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ZIRCON TYPOLOGY IN GRANITOID ROCKS OF THE DITRÓ MASSIF, TRANSYLVANIA, ROMANIA

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ABSTRACT

The complex magmatic body of the Ditró Massif (Transylvania, Romania) was formed between the Middle Triassic and Lower Cretaceous times. Granitoid rocks can be found in a large area in the NE part of the massif. They were formed either by differentiation of an upper mantle ultramafic intrusion or by assimilation of crustal material.

By the zircon morphological study it was stated that the most frequent zircon types in the granitoid rocks are P_4,P_5, P_3, P_{19}, P_{24} and D. This suggests that the zircon crystals could be formed in hyperalkaline or hypoaluminous environment at high (800-850 °C) temperature. On the basis of the calculated I.A. and I.T. values the studied granite belongs to the alkaline field, close to the alkaline-subalkaline boundary. This indicates an upper mantle origin in the Pupin's system, therefore, granites are supposed to be differentiation products of an upper mantle ultramafic body.

Keywords: zircon, granite, Ditró Massif

INTRODUCTION

Structure and development of the Ditró Syenite Massif (Transylvania, Romania) has been discussed for more than 150 years, and several hypotheses have been suggested (PÁL MOLNÁR, 1994). Here those are mentioned that deal also with the formation of the granitoid rocks.

According to STRECKEISEN (1935, 1938) a mafic intrusion assimilated the limestones of the Eastern Carpathians forming an alkaline gabbro melt in shallow depth which differentiated through the alkaline diorite (orotvite) - alkaline syenite - nepheline syenite path. The ascendent alkaline syenite and nepheline syenite melts assimilated the quartz-rich schists close to the surface producing granitoid rocks as well as all the intermediate members between granite and syenite. On the basis of field observations, in 1952 he stated the chronological order of the rocks (STRECKEISEN, 1952). He regards the ultramafic rocks (and the ditroessexite) to be the oldest ones, supposes the alkaline syenite and alkaline granite to be of the same age, and the nepheline syenite to be a little bit younger.

According to ANASTASIU and CONSTANTINESCU (1977, 1981) the massif is an autochtonous body which formed in several phases, and rooted in the upper crust. They supposed two independent magmatic intrusions. The first has an upper mantle origin and is mafic, while the second one is an intrusion that assimilated Si-poor rock assemblages in the crust.

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JAKAB (1982) separated three magmatic intrusions from each other. The first is a mafic-ultramafic one of upper mantle origin, calk-alkaline, slightly alkaline in character. The second one is a syenite intrusion that formed alkaline syenite, monzonite and, in the margins, also granitoid rocks. The third one is also a syenitic intrusion forming the rocks of the central part of the massif.

Using K/Ar geochronological data on mineral fractions of some rock types PÁL MOLNÁR and ÁRVA-SOÓS proved the existence of two intrusions (PÁL MOLNÁR, ÁRVA-SOÓS, 1995; PÁL MOLNÁR, 1998). The first one is Middle Triassic - Lower Jurassic in age, when ultramafic rocks, nepheline syenite and granite were formed. The second intrusion is Middle Jurassic - Lower Cretaceous and resulted in syenite and alkaline plagioclase syenite.

According to the above mentioned hypotheses there are two possibilities concerning the origin of the granite: it is either a differentiation product of mantle ultramafic melts or it was formed by ACF processes of the intrusion.

A possible way to determine the origin of a granite intrusion is the study of the morphological characteristics of its zircon crystals (PUPIN, 1980, 1985, 1988). He found a tight relationship between the development of pyramid faces of zircons and the alkalinity of the magma as well as between prism faces and the crystallization temperature. The increasing alkalinity is indicated by the increase of the (101) and (301) faces to the detriment of the (211) faces. As the temperature increases, the (100) faces become to be increasingly dominant to the detriment of the (100) faces.

The purpose of this paper is to study the formation of the main granitoid rock types in the Ditró Massif using the zircon morphology method.

PETROGRAPHY OF THE GRANITOID ROCKS OF THE DITRÓ MASSIF

Geographical situation and geological sketch of the Ditró Massif, as well as petrography and geological relationship of its granitoid rocks were discussed by KOVÁCS and PÁL MOLNÁR (1998) in details. The mafic rock-forming minerals are important markers in the granite classification. On the basis of mafic minerals we can subdivide the granitoid rocks of Ditró Massif into two groups. The first group consists of biotite and/or hornblende whereas the second one contains aegirine (overgrown by alkali amphibole) and/or biotite. According to Shand (1947) the biotite-hornblende bearing rocks are metaluminous while the others are peralkaline. In the cases when hornblende and biotite coexist, hornblende is surrounded by biotite. In some metaluminous rocks, however, biotite is the only mafic phase present. In the peralkaline rocks aegirine forms relic core in the alkali amphiboles. Based on optical features these alkali amphiboles may be riebeckite or arfvedsonite, their identification is, however, not exact enough. In several cases alkali amphibole occurs also independently. The mafic minerals are altered significantly, e.g. biotite is replaced by chlorite and alkali amphiboles forms limonite and siderite.

Here, only the samples chosen for zircon morphological studies are characterized petrographically. On the basis of the petrographic features, three handspecimens (ÁGK-6836, ÁGK-6839, ÁGK-6853) were chosen for the studies; those which characterize the granitoid rock types of the massif well enough.

– The first sample (ÁGK-6839) is a hypidiomorphic monzogranite of granular texture. It is the main type of the granitoids occurring along the Török and Laposbükk brooks. Felsic components (quartz, microcline, oligoclase) represent 92% of the rock. The dominant mafic phase is biotite which is chloritized and contains rutile inclusions. The accessory minerals are apatite, zircon, magnetite and orthite.

– The second sample (ÁGK-6853) is a syenogranite with hypidiomorphic texture representing the biotite and amphibole bearing granitoids that are frequent in the massif. Quartz, microcline and sodic plagioclase give 97% of the rock. The main mafic constituent is biotite (with zircon and apatite inclusions) which at places occurs in contact with hornblende. The accessory phases are zircon, titanite and epidote.

– The third sample (ÁGK-6836) is a liebneritized foidic monzosyenite. Because it occurs in direct contact with the granite, we intended to study their genetic relationship by the zircon analyses.

METHOD OF THE ZIRCON SEPARATION

Density (4.7 g/cm^3) and diamagnetic property of zircon was used for separating them from rock-forming minerals of the granitoids.

About 800-1000 g of each sample was ground, and then strained through wet sieves of 0.25 and 0.063 mm, subsequently. Afterwards, fraction of 0.25-0.063 mm was sedimented in bromoform, since most of zircons in granite are of 0.16 0.05 mm size (PUPIN, 1980). The third step was to separate the heavy minerals by a Frantz Isodynamic magnetic separator at 15° transverse and 10° longitudinal slopes. Part which did not proved to be magnetic at 2 A current intensity was sedimented in methylene iodide; this way, a more than 90 % pure zircon fraction was obtained. The inclusion-rich grains were separated at lower current intensity (1.6-1.7 A).

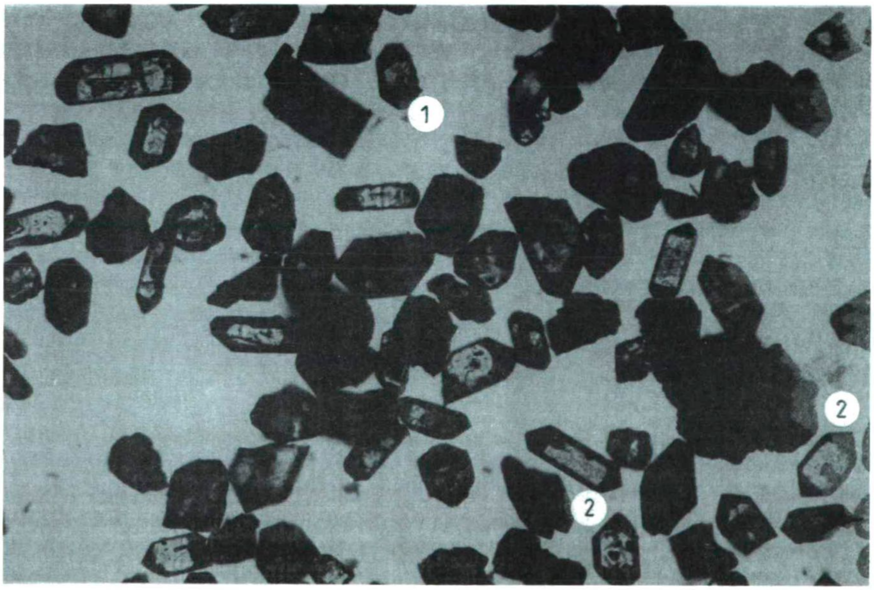
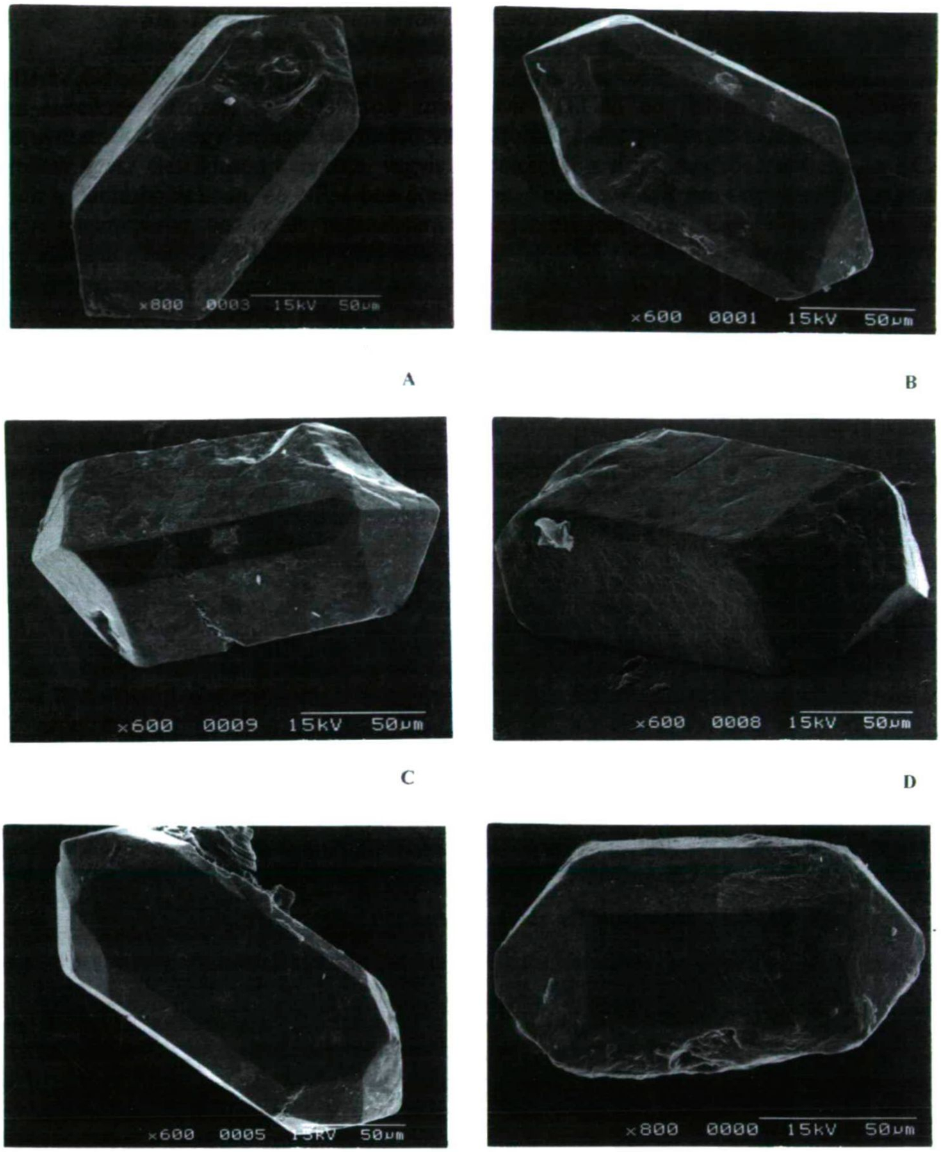


Fig. 1: Zircons from ÁGK-6839 sample under microscope 10x, |N; 1. zircon with inclusion of earlier stage, 2. magnetite inclusion in zircon.



A B

C D

E F

Fig. 2: SEM images of typological zircon types from the Ditró granites; P_4 type (A), P_4 type (B), P_2 type (C), P_5 type (D), S_{19} type (E), S_{20} type (F).

The samples ÁGK-6836, 6839 and 6853 were using for separation. The quantity necessary for typological study, 100-150 possible fresh grains (PUPIN, 1980, 1988), was able to be collected only in the case of the sample ÁGK-6839. Only some tens of grains were separated from the sample ÁGK-6853; this quantity is not enough for a statistical evaluation. The sample ÁGK-6836 did not contain zircon crystals. The separated fraction was studied by binocular microscope in reflected light at sixtyfold magnifying.

RESULTS

Based on the basic optical features (color, shape, contour, structure (zoning, inclusions) the two zircon-bearing samples (ÁGK-6839 and 6853) are similar. The crystals are mainly transparent, colorless, pale yellow or pale brown in color. Rarely also reddish brown and opaque grains occur. The darker grains contain more magnetite inclusions (*fig.*1.) which changed their magnetic character making the separation at lower current intensity possible. The zircon grains are idiomorphic, they were only mechanically damaged. Most crystals are zoned with a core representing previous crystallization phases. Zonality in several cases makes the recognition of the pyramid faces difficult.

Based on the present typological study, P_4, P_5, P_3, P_{19}, P_{24} and D are the most frequent subtypes of the zircon crystals in both granitoid rock samples of the Ditró Massif (*fig.* 2.).

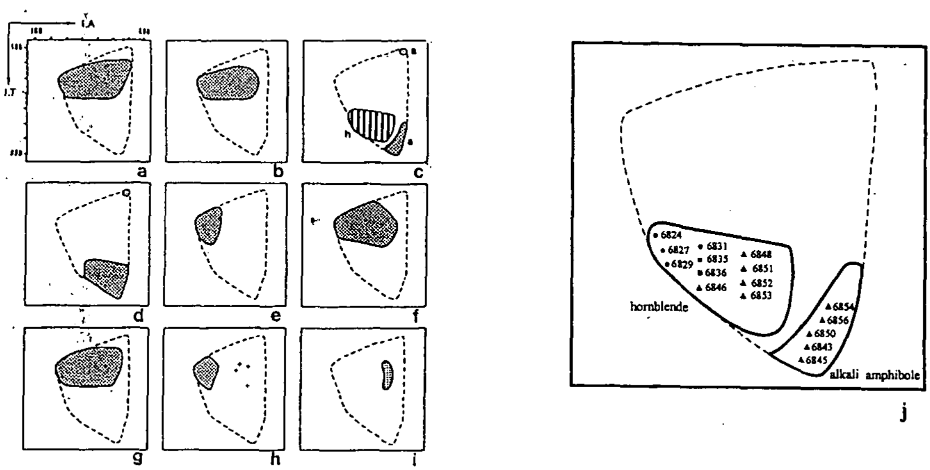


Fig. 3: (a-i.) Distribution of mineral associations in granitic rocks (Pupin, 1980): muscovite (a), anatase and brookite (b), amphiboles (c), pyroxenes and olivines (d), cordierite (e), garnet (f), tourmaline (g), monazite (h), xenotime (i), granitoid samples of Ditró Massif /e.g. ●ÁGK-6827/ (j)

DISCUSSION

Of the investigated granitoid types, only the interpretation of zircon population of the sample ÁGK-6839 is correct statistically. However, having a homogeneous granitoid body, study of even one sample may be enough to obtain correct data about the origin of the intrusion (PUPIN, 1985). Since the sample studied represents the most characteristic rock type of the area (monzogranite), the results were regarded to be representative.

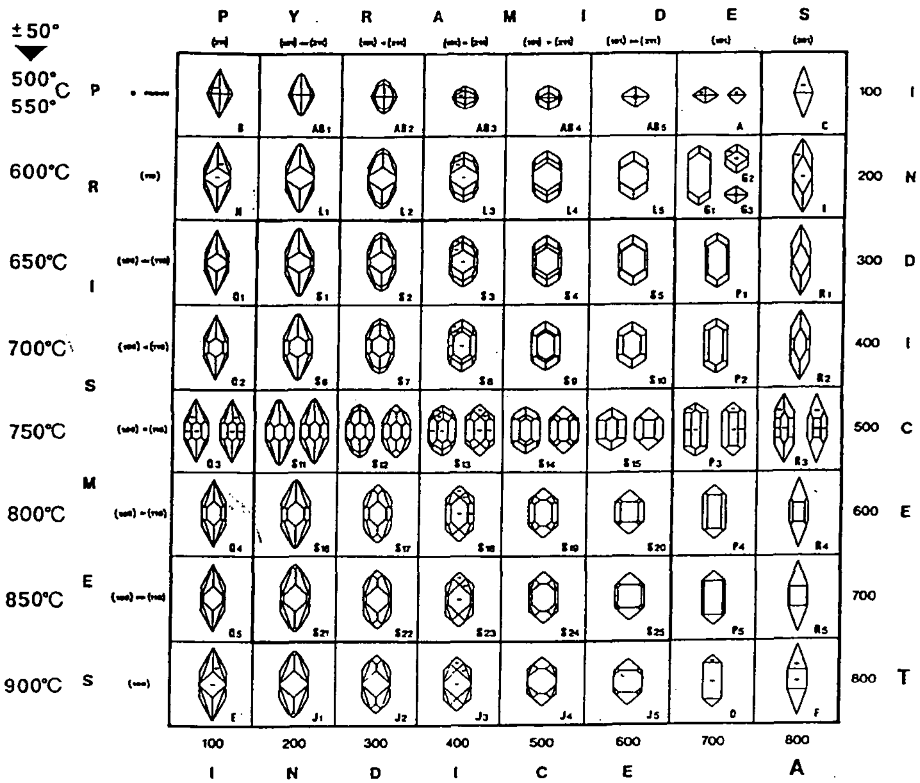


Fig. 4: Main types and subtypes of the typological classification and the corresponding geothermometric scale (PUPIN, 1980)

By the study of zircon crystals from the samples ÁGK-6839 and 6853, it could be stated that they are often zoned, and contain magnetite inclusions as well as older zircon grains representing probably earlier crystallization phases (*fig.* 1.). Interpretation of zoning of the zircon crystals is, however, not obvious. Growing of zircon in granitoids may take a long time and continues through the whole crystallization process of the magma. At present, no data is available to decide weather the core and rim regions of the zircon grains formed during the same event or represent significantly different intrusions. Detailed U/Pb and Pb/Pb radiometric dating would help to trace the successive magmatic events (KLÖTZLI, PARRISH, 1996).

On the basis of the characteristic mineral association of the granitoid rocks, common subtypes of the zircon population can be predicted (PUPIN, 1980). By the hornblende and/or alkali amphibole occurring in the studied granitoids the zircon crystals developed at high temperature and low Al/alkaline ratio (*fig.* 3.). The most frequent zircon types are P_4, P_5, P_3, P_{19}, P_{24}, and D which suggest that the zircon grains were formed in hyperalkaline or hypoaluminous environment at about 800-850 °C (*fig.* 4.).

On the basis of the calculated I.A. and I.T. values, the studied sample belongs to the boundary of the subalkaline and the alkaline fields (*fig.* 5.). According to PUPIN's classi-

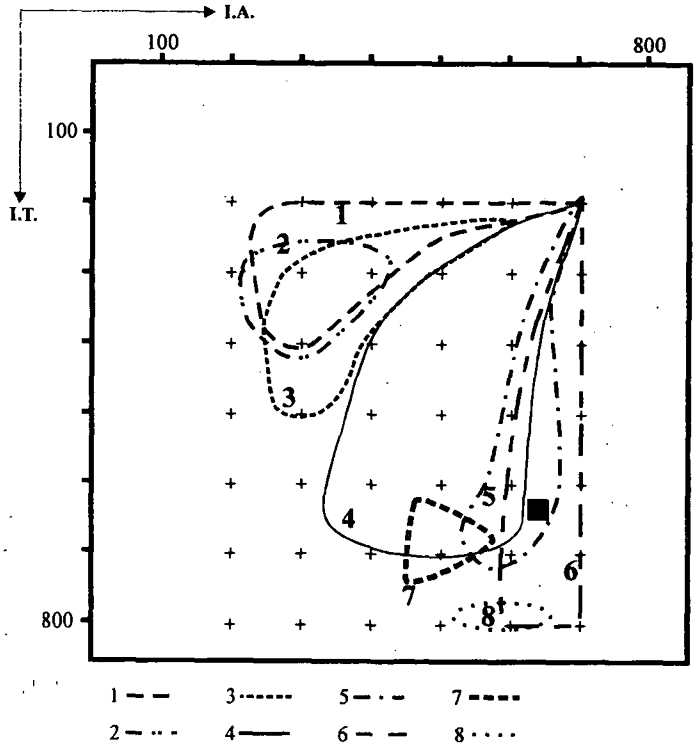


Fig. 5: Distribution of granitic rocks in the typologic diagram (PUPIN, 1980, 1985 slightly modified): aluminous leucogranites (1), (sub)autochtonous monzogranites-granodiorites (2), intrusive aluminous monzogranites-granodiorites (3), calc-alkaline and K-calc-alkaline series granites (4), subalkaline series granites (5), alkaline series granites (6), continental tholeiitic granites (7), oceanic tholeiitic series granites (8), sample ÁGK-6839 (■).

fication scheme (1985) it means that it is either a granite of hybrid (mantle+crust) origin, or represents mantle-derived granitoid rocks. Comparing typological distribution diagrams of the zircon population with that of the studied granite (*fig.* 6.), it can be experienced that it is similar to the alkaline series type (h type).

On the basis of the frequency of the zircon types, it can be stated that the rock studied belongs to the group of alkaline granites of mantle origin. Possibly, it is a differentiation product of mantle ultramafic rocks. This statement is in good agreement with the model given by PÁL MOLNÁR (1998).

Considering the rock-forming minerals of the studied samples, some of them contain hornblende. Therefore, in the *fig.* 3. they fall into the section of the fields of crust+mantle (i.e. hybrid origin) and alkaline rocks. However, origin based on the characteristic minerals is only informative, so the mantle origin of the studied sample based on the zircon typology is acceptable.

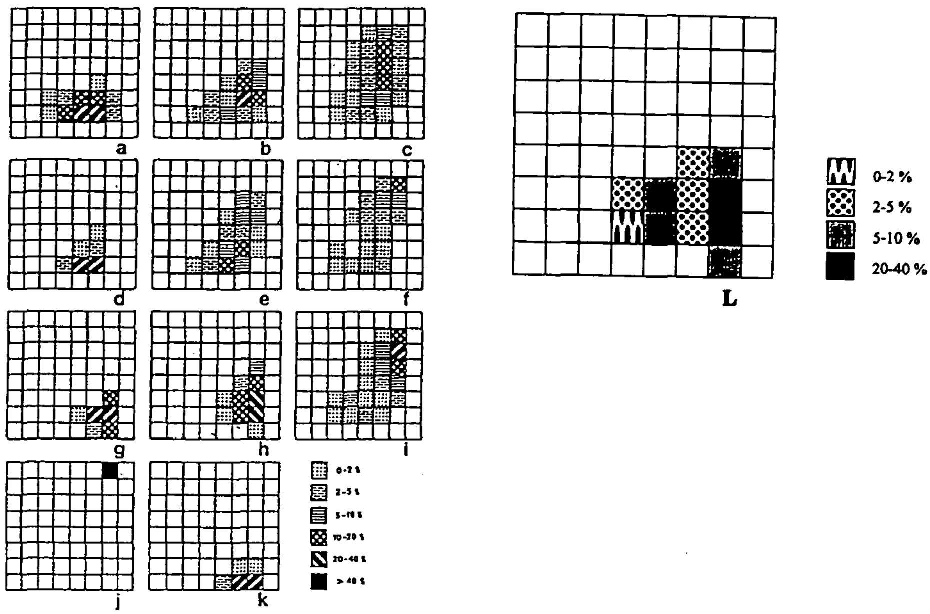


Fig. 6: Zircon crystals from granitic rocks with their subtypes. Typologic classifications from granites (Pupin, 1980): calc-alkaline series (a, b, c); subalkaline series (d, e, f); alkaline series: hypersolvus (g), transsolvus (h), subsolvus (i) granites; hyperalkaline albitized granite (j); tholeiitic series (k); sample ÁGK-6839 (L).

CONCLUSIONS

Zircon morphological studies of granitoid rocks from the Ditró Massif presented here are the first analyses of this kind. The most frequent zircon types of the monzogranite (ÁGK-6839) and syenogranite (ÁGK-6853) samples are P_4, P_5, P_3, P_{19}, P_{24}, and D. This fact suggests that the zircon crystals were formed in a hyperalkaline environment at 800-850 °C. On the basis of the calculated I.A. and I.T. values, the studied granite belongs to the field of the subalkaline hybrid (crust+mantle) granites or that of mantle-derived alkaline granites. Based on the zircon morphological studies, we prefer the mantle origin. Since the studied sample represents a characteristic type of the Ditró Massif, we regard these results as generally acceptable for the origin of the granitoid rocks from the Ditró Massif.

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