Geophysical Research Abstracts, Vol. 7, 08828, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08828

New results for the S-wave structure of the Aegean area using Rayleigh and Love wave group velocity inversion and comparison with independent 3-d traveltime velocity models: Do the models match?

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In the present work we present the results from a large scale study of surface wave group velocity dispersion beneath the Aegean area. The main aim of the work is to derive a 3D tomographic model of the S wave velocity structure of the crust-uppermost mantle in the Aegean area using the group velocities of Rayleigh and Love wave of the fundamental mode. The database consists from regional earthquakes recorded at portable broad-band 3-component digital stations. For each epicenter-station ray path group velocity dispersion curves are measured using appropriate frequency time analysis (FTAN) and dispersion measurements for more than 600 Love wave paths were used. We have also incorporated previous results concerning 700 Rayleigh wave-path of the study area (Karagianni et al., 2002). The local dispersion curves were used to perform surface wave tomography and group velocity maps for Rayleigh and Love waves were computed for periods from 6 to 30sec, both independently and jointly. On the basis of a regionalization of the dispersion measurements, local averaged dispersion curves have been obtained and non- linearly inverted in order to obtain models of shear-wave velocity versus depth. Strong lateral variations of the S-wave velocities of the crust and uppermost mantle of the studied area are found due to the complex tectonic setting of the Aegean area. In the Southern Aegean Sea, as well as in a part of the Central Aegean Sea a thin crust of approximately 20-22 km is observed, whereas the remaining Aegean Sea area exhibits a crustal thickness less than 28-30km. On the contrary, a crustal thickness of 40-46 km is observed in western Greece along the Hellenides mountain range, whereas in the eastern continental Greece the crust

has a typical thickness of about 30-34 km, in agreement with previous results. In the Southern Aegean Sea very low S-wave velocities (3.6-4.0 km/sec) are observed in the mantle wedge just below the Moho discontinuity, which can be associated with the presence of a partially melt mantle wedge in the Southern Aegean subduction zone. It should be noted that when inverted independently Love wave dispersion curves tend to lead to a systematic increase of the determined velocity models compared to Rayleigh waves. However, in most cases the joint inversion is able to determine a single model (out of the multiple models compatible with the data) that can interpret both Rayleigh and Love dispersion data. The obtained results are compared with an independently determined 3-d P and S velocity model for the crust and uppermost mantle of the Aegean area (Papazachos and Nolet, 1997). In general the crustal thickness variations mainly reflected in the P-wave structure from body waves (traveltimes) and S-waves (from surface wave group velocity inversion) are in excellent agreement. However, the amplitudes of the S-waves velocity anomalies determined from surface wave inversion are significantly larger (up to more than 200% higher) when considering the S-wave structure from travel times. This effect is especially prominent for the southern Aegean mantle low velocity layer, corresponding to the mantle wedge above the southern Aegean subduction zone, where very low upper mantle velocities are detected from surface-wave inversion. These results suggest a possible bias not only of the tomographic approach in travel-time inversions (e.g. S-wave structure is often obliged to “follow” the P-wave structure) but also of the original travel-time data, as large S residuals are often rejected during the preliminary relocations procedures followed by seismological networks. Moreover, additional factors such as anisotropy need to be considered to account for such discrepancies.

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