Two Types of "Augen Gneisses" in the Śnieżnik Metamorphic Unit, West Sudetes, Poland

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Śnieżnik Metamorphic Unit is the easternmost part of the Orlica-Śnieżnik Dome. It comprises metasedimentary-metavolcanogenic rocks of the Stronie-Młynowiec formation and widespread gneissic formation, traditionally subdivided into Śnieżnik and Gierałtów gneisses (see Don et al. 1990). The first ones are defined as coarse- to even-grained, rodding to flattened, augen (ortho)gneisses, while the second ones are diversified assemblage of rocks, within which one can identify fine-grained and compositionally banded (para)gneisses to embrechnites, biotite-rich and biotite-poor aplite-like homogenous gneisses, and coarse-grained gneisses with porphyroblasts. All the gneisses of the Orlica-Śnieżnik Dome underwent Variscan constriction and mylonitization, which resulted in imparted similar outlook of many types of gneissic rocks, especially in local shearing zones. Thus the grain-size and/or briefly noticed similar attitude as main criteria of classification of different types of gneisses are not sufficient. Detailed structural analysis, carried out in the Międzygórze area, revealed that some gneisses with augen structure, traditionally accounted to the augen Śnieżnik gneisses, are in fact migmatitic rocks of the Gierałtów type, different in orientation and complication of their fabric and, most of all, position and genesis of title "augens".

In the Śnieżnik augen gneisses (metagranites), the augen structure results from the constriction and flattening of the original porphyritic granite. They posses distinct pure constriction fabric, with no foliation, but ductilely stretched monomineral rods of quartz, K-feldspar, and mica streaks ($L3^*$=160–210/15–30). Subsequent strain converted into flattening lead to dominant planar fabric (S3 = 90–160, 200–260/15–30), formed by separate layers of HT dynamically recrystallized quartz; K-feldspar; plagioclase and micas, accompanied by augen porphyroclasts, around which the foliation anastomoses. Porphyroclasts are composed of [1] white and/or pinkish (hip)automorphic megacrysts (up to 10 cm) of K-feldspars (microcline) with tails of pressure shadows and minor [2] quartz, characteristically elongated and flattened. Such augens are more or less flattened porphyroclasts derived from porphyrocrystals of the original granite, which produce typical pinch-and-swell structures in the XZ sections of the local strain ellipsoid. Singly/simply twinned K-feldspar megacrysts are often affected with recrystallization. Subgrains occurring in the core of megacryst, being slightly bigger and definitely more lobate (dynamically recrystallized) towards megacryst edges are getting smaller and polygonal in shape (static recrystallization). In more flattened varieties, K-feldspars are deformed into the long, foliation-parallel ribbons. If persisted, the parent grain occurs in the central part of the lamella, and smaller, dynamically recrystallized grains project out of it.

This simple fabric is only locally overprinted by S-C' bands and small-scale E-W trending folds. Their reorientation to NW-SE and NE-SW due to syn- and post-mylonitic distortions was accompanied by weak biotite lineation and local crenulation. The character of all these phenomena reflects an amphibolite facies conditions. Further deformation brought about large-scale, brittle, E-vergent kinking folds (F4), which have developed during compressional regime, with "top-to-the-E" kinematics. These contrasting with mylonitic conditions, much more brittle deformation must have developed in the retrograde greenschist facies conditions.

The rocks so far being considered as the Śnieżnik metagranite due to the presence of big feldspar augen-like blast are in fact coarse-grained, biotite-rich, often pinkish (ortho)gneisses, with two HT mylonitic foliations and characteristic felsic porphyroblasts ("augens") and leucosome nests. They are characterised by mylonitic, monomineral layering expressed by alternation of disrupted layers of quartz, K-feldspar, plagioclase and micas, with microstructural evidence of HT shear deformation and strong recrystallization overprint (presently subhorizontal foliation S1). Small-scale isoclinal to disharmonic W-vergent folds (F1/2) with "z" asymmetry and "top-to-the-W" kinematics was accompanied by migmatization, as leucocratic aggregates commonly occupy the triangle dilatant sites of the small folds, and readily nucleate parallel to the axial plane foliation (S2, emphasized additionally by shearing zones and S-C' structures), overprinting the mylonitic fabric in a shape of augen-like blasts. These "augens" are polymineral (K-feldspar + quartz + plagioclase ± biotite) and in contrast with the porphyroclasts in the Śnieżnik metagranite, these are porhyroblasts with clearly metamorphic/migmatitic provenance. These fabric is overprinted by indistinct "s" asymmetrical ("top-to-the-E" shearing), the same scale folds (F1/2), which are also convoyed by migmatization, as the leucosome big augens/nests grow completely disorderly over the existing fabric. All the blastic augens (up to 10 cm) are similar in composition. Bigger, elongated K-feldspars are gathering in the core of the augen, surrounded successively by a thin plagioclase mantle, then by a quartz mantle tapering gradually off from the augen and contributing to the mylonitic banding, and closed finally by a mica layer. Polymineral and zonal composition of such augens are in evidence of their secondary/migmatitic origin. Pure quartz augens are surrounded only by mica assemblages.

Over the complex fabric the second mylonitic flattening (S3 = 100–160/20–45) and elongation lineation (L3=160–190/30) so characteristic for the whole region is printed. These structures do not deflect/anastomose around migmatitic blasts, evidencing that none significant (directional) deformation after the growth of blasts has occurred. More strongly flattened varieties, with clearly distinguished S3 mylonitic layering, have occasional relicts ("ghost structures") of the hinges of F1/2 folds in the form of bent mica and recrystallized aggregates of quartz.

The late and asymmetrical kinking folds F4 are the same as observed in the Śnieżnik gneisses. All described features are characteristic for the migmatitic suite of the Gierałtów type. These rocks do poses the same style, sequence and amount of deformational events as the Gierałtów gneisses (Dumicz 1989). The only Variscan obliteration and mylonitization of the earlier, complicated fabric (twice folded and migmatized), make some of the Gierałtów gneisses locally very similar to the original augen Śnieżnik metagranites.

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[*] Chronology of deformational events after Dumicz (1989).

Variscan Hydrothermal Veins in the Prague Synform (Barrandien Area)

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A few papers dealt with hydrothermal veins of various relative ages in Lower Palaeozoic sediments of the Prague basin (e.g. Suchy et al. 2002). Not many of them were concentrated on study of character of the fluid systems related to deformation stages, which affected the basin. In our present research stage we are focused on a definition of the Variscan (synorogenic) fluids and conditions of their origin and migration. First of all it is important to specify P-T conditions of Variscan deformations and their genetic connection with relevant fluid systems and thermal histories (Glasmacher 2002).

Field work took place at several localities of SW part of the basin (e.g. Homolák quarry, Srbsko). Preliminary research on Variscan veins revealed that calcites are dominant mineral phase in veins, which are mostly deformed and recrystalised, and calcite is fine and medium grained (in Devonian limestones). Veins are not very long, frequently have irregular or lenticular shape and they are arranged into en echelon arrays. Veins in Ordovician quartzite-sandstone are filled with quartz showing a fibrous structure. In drusy cavities a black organic matter occurred. Older hydrothermal veins are deformed and may be penetrated by younger veins.

So far two fluid systems have been found in fluid inclusions (FIS) of calcites, aqueous and liquid hydrocarbons. Sizes of FIS are around 5 micrometers. Due to the small size of the fluid inclusions there were difficult to observe eutectic temperatures (Te).

Homogenisation temperature (Th) primary and/or pseudosecondary aqueous FIS have values between 77–120 °C and generally have lower salinities (0,2–7,9 wt.% NaCl equiv.). Primary inclusions rich in hydrocarbons show Th between 41–85 °C.

Parent aqueous solutions have $\delta^{18}O$ values between +0,4 ‰ and +2,2 ‰ SMOW. When fluids were isotopically buffered by wall rocks than isotopic composition of fluids is more positive.

Preliminary results suggest accord with other authors (e.g. Suchy et al. 2002) that tectonically deformed veins were generated in condition of the oil window. Relationships between tectonic evolution and hydrothermal veins of the Prague synform will be subject of the further study.

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