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Chronometry of a nappe-scale thermal event inferred by thermobarometry and viscous relaxation of quartz inclusion pressure (Adula nappe, Alps)

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The Adula nappe is located at the eastern flank of the Lepontine dome in the Swiss Alps. It consists mainly of orthogneiss and paragneiss with intercalated lenses of eclogite, amphibolite and metasediments. Previous petrological studies on the peak pressure and temperature (P-T) conditions yield somewhat inconsistent results, particularly the pressure in the southern part of the nappe, but in general exhibit an increasing trend in both P-T towards the south. In this work, we applied zirconium-in-rutile thermometer and quartz-in-garnet Raman elastic barometer to constrain the P-T conditions using samples covering most of the nappe with high spatial coverage within the 600 km^2 area to obtain an internally consistent dataset. Based on the results of zirconium-in-rutile thermometer, the temperature gradually increases from the north at ca. 540 °C to the south at ca. 680 °C. Using the quartz-in-garnet elastic barometer, the calculated entrapment pressure increases from ca. 2.0 GPa to ca. 2.2 GPa from the north to the middle-south region of the Adula nappe, but rapidly falls to ca. 0.8-1.2 GPa towards the southern region, where the temperature exceeds ca. 650 °C. It is speculated that due to the temperature increase towards the south, viscous relaxation became activated that led to an apparent drop of the recorded residual quartz inclusion pressure. This suggests that by applying a pure elastic model to high temperature conditions, one may potentially underestimate of the formation pressure of garnets. Therefore, this study may provide information on the limit of the quartz-in-garnet (pure) elastic barometry technique. Moreover, it may offer a potential opportunity to constrain the duration of the near-isothermal decompression path if a viscoelastic model can be applied, which requires not only the equation of state of minerals but also the creep behavior of the inclusion-host system.