AGE AND CONTACT-METAMORPHIC EFFECTS OF THE NEPHELITE SYENITE STOCK OF DITRÓ (TRANSSYLVANIA)

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Introduction.

In the course of the surveys of 1941 and 1942 I had the occasion with my colleague Gábor Pantó to observe the geological, structural and petrographical features of the nephelite syenite stock of Ditró. Since the middle of the 19th century petrographical investigations were carried out by several authors, but the position of the stock in the general geological constitution of the region is yet not accurately defined. An attempt was made by the author to sketch it based on earlier data and own observations.

Nowadays two divergent types of petrological investigations may be distinguished. The analytical direction intends to define several rock types of slightly differing composition. On the other side R. A. Daly and other scientists tried to collect different rock types by their geological relations and consanguinity. Rock clans and families were established. The results of this second type investigations may furnish very useful knowledges for field geologists for ascertaining the role of an igneous rock mass in the geological structure of its surrounding.

1. *Peculiar appearance and origin of nephelite syenites.*

Nephelite syenites occur very seldom compared with the rocks of the granitic, dioritic or gabbro clans. R. A. Daly estimates the quantity of outcropping alkaline rocks of North America for 0,1 per cent of all other igneous rocks. In Europe is their propor-

tion below 1 per cent, in Asia 0,1 per cent. In the Bushveld complex (Transvaal, S. Africa) syenites and nephelite syenites makes up only 0,01 per cent of all igneous rocks.

These figures diminish if used the term alkaline rocks only for rocks having silica-alkali ratios below 1 : 4 according to S. J. Shand. Above data of R. A. Daly refer to alkaline rocks including the families of normal syenites and monzonites.

The outcrops of alkaline rocks are also small in dimensions compared with other igneous rocks. The greatest known nephelite syenite intrusion is the one of Kola peninsula with 1100 squ. km. surface as related by S. J. Shand. But this is exceptionally large, the nephelite syenite intrusion of Serra de Monchique has only 60 squ. km. surface, the one of Ditró 180 squ. km. The underground extension of this later may be estimated on base of its contact-metamorphic effect for 280 squ. km.

„These considerations have suggested that there can be no large reservoirs of alkaline magma in the lithosphere; but that such magmas are purely local products formed by the differentiation under special conditions of granitic or basaltic magma". (S. J. Shand.)

This is justified by the observation, that alkaline rocks are always the youngest products compared with other igneous rocks. These are therefore later derivatives of them.

R. A. Daly and S. J. Shand conclude from the close relations of nephelitic rocks with limestones (observed in many instances on the field) that the origin of nephelite syenites is due to the assimilation of limestones by granitic magmas. Very instructive examples reported by R. A. Daly and S. J. Shand are the following occurrences: Sekukuniland (Transvaal, S. Africa), Alnö Island (Sweden), Ontario (U. S. A.) and Montreal (Canada). These examples suggest the necessity of limestone assimilation even in cases where the connection is not immediately apparent.

2. *Nephelite syenite occurrences in the Carpathian and Alpine Ranges.*

A nephelite syenite occurrence was recently reported by A. Streckeisen, D. Giusca, A. Codarcea, A. Vendl from Orsova and Ógradina (S. Carpathians). The nephelite syenite dikes are included in the schists of the Almás Mountain piercing and assimilating mesozoic limestones which were folded below the schist

complex as related by A. Streckeisen. The intrusion of the nephelite syenite dikes is posttectonic (upper cretaceous).

Near Ujmoldova, Stájerlak and Anina (S. Carpathians) alkaline effusive rocks were described by K. Emszt, P. Rozlozsnik, A. Vendl. These rocks penetrate even lower cretaceous formations.

Alkaline effusives of the Carpathian Basin (phonolites and trachydolerites from the Mecsek Mountain) have close consanguinity and identical differentiation with the nephelite syenites of Ditró as described by B. Mauritz. The small magnesia content is remarkable on both territories. E. Vadász reports that the effusives of the Mecsek Mountain penetrate even the lower cretaceous beds (hauterivien). Recently essexite (hypabyssal type of alkaline rocks) was found by T. Takáts in the Mecsek Mountain, which effected contact metamorphism on the marls of the coalcover.

An occurrence of »episyenite« is described by A. Lacroix from Pouzac and Bagnères de Bigorre near Tarbes (Haute Pyrénées). P. Viennot showed, that cretaceous (albien) black slates were intersected and metamorphosed by nephelite syenite dikes intruded during the upper cretaceous. These intrusions are probably connected with granitic hearths of the Pyrénées.

The nephelite syenite intrusion of Serra de Monchique is very similar to that of Ditró. Kulm schists and graywacke were metamorphosed by the intrusion. Jurassic and cretaceous limestones of the surrouding were intersected by dikes of alkaline effusive.

This review of the alkaline rock occurrences is far from being complete, but general conclusions may be drawn from it. It is remarkable that all the alkaline intrusions of the Alpine Range are posttectonic.

3. *Possibilities of limestone assimilation at the forming of the nephelite syenite of Ditró.*

Several outcrops of granitic and dioritic intrusions were observed in the Carpathians. The granitic intrusions, which succeded necessarily the forming of the Carpathian Range are concealed. The presence of a deep-seated granitic intrusion is indicated even by a row of tertiary andesite, dacite and rhyolite volcanoes on the inner margin of the Carpathians. The roots of these volcanoes must reach to granitic dioritic hearths. Textures of several types of these ter-

tiary extrusives ("dacogranite", "diorite porphyry") suggest a hypabyssal formation.

G. Pantó pointed out in his just heared report the unavoidable supposition of a younger granitic batholit to explain the formation of ore deposits of the NE Carpathians. Ore-forming granitic intrusions were mentioned from the N Carpathians by H. Böckh, P. Rozlozsnik, A. Földvári. Outcrops of younger granodiorites and diorites around Selmecbánya were described by H. Böckh. According to reports of B. Cotta and P. Rozlozsnik the intrusions of granodiorites (banatites) in the S Carpathians are upper cretaceous.

The granitic masses which produced the nephelite syenite stock of Ditró are hidden below the Carpathian Range. Granite outcrops due to erosion and described as autochtonous are not obviously identical with the younger granitic intrusion.

The nephelite syenite of Ditró has a fresh, unaltered appearance, palaeozoic or prepalaeozoic age is therefore improbable. The nephelite, which mineral shows small resistence to weathering might not remain undetached during such a long period. On the margin of the nephelite syenite stock rocks of granitic type are cropping out. The nephelite syenite is younger than the schists of the E Carpathians manifested by their contact metamorphism. The nephelite syenite stock was not affected by dynamic metamorphism, it is therefore posttectonic. The stock was not affected by stress at all. On its margin, below the contact metamorphic envelop oriented texture was observed, but this is a primary fluidal texture. The microscopical study of these types did not reveal any trace of dynamic effects. The age of the deep-seated granitic intrusion and of the nephelite syenite stock may such correlate.

Limestone occurrences indispensable for development of nephelite syenites by assimilation are present in the surrounding. In the schists intercalations of limestones and marbles are common. But these do not represent such masses, which could modify the composition of greater intrusive bodies. By the assimilation of the including phyllites large quantities of aluminium should be induced into the granitic magma. High al, c and alk Niggli-ratios of the nephelite syenite correlate with this supposition. Marble intercalations are nevertheless so very subordinate, that the procuring of the whole amount of lime this way might involve the assimilation of an absurdly large quantity of phyllite.

The limestone represented in the marble-range which begins on the western side of the nephelite syenite stock and trends to Csikszenttamás following the outcrops of contact metamorphic schists is a considerable mass, able to modify the composition of a larger magma hearth. (Ianovici V.) But this complex testifies only thermometamorphism (by content of muscovite, tremolite) and no trace of assimilation can be revealed. The marble complex belongs to the contact-metamorphic cover of the nephelite syenite stock, its assimilation was prevented by its position. The marble existed undoubtedly before the nephelite syenite intrusion being intersected by hornblendite veins at Vasláb.

The dolomites of the neighbouring Hagymás area could not participate in the formation of the nephelite syenite due to their great $MgCO_3$ content ($\sim$45 per cent), the nephelite syenite being characterized by a low mg-ratio.

Eastwards from the nephelite syenite stock there are huge mesozoic limestone beds. Their western boundary is marked by a sharp straight edge in the Hagymás Mountain for reappearing only in the Bihar Mountain. In the followings an attempt is made to show a possible way how the mesozoic limestones of the Hagymás Mountain could influence the formation of the nephelite syenite stock of Ditró.

4. *Mineralogical proof of contact-metamorphism and assimilation.*

The contact-metamorphism affected phyllites and limestones. The contact-metamorphism of the phyllites is reported by A. Streckeisen as manifested by their recrystallization, hardening, muscovite, biotite and andalusite content. We can complete these marks with strong silicification and feldspathization. Different sheets of the same exposure are metamorphosed to various degrees. Sheets with plenty of andalusite crystals alternate with unchanged phyllites.

According to a verbal communication of B. Mauritz corundum occurs in contact-metamorphic phyllites in the Várpatak at Gyergyószentmiklós. I have ascertained the presence of corundum in a sample collected by F. Pávai-Vajna from Szárhegy and my own sample from the Lok-vize creek (SW slope of Siposkő) near Vasláb. A contact-metamorphic phyllite exposure in the Nagy Kürüc creek (near Gyergyószentmiklós) furnished the largest andalusite crystals observed until now in the Carpathian Basin. Another

occurrence on the northern slope of Kicsi Ferenc sarka (near Vasláb) consists of a garnet-andalusite schist.

On the limestones effected the contact-metamorphism recrystallization and produced tremolite, muscovite and other minerals.

Field observations made with my colleague Gábor Pantó showed that contact-metamorphism is especially strong on two areas. The first between Ditró and Gyergyószentmiklós bordering the outcrop of the nephelite syenite stock and the second between Vasláb and Csikszenttamás. On this second area no exposure of nephelite syenite is known. Below the surface the nephelite syenite might have a larger extension. Between the two contact-metamorphic areas (from Gyergyószentmiklós to Tekerőpatak) very weak contact-metamorphic effects were manifested. Marble is recrystallized in very fine grains. It is impossible to decide now wether two independent laccoliths exist or a single one dislocated in two parts or even a consistent mass of nephelite syenite with two sharp culminations. The northern culmination was exposed by erosion, only a fragment of its contact-metamorphic envelop remained eastwards from Szárhegy. The southern culmination is covered and indicated only by its contact-metamorphic envelop.

F. Pávai-Vajna ascribed the formation of marbles and other contact-metamorphic rocks to andesites. This theory cannot be accepted. Extrusive rocks do not produce ever a contact-metamorphism of such extension. On the other hand occurrences of contact-metamorphic rocks correlate with the outcrops of nephelite syenite.

The applicability of the assimilation theory (R. A. Daly and S. J. Shand) is enhanced by the appearance of cancrinite in the nephelite syenite. The conditions of formation of this mineral were accurately determined by the laboratory experiments related by W. Eitel. S. J. Shand showed the microscopical appearence of cancrinite in the nephelite syenite occurrence of Transvaal.

The assimilation of limestone at the formation of the nephelite syenite of Ditró is attested even by myrmekite-like reaction rims on the nephelite-cancrinite contact as described by B. Mauritz and A. Streckeisen. A thin section of a sample from Komárnik tető examined by A. Streckeisen clears away every opposition: a crumb of limestone is separated from the surrounding nephelite by a radial fibrous band of cancrinite.

5. *Geological structure.*

The structure of the region including the nephelite syenite stock and Hagymás Mountain was surveyed by the author and G. P a n t ó. Between the nephelite syenite stock and Balánbánya epizonal phyllites were found with eastern dip, (probably due to isoclinal folding) eastwards from Balánbánya mesozonal metamorphosed rocks appear overlying concordantly the phyllites in anomalous position. Farther to the E in the Domuk valley micaschists are exposed overlain by eastwards dipping phyllites in normal position. This structure may be explained as a westwards overturned fold. No trace of overthrust was revealed between epi- and mesozonal series neither by Roumanian geologists nor by us.

A dolomite of crystalline texture overlies discordantly both series of schists. This formation — of werfenian age according to fossils described by I. S. A t a n a s i u — belongs to the tectonic unit of the schists.

The dolomite is overridden by the mesozoic nappe of the Hagymás Mountain, which was supposed to be pushed forward in W—E direction. This correlates with the general conception about the geological structure of the N and S Carpathian nappes. Nappes moved everywhere from the Carpathian Basin towards its margin.

Our survey revealed the clayey-marly werfenian beds. Author could determine M y o p h o r i a c o s t a t a Z e n k., G e r v i l e i a c f r. m o d i o l a F r e c h and „rhizocorallia" in this formation. They show a close analogy with the campilli beds of the Balaton region. They served as gliding layer for the mesozoic nappe on the surface of the schist-dolomite basement. The nappe-structure is ascertained by two lower trias formations of identical age and fauna but of differing petrological facies overlying each other.The werfenian dolomite described by I. S. A t a n a s i u is autochtonous but the campilli slates of Transdanubian facies were overthrusted being a gliding sheet of the mesozoic nappe.

On the base of our investigations around Balánbánya, which will be reported otherwhere, we are pointing out the possibility (opposed with earlier views about the structure of the E Carpathians) of a E—W overthrust directed towards the Carpathian Basin.

Below the western front of the mesozoic cliffs in Hagymás Mountain huge glacier-like tali cover the slopes trending towards

the Olt valley. Below the recent tali older ones were observed which are already cemented to breccia or conglomerate respectively. Scraps of such older tali were discovered by G. Pantó even on the W side of the Olt valley. This fact suggests that the mesozoic nappe of the Hagymás Mountain extended before the cutting in of the Olt valley (pleistocene, upper pliocene) far westwards and was pulled down by erosion since than. The front of the cliffs moved gradually backwards to the E.

This supposition is enhanced by a chip of crystalline limestone found on the Fekete rez ridge. This is surely no intercalation in the phyllite series, lying discordantly over it. This occurrence should indicate the connection between the mesozoic limestones of the Hagymás Mountain and the contact-metamorphic envelop of the nephelite syenite stock. The marble patch on the Fekete rez is supposed to be a relic of the western prolongation of the mesozoic nappe affected by contact-metamorphism.

The marble-range has a general eastern dip but at Szárhegy both marbles and contact-metamorphic schists stand upright on the western margin of the nephelite syenite stock and stratch consistently downwards.

By any reason, dealing with mesozoic nappe overthrusted either from the W (I. S. Atanasiu) or from the E (A. Földvári), the floor limb of the nappe is bending to the bottom of the nephelite syenite stock. This floor limb could have induced assimilation, while the hanging flank was effected by contact metamorphism. (The nephelite syenite could not exert assimilative effects on the root limb being separated from it by the schists of the contact-metamorphic envelop.) Farther on the E where thermal effects of the intrusion ceased, mesozoic limestones were not metamorphosed. According to this scheme nephelite intrusion must be cretaceous, lower cretaceous limestones being represented in the nappe.

This structure is shown in the theoretical section.

A farther problem : if the nappe derives from the W (according to I. S. Atanasiu) it should be present below the Hargita tertiary volcanic range. But than extrusive rocks ought reveal any trace of assimilation. We shall get probably better insight into the question by actual investigations of L. Jugovics either by the properties of the inclusions of andesites and their agglomerates or by the chemical composition of the extrusive rocks.

SUMMARY.

My conclusions drawn from investigations about the origin of the nephelite syenite stock of Ditró correlate with the results of A. Streckeisen. The nephelite syenite stock is due to the limestone assimilation of a posttectonic granitic intrusion. The assimilated limestone was deducted from the limestones of the mesozoic nappe of the Hagymás Mountain.

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HOZZÁSZÓLÁSOK.

Jugovics Lajos: Személyesen bejárta a területet Lóczy Lajos igazgató úrral, áttekintő bejárás keretében, melynek célja elsősorban a kristályos palának a mészkőhöz való viszonyának a tisztázása volt. Megjegyzi, hogy dolomitot Borszék környékén is talált a kristályospalában és lehetségesnek tartja, hogy a szienit az alkáliáját ezekből kapta.

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