Geophysical Research Abstracts, Vol. 7, 04330, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04330

Thermobarometry of the Innsbruck Quartzphyllite and implications for its polymetamorphic nature

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The Innsbruck Quartzphyllite (IQP) is located in the north of the Tauern Window and was long treated as an undifferentiated mass, which underwent low-grade metamorphism. The first petrological explorations, based on mineral assemblages from metabasic interlayers of the Quartzphyllite, started in the late seventies (Hoschek et al., 1980) and inferred middle greenschist-facies conditions. Sassi and Spiess (1992) obtained 3 – 4 kbar and ca. 450˚C, estimated with the aid of petrogenetic grids and b_0 data from unit cells of muscovites. Detailed petrological investigations, to unravel the metamorphic history of the IQP and its adjacent lithological units with the help of petrological calculation programs, started in the frame of the TRANSALP project in the late nineties (Piber, 2002; Piber and Tropper, 2002).

In the westernmost part of the Innsbruck Quartzphyllite mineralogical evidence points to different $P - T$ conditions, compared to the eastern part in the northern Zillertal area. The westernmost IQP contains the mineral assemblage muscovite + plagioclase + quartz $\pm$ chlorite $\pm$ biotite $\pm$ garnet $\pm$ clinozoisite. In the central part of the western IQP garnet mica schists with the mineral assemblage muscovite + chlorite + garnet + plagioclase occur. In contrast, the rocks of the eastern IQP, located in the Zillertal area, contain the mineral assemblage muscovite + albite + quartz + chlorite $\pm$ biotite.

Application of the garnet – biotite thermometer and the garnet – plagioclase – muscovite – quartz barometer, yields temperatures of 470˚C to 525˚C and pressures ranging from 6.6 to 8.9 kbar for the uppermost area of the western IQP underneath the polymetamorphic Patscherkofel Crystalline Complex (PCC). Thermobarometry with multi-equilibrium programs such as TWQ v 1.02 (Berman, 1992) and THERMO-

CALC v 3.1 (Holland and Powell, 1998), yields pressures of 8.2 – 10.5 kbar and temperatures of 458 – 523˚C, which are similar to the Eo-Alpine $P-T$ estimates from the overlying PCC. Thermobaroemtry in the central western IQP with schists without biotite yield $P-T$ conditions of 500 ± 50˚C and 4.5 ± 2 kbar with phengite-chlorite-quartz thermobarometry (Vidal, 2004 written comm.). $P-T$ estimates with multi-equilibrium thermobarometry of a biotite-bearing quartzphyllite sample from the eastern IQP range from 3.8 – 5.9 kbar and 296 – 325˚C. Due to the lack of suitable mineral phases for thermobarometric calculations, in most samples, only limiting pressure estimates of 3.5 to 6 kbar in a temperature range of 300 – 400˚C, with the reaction paragonite + celadonite = muscovite + albite + clinochlore + quartz + H_2O, can be obtained. In the eastern IQP, intercalations of greenschists with the mineral assemblage amphibole + biotite + clinozoisite + plagioclase + quartz occur. Application of THERMOCALC v 3.1 and TWQ v 1.02 yields $P-T$ conditions of 360 ± 45˚C and 5.4 ± 2.0 kbar.

Mineral chemical evidence and geochronological constraints also point to a polymetamorphic nature of the IQP. The discontinuous chemical zonation of plagioclase from the central western IQP implies a polymetamorphic development such as that Ca-rich cores might represent a thermally slightly higher earlier event. Age data from this zone indicate a pervasive Permian metamorphic overprint which probably corresponds to the Ca-poor plagioclase rims (Rockenschaub et al., 2003). On the other hand, plagioclase zonation in the uppermost parts of the IQP directly underneath the PCC show Na-rich cores and Ca-rich rims, which correspond to the Eo-Alpine metamorphic overprint which has also been found in the PCC (Rockenschaub et al., 2003). In the eastern IQP, geochronological data point to a Permian metamorphic event and Eo-Alpine re-juvination on a very local scale. Based on microstructural evidence and the low temperature nature of the Eo-Alpine metamorphic overprint (Piber and Tropper, 2002), it is thought that the $P-T$ data from the eastern IQP correspond to the Eo-Alpine metamorphic overprint. In addition, mineral chemical evidence for a higher metamorphic grade in the western part of the IQP are also manifested through higher Si contents in phengites, which are 3.10 – 3.28 a.p.f.u., while the Si contents in the northern Zillertal area are lower and 3.06 – 3.18 a.p.f.u. (Piber, 2002). The data show that the IQP has been affected by a pervasive Permian metamorphic overprint as well as an Eo-Alpine metamorphic overprint. Latter event is manily manifested in the eastern IQP and the top parts of the western IQP, whereas the Permian event is manifested in the central parts of the western IQP. The observed metamorphic grading therefore reflects not a single metamorphic event but at least two metamorphic events (Permian and Eo-Alpine) and indicates incomplete Eo-Alpine re-juvination within the IQP.

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