MITT.ÖSTERR.MINER.GES. 146 (2001)

INDICATIONS FOR A PERMO-TRIASSIC METAMORPHIC IMPRINT IN THE AUSTROALPINE CRYSTALLINE ROCKS OF THE DEFREGGEN ALPS (EASTERN TYROL)

by

R. Schuster[1], A. Proyer[2], G. Hoinkes[2] & B. Schulz[3]

[1]Institute of Geology
University of Vienna, Geozentrum, Althanstrase 14, A-1090 Vienna
[2]Institute of Mineralog and Petrology
University of Graz, Universitätsplatz 2, A-8010 Graz
[3]Institute of Mineralogy
TU Bergakademie, Brennhausgasse 14, D-09596 Freiberg

In the past years a widespread Permo-Triassic high temperature/low pressure metamorphic (HT/LP) imprint of various grade has been recognised within the Austroalpine units [1][2]. We discuss the effects of this imprint for the Austroalpine unit in the Deferegger Alps. From the Uttenheim area, that forms the continuation to the west, "late Variscan" pegmatites and a HT/LP metamorphic imprint have been reported [3]. New geochronological data from the southern part of the Deferegger Alps demonstrates striking analogies to the Austroalpine unit in the Kreuzeck-Goldeck-Drauzug section c. 50 km in the east:

In the Kreuzeck-Goldeck-Drauzug, a section through a Permo-Triassic middle and upper crust and overlying sediments has been preserved [4]. 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 deeper sillimanite-zone with local anatexis, an upper sillimanite-zone with relicts of staurolite, an andalusite-zone and a zone of preserved pre-existing assemblages can be distinguished from bottom to the top [5]. 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. Magmatic feldspars in the pegmatites exhibit syn- to post-intrusive ductile deformation at temperatures above 500°C. Formation ages of garnets from the pegmatites, determined by the Sm-Nd method are 260 ± 30 Ma. Ar-Ar data from muscovite in the pegmatites and surrounding schists, yield plateau ages of 190 ± 10 Ma which are interpreted as cooling ages below c. 400°C. 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 [4].

The Austroalpine basement of the Deferegger Alps is situated between the Penninic Tauern Window to the north and the Periadriatic Lineament to the south. It is subdivided by the Oligocene Defereggen–Antholz–Vals-Line (DAV) which is marked by slices of anchizonal lower Triassic sediments [6]. Both subunits show lithological similarities, but the northern one experienced a more intense Alpine overprint. The structurally deepest parts of the southern unit are cropping out immediate to the south of the DAV and in the core of an anticline in the Michelbach valley. The rock series consists of sillimanite-bearing biotite schists and biotite-plagioclase gneisses with intercalations of pegmatites, amphibolites and marbles [7]. In the metapelites sillimanite is intergrown with biotite and aligned to the dominant schistosity of the rocks. Sillimanite also forms millimeter-sized patchy pseudomorphs after garnet, indicative of prograde breakdown of garnet by Grt + Ms $\Leftrightarrow$ Sil + Bt + Qtz + H_2O. The pegmatites are mostly concordant and exhibit a magmatic mineral assemblage of Grt + Tur + Kfsp + Pl + Qtz + Ms. Garnet occur as up to 4 mm large ikositetraeders, the tourmalines are optically zoned. A ductile deformation which started at more than 500°C and continued to lower temperatures is expressed by dynamic recrystallisation and wavy extinction of feldspar and quartz. Above the sillimanite-bearing zone, fine grained biotite-plagioclase gneisses with intercalations of staurolite and/or garnet-rich micaschists occur [8]. Andalusite-quartz veins have been observed within the micaschists. The upper part of the unit is formed by garnet-micaschists, orthogneisses and phyllitic micaschists which continue into the Thurntal quartzphyllites [8].

Pegmatites also occur within biotite-rich schists and gneisses of the northern unit. Those from the Uttenheim area are interpreted as partial anatectic melts from the residual sillimanite-biotite schists. They formed during a HT/LP event at 650 ± 30°C and 0.6 ± 0.1 GPa [3]. To the east near Radlach a spodumene-bearing pegmatite has been found. A Permian age for the pegmatites from the Uttenheim area is confimed by a Rb-Sr whole rock isochron of 262 ± 7 Ma [9]. From the Michelbach valley, a Sm-Nd garnet isochron yields a Permian age of 253 ± 7 Ma from the pegmatite. An Ar-Ar age on muscovite from the surrounding sillimanite-biotite-schist yielded 193 ± 2 Ma and is interpreted to date cooling below c. 400°C. It is identical to those of the sillimanite-zone from the Kreuzeck area. The Rb-Sr isochron age of biotite from the same sample is 204 ± 2 Ma. As closure temperatures for the Rb-Sr isotopic system in biotite are expected to be around 300°C and since the age was not reset during a later event, Alpine temperatures did not exceed 300°C. These observations signalize a Permian age of the high-temperature ductile deformation of the pegmatites, and implies a similar minimum age of the HT/LP imprint of the surrounding rocks.

Summarising the data the following conclusions can be deduced: The Austroalpine crystalline rocks from the Deferegger Alps experienced a Variscan metamorphic imprint [3] [8]. During Permo-Triassic times, extension of the lithosphere caused an elevated geothermal gradient and a HT-LP imprint. At middle crustal levels, sillimanite-bearing assemblages developed and pegmatites were emplaced. Subsequent cooling to the steady state geotherm produced Ar-Ar cooling ages of c. 190 Ma in the sillimanite-zone. In the southern block the Alpine temperatures were just below 300°C, in the northern unit upper greenschist facies conditions were reached [3].

References

[1] SCHUSTER, R., SCHARBERT, S. & ABART, R. (1999): Permo-Triassic crustal extension during opening of the Neotethyan ocean in the Austroalpine-South Alpine realm. - Tübinger Geowissensch. Arb., Serie A, 52: 5-6.

[2] THÖNI, M. (1999): A review of geochronological data from the Eastern Alps. – Schweiz. Mineral. Petrogr. Mitt., 79/1: 209-230.

[3] STÖCKHERT, B. (1987): Das Uttenheimer Pegmatitfeld (Ostalpines Altkristallin, Südtirol) Genese und alpine Überprägung. - Erlanger geol. Abh., 114: 83-106.

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

[5] HOKE, L. (1990): The Altkristallin of the Kreuzeck Mountains, SE-Tauern Window, Eastern Alps - Basement Crust in a Convergent plate Boundary Zone. - Jb. Geol. B.-A., 133: 5-87.

[6] STÖCKHERT, B. (1982): Deformation und retrograde Metamorphose im Altkristallin S' des westlichen Tauernfensters (Südtirol). - Thesis, Univ. Erlangen: 214pp, Erlangen.

[7] SENARCLENS-GRANCY, W. (1972): Geologische Karte der westlichen Deferegger Alpen 1:25 000. - Geol. B.-A. Österreich, Wien.

[8] SCHULZ, B., SIEGESMUND, S., STEENKEN, A., SCHÖNHOFER, R. & HEINRICHS, T. (2001): Geologie des ostalpinen Kristallins südlich des Tauernfensters zwischen Virgental und Pustertal. - Z. dt. geol. Ges., 152 (in print).

[9] BORSI, S., DEL MORO, A., SASSI, F. P., VISONA, D. & ZIRPOLI, G. (1980): On the existence of Hercynian aplites and pegmatites in the lower Aurina valley (Ahrntal, Austrides, Eastern Alps). - N. Jb. Miner. Mh., 1980/11: 501-514.