GEOCHEMISTRY OF RETEZAT AND PARÂNG GRANITOIDS AND THEIR ROLE AND PLACE IN THE EVOLUTION OF DRĂGŞAN PAN-AFRICAN TERRANE (SOUTH CARPATHIANS, ROMANIA).

T. BERZA and M. TATU

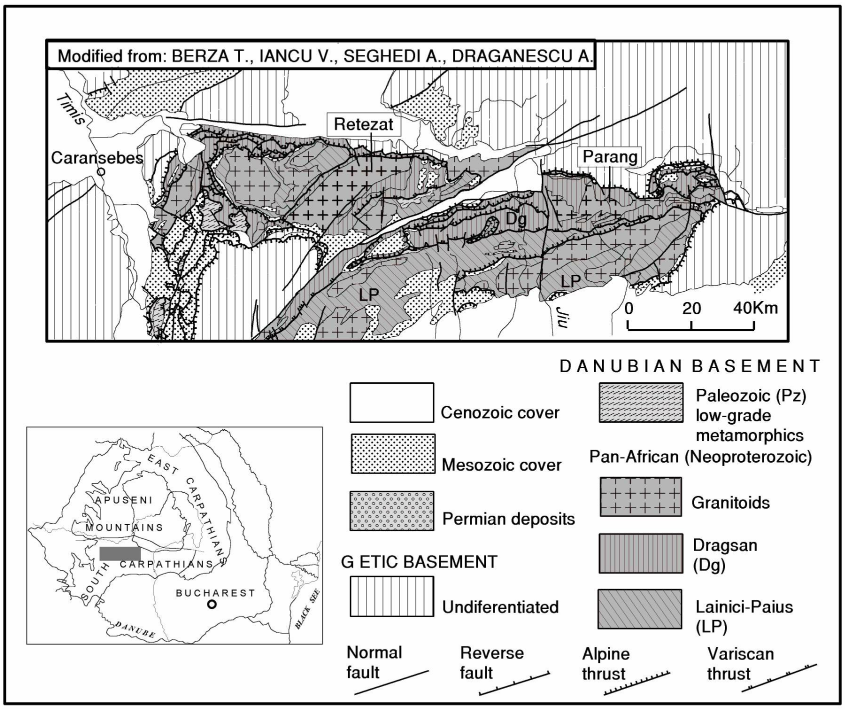
Geological Institute of Romania, Caransebeş str. No 1, RO-78344, Bucharest, Romania; berza@igr.ro; tatu@igr.ro

Abstract: Two granitoid plutons intruded under different pressure in a Pan-African oceanic arc terrane and post-dating its HT-HP metamorphism, display calc-alkaline medium- to high-K trends and represent younger stage(s) of continental crust involvment in a mature arc.

1. Introduction.

An essential feature of the South Carpathian' geology is the abundance and variety of pre-Late Permian granites, mostly hosted in the basements of Danubian nappes, the lower part of the Cretaceous nappe pile. Danubian metamorphic basement can be ascribed to one of two contrasting groups of lithology: the Neoproterozoic metabasic Drăgşan Group, a HT-HP metamorphosed oceanic island arc (Liégeois et al., 1996) and the Neoproterozoic metasedimentary Lainici-Păiuş Group, a HT-LP metamorphosed continental margin. The present relation between these two groups is tectonic, field evidence supporting a Carboniferous thrusting of the Drăgşan Group over the Lainici-Păiuş Group. Both groups are intruded by a variety of granitoids, mostly calc-alkaline, but shoshonitic plutons are known in the Lainici-Păiuş-type basement (Duchesne et al., 1998). Drăgşan-type basement contains two types of granitoid intrusions: the mainly medium-K (leuco) granodioritic Retezat pluton and several high-K composite plutons (diorite to granite), among which we present here the Parâng pluton (Fig. 1, Berza, Iancu, 1994).

Fig. 1. Retezat and Parâng granitoid massifs from South Carpathians.



2. Geology and petrography.

Retezat pluton outcrops on 200 km^2, but below the Mesozoic cover it extends northward and southward probably 100-200 km^2 more (Berza et al., 1994); the eastern and western contacts are intrusive, even if highly strained (mylonites) westwards and locally faulted eastwards. The rocks are granodiorites, tonalites and granites, all with biotite, primary muscovite and primary epidote – the only granitoids in Romania with primary epidote. Low contents in biotite (up to 3%) and epidote (up to 1%) give to the Retezat granitoids a leucocrate character, accentuated by 2-5% muscovite, always present. However, on the eastern border there are some meters or decameters of biotite rich (10-15% + 1-2 % epidote, no hornblende) quartz diorites, interpreted by Berza et al. (1994) as a chilled margin of the Retezat pluton. On the western border, between the main intrusion and the Drăgşan (retrogressed) amphibolites, there is a strip, up to 200 m large, of hornblende-biotite diorites, with clear-cut contact on both sides, representing clearly a distinct (probably older) intrusion. The extensive mylonitization of all rocks in the Râul Mare eastern bank area, due to pre-Alpine and Alpine thrusts, makes difficult the study of the initial intrusive relations, so the links of these hornblende-rich diorites with the hornblende-absent, but epidote-bearing, granitoids from the Retezat main pluton are not clarified yet.

The magmatic petrography of the Retezat granitoids is obscured in most areas by intense deformation and recrystallization of the rocks, now albite, quartz, microcline, chlorite and muscovite mylonites, sometimes even folded. Only in the southern part of the central zone the initial coarse-grained isotropic fabric is preserved, but southward of the Lapusnicul Mare valley the Mesozoic sedimentary cover limits the outcrop area. On the northern end of the Retezat pluton, the East-West/North dipping mylonitic foliation is parallel to, and accentuated towards, -the Alpine thrust and normal faults bordering northward the Lower Danubian unit hosting in its basement the Retezat pluton; an Ar-Ar age of 80 Ma of mylonitized Retezat granite (Dallmeyer, pers. comm., 1996) confirms this. On the eastern and western margins of the Retezat pluton, the NE-SW trending mylonitic foliations are parallel to the pre-Mesozoic thrust plane of Drăgşan-type basement over Lainici-Păiuş-type basement, dipping West in the eastern side and East in the western side.

Berza et al. (1994) have presented a QAP modal diagram of 110 Retezat granitoids, the majority plotting in the granodiorite field, some in the granite and tonalite fields and a few in the quartz diorite field; the cloud is subhorizontal in the 20-30 % Q area, suggesting that only the K-feldspar content discriminates these epidote-bearing leucogranitoids, biotite-poor and muscovite-rich .

Parâng granitoid pluton outcrops on 100 km^2, intruding the Drăgşan Group amphibolites and gneisses in Parâng Mountains, 50 km East of the Retezat Mountains. Both western and eastern ends of the outcrop area of Parâng pluton are tectonically truncated, but the southern border, and partly the northern one are intrusive, marked by Drăgşan roof pendants. Contrary to Retezat rocks, Parâng granitoids are mesocratic, hornblende-biotite granodiorites and biotite granites, showing normal percentage of dark minerals. The distribution of these two main types is random, granodiorites outcropping as kilometric patches, mainly in the western part of the body. Here also pre-Alpine and Alpine tectonics have induced strong mineralogical and structural changes of magmatic parageneses and fabric. From 25 thin sections measured and ploted in the QAP normative diagram, all points plotted in the granite and granodiorite fields, at around 30 % quartz.

In the Retezat Mountains, Verrucano-type red-beds overlie Drăgşan amphibolites and granitoids. Both Retezat and Parâng plutons clearly postdate the regional staurolite-kyanite grade metamorphism and the first deformation phases of the Drăgşan group; for the moment being there are no direct data on the age of this metamorphism. However, constraining numbers come from several papers. U-Pb zircon ages at 777 ± 3 Ma of Drăgşan augen gneisses, and Sm-Nd model ages on banded amphibolites in the 850-750 Ma range, certify Neoproterozoic protoliths (Liégeois et al., 1996). K-Ar (Grünenfelder et al., 1983) model ages on Drăgşan rocks and Retezat or Parâng granitoids range between 320 and 150 Ma, clearly showing partial Alpine resetting. Plateau Ar-Ar ages (Dallmeyer et al., 1998) of 300 Ma (hornblende) and of 296 Ma (muscovite) testify of more than 500-400^{o} C (re-?)heating prior to Permian, enough for the authors to claim Variscan metamorphism of Drăgşan schists. If the latter is the staurolite-kyanite grade metamorphism, as both Retezat and Parâng plutons postdate it, their intrusion has to be early Permian, but for the moment being their Variscan afiliation is far of being demonstrated.

3. Geochemistry.

Several authors have presented in the last decades chemical analyses of Retezat and Parâng granitoids, but special geochemical papers are those of Berza et al. (1994) for Retezat pluton and Savu et al. (1976) for Parâng pluton. These papers showed both the variation limits and the main geochemical trends of these two plutons. Some geochemical characteristics of the Parâng and Retezat, are discussed here, based on 36 new analyses performed (in 2001 by M. Tatu) at the Geological, Petrological and Geochemical Associated Laboratories (Liège University, Belgium) by X-ray fluorescence spectroscopy (major and trace elements) and inductively coupled plasma–mass spectroscopy (ICP-MS) (trace elements, especially REE). In the Retezat pluton, for each rock type the variation range of some major elements (in %) is: diorites, SiO_2, 53.61 - 58.17; TiO_2, 0.72 - 0.93; CaO, 5.70 - 6.77; K_2O, 1.21 - 2.54; Fe_2O_{3t}/MgO, 1.45 – 2.17; tonalites, SiO_2, 60.38 - 63.04; TiO_2, 0.48 - 0.69; CaO, 3.99 - 5.06; K_2O, 1.65 - 3.04; Fe_2O_{3t}/MgO, 3.18 - 2.52; granites–granodiorites, SiO_2, 68.45 - 71.40; TiO_2, 0.17 - 0.32; CaO, 1.82 - 2.97; K_2O, 2.13 - 2.93; Fe_2O_{3t}/MgO, 2.26 – 4.21. Different as petrographical composition, the Parâng massif shows our data the following range variation: tonalites, SiO_2, 63.36 - 67.14; TiO_2, 0.57 - 0.73; CaO, 2.28 - 3.54; K_2O, 3.17 - 3.51; Fe_2O_{3t}/MgO, 2.63 - 2.72), and granites–granodiorites, SiO_2, 68.24 - 74.18; TiO_2, 0.19 - 0.52; CaO, 0.66 - 2.88; K_2O, 3.35 - 5.62; Fe_2O_{3t}/MgO, 2.34 – 4.34.

Using the Peacock index, in the $CaO/(Na_20+K_20)$ versus SiO_2 diagram (Fig. 2), both massifs show typical calc-alkaline tendencies.

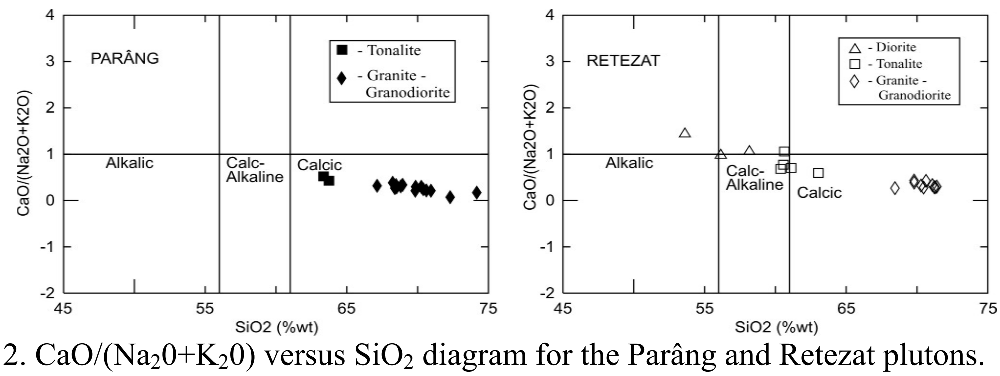


Figure 2. $CaO/(Na_20+K_20)$ versus SiO_2 diagram for the Parâng and Retezat plutons.

As in the previous figures, the K_2O versus SiO_2 diagrams (Fig.3) show that the two massifs are calc-alkaline. The Parâng granitoids have constant high K_2O contents, common for the “high-K series”. In contrast, the Retezat Pluton displays a large K_2O range for diorite and tonatite rocks, between “medium” and “high-K series”, but granites have medium K_2O contents and all plot together in the diagram.

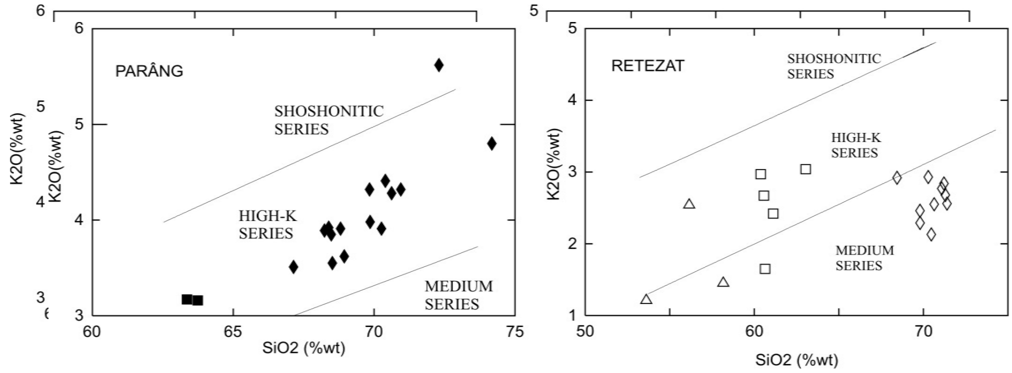


Figure 3. K_2O versus SiO_2 diagram for the investigated granitoids; symbols are the same as in Fig. 2.

Zr and Ti for the Parâng massif and Ce and Zr for the Retezat pluton are nicely correlated, pointing to zircon and ilmenite, respectively zircon and epidote fractionation (Fig. 4).

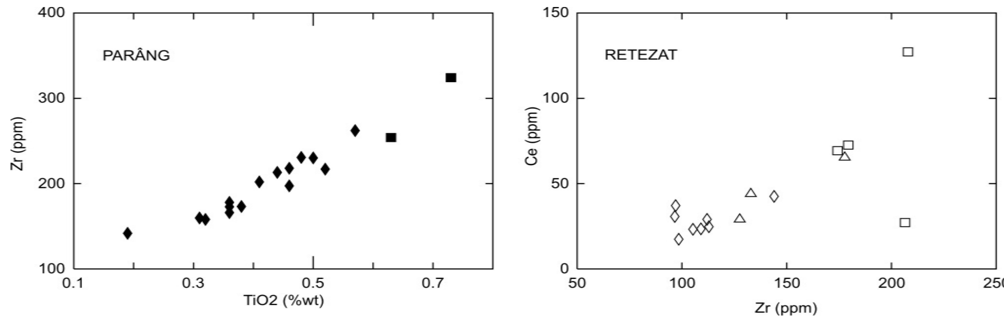


Figure 4. Zr versus TiO_2 diagram for Parâng and Ce versus Zr diagram for Retezat; symbols are the same as in Fig. 2.

The REE patterns (Fig. 5) are enriched in light REE (LREE) and depleted in heavy REE (HREE) showing an important fractionation trend for both massifs; in general the HREE are slightly fractionated from Gd to Lu. In the two massifs the contents in REE decrease with increasing SiO_2. For the Parâng the Eu negative anomaly suggests fractionation of the feldspars. In contrast the lack of this anomaly for Retezat suggests that feldspars fractionation was buffered by another trace mineral

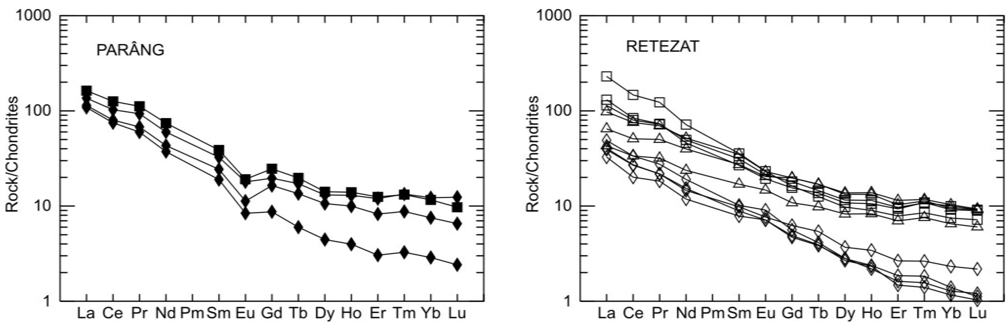


Figure 5. Chondrite – normalized REE patterns for the Parâng and Retezat granitoids; symbols are the same as in Fig. 2.

with a negative Eu anomaly (biotite?).

The MORB normalized trace-element patterns (Fig. 6) exhibit similar features for the two massifs, with an important fractionation from the most incompatible (Rb, Ba, etc.) toward the less incompatible elements (HREE), and the negative anomalies for Nb, P and Ti. The Nb negative anomaly suggests a Nb-depleted crustal source, a fractionation of Nb during crustal melting, or a subduction envinronment. The crustal involvement is attested by the Rb and Th positive anomalies.

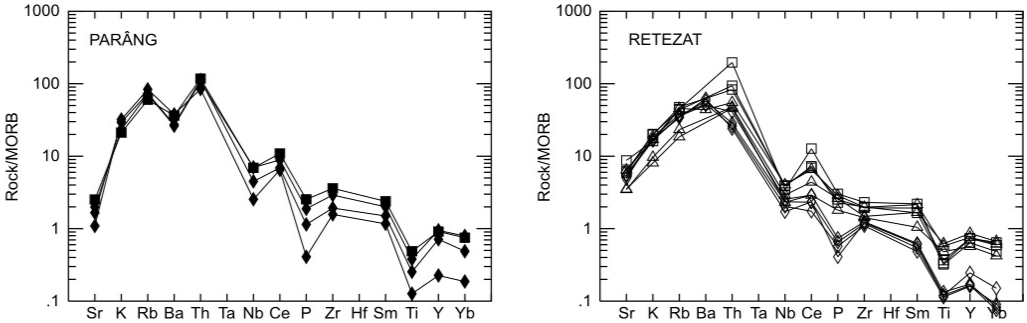


Figure 6. MORB-normalized trace-element patterns for the investigated granitoids; symbols are the same as in Fig. 2.

The subduction environment is suggested also by the abundances of Rb, Y and Nb reported in the discriminant diagram (Fig. 7) (Pearce et al., 1984). The data indicate that the two investigated plutons show a volcanic-arc signature which supports the previous comments on the evolution of the REE and others trace elements.

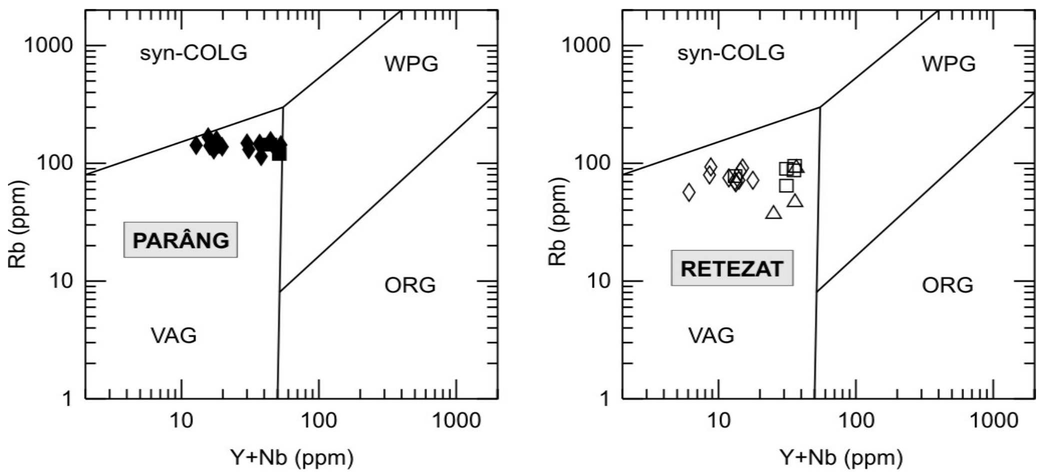


Figure 7. Discriminant element diagrams of Pearce et al. (1984) for the investigated granitoids; symbols are the same as in Fig. 2.

4. Discussion.

The oceanic island arc nature of the pre-metamorphic evolution of the Drăgşan Group was followed by a first granite emplacement at 777 Ma, now represented by augen gneisses and testifying a first continental crust participation (Liégeois et al., 1996). The timing of the following staurolite-kyanite grade metamorphism is not well known (Pan-African or Variscan), but geologic evidence point to a late-stage intrusion of both Retezat and Parâng plutons in respect to the medium-grade metamorphism of the host Drăgşan Group rocks. This demonstrates that a second moment of crustal involvement, in a subduction envinronment, occurred in the pre-Alpine evolution of Drăgşan terrane. Now different series were emplaced : «high-K » for the Parâng pluton and “medium-“ to “high-K” for the Retezat pluton. These two different granitoid series, calc-alkaline (“medium-“ to “high-K”) in composition, were emplaced in the mature stage of the Drăgşan terrane evolution. The contrast between hornblende-bearing rocks (Parâng) and epidote-bearing rocks (Retezat) points to an important difference in the emplacement level of the two plutons : deeper for Retezat and shallower for Parâng. When geochronological data will permit, a P-T-t path for Drăgşan terrane will better constrain this poly-phase evolution.

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