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Deciphering P-T paths in metamorphic rocks involving zoned minerals using quantified maps (XMapTools software) and thermodynamics methods: Examples from the Alps and the Himalaya.

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Metamorphic rocks are made by mosaic of local thermodynamic equilibria involving minerals that grew at different temporal, pressure (P) and temperature (T) conditions. These local (in space but also in time) equilibria can be identified using micro-structural and textural criteria, but also tested using multi-equilibrium techniques. However, linking deformation with metamorphic conditions requires spatially continuous estimates of P and T conditions in least two dimensions (P–T maps), which can be superimposed to the observed structures of deformation. To this end, we have developed a new Matlab-based GUI software for microprobe X-ray map processing (XMapTools, http://www.xmaptools.com) based on the quantification method of De Andrade et al. (2006). XMapTools software includes functions for quantification processing, two chemical modules (Chem2D, Triplot3D), the structural formula functions for common minerals, and more than 50 empirical and semi-empirical geothermobarometers obtained from the literature. XMapTools software can be easily coupled with multi-equilibrium thermobarometric calculations.

We will present examples of application for two natural cases involving zoned minerals. The first example is a low-grade metapelite from the paleo-subduction wedge in the Western Alps (Schistes Lustrés unit) that contains only both zoned chlorite and phengite, and also quartz. The second sample is a Himalayan eclogite from the high-pressure unit of Stak (Pakistan) with an eclogitic garnet-omphacite assemblage retrogressed into clinopyroxene-plagioclase-amphibole symplectite, and later into amphibole-biotite during the collisional event under crustal conditions. In both samples, P-T paths were recovered using multi-equilibrium, or semi-empirical geothermobarometers included in the XMapTools package. The results will be compared and discussed with pseudosections calculated with the sample bulk composition and with different local bulk rock compositions estimated with XMapTools.

De Andrade, V., Vidal, O., Lewin, E., O'Brien, P., Agard, P., 2006. Quantification of electron microprobe compositional maps of rock thin sections: an optimized method and examples. Journal of Metamorphic Geology 24, 655–668.