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Messinian evaporites across the Anaximander Mountains, Sırrı Erinç Plateau and the Rhodes and Finike basins, eastern Mediterranean Sea

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ABSTRACT

In various previous studies the Messinian evaporite successions are reported to be absent across Rhodes and Finike basins, the Anaximander Mountains, and the Sırrı Erinç Plateau regions of the eastern Mediterranean. In this paper we use new seismic reflection profiles and interpretation to document that the Messinian evaporite successions are indeed present as a notably thinner layer across these areas. We based this interpretation on several lines of evidence, including (a) the absence of a structural barrier between the regions of the eastern Mediterranean where evaporites are present and the region where they were purportedly absent, which would have been needed to isolate these regions from the evaporative Mediterranean basin(s), (b) the absence of a notable lateral lithofacies transition between the regions where Messinian evaporites are present and the region where they were reportedly absent, (c) the acoustic similarities in the new industry seismic reflection profiles between the successions below the TS/TES (i.e., M–reflector) in the Mediterranean Ridge and Antalya Basin where the Messinian evaporites are present, across the Anaximander Mountains and Sırrı Erinç Plateau into the Rhodes and Finike basins where they were reportedly absent (d) the strong velocity contrast at the TS/TES where the P-wave velocities dramatically increase from ~1900–2100 m s^{-1} within the uppermost Miocene–Quaternary Unit 1 to ~3500–4600 m s^{-1} in the underlying Unit 2.

1. Introduction

The Messinian salinity crisis is a prominent series of events that has profoundly modified the Mediterranean within a relatively limited time span, and led to the deposition of thick evaporite successions in basins that are presently located both onland and offshore (e.g., Lofi et al., 2011; Manzi et al., 2014; Roveri et al., 2014a; Bache et al., 2015; Gorini et al., 2015). However, there are sectors of the Mediterranean Sea where the Messinian evaporites are reported to be absent (Fig. 1), such as the crestal regions of the Cyprus Arc (e.g., Loncke et al., 2011; Maillard et al., 2011) and the northwestern regions of the eastern Mediterranean, including the Anaximander Mountains, and the Rhodes and Finike basins (Mascle et al., 1986; Woodside et al., 2000; ten Veen and Kleinspehn, 2002; Zitter et al., 2003; ten Veen et al., 2004; Aksu et al., 2009, 2014; Hall et al., 2009). The purported absence of the Messinian evaporites across the deepest basins of the Mediterranean, such as the Rhodes and Finike basins creates considerable tectonic challenges. For example, in order to explain the absence of evaporites across the Anaximander Mountains, the Rhodes and Finike basins and the Sırrı Erinç Plateau, Hall et al. (2009) and Aksu et al. (2009) argued that these regions must have been situated above the depositional base of the Messinian evaporative basin(s), and must have subsequently experienced a dramatic subsidence during the Pliocene-Quaternary.

The absence of the Messinian evaporites across the Anaximander Mountains, Sırrı Erinç Plateau and the Rhodes and Finike basins is entirely based on the seismic stratigraphic architecture of the Miocene–Recent sedimentary successions in these areas (Mascle et al., 1986; Woodside et al., 2000; ten Veen and Kleinspehn, 2002; Zitter et al., 2003; ten Veen et al., 2004; Aksu et al., 2009, 2014; Hall et al., 2009). The typical acoustically transparent seismic character of the Messinian deposits with prominent halokinetic structures that shape the overlying Pliocene–Quaternary succession, as observed elsewhere in the eastern Mediterranean (e.g., the Antalya, Cilicia, Latakia basins), are absent in the Rhodes and Finike basins (e.g., Aksu et al., 2009; Hall et al., 2009; Işler et al., 2005; Aksu et al., 2005; Hall et al., 2005, 2014). However, a thinner and predominantly siliciclastic Messinian succession with evaporite interbeds, such as the Lower Unit of Lofi et al. (2011) would not necessarily create these prominent halokinetic structures. This is exactly what is observed in the Valencia Basin where no salt nor halokinetic structures are observed but evaporites interbeds have been drilled (e.g., Pellen et al., 2016).

In this paper, we present new data and interpretations to suggest

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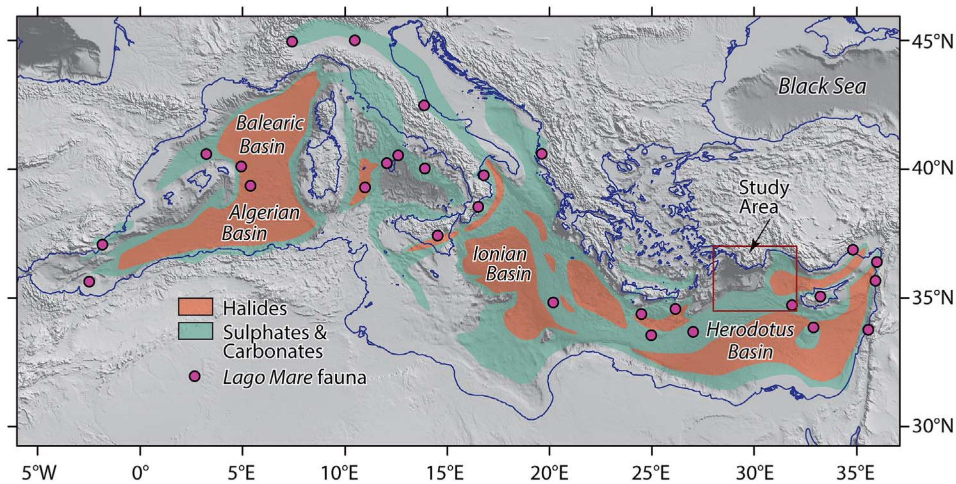

Fig. 1. Present-day distribution of the Messinian evaporites across the Mediterranean (redrawn from Ryan, 2009), and sites where *Lago Mare* fauna has been identified (from Ryan, 2009; Tekin et al., 2010; Bowman, 2011; Cipollari et al., 2013a, 2013b; Manzi et al., 2014). The morphological basemap of the Mediterranean region is compiled using GeoMapApp (Ryan et al., 2009), and shaded using Caris Base Editor (4.1). Coastline is from the International Bathymetric Charts of the Mediterranean (IOC, 1981). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

that the Messinian evaporites are indeed present as a considerably thinner succession with notable dilution with siliciclastic input across most of the Anaximander Mountains, the Sırrı Erinç Plateau and the Rhodes and Finike basins in eastern Mediterranean.

2. Morphology of Anaximander Mountains, Sırrı Erinç Plateau, Rhodes and Finike basins

The morphology of the northwestern sector of the eastern Mediterranean at the junction between the northwest-southeast trending Florence Rise and the northeast–southwest trending Pliny–Strabo Trenches is delineated by the Anaximander Mountains (*sensu lato*) in the south and three depressions in the north: the Antalya, Finike and Rhodes basins (Fig. 2). The Anaximander Mountains (*sensu lato*) emerge as three prominent bathymetric highs: (a) the Anaximander Mountain (*sensu stricto*) is an open V-shaped narrow and arcuate ridge with its crest at ~1100 m depth (x in Fig. 2), (b) the Anaximenes Mountain is a northeast–southwest trending broadly arcuate ridge with its crest at ~750 m depth, and (c) the Anaxagoras Mountain is a northwest–southeast trending broad bathymetric high with several prominent peaks at ~1200–950 m water depth (Fig. 2).

A prominent arcuate zone characterized by corrugated seafloor occurs between the Anaximander Mountain (*sensu stricto*) and the combined Anaximenes and Anaxagoras Mountains. This zone is informally referred to as the Sırrı Erinç Plateau (Aksu et al., 2009), which extends from the Finike Basin in the northeast to the southern fringes of the Rhodes Basin in the west, with water depths ranging ~2100 m in the northeast to ~3500 m in the west and southwest (Fig. 2). Two broadly north–south trending prominent lineaments mark the boundaries between the Sırrı Erinç Plateau and the Anaximander Mountain in the northwest and the Sırrı Erinç Plateau and the Rhodes Basin in the west (y and z in Fig. 2). Previous studies revealed that these lineaments are the surface expressions of two prominent north–south striking and west-verging thrust culminations (e.g., Aksu et al., 2009; Hall et al., 2009). A second prominent zone characterized by corrugated seafloor morphology occurs across the southwestern Antalya Basin, immediately northeast of the foothills of the Anaxagoras Mountain (w in Fig. 2).

3. Data acquisition and methods

The principal data used in this paper consist of (a) ~4500 km of multichannel seismic reflection profiles collected in 1992 and 2001

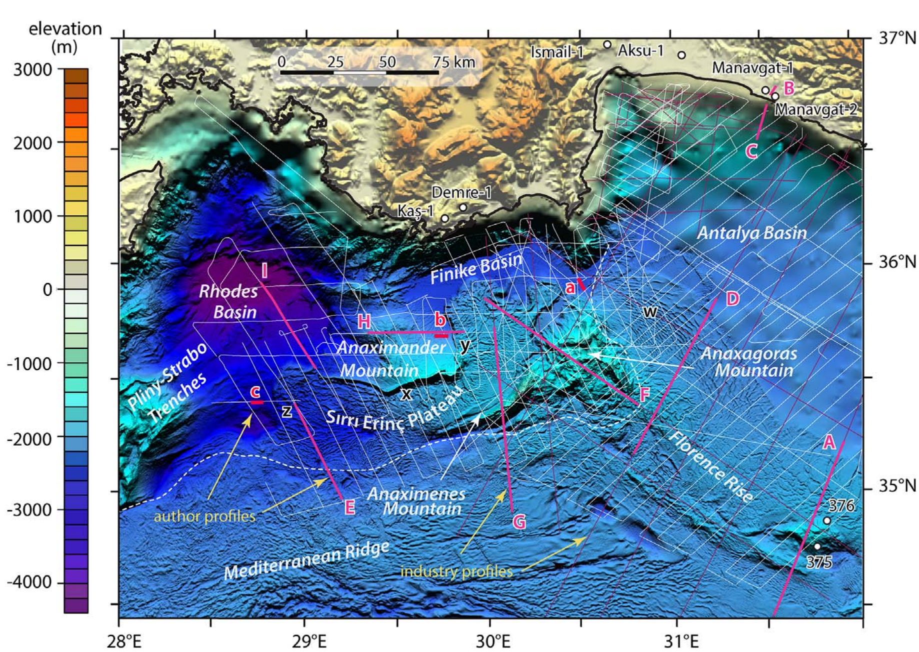

Fig. 2. Bathymetry and topography of the study area showing the locations of the multichannel seismic reflection profiles and exploration wells used in this study. The topography is compiled using GeoMapApp (Ryan et al., 2009), and shaded using Caris Base Editor (4.1). The multibeam bathymetry is from the 100 m-resolution ANAXIPROBE 95 data (Woodside, 1995) for the Anaximander Mountains and Rhodes Basin and the 500 m–resolution EMODnet (European Marine Observation and Data Network, Portal for Bathymetry, http://www.emodnet-hydrography.eu/) data for the southern Antalya Basin and Florence Rise. The bathymetry of the Turkish continental shelf and the Antalya Basin is from the International Bathymetric Charts of the Mediterranean (IOC, 1981). Thick burgundy lines are illustrated in text figures. White dashed line represents the purported boundary between the occurrence of Messinian evaporite deposits (south and east of line) and their absence (north and west of line) by various authors (see text for detail). Black letters show the open V-shaped narrow and arcuate ridge of Anaximander Mountain (**x**), which connects two N–S trending escarpments between the Sırrı Erinç Plateau and the southern continuation of the Finike Basin (**y**) and the Sırrı Erinç Plateau and the southern sector of the deep Rhodes Basin (**z**) and the corrugated seafloor across the northeastern foothills of the Anaxagoras Mountain (**w**). Red line segments with red letters **a, b, c** are multichannel seismic reflection profiles for which interval velocities are calculated. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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