Petrologische Untersuchungen im Angerkristallin, Steiermark

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Introduction

The Angerkristallin is located about 30 km NNE of Graz, with a total area of about 90 km^2 (Fig.1.). According to Tollmann (1977) the Angerkristallin is a part of the Middle Austroalpine Unit, squeezed between the Upper Austroalpine nappes of the Graz Paleozoic in the SSW and the Lower Austroalpine Unit in the NNE. Neubauer (1982) proposes that the Schöckel marbles from the Graz Paleozoic are equivalent to the Koglhof marbles of the Angerkristallin and thus following this interpretation the Angerkristallin is part of the Upper Austroalpine Unit.

Petrographic field work showed that this crystalline is not a homogeneous unit. It consists of at least two lithostratigraphic units, which are widespread in the Austroalpine unit east of the Tauern Window.

The southern part consists of dark grey micaschists and paragneisses with intercalations of amphibolites and marbles. The occurrence of spodumene-bearing pegmatite-gneisses with Permian intrusion age is characteristic for this unit (Esterlus, 1983). All petrographic and lithological features clearly indicate that the southern part of the Angerkristallin is part of the Rappold Complex, which is widespread in the Gleinalm and the Niedere Tauern area. Most probable the garnet cores where formed during the Variscan orogeny, whereas the garnet rims reflect an eo-Alpine event.

Lithologies in the northern part of the Angerkristallin are garnet micaschists with intercalations of quartz-albite mobilisats and amphibolites. The amphibolites diversify from amphibolites to mica-bearing amphibolites (=Garbenschiefer), both with or without garnet, which is usually smaller than 5 mm in diameter and mostly of idiomorphic shape. Based on the lithological content it represents a part of the Wölz Complex of the Niederen Tauern. The garnet cores are formed by Permian metamorphism, whereas the second garnet generation grew during the eo-Alpine tectonometamorphic event.

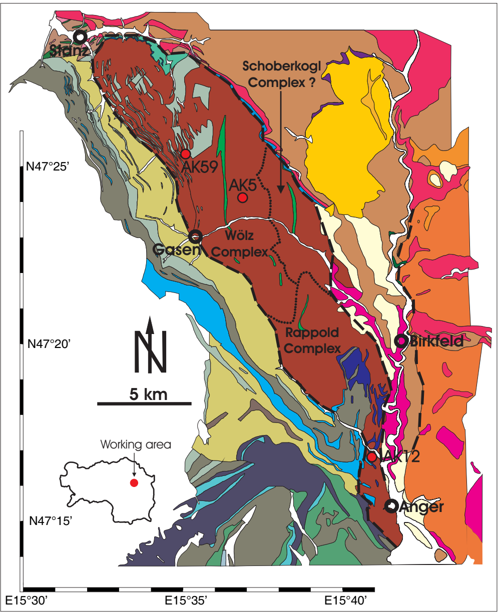

Fig.1. Simplified geological map of the Angerkristallin and surrounding units. Sample locations are labelled with a red circle. Dotted line shows the proposed border between the Wölz Complex, the Schoberkogl Complex and the Rappold Complex.

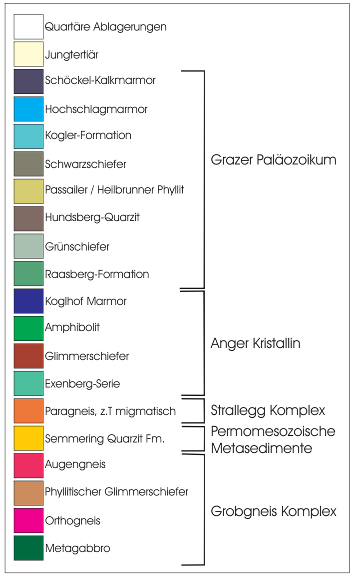

Fig.2. Legend

Geochronology

Monazite dating by EPMA was done on two samples from the poly-phase garnets from the Wölz Complex. Six Monazites from sample AK5 have been dated. One monazite grain is enclosed in a garnet core from a two-phase garnet, four are from the outermost portion of the rim and one is from the rock-matrix (Fig.4.). The monazite from the core is 213 ± 28 Ma in age. The weighted mean age of the alpine monazites is 84 ± 25 Ma. Even though the monazite in the core is slightly too young for a typical Permian age, there is a significant difference between this monazite and the alpine monazites. Monazites from the matrix and the second generation garnet have an Yttrium content near the detection limit, whereas the monazite inclusion in the core has 1.36 wt% Y_2O_3. Maybe the monazite from the core is altered, but this is just the first monazite with probably Permian age that we have measured. More monazite ages from garnet cores from the Rappold and Wölz Complexes will follow soon.

Second sample AK24 has no monazites in the inner garnet zone. The six measured monazites from the matrix and the outermost portion of the garnet have a weighted mean age of 85 ± 23 Ma.

Two- phase Wölz Complex

Two-phase garnets have a diameter of approximately 5 - 10 mm. Core and rim are idiomorphic in shape, but retrograde alteration to chlorite is common (Fig.4.). The transition zone between first- and second generation garnet is characterized by a discontinuous increase of X_{Grs} from 0,06 at the outermost portion of the core to ~0,17 at the inner part of the rim. Further growth of garnet shows a steeply decrease of the X_{Grs}. X_{Alm} in the core shows a moderate increase towards the rim. At the transition zone X_{Alm} drops off sharply from 0,80 to 0,70. Afterwards the garnet increase in X_{Alm} again. X_{Prp} increases shallow from the innermost portion of the garnet to the rim to values of about 0,12. X_{Sps} decreases outwards (bell-shaped curve), but like the Pyrop content it shows no discontinuous change during the second growth period (Fig.6.).

Inclusions in garnets are quartz, ilmenite, tourmaline, epidote, zircon and monazite (Fig.4.). Relics of staurolite with up to 3,7 wt% Zn are embedded in the outermost rim of the two-phase garnets, although the matrix is staurolite free.

The rock-matrix is composed of white mica, biotite, quartz, plagioclase and minor amphibole. White mica is the dominant matrix mineral, where muscovite is most abundant and paragonite is only present in minor amounts. Accessories are zirkon, tourmaline, apatite, ilmenite, epidote and rutile. White mica, biotite and ilmenite define the pervasive foliation of the rock. Tourmaline shows a clear zonation, which is seen chemically by a change in the Fe/Mg ratio. Epidote and its variety allanite are widespread.

PT estimates for the eo-Alpine event for two-phase Wölz Complex yield conditions of 10 - 14 kbar and 540 - 570°C (Fig.7.).

Retrograde effects are seen in albit blast-growth over the white mica fabric (Fig.3.). Garnet is altered at the margin to chlorite, or even totally paramorphosed.

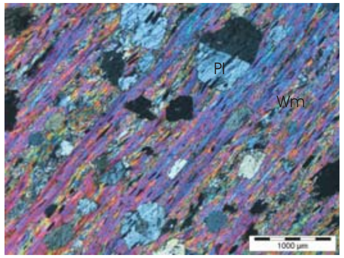

Fig.3. Sample AK5 shows Albit blasts which are a indicator for a retrograd greenschist overprint.

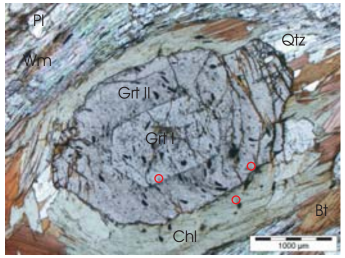

Fig.4. Two-phase garnet (AK5) with retrograde chlorite and biotite. Monazites are labelled with a red circle.

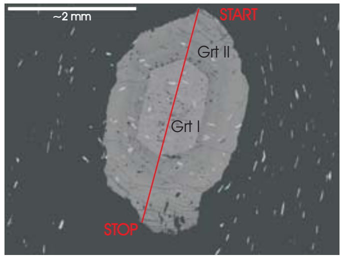

Fig.5. BSE image of a two-phase garnet from the sample AK5.

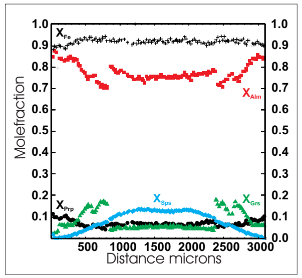

Fig.6. Garnet profil from the garnet of Fig.5.

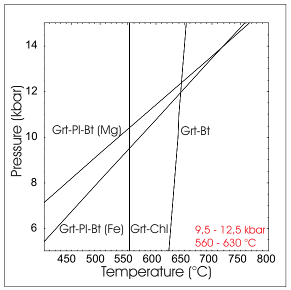

Fig.7. PT estimations for the sample AK154 (two-phase Wölz Complex).

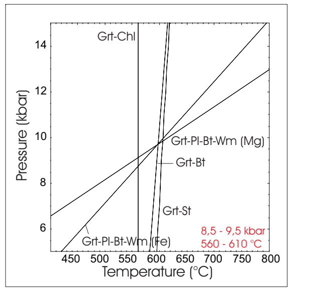

Fig.13. PT estimations for the sample AK12 (Rappold Complex).

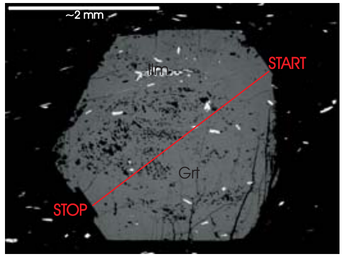

Fig.8. BSE image of an one-phase garnet from the sample AK59

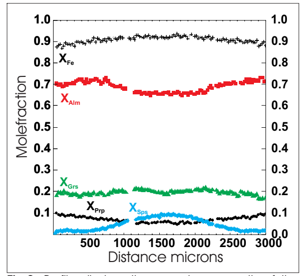

Fig.9. Profile displays the one-phase growth of the garnet of Fig.8.

One-phase Wölz Complex

With a maximum of 5 mm in diameter the one-phase garnets are obvious smaller than the two-phase garnets from the Wölz Complex (Fig.8.). The idiomorphic garnets sometimes show a poicilitic growth with Quartz-Inclusions. X_{Alm} increases from the core towards the rim from 0,60 to 0,70. X_{Prp} from the core (~0,05) shows a shallow continuous outward increase and reaches finally approximate 0,12. The spessartine content shows a bell-shaped distribution across the garnet. X_{Grs} is probably higher (~0,20) than in two-phase garnets and is homogenously distributed across the garnet (Fig.9.).

PT estimation for this mineral assemblage is 11 - 12 kbar and 520 - 550°C (Fig.10).

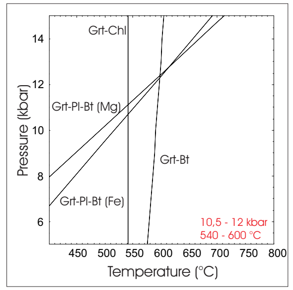

Fig.10. PT estimation for the sample AK59 (one-phase Wölz Complex).

Rappold Complex

Garnets from the Rappold Complex show a two- to three-phase growth zonation (Fig.11.). The first generation is graphite free, the second generation has few graphite flakes and the third generation is strongly graphitic. Some garnet profiles indicate a possibly three-phase growth. X_{Grs} in the core is relative high (~0,20), compared to the cores from the two-phase garnets from the Wölz Complex. A more or less steeply decrease towards the rim characterises the second generation. The transition zone shows a sharp increase from 10 mol% to about 20 mol%. X_{Alm} increases from the homogenous core to the transition zone, where the Fe-endmember drops off from 80 mol% to 70 mol%, followed by a slight increase towards the rim. X_{Sps} reaches up to 0.20 in the core, but is low at the rim. X_{Prp} shows a shallow increase towards the margin (Fig.12.).

Staurolite is stable within the matrix and the outermost rim of garnet. Its X_{Fe} (=FeO/FeO+MgO+ZnO) varies from 0,63 to 0,79, whereas the Zn-content reaches a maximum of about 3.5 wt%. There is no remarkable chemical zoning from core to rim in staurolite. Investigations of Eo-Alpine mineral assemblage yield P–T conditions of 550 - 600°C and 8 - 10 kbar (Fig.13.).

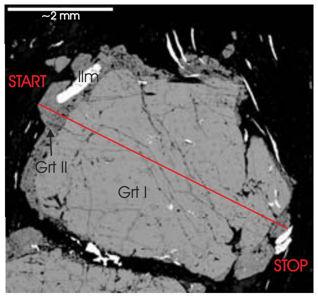

Fig.11. Garnet from the sample AK12 shows a two-phase growth

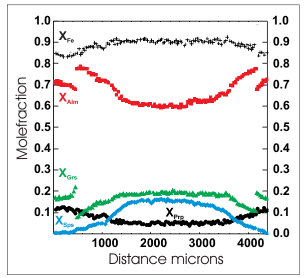

Fig.12. Garnet profile from the garnet in Fig.11.

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