ISSN 1028-334X, Doklady Earth Sciences, 2006, Vol. 408, No. 4, pp. 526–529. © Pleiades Publishing, Inc., 2006.
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GEOLOGY

Structural Position of Gold Ore Deposits in the Intrusive Volcanogenic Framing of the Precambrian Gonzha Salient (Upper Amur Region)

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Presented by Academician Yu.M. Pushcharovsky August 25, 2005

Received September 1, 2005

DOI: 10.1134/S1028334X06040040

When studying geological constraints of mineral deposits and their aureoles, V.A. Obruchev, S.S. Smirnov, and Yu.A. Bilibin paid attention to the important role of early fold–block tectonic structures in distribution of endogenic mineralization of later metallogenic epochs.

The abundance of closed and fragmentary ore belts along such structures was noted in [1]. Recent geological–geophysical studies of gold ore districts in the Russian Far East [2, 3] specified the essential role of Precambrian massifs, salients, blocks, deep faults, and protomagmatic chambers in distribution of noble metal deposits. However, additional information on position and major factors determining localization of explored deposits is needed to predict new objects in known ore districts and select the most promising ore occurrences. The analysis of geological data on the Gonzha area from this standpoint revealed that gold deposits in this area are associated with necks, stocks, sills, and paleovents located at the margins of volcanoplutonic granitoid massifs surrounding the local Precambrian salient.

The Precambrian Gonzha salient (PGS) represents an element of the northern Bureya Massif that is defined by some geologists as the Khumakhe–Gonzha–Mamyn megablock [4]. The salient is composed of intrusive metamorphic rocks of the Upper Archean Gonzha Group (various gneisses, amphibolites, and quartzites) and Lower Proterozoic greenstone sequences (schists, metadolerites, and phyllites of the Chalovka Formation) with ultramafic bodies. The deformed PGS sedimentary cover comprises Riphean–Lower Cambrian sandstones, siltstones, carbonaceous–siliceous, and micaceous schists, which are irregularly metamorphosed up to the epidote–amphibolite facies, and Silurian–Carboniferous siliciclastic–carbonate sediments largely of the Devonian Verkhnii Amur Group with Late Devonian intrusions of the Urusha gabbro–diorite–plagiogranite complex.

The salient is surrounded by Upper Mesozoic rock complexes (Fig. 1) composed of Middle–Upper Jurassic siliciclastic sediments of the Osezhin Trough (Middle Jurassic Osezhin, Upper Jurassic Ayak, and other formations) and Cretaceous complexes of the Umlekan volcanoplutonic zone. Magmatites of the Umlekan volcanoplutonic zone belong to the Upper Jurassic–Lower Cretaceous Magdagachi granosyenite–granite porphyry, Lower Cretaceous Verkhnii Amur diorite–granodiorite, Lower Cretaceous Burinda monzodiorite–monzogranodiorite, Upper Cretaceous subvolcanic granite porphyry, Lower Cretaceous Taldan andesite–dacite, Lower Cretaceous Kerak dacite–rhyolite, and Lower Cretaceous Gal'kino contrast (basaltic andesite–rhyolite–trachyrhyolite) complexes. Effusive–pyroclastic accumulations of the cited rocks with comagmatic extrusive and subvolcanic bodies (necks, stocks, dikes, and sills) are localized in several volcanotectonic depressions. The intrusive volcanogenic periphery of the PGS is covered by slightly lithified Neogene–Quaternary sediments.

Intense magmatism in the PGS area fostered the formation of an oval dome structure. Its central part consists of ancient crystalline complexes, while the periphery includes Late Mesozoic intrusions and volcanic fields. According to geophysical data, the central part of the PGS coincides with an inferred regional gravitational minimum [2, 3]. Geophysicists explain this phenomenon by the existence of granitoid roots in the salient overlain by a relatively thin (<1 km) relict cover of ancient crystalline rocks. According to DSS data, the decompaction zone (maximum decompaction at depths of 20–30 km) is underlain by a zone of "seismic transparency" that reaches even the upper mantle [5]. The existence of several linear zones with high gravity gradients within the oval dome is considered an indicator

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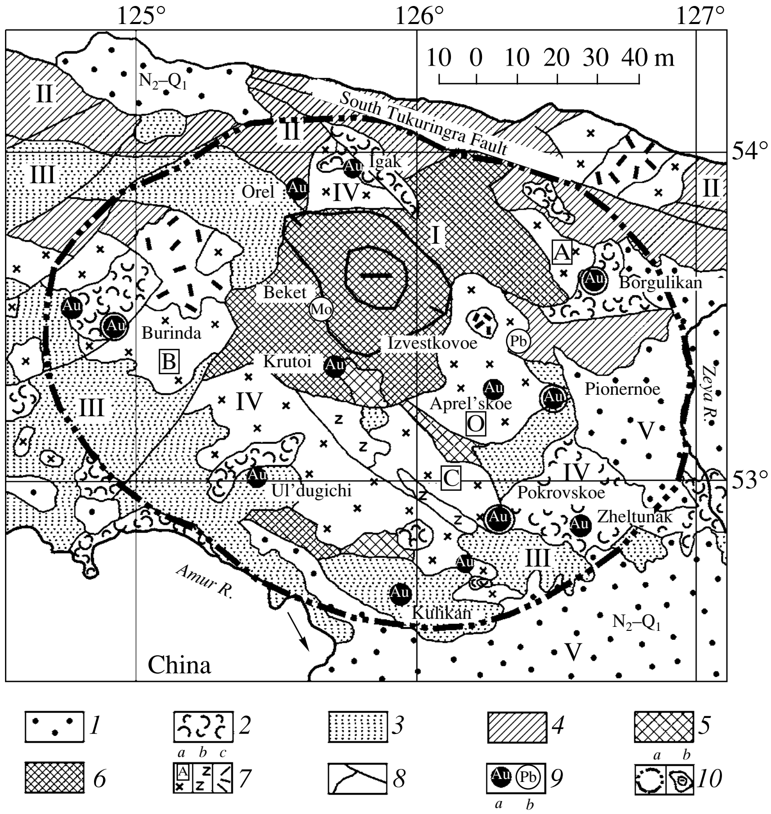

Fig. 1. Schematic geological–metallogenic structure of the Gonzha ore district. (*1–7*) Different-age geological complexes: (*1–4*) stratified complexes: (*1*) Neogene–Quaternary siliciclastic, (*2*) Cretaceous effusive pyroclastic, (*3*) Jurassic siliciclastic, (*4*) Lower–Middle Paleozoic volcanosedimentary complexes enclosing coeval igneous rocks, (*5, 6*): intrusive metamorphic complexes: (5) Upper Proterozoic–Lower Paleozoic, (*6*) Middle Archean–Lower Proterozoic, (*7*) Late Mesozoic intrusive complexes: (*a*) monzodiorite, granodiorite–granite (K_1), (*b*) granosyenite porphyry (J_3–K_1), (*c*) subvolcanic granite porphyry (K_2); (*8*) large faults; (*9*) deposits and some large occurrences of (*a*) gold and (*b*) other metals; (*10*) (a) contours of (*a*) oval dome and (*b*) isolines in the central part of negative gravimetric anomalies. (I–V) Major tectonic structures: (I) Gonzha salient, (II) Mongol–Okhotsk system, (III) Osezhin Trough, (IV) volcanoplutonic framing (depressions and granitoid massifs indicated by letters in boxes): (A) Arba, (B) Burinda, (O) Ol'ga, (S) Sergeev; (V) Amur–Zeya Depression.

of the presence of large deep faults feathering the South Tukuringra Lineament (Fault), which serves as a tectonic boundary between the Yankan–Dzhagda fragment (Mongol–Okhotsk fold–thrust system) and the Bureya Massif (Fig. 1).

The thickness of granitoid massifs surrounding the PGS varies from 2.5–2.0 to 1.5–1.0 km or less. They have wedge-shaped outlines in the cross section because of the thinning of intrusions in marginal (relative to the root) parts.

The Mesozoic framing of the PGS hosts numerous gold placers that are grouped into several auriferous clusters (Igak, Taldan, Osezhin, Magdagachi, Kulikan, Tygda–Ulunga, Aprel'skii, and Umlekan). Virtually all of these clusters host occurrences of noble metals, frequently with specific structural, genetic, formation, and mineralogical–geochemical properties. In addition to gold ore occurrences, manifestations of molybdenum, copper, and base metals are also present. The Pokrovskoe, Pionernoe, Burinda, and Borgulikan deposits are the most known deposits in the Gonzha ore district.

The Borgulikan gold–molybdenum–copper deposit is located in the eastern sector of the Gonzha dome near the edge of the Arba pluton and its junction with the local volcanotectonic depression [6, 7]. The ore field comprises effusive–pyroclastic accumulations (Lower Cretaceous Taldan Complex), subvolcanic bodies of monzodioritic porphyrites, porphyritic biotite–hornblende quartz monzodiorites (Lower Cretaceous Burinda Complex) of the marginal Arba hypabyssal massif, and explosive breccia bodies. Hydrothermal–metasomatic alterations are represented by thick (1–2 km) and extended (up to 12 km) aureoles of quartz–K-potassic feldspar–biotite, albite–epidote–actinolite, quartz–sericite–chlorite (with tourmaline), argillisite, and carbonate–zeolite (with fluorite) associations. They also include zones of vein–disseminated (porphyry) gold–molybdenum–copper mineralization (magnetite–bornite–chalcopyrite, pyrite–chalcopyrite–molybdenite, and magnetite–pyrite associations). Ore-bearing lodes with relatively high concentrations of useful components (Cu, Mo, and Au) are largely localized in apical endocontact zones

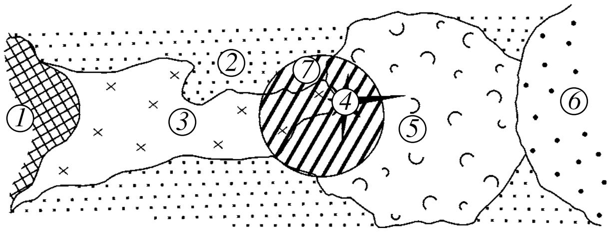

Fig. 2. Schematic relationships between different-age lithostructural elements in gold deposits of the Gonzha ore district. (*1, 2*) Geological complexes of the basement and sedimentary cover in the Precambrian Gonzha salient: (*1*) rigid blocks of the Precambrian salient, (*2*) granitized, metamorphosed, siliciclastic–carbonate, and siliciclastic rocks of sedimentary cover; (*3–5*) geological complexes of the Late Mesozoic volcanoplutonic framing of the PGS: (*3*) intrusive rocks of the monzogranodiorite and granodiorite complexes, (*4*) local paleovolcanic center and relevant necks, stocks, sills, and dikes of variable composition, (*5*) volcanotectonic depression (volcanic field); (*6*) Cenozoic siliciclastic sediments of taphrogenic depressions; (*7*) aureoles of metasomatic alteration of rocks enclosing auriferous vein–metasomatic bodies and lodes.

of porphyry intrusions, which are considered major elements of the local ore-magmatic system [7].

The Pionernoe gold ore field is located in the southeastern sector of the Gonzha dome at the margin of the Ol'ga monzodiorite–granodiorite intrusion (Lower Cretaceous Burinda Complex). This area is marked by an intersection of NE-, NW-, and NS-trending strike-slip fault zones that control linear ore zones (up to 1–2 km long), large subvolcanic dioritic porphyry and granite porphyry bodies, andesite and spessartite dikes, and explosive breccia. Metasomatic alterations of rocks are represented by hundreds of meters long and tens of meters thick zones of K-feldspathization, tourmalinization, propylitization, sulfidization, silicification, argillization, hydromicatization, and carbonatization.

The elevated contents of Cu, Mo, W, Zn, and Ag (3–5 times higher than background values) and relatively high Au concentrations in metasomatic aureoles imply the existence of hidden porphyry copper or molybdenum–copper mineralization in this deposit. The commercial mineralization in metasomatic and vein–silicified (terrigenous and igneous) substrate is related to gold–quartz–carbonate and gold–quartz mineralization accompanied by adularia–quartz, sericite–adularia–quartz, and quartz–adularia–hydromica–chlorite associations. Ore minerals in productive fine-grained chalcedony-like quartz are represented by native gold and subordinate fahlore, chalcopyrite, bornite, galena, and sulfosalts of Pb.

The Pokrovskoe gold–silver ore field is located in the southern sector of the Gonzha dome corresponding to the marginal part of the Sergeev Massif (Lower Cretaceous Upper Amur Complex) among Lower Cretaceous volcanics of the Kerak Complex. The deposit is structurally connected with a paleovolcanic vent and dikes of diorite porphyries, granodiorite and granite porphyries, and porphyric and aphyric dacites [8]. The major element of the Pokrovskoe ore field is a paleovolcano, represented today by a vent (up to 600 m across) filled with coarse-grained dacite–granodiorite–porphyries, extrusive and lava–pyroclastic rocks near the vent, thin flows of volcanic rocks along the caldera, and the dikes mentioned above.

The granitoids, volcanics, and subvolcanic bodies show the development of propylitization, feldspathization, silicification, argillization, sulfidization, and carbonatization. In the near-surface zone (particularly, at 0–50 m), hypergene argillization is enhanced by weathering and disintegration of rocks.

The major ore-bearing areas are localized near the paleovent and have no distinct geological boundaries. Therefore, they are only defined on the basis of sampling data as low-grade sulfide zones with concentrated vein–disseminated and vein gold–silver mineralization in silicified and argillized rocks. The deposit is characterized by the presence of native gold, silver, argentite, proustite, pyrargyrite, and polybasite. Pyrite, marcasite, and arsenopyrite are the major ore minerals. Chalcopyrite, sphalerite, galena, pyrrhotite, hematite, magnetite, freibergite, molybdenite, antimonite, and cinnabar are subordinate.

The ore field is characterized by the abundance of intrusions and their influence on the distribution of mineralization. The lower level of commercial mineralization in the central part of the deposit is governed by dacite–granodiorite porphyry sill, which is associated in deep zones with the paleovent mentioned above. This sill was responsible for the formation of a hidden dome in the marginal part of the Sergeev Massif. Gold mineralization is localized above thick zones of the sill and is laterally restricted by its pinchout zones [8].

The Burinda gold–silver deposit is situated in the western sector of the Gonzha dome at the intersection of NE-trending and near-meridional faults. The deposit occupies the south-southwestern part of the Taldan volcanic field at the end of the Early Cretaceous granite–granodiorite massif [6]. The area corresponds to a local volcanotectonic depression filled with Lower Cretaceous effusive–pyroclastic rocks of the Taldan Complex. The depression hosts extrusive bodies and dikes of andesites, granite porphyries, large bodies of hypabyssal monzodiorites, granodiorite porphyries, and adamellites of the Burinda Complex. Both volcanic and subvolcanic rocks are subjected to propylitization, argillization, and silicification (locally, transformed into hydrothermal quartzites). Low-grade sulfide ore bodies are represented by veins and veinlets hundreds of meters long and up to 15 m thick. They contain abundant carbonates and quartz accompanied by subordinate chlorite, sericite, adularia, albite, and other vein minerals. Ore minerals include pyrite, galena, sphalerite, chalcopyrite, argentite, pyrargyrite, proustite, fahlore, and native gold and silver.

Thus, the distribution, geological structure, and hydrothermal–metasomatic transformations of rocks in the best-studied intrusive volcanogenic gold ore fields around the PGS make it possible to define the following major elements of typical lithostructural associations (Fig. 2): the central zone with rocks of the PGS; marginal (relative to boundaries of the salient) parts of Late Mesozoic granitoid massifs; and zones of their conjunction with local volcanotectonic depressions. Such zones are marked by paleovents, subvolcanic bodies, variegated dikes, explosive breccia, and metasomatic aureoles. The major elements are typical of many other gold ore clusters and districts of the Russian Far East and Transbaikal region [9].

Several other (yet poorly studied) noble metal occurrences occupy rather similar structural positions in the Gonzha ore district (Fig. 1). This means that metallogenic potential of the study region is insufficiently explored. Hence, it is necessary to activate further prospecting and exploration of new deposits in the Gonzha district.

ACKNOWLEDGMENTS

This work was supported by the Russian Foundation for Basic Research and the Siberian Division of the Russian Academy of Sciences, project no. 06-05-96013.

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