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The deformation pattern of high-pressure exhumation in the Adula Nappe (Switzerland) – Preliminary results from crystallographic preferred orientations of quartz

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The Adula Nappe in the central Alps forms the easternmost part of the Lepontine dome, which mainly consists of basement nappes and their Mesozoic cover. The Adula Nappe was originally part of the distal European continent and entered a south-dipping subduction zone experiencing high- to ultrahigh pressure peak conditions at about 38 Ma. The unit underwent several deformation phases after peak conditions including the Zapport phase, which accomplished the largest part of the exhumational deformation. Despite extensive research in the Adula Nappe, the internal deformation during exhumation is not completely understood. Especially the large pressure-temperature gradient from 12–17 kbar/500–600 C° in the north to 30 kbar/800–850 C° in the south is a topic of recent discussion. This phenomenon either originates from internal, heterogeneous deformation of the Adula Nappe during its exhumation, or it was caused by tectonic overpressure, which would indicate that the Adula Nappe was not as deeply subducted as previously assumed.

In this study, we sampled quartzites, micaschists, para- and orthogneisses in a close-meshed net throughout the entire Adula Nappe. Only samples showing Zapport deformation without significant younger overprint were collected. Crystallographic preferred orientations (CPOs) of all mineral phases in the samples were measured with time-of-flight neutron diffraction using the SKAT diffractometer at JINR, Dubna, Russia.

Quartz CPOs show great variability. Most of the c-axis patterns yield an asymmetry charateristic of a top-to-the-north sense of shear, although there are few top-to-the-south samples. Most c-axes exhibit peripheral maxima at an angle to the foliation normal pointing to dominant basal <a> slip, especially in the northern Adula Nappe. The samples from the central Adula Nappe show also maxima between Z and Y of the c-axis pole figure indicative of rhomb-, π- and prism <a> slip. These maxima are usually combined with asymmetric crossed or single girdles of quartz c-axes. A few samples yield small circle distributions suggesting a flattening component. Maxima range from 1.3 to 9 multiples of random distribution (m.r.d.) independently of rock type, CPO pattern or location. For comparison, mica exhibits a pronounced alignment of its basal plane within the foliation and high m.r.d. in all samples, even in the ones with weak quartz CPO.

From the variability of the quartz c-axis patterns, which appears to be independent from lithology, we can infer dominant top-to-the-north directed shear at the exhumational front in the northern Adula nappe during Zapport deformation corresponding to previous field and microstructural investigations. The pattern of the central Adula nappe is more complex with a multiple slip system activity and plane as well as flattening strain. Further sampling and CPO measurements also on other mineral phases may provide comprehensive details of the Zapport deformation pattern to unravel the high-pressure exhumation conditions of the Adula nappe.