MITT.ÖSTERR.MINER.GES. 143 (1998)

TIMING AND CONDITIONS OF METAMORPHIC EVENTS ALONG A PROFILE FROM THE BASE OF THE NORTHERN CALCAREOUS ALPS TO THE AUSTROALPINE BASEMENT UNITS (LOWER AUSTRIA- STYRIA)

by

K. Schmidt, W. Frank & R. Berka

MinPet 98

Institut für Geologie, Universität Wien, Geozentrum, Althanstraße 14, A-1090 Wien

This study deals with the effects and intensity of Alpine metamorphism on Permo-Mesozoic rocks in the Northern Calcareous Alps (NCA), the Greywacke Zone (GRWZ) and the Austroalpine basement units.
In the following, the results of illite crystallinity (IC) and geochronological investigations are reported. The IC data have been calibrated with the Interlaboratory Crystallinity Index Standards of WARR & RICE (1994). Fine fractions and detrital mica have been dated with the $^{40}Ar/^{39}Ar$ stepwise heating technique. Metamorphic minerals of the crystalline units were investigated by the $^{40}Ar/^{39}Ar$ stepwise heating technique and/or the Rb/Sr technique.

In the **NCA** the Werfen Beds, which represent the basal layers of the Schneeberg and the Mürzalpen nappes have been sampled. The IC-values of the Schneeberg nappe are still diagenetic whereas samples from the Mürzalpen nappe show transitional upper anchizone conditions. The presently available $^{40}Ar/^{39}Ar$ age data indicate metamorphic formation ages of about 120 - 150 Ma.
GRWZ: The samples of the Permo-Mesozoic Silbersbergschiefer, which form a major portion of the Silbersbergnappe (NIEVOLL, 1984; NEUBAUER et al., 1994), yielded IC-values that indicate upper anchizone to epizone Alpine metamorphic conditions. The index mineral stilpnomelane occurs occasionally. Dating these fine fractions resulted in consistent $^{40}Ar/^{39}Ar$ plateau ages between 110 - 115 Ma. The $^{40}Ar/^{39}Ar$ plateau age of detrital mica immediately below the Vöstenhof-crystalline is 375 ± 4 Ma.
This age is identical with several $^{40}Ar/^{39}Ar$ ages of white mica of the Vöstenhof-crystalline itself, which cluster between 375 - 380 Ma. For the Alpine event, therefore maximum temperatures below the closing temperature of ca. 420°C for white mica can be estimated, since the low temperature steps shows no influence of an overprint.
The **Tattermannschiefer**, which are lithologically similar to the Silbersbergschiefer, represent another equivalent of the Alpine Verrucano. In a profile close to Preiner Gscheid, the occurrence of the index minerals stilpnomelane and paragonite corresponds well with the epizone IC values. K/Ar and $^{40}Ar/^{39}Ar$ ages cluster around 90 Ma, significantly younger than the $^{40}Ar/^{39}Ar$ data of the Silbersbergschiefer.

The **Drahtekogel Deckscholle**, which is situated as a klippe on the Lower Austroalpine (**LAA**) unit is the continuation of the Troiseck Floning Unit and represents a frontal portion of the Austroalpine crystalline basement. $^{40}Ar/^{39}Ar$ mineral-ages show an initial metamorphic imprint in Variscan time (Ms 320 - 360 Ma, Hb 360 Ma) and maybe a thermal overprint in the Permian. The Alpine metamorphic event was accompanied by extensive fluid flow, evidence for which is seen in the common alteration of mineral assemblages and sericitisation of feldspar. Furthermore, indications of major fluid flow have also been inferred from the strongly disturbed Rb/Sr isotopic system of the metapelitic country rocks.
The occurrence of chloritoid and the beginning of isotopic rejuvenation of muscovite/biotite support temperatures of c. 350°C for Alpine metamorphism.

The **LAA** Semmering unit is represented by quartz phyllites, phyllonitic mica schists, granitic gneisses (Grobgneis) and a Permo-Mesozoic cover series. The Kapellener Schiefer are black phyllites/schists of Carnian age, which have been correlated with the Lunzer Sandstein (BARNICK, 1966).
IC in the Kapellener Schiefer gave lower anchizone values, despite the fact that the presence of biotite in thin section clearly indicates a mid greenschist facies metamorphism. The broad IC values are ascribed to the high contents of graphite and Fe-oxides restricting illite/muscovite crystallisation and the overlapping of (001) illite and biotite peaks. The appearance of biotite in the sequence fits well with the uniform greenschist facies Alpine imprint in the crystalline basement, of about 350 - 400°C.
The age of Alpine metamorphism in the Semmering unit is well defined by numerous age data from several lithologies: Fine fractions of the Kapellener Schiefer and the Keuperphyllite yielded late Cretaceous $^{40}Ar/^{39}Ar$ plateau ages of 82 ± 3 Ma and 83.5 ± 1.2 Ma respectively. White mica from middle Triassic marbles are 81.1 ± 1.0 Ma in age whereas a sericite schist yielded 79 ± 1 Ma. Additional age data in the same time span have been reported from adjoining LAA units by DALLMEYER et al (1998), HANDLER (1994), and MÜLLER (1994).

For the **Strallegg complex** (BERKA et al., 1998) upper greenschist to amphibolite facies Alpine conditions within the stability field of kyanite can be deduced from the occurrence of staurolite near Mürzzuschlag (Traibach schists) and the Hartberg area (PEINDL, 1990). This estimate corresponds well with results of MOINE et al. (1989), who reported conditions of 500 - 550°C at 8 - 9 kbar for the formation of the talc deposit at Rabenwald. The age of the thermal event was determined by Rb/Sr dating of the Traibach schists (biotite 109 ± 2 Ma, white mica 103 ± 3 Ma and biotite 126 ± 2 Ma) and from an $^{40}Ar/^{39}Ar$ muscovite plateau age of 94 ± 2 Ma from the Sopron area.

Discussion

Due to the fact that detrital white mica of the Silbersbergserie yielded identical $^{40}Ar/^{39}Ar$ plateau ages as the Vöstenhof crystalline, we conclude that the Vöstenhof complex was at least in part the sediment source for the Silbersbergserie. This relationship is similar to the Kaintaleck and Kalwang basement-cover relationship of HANDLER et al. (1997) and NEUBAUER (1994). Due to wide spread tectonism the early Variscan crystalline slices occur in different positions with respect to the transgressive unit.

From north to south, a gradual, but not continuous increase of the metamorphic grade has been observed. In the northern portion it increases fom diagenesis in the uppermost Schneeberg nappe to lower greenschist facies in the Semmering unit, wheras in the southern part an increase from the Semmering unit to the higher basement units has been determined. Alpine metamorphism reached amphibolite facies in the Strallegg complex and locally eclogite facies conditions in the Sieggraben, Schäffern and Kirchschlag Deckscholle.

The Drahtekogel Deckscholle and the Semmering and Wechsel units got their Alpine metamorphic imprint during the same time span, at ca. 80 - 85 Ma. In the Permo-Scythian of the overlying, low grade metamorphic units in the north, the timing of the thermal imprint gets older (Tattermannschiefer 90 Ma, Silbersbergschiefer 110 - 115 Ma, NCA 120 - 150 Ma). The $^{40}Ar/^{39}Ar$ ages of these low grade metamorphic units represent the time of their metamorphism and growth of white mica. Following the profile towards the south the metamorphic ages in the tectonically higher crystalline units also increase. The Strallegg complex yielded 100 - 120 Ma in its northern frontal portion (BERKA et al., 1998).

References

BARNICK, H. (1966): Die Kapellener Schiefer im unterostalpinen Semmeringmesozoikum.- Mitt.Geol.Ges., 59/2, 121-138.

BERKA, R., SCHMIDT, K., SCHUSTER, R. & FRANK, W. (1998): Hercynian and Permian metamorphism in the eastern part of the Austroalpine basement units (Eastern Alps).- Mitt. Österr. Mineral. Ges., 143, 242-245

DALLMEYER, R. D., HANDLER, R., NEUBAUER, F. & FRITZ, H. (1998): Sequence of thrusting within a thick-skinned tectonic wedge : evidence from $^{40}Ar/^{39}Ar$ and Rb-Sr ages from the Austroalpine nappe complex of the Eastern Alps.- Journal of Geology, 106, 71-86.

HANDLER, R., 1994: $^{40}Ar/^{39}Ar$ and Rb-Sr mineral dating within a complex polymetamorphic terrain: the northeastern Alps, Austria.- unveröff. Diss. Naturwiss. Fak., Karl-Franzens-Universität in Graz, 143pp.

HANDLER, R., DALLMEYER, R.D. & NEUBAUER, F. (1997): $^{40}Ar/^{39}Ar$ ages of detrital white mica from Upper Austroalpine units in the Eastern Alps, Austria: Evidence for Cadomian and contrasting Variscan sources.- Geol. Rundschau, 86, 69-80.

MOINE, B., FORTUNE, J.P., MOREAU, P. & VIGUIER, R.F. (1989): Comparative mineralogy, geochemistry and conditions of formation of two metasomtic talc and chlorite deposits: Trimouns (Pyrenees, France) and Rabenwald (Eastern Alps, Austria).- Economic Geology, 84, 1398-1416.

MÜLLER, W. (1994): Neue geochronologische und strukturgeologische Daten zur geodynamischen Entwicklung des nördlichen Semmering- und Wechsel Gebietes (Niederösterreich).- unveröff. Diplom. Arb. Formal- u. Naturwiss. Fak. Univ. Wien, 267 S., Wien.

NEUBAUER, F., HANDLER, R., HERMANN, S. & PAULUS, G. (1994): Revised Lithostratigraphy and Structure of the Eastern Graywacke Zone (Eastern Alps).- Mitt. Österr. Geol. Ges., 86, 61-74.

NIEVOLL, J. (1984): Der Südrand der Grauwackenzone zwischen St¸bming und Neuberg (Obersteiermark, ÖK 103 Kindberg).- Mitt. Österr. Geol. Ges., 77, 63-71.

PEINDL, P. (1990): Variszische und alpidische Entwicklungsgeschichte des südöstlichen Raabalpenkristallins (Steiermark).- Diss Karl Franzens Univ. Graz, 252pp, Graz.

TOLLMANN, A. (1963): Ostalpensynthese.- VIII, Deuticke, Wien, 256pp.

WARR, L.N. & RICE, H. (1994): Interlaboratory standardization and calibration of clay mineral crystallinity and crystallite size data.- J. metamorphic Geol., 12, 141-152.