Large-Scale Deformation of the Eastern Alps from Seismic Anisotropy

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Internal deformation in the Eastern Alps is documented by seismic anisotropy, and we report here observations from SKS shear-wave splitting. Together with earlier observations from the Western Alps, these observations present one of the clearest examples yet of "mountain chain parallel fast orientations" worldwide, with a stunningly simple pattern of fast orientations, nearly parallel to the trend of the mountain chain. This simple pattern (of deformation) appears to be in contrast with the complex surface geology of the Alps. Regarding the pattern, we make a number of important observations: there are rapid spatial variations of fast orientation in certain parts of the Alps while there is little variation in others. Where fast orientations vary (Western Alps and the Tauern-Window region), they do so with nearly constant spatial rotation rate. In the Eastern Alps, the fast orientations do not "connect" with neighboring mountain chains, neither the present-day Carpathians, nor the present-day Dinarides, but rather with an intermediate orientation.

There is a clear jump of fast orientations across the Tauern Window, by about 45 degrees, somewhat similar to the geometry of the Adriatic indenter. In the very east, where lithosphere is thin, and where we most likely observe asthenospheric anisotropy, the anisotropy is consistent with eastward extrusion toward the Pannonian basin, if we assume that the anisotropy recorded relative motion of the surface with respect to the deeper Earth moving coherently with the Central Alps. An eastward extrusion has been suggested before, based on the pattern of seismicity, surface geology, and more recently geodesy. It appears that much of the deformation associated with the eastward extrusion is accommodated within the asthenosphere. This suggests that the entire lithosphere is escaping to the east, not only the crust.