Geophysical Research Abstracts,
Vol. 11, EGU2009-11855, 2009
EGU General Assembly 2009

Seismic slip at the base of the seismogenic crust along the exhumed extensional Oligocene Trois Villes Fault (Western Italian Alps)

A. Bistacchi (1), G. Pennacchioni (2), G.D. Gatta (3), and R. Grizzetti (1)

(1) Università di Milano Bicocca, Dipartimento di Scienze Geologiche e Geotecnologie, Milano, Italy (andrea.bistacchi@unimib.it), (2) Università di Padova, Dipartimento di Geoscienze, Padova, Italy, (3) Università di Milano, Dipartimento di Scienze della Terra, Milano, Italy

The Trois Villes Fault is a major Oligocene extensional fault of the internal NW Alps that offsets of ca. 1 km the flat-lying boundary between the Austroalpine basement (hangingwall) and Piedmont calcschists (footwall). Faulting developed at conditions close to the base of the seismogenetic crust during a regional phase of post-collisional orogen-perpendicular extension (Bistacchi and Massironi, 2000).

Fault rocks derived from banded greenschist facies felsic mylonites (predating this faulting event), consisting of an alternation of decimetre-thick leucocratic quartz-feldspar-rich layers and green phyllosilicate-rich mylonites (white mica and chlorite). They include: (i) green protocataclasites to ultracataclasites, which form two main metric layers within the 8-15 m-thick fault zone, and (ii) pseudotachylytes, forming a single decimetric zoned fault vein, continuous over distances of tens of meters, within each one of the two cataclasite layers .

Cataclasites are characterized by stable quartz+albite+chlorite+epidote+titanite, hence developed under low-temperature greenschist facies conditions (about 270-300°C, 8-10 km). Pseudotachylytes are localized within the ultracataclasite domains and consist of several contiguous subparallel fault veins. Injection veins are rare and small. Different veins show different clast/matrix ratios, ranging from clast-dominated to almost clast-free end-members. The clast-rich pseudotachylytes contain lithic clasts of host mylonites, cataclasites and early pseudotachylytes, and monocrystalline clasts of quartz, albite and apatite. Chlorite and white mica do not occur as monomineralic clasts. Pseudotachylytes lack features sometimes considered diagnostic of frictional melts (glass, spherulites, etc.), but show a rather homogeneous matrix, which almost entirely consists of a K-feldspar (92% Or) classified (by means of crystallographic analysis) as low sanidine. This distinctive matrix mineralogy indicates crystallization at ca. 1000°C and demonstrates the frictional-melting origin of the Trois Villes fault pseudotachylytes. Hence, a new diagnostic criterion to recognize pseudotachylytes, based on crystallographic analysis, is introduced in this work. The sanidine matrix is interpreted as the result of preferential melting of phyllosilicates and subordinate albite.

At the sample and thin section scale, the boundaries between different pseudotachylyte veins and between pseudotachylyte and cataclasites are either sharp or transitional. The latter consist in a transition zone where small pockets of frictional melt are present in the cataclasites. These relationships indicate: (i) the intrusive character of most pseudotachylytes, (ii) the re-melting of early pseudotachylytes by successive frictional melting events, and (iii) the distributed production of incipient frictional melts in an incoherent fault gouge during granular flow (particularly common in clast-rich pseudotachylytes). Therefore, frictional heating due to granular flow is confirmed as a necessary precursor to melt generation, and a very incipient stage of frictional melting is documented in pseudotachylytes with the highest clast/melt ratio (this compares very well with some recent rotary shear experiments).

Melting temperature of white mica is ca. 750°C, but temperature of the frictional melt exceeded 1000°C (crystallization of sanidine) and may have reached even higher temperatures, as can envisaged by partial assimilation of albite and quartz (assumed single-mineral non-equilibrium melting). Superheating of the melt may be explained by shear heating of the high-viscosity acid melt. High viscosity may also explain the scarce mobility of the melt, evidenced by very limited occurrence of injection veins.

In many fault zones (e.g. the Gole Larghe Fault zone: Di Toro and Pennacchioni, 2005), especially within strongly anisotropic host rocks, the development of pseudotachylytes acts as a sealing of the rupture plane and successive ruptures migrate to new pre-existing unexploited slip planes. The peculiar characteristic of the Trois

Ville fault zone, if compared to other pseudotachylyte-bearing fault zones, is that successive seismic ruptures remain localized along the same slip surface. This could be explained by the development of the strong, planar and continuous mechanical discontinuity represented by the pseudotachylyte/ultracataclasite boundary. This bi-material interface might have acted, in accordance to theoretical models, as a guide for successive seismic fracture propagation events.

References:

Bistacchi A., Massironi M., 2000. Tectonophysics 327, 267-292.

Di Toro G., Pennacchioni G., 2005. Tectonophysics 402, 55-80.