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HERCYNIAN- AND PERMIAN METAMORPHISM IN THE EASTERN PART OF THE AUSTROALPINE BASEMENT (EASTERN ALPS)

by

R. Berka, K. Schmidt, R. Schuster & W. Frank

MinPet 98

Institut für Geologie, Universität Wien
Geozentrum, Althanstraße 14, A-1014 Wien

Introduction

During the last few years geochronological data has given more insight into the Prealpine history of the easternmost part of the Austroalpine basement units (HANDLER, 1994; MÜLLER, 1994; DRAGANITS, 1996). In this study, additional age data are presented which indicate a contrasting thermal history of these units in Hercynian time. The most important result is that the upper part of the Semmering Unit (Grobgneis Unit), termed the Strallegg Complex, has to be separated from the rest, due to its different Permo-Triassic thermal imprint.
In the easternmost part of the Eastern Alps, Austroalpine basement units overlie the Pennin of the Rechnitz Windows. The Austroalpine unit is divided from bottom to the top into the Lower Austroalpine Wechsel-, Waldbach-, and Semmering (Grobgneis) Units. Above these, eclogite bearing basement occurs in the Sieggraben-, Schäffern- and Kirchschlag Klippe. In the north the Troiseck Floning Unit and its continuations, the Mahdtal and Drahtekogel Klippen overlie the Semmering Unit. The Vöstenhof crystalline unit is located within the Greywacke zone (e.g. DALLMEYER et al., 1998).

Prealpine metamorphic evolution of the units

In the *Wechsel Unit* the Wechselgneisses are overlain by Wechselschists. Phengitic mica in the gneisses yield Ar-Ar ages of c. 360 Ma, documenting an early Hercynian metamorphic imprint. The overlying Wechselschists experienced their first metamorphic imprint in Permian time, at c. 245 Ma. Fine grained paragonitic mica of the gneisses have Ar-Ar ages in the same range (MÜLLER, 1994).
For the *Waldbach Complex* FAUPL (1972) estimated Prealpine metamorphic conditions of upper amphibolite facies with, local partial melting of the rocks. It is characterised by abundant intermediate orthogneisses and various amphibolites. No geochronological data are available.

The *Semmering Unit* consists of phyllitic mica schists, porphyric granite gneisses (Grobgneis), subordinate gabbros, and a Permo-Mesozoic cover series. In cases of an Alpine overprint the Prealpine assemblages are only partly preserved. Garnet and an old mica generation represent relics of at least upper greenschist metamorphic conditions. The age of the Prealpine imprint is yet not clear. For the porphyric orthogneisses SCHARBERT (1990) determined a Hercynian Rb-Sr whole rock isochron of 338 ± 12 Ma, whereas three Rb-Sr whole rock- muscovite isochrons yielded Permian ages of 249 - 277 Ma (MÜLLER, 1994). Lazulite-quartz veins of Permian age (246 ± 23 Ma BERNHARD, 1998) are another argument for a low grade Permian imprint. In addition, there are mica schists characterised by abundant pseudomorphs of staurolite and up to 2 mm large ilmenite flakes, which are difficult to differentiate from the phyllitic mica schists. They are often associated with fine-grained granitic gneisses and pegmatites. WIESENEDER (1981) called them the *Tommer schist.* In the Sopron area DRAGANITS (1996) uses the term Sopron Series. The schists are characterised by Prealpine garnet-staurolite assemblages, indicating medium-P amphibolite facies metamorphic conditions. During the Alpine overprint, staurolite was pseudomorphosed by chloritoid and white mica. Garnets show a distinct Alpine overgrowth.

Further, there are lithologies characterised by a medium to high grade high temperature/low pressure (HT/LP) imprint which are referred to as the *Strallegg Complex* (WIESENEDER, 1981). In the Sopron area (Òbrennberg Kaltes Bründl Series, DRAGANITS, 1996) and between Strallegg and Hartberg (Strallegg gneisses) these rocks overlie the Semmering unit, whereas near Mürzzuschlag (Traibach schists) the relationships are obscured by an intense tectonic overprint. The Strallegg unit is characterised by aluminosilicate bearing biotite-rich metapelites which exhibit clear evidence for two pre-Alpine metamorphic events. Further, it is composed of polyphase micaschists, amphibolites, fine-grained granitic gneisses and pegmatites. In the biotite-rich metapelites, large almandine-rich garnets and relicts of staurolite and ilmenite form the oldest mineral assemblage, suggesting a similar early metamorphic history to the Tommer schist.

The second event, a HT/LP metamorphism, resulted in prograde staurolite breakdown and formation of andalusite by the reaction staurolite + muscovite = andalusite + biotite + garnet. Sillimanite in shear bands, which cut through andalusite, is the youngest pre-Alpine aluminosilicate phase. Mica schists with garnet and up to 8 cm large pseudomorphs after andalusite occur in the area of Hartberg. They experienced their first imprint during the HT/LP metamorphic event. Amphibolites typically show assemblages of hornblende + clinopyroxene + plagioclase. In the southern part of the Strallegg Complex and in the Sopron area, the beginning of migmatisation of the rocks is visible. The HT/LP metamorphism reached up to 650°C at about 4 kbar, which represents a geothermal gradient of more than 40°C/km. The pre-Alpine minerals suffered alteration during the Alpine overprint. Chloritoid + staurolite + white mica ± kyanite replaced andalusite, biotite reacted to muscovite + ilmenite and plagioclase to muscovite + biotite. Alpine almandine-rich garnets grew preferentially within plagioclase pseudomorphs.

Garnet of the Traibach schists related to the first metamorphic imprint yielded a garnet-whole rock isochron age of 320 ± 2 Ma, which fits well with electron microprobe ages on monazite of 310 ± 17 and 323 ± 25 Ma (BERNHARD, 1998). Therefore, the first metamorphic event can be assumed as Hercynian in age.

For the HT/LP imprint, a Permian age has been determined; a Rb-Sr muscovite-plagioclase-whole rock isochron of a biotite-rich, andalusite and sillimanite bearing metapelite from the Sopron area yielded an age of 283 ± 7 Ma. The Sm-Nd garnet-biotite-whole rock isochron age of garnet + biotite + quartz rock from the same locality is 263 ± 3 Ma. For garnet cores of a mica schist form Hartberg 276 ± 4 Ma was determined (Sm-Nd garnet-whole rock isochron). Fine grained orthogneisses and pegmatites from the southern, partly migmatised part of the unit are in the range of 230 to 260 Ma old (SCHARBERT, 1990). A pegmatite from the Traibach schists yielded a Rb-Sr muscovite-whole rock isochron of 244 ± 3 Ma and an Ar-Ar muscovite plateau age of 240 ± 2 Ma.

The *Troiseck Floning Unit* and its continuations the Mahdtal and Drahtekogel Klippen are composed of gneisses, amphibolites, mica schists and subordinate pegmatites. In the north, they are transgressed by Permo-Mesozoic sediments. Geochronological data cover a wide range of the Hercynian period: A hornblende Ar-Ar plateau age from the Drahtekogel Klippe is 358 ± 3 Ma, Rb-Sr muscovite-whole rock isochrons are about 330 Ma (HANDLER, 1994) and Ar-Ar total gas ages of muscovite yielded 313 ± 2 Ma and 309 ± 2 Ma.

The paragneisses and amphibolites of the *Vöstenhof crystalline rocks* are the basement of the Permo-Skythian Silbersberg Series (SCHMIDT et al., 1998). They form the Silbersberg Nappe, which is located between the upper Noric Nappe and the lower Veitsch Nappe of the eastern Greywacky Zone. Mica from paragneisses shows cooling ages of 382 ± 4 Ma and 385 ± 5 Ma respectively.

Conclusions

The Vöstenhof crystalline of the Silbersberg Nappe shows the oldest Ar-Ar muscovite cooling ages of c. 380 Ma. After that it always had a shallow tectonic position.
An early Hercynian metamorphic imprint of c. 360 Ma is present in the Wechsel Unit and in the Drahtekogel Klippe, which is part of the Troiseck Floning unit.
Typical Hercynian ages of c. 340 - 320 Ma and related cooling ages of c. 310 Ma have been recorded in the Troiseck Floning Unit. In the Strallegg Complex, a first metamorphic peak at about 320 Ma is recognised; Hercynian cooling ages were destroyed by later techtonothermal overprinting.
A Permo-Triassic thermal imprint of low-grade metamorphic conditions can be found in the Wechsel and probably the Semmering Unit. The medium to high grade HT/LP event of the Strallegg Complex is Permian in age.
The Strallegg Complex has a very similar Prealpine evolution as the Saualpe-Koralpe Complex, but a different Alpine overprint (HABLER & THÖNI, 1998; SCHUSTER et al. 1998). The Permo-Triassic and Alpine (SCHMIDT, 1998) metamorphic imprint is also significantly different from that of the Semmering Unit. Therefore, it has to be separated from the Lower Austroalpine Units.

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