Journal of African Earth Sciences 96 (2014) 39–50

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Brittle tectonics within the Jurassic formations of the Ouarsenis culminating area, northwestern Algeria

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ARTICLE INFO

Article history:
Received 9 November 2012
Received in revised form 18 March 2014
Accepted 20 March 2014
Available online 3 April 2014

Keywords:
Polyphased Tectonics
Paleostress
Rotation
Shear
Joint
Jurassic

ABSTRACT

Brittle structures within the Ouarsenis culminating zone were studied in order to characterize the polyphased tectonics. Field observations revealed that the dominant structures are highly tilted. They are represented by faults and joints, shears, reverse or curvilinear, locally associated with gypsum intrusions. Field data analysis shows that large scale shear faults are localized within the limits of the structural entities. Two main tectonic phases, having affected the Ouarsenis culminating zone were identified: (i) A NW–SE oriented compressive phase, represented by the contacts marked out by in-depth reverse faults and folding, mainly located in the westernmost part of Sra Abdelkader, Rokba Atba and in the western part of Batha, Fartas and Belkeiret (thrusts), respectively. This phase was also identified in reverse and sinistral faulting within Sidi Djber at the easternmost part of Sra Abdelkader, and the Grand Pic and the southern massif of Belkheiret respectively. (ii) A NNE–SSW oriented compressive phase, characterized by dextral strike-slips, is located in the easternmost part of Sra Abdelkader and Rokba Atba.

North of the Grand Pic, a sinistral ~N120° oriented shearing occurred, with a lateral slip reaching ~2 km. The examination and the data analysis show a major N110-120° oriented fault with a sinistral signature. This movement would be responsible for block rotations and tilts. Counterclockwise rotations of the paleostress of ~38° and ~43° from west to east of the Sra Abdelkader massif and from Belkeiret to Batha, Fartas blocks were recorded, respectively. This local change of the stress field is mainly due to a deformation controlled by the regional post-Miocene geodynamic system, possibly explained by the proposed model.

1. Introduction

The Ouarsenis massif belongs to the external domain of the western Tellian Atlas. The Tellian Atlas, sometimes also called the external Tell, is composed of overlapping allochtonous nappes imbricated inside each other (Fig. 1a), mainly of Triassic to Neogene marls, coming from the African paleomargin and sometimes thrust a 100 km southwards. Autochtonous massifs also exist (Durand-Delga, 1969) such as, for instance the massifs of Bou Maad and Blida and the massifs of the Chelif area (Fig. 1a) which would be anticlinal structures where the allochtonous nappes are lacking or eroded by post-nappes tectonics (Blès, 1971). The study area is located 50 km to the SE of the highly seismic Chelif area (Meghraoui, 1988; Yielding et al., 1989). The Ouarsenis is represented by Jurassic massifs emerging like small islands from a Cretaceous sea characterized by a flyschoid or turbidite formation, Albo-Aptian in age. It is the central massif of the Grand Pic (large peak, altitude ~1985 m), of Rokba Atba (an insulated piton towards the NW), Sra Abdelkader (a small calcareous chain elongated from east to west), and the Batha massif towards the SE. Batha is separated from the southernmost massif of Belkheiret by a satellite massif called Fartas. Together they stretch from NNE to SSW. All these five massifs constitute the main structural entities of the Ouarsenis culminating zone (Fig. 1b). The structuration and the emplacement of the various massifs of the culminating zone were controlled by complex, polyphased tectonics (Mattauer, 1958), responsible for the deformation of the Mesozoic series during the major part of the Cenozoic. Consequently, these deformations are represented by a series of lower Liassic to the Albo-Aptian limit (Calembert, 1952; Mattauer, 1958; Polvèche, 1960; Farès Khodja, 1968) which (i) intruded into overlying inlier formations: Sra Abdelkader, Belkeirat; (ii) completely upturned the formations of the same age: Grand Pic; (iii) strongly tilted lower to

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http://dx.doi.org/10.1016/j.jafrearsci.2014.03.020
1464-343X/

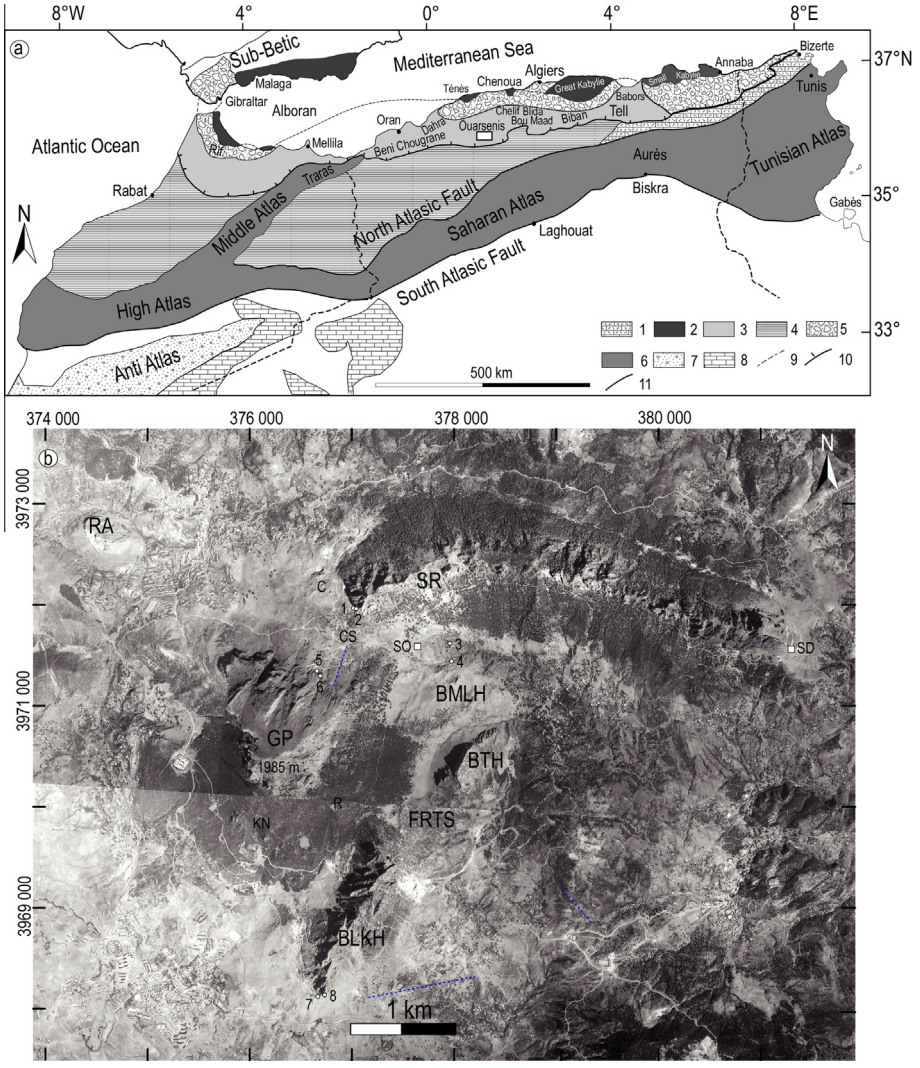

Fig. 1. Location of the study area. (a) Strutural map showing the Alpine domain in the north of Africa, 1: Miocene post and synchro-stacks, 2: Internal domain, 3: External domain, 4: High plateaux, 5: Maghrebin turbidites, 6: Atlassic system, 7: Anti Atlas, 8: Ougarta, 9: State borders, 10: Internal domain front, 11: North and South Atlassic faults. (b) Aerial map composed of 20 views at 1/20,000 (UTM WGS84) showing the location of the study area among the structural units of the Tellian domain. SR: Sra Abdelkader, RA: Rokba Atba, BTH: Batha, FRTS: Fartas, GP: Grand Pic, BLKH: Belkheiret, BMLH: Bou Malah, SD: Sidi Djber, SO: Sidi Ouadhah, CS: Senan pass (Col du Sénan), C: Chicots massif, KN: Kef N'Sour, R: Roubia. Numbers 1–8 refer to shots of Fig. 7. Blue dashed lines represent lithostratigraphic profiles used to built the synthetic section of Fig. 2. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

middle Jurassic formations southwards and southeastwards. Except for Grand Pic, the massifs are limited by sheer, abrupt cliffs along curvilinear shear faults; (iv) fault distributions in various directions, N0–10°, N50–60° and N100–120° oriented. We note that faults oriented ~N100–110° are associated with mineralizations represented by non-ferrous elements such as barytine and with the same orientation as the sedimentary layers (Calembert, 1952). The N0–10° faults are dextral shears at the easternmost part of Sra Abdelkader; nevertheless they become sinistral in its western part. The N120–140° faults are dextral shears with slips which may reach 500 m between Belkheiret and Fartas and 250 m between Fartas and Batha. The tectonic contacts girdle the massifs in the northern part, as in the case of Sra Abdelkader and the northern front of Rokba Atba. They are also visible on the western front of the southernmost massifs of Belkheiret, Fartas and Batha (Calembert, 1952).

The arrangement of the various structural entities is according to three main directions of EW, NW–SE and NNE–SSW oriented faulting. These faults are dextral shears oriented radially and limiting these massifs. They show lithostratigraphic anomalies from one massif to another (reduced thickening or complete lack of stratigraphic level). The main purpose of this paper is to examine their architecture. Consequently the analysis of the brittle deformations within these tectonic features may help to restore the puzzle pieces and to deduce a geodynamic evolution from it. It is from this standpoint that the present study first of all endeavours to analyze and interpret the brittle deformations (faults, thrusts, etc.). However, the emphasis will be on the network of heterogeneous faults affecting the Jurassic formations, especially to characterize the tectonic events responsible for the development of the faults. Consequently, the paleostress regime which was at the origin of these deformations will be highlighted.

To fulfill this task, we carried out observations at different levels of (i) the outcrop in order to obtain three-dimensional geometrical data (tension gashes, stylolitic joints, etc.), (ii) a geological map (aerial photographs, digital terrain model (DEM), etc.), especially in the inaccessible zones, constitutes a tool base to supplement the field gaps.