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Integrated application of gravity and seismic methods for determining the dip angle of a fault plane: Case of Mahjouba fault (Central Tunisian Atlas Province, North Africa)

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ABSTRACT

A procedure for a dip angle determination of a fault plane from gravity field data is presented to constrain a seismic profile interpretation. This procedure is applied on Mahjouba normal fault at the western border of Kalaa Khesba graben (Central Tunisian Atlas Province, North Africa). Seismic and detailed gravity data, in this region, were analyzed to provide more constraints on the geometry of the fault dip angle. The Mahjouba fault is mapped as three major parallel lineaments extended for 2 km with a NW-SE to N-S trend. The dip of the Mahjouba fault is estimated from the gravity modeling data to be 45°E. This study reveals that integrating gravity and seismic data provides accurate mapping of faults geometry and such result provides useful information and constraints on the exploration of natural resources.

1. Introduction

The determination of the dip angle of a fault plane from gravity field is possible (Geldart et al., 1966; Telford et al., 1990; Abdelrahman et al., 1989) and provides important information to constraint a seismic profile interpretation. The knowledge about the geometry of a fault plane is a significant component of hydrocarbon/hydrogeological pattern. An integrated approach (gravity and seismic) offers new solutions to define fault geometry. This paper describes the result of the seismic reflection and gravity data analysis and discusses the deep fault geometry associated with graben formation. An accurate knowledge of the geometry of faults is needed and deemed to be very useful for natural resources exploration (Gabtni et al., 2005, 2006, 2012).

2. Geostructural setting

The study area belongs to Central Tunisian Atlas Province, a folded area with a series of NW-SE grabens as a result of a regional crustal extension along northeast-southwest direction (Fig. 1). Extension was considered have started during the Lower-Middle Miocene (Philip et al., 1986; Chihi, 1995) to Plio-Quaternary (Burollet, 1956; Ben Ayed, 1975; Jauzein and Perthuisot, 1976; Caire, 1977; Belguith et al., 2011). The Kalaa Khesba graben is one of these tectonic troughs with a length of 30 km, and an orientation of NW-SE (Fig. 1). The Mahjouba fault is the western border fault of the Kalaa Khesba graben. The Mahjouba fracture zone appears as a 2 km band of parallel faults trending at NW-SE to N-S (Fig. 2). This fracture zone is not well defined in the subsurface. The geological cross section calibrated by Cretaceous outcrops toward the West and a hydrogeological well toward the East shows an abrupt transition from Mesozoic to Tertiary sediments controlled by the Mahjouba fault (Fig. 2). Bouguer gravity map illustrates also the tectonic importance of the Mahjouba fault which is associated with a significant gravity gradient.

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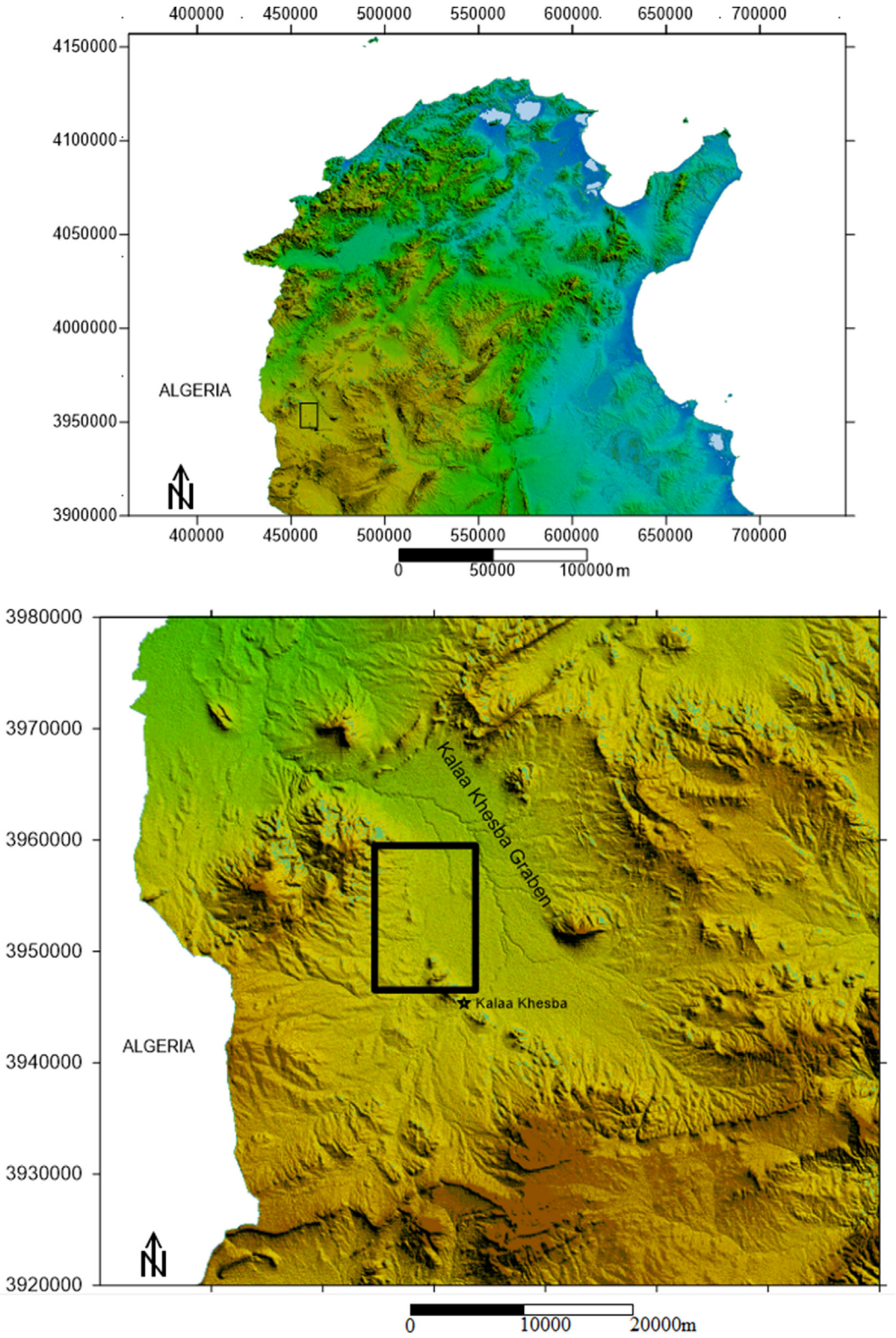

Fig. 1. Location of the study area, the western border of Kalaa Khesba graben (Central Tunisian Atlas Province).