Geophysical Research Abstracts,
Vol. 11, EGU2009-8969, 2009
EGU General Assembly 2009
© Author(s) 2009

Fluid-rock interaction along the Simplon fault zone (central-western Alps): constraints from oxygen and carbon stable isotope geochemistry

I. Guerra (1,2), T. Vennemann (1), N. Mancktelow (2), F. Negro (3), and A. Kalt (3)

(1) Institut de Minéralogie et Géochimie, Université de Lausanne, L'Anthropole, CH-1015 Lausanne (ivan.guerra@unil.ch), (2) Geologisches Institut, ETH Zürich, CH-8092 Zürich , (3) Institut de Géologie et d'Hydrogéologie, Université de Neuchâtel, Rue E. Argand 11, CH-2009 Neuchâtel

The role of fluids during faulting and fracturing associated with the Miocene to present exhumation of the Lepontine dome (central-western Alps) is examined along its south-western border, the Simplon Fault Zone (SFZ). In this region, the dominant strike orientation of late faults, joints and veins is NW-SE, i.e. parallel to the major Simplon low-angle normal fault. Two other important strike directions, NE-SW and E-W, can also be distinguished, with the E-W direction apparently the latest one. Most measured fault planes are normal faults, consistent with extension and exhumation of the region since the Miocene.

Oxygen stable isotope analyses on minerals filling these late fractures, sampled from both the hanging wall and footwall of the SFZ, indicate that there are two different fluid circulation systems. In the footwall, along the length of the SFZ, the $\delta^{18}O$ values of quartz both for host rock and late veins range between 10 ‰ and 12 ‰ which are values typical for quartz either coming from metagranitic rocks or having precipitated from fluids that were equilibrated with such rocks. This is consistent with buffering of infiltrating fluids by the host rock during fracturing and vein precipitation. In the hanging wall of the SFZ, the situation is different. Similar $\delta^{18}O$ values for quartz from host rock and late veins are found in the northern and southern part of the detachment. In these two areas, both hanging wall and footwall have been metamorphosed at similar temperatures: around 450 ˚C to the north and around 650 ˚C to the south (Oberhänsli et al., 2004 and Oberhänsli & Goffé, 2004). In contrast, in the central part of the SFZ, where there is a jump from peak amphibolite facies in the footwall to only greenschist facies in the hanging wall, the $\delta^{18}O$ values for quartz from the hanging wall late veins are approximately 3.0 ‰ lower than the values observed in the footwall (8.0 ± 0.4 ‰ and 11.1 ± 0.8 ‰ respectively). First results on oxygen and carbon stable isotope analyses from carbonates indicate a host rock-buffered late fluid circulation in the northern part of the Simplon, while in the central part there are at least two different types of late fluids.

In general, the hanging wall of the SFZ is much more pervasively fractured than the footwall because it was relatively cold and brittle from the onset of faulting, whereas the footwall underwent a transition from ductile to brittle behaviour as it was exhumed and cooled. These observations, together with the isotopic data, suggest that infiltration of meteoric water may have occurred in the most fractured part of the hanging wall, where relative displacement on the SFZ was greatest (i.e. in the central region). In contrast, the isotopic data from the less fractured footwall reflect a rock-buffered system. Locally, clay-rich fault gouge developed on the detachment could have acted as an impermeable barrier if the fluid-rock exchange occurred during or after displacement along the fault. This could have helped to maintain the difference in fluid circulation between footwall and hanging wall.

Additional oxygen isotope investigations for mineral pairs in structural and chemical equilibrium (i.e. quartz-muscovite, quartz-hematite, calcite-muscovite, quartz-calcite) within late veins, as well as in the host rocks, will give more precise indications on the conditions of vein formation and fluid-rock interaction.

REFERENCES

Oberhänsli, R., Bousquet, R., Engi, M., Goffé, B., Gosso, G., Handy, M., Koller, F., Lardeaux, J.-M., Polino, R., Rossi, P., Schuster, R., Schwartz, S., Spalla, I. E., w. c. of Agard, P., Babist, J., Berger, A., Bertle, R., Bucher, S., Burri, T., Heitzmann, P., Hoinkes, G., Jolivet, L., Keller, L., Linner, M., Lombardo, B., Martinotti, G., Michard, A., Pestal, G., Proyer, A., Rantisch, G., Rosenberg, C., Schramm, J., Soelva, H., Thoeni, M. & Zucali, M. (2004).

Metamorphic structure of the Alps 1:1’000000. Paris, CGMW.

Oberhänsli, R. & Goffé, B (2004). Explanatory notes to the map: Metamorphic structure of the Alps - Introduction. Mitt. Österr. Miner. Ges. 149, 115-123.