Marine and Petroleum Geology xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Marine and Petroleum Geology

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

Research paper

Field-scale depositional evolution of the Upper Jurassic Arab Formation (onshore Abu Dhabi, UAE)

Elisabetta Marchionda[a,*], Rémy Deschamps[b], Miriam Cobianchi[a], Fadi H. Nader[b], Andrea Di Giulio[a], Daniel J. Morad[c], Fatima Al Darmaki[d], Andrea Ceriani[e]

[a] Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Pavia, Italy
[b] IFP Energies nouvelles, Rueil-Malmaison, France
[c] Department of Geosciences, University of Oslo, Oslo, Norway
[d] Al Hosn Gas, Abu Dhabi, United Arab Emirates
[e] Department of Petroleum Geosciences, Khalifa University of Science and Technology, Petroleum Institute, Abu Dhabi, United Arab Emirates

ARTICLE INFO

Keywords:
Carbonate ramp
Facies distribution
Well correlations
Kimmeridgian-Tithonian
Arab Formation

ABSTRACT

The paper aims to provide a new field-scale depositional model for the Upper Jurassic Arab Formation, in order to enlarge the stratigraphic and facies architecture knowledge in the onshore Abu Dhabi (UAE). The goal is reached following a threefold workflow structured by: (i) subsurface high-resolution facies analysis; (ii) well correlations; and (iii) paleofacies maps.

The facies analysis was based on 540 m of cores and 277 thin sections. Eighteen facies were defined, and were grouped into five facies associations, representative of a shallow marine carbonate ramp succession. The ramp ranges from outer ramp to supratidal and intertidal environments, with a shoal complex protecting a lagoon. A micropaleontological approach helped at defining the field-scale evolution of the different sedimentary environments through time and space. The results were integrated with well log data (Gamma Ray and Density-Neutron Log), and were used to establish the stacking pattern of the Arab Formation. The vertical and lateral distribution of the facies associations in the area of study were highlighted by the well correlations. These latter were useful to generate several new paleofacies maps corresponding to key stratigraphic surfaces identified within the succession. The model reveals different directions of progradation, suggesting a local topographic control on the deposition of the Arab Formation. The cyclical arrangement of the facies associations and the peculiarities of this new model have been discussed at regional scale, suggesting a new paleogeographic scenario.

1. Introduction

Carbonate ramps are traditionally sites of interest in exploration activities forming hydrocarbons sources and reservoirs (Burchette and Wright, 1992; e.g. Burchette et al., 1990; Palermo et al., 2010; Kietzmann et al., 2014). The facies distribution on ramps, and carbonate platforms in general, is controlled by multiple factors such as relative sea-level changes, type of carbonate-producing biota, hydraulic energy, climatic impact and ecological parameters (Pomar, 2001; Pomar and Hallock, 2008; Pomar and Kendall, 2008) that constrain the sediment production and transport, giving rise to heterogeneous depositional systems. High-resolution cores and well-log studies are fundamental in order to understand the temporal evolution of a sedimentary system at the change of the different environmental conditions, reconstructing from 1D data conceptual depositional scenarios (e.g. Al-Awwad and Pomar 2015; Abdolmaleki et al., 2016; Wang et al., 2016; Beigi et al., 2017).

This study aims to provide new insights concerning the evolution of an ancient carbonate ramp with the attention focused on the sedimentology and stratigraphy of the Upper Jurassic Arab Formation (Fm.; lithostratigraphic members A-B-C-D) in the onshore Abu Dhabi (UAE). The Arab Fm. extends over a large area of the Arabian Platform and includes one of the most prolific Upper Jurassic reservoirs of the world (Alsharhan, 1989).

In the United Arab Emirates (UAE), major reservoirs where discovered in the Arab Fm. in numerous fields onshore and offshore Abu Dhabi, making the UAE one of the major hydrocarbon-producing areas in the world (Alsharhan and Nairn, 1997). The Arab Fm. was widely studied, following numerous relevant discoveries in the offshore of Abu Dhabi (e.g. Azer and Peebles, 1995; Al-Silwadi et al., 1996; Lehmann

* Corresponding author.
E-mail address: elisabetta.marchionda01@universitadipavia.it (E. Marchionda).

http://dx.doi.org/10.1016/j.marpetgeo.2017.10.006
Received 1 June 2017; Received in revised form 19 September 2017; Accepted 7 October 2017

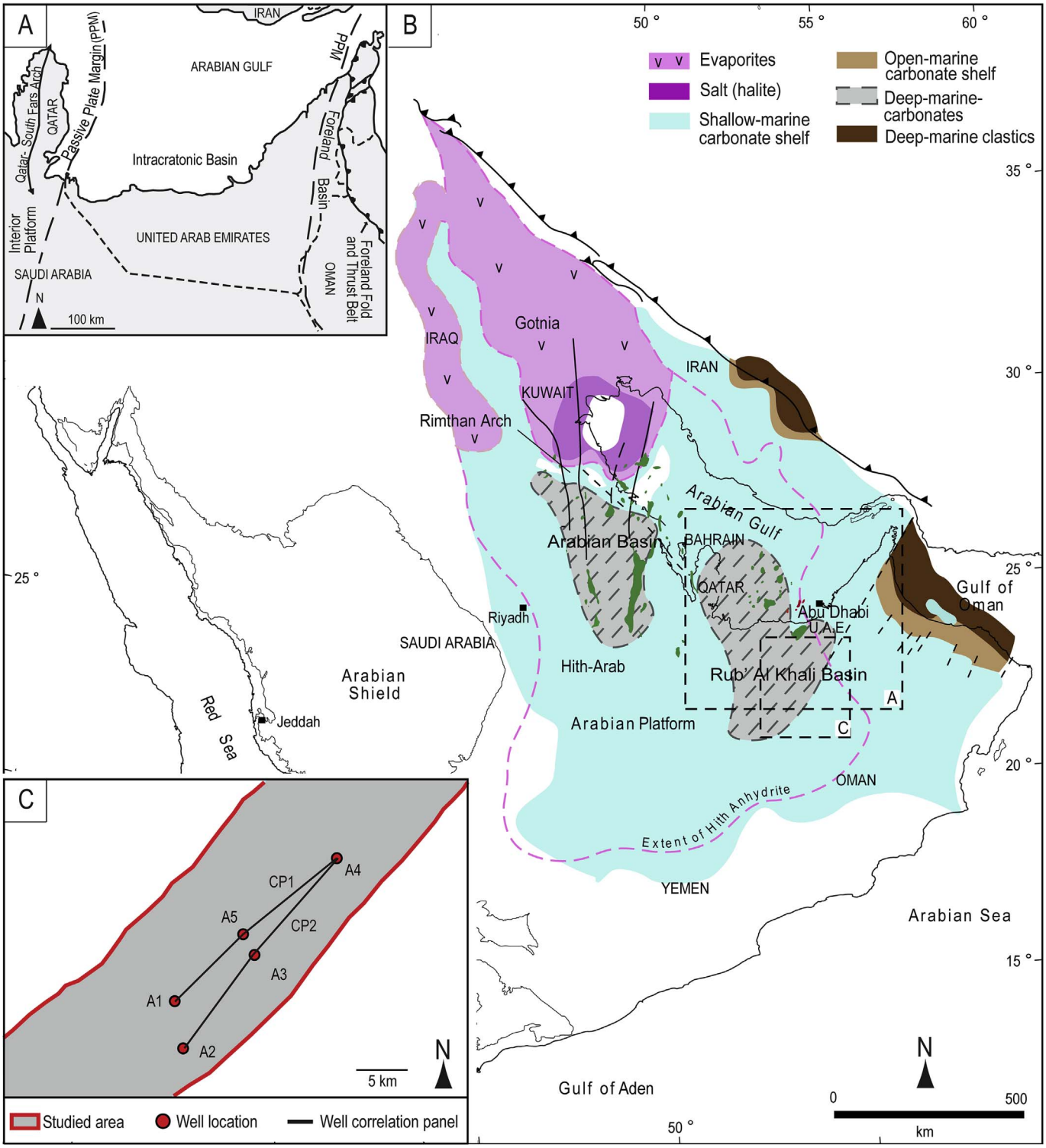

Fig. 1. (A) Main tectonic provinces of the UAE: the intracratonic basin (passive plate-margin region) and the foreland basin and adjacent foreland fold- and thrust-belt region (redrawn and modified from Alsharhan, 1989). (B) Paleofacies map of the Late Jurassic (Kimmeridgian to Tithonian) during the deposition of the Arab Fm. (modified and simplified from Ziegler, 2001, Hughes, 2004b). Some of the main fields on the Arabian Platform are pictured in green and red. The names of the two intrashelf basins (Arabian and Rub' Al Khali) are gathered from Al-Awwad and Collins (2013) and Al-Awwad and Pomar (2015). (C) Sketch map of the study area shaped on a northeast-southwest anticline structure. The field borders are underlined in red. The location of the five wells available for this study is circled in red. The black lines represent the two transects encompassed by the well correlation panel CP1 (Fig. 8) and CP2 (Fig. 9). The field of study is approximately located in the southward Abu Dhabi area (inside the dashed-line area with the C letter). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

et al., 2008; Morad et al., 2012). In contrast, only a few publications are available for the onshore area concerning specifically the stratigraphy of the Arab Fm. (e.g. Grötsch et al., 2003; Lawrence et al., 2015).

This research aims to: (i) unravel a new conceptual field-scale depositional model for the Arab Fm.; (ii) compare it with a previously existent model and with other ones scattered in the Abu Dhabi area; and (iii) suggest a new regional paleogeographic picture. To reach these objectives, an integrated workflow that combines core and