16th Emile Argand Conference
Alpine Workshop
16-18 September 2024 - Siena, Italy

alpshop2024-40, updated on 20 Aug 2024
16th Emile Argand Conference on Alpine Geological Studies

P-T-t-d history of low-grade Permian metasediments in the Austroalpine Unit

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The Austroalpine Unit is a nappe stack that formed by accretion of Adria-derived material in Late Jurassic to middle Late Cretaceous times. Its history is mostly recorded by upper crustal non-metamorphic rocks and lower crustal upper greenschist to eclogite facies metamorphic rocks. Data from the ubiquitous mid-crustal, low-grade metamorphic units are, however, either missing or difficult to interpret, complicating the link between the shallow and deep orogenic levels. We present new pressure-temperature-time-deformation data for the Permian Präbichl Formation, sampled in the Tirolic-Noric Nappe System (TNNS) below the overlying Juvavic Nappe System (JNS) at two localities. This formation consists of lower greenschist facies clastic sediments and corresponds to the Permian cover of the pre-Variscan basement. The metamorphic assemblage of the Präbichl Formation contains chloritoid + muscovite ± pyrophyllite + hematite + rutile + quartz. Phase equilibrium calculations and Raman spectroscopy on carbonaceous material indicate peak P-T conditions of ~350°C and 0.4-0.5 GPa. In both samples, 10 to 30 µm xenotime show systematic chemical zoning with a heterogeneous core and a distinct MREEs-rich rim. We targeted each chemical domain by in-situ LA-ICP-MS U-Pb dating. The concordant U-Pb ages from cores range between 632 Ma and 250 Ma, and likely reflect an inherited component. Younger dates were measured in the xenotime rims. In the eastern sample (Noric Nappe), a concordant cluster yields a weighted mean age of 133.6 ± 2.8 Ma (MSWD: 1.7, n: 14). Host-inclusion relationships of chloritoid and xenotime suggest coeval growth of the xenotime rim and chloritoid porphyroblasts, linking the U-Pb age to the growth of the main metamorphic assemblage. An additional set of discordant analyses yield an anchored discordia age of 91.5 ± 3.6 Ma (MSWD: 1.2, n: 7). In the western sample (Staufen-Höllengebirge Nappe), a set of concordant and discordant analyses yield an anchored age of 90.1 ± 1.4 Ma (MSWD: 1.8, n: 16). Xenotime and chloritoid are not observed in direct contact, and this sample is characterized by a pervasive crenulation cleavage, which postdates chloritoid growth. From the distribution and morphology of xenotime we conclude that post-peak dissolution-precipitation related to crenulation cleavage formation facilitated growth of the rim. These results have two key implications. Firstly, the 133.6 ± 2.8 Ma date coincides with the age of the latest syn-orogenic sediments overthrusted by the Juvavic Dachstein Nappe. It is therefore interpreted as the age of peak metamorphism after thrusting of the JNS over the TNNS ceased. The peak pressure of 0.4-0.5 GPa at that time corresponds to an overburden of ~17 km, which cannot be solely explained by the thickness of the JNS, which has a present day thickness of 5-10 km, suggesting the existence of a missing unit. Secondly, the 90-92 Ma dates correspond to the timing of the onset of post-orogenic sedimentation in the Gosau basins overlying both the TNNS and JNS and the exhumation of the Austroalpine eclogites. This implies a major change of dynamics at all levels of the orogen at that time.