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Temperature micro-mapping and redox conditions of a chlorite zoning pattern in green-schist facies fault zone

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Faults are major discontinuities driving fluid flows and playing a major role in precipitation of ore deposits. Mineral paragenesis and crystal chemistry depend on Temperature (T) condition, fluid composition but also on the redox environment of precipitation.

The studied samples come from the Pic de Port Vieux thrust sheet, a minor thrust sheet associated to Gavarnie thrust fault zone (Central Pyrenees). The Pic de Port Vieux Thrust sheet comprises a 1-20 meter thick layer of Triassic red beds and mylonitized Cretaceous limestone. The thrust sheet is affected by faults and cleavage; the other important deformation product is a set of veins filled by quartz and chlorite. Microstructural and mineralogical investigations were performed based on the previous work of Grant (1992). The crystallization of chlorite is syn-tectonic and strongly controlled by the fluid circulation during the Gavarnie thrust sheet emplacement.

Chlorite precipitated in extension veins, crack-seal shear veins or in open cavities. The chlorite filling the open cavities occurs as pseudo-uniaxial plates arranged in rosette-shaped aggregates. These aggregates appear to have developed as a result of radial growth of the chlorite platelets. According to point and microprobe X-ray images, these chlorites display oscillatory chemical zoning patterns with alternating iron rich and magnesium rich bands. The chlorite composition ranges from Fe rich pole ($Si_{2.62}Al_{1.38}O_{10}(Al_{1.47}Fe_{1.87}Mg_{2.61})_6(OH)_8$) to Mg rich pole ($Si_{2.68}Al_{1.31}O_{10}(Al_{1.45}Fe_{1.41}Mg_{3.06})_6(OH)_8$). In metamorphic rocks, zoning pattern or rimmed minerals results for varying P or T conditions and can be used to unravel the P-T history of the sample.

In the present study, temperature maps are derived from standardized microprobe X-ray images using the program *XMapTools* (Lanari et al 2014). The (Fe^{3+}/Fe_{tot}) value in chlorite was directly measured using μXANES spot analyses collected at the Fe-K edge.

The results indicate a homogeneous temperature of 300-350˚C throughout the crystallization. This result excludes the T as the main parameter to explain the Fe and Mg zoning patterns. Several other origins can be proposed and discussed in order to understand zoning patterns such as fluid chemistry, pressure, pH or redox variations of the fluid.

Grant, N.T., 1992. Post-emplacement extension within a thrust sheet from the central Pyrenees. Journal of the Geological Society 149, 775–792.

Lanari, P., Vidal, O., De Andrade, V., Dubacq, B., Lewin, E., Grosch, E.G., Schwartz, S., 2014. XMapTools: A MATLAB©-based program for electron microprobe X-ray image processing and geothermobarometry. Computers & Geosciences 62, 227–240.