

# Integrated stratigraphy of the uppermost Barremian-lower Albian in the Essaouira-Agadir Basin (western Morocco) and correlations with northern Tethyan basins

## Walid Hassanein

Cairo University, Faculty of Science, Geology Department, Giza, Egypt; walidgkassab@yahoo.com

## Fabienne Giraud

Université Grenoble-Alpes, ISTERre, UMR 5275, IRD, BP 53, 38041 Grenoble cedex 9, France; Fabienne.Giraud-Guillot@univ-grenoble-alpes.fr

## Emmanuel Robert

Université de Lyon, Université Claude Bernard Lyon 1, ENS de Lyon, CNRS, UMR 5276 LGL-TPE, F-69622 Villeurbanne, France; emmanuel.robert@univ-lyon1.fr

## Etienne Jaillard

Université Grenoble-Alpes, ISTERre, UMR 5275, IRD, BP 53, 38041 Grenoble cedex 9, France; etienne.jaillard@univ-grenoble-alpes.fr

## Moussa Masrour

Université Ibn Zohr, Faculté des Sciences, Département de Géologie, B.P. 8106, Cité Dakhla, Agadir, Maroc; moussamasrour5@gmail.com

## Mohamed Aly

Cairo University, Faculty of Science, Geology Department, Giza, Egypt; mf\_alaly@yahoo.com

## Mohamed Hammed

Cairo University, Faculty of Science, Geology Department, Giza, Egypt; salehhammed@gmail.com

The latest Barremian-lower Albian interval of the southern Tethyan margin is poorly understood because sedimentary successions are frequently incomplete, and dating is difficult. The Essaouira-Agadir Basin (EAB) contains numerous, fossiliferous, and accessible outcrops of the Lower Cretaceous series. The aim of this work was to establish an integrated stratigraphic framework for this time interval in the EAB based on (1) high-resolution ammonites and calcareous nannofossil biostratigraphy, (2) identification of sedimentary discontinuities, and (3) carbon isotope stratigraphy. This study, which provided an excellent opportunity to calibrate the different stratigraphic records, resulted in a coherent scheme for the uppermost Barremian-lower Albian interval.

Six sections, located along two different transects (east-west and south-north), were selected that contained proximal to distal environments. In the EAB, the late Barremian was defined by ammonite zone *sarasini* and nannofossil Zone NC5. The Barremian-Aptian boundary

was defined by ammonites. The early Aptian was defined by the ammonite zones *deshayesi* to *furcata*, and was bounded by a first minimum  $d^{13}C$  value at the base and a first maximum value at the lower-upper Aptian boundary. The upper Aptian interval was defined by four ammonite zones (*martini*, *melchioris*, *nolani*, and *jacobi*), two discontinuity surfaces, four maximum and minimum  $d^{13}C$  values, and by the upper part of nannofossil Zone NC6 to the lowermost part of nannofossil Zone NC8. The Aptian-Albian boundary was placed within a discontinuity surface (base of the *tardefurcata* ammonite Zone) and was recognized by the first occurrence (FO) of the nannofossils *Prediscosphaera columnata* and *Hayesites albiensis* and by a marked decrease in  $d^{13}C$  values. Early Albian times were represented by the *tardefurcata* and *mammillatum* ammonite zones and by minimum  $d^{13}C$  values.

Diachronism of some nannofossil bioevents, which was observed between the EAB and other Tethyan basins, is also discussed.