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Pressure-Temperature-time paths for geodynamic and tectonic modeling: a comparison between samples and models

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Metamorphic rocks are common targets to obtain detailed Pressure-Temperature-time (P-T-t) paths as they can preserve different generations of mineral parageneses, reflecting multiple stages of equilibration. Such P–T–t paths of rocks from different structural positions in a metamorphic belt can constrain models of large-scale tectonic processes. Dynamic thermo-mechanical models were recently developed and intensively used to predict theoretical P–T–t trajectories of rock units in subduction and collision zones. However, significant differences remain between the modeled P–T–t trajectories and the natural record.

The ultra-high pressure slice of Dora Maira (Western Alps, Italy) is an excellent example of such discrepancies. The synthetic P-T-t path of this coherent slice of continental crust – made of granitic gneiss with intercalated whiteschists, metabasites and marbles – indicates vertical burial and exhumation rates > 3.5 to 4 cm/yr, much faster than the horizontal subduction rate (∼1.5 cm/yr). If some of the published models can reproduce the P-T trajectory, the duration of the HP-UHP stage is then overestimated by a factor of up to 2.5. Alternative proposals such as non-lithostatic pressure exacerbate the discrepancy in P–T conditions between samples (thermobarometry) and models. Most of the thermo-mechanical models predict both lower peak temperatures and much lower burial and exhumation rates. The reason for this discrepancy remains an open question. Tightly constrained petrochronologic dataset, such as the one for the Dora Maira unit, can help us to find out why samples and models are so different.