Geol. Paläont. Mitt. Innsbruck, ISSN 0378–6870, Band 25, S. 1–242, 2001

INDICATIONS FOR A PERMO-TRIASSIC METAMORPHIC IMPRINT IN THE AUSTROALPINE SILVRETTA NAPPE (EASTERN / ALPS)

Ralf Schuster, Rufus Bertle & Wolfgang Frank

In the past years a widespread Permo-Triassic high temperature/low pressure (HT/LP) event of various grade has been recognised within crystalline rocks of the Austroalpine unit (SCHUSTER et al., 1999). In this abstract we discuss indications for this event in the Austroalpine Silvretta Nappe. The study is based on data from the literature and new Ar-Ar age determinations which demonstrate striking analogies to the Austroalpine unit in the Kreuzeck-Goldeck-Drauzug section c. 50 km in the east.

In the Kreuzeck-Goldeck-Drauzug section a more or less continuous section through a Permo-Triassic middle and upper crust, up into the contemporaneous sediments has been preserved (SCHUSTER & FAUPL, 2001). The HT/LP imprint shows a characteristic zonation expressed in mineral assemblages, the occurrence of pegmatites and typical cooling ages for different structural levels. From the petrological point of view a sillimanite-zone with local anatexis, an andalusite-zone and a zone of preserved Variscan assemblages can be distinguished from bottom to the top (HOKE, 1990). Synmetamorphic pegmatites are frequent in the sillimanite-zone and die out in the andalusite-zone, where andalusite-quartz veins occur within staurolite and garnet-rich layers. With respect to ductile deformations of the magmatic feldspars the pegmatites exhibit syn- to postintrusive deformation at temperatures of more than 500°C. Formation ages of the pegmatites, are 260 ± 30 Ma. Ar-Ar cooling ages on muscovite from the pegmatites and the surrounding schists, which are interpreted as cooling ages below c. 400°C, yield plateau ages of 190 ± 10 Ma. Those from the andalusite zone are 210 ± 10 Ma. Going upward in the section plateau-type Ar-Ar cooling ages increase up to c. 270 Ma until saddle-shaped age spectra with total gas ages of 270 to 310 Ma occur. Rocks below the transgressive Permo-Mesozoic sequences of the Drauzug experienced less than c. 400°C during the Permo-Triassic thermal event and exhibit Variscan Ar-Ar plateau ages of c. 310 Ma. The sequence is interpreted as the result of Permo-Triassic lithospheric extension, subsequent thermal relaxation and sedimentation of the cover series (SCHUSTER & FAUPL, 2001).

For the Silvretta Nappe literature with important implications for this study and/or geochronological cooling ages exist from HOERNES (1971), GRAUERT (1969), THÖNI (1981), KRECZY (1981), AMMAN (1985), FLISCH (1986) and SPIESS (1987). Based on the literature pegmatites postdating the Variscian structures occur along the eastern limit of the unit. They are embedded within sillimanite-bearing gneisses and micaschists. Sillimanite in this eastern part is younger than Variscan kyanite, postkinematic with respect to the Variscian deformation and growing by the breakdown of pre-existing garnet and staurolite (AMMAN, 1985). At present no reliable formation ages of the pegmatites are available. Ductile deformation of magmatic feldspars indicates deformation at temperatures of more than 500°C. K-Ar cooling ages of muscovites from the pegmatites and the surrounding schists are 144, 160, 174, 184, 199 and 207 Ma. New Ar-Ar ages yielded 191 ± 2 and 189 ± 2 Ma. Towards tectonically higher levels in the north and west, no more pegmatites can be observed and the K-Ar and Ar-Ar cooling ages are increasing. E.g.

northwest of Galtür an Ar-Ar plateau age of 246 ± 2 Ma was determined on an orthogneiss muscovite. However data of this zone are scarce. In the southwest and in the north the Silvretta Nappe is locally transgressed by Carboniferous and the widely developed Permo-Triassic sedimentary piles of the Ducan and Langwasser synclines and the Northern Calcareous Alps. Ar-Ar ages on muscovite and Rb-Sr ages on biotite from the crystalline basement below the transgressional contacts yield Variscan cooling ages of about 310 ± 5 Ma respectively 290 ± 15 Ma.

Until now geochronological ages below 280 Ma have been interpreted as Variscan ages partly reset by an Alpine overprint. Several arguments argue against this interpretation: If the muscovite K-Ar and Ar-Ar ages represent Alpine overprinted ages, a stepwise pattern with low-temperature ages close to the overprinting event would be expected. However even the Triassic and Jurassic Ar-Ar cooling ages exhibit plateau-type pattern without steps of Alpine ages of c. 90 Ma. On the other hand if the Ar-Ar system of the muscovites would be partially reset, temperatures close to 400 °C, would be indicated for the Alpine overprint. In this case totally or nearly totally reset Rb-Sr ages of biotites would be expected because of the lower closure temperature of about 300°C for this isotopic system. However from thirtyone age data the five lowest are 124, 173, 181, 182 and 196 Ma.

Conclusions: The Silvretta Nappe represents a crustal block with a prominent Variscian structural and metamorphic imprint (e.g. HOERNES, 1971; GRAUERT, 1969). During Permo-Triassic times (at 260 ± 30 Ma) an elevated geothermal gradient caused a HT-LP imprint. At middle crustal levels sillimanite-bearing assemblages developed and pegmatites were emplaced. Subsequent cooling to the steady state geotherm produced a characteristic pattern of Ar-Ar muscovite ages. They are ca. 190 Ma in the sillimanite-zone and increase up to 310 Ma below the Permo-Triassic sediments. The Alpine temperatures did not exceed 400°C and were most probable just below 300°C in the main parts of the Silvretta Nappe. Late Alpine tectonics caused a large scale tilting of the Silvretta Nappe and exhumation of the structurally deepest parts in the southeast.

References

AMANN, A. (1985): Zur Metamorphose des nördlichen Silvrettakristallins. – Unpubl. Diss. Naturwiss. Fak Univ. Innsbruck, Innsbruck, 114 pp.

FLISCH, M. (1986): Die Hebungsgeschichte der oberostalpinen Silvretta-Decke seit der mittleren Kreide. – Bull. Ver. schweiz. Petroleum-Geol. u. Ing., **53/123**, 23–49.

GRAUERT, B. (1969): Die Entwicklungsgeschichte des Silvretta-Kristallins auf Grund radiometrischer Altersbestimmungen. – Inauguraldiss. Phil.-naturwiss. Fak. Univ. Bern, Bern, 166 pp.

HOERNES, S. (1971): Petrographische Untersuchungen an Pargneisen des polymetamorphen Silvrettakristallins. – Tschermaks Min. Petr. Mitt., **15**, 56–70.

KRECZY, L. (1981): Seriengliederung, Metamorphose und Altersbestimmung in der Region der Thialspitze SW Landeck, Tirol. – Unpubl. Diss. Univ. Wien, 125 pp.

SPIESS, R. (1985): Kristallingeologisch-geochronologische Untersuchungen zur Entwicklungsgeschichte des Westrandes der Phyllitgneiszone i.w.S. im Montafon (Vorarlberg). – Unpubl. Diss. Univ. Wien, Vienna, 74 pp.

SCHUSTER, R., SCHARBERT, S. & ABART, R. (1999): Permo-Triassic crustal extension during opening of the Neotethyan ocean in the Austroalpine-South Alpine realm. – Tübinger Geowissenschaftliche Arbeiten, Serie A, **52**, 5–6.

SCHUSTER, R. & FAUPL, P. (2001): Permo-Triassic sedimentary record and contemporaneous thermal basement evolution in the Drauzug-Goldeck-Kreuzeck area (Eastern Alps/Austria). – Mitt. Österr. Mineral. Ges., 146.

THÖNI, M. (1981): Degree and evolution of the Alpine Metamorphism in the light of K/Ar and Rb/Sr age determinations on micas. – Jb. Geol. B.- A., **124/1**, 111–174.

Authors' address:
Mag. Dr. Ralf Schuster (Ralf.Schuster@univie.ac.at), Mag. Rufus Bertle (Rufus.Bertle@univie.ac.at), Dr. Wolfgang Frank (Wolfgang.Frank@univie.ac.at) Institute of Geology, University of Vienna, Althanstraße 14, A-1090 Vienna, Austria