Journal of African Earth Sciences 103 (2015) 71–80

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

3D gravity modeling of a salt structure associated to the Trozza–Labaied lineament (Central Tunisia) constrained by seismic and borehole data

M. Djebbi *, H. Gabtni

Georesources Laboratory, Centre of Water Research and Technologies, B.P. 273, Borj Cédria, Soliman 8020, Tunisia

ARTICLE INFO

Article history:
Received 3 July 2014
Received in revised form 10 November 2014
Accepted 14 November 2014
Available online 19 December 2014

Keywords:
Central Tunisia, Triassic salt body
Gravity
3D modeling

ABSTRACT

Gravity and seismic are two distinctive geophysical methods which are used combined in integrated geophysical studies. The rationale behind this integration is to construct a 3D gravity model for a salt structure associated to the Trozza–Labaied major tectonic deformation.

The Trozza–Labaied area witnessed the occurrence of several tectonic events during the Atlassic phase resulting in the creation of various salt structures. Interpretation of the available seismic data revealed the different lithological units forming the geologic setting. Whereas the analysis of the gravity data contributed in exposing the existence of different gravity anomalies. Thus, the integrated seismic and gravity data are fundamental in constructing a 3D gravity model. The resulting model provides an accurate image of the salt body extent and its geometry and determines its effect over the surrounding sedimentary deposits.

1. Introduction

The complexity of the different tectonic events that affected Central Tunisia, (Fig. 1) resulted in various salt structures of different geometries and extensions and which are associated to the major fault corridors resulting from the regional compressional and extensional stresses. For the present case of study, a positive gravity anomaly was detected over the faulted zone of Trozza–Labaied (Fig. 2). The ultimate objective behind this investigation is to determine the possible causes of this positive anomaly, which over the major types of other salt structures is consistently negative.

2. Geologic overview

Historically, the halokinetic movements are a particularity of the Central Tunisian area. In fact, these special movements were guided by the major structural alignments and tectonic events that have affected this zone in the past. Although these deformations were significant, the resulting salt structures did not exceed the pillow stage. However, the diapir stage is only observable along the major tectonic nodes formed by the intersection of master faults and secondary strike-slip faults such as those along the Jebel Trozza and Rheouis structures, (Soyer, 1987; Bédir, 1995; Boukadi and Bedir, 1996; Tanfous-Amiri et al., 2005, 2012; Zouaghi et al., 2013).

These movements were specially amplified during the Late Aptian and the Late Cretaceous to Eocene periods, (Soyer, 1987; El Ghali, 1993; Zouaghi et al., 2005; Tanfous-Amiri et al., 2012). In effect, during the Early Cretaceous, Central Tunisia was affected by a NW–SE extensional phase, (Ben Jemiaa, 1986; Martinez et al., 1990; Rabhi, 1999; El Ghali, 1993; Boukadi, 1994; Bédir, 1995; El Ghali et al., 2003; Haji et al., 2014). The succession of NE–SW to EW faults caused the formation of the mega structure of Mrhila-Cherichira alignment (Abbes and Boukadi, 1988; Boukadi, 1994; Abbes, 2004). The latter was represented by a mega NE–SW fault corridor which has been intruded by Triassic evaporites.

This lineament fracture zone was reactivated during the Aptian and all the Upper Cretaceous in a NW–SE compressional regime. This transpressive dextral movement reactivated the NE–SW and E–W faults in dextral strike-slip movements and created the major faulted Labaied area to the south and the Trozza zone to the north. In addition, and subsequently to the late Aptian compressional regime, there was remobilization of the Triassic along the major accident causing a simultaneous and conjugate action between the reactivation of the faulting system and the halokinetic movements. According to Boukadi (1994) and Zouaghi et al. (2013), the inflection points of strike slip accommodation zones along this alignment are marked by stratigraphic overlapping such as those present at the south eastern edge of Trozza and evaporitic outcrops

* Corresponding author. Tel.: +216 21 44 35 05.
E-mail address: djebbimarwa20@yahoo.fr (M. Djebbi).

http://dx.doi.org/10.1016/j.jafrearsci.2014.11.012
1464-343X/

especially at the Mrhila–Labaied and Labaied–Trozza tectonic nodes.

Up to the Lutetian, the general compression regime was quite active. Also, from the Upper Cretaceous to the Early Miocene, the Mrhila-Cherichira accident was continuously active along with an extensional regime. In fact, the dextral strike-slip regime dominating this area led to the remobilization of Triassic extrusions to the north of this major discontinuity. During the Atlassic phase, the reactivation of the NE–SW to E–W faults combined with the influence of the halokinetic movements created the Labaied structure to the south and the Trozza anticline to the north. Locally, along the Trozza–Labaied fracture zone, and near Ouled Zaid area, the Triassic extrusions encase the shales and limestones of Upper Cretaceous and Eocene ages.

These extrusions are largely affected by multidirectional fracturing systems which indicate a multiphase tectonic regime. Furthermore, the presence of several fold structures with vertical axis signals rotational movements due to the strike slip shear (Boukadi, 1985). These folds also reflects the superposition of dextral and sinistral strike slip faults mainly directed NS and NE–SW. The continuity of this tectonic deformation, to the east of Trozza massif, is represented by Triassic gypsum extrusions causing the overlapping of upper Cretaceous shales on the sandy lower cretaceous deposits. Westward, this deformation continues with an E–W trend.

In fact, the Labaied massif is a part of a complex tectonic structure formed by different deposits of mainly Cretaceous to Miocene in age. The center of this structure is crossed by chaotic seismic facies concentrated along deep-seated faults which could have facilitated the rising of evaporites in this area. The axis of this mega structure shows a N110 trend. It is limited to the north by the major deformation of Labaied forming the extension to the east of Sbiba one, (Ben Jemiaa, 1986; Boukadi, 1994; Zouaghi et al., 2013).

The Trozza Jebel is a faulted anticline with a NE–SW to N40 direction. The tectonic evolution of this structure is essentially a part of the evolution of the Trozza–Labaied tectonic deformation.

Nevertheless, numerous tectonic phases exerted an important impact over this zone. The most outstanding motions that affected this area were the compressional movement of the Atlassic phase during the Tortonian, with a NW–SE major trend, and the compressional Villafranchian phase during the Pleistocene with a NNW–SSE direction.

3. Seismic and gravity data analysis

The performance of a 3D gravity model for the salt structure requires the integration of both outcrop information and subsurface data. In fact, the outcrop data are represented by allochthonous salt series outcropping within a NE–SW fault joining the Trozza and Labaied structures. The continuity of these series and their associated structures in subsurface allows a better imaging of the salt body's geometry and extension. Hence, the subsurface study was based on the interpretation of seismic data plus a detailed gravimetric analysis of the zone.

The gravity data used for this current study were obtained from Tunisia Office National des Mines (ONM). The gravimetric survey (CG7) was performed in 2007 and the sampling of gravity data was set to obtain a coverage of one station per km^2. The free-air and Bouguer gravity corrections were made using the 1967 gravity formula. The terrain correction was performed, using the topography as a datum, up to 21 km with 2.34 g/cm^3 as a reduction density. The resulting Bouguer gravity map was obtained using the

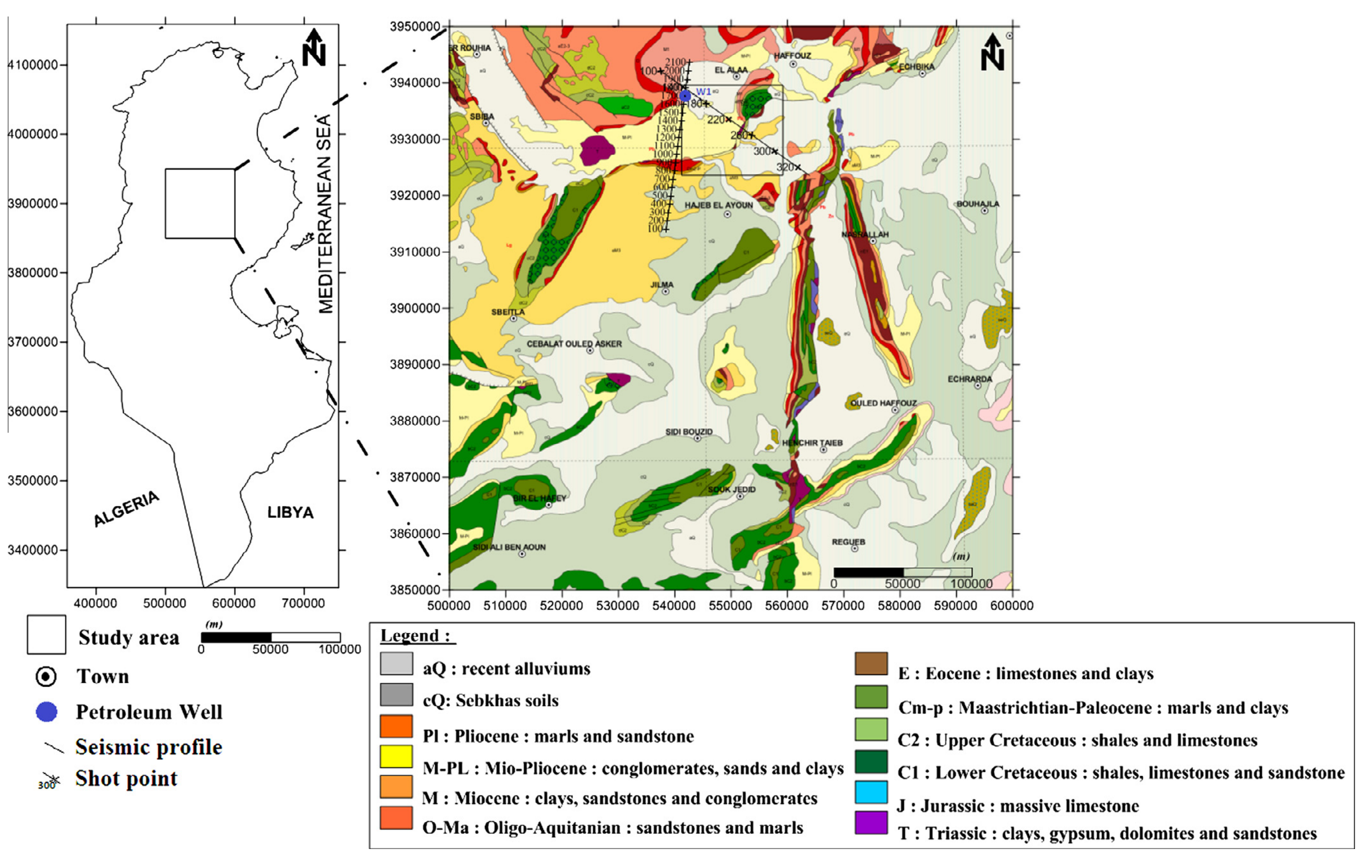

Fig. 1. Location map and geological setting of the Trozza–Labaied area.