Geophysical Research Abstracts, Vol. 8, 08366, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08366

Imaging a fossil seismogenic coupling zone – ancient counterparts of active systems

R. Bachmann, V. Georgieva, O. Oncken

GeoForschungsZentrum Potsdam, Germany

(raik@gfz-potsdam.de)

Most of the world's seismicity is concentrated along convergent plate margins. Earthquakes nucleate within the upper part of subduction zones within the seismogenic coupling zone of the so called subduction channel. The unstable slip in the upper part of the plate interface occupies only a limited depth range, roughly 10 km to 50 km. Unfortunately, active subduction zones cannot be directly accessed, only geophysical methods, numerical modeling or sandbox simulations throw light on these geodynamic settings. We additionally use direct investigation of exposed ancient convergent plate boundaries to understand their internal geometry and processes operating.

For this purpose we studied an up to 1000 m thick mélange within the Central Alps of Europe. This zone is sandwiched between the overlying Austroalpine nappes (African plate) and the underlying Penninic/Helvetic nappes (European plate) during Alpine convergent plate motion. The analysis of transects crossing the former plate boundary contributes to the identification of changes within the fossil subduction channel. The matrix of the subduction channel is composed of metasediments with increasing metamorphic grade from north to south. Deformation of the metasediments increases similarly. The matrix contains clasts of different size consisting of upper plate basement and metasediments as well as slivers of the oceanic lower plate and its sedimentary cover. The clast size varies from a few millimeters to hundreds of meters. With increasing metamorphism and deformation both upper plate basement and metasedimentary clasts are strongly mylonitized along their rims – internally they still retain their original texture. Mylonitic shear zones cut into the clasts and enforce their disintegration. Pseudotachylytes as evidence for fossil earthquakes have been found at a limited depth range (previously published data point to app. 3-6 kbar, $<$350˚C, corresponding to a depth of about 10 km to 20 km) at the base of the upper plate. Metasedimentary clasts and metabasics reveal abundant hydraulically fractured veins. Additionally, a vast number of foliation parallel mineralized veins invade the matrix of the fossil subduction channel, pointing to transient changes in fluid pressure and stress regime. The relationship of these coarse grained mineralized veins to seismic faulting has yet to be evaluated. They may result from dehydration processes during prograde metamorphism within the subduction zone and subsequent rapid hydraulically fractured vein formation with rapid crystallization. They may be indicators for fluid driven seismicity. Since the exposed ancient subduction channel has experienced flow and fracturing over several cycles (including some overprint during collision and exhumation) it still may bear resemblance to cumulative active margins that have been active over 10s of Myrs.

To obtain additional information about structures and processes within subduction channels we also studied outcrops along the active continental margin of Southern Chile. There, material underwent deformation along the plate interface and was subsequently exhumed by basal accretion. The advantage of this supplementary study area is the absence of any collisional overprint subsequent to the deformation within the subduction channel despite its exhumation. There, we also observed rapid hydraulically fractured veins, which are well comparable to those found in the Central Alps in terms of structures and PT conditions.