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Seismic structure of the Carboneras fault region, SE Spain from ambient noise analysis and laboratory measurements

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The Carboneras fault in southeastern Spain is a left-lateral strike-slip fault forming part of the trans-Alboran shear zone. Detailed mapping has revealed a complex fault structure, including a number of high-strain fault gouge bands. The geology of the surrounding area varies widely, with metamorphic basement rocks, sedimentary basins, and areas of igneous intrusion within a 50 km^2 area. Preliminary results are presented, building towards an integrated geological and seismological structure of the region.

A temporary network of 24 seismometers, including 10 regional broadband 3T, and arrays of ESPDs/6TDs across sections of the fault was deployed in 2010-2011. Ambient seismic noise recorded on this network is used to image the subsurface in the area. Cross-correlations of ambient seismic noise are calculated between stations and approximate to the Green's functions between each station-station pair. Short-period surface wave dispersion curves are estimated for each raypath from the Green's functions using frequency time analysis. The suite of determined dispersion curves are then used to obtain velocity maps for various periods, relating to different depths. The data are then also used to obtain 1D to 3D velocity-depth models. Sensitivity kernals show that depths down to 8-10km are sampled. An average 1D velocity model over the area, to fit the average dispersion curve, suggests a shallow surface layer of 0.5 km with velocities of 1.5 kms^{-1} or less. This model suggests a velocity jump to 2.5 kms^{-1} below this until 2 km depth, followed by a velocity of 3.3 kms^{-1} until 7km depth and a velocity of 3.95 kms^{-1} below this.

The observed 3D velocity structure correlates well with mapped surface geology of the area. Metamorphic basement rocks and areas dominated by igneous intrusion are observed as relatively high-velocity areas. Major sedimentary basins in the area appear to exhibit lower velocities. Different rock types correspond to lateral changes in velocity of the order of 1 kms^{-1}.

Seismic velocities of rocks in the Carboneras fault area are further investigated through laboratory experiments to provide a higher resolution view of the fault structure. Samples used are from the Carboneras micaschist, from which the fault gouge is derived. Ultrasonic P and S waves are pulsed through the samples. The signals from uniaxial and triaxial experiments are analysed. The effects of differential stress and and confining pressure on velocity and attenuation properties are studied. Velocities determined from S-wave laboratory experiments at various confining pressures are compared to those obtained at various depths from Green's function analysis.