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Upper Jurassic–Lower Cretaceous depositional environments and evolution of the Bilecik (Sakarya Zone) and Tauride carbonate platforms, Turkey

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ABSTRACT

Three Late Jurassic–Early Cretaceous carbonate platform stratigraphic sections have been studied in central western Turkey (Bilecik carbonate platform at Bilecik and Sarıcakaya) and in the Taurides in southern Turkey (Tauride carbonate platform at Beysehir) by using sedimentological and cyclostratigraphical methods. One section was analyzed by detailed magnetic susceptibility measurements. Peritidal carbonates on both platforms display cyclic patterns throughout the sections and do not contain any siliciclastic material. This cyclicity is generally expressed as shallowing upward cycles and interpreted as records of short-term sea-level changes.
Magnetic susceptibility (MS) analysis revealed that small scale changes in the MS values can be followed by cyclic alternation of facies and may indicate that varying detrital input during wet and dry climate alternation can be one of the controlling factors for short term sea level changes. The large-scale MS evolution records an increase just around the Jurassic–Cretaceous boundary interval, and a decrease above the boundary. This curve pattern can be correlated with some European MS sections and seems to indicate a consistent MS pattern around this critical interval. Consequently, this study implies that sea-level variations on studied shallow carbonate platforms were on the order of few meters. Pelagic equivalents of these sea-level records can be traced along the margins. Short term climatic control can be seen as one of the controlling factors for small-scale sea-level changes. The large-scale changes can be associated with oceanographic/climatic, third-order sea-level changes and the influence of regional tectonics.

1. Introduction

Jurassic–Cretaceous carbonate successions are generally well studied all around the world because of their scientific importance for paleoceanography, paleoclimatology, and hydrocarbon exploration (Klett, 2001; Hammer et al., 2011; Föllmi, 2012; Abeed et al., 2013; Holz, 2015; Shurygin and Dzyuba, 2015; Zeinalzadeh et al., 2015, and many others). Turkey hosts several Jurassic–Cretaceous carbonate platform successions of the wider Tethys ocean system, including the Bilecik carbonate platform in the Sakarya zone of the western Pontides. (Altıner et al., 1991; Koçyiğit et al., 1991; Tunç, 1991) and the Tauride carbonate platform to the south (Altiner et al., 1999; Yilmaz, 1999; Yilmaz and Altiner, 2001). These carbonate platforms not only record significant environmental changes during the Jurassic to Cretaceous time interval, but are also of special interest to reconstruct the plate tectonic evolution of the area, e.g. of the Pontides (e.g. Altıner et al., 1991; Koçyiğit et al., 1991; Varol and Kazancı, 1981; Yiğitbaş et al., 1999).

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Continuous successions of shelf carbonates and associated pelagic equivalents spanning the Jurassic–Cretaceous boundary (J/K boundary) carry another scientific importance. Besides providing archives for paleoclimatic and paleoceanographic changes across this system boundary, regional tectonics may play an additional role in controlling sequences and cycles. Transported carbonates may be interpreted to be the result of crustal movements due to regional tectonics. i.e. faulting in the basin. Carbonate breccia deposits in shelf and pelagic settings can be also studied from this point of view to demonstrate whether they were triggered by storm/earthquake/sea-level changes, or they were related to tectonically induced slope instability.

This study aims to analyze the change in depositional style, evolution of carbonate platforms, records of sea level and climate changes on the Bilecik platform in western Sakarya Zone and the Tauride platform by investigating three measured sections in north-western and south central Turkey. In addition, it is also targeted to apply magnetic susceptibility methods for the first time on the J/K boundary beds in Turkey to enable a better correlation and understanding of the causes of cyclicity and environmental changes such as sea-level changes on these shallow-water platforms.

2. The Jurassic–Cretaceous boundary interval—Paleoclimate, paleoceanography, sea-level cycles and tectonics

Paleoceanographic and paleoclimatic changes across the J/K boundary were discussed, among others, by Tremolada et al. (2006) based on the calcareous phytoplankton response. They indicated a cooling in the Late Tithonian, followed by a temperature increase in the Berriasian. In contrast, Weissert and Erba (2004), based on European sections, reconstructed an increase in ariditiy and North Sea warming in the Late Tithonian, and a high latitude cooling in the Berriasian.

Sequence stratigraphic and cyclostratigraphic studies, and sea-level reconstructions around the J/K boundary are numerous, both from shallow-water and deep-water settings. Molinie and Ogg (1992) reported already the presence of Milankovitch cycles within deep basinal sediments in the equatorial Pacific, indicating a possible disconformity at the boundary. Mancini and Puckett (2005) and Zorina et al. (2008) demonstrated that the transgressive–regressive cycles between Northern Gulf of Mexico, USA, and European and Asian basins were not coeval and that a prominent sequence boundary is present in the European successions. Kietzmann et al. (2014) recorded five 3rd and fifteen 4th order depositional sequences on a Tithonian–Valanginian carbonate ramp succession in Argentina, and Kietzmann et al. (2015) identified climatic fluctuations due to eccentricity modulated precessional cycles throughout the J/K boundary interval. The overview by Haq (2014) identifies a major sequence boundary (JTi6, 146.2 Ma) near the boundary interval, and a rising sea-level into the early Berriasian (short-term curve), but a general sea-level fall of the longer-term curve.

Tectonism around the Late Jurassic to early Early Cretaceous is especially known from carbonate platforms of the northwestern Tethys and European basins. Rehakova et al. (1996) described deep-water breccia deposits within pelagic carbonates of Tithonian–Berriasian age within the Penninic Nappe in the Eastern Alps (Austria), and Rehakova (2002) described microbreccias from the Tithonian of the west Carpathian area (Slovakia). Mandl (2000) indicated that the Upper Jurassic–Lower Cretaceous platform-to-basin carbonate succession, including breccias and overlying a tectonic unconformity, served as a seal in the Northern Calcareous Alps of Austria. Savary (2005) recorded the presence of Tithonian-aged carbonate breccia deposits in relation to turbiditic flow and/or wave-induced transportation in SE France. The Late Jurassic–Early Cretaceous evolution of the Alpine carbonate margin of the northwestern Tethys has been reconstructed by Ortner et al. (2008). Tithonian breccia deposits of the Northern Calcareous Alps of Austria were interpreted as slope breccia in front of a fault scarp. Mohn et al. (2011) demonstrated that the Upper Jurassic sediments were post rift deposits in Austroalpine and Penninic Nappes of Switzerland, and indicated that they were not syndepositional with the deformational phases.

3. Geologic setting and stratigraphy

Study areas belong to the Sakarya zone of the Pontides in the north, and the Taurides to the south of Turkey (Fig. 1). In the Sakarya zone, 2 stratigraphic sections, one from pelagic (Sarıcakaya section) and one from shallow water (Bilecik section), have been measured and 1 stratigraphic section from platform carbonate of Taurides (Fele section). Generally, in the Sakarya zone, the studied Jurassic–Cretaceous successions rest on the metamorphic basement with an unconformity (Figs. 1, 2). These metamorphics composed of phyllites, schists, gneisses and other metavolcanics and sediments belong to the Triassic Karakaya Orogeny (Altıner et al., 1991; Koçyiğit et al., 1991). In the Sakarya Zone, the Jurassic successions start with the siliciclastic Bayirkoy Formation in Hettangian–Pliensbachian times. The Bilecik Group overlies the Bayirkoy Formation with an unconformity (Fig. 2). The Callovian–Oxfordian Tascibayiri Formation in the lower part of the Bilecik Group is composed of alternations of thin-medium bedded siliciclastic sandstones, siltstones and mudstones. The Kimmeridgian–Hauterivian Gunoren Limestone conformably overlies the Tascibayiri Formation and forms the upper part of the Bilecik Group. The Bilecik Group is overlain by pelagic carbonates of the Barremian-Aptian Soğukçam Limestone with both conformable and unconformable contacts, and the Albian to Maastrichtian Yenipazar Formation (Fig. 2) (Tuysuz, 1999; Tuysuz et al., 2004; Yilmaz, 2008), again with an unconformity at the base.

The study area in the Taurides lies to the north of Beysehir Lake, Fele village, in Beysehir town, Konya city. The studied succession belongs to the Geyik Dağı unit of Özgül (1976) which was recently named the Sultan Dağı subunit (Özgül et al., 1991; Özgül, 1984, 1997). The Jurassic period of the Sultan Dağı subunit of the Geyik Dağı unit is characterized by sandstones, sandy limestones and limestones of the Sarakman Formation of Bajocian age (Altıner, 1981) (Fig. 2b) and unconformably overlies the irregular topography of the basement which was formed by Triassic tectonic events. This unit is followed continuously by the dolomites of the

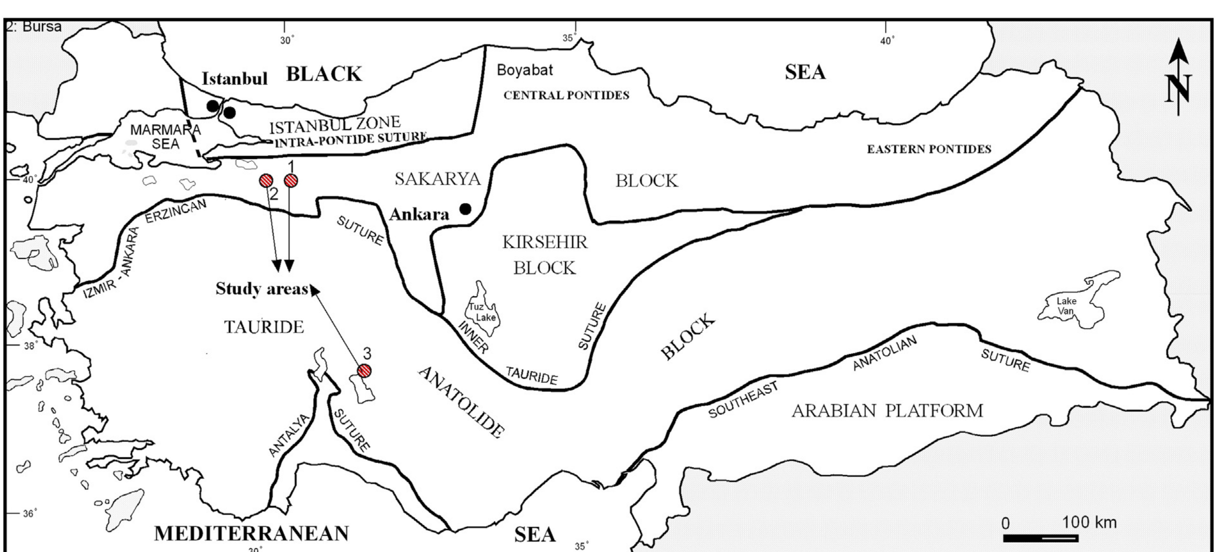

Fig. 1. Location of the studied areas in the Sakarya Zone (1—Saricakaya, 2—Bilecik) and the Turides (3—Beysehir) on the schematic tectonic map of Turkey (modified from Okay and Tuysuz, 1999).