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SYN-DEFORMATIVE FLUID CIRCULATION AT THE GLARUS THRUST, E-SWITZERLAND

by

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The Glarus thrust in eastern Switzerland has been recognized as a major control on fluid flow associated with the Early Miozene emplacement of the Helvetic thrust mass on the Infrahelvetic realm.

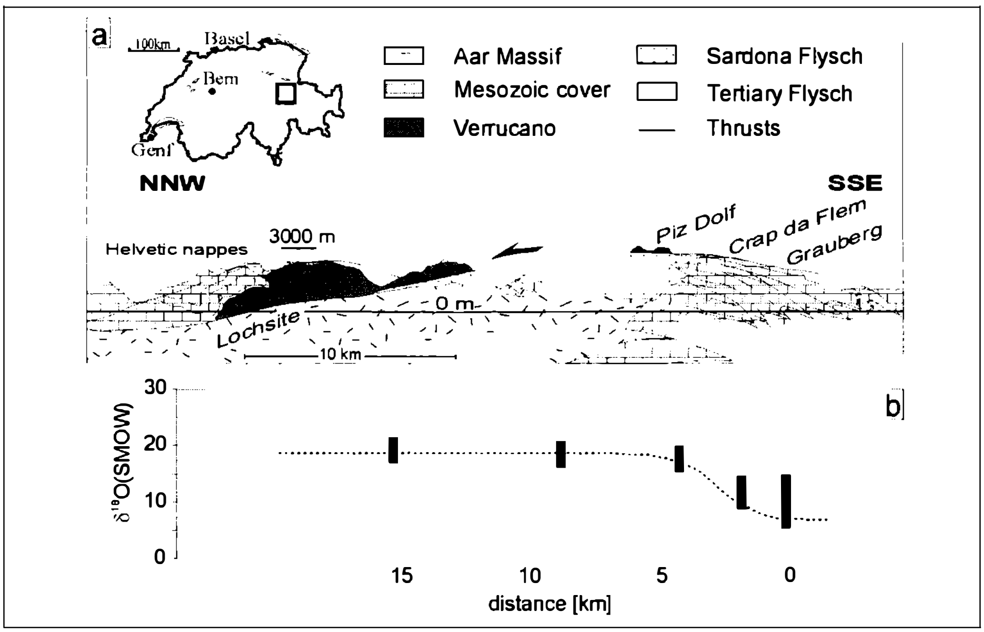

Figure 1

(a) Schematic cross section through the eastern Helvetic Alps, modified from Burkhard and Kerrich (1990) [1], (b) regional oxygen isotope trend in the Lochseiten Limestone, black bars are data form BURKHARD & KERRICH [1], dotted line represents the model interpretation as a large scale oxygen isotope front [2].

In the Lochseiten Limestone, a thin calc-mylonite at the thrust contact, a regional south to north ^{18}O enrichment trend was documented by BURKHARD & KERRICH (1990) [1] (see Fig. 1) and interpreted in terms of one-dimensional flow with a thrust parallel time integrated volumetric flux on the order of 10^3 m^3/m^2 [2]. In this communication we relax the assumption of purely one-dimensional transport and investigate the possible contributions of cross thrust transport components.

The sampling localities at Grauberg and at Lochseite represent two fundamentally different geological situations that occur in the southern (Grauberg) and northern (Lochseite) sections of the Glarus thrust. Whereas at Grauberg the footwall is represented by Cretaceous limestones, the footwall in the north is comprised of Tertiary Flysch. The hangingwall is represented by siltstones and metavolcanic rocks of the Verrucano formation over the entire length of presently exposed thrust. All along the thrust, there is a large difference in the background isotopic compositions between the footwall and hangingwall lithologies. The isotopic patterns as well as bulk rock water contents observed in sub-vertical sampling profiles at the Grauberg and Lochseite localities are shown in Fig. 2.

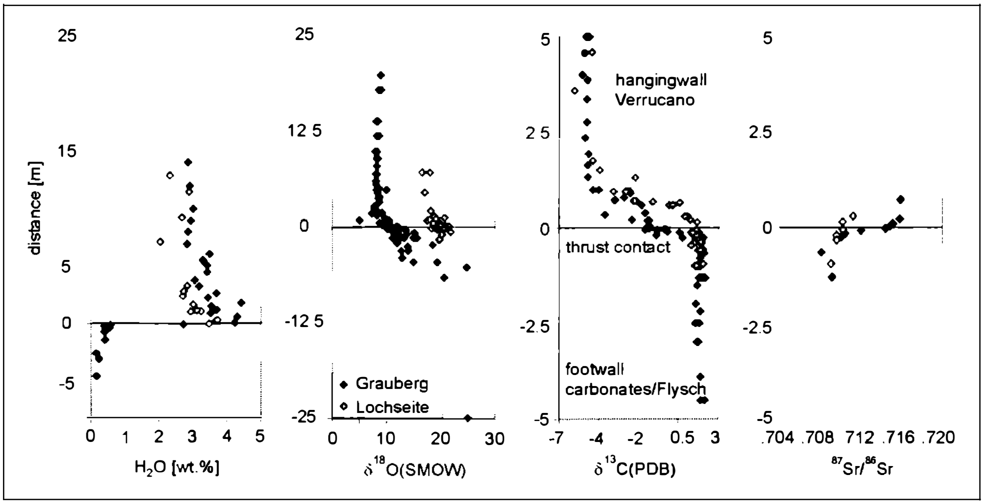

Figure 2

H_2O contents, oxygen-, carbon- and strontium isotope variations across the Glarus thrust at the Grauberg (south) and Lochseite (north) localities.

In both profiles the isotopic compositions show a smooth transition across the thrust contact. At Grauberg only the lowermost one meter of the hangingwall Verrucano shows ^{18}O and ^{13}C enrichment and concomitant ^{87}Sr depletion towards the thrust contact. The relatively ^{18}O and ^{13}C enriched and ^{87}Sr depleted compositions of the footwall carbonates are gradually shifted towards the compositions of the Verrucano in the uppermost five meters below the thrust. This pattern may be explained by material exchange between the footwall and hangingwall lithologies. The fact that alteration is more pronounced in the footwall carbonates than in the hangingwall Verrucano suggests that net material transport was downwards directed. The geometry and the position of the isotopic fronts indicate a maximum time integrated flux on the order of 6 m^3/m^2.

At Lochseite isotopic alteration is only evident in the Verrucano, where the isotopic compositions are shifted towards typical Flysch values in the lowermost 10 to 20 meters of the hangingwall. The fact that the footwall Flysch does not show any sign of isotopic alteration indicates that at Lochseite fluid flow was upwards directed with a time integrated volumetric fluid flux on the order of 3 m^3/m^2. Although relatively small, cross thrust transport buffered the thin layer of Lochseiten Limestone towards the relatively ^{18}O, ^{13}C depleted and ^{87}Sr enriched composition of the hangingwall Verrucano in the south and towards the relatively ^{18}O and ^{13}C enriched and ^{87}Sr depleted composition of the footwall Flysch in the north. The large scale ^{18}O trend in the Lochseite limestone may at least in part be ascribed to the regional differences in cross thrust transport.

In both the Grauberg and Lochseite localities the H_2O content of bulk rock samples increases systematically in the hangingwall Verrucnao towards the thrust contact (see Fig. 1). Whereas in the north, the dewatering footwall Flysch is a potential fluid source, the Cretaceous limestones in the south do not have any potential to release water during thrusting. At Grauberg, hydration of the lowermost Verrucano requires introduction of a water rich fluid along the thrust surface. Based on the assumption that hydration of the Verrucano is equally pronounced all along the thrust, time integrated volumetric fluxes on the order of 200 m^3/m^2 are inferred for sub-horizontal thrust parallel flow.

References

[1] BURKHARD, M. & KERRICH, R. (1990): Fluid-rock interactions during thrusting of the Glarus nappe – evidence from geochemical and stable isotope data. - Schweiz. Min. Petrogr. Mitt., 70, 77-82.

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