Journal of African Earth Sciences 110 (2015) 34–51

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Facies analysis and depositional environments of the Upper Jurassic Jubaila Formation, Central Saudi Arabia

Hesham M. El-Asmar [a,b], Ehab M. Assal [a], Abdelbaset S. El-Sorogy [c,d,*], Mohamed Youssef [c,e]

[a] Geology Department, Faculty of Science, Damietta University, New Damietta City, 34517 Damietta, Egypt
[b] King Saud University, Saudi Arabia
[c] Department of Geology and Geophysics, College of Science, King Saud University, Saudi Arabia
[d] Geology Department, Faculty of Science, Zagazig University, Egypt
[e] Department of Geology, Faculty of Science, South Valley University, 83523 Qena, Egypt

ARTICLE INFO

Article history:
Received 8 February 2015
Received in revised form 30 May 2015
Accepted 1 June 2015
Available online 9 June 2015

Keywords:
Facies analysis
Depositional environment
Jurassic
Jubila
Saudi Arabia

ABSTRACT

This article deals with the Upper Jurassic carbonates of the Jubaila Formation, exposed throughout the Tuwaiq Mountains, Central Saudi Arabia and discusses the succession of palaeoenvironments resulting from detailed field and lab work. Based on microfacies analysis and sedimentological data, twelve facies are identified within the Upper Jurassic carbonates at Wadi Hanifa, Central Saudi Arabia. These facies are attributed to six main facies belts. Within these facies and facies belts, four distinct biofacies assemblages are recognized. Deposition took place on an extendable ramp, which probably dipped gently eastwards to the sea. A depositional model relates the identified facies and biofacies to a downdip depositional profile of an inner, middle and outer carbonate ramp. The burrowed lime mudstone and bioclastic wackestone–floatstone of facies belt 1 accumulated in a distal middle ramp to outer ramp. The mollusk-coated grains–intraclast rudstone of facies belt 2 were deposited in the distal middle ramp. The branched stromatoporoids *Cladocoropsis* were deposited in the proximal middle ramp of facies belt 3. The facies of the open lagoon (facies belt 5) and the tidal-flat (facies belt 6) were deposited in the inner ramp behind the ramp crest/shoal facies belt 4. The Early Kimmeridgian Jubaila Formation has been deposited as transgressive and highstand deposits of a third-order depositional sequence, which are mainly controlled by eustatic sea-level changes. During the transgression, an aggradational trend developed, with the construction of a deep subtidal facies of small-scale stacked cycles of mudstones with frequent mottled firm ground and hard ground, storm beds and tempestites. The regressive part has a characteristic progradational trend, with shallow-water carbonate platform deposits arranged into meter-scale coarsening-upward cycles ranged from dolomitic mudstone and wackestone to stromatoporoid packstone and rudstone into bioclastic intraclastic peloidal packstone and grainstone.

1. Introduction

During the Jurassic period the Arabian Plate was tectonically stable and was located at the Equator enabling the development of a wide shallow shelf on the western passive margin of the Neo-Tethys Ocean on which carbonates accumulated over the shelf and inner platform (Al-Saad, 2008). Eustatic sea-level rise combined with intraplate subsidence, led to the development of intrashelf basins on the passive continental margin, including the Gotnia, Arabian, and Rub'Al Khali basins (Al-Husseini, 1997; Ziegler, 2001). In Central Saudi Arabia, Upper Jurassic strata are well exposed and were deposited extensively over the Central Arabian Arch. These strata are the most productive oil reservoirs in the world. They have a significant petroleum potential, and contain an important source, reservoir and seal rocks. Jurassic rocks in Central Saudi Arabia have been described by many authors (Steineke and Bramkamp, 1952; Steineke et al., 1958; Powers et al., 1966; Powers, 1968; Vaslet et al., 1983, 1984, 1991; Manivit et al., 1985a,b, 1986; Enay et al., 1987; Droste, 1990; Le Nindre et al., 1990; Al-Husseini, 1997; Sharland et al., 2001) and several palaeogeographic maps have been published (e.g. Murris, 1980;

* Corresponding author at: P.O. Box: 2455, Riyadh 11451, Saudi Arabia. Tel.: +966 540325046; fax: +966 14676214.
E-mail addresses: elsorogyabd@yahoo.com, asmohamed@ksu.edu.sa (A.S. El-Sorogy).

http://dx.doi.org/10.1016/j.jafrearsci.2015.06.001
1464-343X/

Al-Husseini, 1997; Ziegler, 2001), based on generalized and sparse lithological evidence. The stratigraphy and fossil content have been studied by many authors (e.g. Galal and Kamel, 2004; Hughes, 2004, 2006, 2008; AL-Saad, 2008; El-Sorogy et al., 2014; Youssef and El-Sorogy, 2015; El-Sorogy and Al-Kahtany, 2015).

The present work aimed to describe and interprets the Upper Jurassic strata of the Jubaila Formation Wadi Hanifa, Central Saudi Arabia (Fig. 1) and discusses the palaeoenvironments of the succession resulting from detailed field descriptions and petrographic analysis. The significance of this work comes from the detailed description using facies, facies belts and biofacies assemblages to construct a depositional model for the studied sequence.

2. Materials and methods

Exposures on road-cuts and natural outcrops allowed the analysis of lithofacies, bedding geometries and facies architecture of the Upper Jurassic Jubaila Limestone. Fieldwork was undertaken in 3 main areas on the margins of ravines perpendicular to the depositional dip direction, allowing facies characterization from the shallow-water inner belt to the deeper-water outer belt (see Fig. 1 and descriptions in previous section). Stratigraphic and sedimentological interpretations are based on mapping on outcrop photographs where samples have been located. The sedimentological data gathered included lithology, texture, sedimentary structures, and fossil content. Field observations were complemented

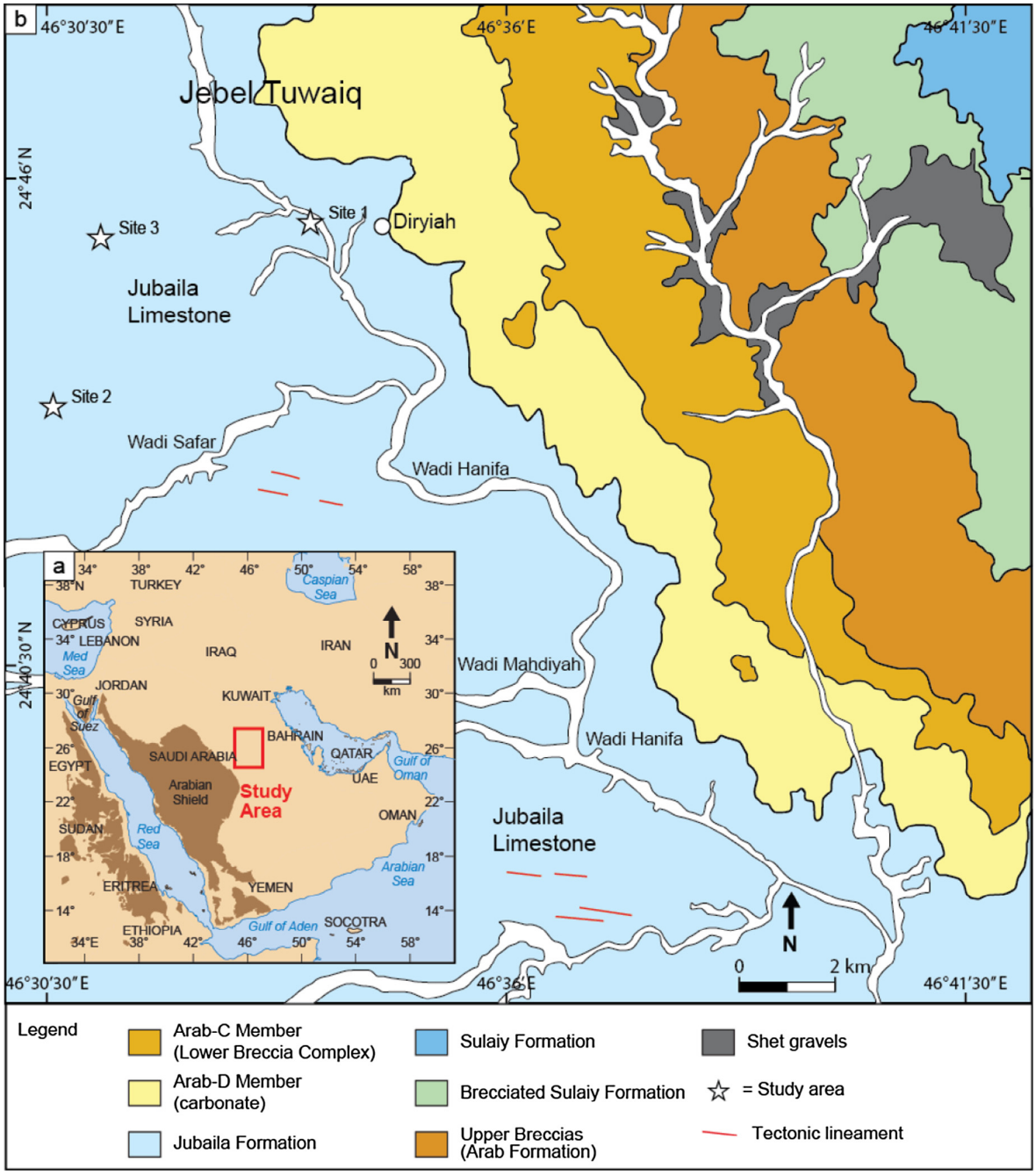

Fig. 1. (a) Regional map of Saudi Arabia. (b) Location map of the study area in Central Saudi Arabia.