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New Data on the Copper Mineralization of the Pribrezhny Volcanic Complex of Southern Kamchatka

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Abstract—This paper reports new data on the copper mineralization in the Pribrezhny Volcanic Complex (PVC), which is a part of the Eastern Kamchatka–Kurile volcanic plutonic belt (part of the Kurile-Southern Kamchatka island-arc system). The study area is situated along the eastern coast of the southern Kamchatka Peninsula, from Avacha Bay to Mutnaya Bay. It was found that the majority of collected volcanic and intrusive rocks have the elevated copper contents compared to the clarke values. The sources of copper in the PVC rocks are debatable, and this paper considers its possible origin. The distribution of porphyry copper deposits on other island arcs of the Pacific Ring in similar tectonic settings highlights the need for searching similar deposits in the coastal band of southeastern Kamchatka. Based on the geology, structure, and composition of the PVC, the authors admit the principal possibility of the existence of unexposed porphyry copper systems. Obtained results could be used for substantiation of thematic prospecting.

Keywords: copper, island arc, porphyry copper systems, forecasting, Kamchatka

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INTRODUCTION

One of the regions promising for the discovery of porphyry copper systems in Russia is the Kamchatka Peninsula (Beskin et al., 2016; Migachev et al., 2015, 2020). At the same time, the prospects of the considered southeastern coast of Kamchatka for porphyry copper occurrences are poorly studied. Of great importance in this relation are new data on the distribution of copper and associated elements in all geological complexes available for the direct study.

The comprehensive geological study of the Pribrezhny Volcanic Complex (PVC) is crucial for the refinement of the genetic nature of Miocene magmatism of South Kamchatka and the geodynamic evolution of the Asian continental margin (Bergal-Kuvikas and Rogozin, 2023). Based on the petrological features, the PVC rocks could carry the porphyry copper mineralization. At present (Chiaradia et al., 2022), theoretical works consider the porphyry copper systems as the manifestation of large eruptive systems evolution of which was interrupted. Thus, even assuming the poor economic significance of potential porphyry copper objects, their discovery and study is important to specify the evolution of the Cenozoic magmatism in the region.

GEOLOGICAL CHARACTERISTICS OF THE STUDY AREA

The study area is located along the eastern coast of South Kamchatka, from Avacha By to Mutnaya Bay (Fig. 1). The area is composed of the (PVC), which belongs to the Eastern Kamchatka–Kuril volcanic plutonic belt (₽$_3$–N_2) (*State*..., 2000). Geological data on the PVC and urgent questions of its present-day study are reported in (Bergal-Kuvikas and Rogozin, 2023). Paleomagnetic data on the Miocene magmatic rocks of the PVC (Latyshev et al., 2023) indicate their formation at latitudes close to the present-day ones, i.e., they did not experience significant horizontal displacements since formation.

Reliable volcanic centers have a Miocene age (*State...,* 2000). The volcanic activity has continued in this area during Early and Middle Miocene and produced andesite formation in the PVC. The complex includes the Zavoykovskaya plutonic association, Akhomtensky volcanic complex, and Asachinsky volcanic complex, which is located to the south of the studied area (*State* ..., 2006).

The Zavoykovskaya volcanoplutonic association is subdivided into the early (subvolcanic dacite and tuffisite bodies) and late (sheet flows of basaltic andesites and their tuffs; subvolcanic bodies of andesites, diorite porphyries, porphyritic diorites, dolerites, and andesite dikes) phases. The granodiorites, quartz diorites, and diorites of the Zavoykovsky hypabyssal complex in the Sarannaya Bay area form the Saranskaya intrusion around 40 km^2 in area. The intrusion cuts across the Oligocene–Miocene rocks of the Mutnovskaya Formation and subvolcanic andesite bodies of the late phase of the Zavoikovsky volcanic complex (VC), and is overlain by the basaltic andesite flows of the Pliocene volcanic complex (*State...,* 2000). Based on petrographic composition, it could be a part of the potentially productive volcanic plutonic association (VPA).

The rocks of the Akhomtensky VC include the Lower Miocene intermediate and felsic volcanic rocks, which are developed along the eastern coast of Kamchatka from Vilyuchinsksya Bay to Avacha Bay (Fig. 1). The complex consists of two phases. The early phase is made up of felsic rocks represented by sheet flow facies (ignimbrites, felsic tuffs, and tuffaceous siltstones) and subvolcanic bodies (dacites, more rarely andesites). The late phase is represented by volcanic–pyroclastic sheeted flows of intermediate–basic composition and subvolcanic intrusions and dikes varying from mafic to intermediate composition. The granitoids of the Akhomtensky VC form the large intrusive body (Akhomtensky granitoid massif) in the Russkaya Bay area, which includes the subvolcanic bodies of the late phase of VC along its periphery (*State...,* 2000).

The copper potential of the studied area is known and represented by the geochemical anomalies and copper mineralization points, which were discovered mainly during prospecting works (*State*..., 2000). Near the Vilyuchinskaya hill, in the middle reaches of the Vilyucha River (Fig. 1), quartz veins with pyrite, chalcopyrite, and copper were found in the boulder debris (*State* ..., 2000). In addition, chalcosite ores are mentioned in the walls of the Pravaya Bystraya River, 15 km from the Elizovo aeroport (Fig. 1). Such facts could be considered as evidence for the presence of porphyry copper magmatic systems. Most part of the copper anomalies are characterized by the low–moderate copper contents of 0.015–0.1%.

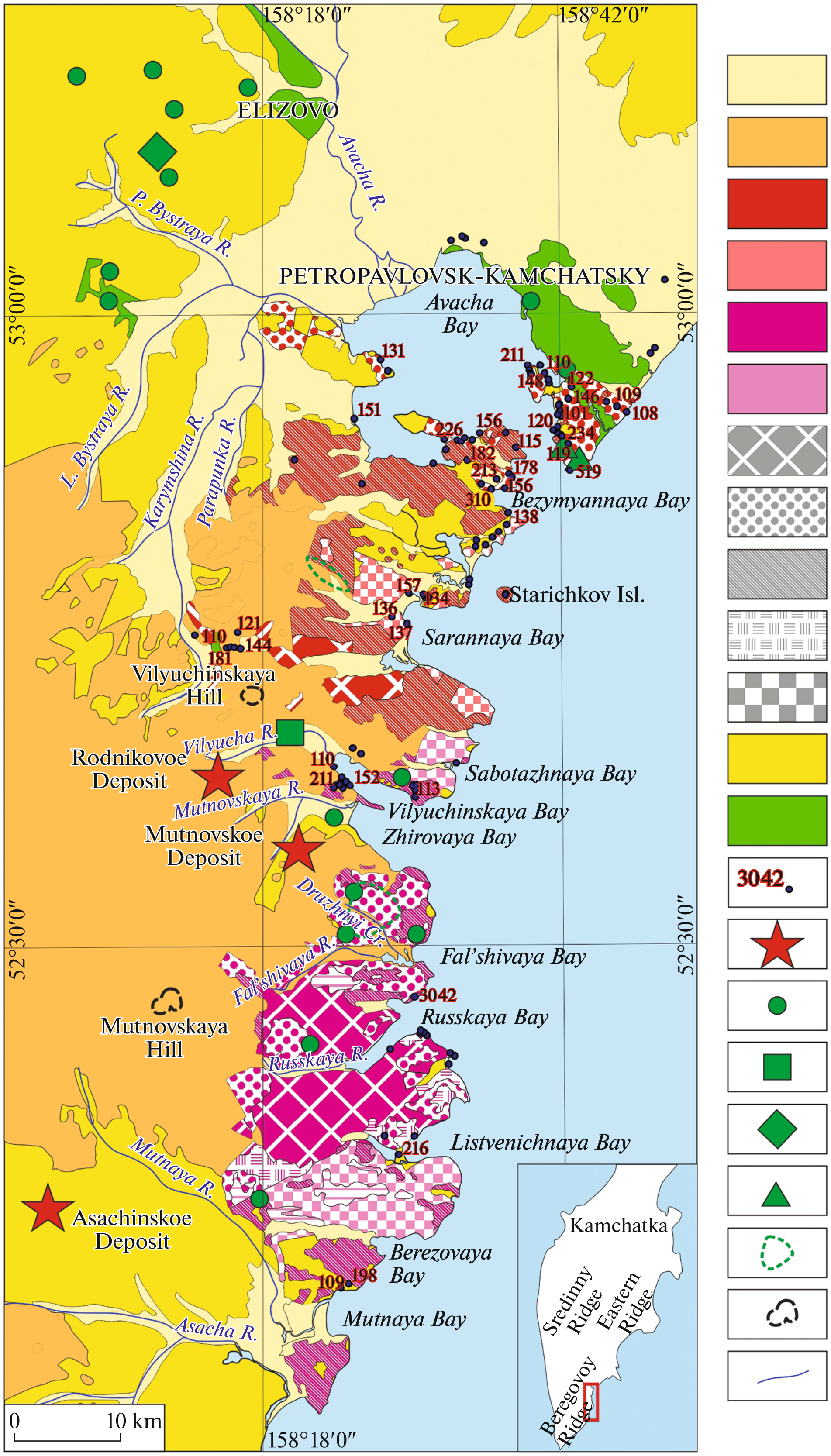
The presence of copper ores in Zhirovaya Bay has been noted by Stepan Petrovich Krasheninnikov as early as 18th century (1755) in the first scientific description of Kamchatka. In the cliffs of the Zhirovaya and Peschanaya bays, copper mineralization of two types was identified in the sheet subvolcanic facies of the late phase of the Akhomtensky VC and associated hydrothermally altered rocks: copper wires in cavities and thin prehnite–chalcocite veinlets. The copper content in single lumps reaches 4% (*State...,* 2000)

Copper mineralization was also established (Palyanova et al., 2020) in the agate nodules among basalts of the Avacha Bay coast. It is represented by the native copper, as well as copper sulfides (chalcocite, djurleite, digenite, anilite, yarrowitee, and more rarely chalcopyrite), and cuprite. In addition to copper minerals, the agates contain sphalerite and native silver.

Tectonic and metallogenic prerequisites of the prospects of the area for porphyry copper mineralization. The prospects of the volcanic plutonic belts (VPB) of Kamchatka for the discovery of porphyry copper mineralization are based on the presence of potentially productive VPA, the presence of porphyry copper occurrences, as well as the wide development of similar deposits, including superlarge deposits in other chains (Beskin et al., 2016; Kremenetsky et al., 2010; Migachev et al., 2020) of the Pacific volcanic belt (Fig. 2).

The Koryak–Kamchatka region is considered (Migachev et al., 2020) as the potential porphyry cop-

Fig. 1. Geological scheme of the studied area (modified after *Russian...,* 2000): (*1*) Quaternary sediments; (*2*) Quaternary volcanic complexes; (*3–6*) Pribrezhny volcanic complex: (*3*) late phase of the Zavoykovsky complex; (*4*) early phase of the Zavoykovsky complex; (*5*) late phase of the Akhomtensky complex; (*6*) early phase of the Akhomtensky complex; (*7–11*) rocks of the Pribrezhny volcanic complex: (*7*) granodiorites, granites, alaskites; (*8*) sheet flow facies: basaltic andesites, andesites and their tuffs, (*9*) subvolcanic bodies of porphyrite diorites, andesites, and andesite basalts; (*10*) subvolcanic basaltic bodies of complex composition; (*11*) subvolcanic bodies of dacites and tuffisites; (*12*) other Cenozoic volcanoplutonic complexes; (*13*) Cretaceous volcanoplutonic complexes; (*14*) points of lump sampling and the highest copper contents according to XRF data (ppm); (*15*) noble-metal epithermal deposits; (*16–20*): copper occurrences according to previous data: (*16*) mineralization points; (*17*) quarts–sulfide copper ores; (*18*) chalcocite ores; (*19*) native copper in agates; (*20*) lithochemical copper anomalies; (*21*) active volcanoes; (*22*) rivers.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Avacha Bay
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L. Bystraya R.
Karymshina R.
Paratunka R.
Bezymyannaya Bay
Starichkov Isl.
Sarannaya Bay
Vilyuchinskaya Hill
Vilyucha R.
Rodnikovoe Deposit
Mutnovskaya R.
Mutnovskoe Deposit
Sabotazhnaya Bay
Vilyuchinskaya Bay
Zhirovaya Bay
Druzhnyi Cr.
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Fal'shivaya R.
Fal'shivaya Bay
Russkaya Bay
Mutnovskaya Hill
Russkaya R.
Listvenichnaya Bay
Mutnaya R.
Asachinskoe Deposit
Berezovaya Bay
Mutnaya Bay
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per province due to the discovery of VPA and plutonic formations productive for the porphyry copper mineralization. These formations and associations are also related to the gold-bearing copper–arsenic, and gold–polysulfide occurrences (part of the common ore-magmatic systems (OMS)) with complex metallogeny.

The porphyry copper occurrences known within Kamchatka differ in insignificant sizes and comparatively low contents of useful components, whereas spacious areas bearing potentially ore-bearing VPA and intrusions promising for the discovery of the porphyry copper objects are overlain by the younger volcanogenic rocks, including Quaternary rocks (Migachev et al., 2020). It is suggested (Migachev et al., 2020) that Kamchatka is characterized by a relatively shallow depth erosion level, which, correspondingly, suggests the great depth (hundreds of m to a few km) of localization of OMS inner parts that are potentially productive for the porphyry copper ores, the estimation of which by drilling is economically unreasonable.

The Cretaceous Pebble deposit in Alaska is the closest superlarge porphyry copper object (Kremenetsky et al., 2010; Kelley et al., 2013). The Alaska and Kamchatka peninsulas represent symmetrical en-echelon uplifts relative to the Bering Sea basin (combination of the Aleutian, Commander, and Bowers basins (Fig. 2)). It is noted that the western and eastern margins of the Bering Sea in general have a symmetric structure (Kremenetsky et al., 2010).

It is generally accepted that the conditions necessary for the localization of porphyry copper system in the Kamchatka potential porphyry copper province could occur within Central and Northern Kamchatka rather than in its southeastern part (Beskin, 2016). Based on the symmetry of geological structures, we suggest that the porphyry copper objects similar to the Alaskan porphyry copper objects could be developed both on Kamchatka as a whole and in the PVC area.

The known porphyry copper occurrences on Kamchatka are accumulated in its central and western parts (Migachev et al., 2020; Soloviev et al., 2020). It is hypothesized (Beskin et al., 2016; Migachev et al., 2020; Soloviev et al., 2020) that the Late Cretaceous–Paleocene Khim–Kirganic ore cluster (Fig. 2) comprises unexposed granitoid porphyry intrusions, which could be accompanied by the larger and higher grade ore bodies than presently known objects. Only Kumroch occurrence is known in the Kamchatka part of the Eastern Kamchatka–Kuril VPB, in its northern part (Fig. 2). Its veinlets in general correspond to the gold–polysulfide ores of porphyry copper deposits (Migachev et al., 2020). The Northern Olyutorsky–Kamchatka area of possible localization of Cu–Au–Mo mineralization (Fig. 2) is distinguished northward, in the Olyutorsky belt (Kremenetsky, 2010).

The Olyutorsky and Eastern Kamchatka belts in general are considered (Migachev et al., 2015) as a poorly promising zone for the discovery of porphyry copper systems. At the same time, the prospects of the coastal part of the Eastern Kamchatka belt (coastal ridges and shore zone) in the southern part of Kamchatka (the studied area in this work) for the presence of porphyry copper OMS are poorly studied (*State...*, 2000). Thereby, this area comprises intermediate and felsic intrusions, which in composition are favorable for the localization of porphyry copper mineralization.

Data on the position of porphyry copper objects in Indonesia and Alaska (Zvezdov, 2019; Kreiner et al., 2021; Maryono et al., 2018) show the principal opportunity of localization of large Miocene porphyry copper objects not only in the rear zones (relative to the present-day volcanic arc), but also within external (fore-arc, frontal) zone relative to the present-day active volcanic zone of (coastal) part of island arc.

In particular, Cenozoic porphyry copper and porphyry molybdenum Pyramid, Mike, Rex, Cape Kumlik, and Mallard Duck Bay (200 million tons of ore) and other occurrences are confined to the Pacific coastal zone on Alaska (Kreiner et al., 2021) (Fig. 2).

In Indonesia, the giant porphyry copper and epithermal deposits are localized within the eroded Miocene–Pliocene volcanoplutonic clusters (including diorite intrusions) (Maryono et al., 2018). The position of these clusters in the Eastern Sunda Arc relative to the subduction zone and the present-day volcanic centers is similar to that of PVC in the structure of the Kuril–Kamchatka arc.

The studied area belongs to the frontal part of the present-day Kuril–Kamchatka arc. The front of the arc in general is relatively uplifted, which suggests the occurrence of the inner parts of OMS at moderate depths relative to the erosion section of the eastern coast of South Kamchatka. It is believed that the eastward displacement of structural-facies zones and volcanism of the Kuril–Kamchatka arc during Miocene and Pliocene was accompanied by the orogenic movements and formation of the planation surface, which during subsequent differentiated movements at present are partially subsided in the modern bays of East Kamchatka (Seliverstov, 1998). In our opinion, the potential Miocene OMS of southeastern Kamchatka during Pliocene could approach the present-day erosion level.

Significant abundance of noble and rare-metal epithermal mineralization (Bortnikov, 2023) within the Eastern Kamchatka–Kuril VPB suggests the presence of deep-seated ore sources of metals, first of all, gold and silver. It is known that the gold-bearing epithermal deposits are frequently genetically related to the porphyry copper systems, being confined to their

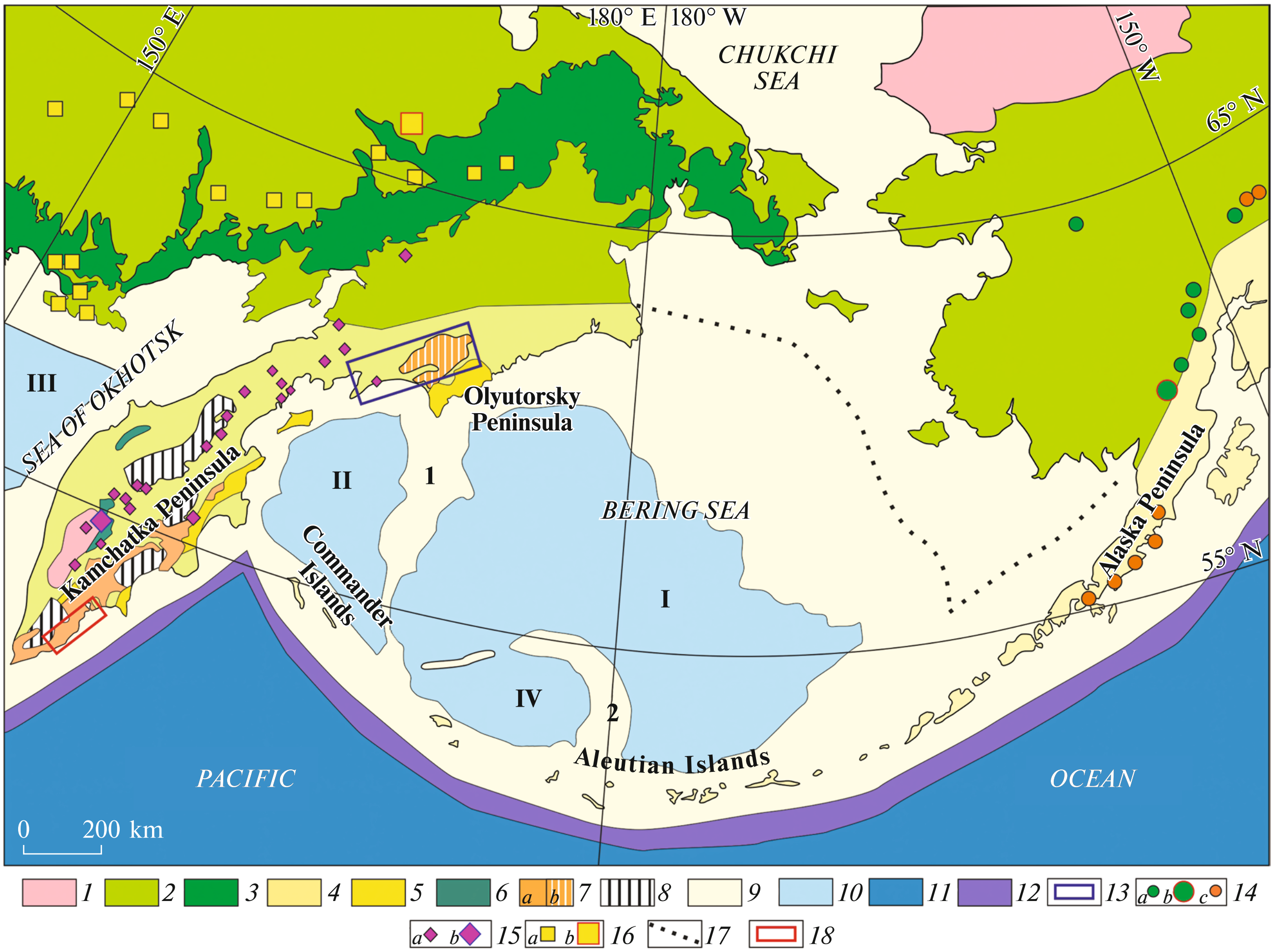

Fig. 2. Localization scheme of porphyry copper objects at Kamchatka, Chukotka, and Alaska compiled and modified after (Kremenetsky et al., 2010) and using data from (Kolova et al., 2023; Migachev et al., 2020; Kreiner et al., 2021): (*1*) exposed blocks of ancient continental crust; (*2*) Mesozoic folded area of the Verkhoyansk-Kolyma orogenic belt, Russia, and Northern America; (*3*) Cretaceous Okhotcko-Chukotka volcanoplutonic belt (OCVB); (*4*) modern Cenozoic folded area with zones of older crust and island-arc complexes; (*5–8*): volcanoplutonic belts (VPB) of Kamchatka: (*5*) inferred basalts of the Achayvayam–Valagin island arc (K_2), (*6*) Irunei–Kirganik (K_2–$Ꝑ_1$), (*7*) Eastern-Kamchatka–Kuril ($Ꝑ_3$–N_2) (*a*), Olyutorsky ($Ꝑ_3$–N_2) (*b*); (*8*) modern Kamchatka–Kuril (N_2–Q); (*9*) shelf and seamount areas; (*10*) Cenozoic deep-water basins with oceanic and suboceanic crust; (*11*) oceanic crust of the Pacific Ocean (Pacific plate); (*12*) Aleutian and Kurilo-Kamchatsky deep trenches; (*13*) North Olyutorsky–Kamchatka prospective area; (*14*) porphyry copper objects of Alaska. Cenozoic: (*a*) occurrences, (*b*) super-large Cretaceous Pebble deposit; (*c*) other Cretaceous objects; (*15*) porphyry copper objects of the Kamchatka–Kuril area: (*a*) occurrences, (*b*) perspective Kirganik object; (*16*) porphyry copper objects of Chukotka: (*a*) occurrences, (*b*) Peschanka deposit; (*17*) inferred boundary between the Mesozoic and Cenozoic folding areas at shelf; (*18*) studied area. Numerals show the basins with oceanic and suboceanic crust: (*I*) Aleutian basin, (*II*) Commander Basin, (*III*) Tinro basin, (*IV*) Bowers basin; seamounts: (*1*) Shirshov ridge, (*2*) Bowers ridge.

periphery in the upper parts of erosion section (Silitoe, 2010).

The porphyry copper deposits are the parts of the hydrothermal-metasomatic systems, the central ore-bearing element of which is a multiple porphyry intrusive stock, while the highest grade and economically significant copper concentrations are formed in early phases (Krivtsov et al., 1986, Sillitoe, 2010). In spite of the presence of intrusive bodies, which could be a part of porphyry copper OMS (diorite porphyries, granodiorites, and others) within southeastern Kamchatka, direct evidences for porphyry copper systems (typical metasomatic alterations, peculiar quartz veinlets, and copper sulfide mineralization (Silitoe, 2010)) have not been found yet. In this work, we consider the indirect arguments in support of their existence in the studied area.

METHODS

Field studies included sampling of lumps in the PVC exposures in the cliffs of the Beregovoy Range (Fig. 1) from the side of the Pacific coast of South

Kamchatka and the visual determination of copper minerals (Bergal-Kuvikas et al., 2022).

The quantitative analysis of major and some trace elements was carried out by X-ray fluorescence at the Center for Collective Use of the Institute of Geology of Mineral Deposits, Petrography, Mineralogy, and Geochemistry of RAS on an Axios vacuum wavelength dispersive XRF spectrometer following technique 439-RS (*Technique...,* 2010).

Thin sections of andesite porphyrites were examined on an Olympus BX51 microscope at the Central Research Institute of Geological Prospecting for Base and Precious Metals.

RESULTS (ROCK COMPOSITION)

During field studies, 141 samples were collected from PVC rocks. The samples are represented by lumps of intrusive, volcanic, and sedimentary rocks (Bergal-Kuvikas et al., 2022). The results of geochemical studies revealed the elevated (>100 ppm) copper contents in 49 samples, reaching the maximum value of 3042 ppm in the gabbro dike of the Zavoykovsky VC in Russkaya Bay. The average copper content in samples with concentration higher than 100 ppm is 223 ppm, while Cu content in other (92 samples) analyzed samples varies from 10 ppm to 100 ppm Cu, averaging 45 ppm.

The copper clarke in the Earth's crust according to different estimates varies from 47 to 100 ppm (Vinogradov, 1962). Thereby, the copper clarke significantly differs for types of magmatic rocks, amounting $2 \times 10^{-3}\%$ (20 ppm) in felsic rocks and $\sim 1 \times 10^{-2}\%$ (100 ppm) in basic rocks.

Correlation between the petrographic determination of samples and copper content in them shows that the highest Cu contents are typical of basic and, to lesser degree, of intermediate rocks. Thereby, the copper contents found in felsic rocks are slightly higher than clarke values: only several samples showed the copper contents around 90 × 100 ppm (Fig. 3).

The level of copper content depends on the genetic type of the rocks (Fig. 3). In particular, the largest number (30) of Cu-rich lumps was found among intrusive rocks, accounting for 43% of all studied intrusive rocks. The elevated copper contents were determined in 27% of all studied volcanic and sedimentary rocks.

Microscopic studies established that andesite porphyrites have massive structure, and polyphyric, incompletely holocrystalline, pylotaxitic texture. The groundmass is represented by plagioclase laths and altered glass; phenocrysts (45–55%) are plagioclase, magnetite, and amphibole (partly opacitized). Secondary minerals are represented by chlorite, leucoxene, clay minerals, carbonates, iron oxides and hydroxides, and malachite–copper hydrocarbonates (Fig. 4), and native copper (Fig. 5) from 0.1 to 3 mm in size.

It is known (Shvedov et al., 2021) that the presence of association of native copper with As at the porphyry copper deposits could indicate the hypogenic nature of copper. However, according to X-ray fluorescence analysis, arsenic contents above the detection limits (>10 ppm) were found only in nine samples. These values did not exceed 46 ppm, while correlation of copper content with arsenic was not found.

Copper has a positive correlation with oxides of iron (r = 0.62) and vanadium (r = 0.69). Significant correlation between Cu and V is explained by the confinement of the elevated copper contents to basic rocks, in which vanadium is widespread, forming isomorphic admixture in Fe and Ti minerals. The iron hydroxides could be interpreted as the decomposition products of sulfides and as secondary newly formed Fe minerals, for instance, magnetite (Fig. 6). Copper has a positive correlation with cobalt (r = 0.56), in spite of the fact that the cobalt contents in samples on average accounted for less than 20 ppm, at a maximum value of 51 ppm (Fig. 6). A weak positive correlation was determined between copper and zinc (r = 0.3). Molybdenum was found in four samples, lead was determined in eight samples. Thereby, Mo and Pb contents have no correlation with Cu.

The Ni contents above the detection limit of applied method (10 ppm) were found in 88 samples, on average amounting for 40 ppm at maximum value of 270 ppm. No correlation was established between copper and nickel (r = 0.18).

DISCUSSION

In general, the rocks that compose the PVC have prerequisites to localize porphyry copper systems: favorable geological-structural setting and the age of the rocks, and the wide development of basaltic andesite complexes with stocks of granodiorites, granites, and alaskites. Porphyry copper mineralization is frequently confined to the felsic rocks, usually of calc-alkaline series (Silitoe, 2010). The poor exposure of the granite and granodiorite stocks of the PVC constrains the discovery of the early-phase rocks, which usually contain copper concentrations, on the surface, but does not exclude their possible revealing at depth.

The study of the PVC rocks showed that the highest copper contents are typical of the late-phase subvolcanic basaltic andesites of the Zavoykovsky complex. Meanwhile, the maximum copper contents was established in the gabbro dike ascribed to the late phase of the Akhomtensky Complex (outcrops on the coast of

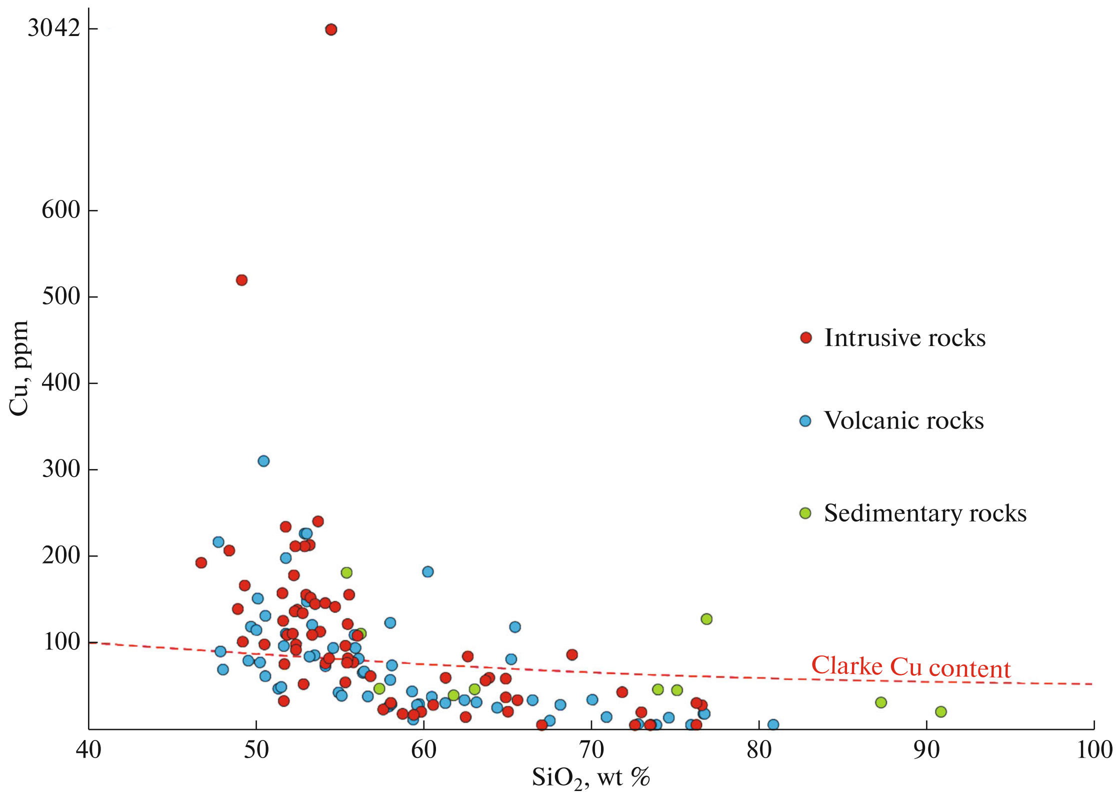

Fig. 3. Variations of copper versus SiO_2 content.

the Vilyuchinskaya and Zhirovaya bays with a visible width around 15 m (Fig. 2)), which confirms known data (*State*..., 2000) on the copper mineralization points in the PVC rocks.

The study of composition of collected lumps showed that the copper mineralization is represented by native copper and copper carbonates (malachite). The upper horizons of the OMS oxidized zones usually contain copper carbonates (malachite) and hydrocarbonates (azurite), and likely copper oxides. However, the found native copper is more typical of the lower groundwater horizons. The native copper is formed through the decrease of acid potential at mixing of acid waters, which are saturated in copper ions forming by sulfide leaching with formation of H_2SO_4 in the higher horizons, and less acid groundwaters that were fed beyond the rocks bearing sulfide mineralization.

A steady trend of increasing copper content with SiO_2 decrease (Fig. 3) for samples with copper carbonates and hydrocarbonates could be explained by the higher permeability of these rocks for the ground and surface waters. This is also partially the case for samples with native copper. The supergene nature of copper mineralization prevents reliable deciphering the nature of its primary source. Nevertheless, the elevated contents of supergene copper and the discovery of secondary magnetite could be indirect evidence for the presence of porphyry copper systems. The average copper concentrations in the rocks with the established contents above 100 ppm taken as a clarke value accounted for 223 ppm, while the average content for the rocks with subclarke concentrations is 45 ppm. This shows both significant distribution of supergene copper mineralization over the entire PVC and the contrast of revealed anomalies. The intensity of the revealed anomalies is comparable to that of the copper anomalies within the ore field of the Peschanka porphyry copper deposit reported in (Kremenetsky et al., 2022). The Peschanka deposit is located in the Chukotka Autonomous Area (Fig. 2) and is one of the Russia's largest porphyry copper deposits.

CONCLUSIONS

Copper mineralization developed over a significant area was established for rocks of the PVC, the prospects of which for economic mineralization remain poorly studied. The highest copper contents are typical of the late-phase subvolcanic basaltic andesites of the PVC. The largest number (30 samples) of copper-rich lumps was found among intrusive rocks, amounting 43% of all studied intrusive rocks.

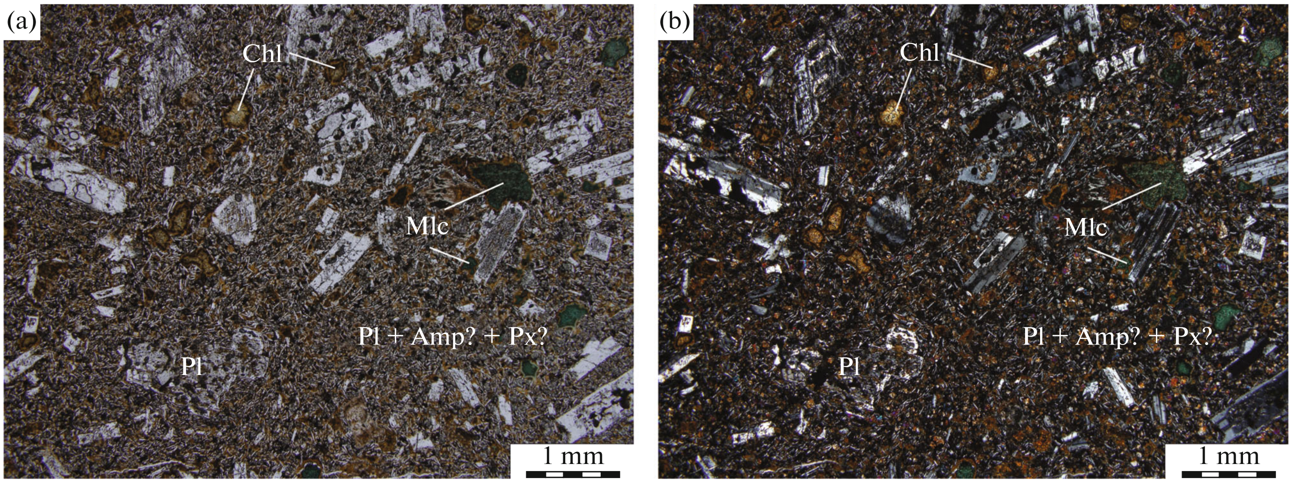

Fig. 4. Moderately altered porphyritic andesite. Plagiophyre texture; (a) without analyzer, (b) with analyzer. Copper content in the initial sample is 192 ppm (XRF data). Abbreviations: (Chl) chlorite, (Mlc) malachite, (Pl) plagioclase, (Amp) amphibole, (Px) pyroxene.

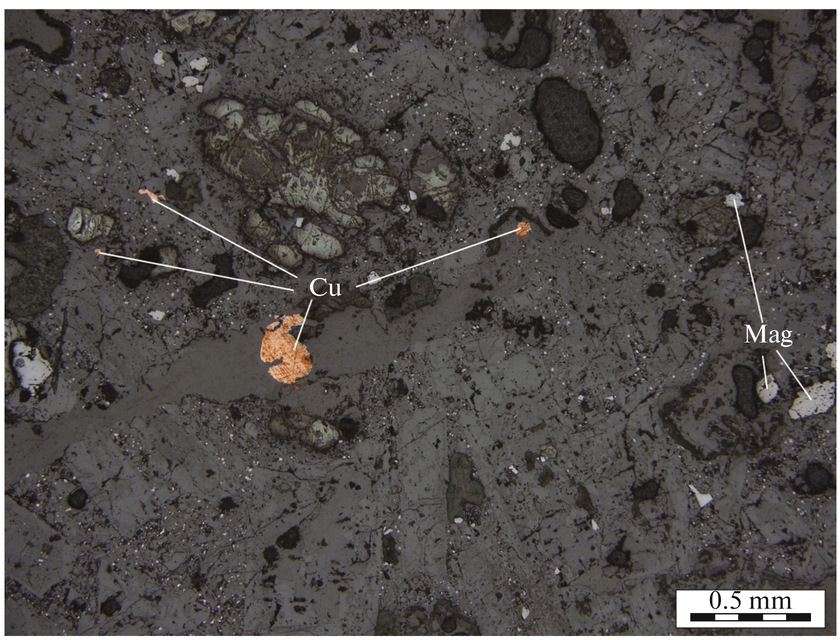

Fig. 5. Native copper in secondary mineral assemblage in porphyritic andesite. Magnetite phenocrysts in the initial rock. Copper content in the initial sample is 109 ppm (XRF data). Abbreviations: (Cu) native copper, (Mag) magnetite.

The presence of the elevated contents of supergene copper in the studied area and the discovery of secondary magnetite could be an indirect evidence for the presence of porphyry copper systems. Numerous gold–silver–epithermal deposits (Bortnikov et al., 2023) developed to the west of the studied area and similarities with other known porphyry copper deposits of active island arcs also suggest the possible localization of OMS producing them within the coastal band of South Kamchatka.

The established copper contents in lumps could be considered as low to medium geochemical anomalies based on primary dispersion halos. Obtained results could be used as substantiation for thematical prospecting works.

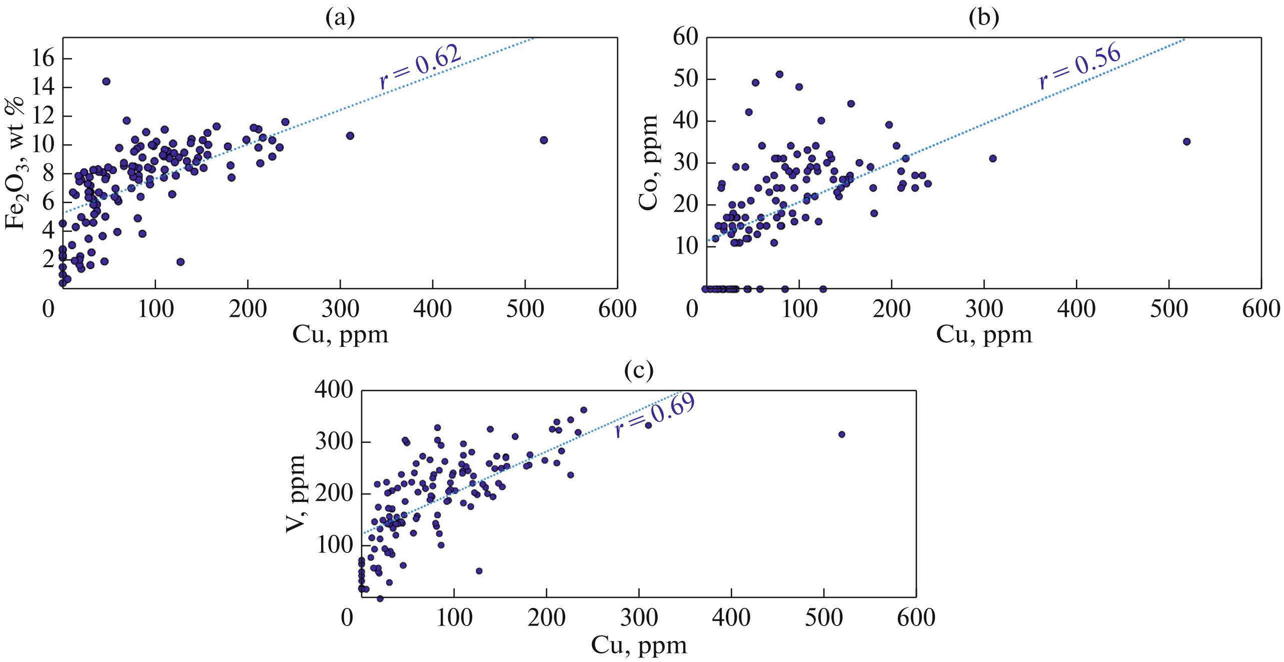

Fig. 6. Variations of Fe_2O_3tot versus Cu content (a), Co versus Cu (b), and Cu versus V (c). Sample with 3042 ppm Cu content was excluded.

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CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

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