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Stratigraphy, mineralogy and depositional environment of the evaporite unit in the Aşkale (Erzurum) sub-basin, Eastern Anatolia (Turkey)

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ABSTRACT

The study area is situated in the Aşkale sub-basin where the Early-Middle Miocene aged Aşkale Formation was deposited in a shallow marine to lagoonal environment, and consists of interstratifications of clastic sediments, carbonates and evaporites. The successions of the Aşkale Formation can be divided into four main members interfingering with one another both vertically and laterally, and composed of the sandstone-mudstone-limestone member, the evaporite member, the gravelstone-sandstone-mudstone intercalations and the limestone member. The evaporite unit comprises of secondary gypsum lithofacies formed by hydration of precursor anhydrite, anhydrite, gypsum-bearing limestone and claystone in the form of wedges and lenses. Massive, nodular, nodular-banded, laminated and laminated-banded gpysum lithofacieses in addition to chicken-wire and rare entrolithic structures were described, indicating a sabhka or a shallow water depositional environment. Alabastrine and porphyblastic textures of gypsum were identified within the all lithofacieses with abundant amount of anhydrite relics. Additionally, saponite and illite/smectite, calcite and dolomite, celestite, epsomite were also observed. Successions of the Aşkale Formation were deposited in stable subtropical climatic conditions within rapidly subsiding sub-basin resulted in conversion of sub-basin to shallow platform and even in lagoon environment.

1. Introduction

Turkey hosts many well characterized economically important Tertiary marine and nonmarine evaporite deposits formed within rift and foreland basins, strike-slip settings and mountain belts (e.g., Brinkmann, 1976; Palmer et al., 2004). These deposits consist of mainly gypsum, anhydrite, halite, thenardite, and glauberite (e.g., Gökçe and Ceyhan, 1988; Çubuk, 1994; Yağmurlu and Helvacı, 1994; Ceyhan, 1996; Gündoğan and Helvacı, 2001; Tekin et al., 2001; Çiner et al., 2002; Orti et al., 2002; Türkmen, 2004; Palmer et al., 2004; Gündoğan et al., 2005; Zeybek, 2007; Kırtıl, 2008; Yeşilova and Helvacı, 2013). The Neogene basins and sub-basins in the Eastern Anatolia of Turkey between the İzmirE–Ankara–Erzincan and the Assyrian–Zagros suture zones (Fig. 1a) have been well documented. Previous studies have been focused mainly on stratigraphy, tectonic history and petroleum potential of the Neogene sediments (e.g., Şengör and Kidd, 1979; Şaroğlu and Yılmaz, 1986; Yılmaz et al., 1998; Akay et al., 1989; Tarhan, 1989; Tarhan et al., 1992; Büyükutku, 2003) but still there is a huge gap about sedimentology and facies features of the evaporites formed in these basins in spite of their importance reflecting fingerprints of tectonic events and climatical changes of Neo-Tethys Ocean. Thus, further investigations should be carried on the evaporites' stratigraphy and petrography in order to understand their depositional features and origin.

One of the Neogene basins, the Aşkale (Erzurum) sub-basin have not been evaluated in terms of evaporitic successions effected by extensive tectonics and diapirism, resulted in destruction of many primary structural and textural features and causing difficulty for interpretation of their depositional environments. This paper present field geology, optical microscopy, X-ray diffraction and scanning electron microscopy features of the Miocene evaporite

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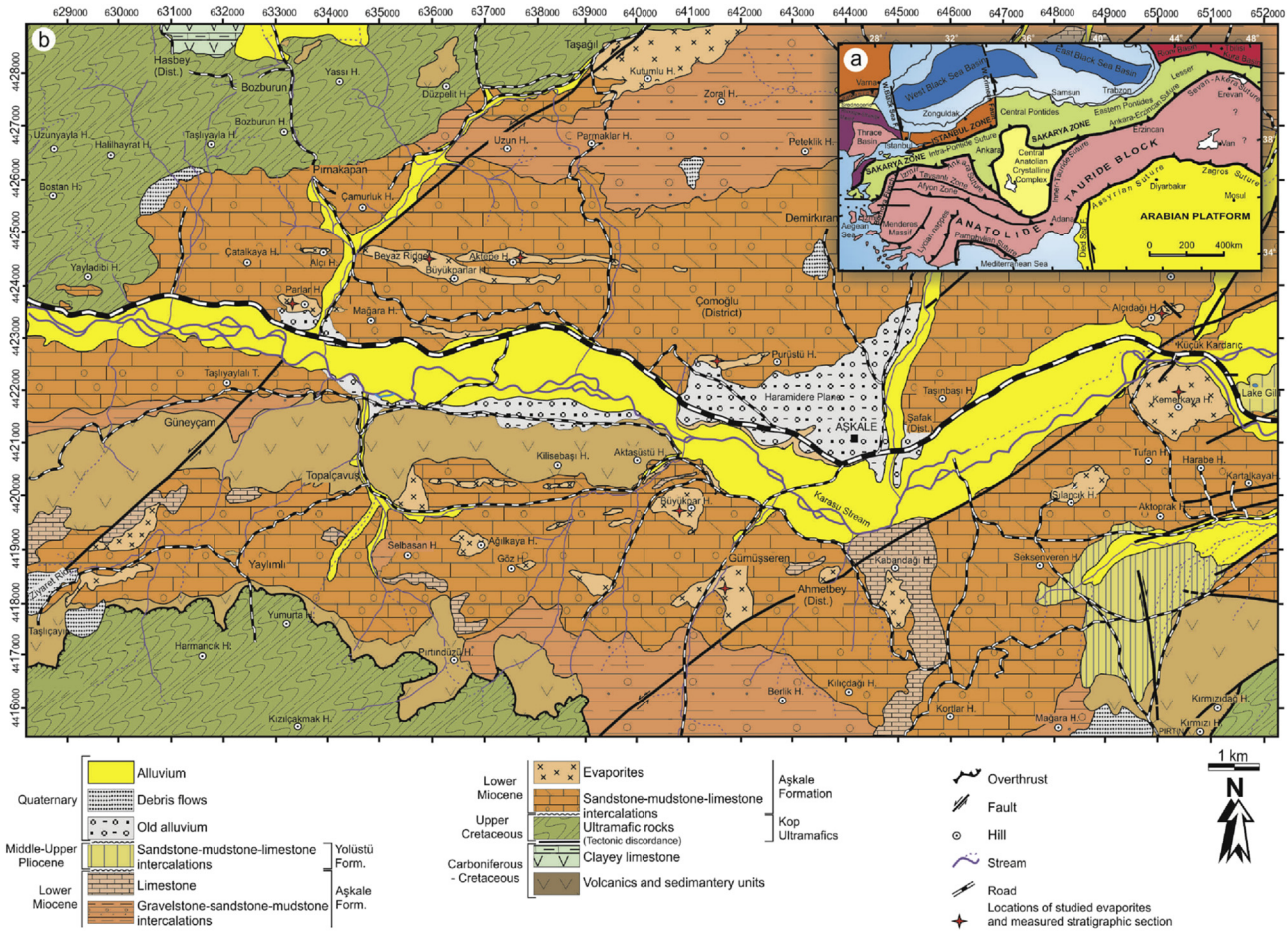

Fig. 1. a) Tectonic map of the north-eastern Mediterranean region showing the major sutures and continental blocks (modified after Okay and Tüysüz, 1999). b) Simplified geological map of the Aşkale (Erzurum) sub-basin (modified after Tarhan et al., 1992).

deposits in the Aşkale sub-basin in order to enlighten their facies and stratigraphic relationships, and to reconstruct the depositional environment and the diagenetic processes, the burial and exhumation history of these deposits.

2. Regional geological setting

Turkey, a part of the Alpine-Himalayan orogenic belt, was structured by four major tectonic units from north to south as the Pontides, the Anatolides, the Taurides and the Border folds (Fig. 1a), as a result of the collision between the African-Arabian and Eurasian plates (Ketin, 1966). The study area is located within the Eastern Anatolian basin at the south of the İzmir–Ankara–Erzincan suture (IAES) zone and also has close relationship with the Eastern Pontides tectonic unit, evaluated from the northward subduction of the northern branch of Neo-Tethys beneath the Eurasian Plate along the IAES zone. The Eastern Anatolian basins at the northwest part of Turkey–Iran plateau (Şengör and Kidd, 1979) are constrained by Pontides, southeast Anatolian suture zone, Karlıova triple junction of the south Anatolian and north Anatolian faults (Allen, 1969; Arpat and Şaroğlu, 1972; Şengör, 1979).

The Eastern Anatolian shallow basins shaped during Late Miocene period and consist of sedimentary rock piles approximately 6000 m in thickness which are generally bordered by faults, folds and ophiolitic complexes in places and were formed on the "East Anatolian Accretionary Complex" described by Şengör (1980). These basins extend in the E–W direction as a result of the N–S directional compressions (Alptekin, 1973; McKenzi, 1976; Tchalenko, 1977), and are subdivided into the Bayburt-Kars plateau (Kars basin), Tercan-Aşkale, Pasinler-Horasan, Tekman-Karayazı-Ağrı, Hınıs-Muş-Van sub-basins (Sancay, 2005).

The Eastern Anatolia has undergone four main depositional and tectonic evolution period (Şaroğlu and Güner, 1981; Şaroğlu, 1985); the Paleozoic-Lower Mesozoic metamorphics, the Upper Cretaceous ophiolithic complex (Şengör and Yılmaz, 1981; Yılmaz, 1993), the Paleocene (?)-Eocene-Early Miocene sedimentary rocks and the Late Miocene Neotectonic Period dominated by terrestrial clastics (Şengör, 1980; Şengör and Yılmaz, 1981). The East Anatolian Accretionary Complex, shaped by the elongation of Anatolides and Taurides correspond to the Paleozoic-Lower Mesozoic metamorphics and meta-volcanic rocks, formed the bottom of the region, and tectonically overlain by the Upper Cretaceous ophiolitic melange consisting of sandstone, tuff, limestone blocks, basic and ultrabasic rocks as a remnant of the Tethyan oceanic crust (Şengör, 1980; Şengör et al., 1980). This melange was thrusted over Jurassic-Cretaceous sedimentary rocks of the Sakarya-Pontide plate (Şengör and Yılmaz, 1981; Şahintürk et al., 1997), and overlain by Upper Eocene-Pliocene sedimentary and volcano-sedimentary lithologies.

The Paleocene (?)-Eocene to Lower Miocene successions, shallowing-upward in character and comprising of limestone, argillaceous limestone, sandstone, and siltstone, overlie unconformably the older units under the active compressional tectonic regime related to the collision of Arabian and Laurasian plates (Yılmaz, 1993). After Late Eocene, the region was uplifted due to the