New paleo-altimeter based on Hydrogen and Oxygen Isotopes of aqueous Fluid Inclusions in hydrothermal quartz

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The evolution of mountain topography is a balance between tectonic and erosion. Their relative roles remaining controversial, understand the long-term topographic history of mountain belts is a key issue. Meteoric water penetrate through the upper crust and is trapped as fluid inclusions (FIs) in minerals sealing veins or crystallising in shear zones. We assume that the isotopic composition of the fluid trapped in the FIs are not modified by post-fluid inclusion formation. This compositions in a $\delta^{18}O$ versus D/H diagram allows comparing the data with the meteoritic water line (MWL) and can be used to estimate the paleo-elevation. The innovative method we have developed consist of observation of FIs host mineral under microscope to determine the generations of FIs. A micro-thermometry and RAMAN analysis allows to characterize the chemical composition and T of entrapment of the fluids. The sample is crushed, the grains are selected under the binocular. Extraction of the gases contained in the FIs is carried out by thermal decrepitation on the vacuum line. The purified H_2O of the FIs is, collected and analyzed by the GV PRISM spectrometer.

To test this method, we have sampled quartz veins at different altitudes from the External Crystalline Massifs (ECMs) of the Alps. To provide a further test, we have also determined the present day relationship between the isotopic composition of precipitations and elevations by measuring the composition of precipitations at different altitudes on the ECMs. The δD and δ18O values obtained for the rainwater taken from the ECMs range from -20‰ to -120‰ and from -5‰ to -18‰ respectively and, plot on the MWL with a good correlation with the altitude.The δD and δ18O values of the fluid in the FIs from the quartz range between -20‰ to -105‰ and between -5‰ to -12‰ respectively and plot also on the MWL.

These values indicate a meteoric source for the water trapped in the IFs in agreement with the micro thermometric data indicating that the IFs contain low salinity aqueous fluids. These results show a good correlation between the isotopic composition of the water contained in the IFS and the altitude of the veins.