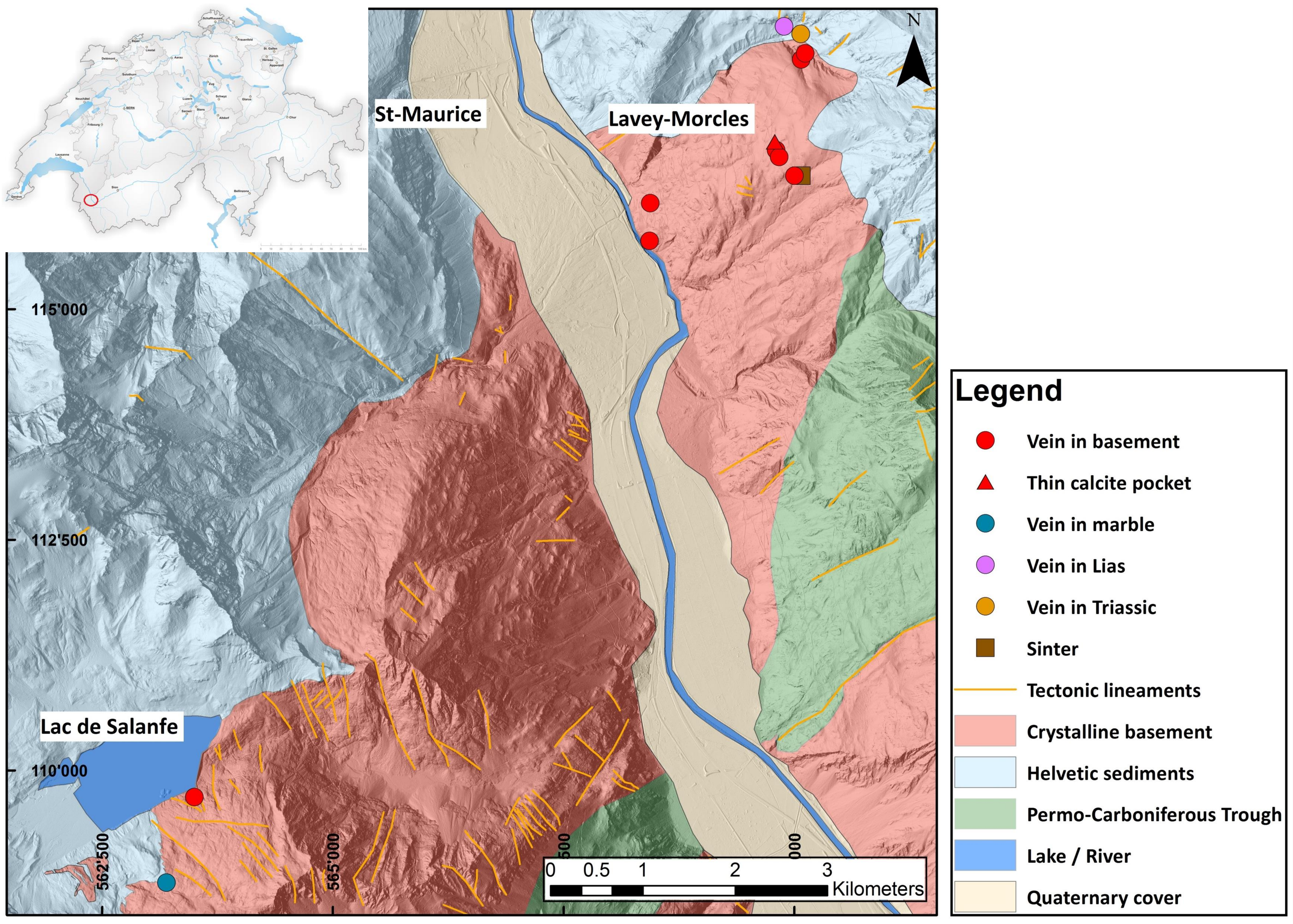
Reconstruction of fluid pathways in the northern Aiguilles Rouges Massif

Yohualli Muñoz*, Marco Herwegh*, Alfons Berger*, Daniela van den Heuvel*

*Institute of Geological Sciences, University of Berne, Baltzerstrasse 1 + 3, 3012 Bern

UNIVERSITÄT BERN

1. Introduction & Geological setting



The study site is located around Lac de Salanfe (SW of St-Maurice) and in Lavey-Morcles (E of St-Maurice) in the northern part of the Aiguilles Rouges (AR) Massif. The AR belongs to one of the External Crystalline Massifs and is composed of polymetamorphic basement (Variscan & Alpine metamorphism and the post-Variscan Vallorcine granite)[6]. The Permo-Carboniferous troughs (e.g. Dorenaz-Salvan) represent another unit of the study site (Fig. 1). The region is overlain by Helvetic units. The Rhône Valley is filled by 0-600 meters of unconsolidated Quaternary sediments[7]. Structures from the Alpine deformation are, amongst others, open fractures and filled fractures (veins), which are investigated in this study. The basement-cover contact at Lac de Salanfe is horizontally oriented whereas in Lavey-Morcles it is steeply inclined. This provides a 3D image of the geological setting.

Fig. 1: Study site whith indication of locations. Sample points are indicated (for more information see legend).

2. Aims of the study

The region around Lavey – Lac de Salanfe is known for its hydrothermal activity (e.g. thermal baths at Lavey-les-Bains). However, the fluid pathways at depth are unknown. The aim of the study is to reconstruct the paleofluid pathways. To do so, fractures and associated vein fillings are studied because they represent former fluid pathways. Furthermore, the origin of the paleofluid is determined by comparing isotope signatures between potential endmembers, host rock and vein fillings.

3. Methods

The reconstruction of fluid pathways and origin includes: ✓ done x in progress

- Field work & sample collection ✓
- Mapping of lineaments (remote sensing & drone mapping) ✓/ x
- Light and scanning electron microscopy x
- Cathodoluminescence microscopy x
- Isotope analysis (δ ^{13}C & δ ^{18}O) ✓

4. Key samples

Fig. 2: Sub-vertical vein in gneiss (basement)

Fig. 3: Calcite vein in claystone (Triassic: Helvetic sediments)

Fig. 4: Sinter (recent precipitation of calcite)

5. Isotope analysis

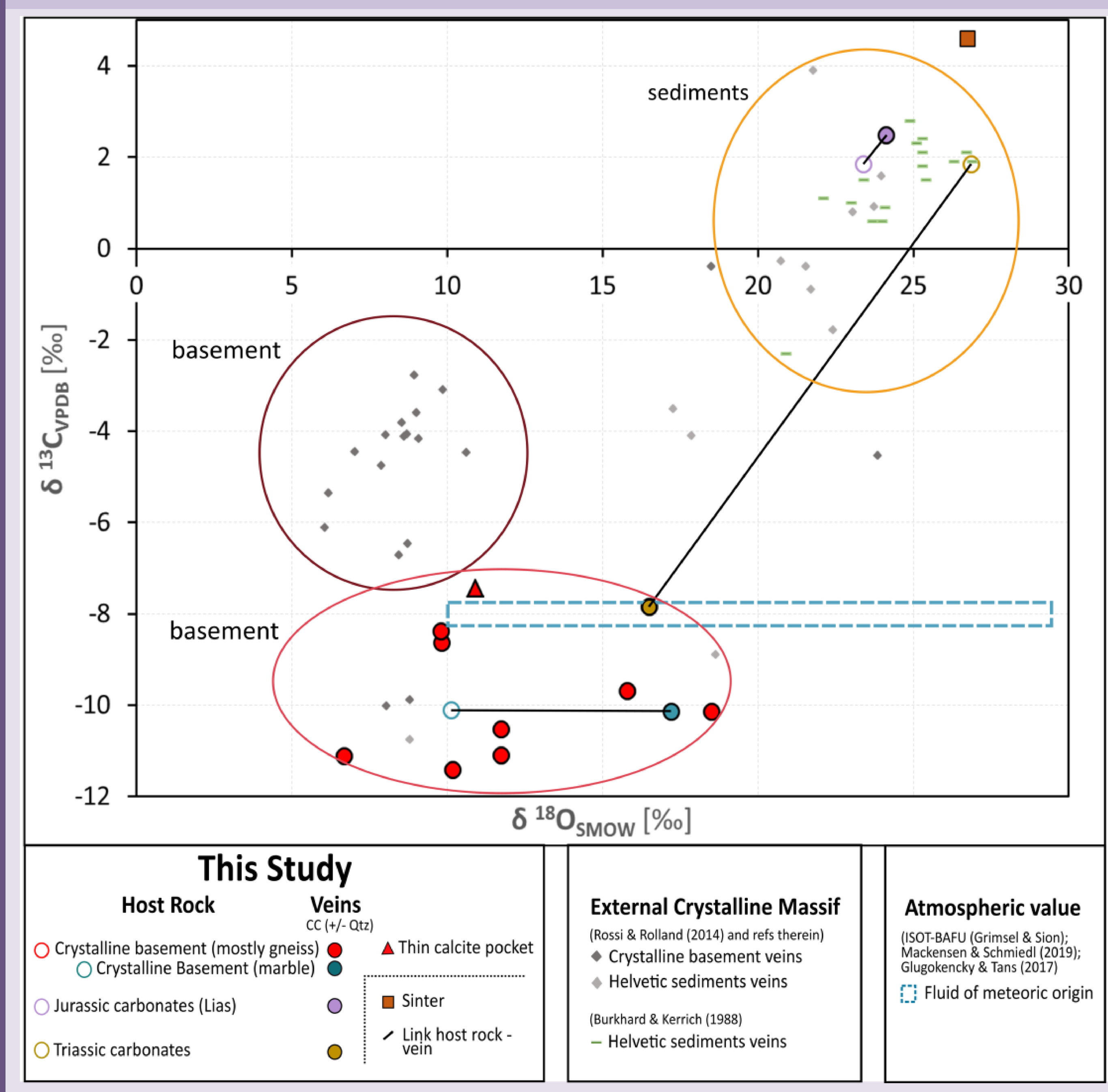


Fig. 5: Stable isotope measurements for own analyses of calcite veins, sediments and surface sinter material and literature data from calcite veins in sediments and basement host rock (for more information see legend)

Three clusters can be determined when looking at the isotope signatures (orange, brown and red circle).

6. Preliminary conclusions

- Liassic: Isotope signature of veins is similiar to the one of the host rock. The system is dominated by the rock («rock-buffered»). Thus, the fluid origin cannot be determined.
- Triassic: Signature of veins is comparable to the isotope signature of basement veins → same fluid source
- Basement: Decrease of δ ^{18}O in the veins may be controlled by oxygen isotope composition of the basement (rock-buffered) but for C another source is needed. The low δ ^{13}C could be influenced by units below the basement.
- Marble: Pre-Mesozoic carbonates show very low δ ^{13}C values similar to the basement veins and therefore could have the same fluid source.
- Sinter: High isotope values are not only influenced by the signature of the fluid of meteoric origin. This needs to be investigated further.

Yohualli Muñoz (yohualli.munoz@hotmail.ch)

-BAFU, MeteoSuisse, 2018. GNIP-Monthly Switzerland: Grimsel and Sion. https://www.bafu.admin.ch/bafu/de/home.html.

-Burkhard, M., Kerrich, R., 1988. Fluid regimes in the deformation of the Helvetic nappes, Switzerland, as inferred from stable isotope data. *Contributions to Mineralogy and Petrology*, 99, 416-429.

-Glugokencky, E., Tans, P., 2017. Trends in Atmospheric Carbon Dioxide. https://www.esrl.noaa.gov/gmd/ccgg/trends/.

-Mackensen, A., Schmiedl, G., 2019. Stable carbon isotopes in paleoceanography: atmosphere, oceans, and sediments. *Earth-Science Reviews*, 197.

-Rossi, M., Rolland, Y., 2014. Stable isotope and Ar/Ar evidence of prolonged multiscale fluid flow during exhumation of orogenic crust: Example from the Mont Blanc and Aar Massifs (NW Alps): Multi-scale fluid flow in the Alps. *Tectonics*, 33, 1681-1709.

-[6]Sonney, R., Vuataz, F.-D., Schill, E., 2012. Hydrothermal circulation systems of the Lavey-les-Bains, Saint-Gervais-les-Bains and Val d'Illiez areas associated with the Aiguilles Rouges Massif in Switzerland and France. *Swiss bulletin für angewandte Geologie*, 17(1), 29-47.

-[7]von Raumer, J. F., Stampfli, G. M., Bussy, F., 2003. Gondwana-derived microcontinents – the constituents of the Variscan and Alpine collision orogens. *Tectonophysics*, 365, 7-22.