Facies analysis of the Lower-Middle Toarcian in the External Subbetic (provinces of Murcia and Granada, Southern Spain): palaeoenvironmental conditions

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The Toarcian is particularly well recorded in the External Subbetic (Betic External Zones, Southern Spain). These sedimentary rocks were deposited in the South Iberian Palaeomargin in the Western Tethys. This is a palaeogeographic important area affected by singular ocean dynamics occurring in the Hispanic Corridor, the connection between Western Tethys and the Proto-Atlantic seaway (≈ 20ºN palaeolatitude in the Toarcian). The physiography of this palaeomargin, configured into trough and swell areas, was irregular due to the Pliensbachian rifting. The Toarcian sedimentary rocks are part of the Zegrí Formation (upper Pliensbachian-Aalenian; Nieto et al., 2004).

This contribution offers an update about lower-middle Toarcian facies from two sections in the External Subbetic and their palaeoenvironmental interpretation. The first studied section is in a ravine in the Loma de la Reina (S of the Guarrumbre Hill, Moratalla, Murcia province; 38°04'53.5"N, 2°10'20.8"W, in their bottom). The second section is in the Bravatas River, near to the road from Huéscar to Las Santas Chapel (Huéscar, Granada province; 37°53'46.4"N, 2°29'19.9"W in their bottom). The lower-middle Toarcian studied sections have more than 160 m in thickness, the maximum for this time in all the Betic External Zones (Jiménez, 1986).

Five types of lithofacies are differentiated in the lower-middle Toarcian in the studied sections: 1) Grey-yellow marl-marly limestone rhythmite and limestones in the lowest Toarcian (lower part of the Polymorphum Zone); 2) dark marls (upper part of the Polymorphum Zone and lower part of the Serpentinum Zone); 3) thin bedded grey-yellow limestones, locally with chert and abundant slumps (upper part of the Serpentinum Zone); 4) grey marls with some marly limestones of the middle Toarcian (Bifrons and Gradata Zones); and 5) yellow or brown laminated calcisiltites and calcarenites, that occur intercalated between facies 3 and 4. Facies 1 to 4 are interpreted as hemipelagites, deposited by the slow accumulation, largely from suspension, on a quiet sea floor of biogenic and very fine terrigenous particles. Facies 2 was deposited in rather depleted oxygen conditions with slightly dysoxic bottom waters but discarding completely anoxic conditions (Reolid et al., 2018). The carbon cycle perturbation related to the Toarcian Oceanic Anoxic Event (T-OAE) is recorded in this facies 2 by some increase of total organic carbon (maximum of 1.05 wt.%) and redox sensitive elements, the decrease of $CaCO_3$ and the negative excursion of $\delta^{13}C$ observed at the base of Serpentinum Zone (Reolid et al., 2018). Facies 5 are mainly peloidal grainstone with bioclasts (brachiopods, bivalves, and echinoderms), ooids and allochthonous shallow water foraminifera, and packstone-wackestone of bioclasts (mainly radiolarians) and peloids. This facies 5 with parallel lamination and locally with normal grading, low angle, wavy, and hummocky cross

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stratification is interpreted as tempestites perhaps related with tropical cyclones, and/or internalites (Molina et al., 2017).

The relative palaeobathymetry of all these facies is difficult to stand out. We consider that the influence of adjacent emerged lands and carbonate platforms, differential subsidence by local tectonics (recorded by slumps in the Serpentinum Zone and by very important changes in thickness and lateral facies), sediment winnowing by currents, sedimentation rates, bioturbation, and diagenesis, may eventually have had more importance in the distribution of the facies types than depth. The evolution of this area during the lower-middle Toarcian was mainly controlled by tectonics (extensional phase of continental rifting) after the break-up of the Lower Jurassic platform during the Pliensbachian, together with a relative sea-level change. Also the beginning of basaltic submarine volcanism to the South in some Median Subbetic areas (Molina and Vera, 2001) had influence. The diversified physiography of the South Iberian Palaeomargin during the Toarcian, related to synsedimentary tectonic activity and oceanic circulation patterns, determined different intensities of winnowing and oxygenation on the sea-floor. The T-OAE is recorded in both sections in the base of Serpentinum Zone (Reolid et al., 2018). The general re-oxygenation after the T-OAE could be favoured changes in oceanic currents and by the tempestite/internalite inputs to the bottom waters during the upper part of Serpentinum and Bifrons zones.

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