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Preliminary data on the petrology and K-Ar dating of the Oligocene volcano Briastovo, Eastern Rhodopes

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Abstract. The Briastovo volcano, located in Borovitza region of the Eastern Rhodope volcanic area, is over 25 km in diameter and comprises lava flows of a total thickness of over 1500 m. They form 3 volcanic complexes (from bottom to top): phenoandesites (of unknown age and chemistry); medium to coarse porphyric ultrapotassic latites (33.4 ± 1.3 Ma) and qaurtz-latite domes (32 ±1.2 Ma). The latter two complexes are part of the II intermediate phase of the Eastern Rhodope volcanism. The latite dome Dolni-Voden, product of the III intermediate phase (31 ± 1.2 Ma), is exposed in the northern periphery of the volcano. Later, the Briastovo volcano was covered by the dome-cluster of Haskovo mineral springs of the III acid phase, composed of three trachyrhyodacite-trachyrhyolite domes with perlitic periphery (29 to 30.4 ± 1.2 Ma).

Key words: ultrapotassic latites, Eastern Rhodopes, Tertiary volcanism.
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Янев, Й., З. Печкай. 1997. Предварителни данни върху петрологията и K-Ar възраст на олигоценския вулкан Брястово, Източни Родопи. — *Геохим., минерал. и петрол.*, **32**, 59-66.

Разположеният в Боровишкия район на Източнородопската вулканска област Брястовски вулкан е с диаметър над 25 km и е изграден от лавови потоци с обща дебелина над 1500 m. Те съставят 3 вулкански комплекса (отдолу нагоре): на феноандезитите (с неизвестна възраст и химизъм), на средно до едропорфирните ултракалиеви латити (възраст 33,4 ± 1,3 млн. г.) и на кварц-латитовите куполи (32 ± 1,2 млн. г.). Последните два комплекса са от II среднокисела фаза на източнородопския вулканизъм. В северната периферия на вулкана се разкрива латитовият купол Долни Воден от III среднокисела фаза (възраст 31 ± 1,2 млн. г.). По-късно върху Брястовския вулкан се разполага вулканският ареал Хасковски минерални бани от III кисела фаза, състоящ се от три трахириодацит-трахириолитови куполи на изстискване с перлитова периферия (възраст от 29 до 30,4 ± 1,2 млн. г.).

Ключови думи: ултракалиеви латити, Източни Родопи, терциерен вулканизъм
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The Briastovo volcano is situated at the Eastern Rhodopes volcanic area, Borovitza region. This is a very large volcano with diameter over 25 km (from the road Novakovo village - Hut "Sini Vrah" in the west to the Susam village in the east

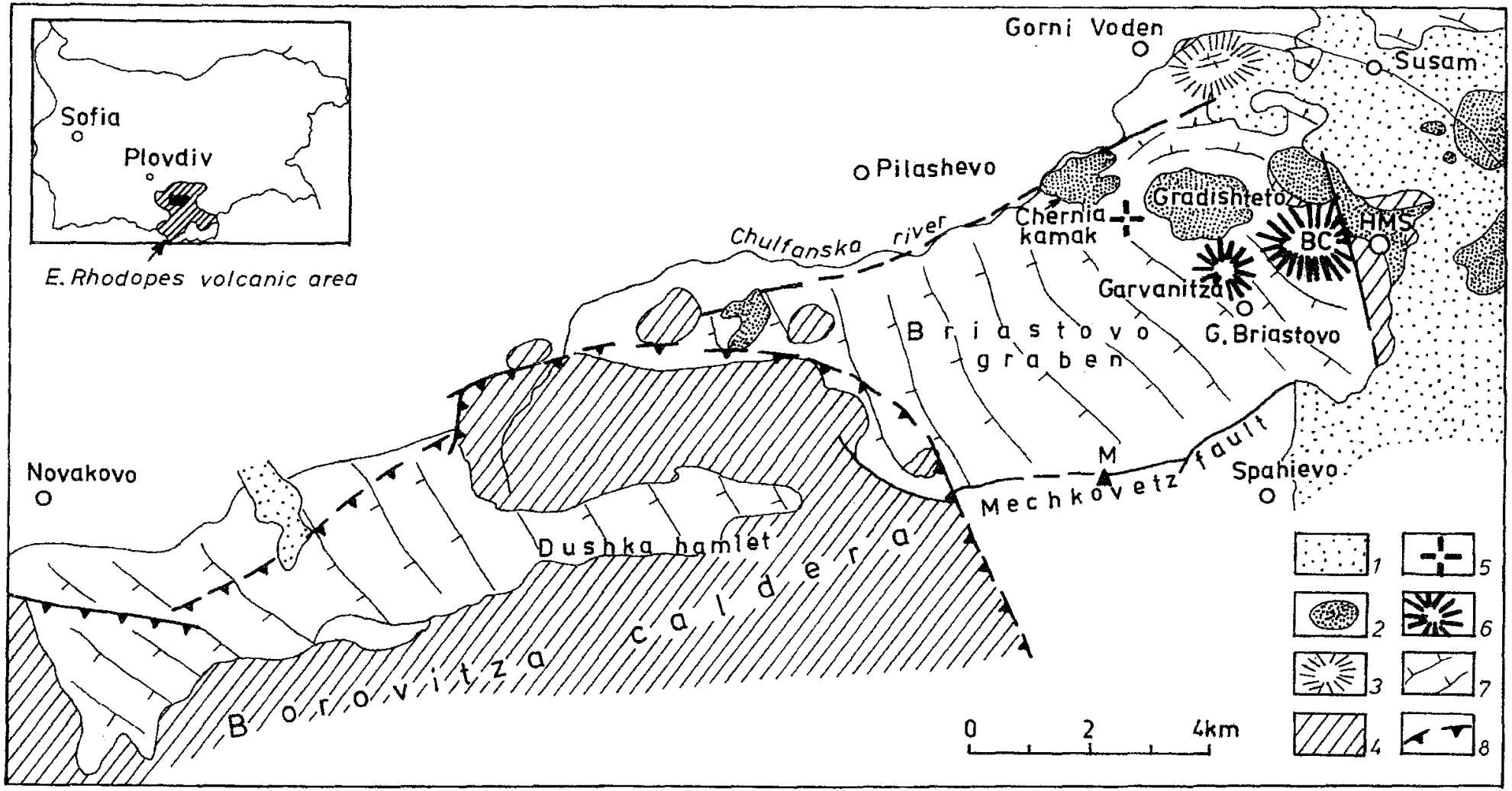

Fig. 1. Schematic geological map of the Briastovo volcano and the NE part of the Borovitza caldera (after Geological Map..., 1989 with additions): 1 — Neogene-Quaternary cover. Oligocene: 2 — acid domes (III acid phase), 3 — latite dome (III intermediate phase), 4 — acid lavas and pyroclastics (II acid phase), 5 — Briastovo intrusion, 6 — quartz-latite domes, 7-ultrapotaяsic latite lava flows (6 and 7 are of II intermediate phase), 8 — caldera faults. In white - latites not discussed in the text. HMS — Haskovo mineral springs, BC — Banska — chuka dome, M — Mechkovetz summit

Фиг. 1. Схематична геоложка карта на Брястовския вулкан и СИ част на Боровишката калдера (по Geological Map..., 1989 с допълнения): 1 — неоген-кватернерна покривка. Олигоцен: 2 — кисели куполи (III кисела фаза), 3 — латитов купол (III среднокисела фаза), 4 — кисели лавови тела и пирокластити (II кисела фаза), 5 — Брястовска интрузия, 6 — кварцлатитови куполи, 7 — ултракалиеви латитови лавови потоци (6 и 7 — II среднокисела фаза), 8 — калдерни разломи. В бяло са дадени латити, необсъждани в текста. HMS — Хасковски минерални бани, BC — вр. Банска чука, M — вр. Мечковец

Table 1

Chemical composition of the magmatic rocks of Briastovo volcano

Таблица 1

Химичен състав на магматитите от Брястовския вулкан

	Intermediate volcanics									Briastovo intrusion	Acid volcanics				
No Analyses	1 1596b	2	3 B-24	4 1581b	5 1580	6	7 1670	8 1672	9 1668	10 1656	11 511	12 1592g	13 1591g	14 137	15 12j
SiO_2	58.46	57.48	58.22	59.34	57.14	58.24	58.22	60.54	59.96	62.83	70.36	70.74	65.08	75.36	75.90
TiO_2	0.65	0.68	0.60	0.59	0.66	0.65	0.65	0.59	0.64	0.53	0.38	0.31	0.37	0.10	0.80
Al_2O_3	14.63	14.43	14.63	13.84	15.01	15.67	14.72	14.87	14.78	13.76	14.30	13.93	13.76	11.54	12.50
Fe_2O_3	5.46$_t$	3.69	4.62	5.95$_t$	6.21$_t$	2.32	6.41$_t$	6.23$_t$	5.64$_t$	4.71$_t$	2.40	2.24$_t$	2.69$_t$	1.08	1.08
FeO	n.d.	2.14	1.27	n.d.	n.d.	2.53	n.d.	n.d.	n.d.	n.d.	0.84	n.d.	n.d.	0.80	0.29
MnO	n.d.	0.14	0.11	0.12	n.d.	0.16	n.d.	n.d.	n.d.	n.d.	0.03	n.d.	n.d.	n.d.	n.d.
MgO	4.18	3.87	4.07	3.66	3.25	3.44	3.19	2.67	2.53	2.49	0.53	0.76	1.33	0.10	0.28
CaO	6.09	5.83	5.18	6.18	5.13	5.76	5.47	3.76	5.09	4.73	1.50	2.38	2.45	1.40	0.52
Na_2O	2.67	2.61	2.01	2.46	2.13	2.45	2.55	2.69	3.80	3.35	3.34	3.51	3.17	2.43	3.80
K_2O	5.25	6.04	6.20	5.61	6.47	5.76	5.20	5.56	5.05	4.78	4.62	5.53	4.47	5.04	4.80
P_2O_5	n.d.	0.79	0.85	0.66	n.d.	0.65	0.66	0.58	0.55	0.49	n.d.	n.d.	n.d.	0.07	0.04
CO_2	n.d.	1.47	n.d.	n.d.	n.d.	0.83	n.d.	n.d.	n.d.	1.17	n.d.	n.d.	n.d.	n.d.	n.d.
H_2O^-	n.d.	0.67	n.d.	n.d.	n.d.	0.35	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.82	0.15
H_2O^+	2.39	0.07	1.76	1.94	3.94	1.31	2.05	1.54	0.99	0.98	1.50	1.38	6.59	1.08	0.72
Total	99.78	100.18	99.52	100.35	99.92	99.12	99.12	99.03	99.03	99.82	99.80	100.78	99.91	99.82	100.82

N o t e: The index "t" indicates all iron given as Fe_2O_3.

L o c a t i o n. Ultrapotassic latites: 1 — east of Dushka hamlet, 2 — west of Mechkovetz summit (after Радонова, 1973), 3 — the same place, 4 — west of Gradishteto summit-borehole 939, 45 m (slightly altered), 5 — the same borehole, 326 m (moderately altered), 6 — the same place, borehole 970, 557 m (slightly altered), 7 — Yurtlenski-cheshmi (slightly altered); quartz-latite: 8 — west of Banska-chuka summit; latite: 9 — south of Gorni-Voden village; quartz-montzonite (with anhydrite): 10 — west of Gradishteto summit, borehole 965, 1502 m; trachyrhyodacites: 11 — Chernia-kamak summit, 12 — Gradishteto summit, borehole 974, 378 m, 13 — same place, borehole 940, 0 m (perlite); thrachyrhyolites: 14 — north and 15 — east of Haskovo mineral springs.

З а б е л е ж к а: Индексът "t" обозначава общо желязо, дадено като Fe_2O_3.

М я с т о н а п р о б а т а. Ултракалиеви латити: 1 — изт. от с. Душка, 2 — зап. от вр. Мечковец (Радонова, 1973), 3 — същото място, 4 — зап. от вр. Градището, сонд. 939, 45 m (слабо променен), 5 — същия сондаж, 326 m (средно променен), 6 — същото място, сонд. 970, 557 m (слабо променен), 7 — Юртленски чешми (слабо променен); кварцлатит: 8 — зап. от вр. Банска чука; латит: 9 — южно от с. Горни Воден; кварцмонцонит (с анхидрит): зап. от вр. Градището, сонд. 965, 1502 m; трахириодацити: 11 — Черният камък, 12 — Градището, сонд. 974, 378 m, 13 — същото място, сонд. 940, 0m (перлит); трахириолити: 14 — сев. и 15 — зап. от Хасковски минерални бани.

- Fig. 1). Its western part forms the fundament of the acid volcanic in the north-eastern sector of the Borovitza caldera and its eastern part fills the Briastovo graben with N-NE direction (9×5 km) in the caldera rim.

This is a lava volcano and it consists of three volcanic units in the Briastovo graben (from the bottom to the top): 1) phenoandesite lava flows, 2) coarsely to medium porphyric ultrapotassic latite lava flows, and 3) quartz-latite domes. The first and second units were formed by several hundred metres thick complexes of great number of lava flows, separated by the subaerial epiclastic beds (red siltstone, coals, etc) some metres thick. Based on the borehole data its total thickness is more than 1500 m in the central part of the volcano.

The first unit occurs in the depth of the volcano with a thickness about 500-800 m. Chemical and radiometric data are not available because the volcanics are strongly altered (K u n o v et al., 1997). They contain phenocrysts of plagioclases, clinopyroxene and biotite. In the 1500 m depth they are cut by one quartz-monzonite body — the Briastovo intrusion — consituted by plagioclase ($An_{40-45.5}Or_{2.6-5.1}$), K-feldspar ($Or_{85-86}Ab_{11-14}Cn_{0-1.5}$), biotite (Mg/Mg+Fe=65-67 and Al^{IV}=2.29-2.42) and actinolitized

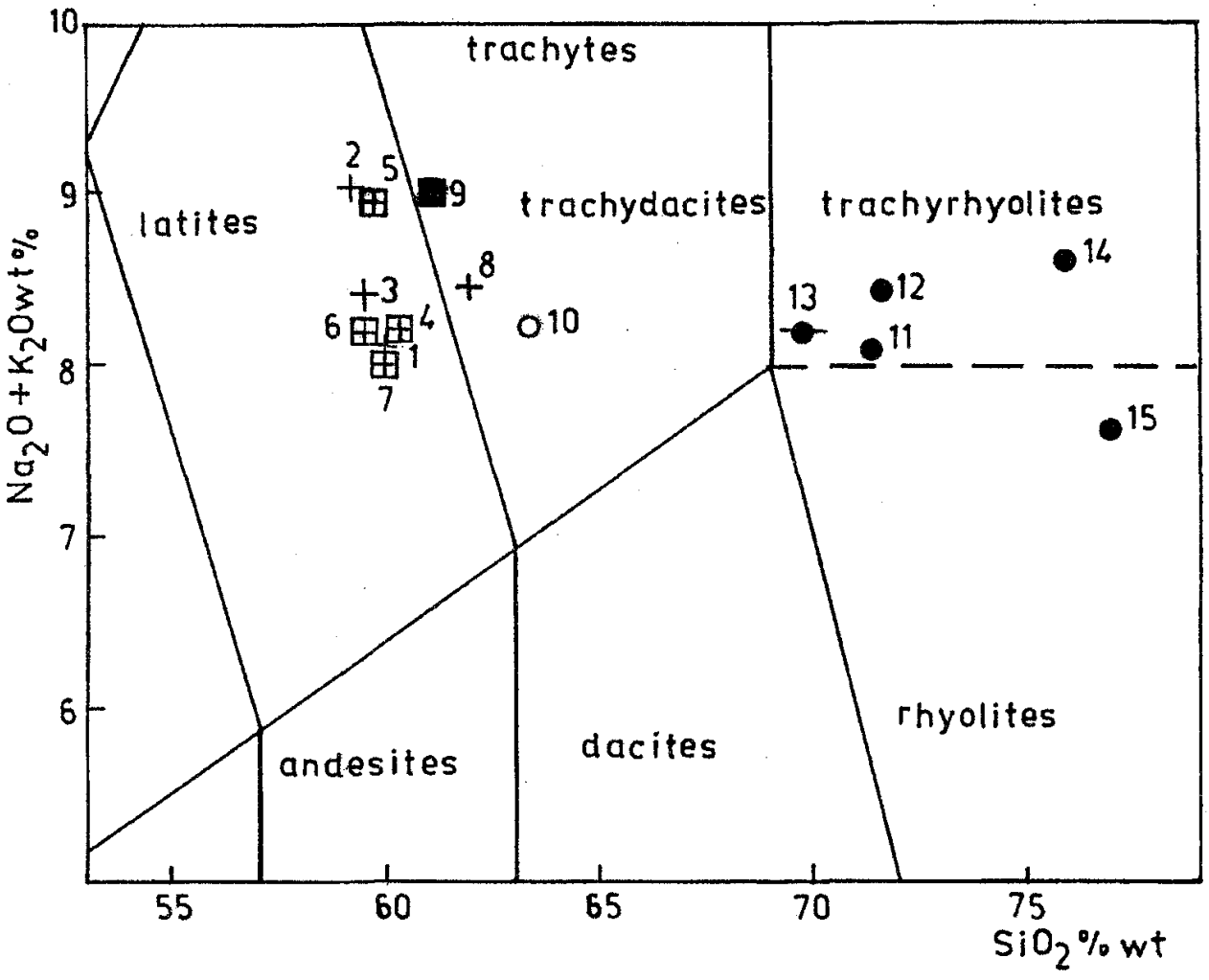

Fig. 2. TAS diagram of IUGS commission (L e M a i t r e, 1989; the limit between rhyolites and trachyrhyolites is according to M y a s h i r o, 1978 and Klassifikatzia..., 1981). For the symbols see Fig. 3; the numbers correspond to Table 1

Фиг. 2. TAS диаграма на IUGS комисия (L e M a i t r e, 1989; границата между риолитите и трахириолитите е според M y a s h i r o, 1978 и Klassifikatzia..., 1981). За знаците на фигуративните точки вж. фиг. 3, а номерата им отговарят на табл. 1

pyroxene. The feldspars crystallisation temperature (according to F u h r m a n, L i n d s l e y, 1988, geothermometry) is 635°C.

The second unit is 800 to 1000 m thick and it appears on the surface. The volcanics are fine porphyric (up to 0.2-0.3 cm) in the depth and medium to coarsely porphyric on the surface. In some parts of the flows the sanidine phenocrysts are up to 1-2 cm, rarely up to 5 cm. The volcanics are also altered (K u n o v et al., 1997) but preserved in some places, where its composition (Table 1) is of ultrapotassic rocks (according to the F o l e y et al., 1988, criteria), i.e. with K_2O>3wt%, K_2O/Na_2O>2 and MgO>3wt%. These rocks ware described as trachytes by Hussak in 1883 and by Bontscheff in 1896 (mentioned in I v a n o v, 1960), but the Na_2O content is very low for a trachyte (Table 1, Fig. 2 and 3). The volcanics contain phenocrysts of sanidine

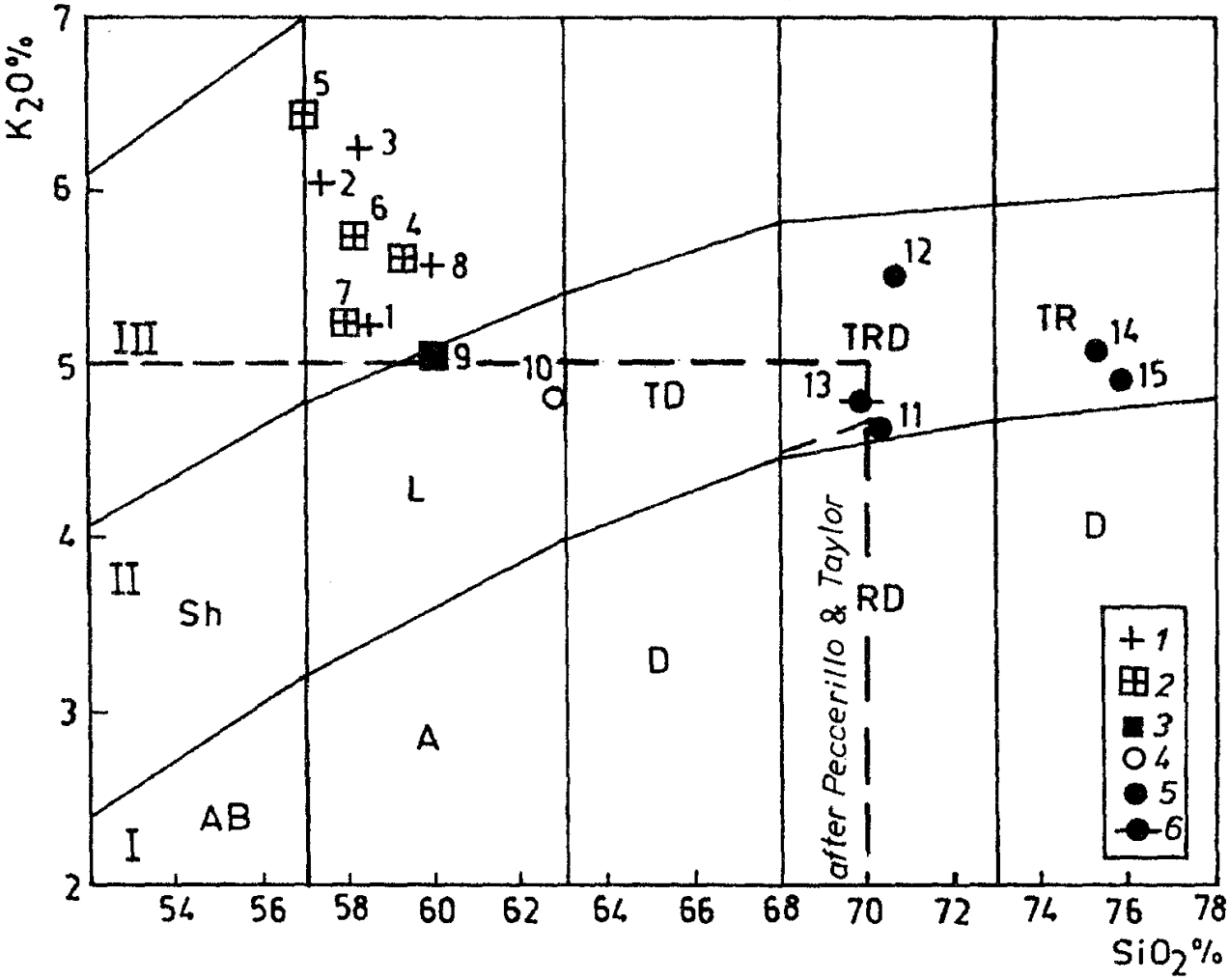

Fig. 3. P e c c e r i l l o, T a y l o r K_2O vs SiO_2 diagram (extend by S t a n i s h e v a - V a s s i l e v a, Y a n e v and H a r k o v s k a in: D a b o v s k i et al., 1991): *1* and *2* — ultrapotassic latites (*2* — slightly altered), *3* — latite, *4* — quartz-montzonite, *5* — trachyrhyodacites and trachyrhyolites, *6* — perlite (calculated at 100% dry mass). Series: *I* — *High-K Ca-alkaline* (BA — basaltic andesite, A — andesite, D — dacite, RD — rhyodacite, R — rhyolite), *II* — *Shoshonitic* (Sh — shoshonite, L — latite, TRD — trachyrhyodacite, TR—trachyrhyolite), *III* — *High-K shoshonitic*. For the location of the analyses see Table 1

Фиг. 3. K_2O/SiO_2 диаграма на P e c c e r i l l o, T a y l o r (разширена от С т а н и ш е в а - В а с и л е в а, Я н е в и Х а р к о в с к а в: D a b o v s k i et al., 1991): *1* и *2* — ултракалиеви латити (*2* — слабо променени), *3* — латит, *4* — кварцмонцонит, *5* — трахириодацити и трахириолити, *6* — перлит (преизчислен към 100% сухо вещество). Серии: *I* — *Висококалиева Са-алкална* (BA — андезитобазалти, A — андезити, D — дацити, RD — риодацити, R — риолити), *II* — *Шошонитова* (Sh-шошонит, L — латити, TD — трахидацити, TRD — трахириодацити, TR — трахириолити), *III-висококалиева шошонитова*. За мястото на анализите виж табл. 1

($Or_{62-70}Ab_{25-28}Cn_{2-3}$), zoned plagioclase (core $An_{86-88}Or_{3-4}$, periphery $An_{38-43}Or_{6-7}$), Na diopside-augite ($Wo_{44-45}En_{43-44}$ with Na_2O=1,25-1.66%wt), biotite to phlogopite (Mg/Mg+Fe=61-81, Al^{IV}=2.36-2.47) in the fine crystalline groundmass with microlites of sanidine with variable composition (from $Or_{63}Ab_{30}$ to $Or_{84}Ab_9$), anorthoclase ($Or_{20}Ab_{70}$), plagioclase and clinopyroxene; accessories: Ti-magnetite, apatite and zircon. The feldspars crystallization temperature (according to F u h r m a n, L i n d s l e y, 1988, geothermometry) is 837°C. The age is given in the Table 2.

The volcanic activity was finished by the formation of two quartz-latite domes (Garvanitza and Banska-Chuka ones) some hundred meters in diameter. They contain phenocrysts of sanidine ($Or_{64-72}Ab_{2-2.5}Cn_{1-3}$), zoned plagioclase (core $An_{52}Or_3$, periphery $An_{43-49}Or_{4-5}$), diopside ($Wo_{47}En_{39-40}$), biotite (Mg/Mg+Fe=60-61, Al^{IV}=2.50-2.56) and subphenocrysts of quartz. The feldspars crystallization temperature (according to F u h r m a n, L i n d s l e y, 1988, geothermometry) is 827°C. The age is given in the Table 2.

At the northern edge of the graben, in the valley of the Chiuflianska River appears the Dolny-Voden latite dome of more recent age. This dome cuts the acid tuffs of the cover of the Briastovo volcano. These latites contain the diopside-augite ($Wo_{43-44}En_{43-45}$), plagioclase ($An_{45-46}Or_{6-7}$) and phlogopite (Mg/Mg+Fe=77, Al^{IV}=2.27) phenocrysts.

Table 2

K-Ar age data for the Briastovo volcanics (analysed at the Institute of Nuclear Research of Hungarian Academy of Sciences - ATOMKI, Debrecen)

Таблица 2

K-Ar данни за възрастта на Брястовските вулканити (анализирани в Института за ядрени изследвания към Унгарската академия на науките - ATOMKI, Дебрецен)

No Analyses	Volcano or dome (locality)	Rock name	K (%)	$^{40}Ar_{rad}$ (%)	$^{40}Ar_{rad}$ (cc Stp/g)	K/Ar age (Ma)	Volcanic phase (Lower Oligocene)
1670	Briastovo volcano (Yurtlenski-Cheshmi)	ultra-potassic latite	4.88	84.9	6.384×10^{-6}	33.4 ± 1.3	II intermediate
B-24*	Briastovo volcano (1km NE of Mech-kovetz summit)	ultra-potassic latite	5.30	—	—	31.5 (average)	II intermediate
1672	Briastovo volcano (Garvanitza dome)	quartz-latite	4.79	89.9	5.997×10^{-6}	31.9 ± 1.2	II intermediate
1668	Dolny-Voden dome	latite	4.78	78.3	5.808×10^{-6}	31.0 ± 1.2	III intermediate
511	Chernia-Kamak dome	trachyrhyo-dacite	4.67	82.2	5.509×10^{-6}	30.2 ± 1.2	III acid
1592g	Gradishteto dome	trachyrhyo-dacite	4.34	86.7	5.162×10^{-6}	30.4 ± 1.1	III acid
12j	Haskovo Mineral Springs dome	trachyrhyo-dacite	4.39	80.5	4.964×10^{-6}	28.8 ± 1.1	III acid

*According to L i l o v et al. (1989).

During the latter acid phase along the northern border fault of the graben three trachyrhyodacite-rhyolite domes with perlitic periphery (Chernia-kamak, Gradishteto and Haskovo mineral springs) were intruded. They form Haskovo mineral springs dome-cluster (Y a n e v et al., 1983). The volcanics contain phenocrysts of quartz, sanidine ($Or_{62-80}Ab_{20-34}Cn_{1-4}$), plagioclase ($An_{18-39}Or_{3-6}$) and biotite (Mg/Mg+Fe=46-65, Al^{IV}=2.22-2.50); accessories: magnetite, apatite, zircon and titanite. The trachyrhyodacites of Gradishteto dome contain also amphibole (edenite to Mg-hornblende) and diopside-augite($Wo_{44-47}En_{39-48}$). The feldspar crystallization temperature (according to F u h r m a n, L i n d s l e y, 1988, geothermometry) in the Gradishteto dome is 692-699°C and in the Haskovo mineral springs dome is 714-750°C. The age is given in Table 2.

The Briastovo volcanics without being defined as a volcanic edifice are considered of Priabonian age (L i l o v et al., 1987) or of Oligocene age - I or II intermediate phase (I v a n o v, 1960, 1972; B o j a n o v, M a v r u d č i e v, 1961; Y a n e v, 1989; Geological Map..., 1989). Latter acid domes are refered to the II acid Oligocene phase (I v a n o v, 1960, 1972; Y a n e v et al., 1983; Geological Map...., 1989).

The geochronologic study of the Briastovo volcano is aimed at providing a time framework for related petrological and volcanological studies of volcanic evolution. K-Ar age determinations from whole rock samples are reported from 6 localities in the studied area. Together with the previously obtained data (L i l o v et al., 1987) they show a range of 33-29 Ma. The anallitycal data are summarized in Table 2, where their K-Ar age is compared with the age of the Eastern Rhodopes volcanic phases according to L i l o v et al. (1987).

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References

B o j a n o v, I., B. M a v r u d č i e v. 1961. Der Paläogene Magmatismus in den Nordöstlishen Rhodopen. I Teil: Stratigraphische, Litologische und Petrographische Notizen über das Paläeogen. — *Ann. Univ. Sofia.* **54**, 2-geol., 113-158 (in Bulgarian with German abstract).

D a b o v s k i, H., A. H a r k o v s k a, B. K a m e n o v, B. M a v r o u d c h i e v, G. S t a n i s h e v a-V a s s i l e v a, Y. Y a n e v. 1991. Geodynamic model of the alpine magmatism in Bulgaria. — *Geologica Balc.*, **21**, 4, 3-15.

F o l e y, S. F., D. H. V e n t u r e l l i, D. H. G r e e n, L. T o s c a n i. 1987. The ultrapotassic rocks: Characteristics, classification, and constraints for petrogenetic models. —*Earth Sci. Reviews,* **24**, 81-134.

F u h r m a n, M., P. L i n d s l e y. 1988. Ternary feldspar modelling and thermometry. — *Amer. Miner.*, **73**, 201-215.

Geological Map of Bulgaria. 1989. Sheet Haskovo, 1:100 000.

I v a n o v, R. 1960. Magmatism of the Eastern Rhodope depression. Part I-Geology. — *Trudove Geol. Bulg.* Seria Geohim. y Polez. Izkop., **1**, 311-387 (in Bulgarian with German abstract).

I v a n o v, R. 1972. Volcano-tectonic structures in the Borovitza depression. — *Izv. Geol. Inst.*, Seria Geokhim., Miner. y Petrogr., **21**, 193-210 (in Bulgarian with an English abstract).

Klasifikatzia y Nomenklatura Magmaticheskih Gornyh Porod (Classification and Nomenclature of Magmatic Rocks). 1981. M., Nedra. 160 p. (in Russian).

K u n o v, A., L. K a t s e v a, N. R a y n o v. 1997. Epitermal argillizites and associated wallrok alterations in the Briastovo polymetallic deposit, Eastern Rhodopes. — *Geochem., Mineral. and Petrol.*, Sofia, **32**, 67-84.

L e M a i t r e, R. W. (ed.) 1989. *A Classification of Igneous Rocks and Glossary of Terms. Recommendations of the IUGS Subcommission on the Systematics of Igneous Rocks.* Oxford, Blackwell .193 p.

Lilov, P., Y. Yanev, P. Marchev. 1987. K/Ar dating of the Eastern Rhodope Paleogene magmatism. — *Geologica Balc.*, **17**, 5, 49-58.
Myashiro, A. 1978. Nature of alcalic volcanic rocks series. — *Contrib. Mineral., Petrol.*, **66**, 91-104.
Radonova, T. G. 1973. Hydrothermal alterations in the Spahievo ore field. — *Izv. Geol. Inst.* Seria Geokhim., Miner. y Petrogr., **22**, 114-161 (in Bulgarian with an English abstract).
Yanev, Y. 1989. Paleogene magmatism and related metallogeny. General description. — In: *Alpine Magmatism and Related Metallogeny in Srednogorie and Eastern Rhodopes.* Guidebook of scientific excursion E-2. XIV Congress of CBGA, Sofia, 76-85.
Yanev, Y., B. Karadjova, A. Andreev. 1983. Distribution of alkalis and genesis of the acid volcanic rocks in part of East Rhodopes Paleogene depression. — *Geologica Balc.*, **13**, 3, 15-44 (in Russian with an English abstract).

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