



Research paper

The Hecataeus Rise, easternmost Mediterranean: A structural record of Miocene–Quaternary convergence and incipient continent–continent collision at the African–Anatolian plate boundary



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ABSTRACT

The Hecataeus Rise represents a plateau-like structure, adjacent to the southern Cyprus margin and directly next to the Cyprus – Eratosthenes Seamount convergence zone, where incipient continent–continent collision is believed to occur. Based on newly acquired seismic reflection and bathymetric data, we report on the Miocene to Quaternary structural evolution of this yet underexplored sector along the African–Anatolian plate boundary. A period of pre-Messinian compression has significantly deformed the western and southern part of the plateau area. Offshore continuation of onshore Cyprus lineaments attests the existence of a pre-Messinian structural link between Cyprus and the Hecataeus Rise. Owing to its relatively elevated position during the Messinian Salinity Crisis, the Hecataeus Rise experienced wide-spread Messinian erosion and only local deposition of evaporites which were precipitated within small, isolated sub-basins. Post-Messinian convergence was accommodated along the southeastern flank of the Hecataeus Rise, where NE–SW trending anticlinal structures experienced reactivation and significant growth. A prominent intra-Pliocene–Quaternary unconformity in the northwestern part of the plateau area may correlate with the Pliocene–Pleistocene transition and indicates the near synchronous occurrence of several tectonostratigraphic events. We suggest that these events represent a chain of structural and depositional changes initiated by incipient collision of Eratosthenes Seamount with Cyprus and the northwestern corner of the Hecataeus Rise. Collision-derived uplift of Cyprus resulted in vertical separation between Cyprus and the Hecataeus Rise and the development of a prominent unconformity in the northwestern part of the plateau area. Increasing the slopes adjacent to Cyprus facilitated more energetic downslope sediment transport, expressed by the development of sediment waves and the evolution of a prominent canyon structure at the northeastern limit of the plateau area.

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1. Introduction

The Cyprus Arc, located in the easternmost Mediterranean Sea, represents a complex zone of tectonic convergence between the African and Anatolian plates (Vidal et al., 2000b; McClusky et al., 2003; Hall et al., 2005; Wdowinski et al., 2006; Le Pichon and

Kreemer, 2010) (Fig. 1a). Major advances in understanding the evolution of the plate boundary were made in the course of scientific drilling at DSDP Leg 42a (Sites 375 and 376) (Shipboard Scientific Party, 1978) and ODP Leg 160 (Sites 965, 966, 967 and 968) (Robertson, 1998a,b) and by reflection seismic profiling at several locations along the Cyprus Arc (Ben-Avraham et al., 1995; Vidal et al., 2000a,b; Woodside et al., 2002; Hall et al., 2005; Kopf et al., 2005; Krashennnikov et al., 2005; Hübscher et al., 2009; Maillard et al., 2011; Sellier et al., 2013; Klimke and Ehrhardt, 2014; Montadert et al., 2014; Reiche et al., 2015).

Yet, the existence of several underexplored sectors along this plate boundary complicates a consensus tectonic interpretation. One of such underexplored regions is represented by the Hecataeus Rise – an approx. 55 km × 65 km sized rectangular, plateau-like

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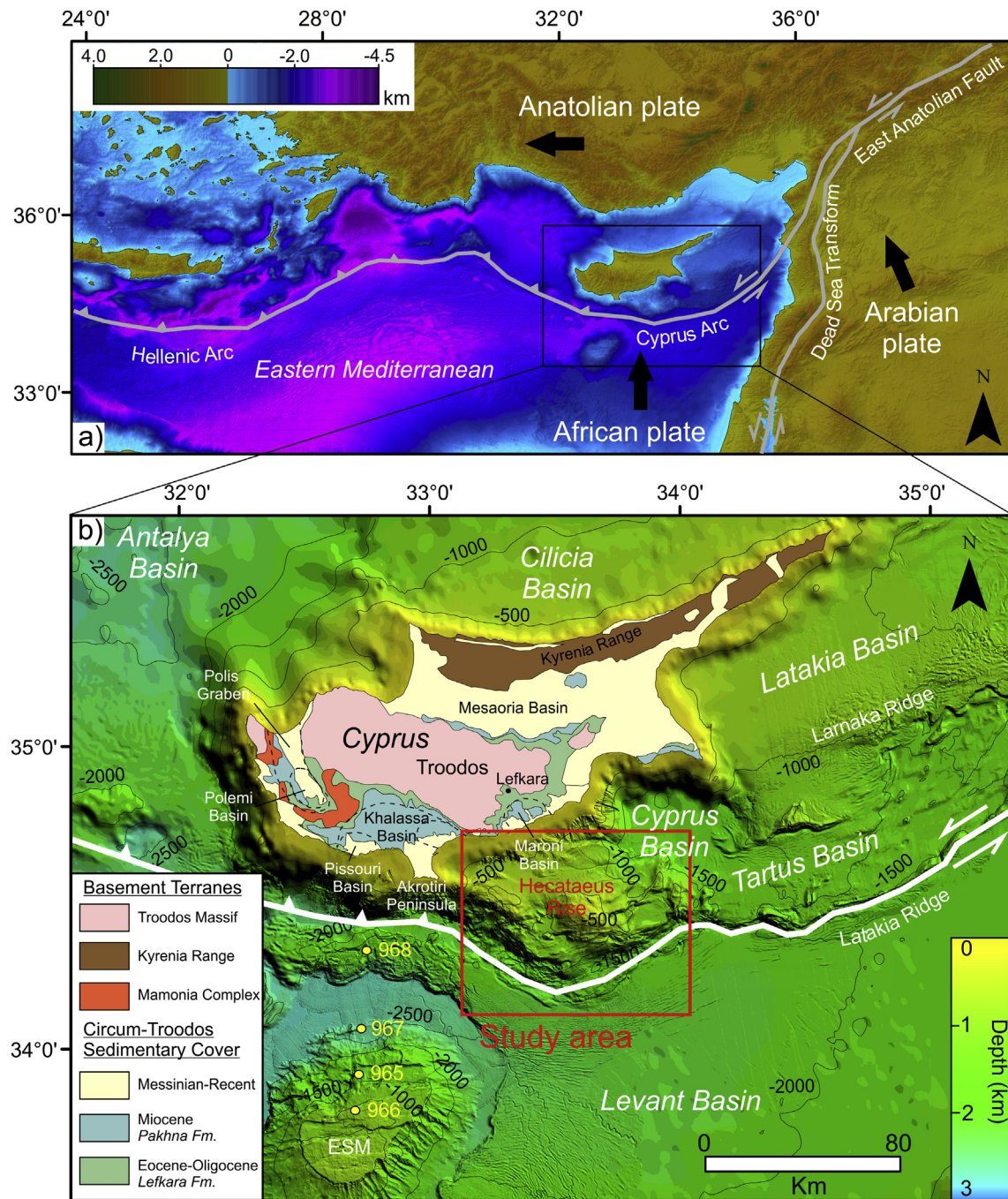


Figure 1. a) Overview and simplified tectonic map of the Eastern Mediterranean drawn with the aid of GeoMapApp® (<http://www.geomapp.org>) comprising data published by Ryan et al. (2009). The large-scale tectonic configuration is based on Hall et al. (2014) and Schattner (2010). b) Enlarged map showing the bathymetry of the offshore-Cyprus-region, including data specified in Section 3.1. A simplified geological map of Cyprus was drawn after Kinnaird and Robertson (2012). Cyprus lineaments and sedimentary basins were delineated after Robertson et al. (1991). The bold white line represents the inferred location of the African-Anatolian plate boundary (see text in 2.1 for references). Yellow dots represent ODP Leg 160 drilling Sites. ESM = Eratosthenes Seamount. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

structure (Fig. 1). The Hecataeus Rise is bordered by Cyprus to the north, the Cyprus and Tartus Basins to the east, the Levant Basin to the southwest and the Eratosthenes Seamount to the southwest (Fig. 1b). With water depths between 250 and 1200 m, this structure is elevated by up to 1500 m above the surrounding seafloor.

Previous workers discussing the possible origin of the Hecataeus Rise have come to conflicting interpretations. While Robertson (1998b) raised the possibility that the Hecataeus Rise may

represent an offshore extension of the Troodos ophiolite, other studies interpreted this structure as an accreted crustal unit (Rotstein and Ben-Avraham, 1985; Ben-Avraham et al., 1988). Yet, only few seismic lines were acquired across the Hecataeus Rise, making inferences on its structural evolution rather speculative.

In this study we interpret a comprehensive set of reflection seismic profiles across the entire Hecataeus Rise in combination with high-resolution bathymetric data (Fig. 2). Based on this newly

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