Alpine subduction revisited - new structural and elastic wave velocity models for improved geophysical imaging towards greater depths

Proponents: Ruth Keppler, Michael Stipp, Niko Froitzheim
PhD student: Michael Schmidtke

Preliminary results

The goal of this study is to constrain deeper structures within the Alps by providing data on elastic properties of different crustal units, which can be used as input parameters in seismic models. A large sample set was collected in different areas within the Central and Western Alps providing sample lithologies representative of lower crust, as well as oceanic and continental upper crust. Bulk crystallographic preferred orientations (CPO) of these rocks were measured using time-of-flight neutron diffraction and used to calculate seismic anisotropies.

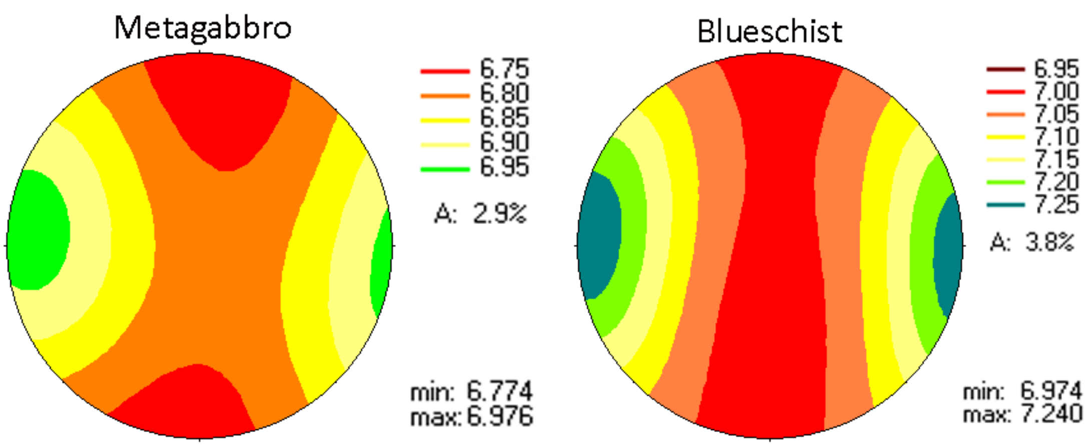

Fig. 2: P-wave velocities in km/sec of a lower crustal and an oceanic rock; A: Anisotropy.

Rocks collected in the Zermatt-Saas zone are blueschists and eclogites. They represent subducted oceanic crust currently found at depth within the Alps. Samples collected in the Ivrea Zone are metagabbros representing lower crust. Samples representative of upper crustal rocks deformed during the Alpine Orogeny were collected in the Adula Nappe and comprise metasediments and orthogneisses.

P-wave anisotropies of oceanic crustal rocks are 1- 4 % and mostly determined by CPO of omphacite, glaucophane and hornblende. They show highest velocities aligned in lineation direction. P-wave anisotropies of mafic lower crust are about 3 %. They are also strongly influenced by CPO of pyroxene and amphibole, hence exhibit high velocities within the lineation direction (Fig. 1).

Determining representative elastic anisotropies for the upper crust is more complicated, since the upper crust within the Alps is strongly heterogeneous, both in lithology and grade of deformation (Fig. 2).

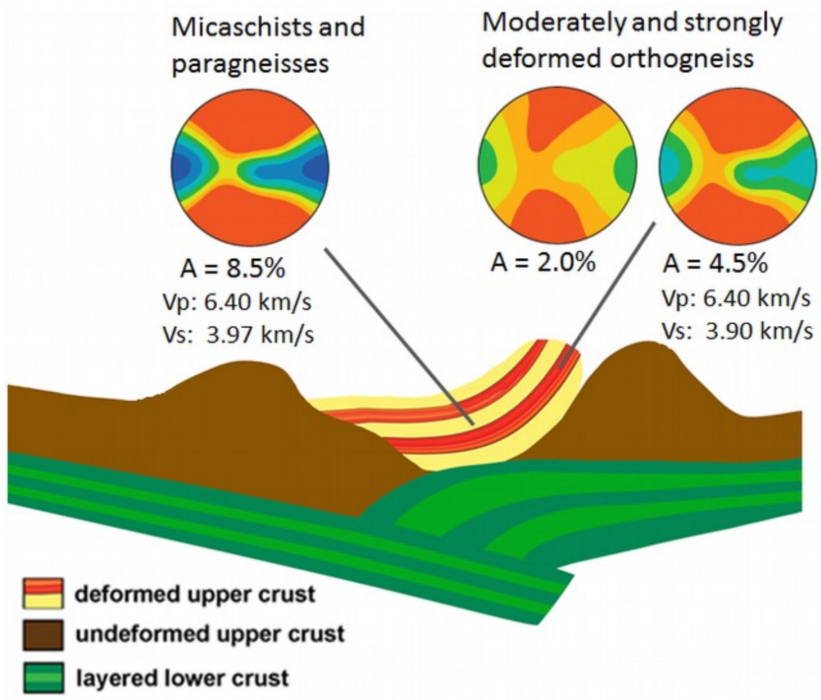

Fig. 2: Simplified tectonic structure of the Alps. Average elastic anisotropy patterns of typical upper crustal rocks are illustrated; A = elastic anisotropy; Vp = P-wave velocity; Vs = average S-wave velocity.

Samples within this study are representative of the deformed part of the Central Alps, which is found north of the Insubric Line. Average anisotropies were calculated from representative CPO of metasediments and of both strongly and weakly deformed orthogneisses yielding 8.5%, 4.5% and 2.5% for P-wave anisotropies, respectively (Fig. 2). They are influenced by both mica and quartz CPO and show a stronger distribution of high velocities within the foliation plane compared to the basic rocks. However, maxima for P-wave velocities are also aligned in lineation direction.

The results of this study will be implemented by our cooperation partners within the SPP and used for interpretation of seismic data.