present-day position of the Carpathians. The olistoplaque formation was postdated by the Karpatian period of intensive subsidence and deposition in the inner foredeep.

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Mineral Chemistry of Variscan Granitoids from Highis Mts. (Apuseni Mts., Romania)

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Introduction

A major proportion of the Pre-Neogene basement of the Apuseni Mts. (Romania) and the Pannonian Basin (Hungary) is built up by the Tisia Composite Terrane Alpine Megatectonic Unit. The crystalline mass of the Tisia Composite Terrane is characterised by granitoid ranges and anticline wings of middle and high grade metamorphites (Pál Molnár et al. 2001A, B, 2002). The largest basement exposure within the Tisia Composite Terrane is represented by the Apuseni Mts. The Apuseni Mts. are partially built up by two Alpine overthrust units (Codru and Biharia Nappe Systems), carrying Variscan granitoid intrusions (Pană 1998). These granitoids were mainly characterized by petrographical and geochronological studies (Giuşcă 1979, Pană 1998), their relation to the Pannonian Basin granites are less studied.

The paper presents results of mineralogical and mineral chemistry studies performed on granitoids of the Codru and Biharia Nappe Systems, exposed in the Highiş Mts. The final aim of the research is to reveal correlations between the granitoids of the Apuseni Mts. and the Variscan granitoids of the South Hungarian Basement.

Geological Setting and Location

The Highiş Mts. are located on the W-SW part of the Apuseni Mts. Its crystalline basement is formed by the Tisia Composite Terrane, its main mass is made up by nappes of the Codru and Biharia Nappe Systems, both of which were formed during the pre-Gosau tectogenesis but with strikes of opposite direction. The Codru Nappe System is in lower position and the Biharia Nappe System is in upper position. Both nappe systems are positioned on the Bihor Unit (Săndulescu 1984), both contains granitoids of Variscan age (Pană 1998). The granitoids of the Codru Nappe Sytem, which are located in the Highiş Mts., are positioned into the Upper Proterosoic Codru sequence as a part of the Finiş Alpine Nappe (Şiria granitoids). Şiria granitoids, located on the N and W part of the Highiş Mts., form a unified mass with a network of aplitic and pegmatitic veins, their contact zone is characterised by biotite-rich hornfels and paragneises of high biotite content. According to Pană (1998), their age is on the boundary of Carboniferous and Permian. With the help of the K/Ar method Soroiu et al. (1969) determined a 221–226 Ma age from the biotites of the Şiria granitoides. The granitoids of the Biharia Nappe System, which are located in the Highiş Mts., are positioned in the Biharia Lower Paleosoic sequence as a part of the Biharia Alpine Nappe. In their contact zones hornfelised metabasites and paragneises can be found (Highiş granitoids). Highiş granitoids are Variscan, postkinematic granites, containing aplitic and pegmatitic veins (Giuşcă 1979). Giuşcă et al. (1964) estimated a 350 Ma age from the Highiş Granitoid Complex with the help of K/Ar (WR) method. Nevertheless, Pană (1998) with the more reliable U/Pb method determined a 264-267 Ma age from zircon fractions, and he explained the formation of Highiş granitoids with a short lasting magmatism at the end of the early Permian.

Sampling and Analytical Methods

Samples are originating from the vicinity of settlement Galşa (Şiria granitoids – 32 rock samples) and Păuliş (Highiş granitoids - 28 rock samples). During the research 84 mineral chemical analyses were made at Department of Mineralogy and Petrology, University of Graz. Measurements were performed at a 15 kV acceleration voltage and 10 nA current. Spectra were evaluated with software Oxford-Isis. Processing of raw data was made with softwares MinPet 2.0 and Minprog.

Mineralogy and mineral chemistry

On the basis of modal analyses, rock samples from Galşa are syenogranites with high mica content (10–12 vol.%). The modal composition of Păuliş samples refers to syenogranites with a 1–3 vol.% mica content. Mineral chemical analyses were performed on feldspar, biotite and muscovite. In all 84 microprobe measurements were made: 36 on feldspars, 10 on biotites and 20 on muscovites. Samples coming from Galşa have a darker, greyish colour, their texture is phenocrystalline, porphyritic at some places. Syenogranites of aplitic texture are also represented. Rock forming minerals are equigranular. The colour of the Păuliş samples is pinkish, sometimes greyish, their texture is phenocrystalline, equigranular, medium-grained. Aplitic veins of greyish colour do also occur.

Quartz: xenomorphic, 2–4 mm grains. As a result of deformation it is always undulating and frequently recrystallized, which lead to the decrease of grain size and the development of subgrains.

Ortoclase: hypidiomorphic, tabular habit, mean grain size is 4–5 mm, though in case of Galşa orthoclase crystals some 7–8 mm large megacrystals also occur. Twinning also appears (Carlsbad twins), twins occasionally have a perthitic structure.

Microcline: hypidiomorphic, rarely xenomorphic, 3–4 mm grains, tabular habit.

The analysed potassium feldspars of Galşa syenogranites have a $Or_{87,28-95,39}Ab_{4,61-12,32}An_{0-0,40}$ composition. The Păuliş potassium feldspars represent $Or_{93,70-97,77}Ab_{2,23-6,30}An_{0}$.

Plagioclase feldspars: hypidiomorphic, tabular, often zoned, mean grain size is 3–5 mm. Albite twins are common. Plagioclase feldspars of Galşa are albite-oligoclases ($An_{2,22-18,91}$). When examining the zoned plagioclase crystals of Galşa, an increased anorthite content can be detected in their centre compared to the margins. The Păuliş plagioclase feldspars are albites ($An_{0,30-1,65}$).

Biotite group

Hypidiomorphic tabular or xenomorphic grains are characteristic, mean grain sizes are 2–5 and 1–3 mm in terms of the Galşa and Păuliş samples, respectively. Their pleochroism is light brown – dark green. If intergrown with muscovite they often contain opaque minerals, apatite and zircon. Along microtectonical deformations they have got a slight orientation. Biotites frequently group into nests. Based on Foster (1960), those samples were considered biotites where the sum of cations in X position and in Y position was between 1.60–2.20 (mean: 1.91) and between 5.30–5.28 (mean: 5.15), respectively. The average TiO_2 content is 2.91 wt% in Galşa biotites and 0.90 wt% in Păuliş biotites. Galşa biotites have an ordinary Mg content, the value of the magnesium number (mg#) varies between 42.56–44.86 (mean mg#=44); ($mg\# = [Mg/(Mg+Fe)] \times 100$, $Fe = Fe^{2+} + Fe^{3+}$). The Mg content of Păuliş biotites is low (mg#=25,15-27; mean mg#=26), and they are replaced by phlogopites along fractures, mg#= 67,81–69,54 (mean mg#=68,77). Based on their Al^{IV} vs. $Fe/(Fe+Mg)$ composition, the Păuliş and Galşa biotites form three well defined classes.

The Al^{VI} and Mg content of biotites provide information on the petrogenetics of granitoids. During magma fractionation the Fe and Al^{VI} content of the rock increases, while the Mg content decreases (Hecht 1994). Biotites of Galşa granitoids are characterised by high Mg and low Al^{VI} content, which refers to a slightly fractioned magma, formed in the early phase of magma evolution. The Mg content of Păuliş biotites is low, which suggests a fractioned magma (Hecht 1994). The high Mg content of Păuliş phlogopites signs postgenetic transformations, which is also supported by the fact that samples containing phlogopite occur only along fractures, they are often weathered, and have a high muscovite content (in this case textural orientation is also apparent).

According to the Mg vs. Al^{tot} distribution of biotites (Nachit et al. 1985), the Galşa and Păuliş granitoids are of calc-alkali and subalkali character, respectively. The $MgO-FeO^{*}-Al_2O_3$ distribution reinforces the calc-alkaline character of Galşa syenogranites, while the Păuliş granites are originating from Fe-K (subalkali) magma (Rossi and Chevremont 1987).

Muscovite: hypidiomorphic tabular and elongated lamellar, the mean grain size is 1–3 mm. It appears often along with biotite, and at some places it is oriented. Small sized muscovite grains are frequent in the fractures of the rock. Both group of samples contains ferrum-rich muscovites, the FeO content of Galşa samples varies between 3.23 wt% and 4.36 wt%, while that of the Păuliş samples is between 2.46 wt% and 7.48 wt%. The Păuliş muscovites have significant (1.29 wt%–3.35 wt%) magnesium content, however, in Galşa muscovites magnesium content is lower than 1 wt%. Based on the Na–Mg–Ti diagram (Miller et al. 1981), Galşa muscovites can be separated as muscovites of primary and secondary character, on the other hand Păuliş samples are uniform in representing only secondary character.

Accessory minerals are apatite, monazite and zircon. Apatite crystals usually have an idiomorphic, partly hypidiomorphic shape, and often appear in biotite crystals. Zircon crystals are idiomorphic, rarely hypidiomorphic, and represent two types of habit. One is squat, reddish-brown, yellowish-brown, the other is colourless, pinkish with an elongated columnar appearance. Opaque inclusions are quite frequent, numerous grains are zoned, which refers to several crystallisation phases.

Conclusions

Samples from both sites have got similar textural characteristics, i.e. they are holocrystalline, equigranular, medium-grained rocks (the only exceptions are aplites), textural orientation is unusual. The main rock forming minerals of Galşa syenogranites are quartz, plagioclase feldspars (albite–oligoclase), ortoclase and microcline, biotite and muscovite. Accessory minerals are apatite and zircon. Based on their chemical composition, Galşa biotites are uniform. The rock forming minerals of Păuliş granitoids are the following: quartz, ortoclase and microcline, plagioclase feldspar (albite) and biotite. Muscovite, apatite, monazite and zircon occur as accessory minerals. The Păuliş biotites can be divided into a Mg-poor group and secondary phlogopites. Galşa biotites are characterised by high Mg and low Al^{VI} content, which suggests an early phase of magma evolution. Nevertheless, the Mg content of Păuliş biotites is low, which refers to a fractionated magma. A postgenetic phase can also be detected, which is signed by the high Mg content of biotites. According to the Mg vs. Al^{tot} distribution of biotites the

Galşa syenogranites show a calc-alkali, the Păuliş syenogranites a subalkali character. In terms of both granitoid groups muscovites have a significant Fe content (2.46 wt%–7.48 wt%). Galşa muscovites can be of primary or secondary character, however, Păuliş samples (based on the Na-Mg-Ti diagram) have a uniform secondary character.

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Upper Jurassic Gravitationally Redeposited Sediments in the Transdanubian Range

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Upper Jurassic sections in the Transdanubian Range generally expose pelagic, relatively calm sediments. These deposits and the locally occurring smaller crinoidal talus cones were interpreted as indicative of an extensional regime throughout the Jurassic (Galácz 1988). Some controversial sections exist, however, which show large amounts of bigger blocks of Upper Triassic–Lower Jurassic age in pelagic Upper Jurassic surroundings. Previous interpretations of these sections resulted in great contradictions. One possible interpretation suggested that the big older blocks were horsts, around which the Late Jurassic sediments transgressed [Császár (ed.) 2002]. An alternative interpretation suggested that the big blocks were redeposited olistoliths (Galácz and Vörös 1989). These interpretations were possible because of not very good exposure conditions.

The aim of field research was to decide between the two interpretations, and to describe the features of these disturbed sediments. Geological mapping, sedimentologic investigation and multielectrode geo-electric measurement were undertaken on the Jurassic exposures of the Eperkés Hill in the Bakony Range, and on the Kétágú Hill in the Pilis Range

Geological mapping has shown that in both areas metric – dekametric blocks of Upper Triassic (and on the Eperkés Hill also Lower Jurassic) blocks of shallow marine origin are found in the surroundings of Upper Jurassic pelagic deposits. While on the Eperkés Hill these blocks are usually in the metre scale and appear in great numbers, the few identified boulders on the Kétágú Hill can reach the size of 50 m in one direction.

These blocks rest directly above Oxfordian – Kimmeridgian radiolarite in the case of Kétágú hill, while they are embedded in Tithonian limestone in Eperkés hill. In this latter area bedding is different within the blocks and with respect to host sediments aswell.