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Review Article

Integrated geophysical and geological study and petroleum appraisal of Cretaceous plays in the Western Gulf of Gabes, Tunisia

Noomen Dkhaili [a,c,*], Saloua Bey [b,c], Mahmoud El Abed [c], Mohamed Gasmi [a], Mohamed Hedi Inoubli [b]

[a] Département de Géologie, Faculté des Sciences de Bizerte, Université de Carthage, 7021 Zarzouna Bizerte, Tunisia
[b] Département de Géologie, Faculté des Sciences de Tunis, Université de Tunis El Manar - Campus Universitaire Farhat Hached, B.P. no. 94, ROMMANA 1068, Tunis, Tunisia
[c] Entreprise Tunisienne d'Activités Pétrolières (ETAP), 54 Avenue Mohamed V, 1002, Tunis, Tunisia

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ABSTRACT

An integrated study of available seismic and calibrated wells has been conducted in order to ascertain the structural development and petroleum potential of the Cretaceous Formations of the Western Gulf of Gabes. This study has resulted in an understanding of the controls of deep seated Tethyan tectonic lineaments by analysis of the Cretaceous deposits distribution. Three main unconformities have been identified in this area, unconformity U1 between the Jurassic and Cretaceous series, unconformity U2 separating Early from Late Cretaceous and known as the Austrian unconformity and the major unconformity U3 separating Cretaceous from Tertiary series. The seismic analysis and interpretation have confirmed the existence of several features dominated by an NE–SW extensive tectonic regime evidenced by deep listric faults, asymmetric horst and graben and tilted blocks structures. Indeed, the structural mapping of these unconformities, displays the presence of dominant NW–SE fault system (N140 to N160) bounding a large number of moderate sized basins. A strong inversion event related to the unconformity U3 can be demonstrated by the mapping of the unconformities consequence of the succession of several tectonic manifestations during the Cretaceous and post-Cretaceous periods. These tectonic events have resulted in the development of structural and stratigraphic traps further to the porosity and permeability enhancement of Cretaceous reservoirs.

Contents

* Corresponding author at: 8 Rue Slimane Ben Slimane, Manar II -2092, Tunisia.
E-mail address: dkhaili.nomen@gmail.com (N. Dkhaili).

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1. Introduction

The study area located in the western part of the Gulf of Gabes basin is limited to the north and to the south respectively by Sfax and Mednine offshore, to the west by Gabes shoreline and to the east by the Pelagian sea (Fig. 1). This area is considered as one of the most productive oil provinces in Tunisia with multiple exploration targets. Many productive oil and gas fields have been discovered in the southern part of the Gulf of Gabes (Ben ferjani et al., 1990; Mejri et al., 2006). Main objectives are located within the Cretaceous carbonates and siliciclastic Formations. Excellent examples of exploration success are found in the El Bibane Field (producing from the carbonates of Cenomanian Zebbag Formation and Middle Jurassic Krachoua Formation), the Ezzaouia Field (producing from dolomites of Cenomanian Zebbag Formation and sandstones of Upper Jurassic M'Rabtine Member) and the Robbana Field (producing from sandstones of Early Cretaceous Melloussi Formation).

2. Stratigraphical and structural setting

2.1. Stratigraphical insight

The drilled Cretaceous series in western Gulf of Gabes has encountered two main units; a siliciclastic unit of Early Cretaceous age and an intercalated evaporate and carbonate unit attributed to the Late Cretaceous. The composite stratigraphic diagram summarizes all available data from available wells and clearly illustrates the complex distribution of Cretaceous Formations and stratigraphic breaks in succession, the result of coeval tectonic activity (Fig. 2).

The basal Melloussi Formation is comprised entirely of sandstone unconformably overlying (U1 surface) the Nara carbonate and its lateral equivalent, the M'Rabitine Member. The Boudinar Formation overlies the Melloussi Formation and the total succession is interpreted as having formed in a deltaic, alluvial plain environment (M'Rabet, 1981). The relationship between this alluvial plain environment and the underlying Nara carbonate suggests that there is a relative fall in sea level at the unconformity U1, with a rejuvenation of the fluvial clastic sequence as a result and a low-stand looding of the former carbonate highstand systems tract. This is a classic relationship and should result in good porosity in the underlying carbonate as a result of subaerial exposure (although of course this may not be sealed if overlain by porous sands). The overlying Bouhedma Formation consists of alternation of shale, limestone, dolomite, anhydrite and indicating the re-establishment of peritidal and shallow marine conditions in a complex of small parasequences. The Sidi Aïch Formation is mainly comprised of sandstones with intercalated thin carbonate and shale layers indicating a persistent shallow marine environment submitted to continental influence. The Orbata Formation is comprised of three main units; dolomite at the base, sandstone in the middle and limestone at the top. The absence of the Upper Aptian and Lower Albian interval is interpreted as a consequence of the occurred Austrian phase (Lazzez et al., 2008; Zouaghi et al., 2011). The Melloussi, Boudinar, Bouhedma, Sidi Aich and Orbata Formations belong to the Early Cretaceous siliciclastic unit, in contrast to the Late Cretaceous Formations described below which are mainly carbonates. The Zebbag Formation is divided into three members distinguished by the thickness of dolomitic, calcareous and anhydritic alternation. The Gattar Member, corresponding to the lower carbonate part of the Aleg Formation, is formed by dolomitic and calcareous thick sequences indicating an extended shallow marine platform. The Aleg Formation is essentially shaly with some thin limestone intercalations. According to well data, the Abiod Formation is totally absent in this region as shown in the chart as consequence of an erosional period (U3 surface) underlines the transition between the Cretaceous and Tertiary series. The drilled Tertiary Formations in this region are the Eocene Tanit formation, the Oligocene Vascus and Fortuna Formations, the Miocene Ketatna, Salammbo, Ain Grab and Om Douil Group and the Pliocene Segui Formation. The Tanit Formation consists of silty-shales with anhydrate intercalations which is unconformably overlying the Aleg Formation and locally the Zebbag Formation. The Vascus member is composed by nummulitic limestone. The Fortuna Formation is essentially made of a sandstone sequences with intercalation of clayey and calcareous beds. The Ketatna Formation consists of limestone with sandstone, shale and dolomite intercalations. The Salammbo Formation is essentially shaly with some sand and marl alternations. The Ain Grab Formation is a sandy bioclastic limestone. The Om Douil Group is a sandstone shale and limestone alternation. The Segui Formation is composed by unconsolidating sandstone and is attributed to fluvial sediment (Touati, 1985).

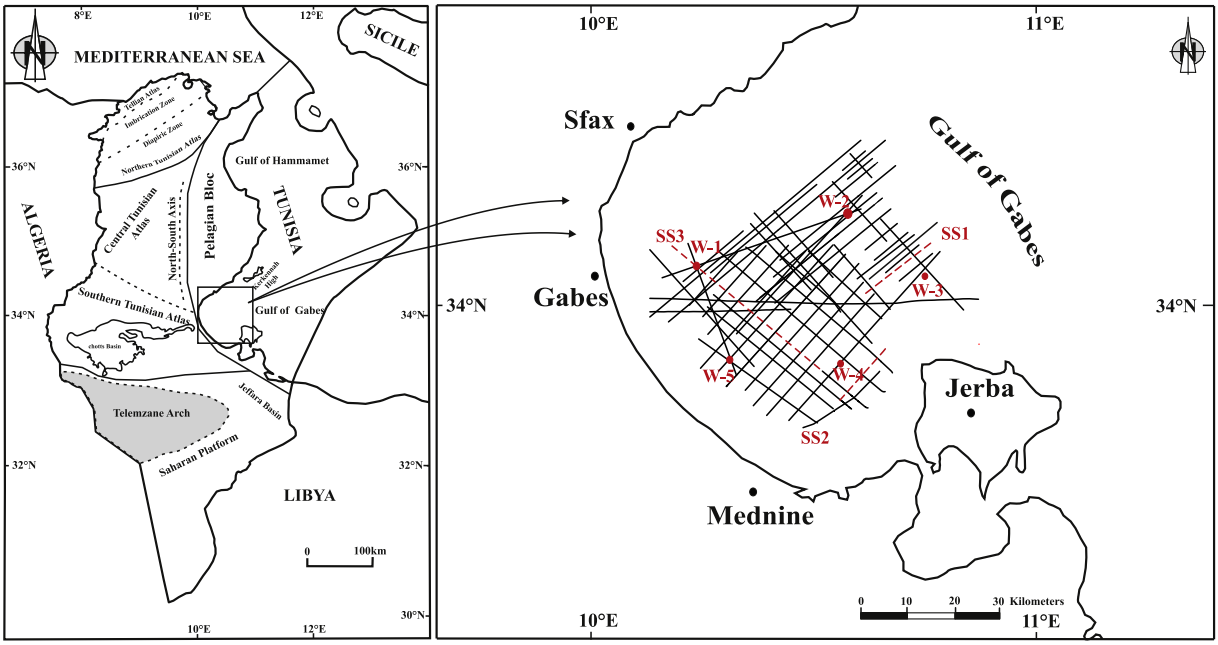

Fig. 1. Geographical seismic surveys and wells location of the concerned study area.