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# PETROGRAPHY OF KERSANTITE DIKES OF THE YANGI UMID DEPOSIT (SOUTH TIEN SHAN)

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**Abstract**
Object of study. Yangi Umid deposit of the Karakutan ore field is interesting because lamprophyre dikes (kersantites, spessartites) participate within mineralized zones, which are characterized by more basic composition, presence of olivine, pyroxene, chromite, nickel and cobalt sulfoarsenides and others in the composition besides the main (plagioclase and biotite). Methods. Determination of content of petrogenic and rare elements in rocks was carried out by ICP MS methods on ICPE-9000 spectrometer in the Central Laboratory of Mingeology of RUz. Description and micrographs of transparent and polished grinds were made on Nikon Optiphot 2 Pol and Polam P-311 microscopes. As a result of the study, olivine kersantites are characterized by low silicic acidity and alkalinity due to the presence of olivine, pyroxene, amphibole and basic plagioclase. These rocks have a high content of gold (from 0.05 to 0.20 g/t), nickel, uranium, silver, arsenic and selenium. The geochemical features of the dike rocks are expressed in the significant presence of siderophile element-impurities - chromium, nickel, cobalt and high Ni/Co values (4.60 g/t). La/Ta (40.31) and La/Yb (16.72) relations in olivine kersantites are typical for post-orogenic continental intraplate environments. The weak europium maximum, Ni/Co=>3 and olivine+plagioclase+amphibole+biotite paragenesis testify to the subcrustal origin of olivine kersantite magmas. Kersantites play a role in the formation of gold-silver-polymetallic mineralization.

## Introduction

Lamprophyres are one of the most complex specific formations of nature, associated with deep ultrabasic and basic magmas of the subalkaline and alkaline series. Lamprophyres are hypabissal porphyric melanocratic, rarely mesocratic rocks with a typical specific lamprophyric structure characterized by phenocrysts of mafic minerals, among which, along with the constantly present micas (biotite, phlogopite) and hornblende (usually rich in titanium), clinopyroxene (augite, titanium-augite) may be present, rarely olivine. The main mass contains the same minerals as in the phenocrysts: melilite, nepheline, analcite, leucite, olivine, and glass in the more alkaline ones. The formation of melted rounded, sometimes corroded phenocrysts of hornblende, plagioclase, mica and quartz phenocrysts is characteristic, which indicates their hybrid origin. Especially, phenocrysts of intratelluric phase of zonal plagioclase are typical for lamprophyres (malchite, spessartite and etc.) of Western Uzbekistan, which indicates closeness to intermediate dioritic porphyries, but some lamprophyres (kersantites, minettes and etc.) are characterized by phenocrysts of intratelluric olivine phase, pyroxene and more basic chemical composition, most likely they have a deep (mantle) origin. Accessory and ore-bearing minerals are magnetite, apatite, zircon, perovskite, orthite, sphene, pyrite, pyrrhotite, galenite and etc. As R.T. Mitchell pointed out [1], despite more than 100 years of studying lamprophyres, among petrologists, they remain one of the unclear and least understood families of magmatic rocks. Lamprophyres were usually treated as unimportant, unrelated to mineralization and were often rejected. Attempts to remedy this situation have studies [2-8] of "lamprophyres" as objects worthy of study.

Kersantite is a hypabyssal micaceous rock of normal series of the lamprophyre family, composed of phenocrysts of biotite (about 1/3 of the rock), usually with hornblende and augite, sometimes olivine in the bulk of the same minerals with plagioclase (oligoclase - andesine) and less frequently alkaline feldspar. Delesset gave a name (Delesset, 1850) kersanton (Kersanton village, France) for dyke rocks in the vicinity of Brest (Brittany). Varieties: augite, bronzite, quartz, olivine, hornblende kersantite.

Shoshonitic lamprophyres, represented by spessartites, kersantites, odinite and minette, often occur in gold ore occurrences and deposits in Western Uzbekistan. Directly with lamprophyres of different composition (in contacts of dikes) in ore fields are associated with gold, gold-silver-poly-rare-metal and skarn mineralization [9-13]. The aim of the study is to investigate the material composition and ore content of olivine kersantite-minettes of Yangi Umid deposit in Karakutan gold field.

## 2. METHODS AND MATERIALS

The study of the composition of rocks and minerals was carried out at the Institute of Geology and Geophysics named after H.M.Abdullaev. The content of petrogenic and rare elements in rocks was determined by ICP-MS methods on an ICPE-9000 spectrometer at the Central Laboratory of the State Committee for Geology of the Republic of Uzbekistan. Description and microphotographs of transparent and polished sections were made on Nikon Optiphot 2 Pol and Polam P-311 microscopes. Graphical editors and specialised petrological computer programmes were used in processing the materials.

Geological setting. The Karakutan ore field, composed of sedimentary-metamorphic deposits of the Katarmai Formation, widely developed in the northern part of the Zirabulak-Ziyaetdin Mountains (Figure 1). They are exposed in a discontinuous band from the Kutchi village area in the east to the Parda well in the west, traceable for more than 65 km. The Katarmai Formation was first identified by A.S.Adelung (1948) in the mountains of the same name. The formation is composed of metamorphic and sericitic-clay shales, metamorphosed graywackes and sandstones, with interlayers and lenses of limestones, dolomites, cherts, gravelites, conglomerates and volcanogenic rocks of predominantly basic and ultrabasic composition. The most characteristic sections are observed in the Katarmai mountains. Here, the rocks of the formation comprise the core part and the northern flank of the west-dipping anticline of latitudinal strike. The Katarmai Formation is represented by four subformations: subformation

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4, terrigenous - siltstones, sandstones, clay shales, mica-quartz, feldspar, chlorite, micaceous. Rare covers of spilites; subformation 3, volcanic-terrigenous – feldspathic, chloritic, micaceous, micaceous-quartz, carbonaceous-clayey shales, interlayers, lenses of dolomites, sandstones, tuffoaglomerates, covers of spilites; subformation 2, terrigenous-carbonate - micaceous-quartz shales, lenses and interlayers of limestone, dolomites; subformation 1, terrigenous-volcanogenic - tuffs, tuff-agglomerates of basalt and olivine-basalt composition, lenses and interlayers of marble, limestone, dolomites of micaceous-quartz shales.

Numerous dikes and small intrusions of granodiorite porphyries, quartz diorite porphyries, lamprophyries and biotite-hornblende tonalites are developed within the 4-subformation. The dikes form a belt traceable mainly in the northern part of the mountains (Fig. 2). The largest number of ultrabasic rocks (ophiolites, about 10 bodies) is developed in the area of the Kutchi village (north-east of the Zirabulak Mountains). In the Katarmay Mountains, ophiolites are found only in the southeast (three bodies) and in the northwest (one body). In the Kutchi region, these formations are represented by tabular and lenticular bodies with a thickness from the first meters to 40 m, with a length from the first tens to more than 650 m. Their boundaries with the host shales are more or less clear and are characterized by a completely consistent occurrence with the surrounding rocks. They are composed of chrysotile, antigorite and bastite-antigorite serpentinites. The apparent thickness of the Katarmai Formation is over 3,400 metres. The age of the formation is debatable, some researchers consider it to be Upper Proterozoic (Korsakov et al, 1993, etc), others consider it to be Є-D1 [14].

According to R.H. Mirkamalov and others [14], the Katarmai Formation (ophiolite complex Є-S) includes the volcanogenic Dzhilandy and carbonate Kyzbibi D1formations and the terrigenous V-S Bulyamush formation, the latter with a thickness of more than 950-980m (previously the third sub-formation of the Katarmai Formation), a continuous stratum of fine-grained metagraywacke, with interlayers (0.01-0.3 m) metasand, siltstones, siliceous phyllitic and clay shales and, less frequently, quartzites, gravelites, carbonate metagraywackes and tuffites.

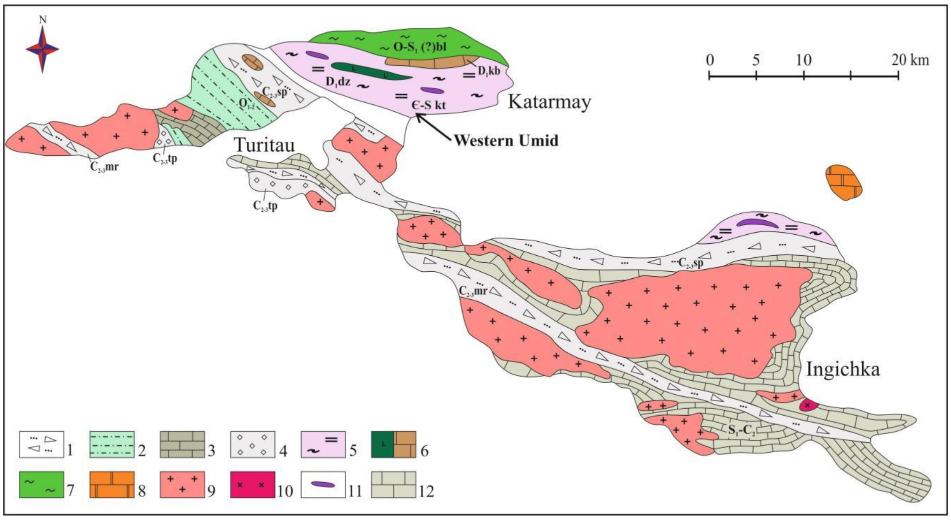


Fig.1. Geological and structural map of Paleozoic formations
Zirabulak-Ziyaetdin Mountains [14]

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1 – the Sappen mixtite complex, 2 – the O-S1 terrigenous formation (Altyaul, Yarmanchi formations), 3 – carbonate sediments (S1-D3) and volcanogenic formations C1-2 (Tym and Kattasai) complexes, 4 – the Tepalik flish-olistostrom formation, 5 – the Katarmai formation (ophiolite complex E-S), 6 – volcanogenic Dzhilandy and carbonate Kyzbibinsky formations D1, 7 – Bulyamush formation, 8 – Rabinjan formation D1-3, 9 – Karatyube-Zirabulak intrusive complex C3-P1, 10 – Ketmenchi intrusive complex P1, 11 – serpentinite bodies, 12 – carbonate deposits of the Kyzylkum-Alai group of covers.

The carbonate rocks of the Kyzbibi formation (D1-2) are multi-scale tectonic bodies ranging in size from a few metres to 300 metres in thickness and up to 6 km in extent. Intermittently, they are drawn across almost the entire ore field. Bodies of carbonate rocks are traced along the shale as ‘layers’, sometimes rounded, ellipsoidal, irregularly shaped blocks with clearly visible stippling in the shale are noted. Numerous organic remains collected in the carbonate rocks define the age of the formation as Early to Middle Devonian.

The Dzhilandy formation is developed in the central part of the Katarmai Mountains, where the Dzhilandy formation’s volcanites are concentrated within two relatively narrow strips of sublatitudinal strike. The streaks are 24 km long and vary in width from a few to 400 m. The formation consists of alternating psammite, lappilite, agglomerate and clastic tuffs of the basic composition, which consist of rounded or lenticular-angular fragments of basalts, ankaramites, amphibolites, gneisses and other rocks, cemented by chloritic groundmass. Occasionally, lavas of amygdalic basalts occur among the tuffs. The thickness is 120-140 m. There are several vents made by volcanoclastic breccia, and subvolcanic bodies of diabases. By composition, volcanites belong to the ankaramite-trachybasalt formation.

The subvolcanic facies of the complex, represented by diabases, dolerites and amphibolized diabases, composes a large lenticular body along the southern band of volcanites in the west of this band and small dike-like bodies south of the Kyzbibi ridge, in the upper reaches of the Dzhilandysai in the area of the Kapkakly and Karakutan deposits [14].

The “Yangi Umid” deposit is located on the border of the second and third sub-formations of the Katarmai formation (Fig.2).

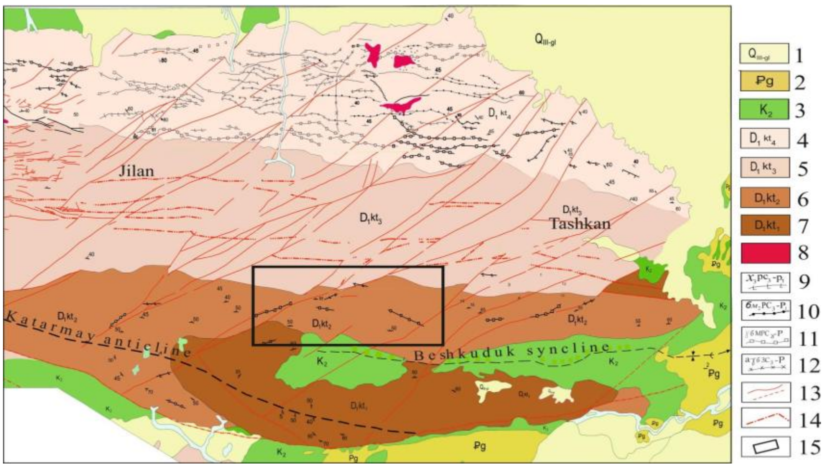
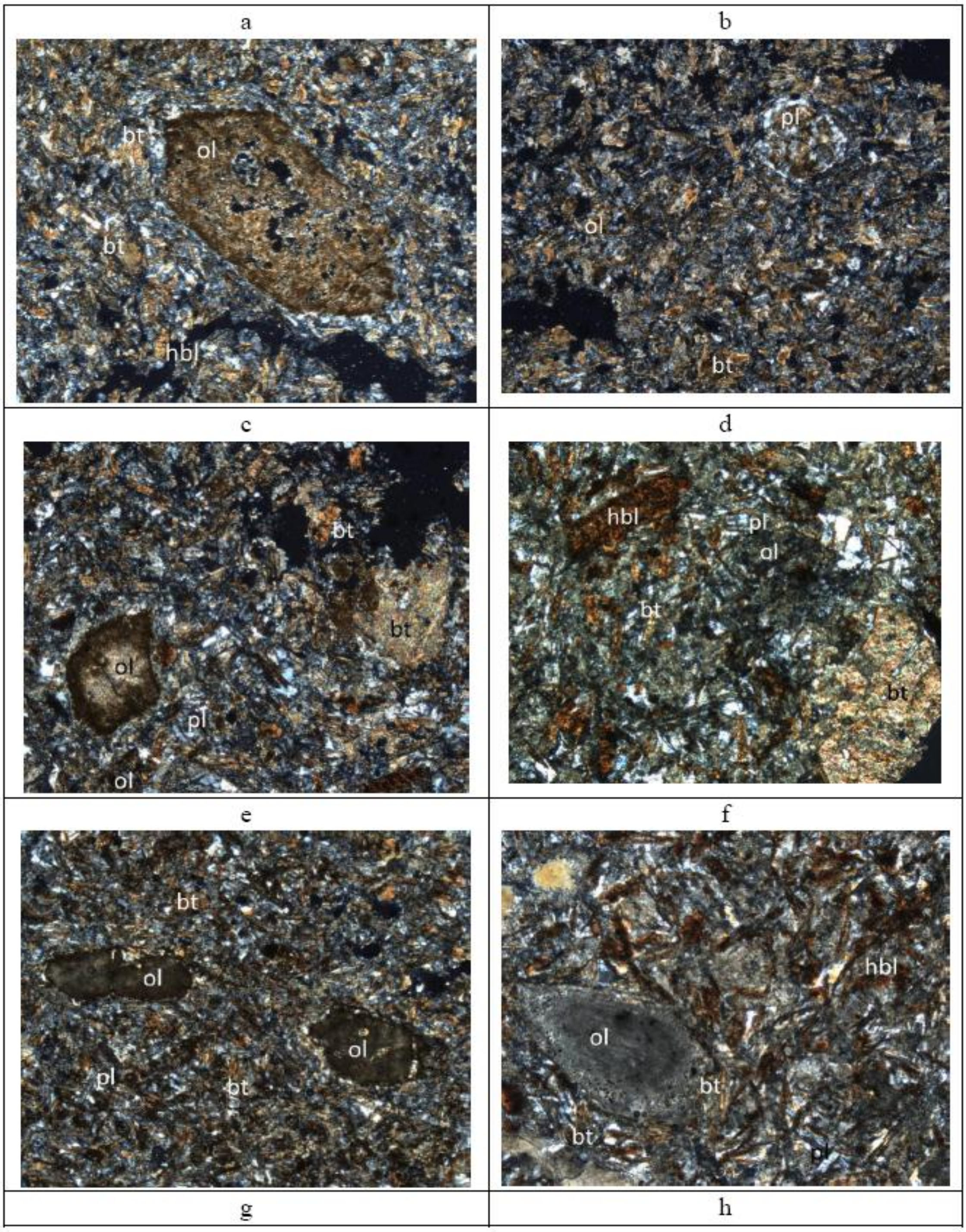



Fig.2. Schematic geological map of the Karakutan ore field
(M 1:25000, according to V.L.Shadrin and others, 1999 with some changes).

1 - modern channel deposits and alluvial, dealluvial-proluvial sediments, 2 - marly clays, feldspar-quartz silty sands, oolitic, siliceous limestones, marly shells, 3 - sandstones, sands, siltstones, clays, conglomerate gravels, 4 - lower division of Katarmai Formation. Subformation 4, terrigenous, consists of siltstones, sandstones, clay shales, mica-quartz, feldspar, chlorite and mica. Rare basalt covers; 5 - Sublayer 3, volcanic-terrigenous - feldspathic, chloritic, micaceous, micaceous-quartz, carbonaceous-clayey shales, interlayers, lenses of dolomites, sandstones, tuffoagglomerates, basalt covers; 6 - Subformation 2, terrigenous-carbonate - micaceous-quartz schists, lenses and interlayers of limestone, dolomites; 7 - Subformation 1, terrigenous-volcanogenic - tuffs, tuff-agglomerates of basalt and olivine-basalt composition, lenses and interlayers of marble, limestone, dolomites of micaceous-quartz schists; 8 - biotite-rhombic tonalites, 9 - lamprophyres, kersantites, spessartites, spessartite-kersantites, 10 - quartz diorite porphyries, quartz sienodiorite porphyries, 11 - tonalite, - granodiorite porphyries, 12 - fine-grained granites, 13 - faults: 1) traced, 2) inferred, 14 - Navruzaly fault, 15 - dike study area.

The third subformation of the Katarmai unit at the Yangi Umid area is composed of volcanogenic-terrigenous formations - feldspar, chlorite, micaceous, micaceous-quartz, carbonaceous-argillaceous shales, interlayers, lenses of dolomites, sandstones, tuff-agglomerates, covers of albitized basalts, with which the second subformation has tectonic contact, composed of terrigenous-carbonate deposits - micaceous-quartz shales, lenses and interlayers of limestones, dolomites. (Fig. 2). Among these sediments, gold ore deposits have been identified, which are associated with dykes of olivine kersantites, kersantite-minettes, data on which are given below.

The material composition of dikes. The composition of dikes is variable (depends on the presence of olivine, hornblende and potassium-sodium feldspar), ranging from olivine kersantites through kersantite-spessartites to kersantite-minettes. In appearance, it is a greenish-gray, black rock of porphyry structure (Fig.3). Almost all dikes (10) are impregnated with an aggregate of iron hydroxide, carbonate, and chlorite. The structure is porphyritic, with a inhomogeneous groundmass (Fig. 3 a-f). Porphyry phenocrysts are represented by biotite, olivine, rarely plagioclase, amphibole and pyroxene, which make up 10-15%. The groundmass is composed of plagioclase, biotite, potassium-sodium feldspar (20-25%), quartz, rarely amphibole. Olivine in phenocrysts forms rounded, elongated sometimes idiomorphic phenocrysts up to 1.8 x 1.0 mm in size. It is completely altered by carbonate and earthy aggregate. Around the phenocrysts there is interaction with the groundmass, expressed by traces of microlites, biotite and plagioclase (Fig.3 a), indicating an intratellular phase. Plagioclase (20-25%) forms isometric and tabular crystals with a zonal structure (Figure 3 b). Biotite (25-35%) is represented by large phenocrysts (Fig. 3c, d) and elongated needle-like and scale-like grains with yellow-reddish-brown pleochroism in the groundmass. Amphibole forms (5-7%) diamond-shaped and elongated prismatic grains with weak pleochroism (Fig. 3 a, d, f). Accessory minerals are represented by apatite, magnetite, pyrite, chalcopyrite, etc. Pyrite, chalcopyrite and magnetite are marked as ore minerals in the form of scattered secretions (J-95). The number of them is less than 1%. Pyrite occurs in the form of cubic, xenomorphic particles (Fig.3 I, j, k). Single grains of chalcopyrite are noted (Fig.3 l). Sometimes it is associated with pyrite. Magnetite has isometric and cubic shape (Fig.3 g, h).



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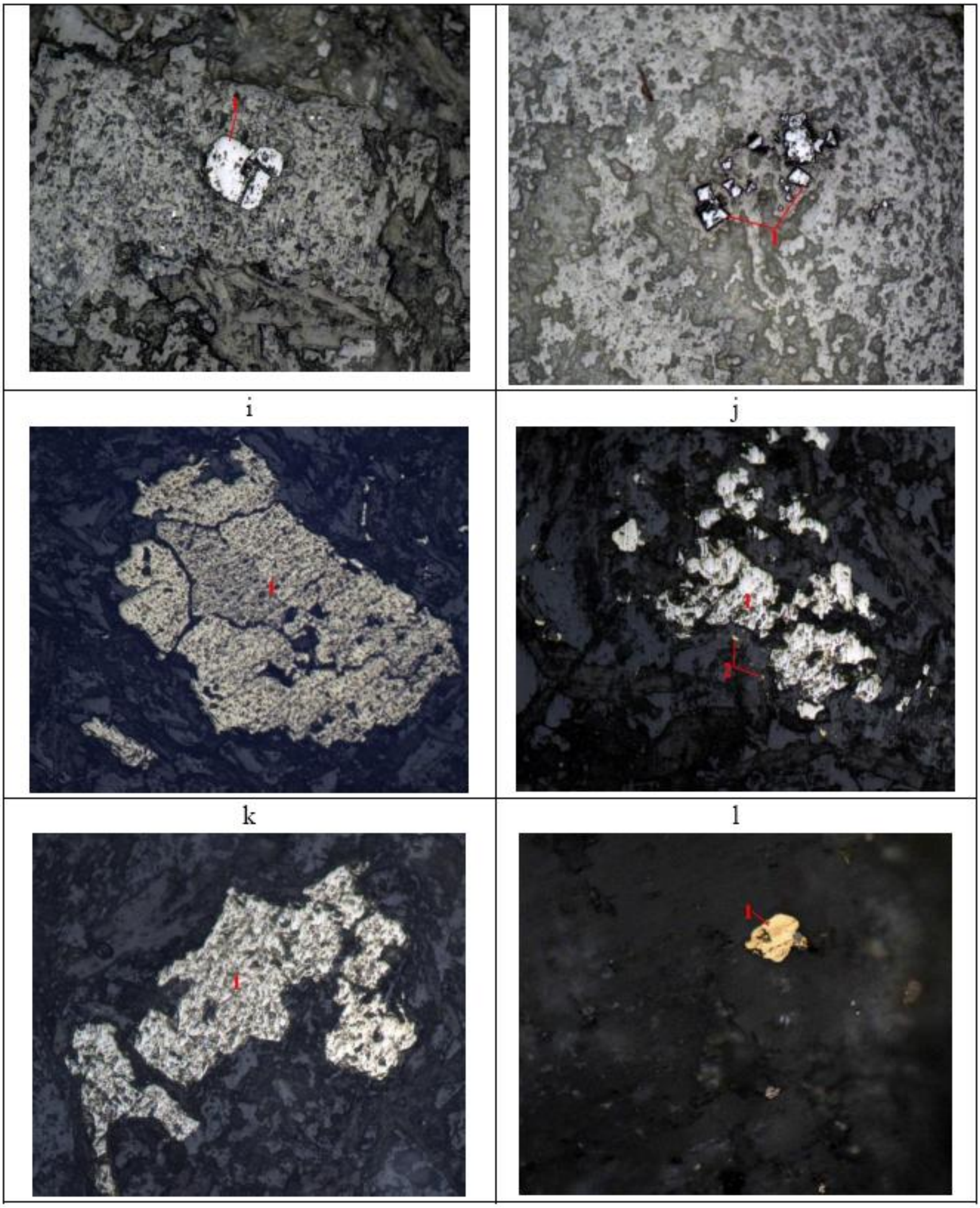


Fig.3. Petrography of representative samples of olivine kersantite-minettes from Yangi Umid deposit of Karakutan ore field:

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a - intratelluric specimens of typical olivine form (sketch J-63), b - isometric specimens of zonal plagioclase (sketch J-63). J-63), c - phenocrysts of olivine and biotite (sample J-64), d - phenocrysts of olivine, biotite, and reddish brown amphibole, possibly barkevikite (sample J-95), e - elongate phenocrysts of olivine (sample J-89), f - the same (sample J-94), g - phenocrysts of magnetite. Magnification 100x, h - magnetite aggregates. Magnification 100x, I - pyrite. Magnification 100x, j - nested aggregates of pyrite. Magnification 200x, k - aggregates of pyrite. Magnification 100x, l - chalcopyrite outcrop. Magnified at 1000x. Microphotographs a-f - taken under a Nikon ECLIPSE LV100NPOL microscope, Nikon Optiphot 2 Pol, Magnification 40x, with analyzer; microphotographs g-l - image taken under a Nikon ECLIPSE LV100NPOL microscope, Nikon Optiphot 2 Pol in reflected light, without analyzer.

## 3. RESULTS AND DISCUSSION

The composition of olivine kersantite dikes is presented in Table 1, 2. They were compared with similar dikes within Muruntau and Pistali deposits, North Nuratau dike complex and global average dikes accompanied by different classification, binary and geodynamic diagrams (Fig. 4). Kersantite dikes of the Pistali gold deposit (North Nuratau) with a thickness of 2-2.5m, which break through the Taskazgan Formation shales. Late ore-bearing quartz-carbonate veins 2-4 cm thick are observed in the dikes. Kersantites cataclased, silicified, limonitised, weakly chloritised. Composition (%): plagioclase (55-60), biotite (35-40), chlorite (5-7) due to biotite, anatase, rutile up to 1%. The structure of the main mass is lepidogranoblastic microgranular with relict lamprophyre. The texture is massive, cataclastic in places. The dyke is characterized by increased contents of Ba, Cr, Mo, Hf, U, Pb, Au, Ag, Cd, As, Se, Bi, which is typical for dikes of the North Nurata dyke complex.

In the TAS classification diagram [15] the composition of olivine kersantites "Yangi Umid" sharply differs from comparable similar rocks by low silica and alkali content. The silica content in the rocks ranges from 45.53 to 58.60%. Dike rocks of olivine kersantites of Yangi Umid area fall in the compact field of monzogabbroids of subalkaline and alkaline series (Fig. 4), which is confirmed by K2O-Na2O and K2O-SiO2 diagrams [2]. They also differ sharply in the amount of titanium, aluminium and magnesium oxides, etc. in the Harker diagram (Fig.4), characterized by low titanium and aluminium content and high magnesium content.

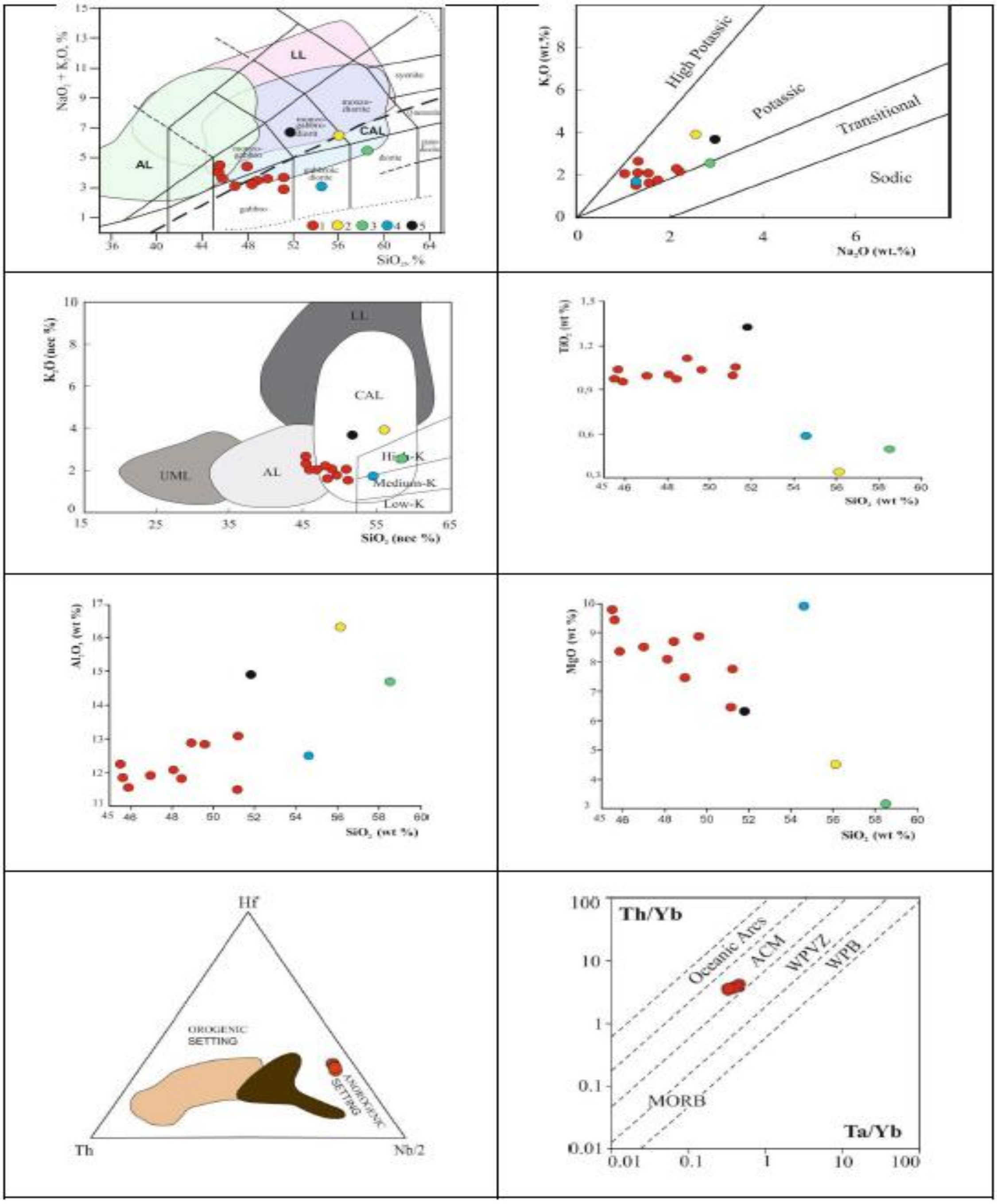

Fig.4. Petrochemical classification and geodynamic diagrams for dike rocks of olivine kersantites: TAS diagram.

Fields: AL - alkaline lamprophyres, LL - lamprophyres, CAL - calcareous-alkaline lamprophyres, bold dotted lines - boundaries of alkaline and subalkaline lamprophyres [15]. 1 - Yangi Umid section, 2 - Muruntau deposit, 3 - Pistali deposit, 4 - North-Nurata dyke complex, 5 - mid-world composition of kersantites; K2O-Na2O, K2O-SiO2 [2], Harker diagram: TiO2-SiO2, Al2O3-SiO2, MgO-SiO2; Hf-Th-Nb/2 [16], Ta/Yb - Th/Yb [17]: Oceanic Arcs, ACM

(Active Continental Margins), WPVZ (Within-Plate Vulcanic Zones), WPB (Within-Plate Bazalts), MORB (Mid-Oceanic Ridge Basalts).

The composition of lamprophyric dikes in the classification geodynamic diagrams Ta/Yb - Th/Yb [17] and Hf-Th-Nb/2 [16] corresponds to the development of rocks of the active continental margin and post-orogenic (intraplate) region (Fig. 4). Kersantites are orthoclase-hypersthene normative (Table 1).

According to the distribution of the content of minor elements, olivine kersantites in comparison with the kersantites of the Pistali gold deposit of Northern Nuratau are characterized by a high content of almost all elements with the exception of niobium, tin, cadmium, indium, lead and bismuth. High content of gold (0.05 to 0.20 g/t), nickel, uranium, silver, arsenic and selenium is characteristic (Figure 5). The geochemical features of the dikes rocks are expressed in the significant presence of siderophile impurity elements - chromium, nickel, cobalt and high value of Ni/Co (4.60 g/t). In order to reveal the distribution pattern of minor and rare-earth elements, spider-diagrams (Fig. 4) are compiled, analysis of which shows that kersantites are enriched with cesium, molybdenum, hafnium, silver, especially arsenic, selenium, bismuth (Fig. 4) and light lanthanides [25].

Analysis of the behaviour of radioactive elements (uranium and thorium) in kersantites shows that thorium prevails over uranium in them (Th/U=1.24). The special specific composition of the rocks is also indicated by the values of Ni/Co relations and the content of chromium and rare metals. In kersantites average value of Ni/Co - ratio corresponds to 4.60, which is close to Ni/Co - ratio [26] in alkaline basalts with normative nepheline.

Table 1 Chemical composition of kersantite dikes from the Yangi Umid deposit of the Karakutan ore field (Ziaetdin Mountains)

| Oxide | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 47.03 | 48.98 | 51.19 | 49.69 | 48.49 | 48.13 | 45.92 | 51.26 | 45.68 | 45,53 | 56.18 | 58.60 | 54.64 | 51.80 |
| $TiO_2$ | 0.99 | 1.11 | 0.99 | 1.03 | 0.97 | 1.00 | 0.95 | 1.05 | 1.03 | 0.97 | 0.34 | 0.49 | 0.58 | 1.32 |
| $Al_2O_3$ | 11.90 | 12.87 | 11.51 | 12.80 | 11.84 | 12.05 | 11.53 | 13.08 | 11.83 | 12.24 | 16.27 | 14.68 | 12.49 | 14.87 |
| $Fe_2O_3$ | 4.33 | 4.56 | 2.96 | 5.22 | 4.99 | 3.82 | 3.42 | 3.47 | 1.81 | 2.14 | 0.93 | 2.42 | 2.34 | 3.03 |
| FeO | 3.38 | 3.84 | 4.96 | 3.23 | 2.94 | 3.81 | 4.24 | 4.38 | 5.60 | 5.82 | 5.20 | 3.14 | 5.41 | 5.32 |
| MnO | 0.09 | 0.17 | 0.13 | 0.11 | 0.12 | 0.13 | 0.14 | 0.10 | 0.14 | 0.14 | 0.13 | 0.11 | 0.18 | - |
| MgO | 8.47 | 7.42 | 6.45 | 8.83 | 8.67 | 8.06 | 8.34 | 7.70 | 9.38 | 9.76 | 4.50 | 3.12 | 9.85 | 6.29 |
| CaO | 6.73 | 6.20 | 7.01 | 4.73 | 6.73 | 8.41 | 8.01 | 5.73 | 7.89 | 7.15 | 7.00 | 6.64 | 4.34 | 6.24 |
| $Na_2O$ | 1.06 | 1.36 | 1.31 | 1.78 | 1.59 | 2.25 | 1.54 | 1.57 | 2.20 | 1.35 | 2.57 | 2.88 | 1.30 | 2.98 |
| $K_2O$ | 2.04 | 2.04 | 1.53 | 1.72 | 1.61 | 2.17 | 2.06 | 2.07 | 2.27 | 2.65 | 3.89 | 2.54 | 1.74 | 3.68 |
| $P_2O_5$ | 0.67 | 0.66 | 0.68 | 0.59 | 0.60 | 0.64 | 0.59 | 0.69 | 0.66 | 0.64 | 0.06 | 0.13 | 0.21 | - |
| $SO_3$ | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | 0.46 | - | - | - | - |
| $H_2O$ | 1.40 | 1.16 | 0.40 | 0.85 | 0.80 | 1.03 | 0.52 | 0.78 | 0.38 | 0.37 | - | - | - | - |
| POI | 12.3 | 9.94 | 10.3 | 9.64 | 10.5 | 8.62 | 12.3 | 8.34 | 10.5 | 10.8 | - | 5.10 | 7.43 | 3.70 |
| ∑ | 100.39 | 100.31 | 99.44 | 100.22 | 99.89 | 100.12 | 99.58 | 100.22 | 99.79 | 100.1 | 99.75 | 100.25 | 100.17 | 99.23 |
| al’ | 0.74 | 0.81 | 0.80 | 0.74 | 0.71 | 0.77 | 0,72 | 0.84 | 0.70 | 0.69 | 1.53 | 1.69 | 0.71 | 1.02 |
| f’ | 17.17 | 16.93 | 15.36 | 18.31 | 17.57 | 16.69 | 16.95 | 16.6 | 17.82 | 18.69 | 10.97 | 9.17 | 18.18 | 15.96 |
| Kф | 47.65 | 53.10 | 55.11 | 48.90 | 47.77 | 48.63 | 47.88 | 50.48 | 44.13 | 44.92 | 57.67 | 64.06 | 44.03 | 57.04 |
| $Na_2O+K_2O$ | 3.1 | 3.4 | 2.84 | 3.5 | 3.2 | 4.42 | 3.6 | 3.64 | 4.47 | 4 | 6.46 | 5.42 | 3.04 | 6.66 |
| $Na_2O/K_2O$ | 0.52 | 0.67 | 0.86 | 1.03 | 0.99 | 1.04 | 0.75 | 0.76 | 0.97 | 0.51 | 0.66 | 1.13 | 0.75 | 0.81 |
| $Fe_2O_3/FeO$ | 1.28 | 1.19 | 0.60 | 1.62 | 1.70 | 1.00 | 0.81 | 0.79 | 0.32 | 0.37 | 0.18 | 0.77 | 0.43 | 0.57 |
| Quartz | 9.40 | 11.24 | 15.10 | 11.57 | 9.76 | 2.46 | 3.74 | 11.50 | - | 0.41 | 3.86 | 14.96 | 13.82 | - |
| Plagioclase | 30.35 | 34.19 | 31.78 | 34.02 | 33.56 | 35.10 | 31.19 | 35.51 | 33.08 | 29.52 | 43.12 | 44 | 31.16 | 41.54 |
| Orthoclase | 12.06 | 12.06 | 9.04 | 10.16 | 9.51 | 12.82 | 12.17 | 12.23 | 13.41 | 15.66 | 22.99 | 15.01 | 10.28 | 21.75 |
| Diopside | 5.46 | 2.44 | 7.19 | | 6.78 | 16.39 | 13.5 | 0.83 | 14.19 | 8.14 | 10.62 | 10.02 | - | 11.71 |
| Hypersten | 19.55 | 18.79 | 17.66 | 21.99 | 18.45 | 14.57 | 17.79 | 22.23 | 15.08 | 27.74 | 14.22 | 5.91 | 31,58 | 9,74 |
| Ilmenite | 1,88 | 2,11 | 1,88 | 1,96 | 1,84 | 1,90 | 1,80 | 1,99 | 1,96 | 1,84 | 0,65 | 0,93 | 1.10 | 2.51 |
| Magnetite | 6.28 | 6.61 | 4.29 | 7.42 | 6.66 | 5.54 | 4.96 | 5.03 | 2.62 | 3.10 | 1.35 | 3.51 | 3.39 | 4.39 |
| Apatite | 1.55 | 1.53 | 1.58 | 1.37 | 1.39 | 1.48 | 1.37 | 1.60 | 1.53 | 1.48 | 0.14 | 0.30 | 0.49 | - |

Note. 1-10 - kersantites dikes from Yangi Umid deposit, 11 - kersantites (2) from Muruntau [19], 12 - kersantites (5) from Pistali gold deposit [13], 13 - kersantites (2) from North-Nurata dike complex, 14 - average composition of kersantites [20].

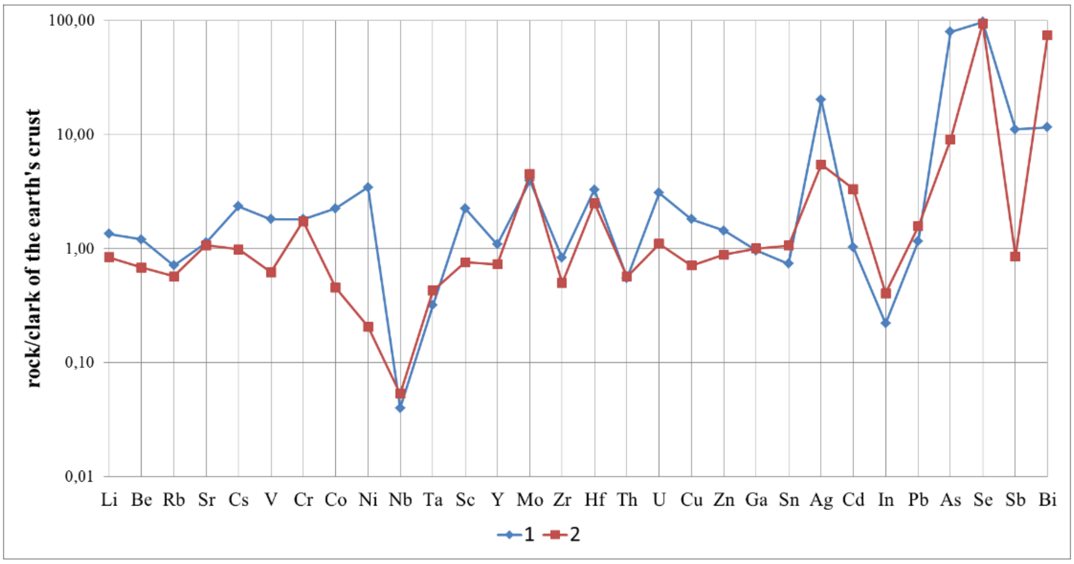


Fig.5. Spider diagram of minor elements distribution in kersantite dikes of Yangi Umid ection of the Karakutan ore field. 1 - kersantites of Yangi Umid section, 2 - kersantites of Pistali gold deposit in North Nuratau.

Thus, the value of La/Ta (40.31) and La/Yb (16.72) ratios in the dyke rocks of olivine kersantites is usually characteristic of post-rhogenic continental intraplate formations [21, 22]. Weak Europium maximum, Ni/Co = >3 [18] and olivine+plagioclase+amphibole+biotite paragenesis indicate the subcorean origin of olivine kersantites.

In general, the presence of olivine, pyroxene, plagioclase, biotite, amphibole and the absence of feldspathoids in the studied dikes brings them closer to olivine kersantites, which are of great metallogenic importance, since gold, rare metal and REE mineralization is associated with them.

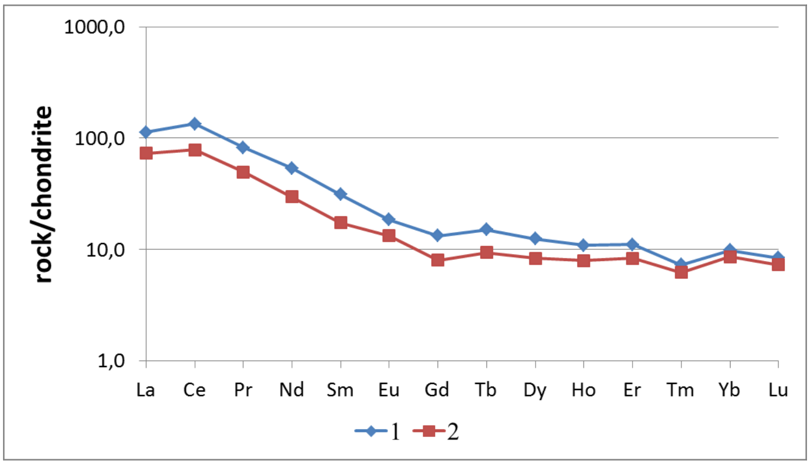


Fig.6. Spider diagram of the distribution of rare earth elements in the dykes of the kersantites of the Yangi Umid section of the Karakutan ore field. See the symbols in Fig. 5.





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The rocks under consideration are enriched with light and heavy lanthanides (La/Yb from 12.8 to 18.3) compared to the kersantites of the Pistali gold deposit of Northern Nuratau.

## 4. CONCLUSION

The studied olivine kersantites are alkaline and subalkaline rocks from the lamprophyre family. They are characterized by low silicic acid and alkalinity, which is due to the presence of olivine, pyroxene, amphibole and basic plagioclase. These rocks have a high content of gold (from 0.05 to 0.20 g/t), nickel, uranium, silver, arsenic and selenium. Geochemical features of dyke rocks are expressed in the significant presence of siderophilic elements-impurities - chromium, nickel, cobalt and a high value of Ni/Co (4.60 g/t). The value of La/Ta (40.31) and La/Yb (16.72) ratios in olivine kersantites is usually characteristic of postorogenic continental intraplate setting. Weak Europium maximum, Ni/Co=>3 and olivine+plagioclase+ amphibole+biotite paragenesis indicate the subcrust origin of olivine kersantite magmas.
In general, the considered olivine kersantites are of great metallogenic importance, since gold, rare metal and REE mineralization is associated with them [10-12].

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