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How precisely evidences of P-T stages are preserved in HP rocks? Insights from micro-mapping of local effective bulk.

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Understanding geodynamic processes in subduction zones critically relies on the reconstruction of precise and accurate pressure-temperature-time-deformation (P-T-t-ε) paths from metamorphic rocks. P-T paths may be obtained using quantitative thermobarometry such as forward thermodynamics models. Most of the models assume that the equilibrium scale in the rock is big enough to use the XRF composition as input composition. However, natural samples of HP rocks show local heterogeneities at the thin section scale with preservation of zoned minerals that are evidences of disequilibrium and reflect changes in growth conditions. In such cases, the concept of LEB (local effective bulk) composition is essential, and the question is how to determine this composition. In this study, we use quantitative X-ray maps together with the program XMapTools to measure LEB compositions. Forward models are then created to constrain P-T conditions of crystallization of the local assemblages.

The studied samples come from two different areas along the carboniferous South-Tianshan suture (Central Asia). The first sample is a well-preserved eclogite made of mm-size garnet, omphacite and rutile. LEB compositions were calculated from the standardized X-ray map and combined with Gibbs free energy minimization to model the composition of the equilibration volume and reconstruct the P-T path. In this example, as the eclogite does not show evidence of retrogression, this micro-mapping approach allows to model the evolution of water content released by the rock along the prograde path. The second sample is a garnet amphibolite made of garnet, diopside, amphibole and plagioclase. This rock preserves domains with local assemblages reflecting the successive stages of the P-T path. The garnet porphyroblasts crystallize at the peak conditions and two types of symplectites are related to the decompression during the exhumation. Following the same strategy, LEB were derived from the chemical maps and used as input for forward models. This approach has been coupled with an inverse modeling approach to calculate maps of P-T conditions. Combined with geochronology adapted to each paragenesis, this study allows reconstructing detailed and precise P-T-t paths.

Both examples show that the micro-mapping approach can improve our understanding of HP rocks and provide tools to calculate detailed P-T paths. This approach can also help us to understand the fluid circulations occurring during slab dehydration and they highlight the textural relationships between different local equilibria. Combined with geochronology this approach deepens our understanding regarding the internal dynamic of the subduction zones.