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Petrology

New Data on the Composition of Late Cretaceous Magmatic Body of the River Iori

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(Presented by Academy Member David Shengelia)

ABSTRACT. A magmatic body of the Late Cretaceous Age in the Iori midstream is the object of our research. Based on the data of petrographic research and chemical analysis, the rocks composing the body were identified as teshenites by previous researchers. Magmatic body presents a sill situated in both limbs of the Bokoni syncline built up of the Upper Cretaceous flysch sediments of the Ananuri suite. The sills compose two bodies which exactly replicate the elements of bedding of the host suite. In the paper, new data of a complex study of rocks composing the Late Cretaceous magmatic body of the Iori midstream is presented. Based on the detailed mineralogical and petrological, structural-textural and petrochemical researches in the composition of magmatic body along with teschenites, the alkaline lamprophyres, such as, camptonites, theralites and tephrites are distinguished. The content of mineral matter in the rocks of the Iori magnetic bodies is inferred by microscopic studies. Main rock-forming minerals are: basic plagioclase (labradore), nepheline, pyroxene, alkali amphibole (barkevikite) small quantities are presented in olivine, K-feldspar. Secondary minerals are: serpentine-iddingsite, clay minerals, zeolite (natrolite, lomontite), calcite, biotite. Apatite is the most important accessory mineral. In the discrimination diagram the figurative spots presenting chemical composition of the sillrocks are situated in the fields of alkaline rocks – tephrites and basanites. *© 2019 Bull. Georg. Natl. Acad. Sci.*

Key words: Iori, camptonites, theralites, teschenites

The first information about the existence of magmatic body of the Late Cretaceous Age in the Iori midstream belongs to A. Riabin [1]. Based on the data of petrographic research and chemical analysis, the rocks composing the body, were determined as teschenites by its first researchers [2-4]. These rocks are mentioned as the teschenites also in the following works of the researchers l [5 - 7].

According to the morphology and character of contact with the host rocks it presents a sill situated in both limbs of the Bokoni syncline built up of the Upper Cretaceous flysch sediments of the Ananuri suite [3, 6]. In the suite, the sills compose linearly elongated two independent parallel bodies of sub-latitudinal direction. They exactly replicate elements of bedding of the host suite (Fig.1).

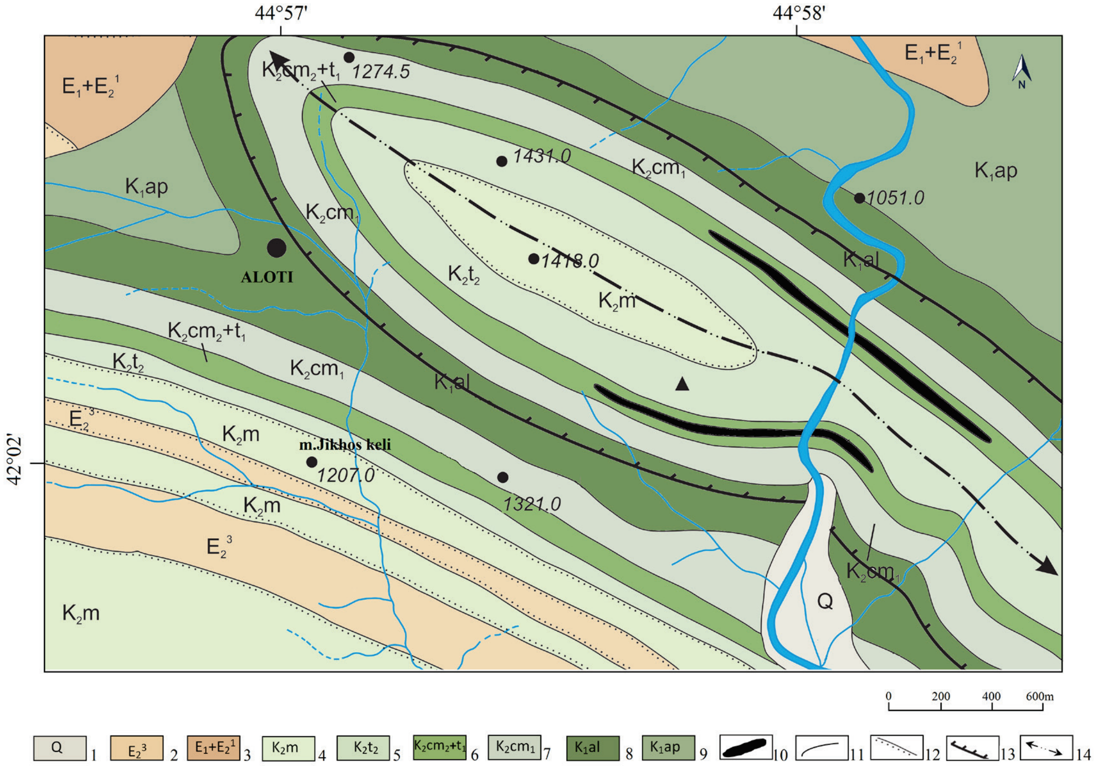

Fig. 1. Geological map of the Cretaceous magmatic bodies of the Iori region [6]:

1 – Quaternary sediments; 2 – the Upper Eocene – ejected blocks, conglomerates, sandstones, schistose clays; 3 – the Paleocene and Lower Eocene(the Shakhvetili suite) – clay slates, sandstones, conglomerates and ejected blocks; 4 – the Maastrichtian stage (the Sabue and orbitoid suites). Ejected blocks, conglomerates, limestones, marls and argillaceous slates; 5 – upper sub-stage of the Turonian stage (the Margaliti suite). Red and pink limestones, marls and schistose marls; 6 – upper sub-stage of the Senomanian stage and lower sub-stage of the Turonian (the Ananuri suite) – flints and siliceous schists; 7 – Bottom sub-stage of the Senomanian stage (Ukugmarti suite): sandstones, marls, conglomerates and ejected blocks 8 – Albian stage (the Navtiskhevi suite). Argillaceous slates with sandstone, marl and limestone intercalations; 9 – the Aptian stage (the Dgnali and Tetrakhevi suites). Argillaceous slates and sandstones; 10 – Cretaceous magmatic body; 11 – boundary between the formations of different age; 12 – contours of discordant and transgressive positions; 13 – boundary of the Bockoni syncline; 14 – axis of the Bokoni syncline.

Characteristic of volcanic rocks of the Iori magmatic body. In Fig.2 the section of magmatic body in the northern limb of the Bokoni syncline is presented. In this intersection, thickness of the sill

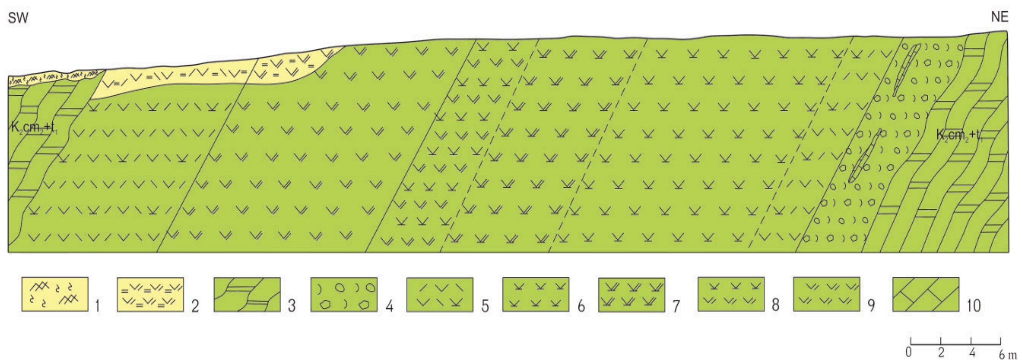

Fig. 2. Section of the magmatic body in the northern limb of the Bokoni syncline:
1 – Soil layer; 2 – weathered tephrite-camptonite; 3 –silicite; 4 – tuffite; 5 – tephrite; 6 – theralite; 7 – teschenite; 8 – teschenite-camptonite; 9 – camptonite; 10 – xenolith.

is 49 m. Hardening zone in the peripheral parts of the body is aphanitic and well crystallized in the central part. In the sole dense, dark gray, almost black, light and dark banded 5-15 cm thick silicate of pelite-carbonate composition occur.

In their quartz-chalcedonic pelitic mass irregularly disposed spheroidal remnants of radiolarian skeleton and numerous elongated sponge spicules are observed. The number of spicules in the dark bands exceeds half of the total mass of the rock, in the light strips – almost a third. The silicite are characterized by a sharply expressed globular structure (Fig.3).

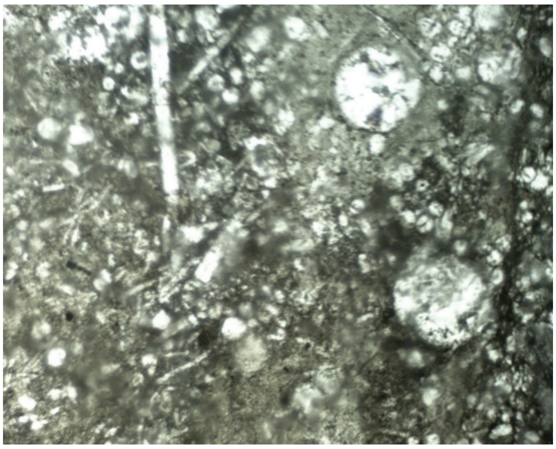

Fig. 3. Silicite with globular structure.

1.6 m thick, greenish-grey tuffs of massive makeup of a brecciate-spotted texture and vitro-crystalline-lithoclastic structure concordantly continue the silicate xenoliths of dark colored porous sponges, cryptocrystalline lavas, fragments of pelite-carbonate and silicite are recorded there.

2.1 m thick dark grey almost black, crypto-crystalline rock with white spherical segregations on the weathered surface overlie the tuffites. The structure is micro-porphyritic with hyaline ground mass. From feldspars the splagioclase of labrador-bytownite series replaced by saussurites and zeolites; participate and from colored minerals olivine relicts of isometric form crazed with serpentine-iddingsiteveins and titanaugite of short prismatic appearance sometimes passing into a green hornblende along the cleavage cracks.

From feldsparhoides the prismatic crystals of nepheline with a low refraction index and low relief participate; they often contain alteration products of radial-fibrous natrolite and lomontite. The amount of isometric pseudo-cubic analcime is insignificant in the rock; hyaline-hyalopilitic vitreous ground mass contains great amount of irregularly scattered microlites of the mentioned rockforming minerals. According to structural-textural peculiarities and mineral composition, the rock is determined as tephrite.

In the section at the interval of 3.4-16.6m, dark-grey, almost black, massive macro-crystalline, even-grained rock with cha-racteristic ophitic-poikilitic texture continues the tephrites. The latter is formed due to pyroxenes idiomorphic crystal inclusions in plagioclases. The main rockforming mineral is the elongate-prismatic and oblate-platy crystals of plagioclase, which are often saussuritized and zeolitized. Olivine forms isometric crystals often replaced by pyroxene, amphibole, serpentine and iddingsite. The pyroxene is of two generations – the first one is formed during the crystallization. It is characterized by short prismatic crystals, light green color, two-direction cleavage in the basal section; it undergoes uralitization and chloritization processes. Pyroxene of the second generation is a product of olivine alteration. The amphibole is also of two generations: the first one is distinguished in sharply elongated forms, pleochroism (from light straw to dark brown coloring) and often is distinguished in well expressed two-direction cleavage (barkevikite); the mineral appears as sporadic crystals and its composition gradually increases from 15.3 m in ascending section. The amphiboles of second generation are the products of pyroxene alteration. They have a characteristic light green color and weak pleochroism uralitic hornblen-de;

from the feldspathoids elongated or short prismatic crystals of nepheline with low relief and a direct angle of attenuation and xenomorphic grains; nepheline is often replaced by fibrous and radial zeolite (natrolite). In the rock, sporadic grains of pelitizated orthoclase are observed; there are lots of magnetite and especially long prismatic and needle-like crystals of apatite. The above-described interval of the magmatic body by its structural-mineral features belongs to olivine-nepheline bearing zeolitizated dolerite of alkaline order, i.e. to theralite.

In the section, the interval of 16.8 - 25.3m is represented by teschenite. The rock is of green-grey coloring with elongated prismatic and fibrous-needle like amphibole separations. It has a diabase-ophitic texture passing into porphyritic. The plagioclase is elongate-prismatic with zonal structure; it is mostly saussuritized and replaced with fibrous and radial zeolite and analcime. The latter, except for the radiation aggregates, also provides the isometric, pseudo-cubic crystals. K-feldspar unitary xenomorphic crystals are also completely pelitizated. The amount of apatite represented by columnar – needle-like crystals is increased.

In 25.3 - 28.9m interval of the magmatic body the teschenite gradually transforms into a comparatively fine-grained, greenish-grey variety in which, olivine reduction and increase of amphibole (barkevikite) is clearly observed; it is determined as teschenite-camptonite.

In the interval of 28.9 - 41.1m, unlike the other varieties the magmatic body building rock is distinguished in abundance of colored minerals that is also clearly visible during the microscopic study. The microscope reveals a typical lamprophyric structure of the rock that is conditioned by the abundance of colored mineral impregnations in the holocrystalline prismatic-grained mass; the colored mineral belongs to the barkevikite type hornblende, it constitutes 60-70% of the total volume of the rock; hornblende produces prismatic-pole-likely elongated, idiomorphic crystal forms with two-direction cleavage and sharply expressed pleochroism.

By optical characteristics, this mineral corresponds to alkali amphibole – barkevikite. Plagioclase is represented in the form of prismatic and wide-platy crystals; comparative to amphiboles it is distinguished in a low grade of idiomorphism that is a characteristic feature of lamprophyre structure [8]; from the products of alteration, unitary zeolite grains are observed. Olivine is scanty or is not observed at all. The secondary light-green amphibole that occurred due to pyroxene alteration is also scarce; in fact, irregularly disposed needle-likely elongated crystals of apatite are abundant. They exceed 5% of total volume of the rock. By structural-textural characteristics and mineralogical composition, the studied rock belongs to camptonite series of lamprophyre group of rocks (Fig.4).

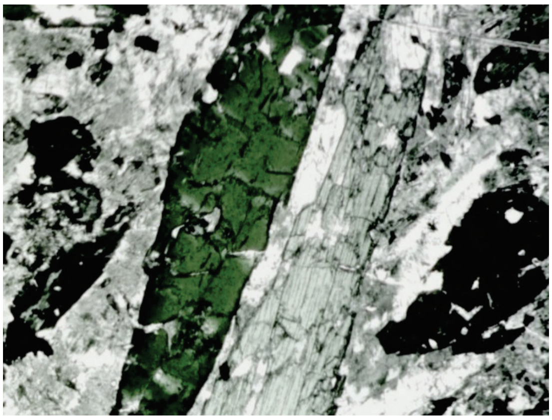

Fig. 4. Camptonite with hormblende (barkevikite) crystals.

The camptonite within the interval of 36.6 - 41.1m on the weathered surface gains a reddish grey coloring, is saturated with hydrous ferric oxides, where the primary minerals are preserved only as relics.

Upwards, within the interval of 41.1 - 49m, the camptonites are concordantly continued by brown-grey almost black cryptocrystalline rock of massive structure; the structure is micro-

Table. Chemical analysis of major oxides (wt%) for magmatic bodies of Iori region

Sam-ple #	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	lol	ppp	total
i-2	41.02	1.60	10.05	5.01	4.20	0.07	7.96	11.6	1.62	1.42	0.28	13.26	2.4	100.49
i-4	38.74	3.40	15.1	9.07	5.56	0.08	8.60	4.80	2.60	0.90	0.6	8.6	2.5	100.48
i -5	41.80	3.01	15.13	5.09	7.50	0.14	7.15	9.28	3.36	1.88	0.6	4.05	0.8	99.88
i-7	41.20	3.07	13.7	7.1	4.16	0.21	4.78	9.06	2.54	3.33	1.3	8.46	1.7	100.4
i-8	42.92	3.33	15.54	4.61	7.13	0.21	4.98	7.09	4.16	2.76	1.2	4.7	0.8	99.5
i-12	43.64	3.15	14.79	6.22	5.58	0.21	5.3	5.82	4.54	2.38	1.0	5.68	1.62	99.93
i-13	40.76	3.14	14.62	6.09	6.84	0.15	8.36	9.18	3.08	1.42	0.48	4.66	1.06	99.84

Symbols: i-2-tephrite, i-4-tuffite, i-5-tephrite, i-7-theralite, i-8-camptonite, i-12 –theralite, 1-13- tephrite

porphyritic – with hyaline groundmass; plagioclase is intensively saussuritizated; from colored minerals barkevikite crystals are rare; hyaline-hyalopilitic ground mass.

Groundmassconsists of devitrified volcanic glass saturated with albite-chloritic flakes, epidote grains and hydrous ferric oxides; it is characterized by abundance of pores often filled with carbonate, epidote, isotropic feldspars (sodalite) or with radial-fibrous zeolite. By composition the rock corresponds to tephrites.

The section is terminated with stripy silicite. They are represented by phthanites in the base as well as in the roof of the section.

The complete chemical analysis of rocks was conducted to determine the petrochemical nature of the magmatic body; the results are given in the Table.

As the Table shows, the rocks of the sill are distinguished in low and medium aluminousness ($Al_2 0_3$=0.64-0.92), low silicification (SiO_2=43-45%), increased Na content compared to K content (Na_2O/K_2O>1), high Ti content (TiO_2=3.1-3.4) with some exceptions (TiO_2=1.6%) (Table). It belongs to the potassium-sodium bearing rocks, rarely to the rocks of potassic series.

In the SiO_2-Na_2O+K_2O discrimination diagram (TAS) [9] the figurative spotspresenting chemical composition of the sill rocks are situated in the fields of alkaline rocks – tephrites and basanites (Fig. 5a).

On the binal K_2O+SiO_2 diagram [10] the figurative spots showing chemical composition of rocks are disposed in the fields of high-K and shoshonitic series rocks (Fig. 5b).

According to K-Ar dating carried out by O. Dudauri and M.Togonidze [7] the age of the magmatic body is 80-83Ma.

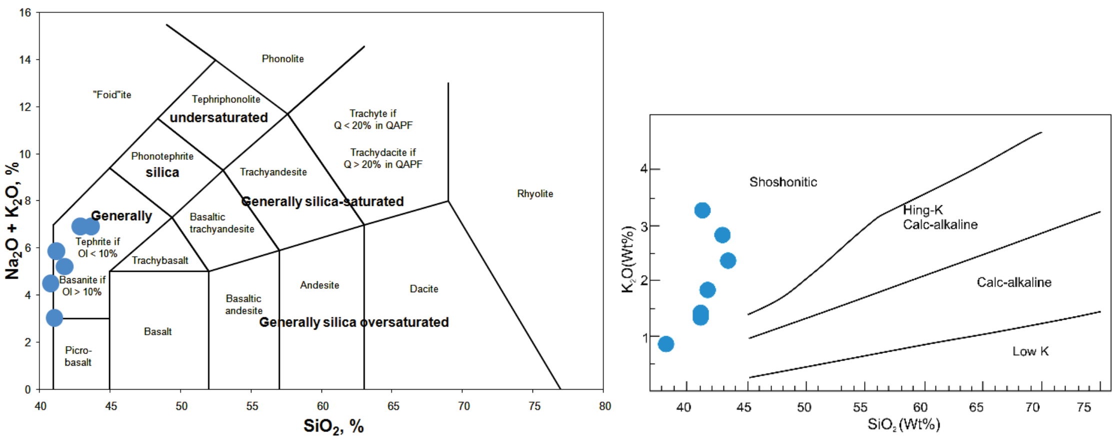

Fig. 5. Discrimination diagrams: SiO_2-Na_2O+K_2O (a) and SiO_2-K_2O (b) for the rocks of Iori magmatic body.

Thus, according to our research data the initial source magma of the Iori magmatic body belongs to alkaline series and is of ultrabasic-basic (tephritic) composition. It intruded into the Upper Cretaceous Ananuri suite in the form of sill, underwent partial crystallization differentiation and formed as teschenite-tephrite-theralite-camptonite lamprophyric complex.

Conclusion

The Iori magmatic body consists of wide spectrum of alkaline rocks, such as: camptonites, theralites, tephrites and teschenites; 2. The rocks of Iori magmatic body are represented by high-Kvolcanits; 3. We suggest that the initial source magma of the Iori magmatic body belongs to alkaline series and is of ultrabasic-basic (tephritic) composition.

პეტროლოგია

ახალი მონაცემები მდ. იორის გვიანცარცული მაგმური სხეულის ნივთიერი შედგენილობის შესახებ

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**ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, გეოლოგიის დეპარტამენტი, ზუსტ და საბუნებისმეტყველო მეცნიერებათა ფაკულტეტი, თბილისი, საქართველო*

(წარმოდგენილია აკადემიის წევრის დ. შენგელიას მიერ)

ჩვენი კვლევის ობიექტია მდ. იორის დინების შუა წელში გამოვლენილი გვიანცარცული ასაკის მაგმური სხეული; წინა მკვლევარების მიერ პეტროგრაფიული შესწავლისა და ქიმიური ანალიზის მონაცემების საფუძველზე სხეულის ამგები ქანები ტეშენიტებად იქნა განსაზღვრული. მაგმური სხეული წარმოადგენს შრეძარღვს, განლაგებულს ზედაცარცული ასაკის ანანურის წყების ფლიშური ნალექებით აგებულ ბოკონის სინკლინის ორივე ფრთაში. შრეძარღვები ქმნის ორ სხეულს, რომლებიც ზუსტად იმეორებენ შემცველი წყების წოლის ელემენტებს. ნაშრომში წარმოდგენილია მდ.იორის შუა წელში გამოვლენილი გვიანცარცული ასაკის მაგმური სხეულის ამგები ქანების კომპლექსური კვლევის ახალი მონაცემები. დეტალური მინერალოგიურ-პეტროლოგიური, სტრუქტურულ-ტექსტურული და პეტროქიმიური კვლევის საფუძველზე მაგმური სხეულის აგებულებაში, ტეშენიტებთან ერთად, პირველადაა გამოყოფილი ტუტე ლამპროფირები: კამპტონიტები, ტერალითები და ტეფრიტები.

მაგმური სხეულის ქანებში მინერალური ნივთიერების შემცველობა განისაზღვრა მიკროსკოპიული კვლევებით. მთავარი ქანმაშენი მინერალებია: ფუძე პლაგიოკლაზი (ლაბრადორი), ნეფელინი, პიროქსენები, ტუტე ამფიბოლი (ბარკევიკიტი); მცირე რაოდენობით

მონაწილეობენ: ოლივინი, K-ფელდშპატი. მეორადი მინერალებია: სერპენტინ-იდინგსიტი, თიხის მინერალები, ცეოლითები (ნატროლითი, ლომონტიტი), კალციტი, ბიოტიტი. აპატიტი არის მთავარი მნიშვნელოვანი აქცესორი მინერალი. დისკრიმინაციულ დიაგრამაზე შრეძარღვის ქანების ქიმიური შედგენილობის ამსახველი ფიგურული წერტილები განლაგებულია ტუტე ქანების- ტეფრიტებისა და ბაზანიტების ველებში.

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