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Thermal structure of Valaisan and Ultra-Helvetic sedimentary units of the northern Lepontine dome – consequences regarding the tectono-metamorphic evolution of the Alps

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The metasediments of the Ultrahelvetic and Valaisan sedimentary units around Olivone/TI show a remarkable metamorphic gradient: From HP/LT metamorphism (blueschist facies conditions) indicated by occurrences of (Fe, Mg)-Carpholite bearing assemblages in the east, to temperature dominated metamorphism (amphibolite facies "Lepontine" metamorphism) in the same units further west. The relationship between these two metamorphic events clearly shows that a separate Barrow-type event overprints an earlier HP/LT event.

This late thermal overprint is documented by Raman spectroscopy of carbonaceous material, performed along an east-west oriented section between Safien valley and Pizzo Molare. Between 15 and 20 Raman spectra were obtained from each sample from a total of over 65 localities. The principle of this method is based on the progressive transformation of organic matter into graphite during metamorphic processes. The degree of crystallization of carbonaceous material is mainly temperature dependent and can therefore be used as a geothermometer. The degree of organization of carbonaceous material appears not to be affected by the retrogression and hence is assumed to record peak metamorphic conditions. The absolute uncertainty on temperature is +/- 50 ˚C due to uncertainties on petrological data used for the calibration. The relative uncertainties regarding temperature are much smaller, i.e. around 10 – 15 ˚C,

allowing for an accurate estimate of the field thermal gradients.

The resulting temperature distribution pattern combined with the occurrences of metamorphic paragenesis can be interpreted as a superposition of two events related to completely different geodynamical processes: (1) During the pressure dominated event, only preserved in the east, the temperature ranges between 350 up to 425 ˚C. The establishment of these peak temperatures seems to be due to subduction of the Valaisan and adjacent Ultrahelvetic units under blueschist facies conditions during Tertiary Alpine collision. (2) During the second Barrow-type event the temperatures exhibit a strong field thermal gradient in the west, starting at around 425˚ and increasing up to 550˚C. This gradient is part of the onion shaped pattern well established for the Lepontine dome and it represents a classical Barrow-type amphibolite facies overprint which clearly postdates HP metamorphism and following decompression. We speculate that this late thermal event may represent a thermal adjustment to the tectonic accretion of heat-producing crustal material during collision, occurring under more or less static conditions.

This new temperature distribution map clearly shows the progressive thermal/Barrowian overprint of HP/LT metasediments form east to the west. Combined with structural data and analysis of microstructures in thin sections, we interpret this thermal event as a separate heating pulse, which occurred after nappe stacking (Ferrera phase) and a first nappe refolding stage (Domleschg phase), but before and during the beginning stages of a second nappe refolding event (Chièra phase).