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A Triassic homoclinal ramp from the Western Tethyan realm, Western Balkanides, Bulgaria: Integrated insight with special emphasis on the Anisian outer to inner ramp facies transition

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ABSTRACT

The Triassic carbonate succession exposed in the Western Balkanides is analyzed in terms of depositional evolution, sequence stratigraphy, sedimentation rate, environmental constraints, and biota distribution. Deposition took place on a storm-dominated ramp which existed at the NW end of the Tethys Ocean from late Olenekian to early Carnian time. Subtidal, intertidal and supratidal sediments were accumulated in three zones of the ramp profile: inner ramp, mid-ramp and outer ramp. The calculated average sedimentation rate is typical for other ancient marine shallow water carbonates including those deposited on ramps. Newly accomplished sedimentological study on part of the Anisian interval reveals a homoclinal ramp model with episodic initial distal steepening. Two main phases of the ramp evolution are distinguished on the basis of changing relative paleobathymetry — transgressive, e.g. retrogradational depositional trend, and regressive, e.g. progradational depositional trend. The maximum flooding zone is marked by the Terebratula Beds having late Pelsonian age. The inferred environmental constraints of the ramp system comprise: normal marine to hypersalinity; warm, well-illuminated water; aerobic and rarely dysaerobic bottom conditions; dominantly soft lime mud substrate; intensive storm activity; temporal seismic influence presumably related to Early Triassic rifting. The vertical distribution of marine fauna indicates shifting from Germanic (Peri-Tethyan) affinity to Alpine (Tethyan) affinity in Anisian time. The sedimentation was not characterized by formation of large buildups because of the paucity or lack of metazoan and other reef builders. The studied rocks are well correlated with the Triassic ramp succession outcropping in the Tizsa Meagunit of Southern Hungary. Similarities to the German, Polish and Spanish Muschelkalk are also clearly outlined and some parallel can be drawn with other platform carbonates from the NW Tethys shelf area and Peri-Tethys basins.

1. Introduction

Carbonate ramps are defined to be depositional systems with a uniform low-gradient slope from shoreline to basin (Ahr, 1973) although an offshore slope break in relatively deeper water, i.e. distal steepening, may also occur (Read, 1982, 1985). Several schemes have been proposed in the literature for their environmental subdivisions (Markello and Read, 1981; Aigner, 1984; Wright, 1986; Calvet and Tucker, 1988; Buxton and Pedley, 1989; Burchette and Wright, 1992; Somerville and Strogen, 1992) using the fair weather wave base and storm wave base as major interfaces. Among these schemes, the general zonation pattern, which postulates inner ramp, mid-ramp, outer ramp and basin depositional zones (Burchette and Wright, 1992), appears applicable for most ramp successions. Meanwhile, Flügel (2004) distinguished 30 Ramp Microfacies Types (RMF) which were common for Palaeozoic and Mesozoic carbonates and dominated in specific parts of the ramp setting.

Knowledge of the lateral and vertical facies successions and sequence architecture in ramp profiles is crucial for the interpretation of their potential as subsurface hydrocarbon reservoirs including especially shoal and other carbonate sandbodies (Read, 1985; Burchette et al., 1990; Kerans et al., 1994; Alsharhan and Magara, 1995; Moore, 2001; Hopkins, 2004; Ruf and Aigner, 2004; Schröder et al., 2005; Borkhataria et al., 2006; Harris and Weber, 2006; Beavington-Penney et al., 2008; Palermo et al., 2010; Götz and Lenhardt, 2011).

Ramps were typical carbonate platforms (sensu Tucker and Wright, 1990) during the Phanerozoic and the Triassic period was a time interval of extensive development worldwide and particularly across the Western Tethys realm (Aigner, 1985; Calvet et al., 1990; Baud et al., 1991; Michalík et al., 1992; López-Gómez et al., 1993; Haas and Budai, 1995; Rüffer, 1995; Hips, 1998; Jinnan and Hongfu, 1998; Török, 1998a,b; Szulc, 2000; Zühlke, 2000; Tong and Yin, 2002; Borkhataria et al., 2006; Decarlis and Lualdi, 2009; Woods, 2009; Jaglarz and Uchman, 2010; Korngreen and Benjamini, 2011; Kovács et al., 2011; Knaust and Costamagna, 2012).

The goal of this paper is comprehensive characterization of an Early to Late Triassic carbonate ramp system from the NW part of the Tethys

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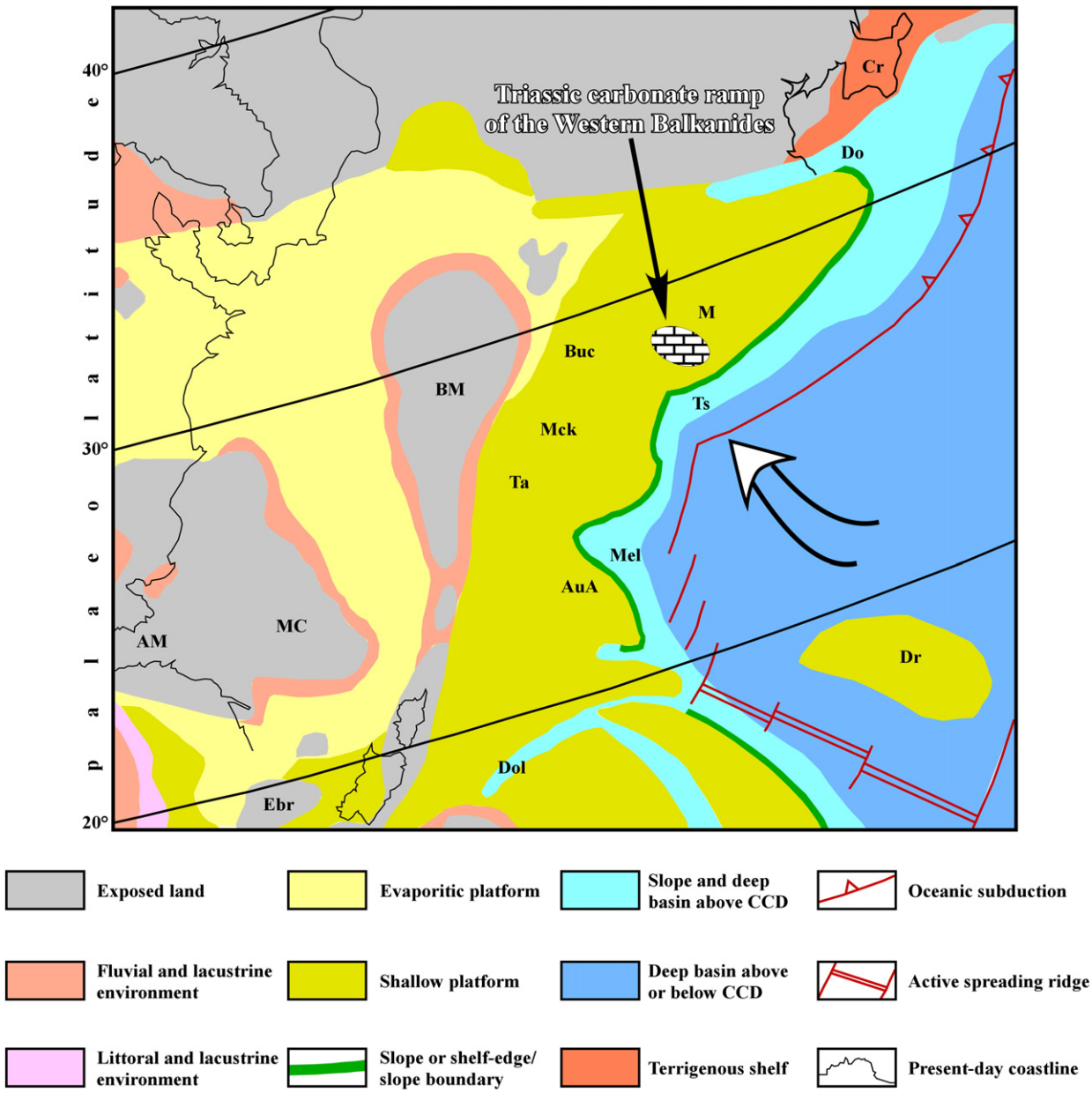

Fig. 1. Paleogeographic map of the Western Tethys realm in late Anisian time (simplified after Marcoux et al., 1993) with designated location of the studied carbonate ramp system. Abbreviations and symbols: AM—Armorican Massif, MC—Massif Central, BM—Bohemian Massif, Ebr—Ebre Massif, Dol—Dolomites, Dr—Drama, AuA—Austro-Alpine, Mel—Meliata Unit, Ta—Tatra, Mck—Mecsek, Ts—Transylvanids, Buc—Bucovina, M—Moesia, Do—Dobrodgea, Cr—Crimea, big arrow—inferred direction of subtropical storms based on the reconstruction of Marsaglia and Klein (1983). Note: Paleomagnetic data of Muttoni et al. (2000) indicate latitude position of 21–24° N for the Bulgarian carbonate platform during the Anisian.

Ocean. The depositional evolution and sequence stratigraphic framework are outlined in the context of the general cyclic pattern of the whole Triassic succession which is exposed in the Western Balkanides of Bulgaria. Environmental constraints of the ramp development and some biota specifics are discussed and the approximate average sedimentation rate is calculated. In order to determine the particular ramp type a new sedimentological study of part of the Anisian succession is accomplished. Macroscopic and microfacies characteristics of carbonate rocks from the examined interval are described in detail. Interpretation of the obtained data reveals temporal transition from outer ramp to inner ramp deposition in Pelsonian to Illyrian time and a homoclinal model of the carbonate ramp is inferred. An attempt is made for correlation with other deposits of Triassic carbonate platforms from the NW Tethys shelf area and Peri-Tethys basins.

2. Geological background and history of research

The Lower to Upper Triassic carbonates outcropping in NW Bulgaria comprise the marine phase in the overall Triassic sedimentary succession (Tronkov et al., 1965). Deposition took place on a carbonate ramp which was configurated at the close of the Early Triassic (Čatalov, 1988; Tronkov, 1993). Tidal flat, shoal and storm-dominated depositional environments of the inner ramp and mid-ramp have been recognized in the upper Olenekian to mid-Anisian interval of the section (Chatalov, 2000c; Chatalov and Vangelov, 2001). An inner ramp fringing shoal complex (sensu Read, 1985) of late Anisian to early Ladinian age has been interpreted by Chatalov (2002). The topmost part of the carbonate succession consists of upper Ladinian to lower Carnian dolomites (Tronkov, 1995) that were initially deposited in an arid peritidal