Marine and Petroleum Geology 77 (2016) 1274–1296

Contents lists available at ScienceDirect

Marine and Petroleum Geology

journal homepage: www.elsevier.com/locate/marpetgeo

Review article

Seismic markers of the Messinian Salinity Crisis in an intermediate-depth basin: Data for understanding the Neogene evolution of the Corsica Basin (northern Tyrrhenian Sea)

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ARTICLE INFO

Article history:
Received 10 September 2015
Received in revised form
29 January 2016
Accepted 8 February 2016
Available online 16 February 2016

Keywords:
Messinian Salinity Crisis
syn-MSC deposits
Incision network
Corsica Basin
Tyrrhenian Sea
Pliocene reflooding

ABSTRACT

The Messinian Salinity Crisis (MSC), which widely affected the whole Mediterranean basin, induced rapid and spectacular palaeoenvironmental changes. It led to a major erosion of the onshore areas and the upper parts of the continental shelves and slopes, as well as important evaporitic deposits in the offshore deep basins. The Corsica Basin belongs to the so-called “intermediate-depth basin” type because of its location between the coastal plain–shelf area of East Corsica and deeper marine basins in the northern Tyrrhenian Sea. The MSC event took place in the Corsica Basin during a period of active regional tectonics, contemporaneous with the opening of the Tyrrhenian Sea, as well as during the development of the Corsica Basin and the Elba-Pianosa Ridge.

Based on the interpretation of high-resolution seismic reflection profiles and a new *1:250,000* scale synthetic geological map, we establish that the MSC is recorded in the Corsica Basin through the occurrence of two sedimentary formations bounded by three remarkable surfaces. These seismic markers suggest local and temporal variations in relative water level and associated depositional environments that differ between the north and south of the Corsica Basin. During the MSC, the northern sector (Golo Basin) was emerged, whereas the southern sector (Orbo Basin) was often flooded or submerged. In the Orbo Basin, the deposits record both an episode of intra-MSC climate change and regional tectonic events. During the MSC, the Corsica Basin was a perched lake, isolated from the deeper Tyrrhenian basins. The connection with the Tyrrhenian basins was re-established during the final stages of the MSC, before the catastrophic Pliocene reflooding, initiated by retrogressive erosion during a relative lowstand. An extensive network of incised valleys was thus established in the Orbo basin, allowing the drainage of the Corsica Basin southwards into the deeper Tyrrhenian basins. These markers record the active regional tectonic context throughout the MSC. The Orbo basin was strongly subsident along its western rim, while its eastern rim was uplifted. In turn, the Golo basin subsided from middle Pliocene times onwards, while the northern, eastern and southern edges of the Corsica Basin were deformed and uplifted.

Contents

Abbreviations: EPR, Elba-Pianosa Ridge; MSC, Messinian Salinity Crisis.

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http://dx.doi.org/10.1016/j.marpetgeo.2016.02.017
0264-8172/

1. Introduction

The Messinian Salinity Crisis (MSC), which affected the whole Mediterranean area (Fig. 1) at the end of the Miocene between 5.97 and 5.33 Ma, induced rapid and spectacular palaeo-environmental changes (Hsü et al., 1973; Krijgsman et al., 1999; CIESM, 2008; Manzi et al., 2013; Roveri et al., 2014 and references therein). The MSC came to an end when the Mediterranean Sea was reconnected to the Atlantic Ocean via the Gibraltar Strait at around 5.46 Ma (Bache et al., 2012), leading to catastrophic reflooding at 5.33 Ma (Roveri et al., 2014). The first stage (5.97–5.6 Ma) is mainly defined from onshore outcrops in the marginal or peripheral basins, where a thinner evaporite sequence has been recognized known as the Primary Lower Gypsum (PLG) (Riding et al., 1998; Roveri et al., 2009, 2014; Manzi et al., 2013 and references therein). The PLG is usually incised by a major erosion surface correlated with the Margin Erosion Surface (MES) (Roveri et al., 2014) observed on the Mediterranean margins. The second (5.6–5.55 Ma) and third (5.55–5.33 Ma) stages (CIESM, 2008; Roveri et al., 2014) are characterized by a continuing fall in sea-level, becoming maximal during the second stage, with subaerial erosion (MES) of the continental margins and coeval with the deposition of a thick evaporite sequence in the deep basins (up to 1400 m thick, i.e. Montadert et al., 1970; Hsü et al., 1973; Krijgsman et al., 1999), This evaporite sequence is composed of three distinct seismic units, recently renamed the *Upper Unit* (UU), the *Mobile Unit* (MU) and the *Lower Unit* (LU) by Lofi et al. (2011). An ambiguity persists concerning the age of the end of the sea-level fall. Thus, the MSC deposits, described in terms of sequence stratigraphy by Gorini et al. (2015), have been divided into two seismic megasequences: i) a *Messinian Lower Megasequence* (MLM) coeval with the sea-level fall (5.97 and 5.55 Ma) includes forced regressive deltas, mass transport complexes, deep basin clastics and evaporites (LU). ii) a *Messinian Upper Megasequence* (MUM), coeval with an increase in base level (5.55–5.33 Ma), includes evaporite units (MU and UU), fluvial incised valley fill, transgressive marine sands and material reworked by the catastrophic reflooding. This stratigraphic pattern is effectively in accordance with the transgressive geometry of the UU (Ryan et al., 1973; Mauffret, 1976) and the age of 5.55 Ma for the MSC paroxysmal phase (CIESM, 2008; Gorini et al., 2015 and references therein). Moreover, around 5.5 Ma ago, there were significant changes in the palaeogeography and climate of the Mediterranean region (Fauquette et al., 2006; Manzi et al., 2013; Roveri et al., 2014).

No continuous record of the MSC has been observed between the onshore marginal basins and offshore deep basins. However, owing to their specific paleodepths at the onset of the MSC (between 200 and 1000 m), the intermediate-depth basins (Maillard *et al.* 2014; Ochoa et al., 2015) may provide important information on events and sea-level fluctuations during the MSC. Intermediate-depth basins have been defined as more or less restricted areas, corresponding to intermittent or thin depocentres located between the shallow platform and the continental slope. These areas were subject to strong erosion during the MSC on one side, while thick evaporitic sequences were deposited in deep basins on the other side. In some intermediate-depth basins, an important seismic unit, known as the Bedded Unit (BU; Lofi et al., 2011), has also been identified, as in the Corsica Basin (Guennoc et al., 2011; Thinon et al., 2011) and in the Balearic Promontory (Maillard et al., 2014; Ochoa et al., 2015). In the Balearic promontory, but only in the onshore coastal and shallow water areas, the BU has been interpreted as an “offshore expression of the PLG” sequence below the MES (Ochoa et al., 2015). From Gorini et al. (2015), the BU units are coeval with MUM deposition in the deep basin, post-dating the rapid draining of the intermediate-depth basin.

In addition to the MSC seismic units, some remarkable surfaces are also markers of the MSC. Clearly identified on all Mediterranean margins, the MES is expressed as a single, generalized and polygenic erosional surface (Maillard and Mauffret, 2006; Lofi et al., 2005, 2011; Bache et al., 2010). At the foot of the Mediterranean margins, the MES divides laterally into at least two remarkable surfaces: 1) *Bottom Erosion Surface* (BES, Lofi et al., 2011) is considered to be the bounding erosive surface marking the base of the syn-MSC deposits; 2) *Top Erosion Surface* (TES), which corresponds to the bounding surface marking the top of the syn-MSC deposits, characterized by major incisions.

This study focuses on the interaction between MSC markers and the Neogene evolution of the Corsica Basin. The Corsica Basin is an intermediate-depth basin, which formed in a shelf environment during the pre-MSC Miocene (Figs. 1 and 2). Our study is based on mapping of the various syn-MSC seismic units and surfaces, as well