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THE TAUERN WINDOW AND THE OROGENIC STRUCTURE OF THE EASTERN ALPS FROM TRANSALP DEEP SEISMIC REFLECTION MEASUREMENTS

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The TRANSALP Group, comprising of partner institutions from Italy, Austria and Germany, acquired data on a 340 km long deep seismic reflection line crossing the Eastern Alps between Munich and Venice [1, 2]. Although the field campaign was split into four different parts, between fall 1998 and summer 2001, the project gathered for the first time continuous sections in the Alps using consistent field acquisition and data processing parameters. These sections include the orogen itself, at its broadest width, as well as the two adjacent basins. Vibroseis near-vertical seismic profiling formed the core of the field data acquisition, mainly designed to get a high-resolution image of the upper and middle crust. It was contemporarily complemented by explosive near-vertical seismic profiling for imaging the lower crust, cross-line recording for three-dimensional control, wide-angle recording by a mobile 3-component receiver array for velocity control and seismicity recording by a stationary array for lithospheric tomography and seismicity studies.

The key observations of all these surveys favour north-south compression tectonics by crustal wedging of both the European and Adriatic-African continental margins along transcrustal ramps as the main mountain-building processes. These observations are (Fig. 1): 1) Bi-vergent structure at whole crustal scale beneath the Alpine axis. This bi-vergent pattern is characterised by some asymmetry and culminates in a relatively narrow zone above the crustal root zone. 2) Transcrustal ramp-like structures. The bi-vergent pattern appears to be bounded at depth by a predominant, about 1–2 s (approximately 3–6 km) thick, reflection pattern, the 'Sub-Tauern-Ramp', which can traced from the Inn Valley dipping to the south at an angle of about 30 degree with a length of 80–100 km into the alpine root zone at 55 km depth. A northward dipping structure, the 'Sub-Dolomites-Ramp' can be traced to the Valsugana backthrust fault system. Both structures show enhanced seismicity in the brittle upper crust. 3) Crustal root and asymmetric crustal structure of maximum 55 km thickness little south of the Alpine axis. The Adriatic-African middle and lower crust shows higher seismic velocities, higher densities and a thickened reflective lower crust with respect to the European crust.

The Tauern Window – a narrow crystalline metamorphic belt of European origin – appears as a huge wedge in the hanging wall of the 'Sub-Tauern-Ramp' (Fig. 2). Except north-dipping reflectors at its northern boundary, which might represent backthrust faults, this wedge is dominated by southward dipping patterns of reflections. The inner parts of the Tauern Window are less clearly characterised by seismic reflections, probably because of complex folding.

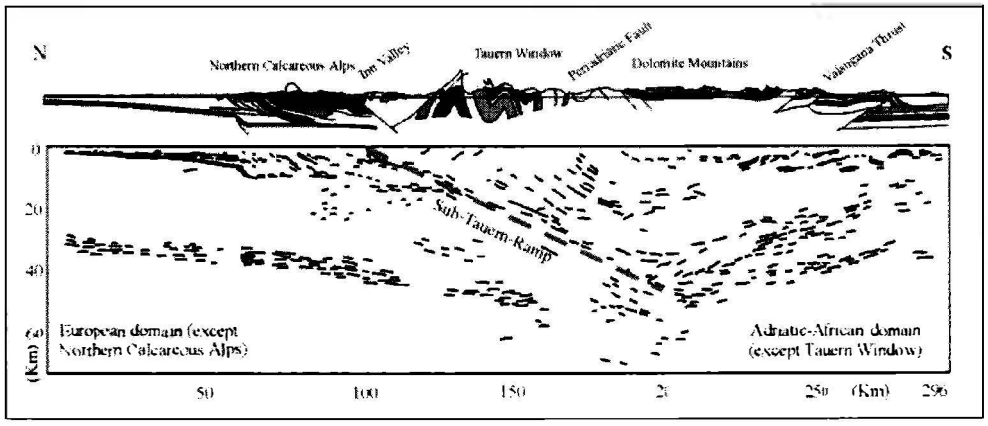

Fig. 1

Summarised reflective structures, compiled from Vibroseis and explosive seismic sections and cross-line recording.

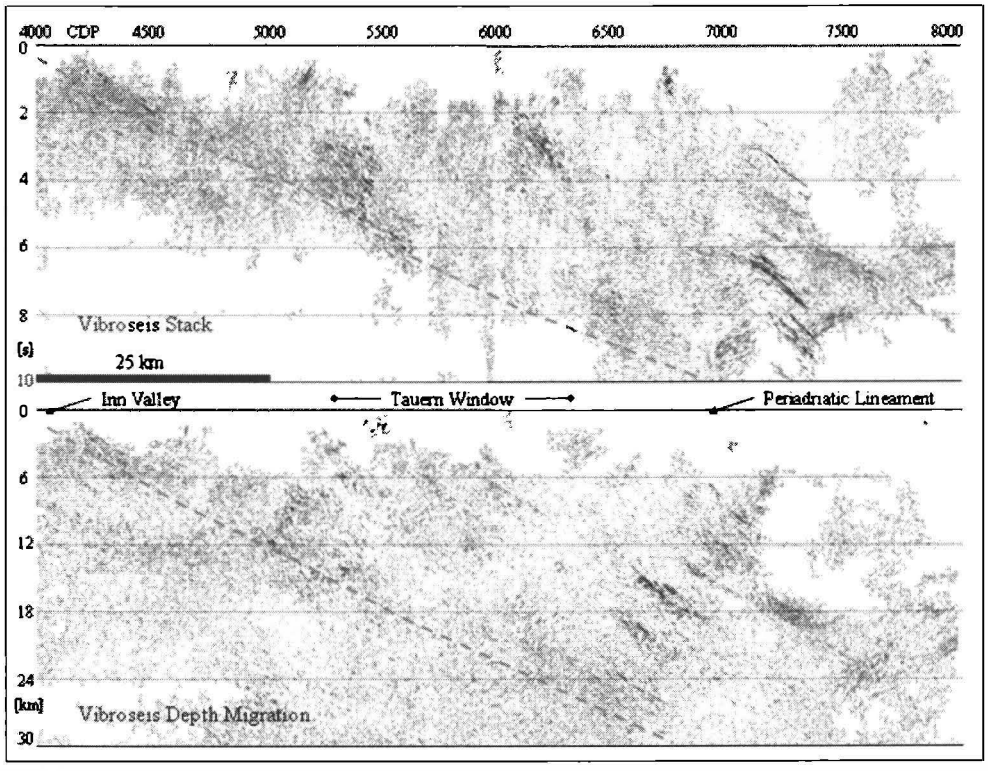

Fig. 2

The Tauern Window within a 100 km long part of the seismic section obtained by the Vibroseis technique, stack section after common-midpoint (CMP) stacking (top) and depth-migrated section (bottom). 'Sub-Tauern-Ramp' is outlined by a dashed line. Additional explosive and cross-line recordings in the CDP-range 6000–7000 have shown that the ramp-reflections are even stronger pronounced than shown here.

The strong sub-parallel reflections beneath the Periadriatic Lineament are interpreted to represent slip surfaces and fracture zones within the deformed wedge of the Tauern Window, as indicated by reduced seismic interval velocities. Uprising fluids from dewatering processes in the Alpine root zone may be responsible for enhancing the reflection strength. Our new evolution model describes the Tauern Window as part of the former European continental margin, exhumed and upthrusted along the 'Sub-Tauern-Ramp'. Alternative views concern the role of the Periadriatic Lineament, which is not directly seen in the seismic sections. Seismic Anisotropy in the Tauern Window, showing preferred orientations in E-W direction, is compatible with N-S compression and E-W stretching seen in the microfabric.

References

[1] TRANSALP Working Group (2001): European Orogenic Processes Research Transects the Eastern Alps. - EOS, Transactions, American Geophysical Union, 82, No.40, pages 453, 460-461.

[2] TRANSALP Working Group (2002): First Deep Seismic Reflection Images of the Eastern Alps Reveal Giant Crustal Wedges and Transcrustal Ramps. Geophysical Research Letters, 29, No. 10, DOI 10.1029/2002GL014911, 92-1 – 92-4.