CHAPTER 1

INTRODUCTION

Considering the complexity of the surface tectonics, it is important to investigate the structure of the underlying upper mantle in order to better understand the tectonic evolution of the region. The global scale tomographic image of the Earth's interior indicates that the structure in the top 100-200 km is closely related to the tectonic regime at the surface. To determine the physical properties of the deep structure, potential (gravity, magnetic, heat flow) or kinetic (seismic waves that generated from earthquakes) energy of the Earth itself and kinetic energy that is created artificially (seismic sounding) have been used in the Aegean region since the 1960' s. The crustal and mantle structures of the Aegean are the result of a complex history that started probably during the late Cretaceous (e.g. McKenzie, 1972) and resulted in the subduction of Africa beneath Eurasia, the building of mountain belts caused by collision between Apulia and western Greece and the creation of stretched regions, which has occurred since the early Miocene. Tectonic processes such as subduction change the equilibrium conditions in the Earth’s layered medium. As a result of these changes in the mantle, the surface geology is greatly affected or directly formed by material carried from the mantle or the subducting oceanic lithosphere.

There is a lot of unknown geological and geophysical details in the Aegean region that need to be determined. The present-day kinematics and surface deformation are reasonably well known because of the large amount of GPS measurements covering the Aegean (e.g. Le Pichon et al., 1995; Reilinger et al., 1997; McClusky et al., 2000). However, the present-day kinematics is certainly different from that of the past, as it is attested by the large amount of rotation that the Hellenic arc experienced since the

Oligocene (Kissel and Laj, 1988). Therefore, a knowledge of the crustal structure, compared with the present day kinematics could help constraining the previous episodes of deformation.

The lithospheric structure in the Aegean area has been the focus of many studies. Travel time analysis from local and regional earthquakes, refraction profiles beneath specific areas in the Aegean, tomographic studies in the Aegean scale and gravity measurements have mapped the structure, but the data are scarce and of varying quality. However, multi disciplinary studies are needed to resolve the complex structure beneath this area.

The main goal of this thesis is to obtain homogeneous and detailed image of the continental Aegean lithosphere and subducting African slab in the region of Crete, the mainland of Greece and the Aegean down to the mantle from direct seismological observations. To reach this goal, I apply the P receiver function technique to the existing data recorded by 43 stations belonging to various networks across the whole area. The fine structure within the crust is resolved by P receiver functions, even though the derived seismological images have large gaps where no station exists. The structure in areas not covered by P receiver functions are obtained with S receiver functions, which offers an opportunity to sample seismic boundaries in sea areas with data from nearby land stations. S receiver functions are computed for 50 stations within the area. Both techniques compliment each other, with P receiver functions resolving the most prominent structures beneath each seismological station and S receiver functions filling in the gaps deduced from P receiver function images and resulting structures of larger distances from the stations and at larger depths in the mantle. S receiver functions have no multiples which disturb P receiver functions and therefore are utilized to identify such a discontinuity like the lithosphere-asthenosphere boundary, which is generally invisible in P receiver functions. The combination of all these data resulted in the most complete high-resolution image of the crustal thickness of the continental Aegean plate as well as the subducting oceanic African plate. The geometry of the subducted plate is also presented using S receiver functions. Finally, a map of the lithosphere-asthenosphere boundary is obtained from the S data.

This thesis consists of six chapters :

Chapter **2** explains the detailed tectonic and geological settings of the Aegean area. The seismicity of the Aegean is presented and the previous works in this region are briefly introduced.

Chapter **3** discusses the P and S receiver function methods as they have been used and developed for this study. Synthetic receiver functions are shown to describe different aspects of the steps taken to process the data.

Chapter **4** introduces the data set, the utilized seismic stations for each method and the various networks, which have been deployed.

Chapter **5** shows the results obtained from P and S receiver function methods across the whole Aegean. The results on the continental Aegean lithosphere as well as on the descending African lithosphere are presented in trems of two maps. The new information about the lithosphere-asthenosphere boundary is also presented for the first time for both, the continental and oceanic plates. The results are then discussed and compared with previous studies in this area.

Chapter **6** includes the concluding remarks of the study.

The additional information on the events and instrumentation used in this study are then presented in appendixes **A** and **B**. Appendix **C** includes the arrival times of Ps and Sp conversions from major discontinuities in the crust and upper mantle as well as calculated depth values.