ՀՀ ԳԱԱ Տեղեկագիր, Գիտություններ Երկրի մասին, 2021, հ. 75, N 1, 5-13
Известия НАН РА Науки о Земле, 2021, т. 75, N 1, 5-13
Proceedings NAS RA, Earth Sciences, 2021, v. 75, N 1, 5-13

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FINDING A NEW DIATREME AT KHOSROV RESERVE (ARMENIA)

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DOI: 10.54503/0515-961X-2022.75.1-5

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Received by the Editor 10.02.2022

We found new diatreme at Khosrov reserve from central part of Armenia (Khosrov river basin) which has an oval shape; 150 m W-E length and 50m N-S width. Judging from the mineral composition, petrography and major element chemistry the main rocks of Khosrov diatreme are vitro- crystallo-lithoclastic tuffs. The tuffs composed mostly of volcanic glass and have diopside, augite, Ti-augite, accessory (garnet, zircon, picotite, sphen) and other minerals. Vitro- crystallo-lithoclastic tuffs are cut by about 2m length trachyandesite dyke in the northern part of the diatreme.

Keywords: vitro- crystallo-lithoclastic tuffs, diatreme, ophiolite, Armenia

Introduction

Diatremes are formed by a range of generally but not necessarily silica-poor magmas (e.g. Ross et al., 2008 report a tholeiitic basaltic andesite diatreme: Coombs Hills), including wide variety of magma types ranging in composition from alkali basalts to kimberlites, various ultramafic melts, carbonatites etc. Alkaline lamprophyre diatremes in Erakh anticline and Vedi area (Armenia) are Jurassic in age (e.g. Satian et al., 2005 and references therein), which crop out in ophiolitic (obducted oceanic lithosphere) units of almost the same age. U-Pb dating on zircon crystals established that lamprophyres of Vedi diatreme were formed at 182±3My, in extensional environment of a subduction setting (Sahakyan, 2022 submitted). Alkaline lamprophyres are not strictly associated with Jurassic ophiolites, but they were probably located on oceanic lithosphere. The origin of the lamprophyric melts generated from a mantle metasomatism associated with a mantle plume described by Stoppa et al. (2013) for alkaline lamprophyres from southern Tuscany.

Lamprophyres are representing volatile-rich magmas rapidly emplaced in crustal layer classified on the basis of their mineralogy and chemistry (e.g., Rock 1991; Tappe et al., 2005). According to Satian et al. (2005 and references therein) the first stage of explosion of a multistage formation of the diatremes

are related to alkaline-basaltic tuffs of holohyaline type, with rare xenoliths. The first stage of explosive activity was followed by the formation of alkaline lamprophyres (including xenoliths) and injection of the dykes of comptonites, monchiquites, basanite and picrobasaltes in Erakh and Vedi areas respectively.

In this paper we briefly describe the geological environment of the diatreme Khosrov; composition, as well as major element concentrations which has not been reported so far. The focus of this study aims to outline the petro-mineralogical features of the rocks that fill the oval shape diatreme.

Geological setting of the studied sections

The new found Khosrov diatreme is situated (39.952108 N, 44.888233 E; fig.1) on the left bank of the Khosrov river basin. The rocks look dark green and clearly contrast with the surrounding limestones. The crumbly rocks (e.g. fig.2, Kh 20/2) are cutted by dyke in the northern part of the diatreme (fig.2, A-19). In the area conglomerates containing pebbles of the ophiolite complex (serpentinites, gabbro, basalts, radiolarites) are outcrops. Besides pillow lavas (probably OIB type) intercalated with radiolarites are exposed about 500m westward from the diatreme. In Vedi area the oceanic crust sequence is covered by variable thicknesses of pillowed OIB alkaline lavas of Lower Cretaceous age (117.3±0.9Ma) dated by $^{40}Ar/^{39}Ar$ method (Galoyan, 2008; Rolland et al., 2009). Here Santonian sedimentary sequence cover the obducted ophiolitic rocks, ophiolitic melange and the Cenomanian-Turonian shallow-water carbonates. Khosrov diatreme also is covered by Santonian, Paleocene and Eocene sedimentary formations, which are onlap deposited on Cenomanian -Turonian limestones (fig.1).

Material and methods

Immersion method was used to study the mineralogical content of samples. Heavy and light fractions were separated using Bromoform (CHBr3). Fractions are studied in immersion Eugenol of different refractive index (Ne= 1.630-1.520) under polarizing microscope. Whole rock major elements were analysed in the laboratory of chemistry at the Institute of Geological Sciences of the Republic of Armenia (analyst S. Mkrtchyan and A. Avetisyan). Analyses were done according to NSAM (Research Council for analytical methods of research) instructions.

Petrography and mineralogy

Khosrov diatreme is composed of ocher green (in places bluish green) crumbly rocks and dyke. Tuffic rocks contain some relatively thin beds mostly showing plane-parallel stratification in some places. Petrographic features of the studied rocks are illustrated in fig.2. Based on their textures under the polarized light microscope the host rocks of diatreme have aphanitic and porphyritic

textures and the principal constituents are lithoclasts, vitroclasts and crystals. Lithoclasts (L in fig.2) are represented by basalts, basaltic andesites, granitits and rare by limestones (fig.2,a,c). They are rounded - angular and the contact with the groundmass is sometimes not clear.

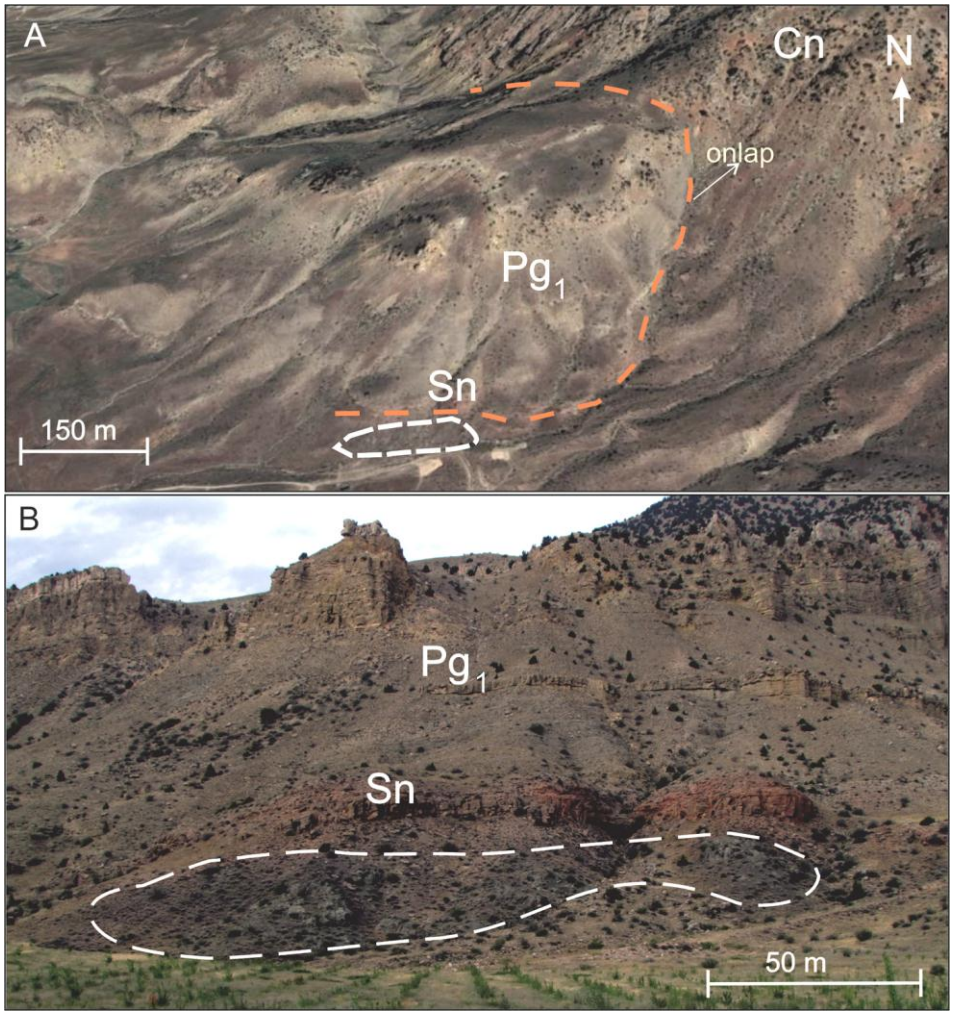

Fig.1. A- Google Earth picture and B-field photo of the Khosrov diatreme. Cn-Cenomanian reefal limestones, Pg_1- Paleocene limestones, Sn- Santonian limestones. The white dash-dotted lines show the contours of Khosrov diatreme.

Crystals are presented mostly by seriticized plagioclase, rare pyroxene (fig.2,d,e,f), altered olivine, individual crystals of calcite, large crystalline leucite, biotite plats and chlorite. Volcanic glass is represented by shards, frills and irregularly shaped contours (fig.2,a). Discontinuous veins of isotropic analcime of irregular form also are formed in some places of the thin section. The volcanic glass matrix is partly replaced by chlorite and hydromica (fig.2,b).

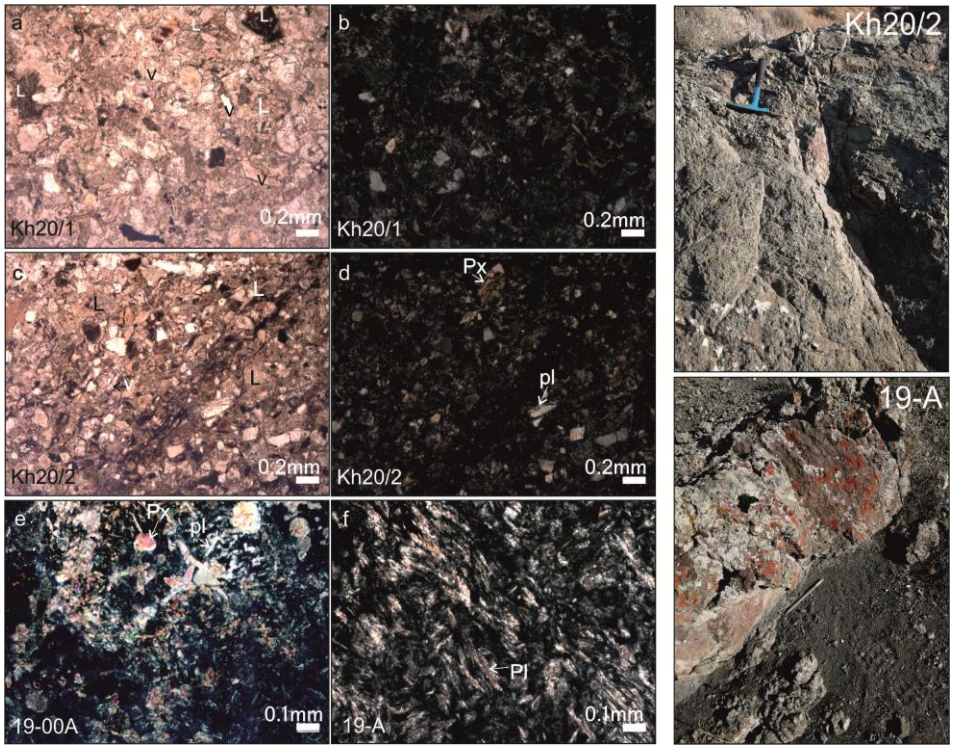

Fig.2. Photomicrographs and field photos of vitro- crystallo-lithoclastic tuffs Kh20/1, Kh20/2, 19-00A, trachyandesitic dyke 19-A from Khosrov diatreme. cl-calcite, Pl-plagioclase, Px-Pyroxene, v-volcanic glass, L-lithoclast. Plane-polarized light (ppl)- a,c; Cross-polarized light (cpl) - b, d, e, f.

Dyke consisting of needles of plagioclase (albite) (fig.2f), small quantities of pyroxenes are present between needles in a volcanic glass matrix. The texture is trachytic (fig.2,f), phenocrysts of plagioclase are seriticized and ferruginous. Altered minerals of calcite, zeolite and chlorite were also identified.

Table 1 presents the mineral composition of studied rocks. For minerals determination used immersion method (see material and methods). Vitro-crystallo-lithoclastic tuffs are characterized by the occurrence of amphibole phenocrysts (hornblende, actinolite, tremolite), clinopyroxene (mainly represents by diopside, augite, Ti-augite), hypersthene, epidote, coisite, plagioclase, mica (biotites), opaque minerals. From opaque minerals, the following association of mineral phases was found: limonite, magnetite, hematite. Zircon, garnets, picotite, sphen etc. occur as accessory minerals. Altered minerals consist of calcite, zeolite and chlorite.

Table 1

Mineralogical composition of vitro- crystallo-lithoclastic tuffs of Khosrov diatreme

	Minerals / sampl. N	19-00A	19-00	Kh20/2	Kh20/4	Kh20/5	Kh20/6
Light fraction	Plagioclase	8%	7%	6%	6%	3%	3%
	Weathered and semi weathered minerals	50%	38%	50%	36%	50%	46.5%
	Chlorite	-	-	+	1%		0.5%
	Serpentine	-	-	-	7%		
	Volcanic glass	42%	55%	44%	50%	47%	50%
Heavy fraction	Limonite	12%	25%	56%	3%	30%	25%
	Magnetite	15%	40%	20%	50%	50%	45%
	Hematite	7%	2%	4%	1%	1%	3%
	Actinolite	5%	7%	1%	5%		3%
	Tremolite	2%	1%	0,5%	2%		1%
	Augite	3%	5%	2%	3%	0,5%	3%
	Ti- Augite	3%	1%	0,5%	2%	0,5%	
	Diopside	26%	8%	3%	16%	0.5%	5%
	Zircon	3%	2%	1%	2%	3%	2%
	Garnet	3%	-	0,5%	-		0.5%
	Hypersthene	3%	-	2%	-		
	Epidote	3%	4%	-	2%		1%
	Coisite	5%	2%	6%	2%		6%
	Hornblende	-	2%	0,5%	4%	0.5%	2%
	Bas. hornblende	-	-	-	2%	0,5%	1%
	Picotite	2%	1%	3%	2%	2%	1%
	Sphen					1.5%	
	Barite	6%	-	-	-	5,5%	
	Celestine	2%	-	-	-	4%	
	Biotite				2%		1%
	Chlorite	-	-	-	2%	0.5%	0,5%
	Yield of heavy fraction	0,4%	0,3%	0,45%	0,2%	0,2%	0,3%

Table 2

Major elements of magmatic rocks from Khosrov diatreme

Samples	Vitro- crystallo-lithoclastic tuffs									dyke
N	19-00	19-00A	Kh20/1	Kh20/2	Kh20/3	Kh20/4	Kh20/5	Kh20/6	Kh20/7	19-A
Location	39.952194 44.888944	39.952098 44.889739	39.952076 44.889992	39.952267 44.88963	39.952208 44.888963	39.952226 44.888873	39.952386 44.888418	39.952196 44.888217	39.952018 44.887769	39.952446 44.889061
SiO_2	59.62	60.74	64.06	56.35	63.35	62.18	62.12	63.64	55.56	62.2
Al_2O_3	14.12	14.74	12.92	12.57	14.26	14.80	15.71	14.64	14.82	19.98
Fe_2O_3	4.05	2.94	4.03	5.45	4.85	2.79	2.84	2.55	2.59	3.36
FeO	1.4	1.68	1.96	1.40	1.40	3.08	1.68	1.50	1.82	1.12
MnO	0.04	0.04	0.06	0.06	0.05	0.06	0.10	0.05	0.05	0.04
MgO	4.48	3.96	3.66	4.04	3.36	3.48	3.76	3.28	5.26	0.37
CaO	4.27	4.76	3.92	7.98	3.22	3.70	3.39	4.86	6.68	1.89
Na_2O	2	2.1	2.20	2.00	2.80	2.30	2.30	2.30	1.60	4.3
K_2O	1.7	1.8	1.30	1.40	1.30	1.60	1.60	1.20	1.20	3.1
TiO_2	0.49	0.51	0.50	0.53	0.49	0.57	0.67	0.65	0.70	0.23
P_2O_5	0.2	0.21	0.092	0.115	0.092	0.115	0.26	0.25	0.23	0.18
H_2O	2.15	1.77	0.41	0.60	0.80	0.86	0.51	0.41	2.34	0.71
LOI	2.76	3.95	2.97	2.80	2.78	2.66	2.27	1.52	1.36	1.83
CO_2	2.81	0.88	2.07	5.06	1.67	2.16	2.81	3.16	5.80	0.78
Σ	100.09	100.08	100.15	100.34	100.42	100.36	100.02	100.01	100.01	100.09
Na_2O+K_2O	3.70	3.90	3.50	3.40	4.10	3.90	3.90	3.50	2.80	7.40

Bulk rock major element geochemistry

Major element data of selected rocks from Khosrov diatreme are listed in tab.2. Bulk-rock major element compositions are characterized by intermediate composition SiO_2 (55.56-64.06 wt.%), Al_2O_3 (12.57-14.82wt.%), MgO (3.28-5.26wt.%), TiO_2 (0.49-0.70wt.%), and variable alkalis (Na_2O+K_2O) contents of 2.80-4.1 wt.% for Khosrov vitro-crystallo-lithoclastic tuffs (tab.2). Na_2O contents of samples are higher than K_2O contents.

The chemical composition of the dyke differs from the surrounding rocks by a higher content of Al_2O_3 -19,98% and Na_2O+K_2O -7,40% , lower MgO-0.37.

According to the geochemical classification of Le Bas et al. (1986), most of the samples fall on the fields of basaltic andesite, andesite and dacite, dyke in trachy-andesitic field (fig.3). The SiO_2 vs. K_2O diagram presents that the most of the analysed rocks fall on the Medium-potassic and dyke in the High-potassic fields (fig.3,b).

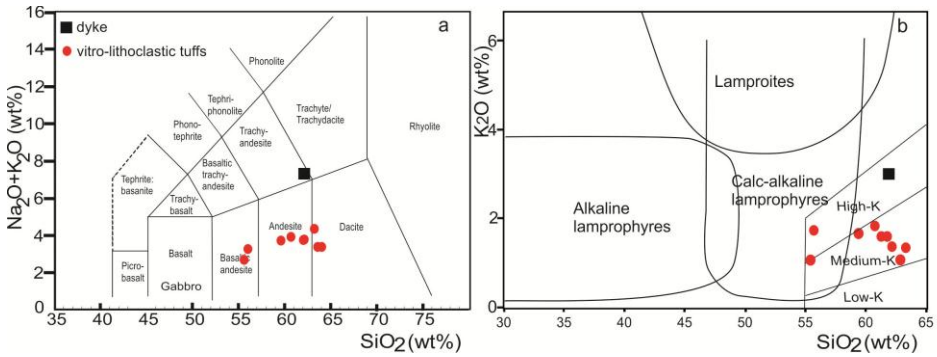

Fig.3. (a) Total alkali content (Na_2O + K_2O) vs. SiO_2 classification plot for vitro- crystallo-lithoclastic deposits and dyke (LeBas et al., 1986) and (b) K_2O vs SiO2 diagram (Peccerillo & Taylor, 1976) from diatreme Khosrov.

Discussion and Conclusion

New diatreme (Khosrov) was discovered in an ophiolitic mélange of southern part of Armenia, which is easily distinctive from the surrounding deposits by their colour and oval shape structure. Based on the petrography, mineral paragenesis and major element compositions the rocks from Khosrov diatremes are classified as vitro-crystallo-lithoclastic tuff probably formed by an early magmatic explosive phase. Diatreme composed also high potassium trachyandesite dyke (fig.2,19-A; tab.2), which is the last, or almost the last, preserved phases of the magmatism.

The material of diatreme is ocherous green crumbly vitro- crystallo-lithoclastic rocks which contain 50–55% fragments of volcanic glass, phenocrystes of hornblende, pyroxenes (mostly diopside) and biotite. The accessories observed are: Fe-Ti oxides (opaque), relicts of olivine, sphene, barite, celestine, zircon, garnet and picotite. Yield of heavy fraction is about 0,2-0,45%. Diagnostic features related to mineralogy (biotite and/or amphibole together with clino- pyroxene set in a groundmass which consist of plagioclase, carbonate, Fe-Ti oxides and glass) is typical of those reported from alkaline lamprophyres (Rock et al., 1991). Geochemical behaviour of studied rocks show an enrichment in SiO_2, Al_2O_3, Na_2O, K_2O and an moderate impo-verishment in MgO and CaO. SiO_2 contents of the rocks from Khosrove diatreme are higher to classify them as lamprophyres. Low LOI (Loss on Ignition) values 1.36-3.95wt.% most probably are related to secondary alteration of these rocks (tab.1), resulting in low volatile content.

Acknowledgement: This research was supported by the basic foundation of the Armenian government.

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ԽՈՍՐՈՎԻ ԱՐԳԵԼՈՑՈՒՄ ՀԱՅՏՆԱԲԵՐՎԱԾ ՆՈՐ ԴԻԱՏՐԵՄԱՆ (ՀԱՅԱՍՏԱՆ)

Սահակյան Լ., Ստեփանյան Ժ., Ավագյան Ա., Սահակով Ա., Հայրապետյան Ա.

Ամփոփում

Հայաստանի կենտրոնական հատվածում՝ Խոսրովի արգելոցում (Խոսրով գետի ավազան) մենք հայտնաբերել ենք նոր դիատրեմա, որն ունի օվալաձև տեսք՝ արևմուտքից արևելք 150 մ երկարություն և 50 մ լայնություն հյուսիսից հարավ: Ըստ միներալային կազմի, պետրոգրաֆիայի և հիմնական տարրերի քիմիական կազմի Խոսրովի դիատրեմայի հիմնական ապարներր ներկայացված են վիտրո-բյուրեղա-լիթոկլաստիկ տուֆերով: Տուֆերը կազմված են հիմնականում

հրաբխային ապակուց և պարունակում են դիոպսիդ, ավգիտ, տիտան–ավգիտ, աքցեսոր (նռնաքար, ցիրկոն, պիկոտիտ, սֆեն) և այլ միներալներ: Մոտ 2 մ երկարությամբ տրախիանդեզիտային դայկան կտրում է վիտրո-բյուրեղա-լիթոկլաստիկ տուֆերը՝ դիատրեմի հյուսիսային մասում:

ОБНАРУЖЕНИЕ НОВОЙ ДИАТРЕМЫ В ХОСРОВСКОМ ЗАПОВЕДНИКЕ (АРМЕНИЯ)

Саакян Л., Степанян Ж., Авагян А., Сааков А., Айрапетян А.

Резюме

В Хосровском заповеднике, расположенном в центральной части Армении (бассейн реки Хосров), нами обнаружена новая диатрема, имеющая овальную форму. Длина ее 150 м с запада на восток при ширине 50 м с севера на юг. Судя по минеральному составу, петрографии и химическому составу главных элементов, основными породами Хосровской диатремы являются витро-кристалло-литокластические туфы. Туфы сложены в основном вулканическим стеклом и содержат диопсид, авгит, Ti-авгит, акцессорные (гранат, циркон, пикотит, сфен) и другие минералы. Трахиандезитовая дайка протяженностью около 2 м прорывает витро-кристалло-литокластические туфы в северной части диатремы.