Etude tectonique et géochimique des fissures post-métamorphiques des Alpes Centrales

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A stable isotope study of post metamorphic quartz veins was undertaken in order to determine fluid sources and mechanisms of formation. The field area is in the southern Central Swiss Alps. This region covers the Helvetic crystalline Gotthard massif and overlying Mesozoic cover (Triassic carbonates, Liassic graphite-rich garnet schists and marbles) and Pennine crystalline massifs (Simano, Lucomagno and Adula nappes) and overlying Mesozoic cover (Triassic carbonates and Bündnerschiefer). The regional metamorphism is greenschist in the north and amphibolite grade in the south, on the basis of both mineral assemblages and stable isotope thermometry.
Veins filled with milky quartz and lesser euhedral qz, calcite, phyllosilicates, oxides, feldspars and other silicates are very common, ranging in size up to 5 m wide and 20 m long. The veins postdate all regional deformation.
The euhedral qz is the most common mineral in fissures. Temperatures were calculated from the oxygen isotope fractionation between the euhedral quartz and other fissure minerals. The temperatures calculated with the D18Oqz-min are 400-550°C for the beginning, 350-400°C during and 250-350°C at the end of the growth of qz. These are in agreement with temperatures calculated by Mullis et al (1994) using fluid inclusion microthermometry and K/Na thermometry. The d18O values of the fissures minerals are in equilibrium with the host rocks. In orthogneiss, paragneiss, meta-amphibolites and meta-arkoses the d18OSMOW of quartz are +9.5 to +14 ‰, in mica schists +14 to +20 ‰, depending on calcite contents, and in marbles and Bündnerschiefer +25 to 30 ‰. The quartz in the host rocks have the same value of the quartz in the fissures. Only in one fissure situated in the orthogneiss of the Adula nappe are the d18OSMOW of the fissure quartz very light, with the core at +9.0 ‰ and the border at +2.2 ‰.
The d13C values of CO2 in fluid inclusions are controlled by the host rocks. In the carbonate rich rocks the CO2 is produced by decarbonation and is in isotopic equilibrium with ost rock carbonate. In Bündnerschiefer and marbles the d13CPDB of CO2 are +4 +8 ‰ (host rocks +2 to +4 ‰) in graphite rich mica schists CO2 are -5 to 0 ‰ (host rocks -7 to -4 ‰), in meta-amphibolites CO2 are -6 to -4 ‰ (host rocks -8 ‰). In paragneiss the values cover a wide range from -12 to +2 ‰, depending of graphite and carbonate content of the rocks. In the orthogneiss the carbonate is a minor constituent of the rocks and the source of CO2 in the fluid inclusions could be a remobilization during brittle deformation. In these rocks the d13CPDB of CO2 are -7 to 0 ‰. The higher values are found in rocks near the contact with Triassic carbonates.
The H2O was the major constituent of the fluid mineralizing the fissures. The dD values of H2O in fluid inclusion are mostly of metamorphic origin, ranging from -40 to -20 ‰, very different from -120 to -75 ‰ in the second generation scepter-like quartz where the fluid is of meteoric origin. Some values are in between these two extremes indicating a mixing of primary and secondary fluid inclusions. The dD of the hydrous minerals show the same trend; most of muscovite, chlorite and amphiboles are -70 to -50 ‰ tourmalines -60 to -40 ‰, they are in equilibrium with metamorphic fluids, in

some fissures chlorites, muscovites and kaolinite have meteoric values ranging from -140 to -90 ‰ depending of the altitude of the fissure.
The fissures begin to open at the ductile-brittle transition about 18 Ma at themperatures of 450-500°C. The source of the fluid is generally locally derived. Late, below 250°C, in the rocks beginn the circulation of meteoric water. This water, with low salt content caused the end of quartz grow.