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Post-Miocene Deformation in the South Aegean: Insights from Seafloor Morphology and Seismic Profiling Data

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Introduction

Geodetic surveys and kinematic models indicate that the western, larger part of South Aegean, along with Peloponnese behaves as a rigid body which translates SSW-wards at 33-34 mm yr-1 while SE Aegean moves at 10 mm yr-1 toward SE, away from the latter (Kreemer & Chamot-Rooke, 2004; Reilinger *et al.*, 2010). Seismological data show a rather week or at least not frequent seismic activity with normal and oblique faulting earthquake focal mechanisms and more or less stable, WNW-ESE trending T-axis (Kiratzi & Louvari, 2003). Old and recent marine geological-geophysical campaigns revealed a complicate seafloor morphology and geological structure indicating that deformation in the South Aegean is active and the long-term kinematics and tectonic movements follow a more complex patter than anticipated by the short-term geodetic and seismological observations (Sakellariou & Tsampouraki-Kraounaki, 2019 and references therein). This paper aims to contribute to the understanding of the post-Miocene evolution and active tectonics in the South Aegean in the framework of the ongoing Hellenic subduction and the effect of the westward propagating North Anatolian Fault.

Methods

The bathymetric relief published recently by EMODNET Bathymetry (https://emodnet.eu/bathymetry) includes literally all available swath bathymetry data and reprocessed GEBCO bathymetry and provides a reliable base for geomorphological analysis (Fig. 1). Old and recent seismic reflection profiles available at HCMR (Fig. 1A) have been used to extract information on the shallow geological structure and seismic stratigraphy.

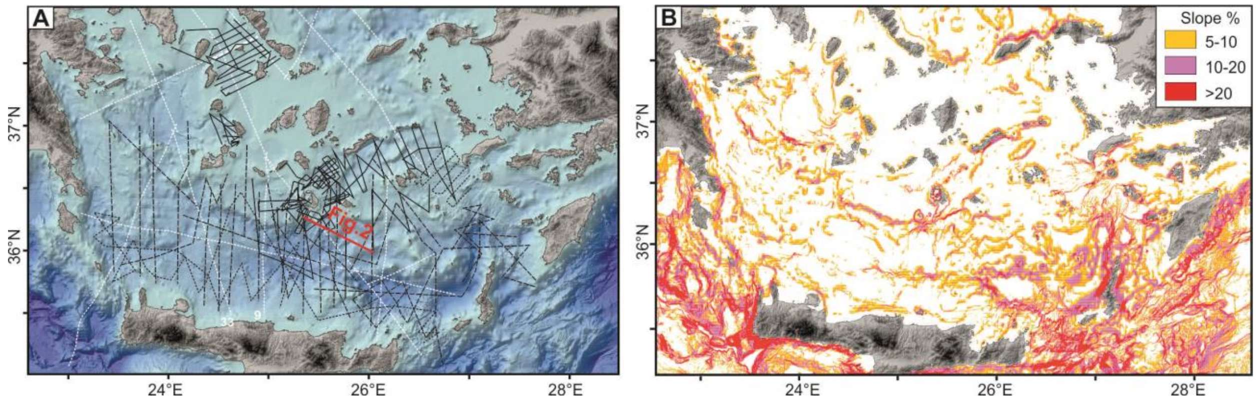

Figure 1. (A) Bathymetry and location of seismic profiles in the South Aegean. (B) Slope map highlighting the complicate morphological structure of the South Aegean.

Results

The seafloor morphology of the South Aegean is characterized by isolated basins with rhomboid, elliptical, trapezoid or spindle shape and dimension of a few tens of kilometers. They are aligned predominantly in NE-SW to ENE-WSW and secondarily in NW-SE to WNW-ESE directions, which coincide with the orientation of the steep slopes and are separated from each other by shallow ridges (Fig. 1B). The southern margin of the Cyclades Plateau is characterized by less than 1000 m deep basins. Maximum depths, between 2000 m and 2500 m, occur at the southeastern part of the South Aegean, while in the western part the depth of the major basins ranges between 1000 m and 2000 m.

Numerous, major and secondary faults cross cut the seafloor of the South Aegean, they group in two main directions, NE-SW to ENE-WSW and NW-SE to WNW-ESE and coincide with the prevailing steep slopes (Fig. 3A). They are largely responsible for the relief of the seafloor and control the margins of the topographic basins and the ones of the active sedimentary basins. A major unconformity M occurs throughout the South Aegean (Fig. 2). Below the margins, it marks the erosional surface of the basement exposed during the Messinian. Below the basins, it represents the top of the Messinian evaporites. A second, widespread unconformity U has been observed in DSDP 378 drill hole in the Cretan Basin (Hsű *et al.*, 1978) and in the sedimentary infill of most of the basins in the South Aegean (Bartole *et al.*, 1983; Mascle & Martin, 1990; Piper & Perissoratis, 2003; Anastasakis & Piper, 2005, Tsampouraki-Kraounaki & Sakellariou, 2017). It marks a major change in the tectonic regime, which led to rearrangement and faulting of the Pliocene basins, basin inversion, local subsidence and/or uplift and the development of the present morphological structure.

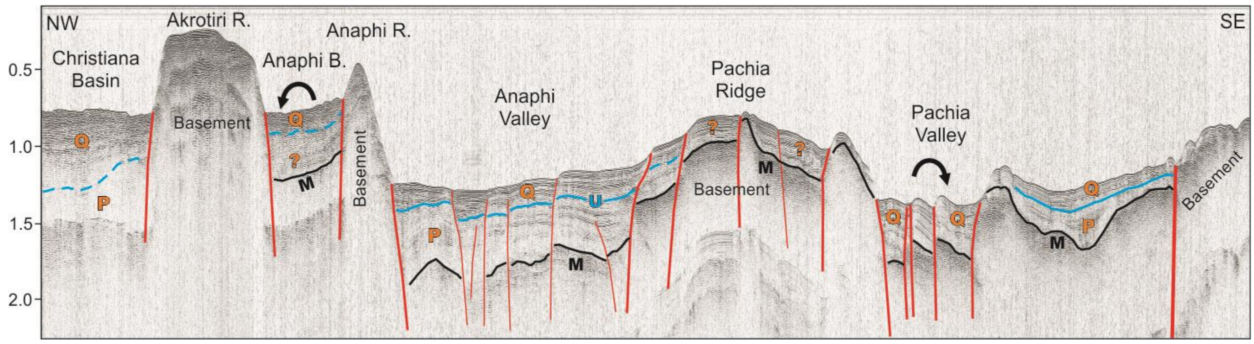

Figure 2. Seismic reflection profile (see Fig. 1A for location). The major unconformity U between the Pliocene (P) and Quaternary (Q) deposits is shown in blue. Note the dense faulting and the opposite sense of basins asymmetry between the northern and southern parts. M: Messinian unconformity

Conclusions

The configuration of the fault network, the spatial distribution of the morphological and sedimentary basins (local subsidence) and ridges and islands (local uplift), along with the seismological data point to a dual kinematic pattern in the South Aegean (Fig. 3B). The southeastern part undergoes transtensional deformation along NE-SW to ENE-WSW sinistral strike slip to oblique faulting, in accordance to the kinematics of the Pliny and Strabo Trenches. The rest of the South Aegean experiences transtenional deformation along NE-SW dextral strike slip to oblique faulting and conjugate NW-SE predominantly normal faulting. The unconformity U in Late Pliocene / Early Quaternary marks the onset of this kinematic pattern which remains active presently. We suggest that the establishment of the present kinematic regime has been triggered by the gradual propagation of the North Anatolian Fault into the Aegean and accommodates the SSW-ward movement and general NNE-SSW extension in the South Aegean.

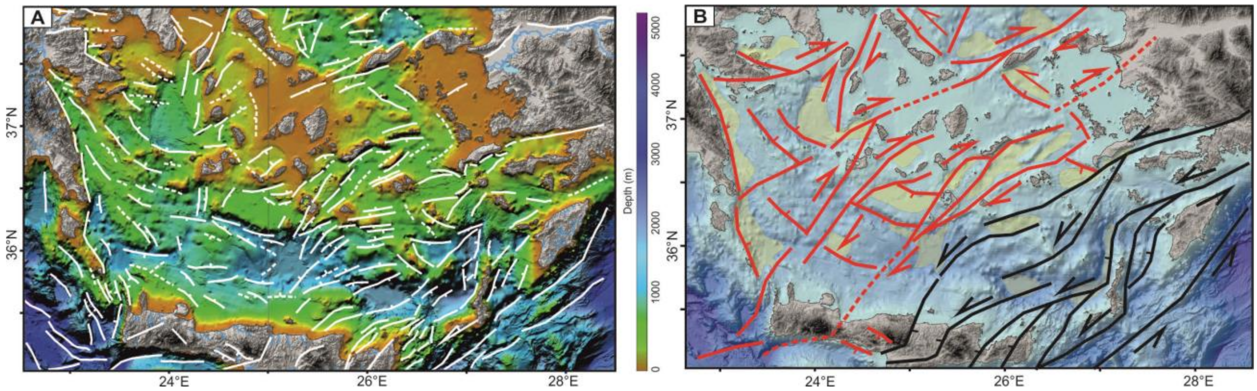

Figure 1. (A) Processed bathymetry and tetwork of main active faults in the South Aegean. (B) Main Plio-Quaternary depocenters (in yellow) and interpreted active, composite, dextral (black) and sinistral (red) fault/shear zones.

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