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Neotectonics of coastal Jeffara (southern Tunisia): State of the art

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ABSTRACT

Helped by the studies and results of previous researchers, we herein study the neotectonic of the coastal Jeffara with the input of numerous 2D reflection seismic profiles onshore, combined with Digital Elevation Model analyses (issued from SRTM) and field works.

Acquired and available data were then integrated within a GIS Geodatabase, where Jerba, Zarzis and Jorf appear to be part of a N-S pull-apart basin within a NW-SE transtensive right-lateral major fault zone. Our structural geologic and geomorphologic analyses confirm and prove the presence of NNW-SSE right-lateral en-echelon tension gashes, NW-SE aligned salt diapirs, numerous active folds offsets, en-echelon folds, and so-on… They are associated with this major right-lateral NW-SE transtensive major coastal Jeffara fault zone that affect the Holocene and the Villafranchian deposits.

We therefore confirm herein a new structural geodynamic Jeffara model, due to the post Lower Cretaceous northward migration of northern African to the Eurasian plates, this NW-SE transtensive fault zone is interpreted as a part of the southern branch of the eastward Sahel block extrusion toward the free Mediterranean Sea boundary. Therefore this geodynamic movement may explain the presence, offshore, of small elongated NW-SE, N-S and NE-SW transtensive basins and grabens with petroleum interest.

To conclude, at the regional scale, the structural geomorphologic approach combined with both field work and 2D reflection seismic profile analyses appear to be an excellent tool to prove and confirm the NW-SE right-lateral transtensive extrusion fault zone of the coastal Jeffara.

1. Introduction

What's the neotectonic, structural and geologic origin of the coastal Jeffara (south of. Gabes Gulf)? Is it an area of particularly active tectonic deformation in spite of the actual weak magnitude seismicity? What place does "the Jeffara faults system" takes in the Africa-Eurasia shortening system? These are the three major questions that are going to be dealt with herein.

Tunisia is located on the north African margin at the boundary of two distinct domains: (1) the passive, continental margin that stretches to the east from Libya to Egypt, at least since the Upper Cretaceous, and (2) the Cenozoic, orogenic Alpine chain that bounds the northwestern Saharan platform from Tunisia up to Morocco (Bouaziz et al., 2002; Frizon De Lamotte et al., 2006, 2009; Outtani et al., 1995; Yelles–Chaouche et al., 2001) (Fig. 1). It represents a permanent area of geodynamic evolution caused by the N-S to NW-SE convergence of the African and Eurasiatic plates (Billi et al., 2011; Bousquet et al., 1988; DeMets et al., 1990, 1994; Dercourt et al., 1986; Guiraud and Maurin, 1991; Mattauer et al., 1977; Nocquet, 2012; Nocquet and Calais, 2004; Serpelloni et al., 2007) with a rate of 5 to 8 mm/year (Billi et al., 2011; DeMets et al., 1994; Faccenna et al., 2004; Serpelloni et al., 2007); that began at the limit of the Lower Cretaceous-Upper Cretaceous (Bouaziz, 1986, 1995; Bouaziz et al., 1999, 2002) and generalized at the Terminal Cretaceous-Eocene, due to the opening of the North Atlantic (Billi et al., 2011; Mejri, 2012; Olivet et al., 1983; Sallarès et al., 2011). Mainly, the Late Cenozoic to Actual tectonic regime in the Tunisia is submitted, to both the Nubia (Africa)–Europe collision in the north and the Sicily basin rifting in the east (Billi et al., 2011; Faccenna et al., 2002; Nocquet, 2012; Piqué et al., 2002; Serpelloni et al., 2007).

The Tunisian Jeffara, located on the south-east of Tunisia, is composed of two contrasting morphostructural, geologic and clearly distinct domains (Gabtni et al., 2009, 2012; Rabia, 1998) (Fig. 2 A, B): (1) the sedimentary-Mesozoic basin of Jeffara, formed since the Lower Palaeozoic (Bahrouni et al., 2014; Ben Ayed, 1986; Ben Ferjani et al., 1990; Burollet and Desforges, 1982; Gabtni et al., 2005, 2012; Raulin et al., 2011) and (2) the Jeffara escarpment including the Tunisian Dahar domain and the Libyan Jebel Nefuza. The latter represents the southern side of a wide gentle anticline, first thrusting unit above the southern Tellian Tunisian deformation front. The NNW-SSE trending anticline axis parallels the Medenine/Jeffara fault zone while its southern

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flank is slightly dipping of 1° to 2° westward (Busson, 1967; Gabtni et al., 2009) and south-west (Bodin et al., 2010; Bouaziz et al., 2002), extending to Libya with a WSW–ENE Jebel Nefuza Escarpment (Bodin et al., 2010). The northern flank of the Jeffara Escarpment is missing as it is collapsed and filled by the Jeffara soft Cenozoic/Quaternary deposits. The Dahar is made up of the reactivation of the Panafrican faults systems (Ben Ayed and Kessibi, 1981; Gabtni et al., 2012) and affected by E-W Tethysian faults (Bahrouni et al., 2014) (Tebaga, south dipping Zemlet el Ghar and north dipping Azizzia fault systems; Raulin et al., 2011).

The Tunisian Jeffara basin represents a low-flat-sub-tabulary topography that is bounded by the Gabes Gulf and the Mediterranean Sea to the north, the southern morphologic edge of the Dahar domain whose layers are covered by sand dunes of the "Grand Erg Oriental" to the east and the administrative Tunisian-Libyan border to the south-east. The geology of the Jeffara basin is poorly known even if it is characterized by two distinct major structural parts: (1) the continental Jeffara, which constitutes a transition area to the Mesozoic-Cenozoic outcrops of the Dahar, and (2) the coastal plain of the maritime Jeffara composed of Jerba Island, Jorf and Zarzis Peninsulas, which is characterized by local several depressions covering the flat low-lands of the east of Tunisia up to the north-west of Libya (Gabtni et al., 2009), such as Bahiret Boughrara in the south-east of the Jorf, Bahiret el Bibane in the south of Zarzis, Sabkhet Boujmel et Sabkhet el Melh (Jedoui, 1979, 2000; Rabia, 1998) (Fig. 2 A).

In this paper, we'd like to precise the structural geology of the Tunisian Jeffara, especially (1) how and where disappeared the northern side of the Dahar/Nefuza anticline; (2) how to simplify the neotectonic chronology and (3) what are the geodynamic stress regimes involved in coastal Jeffara. So we combine herein, using geomatics (GIS), the SRTM DEM data based on tectono-geomorphic analyses with 2D seismic reflection profiles (ETAP), field and bibliographic data to propose a new coherent neotectonic and structural model of the coastal Jeffara.

2. Geologic setting

The lithostratigraphy of the Dahar (Fig. 2 B) is characterized by folded Mesozoic carbonates formations Trias (purple), Jurassic (light and dark blue) to Cretaceous (light and dark green) in age, contrasting with the outcrops of eastern Jeffara mainly made up by Tertiary and Quaternary clay-sandy sedimentation (yellow/beige tone), apart from the E-W trending Jebel Tebaga Permian structure (brown and situated NW of Medenine city) and Triassic outcrops (rose/purple and located east of Tataouine).

2.1. Structural and geodynamic history

It appears from the bibliography that the deformation of the Jeffara seems to be complicated and multi-phases since the Lower Paleozoic (Ben Ayed, 1986; Bouaziz, 1995; Bouaziz et al., 2002; Burrolet, 1991; Burrolet and Desforges, 1982) (Fig. 3).

After the Hercynian phase and in the Permo-Carboniferous, there was a NE-SW Permian widespread extension of the Pangaea (Arthaud and Matte, 1977), coupled with the Eurasia-Africa right-lateral sliding responsible for the opening of the Neotethys (Dercourt et al., 1986; Doglioni, 1990; Doglioni et al., 1999; Ricou, 1995; Ricou et al., 1986; Schettino and Scotese, 2002; Stampfli et al., 2002). The extensive movement resulted in the "compartmentalization" of the Jeffara in horsts, grabens and basculated blocks that are bounded by E-W major faults separating a carbonate platform in the south and a subsiding basin in the north (Ben Ferjani et al., 1990), ESE-WNW and N-S faults (Rabia, 1998) was followed by an important Permian and maritime subsidence in the Tebaga basin (Touati and Rodgers, 1998). This phase led to subsidence of the Permian marine carbonates in the Tebaga basin with a thickness reaching 300 m (Touati and Rodgers, 1998) and lasts until Middle Triassic, enabling the opening of the Jeffara basin, but whose average direction N160°E was modified by the Late Hercynian drift of Africa to the west (Ricou, 1992). During the Upper Triassic (Lower

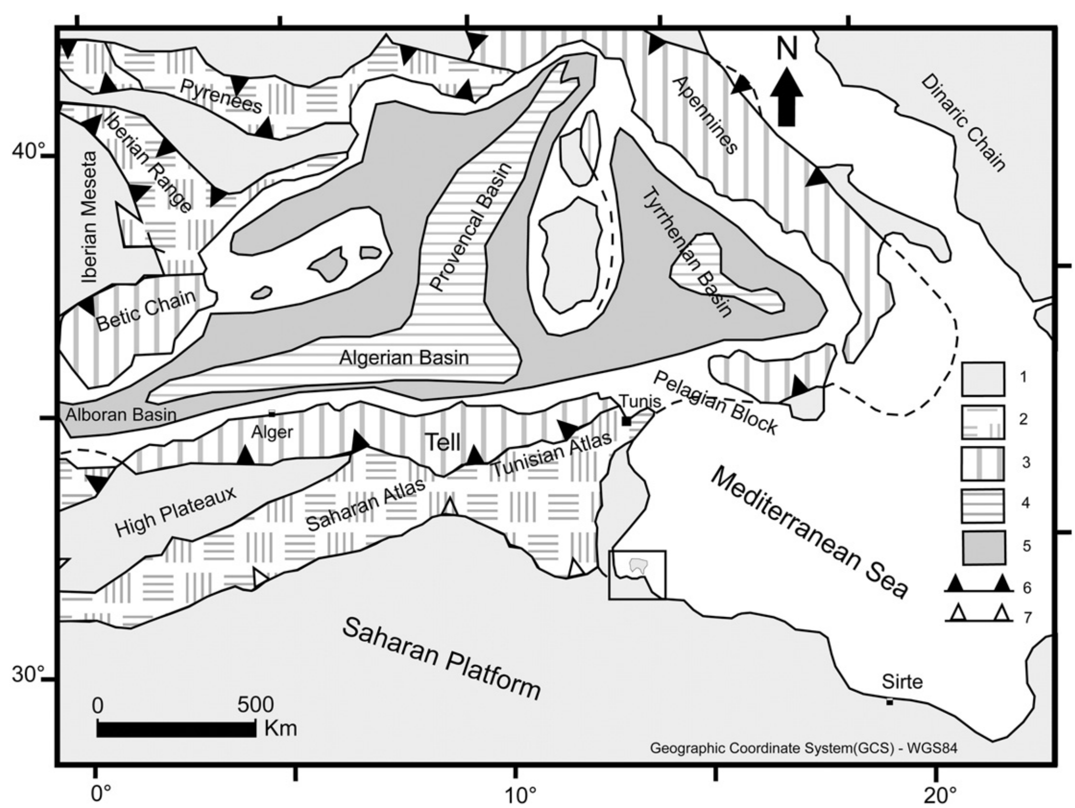

Fig. 1. Geodynamic context of the western mediterranean domain (modified from Doglioni et al., 1999) (1. Continental platforms, 2. Intracontinental fold belts, 3. Alpine chains, 4. Neogene oceanic crust, 5. Neogene thinned continental crust, 6. Thrust fronts, 7. South Atlassic front). The quadrangle corresponds to the studied area.