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Is there a hidden near surface salt diapir in the Guelma Basin, north-east of Algeria?

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ABSTRACT

The diapiric province of north-eastern Algeria and Tunisia extends NE–SW over several hundreds of kilometres. Available, geophysical and geological investigations were focused on the study of known diapiric outcrop. In contrast to the existing work, our study is focused on to identify a new hidden near surface salt diapir in the Guelma Basin, north-east of Algeria.

Integrated geophysical study comprising aeromagnetic, gravimetric and DC resistivity data calibrated with existing well information provides new insights into the geometry of the geologic structure of Guelma Basin. Spatial correlation between magnetic low, strong gravity minimum and resistivity high reveal a hidden near surface salt diapir. The Guelma salt diapir is topped by a local topographic high which follows exactly the underlying salt body. Joint gravity-magnetic modelling indicates that salt is deeply rooted and has a dome-like shape. The Guelma salt diapir was triggered by normal faulting and is directly controlled by regional extension.

1. Introduction

In 1994, geophysicists of the *Office National de Recherche Géologique et Minière (ORGM)* were looking for the source of a prominent high resistivity feature interpreted to be gypsum, and to their great surprise, they drilled into a thick layer of salt. The total depth of the well was 633 m. Salt was topped at a depth of 66 m from the surface and the well was abounded in salt. This is the first evidence of a vast deposit of salt extending across the Guelma Basin. According to geophysical interpretations salt has the shape of a dome. Slight positive topography which coincides with the area of the negative aeromagnetic and gravimetric anomalies is the surface expression of the hidden salt diapir. We believe that the onset of the diapiric rising is directly linked to regional extension in this region. This event took place shortly after the deposition of salt, probably during upper Miocene.

Physical modelling by Vendeville and Jackson (1992a,b) showed that regional extension can initiate and promote diapirism regardless of the thickness, lithology and density of the overburden. This type of diapirism is known as reactive. Reactive diapirism is a particularly robust mechanism for initiating diapirism (Jackson et al. 1994b). Although the study of diapirs began 150 years ago, the term reactive was first used in 1992 by Vendeville (Vendeville and Jackson 1992a) who had demonstrated the importance of regional extension in triggering diapirs.

In recent years, geophysical prospecting has moved toward integrating potential fields and electrical methods for regional and prospect evaluation prior to drilling. For example, Chakravarthi et al. (2007) used an integrated geophysical strategy comprising deep electrical resistivity and gravity data to image subbasalt sedimentary basins in India.

Mapping of faults which affect the area, as well as the geometry of the basin cannot be approximated by surface geological data alone. This is why, for the purpose of this study, aeromagnetic, gravimetric and DC resistivity like tools were used for investigation.

In an attempt to better define the structural details of the Guelma Basin, geophysical data were re-examined in the light of drilling results. We, hereby present the results of the gravity-magnetic modelling and DC resistivity data and conclude that there is a hidden near surface salt diapir in the Guelma Basin.

2. Geological setting

The Guelma Basin is located in north-eastern Algeria (Fig. 1a), approximately 50 km south-west of Annaba. It is a relatively deep valley (Fig. 2) along the Seybousse River within which a thick Miocene fill accumulated. It is considered to represent a pull-apart basin (Yelles-Chaouche et al. 2006), bounded by marginal faults.

In the last few decades, the geology of the Guelma region has been the subject of important revisions by Vila (1980), Lahondère (1987)

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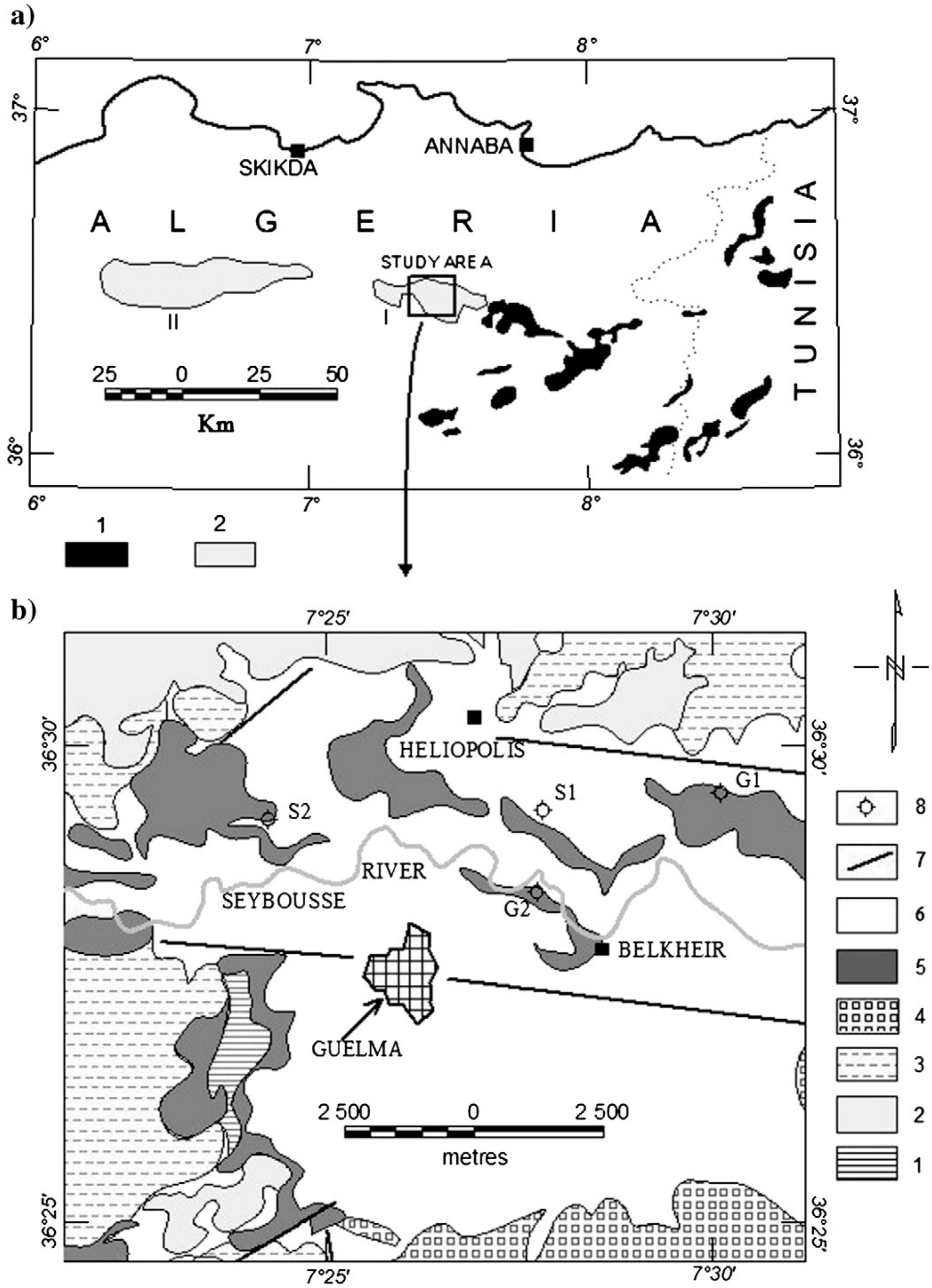

Fig. 1. Simplified geological map of the Guelma Basin (Voronov, 1986). The upper panel of the figure shows the location of study area. a) 1. Outcrop of diapirs near the Algerian–Tunisian border. 2. Miocene Basins in north-east Algeria: I Guelma-Hammam Debagh Basin. II Constantine–Mila Basin. b) 1. Autochthonous unit: limestone, dolomite and clay. 2. Tellian nappe: limestone, marls, calcareous marls and clay. 3. Numidian nappe: lower unit: clay, upper unit: sandstone. 4. Guelma molasse: sandstone, marls and yellow conglomerates. 5. Continental Miocene: conglomerate, marls, limestone, clay with gypsum. 6. Recent sediments. 7. Fault. 8. Borehole and its number.

and Chouabbi(1987). A simplified geological map of the area from an unpublished map compiled by Voronov (1986) is shown in Fig. 1b.

The Guelma Basin is part of the flysch and external zones of the Maghrebides belt. Various geological units outcrop in the investigated area. The region is underlain from older to younger units by: an autochthonous unit of lower Cretaceous age, the Tellian nappe of Cretaceous to Eocene age, the Numidian flysch nappe of Oligocene to early Burdigalian age and a post nappe autochthonous formation consisting of the Guelma molasse and the continental Miocene with gypsum. Details about lithology are presented in the legend of Fig. 1b.

3. Geophysical data

3.1. Aeromagnetic data

The aeromagnetic data used in this study were extracted from a regional-scale aeromagnetic survey of northern Algeria conducted by *Aeroservice Corporation* for the *Société Nationale de Recherches et d'Exploitations Minières (SONAREM)* from 1971 to 1974 as a part of the latter's mineral exploration program. The survey was conducted with NNW–SSE profiles perpendicular to the general geologic strike of the