MITT.ÖSTERR.MINER.GES. 143 (1998)

ELECTRON MICROPROBE AGES OF MONAZITE AND XENOTIME FROM THE AUSTROALPINE BASEMENT UNITS OF THE FISCHBACHER ALPEN, STYRIA, AUSTRIA

by

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Introduction and regional geology

The Austroalpine basement between the Mürztal and the crest of the Fischbacher Alpen, Styria, consists predominantly of the Lower Austroalpine Semmering unit. It comprises mainly phyllites and phyllitic micaschists, subordinate concordant granitoid gneisses of Carboniferous age (Grobgneis), and is covered by Permo-Mesozoic sediments. Alpine metamorphism reached greenschist facies conditions, the typical mineral assemblage in the metapelites is quartz + muscovite + chlorite ± albite ± chloritoid ± epidote ± kyanite. Garnet and a part of the white mica represent relics of a pre-Alpine metamorphism.

In addition, there are two lithologies which are dominated by pre-Alpine textures and mineral assemblages, the Tommer schists and the Traibach schists. In the field they can be recognised by abundant pseudomorphs and are therefore termed „Pseudomorphosen-Schiefer".

Schists of the Tommer type are characterized by a garnet-staurolite assemblage indicating pre-Alpine medium-P amphibolite facies metamorphic conditions. During the Alpine overprint, staurolite is replaced by chloritoid and white mica. Garnets show a distinct Alpine overgrowth. The Traibach schists in the area Traibachgraben-Freßnitzgraben exhibit evidence for two pre-Alpine metamorphic events. Large garnets with locally staurolite inclusions feature the oldest phase, suggesting a similar early metamorphic history as the Tommer schist. The second event, a high-T, low-P metamorphism, resulted in prograde staurolite breakdown and formation of a biotite-andalusite assemblage with locally sillimanite. The pre-Alpine minerals suffered severe alteration during the Alpine overprint. Chloritoid + staurolite + white mica ± kyanite replaced andalusite, biotite reacted to muscovite + ilmenite and plagioclase to muscovite + biotite. Alpine garnets grow preferably within plagioclase pseudomorphs. A characteristic feature of both types of „Pseudomorphosen-Schiefer" are discordant leucocratic granitoid veins and dikes and tourmaline-bearing pegmatites.

About 10 major occurrences of hydrothermal lazulite-quartz veins are known in the Fischbacher Alpen. These up to one meter wide veins are located in the phyllitic micaschists and the Tommer schists. Some veins clearly crosscut an older, most probably Variscan foliation. On the other hand, lazulite-quartz veins are also affected by the Alpine metamorphic overprint, and show local recrystallisation, alteration and remobilisation. An alteration zone with Mg-rich chlorites accompanies the veins.
The ages of the two pre-Alpine metamorphic events (Carboniferous-Permian?), as well as the formation age of the lazulite-quartz veins are uncertain up to now.

Monazite model ages in the „Pseudomorphosen-Schiefer"

The method of monazite dating with the electron microprobe (EMP) has been introduced by SUZUKI et al. (1991). Its theoretical background, its potential and the major error risks are described in MONTEL et al. (1996) and FINGER & HELMY (1998).
Monazites in a sample of typical Traibach schist with andalusite relics from Freßnitzgraben yielded a chemical Th-(U)-Pb age of 310 ± 17 (2σ) Ma (weighted average age from 11 analyses in four grains). These monazites are up to 0.15 mm large, rounded and in most cases unaltered. One of the measured monazites is corroded and surrounded by apatite. Some monazites are enclosed in pseudomorphosed andalusite and show lobate contacts toward the former andalusite. Texturally, these monazites appear older than andalusite. Most monazites are enclosed in biotite or are in contact with Alpine minerals. Inclusions in monazite are biotite and quartz.
A ca. 0.5 mm large monazite crystal in a micaschist from Freßnitzgraben yielded 323 ± 35 Ma (six analyses). This monazite is partly altered to REE-bearing epidote and apatite. An undeformed narrow tourmaline-bearing pegmatite vein crosscuts the pre-Alpine fabric of the schist and characterises the sample as a „Pseudomorphosen-Schiefer". However, the mineral assemblage is typically Alpine (quartz + muscovite + chlorite + garnet) and monazite appears to be the only relict mineral of the pre-Alpine metamorphism.
Due to the consistency of the single point analyses (no evidence for lead loss or relict cores), it may be assumed that the mean model ages given above are close to the primary crystallisation ages of the monazites.

Xenotime model ages in lazulite-quartz veins

Accessory xenotime from the lazulite-quartz vein in phyllitic micaschists at Höllkogel/Alpl contains in some domains enough U to permit EMP dating. Six analyses on four grains from one sample yielded a weighted mean age of 246 ± 23 Ma. As the model ages of all analyses overlap within error, it is assumed that this mean age constrains the formation age of the lazulite-quartz veins (BERNHARD et al., 1998).

Monazite model ages in alteration zones adjacent to lazulite-quartz veins

In these zones, monazites are typically altered to florencite. A sample from Höllkogel was investigated. Analyses in the 5 - 10 mm large monazite relics within florencite yielded geologically meaningless results. Fourteen measurements on six grains gave model „ages" between 273 ± 106 and 67 ± 41 Ma.

Discussion and conclusions

The monazite model ages of ca. 310 and ca. 323 Ma, combined with the observed textures and mineral assemblages, suggest a medium-P, amphibolite facies metamorphic event during Variscan time for the „Pseudomorphosen Schiefer", especially for the Traibach schists. It is possible that the low-P, high-T metamorphism, which is only documented in the Traibach schists, followed immediately after the medium-p, amphibolite facies event. A P-T-t-path of this kind has been, for example, recorded in the extra-Alpine Variscides (e.g. BÜTTNER & KRUHL, 1997). Alternatively, the andalusite forming metamorphism may be related to a Permian high-T event, which has been documented in many other parts of the Eastern Alps (SCHUSTER & THÖNI, 1996; BERKA et al., 1998).

Formation of hydrothermal lazulite-quartz veins in the phyllitic micaschists and the Tommer schists took place at ca. 246 Ma. Their formation may be related to the widespread magmatism and metamorphism in the Austroalpine units during the Permian (e.g. MORAUF, 1980; MILLER & THÖNI, 1997; BERKA et al., 1998). On the other hand, Permo-Triassic Pb-Zn-fluorite-barite veins and pure quartz veins are abundant in extra-Alpine basement units (see BERNHARD et al. (1998) for a brief summary). These veins are in most cases not related to a distinct igneous or metamorphic event. However, very distinct sources and mobilisation, transport and precipitation conditions seem necessary for the formation of the localised, but abundant lazulite-quartz veins in the Fischbacher Alpen.

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