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METAMORPHISM AND FLUID REGIME DURING CORE COMPLEX EXHUMATION: AN EXAMPLE FROM GLEINALM COMPLEX (EASTERN ALPS)

Ana-Voica Bojar, Harald Fritz, Hans-Peter Bojar & Jürgen Loizenbauer

Within the Gleinalm area, high grade Middle Austroalpine crystalline basement units are juxtaposed along a steep shear zone against low grade metamorphosed Upper Austroalpine Graz Nappe Complex (NEUBAUER et al., 2000; NEUBAUER et al., 1995). Condensed isotherms suggest large amount of vertical displacement associated with sinistral shear. In order to quantify pressure-temperature conditions and possible contribution of fluid circulation to metamorphism, collaborative pressure-temperature data from stable mineral paragenesis together with stable isotope and fluid inclusion studies have been performed within the Middle Austroalpine Micaschist–Marble–Complex (MMC).

Within the MMC, temperature-pressure conditions during onset of the Gleinalm core complex exhumation are constraint by: a) garnet I – biotite (FERRY and SPEAR, 1978) and plagioclase – amphibole thermometers (HOLLAND and BLUNDY, 1994) and b)garnet I-plagioclase-biotite-muscovite-quartz barometer (GHENT and STOUT, 1981). The first garnet generation are up to 1 cm, shows prograde zoning with rim P-T conditions of 6-7 kbar and 550°C–600°C. A second stage of exhumation with conditions of 5–6 kbar and ca. 500°C is constraint by garnet II-biotite thermometer and sphalerite-pyrrhotite-pyrite barometer (LUSK and FORD, 1978). This mineral assemblage includes small unzoned garnet II and is found on foliation planes surrounding the first generation of garnet.

Three different types of fluid inclusions, from tension gashes related to late stage exhumation, were used for microthermobarometry. Type one and two inclusions are CO_2 and $CO_2 - H_2O$ rich, low density and low salinity inclusions. Constructed isochores together with temperatures estimated considering the rheological behaviour of quartz define a field of ca. 2 kbar and 350°-400°C. Very late fluids with high salinity and solid NaCl crystals (ca. 30 wt% NaCl equivalent) define a box of ca. 1 kbar and temperatures up to 150°C.

The constructed P-T-path includes isothermal decompression during early stages of exhumation, followed by isobaric cooling at levels about 1–2 kbar. We interpret these data by rapid exhumation of hot Middle Austroalpine units close to surface, exhumation that disturbed the local isotherms.

Detailed oxygen isotope data across marble layers alternating with pelitic schists show modification of initial step function shape during Late Createaceous metamorphism. The oxygen isotope profiles have a shape which fits the modelled curves for advective-diffusive transport in a fluid phase (BICKLE & MCKENZIE, 1987; BICKLE & BACKER, 1990; BOWMAN, WILLETT, & COOK, 1994). The advective displacement of the profiles are around 40 cm towards the lower metamorphic grade which implies an upwards component of fluid flow. For the pinned boundary solution the calculated time integrated fluid fluxes are of ca. 0.3 m^3/m^2. Flow along interconnected porosity took place over a total time of ca. 0.5 Ma.

We interpret the data as follows. (1) During early exhumation internal fluid circulated mainly within lithological units. The calculated vertical fluid flux integrated during the time of fluid flow could not have induced a significant thermal anomaly during the metamorphism. (2) During final exhumation, interconnected pathways opened by brittle deformation. High salinity fluids suggest infiltration of marine surface water. (3) The highly disturbed isotherm is interpreted to reflect rapid exhumation of the Gleinalm core and coeval sedimentation of the Gosau sediments.

References

BICKLE, M.J. & BAKER, J., (1990): Advective-diffusive transport of isotopic fronts: an example from Naxos, Greece. – Earth Planet. Sci. Lett. 97, 78–93.

BICKLE, M.J. & MCKENZIE D. (1987): The transport of heat and matter by fluids during metamorphism. – Contrib. Mineral. Petrol., 95, 384–392.

BOWMAN, J.R., WILLETT, S.D. & COOK, S.J. (1994): Oxygen isotopic transport and exchange during fluid flow: one-dimensional models and applications. – Am. J. Sci. 294, 1–55.

FERRY, J.M. & SPEAR, F.S. (1978): Experimental calibration of the partitioning of Fe and Mg between biotite and garnet. – Contrib. Mineral. Petrol., 66, 113–117.

GHENT, E.D. & STOUT, M.Z. (1981): Geobarometry and geothermometry of the plagioclase-biotite-garnet-muscovite assemblages. – Contrib. Mineral. Petrol., 76, 92–97.

HOLLAND, T., & BLUNDY, J (1994): Nonideal interaction in calcic amphiboles and their bearing on amphibole-plagioclase thermometry. – Contrib. Mineral. Petrol., 116/4, 433–447.

LUSK, J. & FORD, C.E. (1978): Experimental extension of the sphalerite geobarometer to 10kbar. – Am. Mineral., 65, 516–519.

NEUBAUER, F., DALLMEYER, R.D., DUNKL, I. & SCHIRNIK D., (1995): Late Cretaceous exhumation of the metamorphic Gleinalm dome, Eastern Alps: kinematic, cooling history and sedimentary response in a sinistral wrench corridor. – Tectonophysics, 242, 79–98.

NEUBAUER, F., GENSER, J. & HANDLER, R. (2000): The Eastern Alps: Result of a two-stage collision process. – Mitt. Österr. Geol. Ges., 92, 117–134.

Authors' addresses:
Dr. Ana-Voica Bojar, Dr. Harald Fritz, Dr. Jürgen Loizenbauer, Department of Geology and Paleontology, University of Graz, Heinrichstrasse 26, A-8010 Graz, Austria; Dr. Hans-Peter Bojar, Department of Mineralogy, Landesmuseum Joanneum, Raubergasse 10, A-8010 Graz, Austria