International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2017 Vol. 7 (3) September-December, pp. 12-19/ Feruza
Research Article

TYPIFICATION OF DYKES LOCATED IN THE ALMALYK-ANGREN MINING AREA (MIDDLE TIEN SHAN)

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ABSTRACT

The article examines the state of investigations of the dykes located in the Angren-Almalyk mining area. Geological, petrographic and petrochemical data on associations of dykes located in such regions as Kyzylalmasay, Kochbulak and Naugarzansay mining fields are presented.

***Keywords**: Dykes, Petrographic- Petrochemical Features, Magmatism, Ore Deposits, Lamprophyre*

INTRODUCTION

Among the numerous works devoted to the magmatism and mineralization in Uzbekistan, not so many attentions are paid to dykes. The investigations targeted at finding interrelations between the dyke belts, concentrations of metals and deep structure of the lithosphere are currently the most topical. Exploring the dykes and xenoliths enclosed, one can get substantial evidence of the time and place of origin of the initial melts of different composition; sources and geological concentration of the ore material in large minefields, composition, the structure of different levels of the upper mantle, the lower and upper crust.

Since the 50-ies in the former USSR, including Uzbekistan, few researchers are concerned about the problem of small intrusions, dykes, dyke fields and belts. Study of dyke formations contributed to the solution of a number of key issues in geology, petrology and ore formation in Central Asia and other regions (Abdullaev,1957; Dalimov,1993; Tadjibaev,1996; Ahundzhanov et al, 2012; Ahundzhanov et al, 2014).

MATERIALS AND METHODS

Almalyk-Angren region is the leading mining area of Uzbekistan, characterized by a wide range of magmatism products, which are associated with numerous deposits and mineralization of various minerals. Important role among them is given to the gold deposits localized in the volcanic rocks. The association of gold and silver ore to the bodies and breccias automagmatic lamprophyre dykes, associated with syenite-porphyry and ongorhiolite were found in the fields Kyzylalma, Kochbulak, Samarchuk, Chumauk, Kayragach, etc. Dykes association with intrusions of gabbro, diorite, granodiorite, granite, and their sub-alkaline varieties and with the volcanics of calc-alkaline, subalkalic and alkaline series, indicate possible diversity of the genetic types of the dykes. Such genetic diversity can be observed in gold-silver, silver-polymetallic, tin, uranium, fluorite and other deposits of the Angren-Almalyk mining area. For the northern slopes of the Kurama mountains (left bank of the river Angren), Early Permian dykes complex are distinguished, comprising four phases of magma products intrusion: 1) syenodiorite porphyries; 2) adamellite-, granodiorite-, granosyenite - porphyries; 3) granite-porphyries; 4) microgranitic porphyries (Matchanov,1983). In dykes, zoning is noted, expressed in the change in the composition of rocks from the subsilicic ones - in endocontacts, to acidic - in the central parts. The author notes a paragenetic connection with the early features of the complex of copper-molybdenum-gold ore and skarn lead-zinc and tungsten mineralization. It seems that the magmatic focus of this dyke complex was deep (18-30 km). According to intratelluric phenocrysts, magma crystallization temperature is determined in range between 800-1200°C. Study of dyke formations in eastern part of the southern slope of the Kurama mountain (Chadak ore field) had significant contribution, which was expressed in the establishment of the youngest Permian-Triassic dyke systems for the region (Dalimov,1993). Additionally, the study was focused on olivine dolerite, trachydolerites, and a variety of syenoids and rhiolitoids. For the first time in the area dykes of mugearites were determined, which are characterized by presence of acid plagioclase, anorthoclase and normatic feldspathoid under the condition of the main composition of the rock.

Complex dykes are presented as two trinomial structures and consisting in the marginal parts of dolerite, intermediate - microsyenite and central parts - leucogranites. Certain types of rocks of the aforementioned dykes were formed in the same sequence (Dalimov, 1993). Covering the diversity of small intrusions and dykes of the southern slope of the Kurama are systematized information on geology, petrography, petrochemistry and ore mineralization of Karamazar's small intrusions (Tadjibaev,1996). Plutonogenic and volcanogenic facies are distinguished, and the age distribution of dyke formations is compiled. As dyke researchers recommend, lamprophyre rocks can be considered as an independent "lamprophyre" phase of magmatism and "... not only specific associations of intrusive rocks should be taken into account, but the entire series of dyke rocks of the corresponding phase with which most types of lamprophyre rocks are associated with gradual transitions" (Borodin et al, 1976). We used geological observations on the conditions of occurrences, investigated the relationship of rocks, perform mass spectrometric analysis, petrographic and petrochemical data for most of the analyzed samples of Kyzylalmasay ore field.

RESULTS AND DISCUSSION

Taking into account these recommendations, we united the dykes of Kyzylalmasay ore field into the following age groups: 1) trachydolerites lamprophyres and mica; 2) syenodiorite porphyry, syenite porphyry, quartz syenite-porphyry, granosyenite-porphyry and trachyte; 3) quartz porphyry, spherulitic porphyry, and felsite ongorhiolite. These later dykes are widespread in Chatkal-Kurama region and presented as the products of intraplate magmatism (Ahundzhanov et al, 2009, 2014). In the taxonomy of Kh.M.Abdullaev they belong to the class hypomagmatic, genetic type of plutonic dykes and exist independently of other intrusive bodies, related to the deep sources and controlled by a relatively deep location faults (Abdullaev, 1957). In the gold-silver deposits of Angren-Almalyk mining area the most common types of dykes are ‘simple’ and ‘complex’, represented by: 1) kersantites, trachydolerites; 2) syenite porphyry, sodium trachytes; 3) felsites, ongorhiolite and rare-metal leucogranites (Ahundzhanov et al, 2014).

For the first time the association of dykes trahidolerit - syenite-porphyry - ongorhiolite was distinguished in rare-metal deposit Shavazsay (Ahundzhanov et al., 2009). Further investigation revealed the presence of this association in other fields of Chatkal-Kurama region. These types of dyke rocks are established predominantly in the area Central (Kyzylalmasay field) in the process of the study of drill cores (Karimova and Zenkova, 2015a). Considered dyke formations have distinct tearing contact with shales, diorites, alaskite granites. Most often, all three groups of rock dykes occur among syenodiorite porphyry - the most developed intrusive rocks are closely associated with ore bodies in Kyzylalmasay field. Here we have established lamprophyre-kersantite dykes that have distinct contacts with their host syenodiorite porphyries.

In the contact zone, both types of rocks have been altered, which is expressed in the chloritization of femic minerals, mainly hornblende and biotite. These rocks are closely associated with syenite-porphyry and felsite. Table 1 shows the chemical and physical composition of the dyke formations of Kyzylalmasay ore field, which were taken and examined by us in 2013-2015.

Kersantites are black, dense, massive, have a porphyritic texture. Macro-impregnations are combined by elongated (up 0,4x10 mm) and isometric (5 mm) buildups of pyroxene, hornblende and prevailing over them biotite and plagioclase. Micro-impregnations are represented by the same minerals and well-faceted single crystals of leucite and decomposed hexahedrons of olivine. The main mass of the rock is microgranular, prismatically granular, intercellular. Formed by the diopside, glandular augite, hornblende, mostly titaniferous biotite, phlogopite rare lamellar crystals and plagioclase (labrador, andesite, oligoclase) and barium-containing orthoclase. From the ore minerals are developed the titanomagnetite, pyrite, calcite and apatite.

The syenite-porphyries are meat-red in color of porphyry structure, dense, massive. Porphyritic buildups are presented by barium orthoclase, albite, chlorite spots. The bulk consists of the same minerals and contains grains of chromite, barite and calcite containing REE. The bulk of prismatic crystals of albite, orthoclase, quartz create its basis.

Felsites, quartz porphyry, spherulitic porphyres are dense, massive rocks of light gray and light pink color. In the main bulk of quartz-feldspar is composed of biotite, muscovite, pseudoleucites, apatite, epidote, calcite, barite, hematite and chromite were established on microzond analyzer.

In the lower reaches of the river Shavazsay on the right side, there are dykes presented as camptonites (Karimova et al, 2015b). They can be found among adamellites of Karabash-Shavaz intrusion, which is Early Permian subalkalic gabbro-monzodiorite-adamellite association. Dykes in the north-west-trending (220 °), a steep fall of contacts (70 °), thickness is 140 cm. They can be traced for 200 m, have small apophyses with thickness of up to 10 cm. Analysis by the researchers of intrusions in the Angren right bank showed that lamprophyre dykes in the Shavazsay river basin were not previously characterized petrographically, petrochemically geochemically, and in terms of their potential ore content. The dyke of camptonites demonstrate similarity with monzogabbro Karabash-Shavaz intrusion by higher aluminum content and alkalinity. These petrochemical features unite them with lamprophyres, described for the Karabau basin. This is probably a local feature of lamprophyre magmatism inherent to the southwestern spurs of the Chatkal Range.

Odinite dykes are established by us in south-western spurs of Chatkal ridge in Kurtash prospective area. They have a thickness of 6-8 m, and extend in a direction in parallel to the contact of sublatitudinal Kurtash pyroxenite body. They have sharp contacts with host rocks. Odinite dykes are dark gray, dense, massive, porphyritic in buildups, which is expressed macroscopically by presence of plagioclase, pyroxene, fine-grained biotite clusters. Geochemical specialization of these lamprophyres were defined as Cu, Pb, Zn, Cd, W, Sn, Mo, Re, Au, Ag, As, Bi, Se, Te, Sb, Sc and rare earth elements (Table 1).

The most studied objects of Almalyk-Angren mining area are Kochbulak and Naugarzan ore fields, located on the left side of river Angren. In these ore fields are developed volcanic rocks, presented by andesites, andesite-dacytes, dacite and subalkalic species. Cover facies have a thickness up to 2.5 km. They are cut by dykes of submeridional, sublatitudinal and north-east directions, combined by diabase (trachydolerites) granodiorit-, granosyenite, granite, felzit-, quartz porphyry and extrusive breccias (Table 2, 3).

The latter in the individual bodies are replaced by ore-magmatic breccias, which are interpreted as the result of hidden explosions. Kochbulak deposit belongs to gold-sulphide-quartz with telluride formation. The richest are brecciated tubular bodies, as well as some areas of steeply dipping veins and flat deposits. The vertical scale of the mineralization is 1500 m.

Geological observations on the conditions of occurrence, the relationship of rocks, definitions of absolute age, petrographic and petrochemical data for most of the analyzed samples show the evolution of magmatism in Naugarzansay ore field from the calc-alkaline to subalkaline type (Table 3).

During recent years researchers of Kochbulak ore field are studying plutonic dykes of trachydolerites and syenites, and found that trachyte is closely associated with gold-silver mineralization. Based on the foregoing, we believe that the epithermal gold-silver mineralization of Kochbulak and Naugarzansay ore fields are associated with magmatogene-fluidized-explosive rocks (fluidolites) (Petrographic Code, 2009).

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Research Article

Table 1: The chemical composition of dyke formations of Kyzylalmasay ore field

Component / Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SiO_2	66.32	56.85	60.22	51.38	53.5	55.9	63.4	69.8	64.5	71.57	70.9	56.4	62.2	59.7	61.93	64.5	76.4	71.6	71.1	65.20
TiO_2	0.52	0.85	0.89	1.14	1.1	0.89	0.67	0.67	1.12	0.67	0.52	0.74	0.70	0.74	0.55	0.45	0.38	0.28	0.65	0.75
Al_2O_3	11.91	13.99	12.47	18.33	17.	14.9	13.0	10.6	11.3	8.51	9.64	16.6	15.3	16.6	16.26	15.3	5.86	14.2	11.3	16.63
FeO_*	6.29	9.15	9.29	8.58	8.3	9.30	6.72	5.72	6.72	4.58	4.58	6.72	5.44	8.30	6.15	4.15	3.00	2.86	4.29	5.01
MnO	0.10	0.14	0.13	0.2	0.2	0.2	0.13	0.11	0.12	0.13	0.12	0.16	0.10	0.1	0.12	0.12	0.09	0.21	0.13	0.19
MgO	2.99	4.32	3.32	5.15	5.1	3.82	3.98	2.82	2.49	1.44	2.82	4.32	1.83	1.48	2.33	1.83	1.43	1.83	1.66	2.33
CaO	4.90	6.30	6.02	6.86	6.6	8.68	4.06	1.82	3.08	3.64	3.36	5.46	3.78	2.80	3.64	4.76	0.95	2.66	3.22	2.38
Na_2O	2.03	4.05	4.18	3.78	3.6	3.38	2.43	3.78	7.73	3.78	2.84	2.43	4.05	4.19	2.57	3.24	5.27	1.08	2.57	2.97
K_2O	4.22	3.86	3.01	4.10	3.8	2.29	4.82	4.34	2.41	5.06	4.82	3.74	6.03	5.91	5.91	5.30	6.27	5.18	4.70	4.22
P_2O_5	0.435	0.252	0.252	0.229	0.2	0.30	0.46	0.16	0.50	0.39	0.19	0.21	0.25	0.27	0.195	0.18	0.11	0.10	0.16	0.183
Elements Impurities	-	0.234	0.218	0.233	0.22	0.29	0.335	0.198	0.257	0.225	0.225	0.158	0.322	0.235	0.345	0.182	0.178	0.119	0.130	0.123
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Na_2O+K_2O	6.25	7.91	7.19	7.88	7.51	5.67	7.25	8.12	10.14	8.84	7.66	6.17	10.08	10.1	8.48	8.54	11.54	6.26	7.27	7.19
Na_2O/K_2O	0.48	1.05	1.39	0.92	0.95	1.48	0.50	0.87	3.21	0.75	0.59	0.65	0.67	0.71	0.43	0.61	0.84	0.21	0.55	0.70
al'	6.25	1.04	0.99	1.34	1.27	1.14	1.22	1.24	1.23	1.41	1.30	1.51	2.11	1.70	1.92	2.56	1.32	3.02	1.91	2.27
f'	9.80	14.32	13.50	14.87	14.53	14.01	11.37	9.21	10.33	6.69	7.92	11.78	7.97	10.52	9.03	6.43	4.81	4.97	6.60	8.09
Kф	67.78	67.93	73.68	62.49	61.68	70.88	62.80	66.98	72.96	76.08	61.89	60.87	74.83	84.87	72.52	69.40	67.72	60.98	72.10	68.26
Ka	0.52	0.57	0.58	0.43	0.44	0.38	0.56	0.77	0.89	1.04	0.79	0.37	0.66	0.61	0.52	0.56	1.97	0.44	0.64	0.43

Mineral	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Quartz	26.9	3.83	11.97	-	-	8.87	18.9	25.6	8.74	28.94	28.7	10.9	7.88	5.98	13.95	15.3	43.7	37.3	31.3	23.71
Plagioclase	28.1	42.86	41.74	49.3	49.5	47.0	31.0	30.3	44.9	15.60	22.7	44.0	40.0	44.6	37.12	39.0	-	21.7	27.3	35.76
Orthoclase	24.9	22.81	17.79	24.2	22.8	13.5	28.5	25.6	14.2	29.90	28.5	22.1	65.6	34.9	34.93	31.3	32.0	30.6	27.8	24.94
Nepheline	-	-	-	1.95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corundum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	-	3.28
Diopside	6.80	14.05	14.61	5.94	6.8	14.9	3.41	4.41	6.30	7.74	10.6	-	6.91	0.33	-	7.23	2.07	-	5.51	-
Hypersthen	4.29	4.25	1.50	-	6.5	2.58	8.33	4.98	3.28	-	2.11	10.7	1.36	3.53	5.8	1.2	2.60	4.56	1.58	5.8
Wollastonit	-	-	-	-	-	-	-	-	-	1.36	-	-	-	-	-	-	-	-	-	-
Olivin(e)	-	-	-	7.06	2.2		-		-		-	-	-	-	-	-	-			
Akmite	-	-	-	-	-	-	-	1.48	18.1	13.25	1.13	-	-	-	-	-	8.68	-	-	-
K_2SiOs	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4			
Na_2SiO_3	-	-	-	-	-	-		-	-	0.31	-	-	-	-	-	-	8.09	-	-	-
Rutile	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	0.15	-	-	0.28	-	0.75
Hematite	6.29	9.15	9.3	8.58	8.3	9.30	6.72	5.21	0.48	-	4.19	6.72	5.44	8.30	6.15	4.15	-	-	4.29	5.01
Apatite	1.01	0.58	0.58	0.53	0.5	0.69	1.06	0.37	1.17	0.90	0.45	0.49	0.58	0.64	0.46	0.42	0.26	0.23	0.39	0.42
Perovskite	-	-	-	1.94	-	-			-	-	-	-	-	-	-	-	-	-	-	-
Grothite	1.27	2.09	2.17	-	2.7	2.18	1.64	1.64	2.75	1.64	1.27	1.61	1.72	1.80	0.97	1.1	0.94	-	1.6	-
Total	99.6	99.63	99.65	99.5	99.4	99.5	99.5	99.7	99.9	99.64	99.7	96.7	99.6	100.	99.54	99.7	99.7	99.7	99.7	99.67

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An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2017 Vol. 7 (3) September-December, pp. 12-19/ Feruza
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Table 2: The chemical composition of rock dykes Kochbulak ore field

Component / coefficient	Dolerite (FB-133-13)	Dolerite (FB-138-13)	Syenite – porphyry (FB-66)
SiO_2	58.23	55.28	68.61
TiO_2	2.67	2.34	0.45
Al_2O_3	11.15	13.42	10.02
Fe_2O_3+ FeO	12.73	12.58	4.29
MnO	0.23	0.18	0.13
MgO	1.99	3.65	1.83
CaO	7.84	7.84	3.92
Na_2O	2.30	2.56	3.11
K_2O	1.81	1.21	7.11
P_2O_5	0.78	0.66	0.19
Total	99.73	99.72	99.66
Petrochemical coefficients			
al´	0.76	0.83	1.64
F	17.39	18.57	6.57
Cf	86.48	77.51	70.10
Na_2O+K_2O	4.11	3.77	10.22
Na_2O/ K_2O	1.27	2.12	0.44
K_2O/ TiO_2	0.68	0.52	15.80
Normative composition according to CIPW			
Quartz	24.47	18.19	20.03
Plagioclase	34.22	43.21	11.95
Orthoclase	10.70	7.15	42.02
Diopside	7.59	3.80	9.83
Hypersthene	1.44	7.33	-
Wollastonite	-	-	1.67
Acmite	-	-	12.41
Na2SiO3	-	-	0.06
Hematite	12.73	12.58	-
Apatite	1.81	1.53	0.44
Grothite	6.55	5.74	1.10
Total	99.50	99.54	99.53

Table 3: The chemical composition of magmatic formations Naugarzansay ore field

Component / coefficients	1	2	3	4	5	6	7	8	9	10
Number of analyses	22	16	7	8	19	33	5	5	10	5
SiO2	61.15	65.13	72.3	61.16	67.27	72.87	53.64	58.87	66.4	44.01
TiO2	0.58	0.48	0.23	0.44	0.37	0.22	0.73	0.48	0.38	1.52
AI2O3	16.01	14.7	13.37	15.17	14.84	13.61	16.89	14.59	14.05	16.37
Fe2O3	3.07	2.65	1.74	2.38	1.75	1.08	4.18	2.35	1.62	2.45
FeO	2.64	2.47	1.26	4.68	2.35	1.48	3.67	2.88	2.78	8.6
MnO	0.13	0.22	0.05	0.5	0.14	0.06	0.25	0.31	0.48	0.3
MgO	2.41	1.39	0.67	1.74	1.42	0.92	4.25	1.94	0.38	9.41
CaO	3.74	3.65	1.29	3.6	2.26	1.07	6.37	5.16	2.07	7.28
NaO2	2.33	1.14	2.71	0.84	2.05	2.68	1.98	2.56	2.75	1.97
K2O	3.86	3.81	4.66	4.01	4.29	4.67	3.51	4.94	5.64	1.25

H2O	0.23	0.29	0.09	0.21	0.21	0.08	0.18	0.16	0.15	-
Ppp	2.2	3.49	0.59	1.75	1.75	1.1	2.69	1.95	0.85	-
P2O5	0.16	0.12	0.04	0.17	0.1	0.1	0.25	0.13	0.05	0.23
CO2	1.51	1.55	1.24	1.47	1.1	0.41	1.65	3.75	2.6	6.5
SO3	0.13	0.48	0.1	1.07	0.25	0.15	0.64	0.58	0.37	
Total	100.15	101.57	100.34	99.19	100.15	100.5	100.88	100.65	100.57	99.89
Petrochemical coefficients										
al'	1.97	2.26	3.64	1.72	2.69	3.91	1.40	2.03	2.94	0.80
f'	8.70	6.99	3.90	9.24	5.89	3.70	12.83	7.65	5.16	21.98
Cf	70.32	78.65		80.23	74.28	73.56	64.88	72.94	92.05	54.01
NaO2+ K2O	6.19	4.95	7.37	4.85	6.34	7.35	5.49	7.50	8.39	3.22
NaO2/ K2O	0.60	0.30	0.58	0.21	0.48	0.57	0.56	0.52	0.49	1.58
Fe2O3/FeO	1.16	1.07	1.38	0.51	0.74	0.73	1.14	0.82	0.58	0.28
Ka	0.39	0.34	0.55	0.32	0.43	0.54	0.33	0.51	0.60	0.20
Normative composition (on										
Quartz	25.76	40.05	40.13	37.24	35.35	37.16	15.85	23.18	36.90	17.00
Plagioclases	26.83	14.03	19.07	7.55	19.31	23.76	32.10	18.91	8.61	4.46
Orthoclase	22.81	22.52	27.54	23.70	25.35	27.60	20.74	29.19	33.33	7.39
Corundum	5.25	6.55	4.62	8.08	5.82	3.58	3.49	5.39	6.27	14.15
Hypersthene	7.36	5.02	2.17	10.23	5.80	3.75	12.67	7.39	4.09	34.70
Ilmenite	1.10	0.91	0.44	0.84	0.70	0.42	1.39	0.91	0.72	2.89
Magnetite	4.45	3.84	2.52	3.45	2.54	1.57	6.06	3.41	2.35	3.55
Apatite	0.37	0.28	0.09	0.39	0.23	0.23	0.58	0.30	0.12	0.53
Na2S04	0.23	0.85	0.18	1.90	0.44	0.27	1.14	1.03	0.66	-
Calcite	3.43	3.53	2.21	3.34	2.50	0.93	3.75	8.53	3.58	12.45
Na2C03	-	-	-	-	-	-	-	-	2.47	2.47
Total	97.59	97.57	99.61	96.73	98.05	99.26	97.76	98.23	99.09	99.59

CONCLUSION

According to the mass spectrometric data obtained by the author and his colleagues, dykes includes in their composition elements, that have excess clarks in their content in all types of rocks. These elements are Ba, V, W, Mo, Re, Zr, Yb, Ag, Au, Cd, As, Se, Te, Sb, Bi, Pd, and U. The majority of them are indicative of an ore- forming and gold-arsenic, tellurium-gold gold, silver and other formations of the Chatkal-Kurama region, as well as gold-pyrite, gold-polysulfide and gold-tellurium mineral types present in the Kyzylalmasay ore field. Elements such as Au, Ag, As, Se, Te, Bi, Sb, W, Mo are part of typomorphic productive association. Dykes data allow predict the presence of such elements as Re, Zr, Yb, Cd, U and platinum in the ore. Taking into account that selenium is a typical element of the underlying peridotite and basalt magmas, and its recognition as a geochemical indicator of processes of deep magmatism, and exceeding clark content in rocks of all types of dykes - gold, silver and indicator metalloid and metallogeny elements, we tend to recognize essential role of lamprophyre magmatism in the formation of gold-silver mineralization. This proves the formation of dykes of magma saturated with fluids and ore components, which is typical for gold-silver deposits in the region.

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