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TRANSALP: CONCEPT AND MAIN RESULTS OF THE PROJECT

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The Alps as the youngest and highest mountain range in Europe have always been a challenge for geoscientists and have played a key role in the development of new concepts and theories of mountain building. Recently, remarkable progress has been achieved by applying the modern technology of deep seismic reflection profiling to the Western Alps. The combination of the seismic reflectivity pattern with depth extrapolated surface geology resulted in a new concept, in which a wedge-shaped Adriatic indenter splitting the European crust forms the dominant tectonic element in the late stage of continent-continent collision. This model has been readily adopted to the Eastern Alps although the existence of the Austroalpine mega-nappe and the north-ward offset of the Periadriatic Lineament (PL) indicate the necessity of modifications or even basically different processes in the east. TRANSALP is aimed at providing new data and constraints for a better understanding of these processes.

More generally speaking, TRANSALP is conceived as a multidisciplinary research programme for investigating orogenic processes by continent-continent collision, focusing on the Eastern Alps. It consists of several seismic and seismological sub-projects within a 300 km long and 40 km wide north-south transect (approx. between Munich and Venice) and is accompanied by complementary geophysical, geological and petrological research projects.

The backbone of TRANSALP, jointly financed by Italian, Austrian and German partners, is a near-vertical seismic reflection profile designed for high resolution as well as deep penetration into the lithosphere by combining Vibroseis with high energy explosion seismics. The transect has been located at the longitude of the (according to surface geology) most northerly advanced indentation of the Adriatic into the European plate. The 300 km long main line is supplemented by seven 20 km long cross-lines for the control of 3D-effects. Additionally, a large number (up to 128) of continuously recording seismological 3-component stations was installed along the transect for active and passive tomography, for seismotectonic studies, and for imaging lithospheric discontinuities by the receiver-function technique.

Although the acquisition of the reflection data was splitted up in three different campaigns between autumn 1998 and winter 1999, it provided for the first time a coherent, homogeneously measured, and thereby fully migratable section through the complete orogene and parts of its molasse foredeeps. In the meantime the main line has been processed in considerable extent and detail. The velocity model, originally taken from older deep refraction seismic results, was refined by stacking and pre-stack migration velocity analysis as well as by tomographic inversion of TRANSALP travel-time data. State-of-the-art CMP stack sections and post-stack migrated sections of the Vibroseis and dynamite data have been distributed to the international TRANSALP Working Group in two releases in July and November 2000, and provide the basis for interdisciplinary and partially controversial interpretations being presented at this workshop.

The results leave no doubts that the 30 km thick European crust, marked by the top of basement and the Moho, plunges with about 7° more or less undeformed from the northern foreland up to the Inn valley fault. On its top the northern Molasse basin is imaged with unprecedented clearness. Surprisingly, the thickness of the post-Jurassic sediments increases suddenly at the orogenic front from about 6 to 9 km. The thickness of the Northern Calcareous Alps (NCA) is similar, but less well displayed. No evidence for thick Molasse sediments underlying the NCA has been found. The internal seismic structures of the NCA match well with prominent tectonic features known from surface geology. South dipping reflections may indicate a continuation of the Northern Calcareous Alps beneath the "Grauwacken Zone" south of the Inn valley. They seem to be related to a 40 to 50° south-dipping transcrustal reflective zone, which terminates the undeformed European crust and may be interpreted as a shear zone, along which the Tauern window was upthrusted by a lower crustal Adriatic indenter. This shear zone would then represent the actual boundary between the European and the Adriatic Plates at depth. The European Moho can be traced (with increased dip south of the Inn valley) down to 55 km depth below the main crest of the Eastern Alps. Further to the south it disappears in the reflection seismic image, but low frequency receiver functions derived from teleseismic recordings indicate its continuation to south of the PL. It will be attempted to confirm this findings with higher resolution by a supplementary seismic experiment this year.

The Adriatic Moho is displayed by explosion seismics in the south at 45 km depth, but again disappears when approaching the actual collision zone beneath the central Eastern Alps giving room for different tectonic models. The Periadriatic Lineament, supposed to be a key structure for the reconstruction of Alpine mountain building, separates segments of poor (in the north) and excellent reflectivity (in the south) at higher crustal levels. Looking at the sections with seismic eyes only, it can be argued for north-dipping as well as for south-dipping PL, implying quite different collision scenarios. Some of them will be presented at this workshop. They reflect our continuing task to resolve ambiguities and to find compatible and conclusive solutions by bringing data and arguments from different fields of geoscience together.

Another important future task will be the extension of the models to greater depth. To understand the dynamics of Alpine orogeny the entire lithosphere-asthenosphere system has to be considered. TRANSALP has provided excellent teleseismic observations proving that the travel-time delays through the thickened Alpine crust are overcompensated by a body (a slab?) of high seismic velocity (and most likely low temperature) in the upper mantle.

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