Journal of African Earth Sciences 129 (2017) 944–959

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Subsurface Permian reef complexes of southern Tunisia: Shelf carbonate setting and paleogeographic implications

Adel Zaafouri [a, *], Sofiene Haddad [b], Beya Mannaî-Tayech [a]

[a] University of Tunis El Manar, Faculty of Sciences, Department of Geology, 2092, Tunisia
[b] Tunisian Oil Company (ETAP), CRDP: Centre de Recherche et de Développement Pétrolier, 4 Rue des Entrepreneurs, 2035 Ariana, Tunisia

ARTICLE INFO

Article history:
Received 9 February 2016
Received in revised form
27 January 2017
Accepted 20 February 2017
Available online 9 March 2017

Keywords:
Middle to late Permian subsurface reef complex
Southern Tunisia
2-D seismic reflection
Paleogeography
Shelf carbonate

ABSTRACT

2-D seismic reflection sections, borehole data as well as published and unpublished data have been investigated to reconstruct the paleogeography of southern Tunisia during Middle to Late Permian times. Paleogeographical reconstruction based on the integration of petroleum well data and 2-D seismic facies interpretation shows three main depositional areas with very contrasting sedimentary pile. These are 1) a subsiding basin; 2) an outer shelf carbonate, and 3) an inner shelf carbonate. Based on typical electric responses of reef buildups to seismic wave, we shall urge that during Middle Permian times, the outer carbonate shelf was subject of reef barrier development. Lithology evidences from core samples show that reef framework correspond mainly to fossiliferous limestone and dolomite. The WNW-ESE recognized reef barrier led between latitudes 33° 10′ 00″N and 33° 20′ 00″N. The Tebaga of Medenine outcrop constitutes the northern-edge of this barrier. Westward it may be extended to Bir Soltane area whereas its extension eastward is still to be determined. Biogenic buildups took place preferentially over faulted Carboniferous and lower Paleozoic paleohighs resulting likely from the Hercynian orogeny. The subsiding basin is located north of Tebaga of Medenine outcrop where Upper Permian sedimentary sequence is made entirely of 4000 m deep marine green silty shale facies. These are ascribed to unorganized and chaotic reflectors. Inner carbonate shelf facies succession corresponds to a typical interbedding of shallow marine carbonate deposits, shale, dolomite, and anhydrite inducing parallel-layered of strong amplitude and good continuity reflectors. Also within the inner carbonate shelf patch reef or reef pinnacles have been identified based on their seismic signature particularly their low vertical development as compared to reef complexes. Southward, towards Sidi Toui area, the Upper Permian depositional sequence thins out and bears witness of land influences as entailed by the increase of silicoclastic sedimentary supply and the lack of marine fossil.

1. Introduction

During Late Paleozoic times (Permian Epoch) Southern Tunisia was located between the African Saharan shield to the south and the northwestern tip of the Tethys seaway. This structural domain bears one of the most particular Permian rocks ever known in Africa, the marine Permian strata which outcrop some 25 Km northwest of Medenine at the famous Tebaga of Medenine mountain.

It is for these reasons that southern Tunisia is considered as a key area for the geological reconstruction of both the southern margin of the Tethyan realm and the northern African plate during the late Paleozoic.

Since its inception in the geological literature by Devouillé et al., 1933, marine Permian rocks of southern Tunisia have intrigued several geology explorations and investigations. For instance, Mathieu paper (1949) provided the stratigraphic subdivision and the tectonic scheme of these rocks and subsequent authors have used Mathieu stratigraphic subdivision. It is not until before Newell et al. (1976) work when a deep revision of the stratigraphy of the Permian of southern Tunisia has emerged. Particularly, three (3) biohermes have been identified and mapped. Moreover, based on fusulinacean fossils, these authors call for a deep reevaluation of the structural interpretation of the Permian rock exposure. Driggs (1977) provided a general pertographic framework of the biohermes identified earlier by Newell et al. (1976); Khessibi (1985)

* Corresponding author.
E-mail address: zaafouriadel.1986@gmail.com (A. Zaafouri).

http://dx.doi.org/10.1016/j.jafrearsci.2017.02.032
1464-343X/

identified four sedimentary sequences in the Tebaga of Medenine showing abrupt lateral facies changes, Chaouachi (1985a,b) contributed to establish the depositional paleoenvironments of the Permian sequence and emphasized the study of its carbonate diagenesis. Toomey (1991) outlined a framework of the facies pattern, interpreted diagenesis and depositional environment, and provided a comparison between the Permian reefs of southern Tunisia and those of Southwestern United States.

There is no doubt that the Tebaga of Medenine should be seen as a particular control key point in the reconstruction of the sedimentary history of the Permian basin. Nonetheless, our knowledge of this sedimentary basin may be extended southwestward to explore the Permian depositional sequence buried beneath the Dahar Cliff, southward toward the Saharan shield and southeastward with a view to establishing seismic characteristics of the reefal complexes in the Djeffara area. This may help in better understanding the history and depositional environments of the Permian carbonate platform.

Our paper focus mainly on subsurface data, seismic sections and petroleum well data, and aims to:

Identify reef build-ups based on their typical electric response to seismic wave (shape, amplitude, continuity compared to surrounding strata).
Pinpoint the paleogeographic role of these biogenic buildups (direction, lateral extension, facies distribution control and their impact on the carbonate shelf frame).
Emphasize enough lateral and vertical facies evolution of Middle to Upper Permian deposits using well data and their associated lithostratigraphic correlations.
Integrate surface and subsurface data to reconstruct the carbonate platform depositional model of the southern Tethyan margin during Middle to Late Permian times. A 3-D schematic block diagram is proposed for the illustration.
Provide paleogeographic comparison locally with the Ghadames basin in Libya and regionally with the Arabian plate (the Khuff formation in central Saudi Arabia) as well as with reefs in the basinal facies of the Zechstein Limestone (Western Poland).

2. Geological framework

The study area (Fig. 1) constitutes the northern edge of the Saharan platform. It is bounded to the North-East and North-West by respectively the central Mediterranean Sea and the Atlassic folded system (Laurin, 2013). Southward and westward it connects with the Saharan platform (Laurin et al., 2011).

From structural point of view, the study area bears two geological domains with contrasting tectonic evolution as well as sedimentary pile, at least, since the Early Carboniferous (Memmi et al., 1986; Viterbo, 1986). These are the Dahar Plateau to the west, part of the Telemzane Arch, and the Djeffara plain to the east (Busson, 1967; Newell et al., 1976; Khessibi, 1985; Ben Ayed, 1986; Toomey, 1991; Bouaziz, 1986, 1995). Nearly flat lying Cretaceous

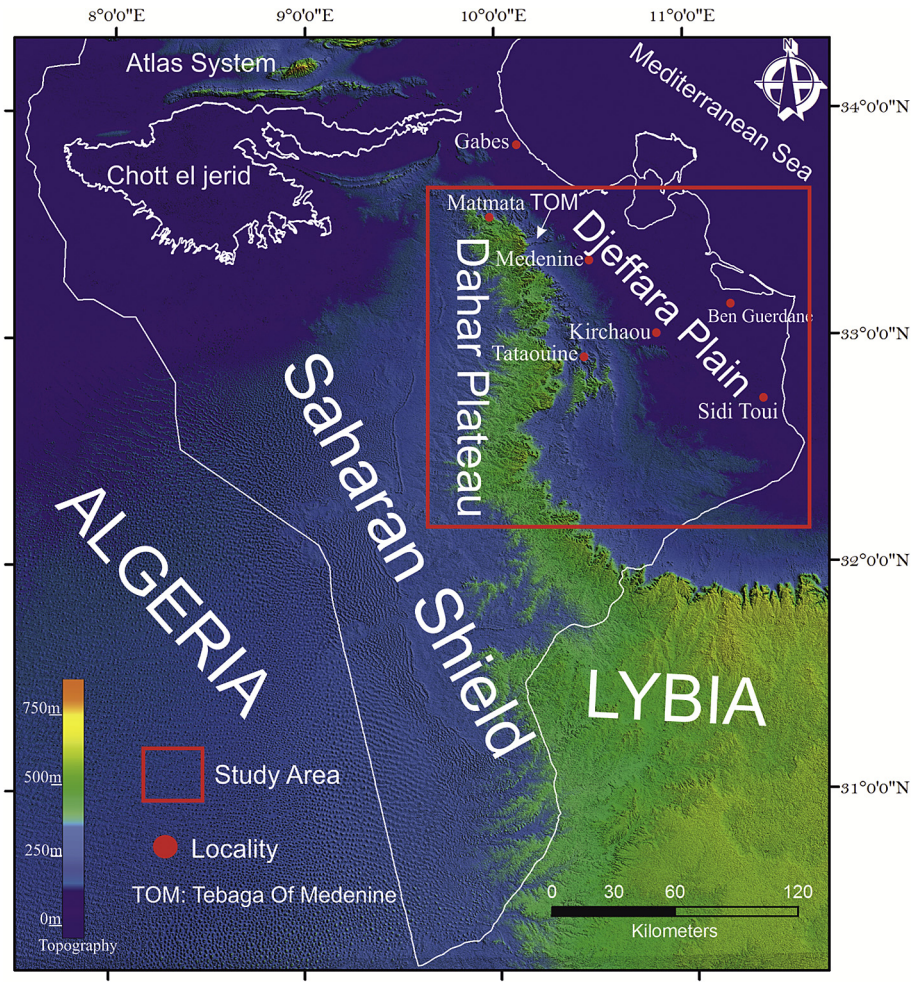

Fig. 1. Location of study area.