Alpine temperatures). These problems in mind, we compiled metamorphic and isotope age data of the Aar massif in a central cross-section. We add own data using different geothermometers solely collected in Alpine shear zones (e.g., Ti-in-biotite, calcite-dolomite thermometry).

The available P-T conditions in the Grimsel area indicate conditions of ~450°C and 6.5 kbar, which is similar or only slightly lower as in the adjacent southern units (Gotthard units). Such elevated temperatures are found up to the central region of the Aar-massif and therefore no substantial change in temperatures from the southern to the central part is indicated. In contrast, the northern part of the massif shows fundamental lower Tmax (~250°C). These Tmax data suggest a change in the temperature field gradient from south (more constant) to north (relative steep).

The Grimsel area requires exhumation from depths of ~18 km since the Miocene, which is consistent with age and metamorphic conditions in the units further south (the thick skinned units of the Lepontine dome). The northern area shows much less vertical transport and is related to the physical emplacement conditions of the Helvetic meta-sedimentary units (thin skinned, fold and thrust belt). This variation and the related difference in vertical transport from south to north have to be connected to an array of numerous vertical shear zones inside the Aar-massif. Several of these shear zones show a steep transport direction, but also strike slip shear zones exist.

Despite the localized deformation in the individual shear zones, their large number and spatially homogeneous distribution is capable to accommodate uplift and exhumation on the scale of the entire Aar massif in a distributed manner. In other words, temperature offsets between individual shear zones are too small to be detected but in light of the whole Aar massif the shear zone arrays bring different former mid crustal levels to today's exposed position at the surface.

The lithosphere-asthenosphere boundary below the Eastern Alps and the effect of eastward extrusion

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The Eastern Alps (EA) are the result of the European and Adriatic plates convergence. The architecture of this portion of the Alpine collision has been furthermore affected by a lateral (east directed) tectonic extrusion caused by the retreating subduction of the nearby Carpathians. Analysis of Ps and Sp receiver functions from datasets collected by permanent and temporary seismic stations, located in the EA, show the presence of a low velocity layer (LVL) at depth. This LVL might indicate the velocity drop that the seismic waves undergo passing through the asthenosphere, and it testifies a sudden lateral thickness change of the lithosphere. The detected thinner lithosphere is bounded by the Bohemian Massif to the north, and by the Lavanttal fault to the South-west. The detected asthenosphere is deeper (100-130 km) below the North Calcareous Alps, and shallower (70-80 km) below the Vienna Basin and Styria Basin. Unraveling the depth extent of the coherent rigid lithosphere moving over a weak asthenosphere helps deciphering the decoupling determining plate motions and tectonics of the EA. For the first time in the area the Lithosphere-Asthenosphere Boundary is imaged with such a clear depth variation, reflecting the depth extent of the dextral extrusion of the EA towards the Pannonian Basin.