (2016) 101–113

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Geological society of Africa presidential review

Discovery of Jurassic ammonite-bearing series in Jebel Bou Hedma (South-Central Tunisian Atlas): Implications for stratigraphic correlations and paleogeographic reconstruction

Néjib Bahrouni [a, b, *], Yassine Houla [a, d], Mohamed Soussi [c], Mabrouk Boughdiri [d], Walid Ben Ali [c], Ahmed Nasri [e], Samir Bouaziz [b]

[a] Geological Survey, National Office of Mines, 24 Energy Street – 2035, Charguia I, B.P. 215, 1080 Tunis, Tunisia
[b] Engineering School of Sfax, University of Sfax, Bp. 1173, 3038 Sfax, Tunisia
[c] University of Tunis El Manar, Faculty of Sciences of Tunis, Department of Earth Sciences, 2092 Tunis, Tunisia
[d] University of Carthage, Faculty of Sciences of Bizerte, Department of Earth Sciences, 7021 Bizerte, Tunisia
[e] Tunisian Enterprise of Petroleum Activities (ETAP), 54 Avenue Mohamed V, 1002 Tunis, Tunisia

ARTICLE INFO

Article history:
Received 11 June 2015
Received in revised form
20 October 2015
Accepted 22 October 2015
Available online 28 October 2015

Keywords:
Atlas
Tunisia
Jebel Bou Hedma
Jurassic
Ammonites
Stratigraphic correlation

ABSTRACT

Recent geological mapping undertaken in the Southern-Central Atlas of Tunisia led to the discovery of Jurassic ammonite-bearing series in the Jebel Bou Hedma E–W anticline structure. These series represent the Southernmost Jurassic rocks ever documented in the outcrops of the Tunisian Atlas. These series which outcrop in a transitional zone between the Southern Tunisian Atlas and the Chott basin offer a valuable benchmark for new stratigraphic correlation with the well-known Jurassic series of the North –South Axis of Central Tunisia and also with the Jurassic subsurface successions transected by petroleum wells in the study area. The preliminary investigations allowed the identification, within the most complete section outcropping in the center of the structure, of numerous useful biochronological and sedimentological markers helping in the establishment of an updated Jurassic stratigraphic framework chart of South-Western Tunisia. Additionally, the Late Jurassic succession documents syn-sedimentary features such as slumping, erosion and reworking of sediments and ammonite faunas that can be considered as strong witnesses of an important geodynamic event around the Jurassic-Cretaceous boundary. These stratigraphic and geodynamic new data make of the Jurassic of Jebel Bou Hedma a key succession for stratigraphic correlation attempt between Atlas Tunisian series and those currently buried in the Chott basin or outcropping in the Saharan platform. Furthermore, the several rich-ammonite identified horizons within the Middle and Upper Jurassic series constitute reliable time lines that can be useful for both paleogeographic and geodynamic reconstructions of this part of the North African Tethyan margin but also in the refinement of the potential migration routes for ammonite populations from the Maghrebian Southern Tethys to Arabia.

Contents

* Corresponding author. Geological Survey, National Office of Mines, 24 Energy street – 2035, Charguia I, B.P. 215, 1080 Tunis, Tunisia. Tel.: +216 96 330 301; fax: +216 71 808 011.
E-mail address: bahrouni_nejib@yahoo.fr (N. Bahrouni).

http://dx.doi.org/10.1016/j.jafrearsci.2015.10.014
1464-343X/

1. Regional setting

The Jurassic series outcropping in the Central Tunisian Atlas are rather scarce and discontinuous since they outcrop exclusively along the so-called North South Axis (NOSA, Fig. 1a and b). These series have been encountered only in petroleum wells to the East and West of this major lineament. The outcropping Jurassic series of the Central Tunisian Atlas have been studied in pioneer geological works (Bonnefous, 1972; Burollet, 1956; Dumont, 1936; Schoeller, 1937), and were supplemented more recently by new investigations on stratigraphy and sedimentology (Memmi, 1968; M'Rabet, 1981, 1987; Busnardo et al., 1980, 1985; Soussi et al., 1990, 1991, 1999, 2000, 2004; Boughdiri, 1994; Boughdiri et al., 1999; Peybernes et al., 1995; Soussi and Ben Ismaïl, 2000; Soussi, 2002, 2003).

The Jurassic series of Central Tunisian Atlas have been ranged within the Nara Formation (Fm) by Burollet (1956). This formation is about 400 m thick and is composed of two major thick carbonate units (lower and upper Members: 350 m thick) separated by a middle unit (middle Member: 50 m thick). The intermediate member is composed of shale/limestone alternations including organic-rich facies which are Toarcian in age (Soussi et al., 1991). Within the middle Nara Fm., important thickness, facies lateral variations and major discontinuities were characterized (Soussi et al., 1991). These discontinuities which are associated to major stratigraphic gaps were interpreted as a result of the interplay between tectonics and sea level changes that accompanied the Tunisian North African Tethyan Margin development (Soussi et al., 2000). Further to the South and Southwest of the NOSA, the Jurassic successions are only known in boreholes. In Gantas-1 Well (Fig. 1) the total thickness of the crossed Jurassic section is about 400 m while in the Chott basin, situated south of the Gafsa range, the penetrated section exceeds 2000 m (Bonnefous, 1972; Soussi, 2002). Further South, in the Saharan Domain, the Jurassic series are dominantly represented by shallow marine mixed evaporites, siliciclastic and carbonate deposits (Tlig, 1978; Ben Ismaïl and M'Rabet, 1990; Busson, 1967; Kamoun, 1988).

In the Southern-Central Atlas (Fig. 1), precisely in Jebel Bou Hedma area, previous geological studies did not mention the presence of any Jurassic outcrops. Solely, at Aïn El Kerma section, the shaly Sidi Khalif Fm. was identified and attributed to the Tithonian-Berriasian interval by Castany (1951), Burollet (1956), Busnardo et al. (1980) and M'Rabet (1987).

The discovery of the Jurassic rocks in the Bou Hedma structure (Bahrouni et al., 2012, 2013) prompted to a revision of these series considering unpublished stratigraphic data and based on new approaches of geological mapping and updated regional correlations between the Central Tunisian Atlas and the study area added to some key petroleum wells where Jurassic rocks have been intersected (Fig. 2a). The present new stratigraphic and geodynamic reconstruction of the area based on this discovery provides new insights on our understanding of the geology of the South Atlas domain during the Jurassic-Early Cretaceous time interval.

2. Results

2.1. Lithostratigraphy

Three sections were logged bed by bed and sampled for sedimentological and biostratigraphic investigations (Fig. 2b). The most complete section is located in Aïn El Ksab (34°28′49″ N; 9°32′53″ E) and is considered in this work as a reference section for detailed lithological description and stratigraphic subdivision. The two other sections, located at Aïn Nourïss (34°28′40″ N; 9°31′15″ E) and Aïn El Kerma (34°29′27″ N; 9° 36′20″ E) exhibit only a part of the Jurassic series and are used for comparison and correlation purposes only.

2.1.1. Aïn El Ksab section

The Aïn El Ksab section (Fig. 2b) belongs to the Northern flank of the Jebel Bou Hedma faulted anticline where the outcropping lowermost levels are bounded by an E–W major reverse fault, itself cut by transverse NE–SW trending normal faults (Fig. 2c). It represents the most complete section, composed of three main informal lithological units (Figs. 3 and 4) which are, from bottom to top:

- **Unit A**; (Na1-9: Figs. 3 and 4b): it is a 50 m thick unit, exclusively made up of dolomitic beds organized in repetitive meter-thick elementary sequences showing algal laminations at the base and rare bioclasts at the top. Two thin greenish shaly intervals (Na 5 and 7) which yield badly preserved benthic foraminifera existing within this massive unit. Petrographic investigations indicate that the dolomitic beds are essentially medium to coarse grained with subhedral to anhedral dolosparitic rhombs letting show through rare bioclast and benthic fauna as well as iron-oxide impregnations.
- **Unit B**; (Na10-15: Figs. 3 and 4b, c): it is 20 m thick and can be subdivided into two sub-units. The first carbonate sub-unit (UB1: 08 m thick) is represented by pseudo-nodular decimeter-thick dark grey limestone beds with rare ammonites and belemnites especially at the top. The second subunit (UB2, 12 m thick) is composed of a dominantly shaly interval including thin light grey to whitish, nodular argillaceous limestone intercalations. The UB1 (Na 10–15) consists of wackestone-packstone textures with pellets, microfilaments, ostracods and some radiolaria. Two important erosive surfaces that may correspond to two major discontinuities, namely D1 and D2, are observed within the Unit B. The first discontinuity marks the top of massive dolomitic Unit A (Na 7–9), while the discontinuity D2 outlines the top of the nodular limestones of the unit UB1 (Na10-15).
- **Unit C**; (Na16-27: Figs. 3 and 4): it is a 35 m thick unit made up of a limestone cliff displaying important facies and thickness lateral variations along the Bou Hedma structure. It is subdivided into three subunits: