Geophysical Research Abstracts
Vol. 18, EGU2016-9113, 2016
EGU General Assembly 2016

Crustal seismic anisotropy and structure from textural and seismic investigations in the Cycladic region, Greece

Élise Cossette (1), David Schneider (1), Pascal Audet (1), and Bernhard Grasemann (2)

(1) Earth & Environmental Sciences, University of Ottawa, Canada (david.schneider@uottawa.ca), (2) Geodynamics & Sedimentology, University of Vienna, Austria

Seismic anisotropy data are often used to resolve rock structures and deformation styles in the crust based on compilations of rock properties that may not be representative of the exposed geology. We use teleseismic receiver functions jointly with in situ rock property data to constrain the seismic structure and anisotropy of the crust in the Cyclades, Greece, located in the back arc region of the Hellenic subduction zone. Crystallographic preferred orientations (CPOs) via electron backscatter diffraction (EBSD) analyses were measured on a suite of samples representative of different structural depths along the West Cycladic Detachment System; average seismic properties of the rocks were calculated with the Voigt-Reuss-Hill average of the single minerals' elastic stiffness tensor. The calcitic and quartzitic rocks have P- and S-wave velocity anisotropies (AVp, AVs) averaging 8.1% and 7.1%, respectively. The anisotropy increases with depth represented by blueschist assemblages, with AVp averaging 20.3% and AVs averaging 14.5% due to the content of aligned glaucophane and mica, which strongly control the seismic properties of the rocks. Localized anisotropies of very high magnitude are caused by the presence of mica schists as they possess the strongest anisotropies, with values of ∼25% for AVp and AVs. The direction of the fast and slow P-wave velocities occur parallel and perpendicular to the foliation, respectively, for most samples. The fast propagation has the same NE-SW orientation as the lithospheric stretching direction present in the Cyclades since the Late Oligocene. The maximum shear wave anisotropy is subhorizontal, similarly concordant with mineral alignment that developed during back-arc extension. Our results strongly favor radial anisotropy in the Aegean mid-crust over azimuthal anisotropy. The receiver function data indicate that the Moho is relatively flat at 25 km depth in the south and deepens to 33 km in the north, consistent with previous studies, and reveal an intra-crustal discontinuity at depth varying from 3 to 11 km, mostly observed in the south-central Aegean. Harmonic decomposition of the receiver functions further indicates layering of both shallow and deep crustal anisotropy related to crustal structures. We model synthetic receiver functions based on constraints from the in situ rock properties that we measured using the EBSD technique. Our results indicate that the shallow upper crustal layer is characterized by metapelites with ∼5% anisotropy, underlain by a 20 km thick and anisotropic layer of possible high-pressure rocks comprising blueschist and eclogite and/or restitic crust as a consequence of Miocene magmatism. Seismic anisotropy models require a sub-vertical axis of hexagonal symmetry in the upper crust (i.e. radial anisotropy), consistent with in situ rock data. Finally, a thinned crust is likely caused by back-arc extension associated with elevated sub-crustal temperatures, in agreement with thermal isostasy models of back arcs. This study demonstrates the importance of integrating rock textural data with seismic velocity profiles in the interpretation of crustal architecture.