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Fluid circulation systems in the Alpine External Crystalline Massifs

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At mid-crustal levels, rock permeability is believed to be very low except in active fault/shear zones. In sedimentary rocks undergoing tectonic burial during collisional shortening, fluid flow is thus considered to be a small-scale process restricted to the sedimentary unit, until the fluid system locally opens during strain localization in fault/shear zones.
During the Alpine collision, the European proximal passive margin (Dauphinois/Helvetic domains, including the External Crystalline Massifs, ECM: Aar, Mont Blanc, Aiguilles Rouges, Oisans massifs) was buried at mid-crustal depth under the internal units and was subsequently shortened and exhumed with contrasting kinematics. Indeed, some of the main tectonic units are sedimentary nappes detached from their basement while other are linked to main basement shear zones.
In this context, many studies of fluid system evolution have been published, mainly focused on the largest tectonic units (e.g., Morcles nappe) and/or on thrust/shear zones with large displacement (e.g., Glarus thrust). In this contribution, we focused on tectonic structures located in the Oisans massif where small amount of shortening occurred (smaller than in the northern ECM, Mont Blanc and Aar). We performed geochemical and microthermometric analyses on calcite + quartz vein and host-rock samples to document and discuss the fluid source and pathway, the scale of circulation and the fluid-rock interactions.
The fluid system in the Oisans ECM is compared to the fluid systems in other ECM and can be considered as an early and/or less shortened analogue. In the Oisans massif cover, the fluid system is generally closed, except locally above the main basement shear zones where signatures of basement-derived fluids were identified by trace element analysis. In contrast, in the Mont Blanc massif, fluids were channelized in the main basement shear zones, while in the Morcles nappe (i.e. the presumable cover of the Mont Blanc), deep fluids may have been channelized in the sheared reverse limb. Further north, in the Glarus thrust (i.e. the largest shear zone of the Aar massif), deep fluids were clearly channelized in the thrust zone. This highlights the influence on fluid systems of both the structural style and the amount of shortening that vary along the strike of the External Alps.