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Mantle wedge anisotropy beneath the Western Alps: insights from Receiver Function analysis

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Orogens and subductions zones are the locus where crustal materials are recycled into the upper mantle. Such rocks undergo to several metamorphic reactions during which their seismic properties vary due to the changes in P-T conditions. Metamorphic reactions can imply: (a) the formation of schist-like materials, and (b) a pronounced water flux from the subducted crust. Both these processes should generate highly anisotropic volumes at upper mantle depths. Thus, unveiling the presence of seismic anisotropy at such depth level can put constraints on the metamorphic reactions and the P-T conditions of the subducted materials.

The Alpine orogen is composed of three main regions where different geodynamic processes shaped a highly heterogeneous mountain chain. Beneath the Alps, a high velocity body has been imaged sinking in the upper mantle, indicating the presence of a relict of subduction. Such subduction process has been probably terminated with the closure of the Piemont-Liguria Ocean, but evidence of continental subduction has been found beneath the Western Alps. Seismic anisotropy is likely to develop both in the subducted materials and in the mantle wedge, where serpentinized materials could be found due to the low T conditions.

We analysed P receiver function (RF) from 46 seismic stations deployed along a linear array crossing the Western Alps, where previous studies revealed the presence of the subducted European lower crust to 80 km depth. RF is a widely used tool for reconstructing subsurface seismic structures, based on the recognition of P-to-S converted phases in teleseismic P-wave coda. The RF data-set is migrated at depth and decomposed into azimuthal harmonics. Computing the first, k=0, and the second, k=1, harmonics allows to separate the “isotropic” contribution, due to the change of the isotropic properties of the sampled materials (recorded on the k=0 harmonics), from the “anisotropic” contribution, where the energy is related to the propagation of the P-wave through anisotropic materials (recorded on the k=1 harmonics). Preliminary results show the presence of a Ps phase on the k=0 harmonics along the western portion of the profile, with increasing time-delay toward East. This phase is interpreted as the European Moho Ps, confirming the geometry of the European Moho beneath the Western Alps. Beneath the internal portion of the orogen, the k=1 harmonics display energetic pulses between 3-7 s, indicating the development of anisotropy within a broad volume of rocks, at lower crustal and upper mantle depths. The presence of anisotropic materials is jointly interpreted with the depicted geometry of the main seismic discontinuities and the location of the intermediate-depth seismicity recorded in the region.