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3D crustal structure in the neotectonic basin of the Gulf of Saronikos (Greece)

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Abstract

An on-/offshore seismic network consisting of 36 three-component stand-alone digital stations was deployed in the area of the Saronikos Gulf, in the vicinity of Athens (Greece), in the fall of 2001. In the present study, from an initial set of more than 1000 micro-earthquakes, 374 were selected and 6666 P- and S-wave arrivals were inverted, based on a 3D linearized tomography algorithm, in order to determine the 3D velocity structure of the region.

The resulting 3D velocity distribution, in agreement to the micro-seismicity distribution, reflects the Saronikos structure down to a depth of 12 km. So, the neotectonic basin of the Saronikos Gulf is divided in two parts by a central platform, which implies the existence of a NNE–SSW-trending rupture zone. This zone is probably the offshore extension of a large thrust belt dominating the adjacent onshore areas. Due to their different structure, the two basins are dominated by different velocity values in comparison to the central platform.

The western part is characterised by higher seismic activity than the eastern one. Furthermore, the western Saronikos Gulf is divided in a northern and a southern part by a well-defined rupture zone trending E–W. This seems to be the extension of the Corinthiakos Gulf fault zone. At the depth of 17 km, the velocity increases considerably and the crustal thickness is restricted down to 20 km. This 'unexpected' low thickness in the region of Saronikos Gulf seems to be the result of the extensional stress field, which dominates the region, as well as of the emergence of the mantle material along the volcanic arc, which clearly appears at the depth of 12 km. Yet the lack of deep events and, hence, the poor resolution below the depth of 17 km does not support a definite conclusion about the crust–mantle boundary in this region.

Keywords: Velocity structure; Tomography; Saronikos Gulf; Greece

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1. Introduction

The Saronikos Gulf is situated in the northwestern part of the Hellenic volcanic arc, between the Pliocene volcano of Aegina and the Pleistocene volcanoes of Methana and Sousaki (Fig. 1). The area is in generally characterised by low seismicity. However, at its northern and western borders, strong historical as well as recent earthquakes have occurred (Fig. 1), all associated with a roughly N–S extensional tectonic field. In the vicinity of the Saronikos Gulf, the existence of the highly populated Attiki region and particularly the city of Athens gives to the seismicity of the area a major significance, from the social and economic point of view (see also Papadopoulos et al., 2000).

During the instrumental observation period of Greece, in the broader area of Athens and particularly in the Saronikos Gulf area, no considerable seismic activity had been recorded prior to the event of September 7, 1999 (Ms=5.9). Therefore, it is not surprising that no systematic micro-seismicity study has been carried out in the past. After the event of 1999, the need of mapping the active faults in the Attiki offshore area was reconsidered. Specifically, the understanding of the active deformation of the Saronikos Gulf area is a must in order to estimate the seismic potential and seismic hazard of the Attiki region. The acquisition of a local velocity model is also judged essential for understanding the seismogenic processes.

The 2D crustal structure of the Saronikos–eastern Corinthiakos basins was investigated in the past, suggesting an intense crustal thinning below the volcanic area of the Saronikos Gulf (Makris et al., 2004a). Following the passive seismic observations of the fall of 2001, a 3D active seismic experiment was also conducted, the results of which are under evaluation (Makris, personal communication). Some work has been also done in the adjacent onshore area of Attiki, after September 7, 1999 earthquake, with 3D passive seismic tomography based on local seismological networks (Drakatos et al., 2002). The existing information

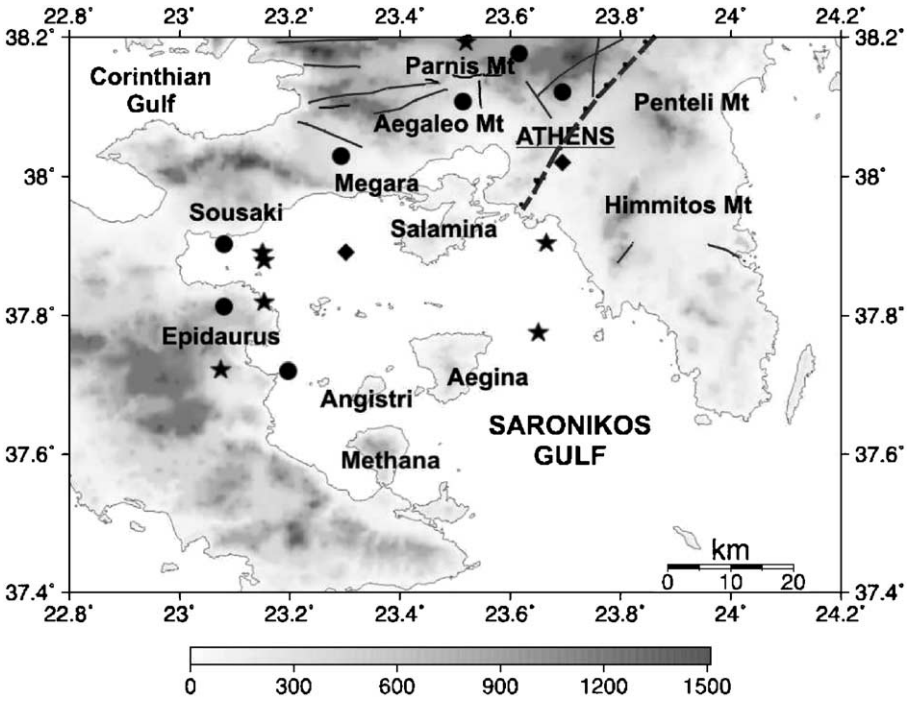

Fig. 1. A simplified tectonic map of the study region is shown. The black lines represent faults, whereas the black broken line represents the thrust belt zone dominating Attiki region. The diamonds represent the historical earthquakes from 450 B.C. to 1900 (M>6.0, after Papadopoulos et al., 2000). The stars show the epicentre distribution from 1901 to 1964 (M>5.0, after Makropoulos et al., 1989; Papazachos and Papazachou, 1997). The black circles show the epicentre distribution from 1965 to 2000 (M>6.0, Monthly Bulletins of Institute of Geodynamics, NOA).