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Geology

Gold Potential of Georgia

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(Presented by Academy Member David Shengelia)

ABSTRACT. The authors' aim was determination of estimated gold resources on the basis of the geological data analysis. The following methods were used for calculation of resources: parameters of ore bodies at gold occurrences, data of geochemical anomalies, geological evidence indicating existence of ore bodies in the depth. The territory of Georgia includes part of the Alpine-Himalayan mountain-fold belt, which is a result of interaction of the Scythian and South Caucasus microplates geologically developed in the marginal area of the Eurasian continent. Four gold bearing complexes are found on the territory of Georgia: 1) Activated in Middle Jurassic south Caucasus microcontinent slope and slope root zones, which are built by Palaeozoic Middle-Early Jurassic marginal sea flischoid-terrigenous sediments (potential in Middle Jurassic deposits in granite stocks - Lukhra and in carbonaceous suite - Arshira, Lasilli, on Svaneti ridge; 2) The Greater Caucasus southern slope suture zone ("main thrusts" zone), built up by Lower Jurassic sediments, activated in Middle Jurassic and Neogene and characterized by mercury, arsenic, antimony, gold, tungsten and copper (Upper Svaneti, Upper Racha, mountainous Kakheti); 3) Intraplate rift volcanic structures, characterized by volcanogenic-epigenetic polymetallic copper-porphyry, gold, as well as skarn iron-ore mineralizations (Adjara, Guria and Trialeti Eocene ore occurences in Georgia); 4) Formations of arc depressions characterized by volcanogenic-epigenetic copper, barite-polymetallic and gold mineralizations (Late Cretaceous deposits: Madneuli, Tsiteli Sopeli, and Sakdrisi and Bektakari). Gold manifestations of the southern slope of the Greater Caucasus refer to the gold deposits, which are spread at carbonaceous terrigenous series. In the limits of Adjara-Trialeti, apparently we have a remote upper level of porphyry copper-gold deposits. In Bolnisi district gold is concentrated in silicified zones of volcanogenic copper deposits. Thus, for manifesting Georgia's gold potential, which according to our estimates is 306 tons, it is necessary to carry out prospecting. That requires restoration of geological survey, which will enable conducting the geological mapping, prospecting and exploration works. To confirm the potential of gold the investigation of ore areas is necessary. *© 2016 Bull. Georg. Natl. Acad. Sci.*

Key words: Georgia, gold, deposit

The territory of Georgia includes part of the Alpine-Himalayan mountain-fold belt, which is a result of interaction of the Scythian and South Caucasus microplates geologically developed in the marginal area of the Eurasian continent. In addition to geological characteristics, real content and data of geochemical halos were taken into account (as for Poladauri volcano structure, which geological-geochemical data were compared with data of Madneuli deposit).

Lithogeodynamic complexes formed in different geodynamic regimes are observed in the Caucasus, and minerals of different age, composition and type are related to them. Fourteen lithogeodynamic complexes are distinguished in the Caucasus. Caucasus metal deposits are discribed in different papers [1-5].

Four gold bearing complexes are met on the territory of Georgia, out of them: 1) Activated in Middle Jurassic south Caucasus microcontinent slope and slope root zones, which are built by Palaeozoic Middle-Early Jurassic marginal sea flischoid-terrigenous sediments (here known potential Middle Jurassic deposits in granite stocks - Lukhra and in carbonaceous suite - Arshira, Lasilli, on Svaneti ridge; 2) Formations of back arc depressions characterized by volcanogenic epigenetic copper, barite-polymetallic and gold mineralizations (Late Cretaceous deposits: Madneuli, Tsiteli Sopeli, Sakdrisi and Bektakari); 3) Intraplate rift volcanic structures, characterized by volcanogenic-epigenetic polymetallic copper-porphyry, gold as well as skarn iron-ore mineralizations (Adjara, Guria and Trialeti Eocene ore occurences in Georgia); 4) The Greater Caucasus southern slope suture zone (“main thrusts” zone), built up by Lower Jurassic sediments was activated in Middle Jurassic and Neogene and is characterized by mercury, arsenic, antimony, gold, tungsten, and copper (Upper Svaneti, Upper Racha, mountainous Kakheti).

Gold manifestations are established in the southern slope of the Greater Caucasus (northern part of the South Caucasus microplate). In Svaneti, in the southern slope of the Greater Caucasus, gold mineralization is localized in areas of middle Jurassic tectono-magmatic activation of early Jurassic and Palaeozoic terrigenous (in some areas volcanogenic) formations.

Middle Jurassic quartz diorite bodies are defined in Dizi series. The Lukhra gold occurence (Fig. 1) is located in one of them, where 10-12 m thick gold-quartz zones are distinguished (average gold content of 8-10g /t). Based on current assessment Lukhra occurence gold potential is about 30 t of metal.

The northernmost occurrences, belonging to quartz-arsenic-sulfide type gold mineralization, are related to tectono-magmatic activation areas and are localized within Early Jurassic flyschoid sediments (Racha) accumulating in axial zones of marginal seas. Ore bearing shale-sandstones are carbonaceous, slightly carbonate. The zones by thickness of 2-3 meters and with gold content of 4.5-7 g/t (Zopkhito occurrence) are represented by carbonaceous shales saturated with pyrite and arsenopyrite.

They are largely spread (hundreds of meters along strike, 200-300 m along dip), and contain small discontinuous, quartz antimony veins, some of them are tungsten containing. Sampling results of gold mineralization zones in mines showed that orebearing shales are enriched by cobalt, lithium, vanadium, arsenic and zinc; diagenetic pyrites are often gold containing. Here, for showing mineralization degree, are given sampling results of mines, where ore bearing shales are enriched also in cobalt, lithium, vanadium, arsenic and zinc; diagenetic pyrite is often gold bearing [6]. The total length of ore vein zones at Zopkhito amounts 5.6 km, and gold potential - 43 tons (Fig. 2).

At the oldest greenstone belt (eg. Abitite, Car-Edison deposit [7], gold mineralization is located near the syenite stocks and associated with komatiite that has signs of liquation processes. Taking into account Rodders’ [8] opinion, it can be assumed that the mantle substance experienced division into alkali-aluminosilicate and mafic melts in undercrustal depths. The latter subjected to liquation close to the

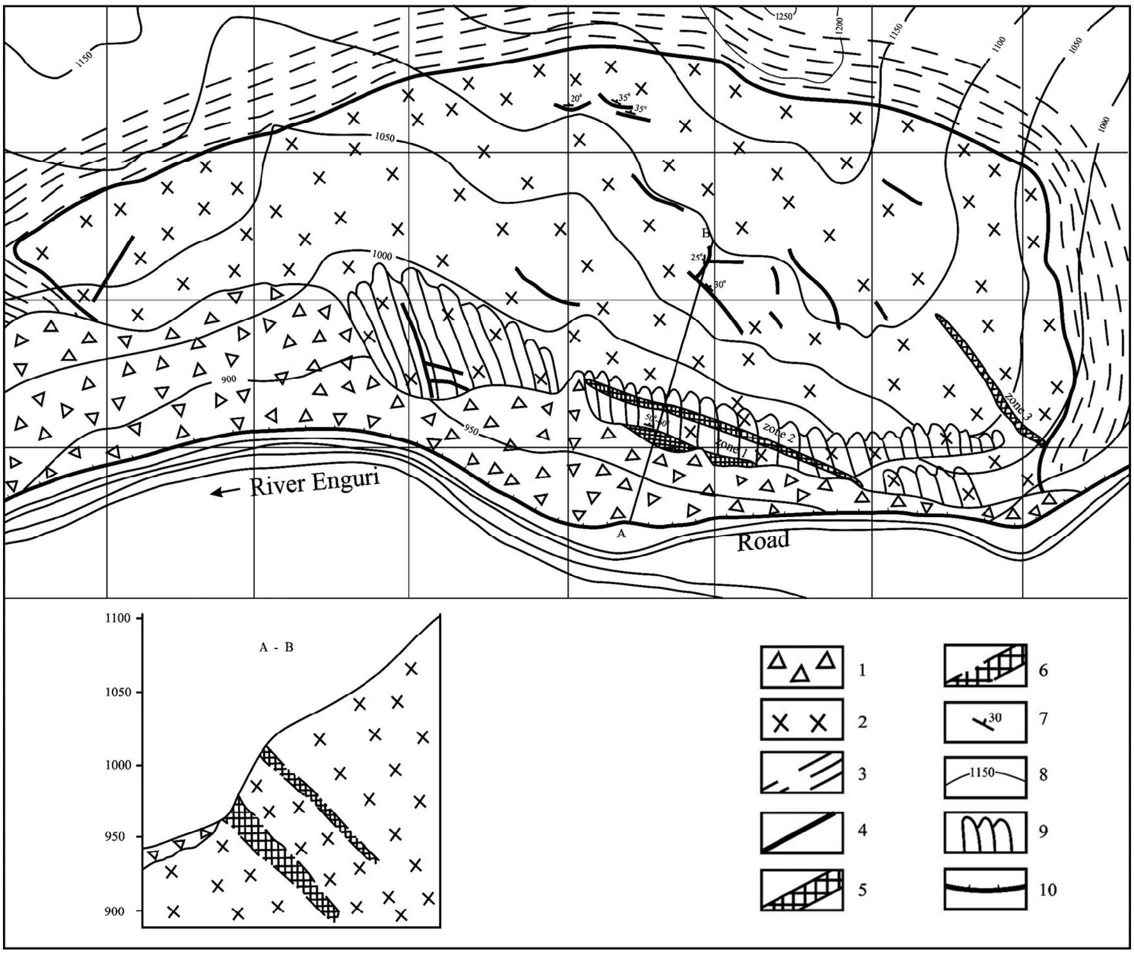

Fig. 1. Geological sketch of the Lukhra deposit (Svaneti, Georgia).
1. Deluvium: debries of large fragments of diorites and granodiorites; 2. Bathonian quartzy diorites and granodiorites; 3. Devonian hornefells mica slates; 4. Quartz veins, some of them goldbearing and included scheelite; 5. Gold bearing zones (brecciated milky white quartz, cemented by quartz-chalcedony); zones (in numerator of gold content in g/t, in denominator-thickness of zone in m): № 1-8.9/6 visible thickness), № 2-3/5; № 3(1.0/5); 6. Probable stretching of the goldbearing zones; 7. Position of the gold bearing zones and quartz veins; 8.Contour lines of relief; 9. Benches; 10. Proection of plane of relief truncation along the road.

surface allocating sulfide constituent. Possibly, this mechanism determines the beginning of gold migration and concentration stage. In our opinion, then exogenous collapse of ultrabazite-bazites and gold transport by alluvial flows in the form of metacolloids into flyschoid sediments took place. In flysch basins gold could be absorbed by microorganisms and could be sorbed by clay minerals, as it is believed by many researchers [9]. Gold grab in flysch accumulation zones is necessary but not sufficient condition for formation of gold deposits. Ore accumulation in carbonaceous terrigenous rocks was preceded by the processes (metamorphism, magma generation), which promoted formation and allocation of gold bearing ''mobilizates" (fluids and fluid-magmatogenic systems). In South Caucasus (within Georgia) Adjara-Trialeti Paleogene volcanics and intrusives, and in the East – Cretaceous volcanogenic plutonic rocks are gold bearing (Fig. 3, deposits: Madneuli, Tsiteli Sopeli, Poladauri, Bektakari).

There is the resemblance between Madneuli and some Miocene Japanese deposits (the presence of isolated barite bodies and barite-polymetallic accumulations, including gypsum in the lower horizons). The main difference, however, is that in Madneuli the process of ore accumulation was realized within the

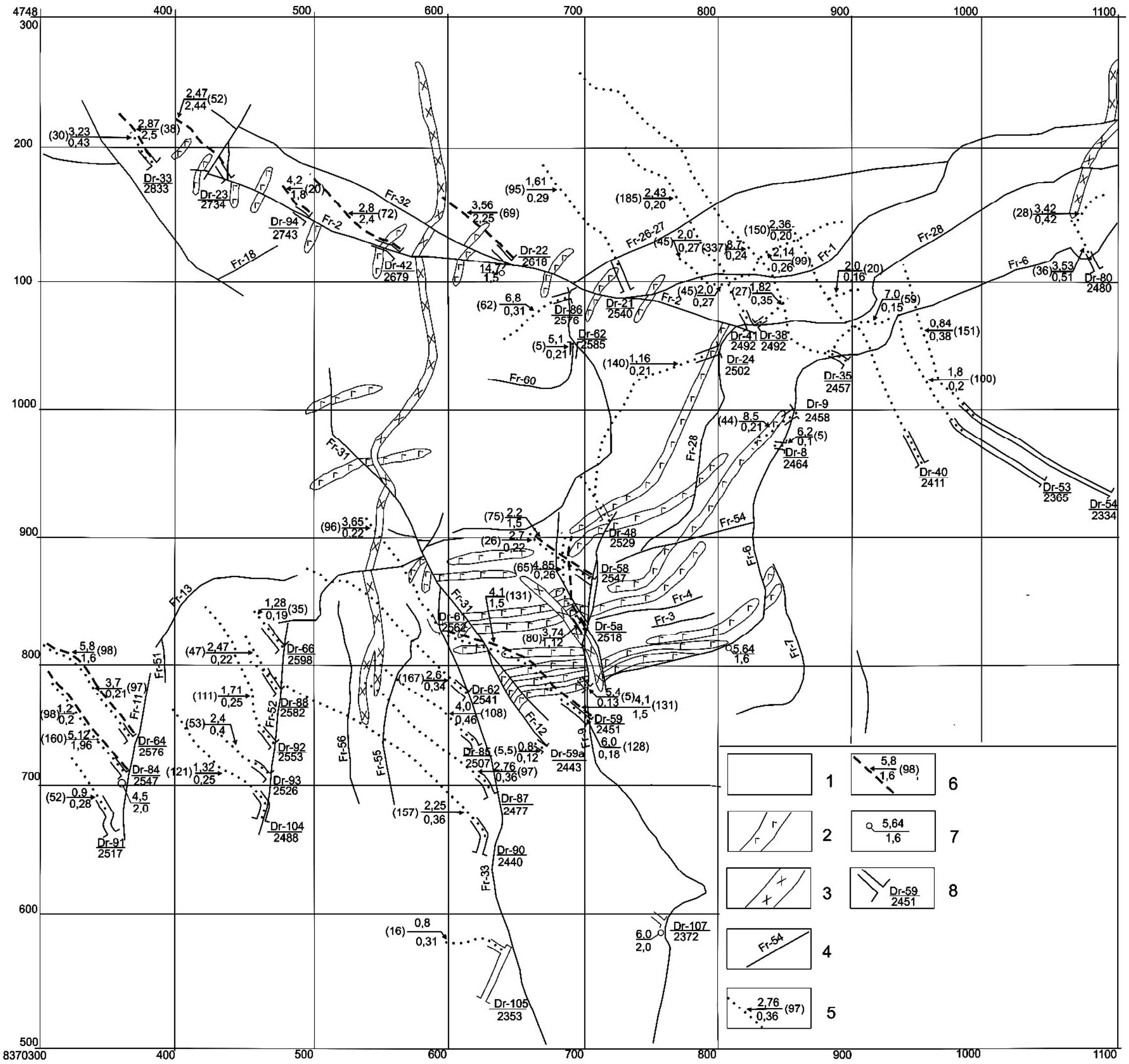

Fig. 2. Scheme of location of mineralized zones at Khirkhi district (Zopkhito,deposit, Ratcha, Georgia) and sampling results on gold from mines.

1 – carbonaceous clayey slates and sandstones (Lias), intensively silicified along the mineralized fracture zones;
2 – diabases (Middle (?) Jurassic); 3 – granodiorite-porphyry (Neogene); 4 – Mineralized fracture zones (and their number), containing quartz-stibnite and earlier quartz-pyrite-arsenopyrite veinlike accumulations. Hosting clayey slates are transformed to quartz-sericite (carbonate) metasomatites with small disseminations of pyrite and needle arsenopyrite;
5 – sampled only quartz-stibnite veins (sometimes with quartz-arsenopyritic accumulations), data of 40-50-ies of the last century; in numerator - average weighted content of gold (g/t) along the sampled (along the strike) quartz-stibnite vein section; in the denominator average thickness of vein in m; in brackets – length of sampled section of vein in m;
6 – sampled mineralized zones transversely to the strike along the width of addits, data of 80-ies of the last century; in numerator – average weight content of gold along the sampled (along the strike) section of mineralized zone in the limits of addit, in g/t; in denominator average thickness of mineralized zone section revealed by addit; in the brackets – length of sampled mineralized section in the limits of addits; 7 – samples from the surface (taken in1999); in numerator – gold content in g/t; in denominator – length of trail samples; 8 – projection of start of addits on the horizontal plane; in denominator - absolute mark of addit mouth.

Note: in 40-50-ies Zopkhito deposit was prospecting on antimony, and gold was considered as accompanying component and were sampled only narrow fracture zones, mainly filled by quartz-antimony veinlike and lencelike accumulations. mineralized fracture zones were investigated in following addits: 1) fr-2 – 21, 22, 23, 33, 35, 40, 41, 42, 53, 54, 94; 2) fr-6 – 8, 9, 35, 80; 3) fr-9 – 5a, 48, 58, 59; 4) fr-11 – 64, 84, 91; 5) fr-12 – 59a, 79; 6) fr-28 – 24, 35, 38, 39; 7) fr-26-27 – 62, 82; 8) fr-33 – 61, 62, 85, 87, 90, 105; 9) fr-52 – 66, 88, 92, 93, 104; 10) fr-54 - 110.

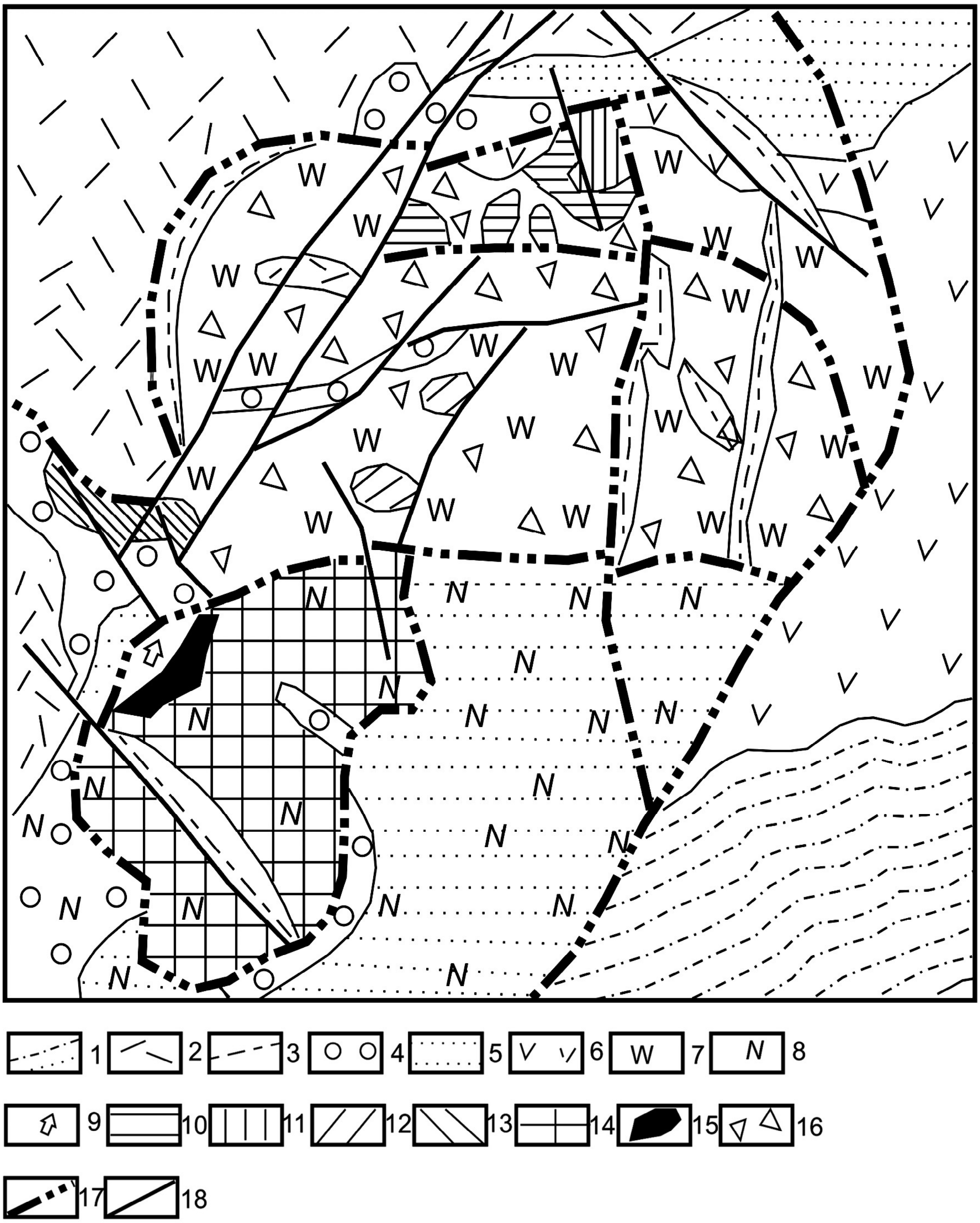

Fig. 3. Geological and structural map of the Madneuli open pit mine.
1 – extrusive rhyodacites; 2 – rhyolite lavas; 3 – subvolcanic rhyolite bodies; 4 – vortoclastic tuffs; 5 – psammo-psephite and alevrolitic tuffs; 6 – agglomerate and psammo-psephitic xenotuffs; 7 - Goldbearing secondary quartzites; 8 – quartz-sericite-chlorite metasomatics; 9 – gypsum and anhydrite accumulations; ores; 10 – barite; 11 – massive barite-lead-zinc; 12 – veinlet polymetallic; 13 – veinlet copper-zinc; 14 – veinlet and impregnation copper; 15 – base metal massive sulphide; 16 – explosive breccia; 17 – gentle faults; 18 – subvertical faults.

closed volcanostructure (whose final formation took place in subaerial conditions), and in most Kuroko type deposits, in Japan - on the sea floor. The semantic-logical genetic model developed previously for Madneuli deposit [10, 11] considered participation of brines in the process of mineralization; among them some were ore bearing from the beginning. Others, which take higher levels and are distanced from volcanic structures, were involved in ore formation at the late stages. They suffered metamorphism and simultaneously got ability of extraction of ore components' part from wall rock space. According to the model, at the first stage, in the result of squeezing rhyolite extrusions locked arch structure was formed on the volcano slope, and then absorption of warmed water saturated with magmatic (volatile) components took place. At 400-500 m from the surface level, the waters suffered a collapse; in the result explosive breccias, mainly from effusives and tuffites (roots of explosives), were formed under an impermeable screen (of lava arches). Breccias in turn, experienced pre-ore transition (before barite and barite-polymetallic ore mineralization), while inside them two paleohydrochemical zones were detached: the top - sulfate-amonium (level of secondary quartzite) and lower - chloride-sodium (level of quartz-seritcite-chloride metasomatites). The border between them is fixed in gypsum accumulations and jasper type quartzites. The pre-ore environment was conducived by: 1) solution boiling, its alkalinization by separation of acidic components (sulfides, gold nuggets, quartz, carbonate, adular separation); 2) H_2S, HCl, CO_2, NH_4 oxidization at the top level; 3) the substitution reactions with host environment of buffer properties.

Gold Bearing Quartzites, Represented at Madneuli Polyformational Deposit

In our opinion, quartz veinlets in gold bearing brecciated quartzites were formed almost simultaneously with explosive breccias. Precipitation of gold, quartz and sulfides in small amounts is perceived as a one-act process, which is related to destabilization of magmatogenic fluids in the environment of high oxidation potential of secondary quartzite development.

Based on library materials it can be concluded that sometimes gold deposits are linked to carbonaceous formations, on the other side - to the mantle substance differentiates. For the first occasion, the following sequence of metal migration and concentration is possible: a) from the beginning gold accumulated in terrigenous formations exogenously, b) the latter then underwent metamorphism and fluid-magmatic replacement, c) at hypabissal level the gold mobilizate separation took place after movement of fluid-magmatic systems. The sources of gold primary anomalies could be ultrabasite-basite complexes of the ancient foundation, and metals apparently were transported to flysch sediments by paleo-channels, whose beds were located along deep fault structures. Gold, relocated by colloid sils, was caught by organisms and adsorbed by clayey minerals. It is possible in volcano-plutonic complexes occurrence of gold bearing magmatic systems at under crust depths, and then their transformation into ore-magmatic systems. At hypabyssal and subvolcanic levels, in suture zones, gold bearing systems might be formed by impact of deep fluid magmatic flows on basite-ultrabasite complexes.

Gold Discovery Perspectives in Georgia

There started exploration works in Sakdrisi deposit, Bolnisi district. In Madneuli deposit copper reserves expire, but the following circumstances are of interest: in deep zones of quartzites copper content reduces and at the same time gold content increases (according to open pit data), it is possible that there is a "hybrid" type deposit in which epigenetic Kuroko type ores are changed by gold-copper porphyry ores in depth. But this is only judgment. At a depth of 1000 m granodiorite porphyry intrusive is established by drilling, the apical part of which contains molybdenum. It is possible that Tsiteli Sopeli and Poladauri gold containing structures are of economic importance.

In the Lesser Caucasus, within the limits of Adjara region there is an interesting gold mineralization of Vaio. Vein zones (gold content ranges between 0.2-80 g/t) are located mainly in syenite-porphyries, which form a dome structure together with volcanics. It can be assumed that the volcanic structure is an outcome of syenite intrusion. Only its eroded apical part could be seen.

There are twelve gold placers in the southern slope of the Great Caucasus, and more than ten gold occurrences, potential deposit of Lukhra in the Kirari-Abakuri ore-knot; Arshira and Lasili in the Svaneti range; Tsana and Zopkhito deposits in Svaneti-Racha ore district. Gold occurrences of the southern slope of the Great Caucasus are described in detail by the authors [12].

Everywhere the works should be carried out with the study of ore technology. Zopkhito similar gold deposits attribute to an economic type gold deposits in carbonaceous series. An example of such type deposit is Muruntau in Uzbekistan, whose gold reserves reach 2000 t.

All gold occurrences known in Georgia are of great interest and deserve assessment. Also detailed prospecting-exploration works should be conducted at Hokrila (Upper Svaneti) and Stori (Kakheti) occurrences.

In the Poladauri structure the gold potential is estimated as 40 tons (on the basis of geological, geochemical and geophysical criteria). Poladauri volcano-structure represents the central type volcanic construction. Here are distinguished geochemical anomalies, which correspond to supra-ore level. Here is also known Samtsverisi barite-polymetallic ore occurrence.

Prognostic resources were assessed by three anomalies and standards using parameters of Madneuli deposit surface. Prognostic resources of copper were estimated at 280.8 th. t, and gold - 43.6 tons.

As for the western part of Adjara-Trialeti, it is assumed that two types of gold occurrences are developed: Merisi ore knot Gold occurrences represent natural formations of copper porphyry paleo-systems development; while Vakijvari, Zoti and Gagvi occurrences are the results of gold hydro-systems functioning. Four areas are allocated in the western part of Adjara-Trialeti: the first area includes a number of gold anomalies and three occurrences - Charnali, Chakvistavi and Khalastavi; the second area contains two - Vakijvari and Zoti orefields; the third one - four gold schlich anomalies, gold occurrence of Gagvi and two polymetallic occurrences; and the fourth is Merisi ore knot.

The total gold potential of the above area is 194 t, where the first area amounts 36 t, the second - 50 t, the third - 50 t, and the fourth - 58 t of gold reserves.

Thus, for revealing Georgia's gold potential, which according to our estimates is 306 tons, it is necessary to carry out prospecting. That requires restoration of geological survey, which will enable conducting of the geological mapping, prospecting and exploration works. Here we can prove that investigation of ore areas is necessary.

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გეოლოგია

საქართველოს ოქროს პოტენციალი

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(წარმოდგენილია აკადემიის წევრის დ. შენგელიას მიერ)

საქართველო ინარჩუნებს ოქროს საბადოთა აღმოჩენის პოტენციალს. ამიტომაც ჩვენ მიზნად დავისახეთ, გეოლოგიური მასალის ანალიზის საფუძველზე, დაგვედგინა ოქროს სავარაუდო რესურსები. ამისათვის გამოყენებული იყო რესურსების დათვლის შემდეგი მეთოდები: ოქროს გამოვლინებებზე მადნიანი სხეულების პარამეტრები, გეოქიმიური ანომალიების მონაცემები, გეოლოგიური ნიშნები, რომლებიც მიუთითებენ სიღრმეში მადნის სხეულების არსებობაზე.

საქართველოს ტერიტორია მოიცავს ალპურ-ჰიმალაური ნაოჭა სარტყლის ნაწილს, რომლის გეოლოგიური განვითარება ხდებოდა ევრაზიის კონტინენტის განაპირა ზოლის ფარგლებში, სკვითური და სამხრეთ კავკასიის მიკროფილაქნების ურთიერთქმედების შედეგად. საქართველოს ტერიტორიაზე ცნობილია 4 ოქროსშემცველი ლითოგეოდინამიკური კომპლექსი: 1. სამხრეთ კავკასიის მიკრო-კონტინენტის ფერდისა და ძირის ზონები აქტივიზირებული შუაიურულში, რომლებიც აგებულია პალეოზოური და ადრე-შუაიურული განაპირაზღვიური ფლიშოიდურ-ტერიგენული ნალექებით (აქ ცნობილია შუაიურული პოტენციური საბადოები გრანიტოიდების შტოკებში - ლუხრა და ნახშირბადიან წყებაში - არშირა და ლასილი სვანეთის ქედზე); 2. კავკასიონის სამხრეთი ფერდის სუტურული ზონა („მთავარი შეცოცების“ ზონა), აგებული ქვედაიურული ნალექებით, რომელიც აქტივიზებული იყო შუაიურულსა და ნეოგენურში და სპეციალიზებულია ვერცხლის წყალზე, დარიშხანზე, სტიბიუმზე, ოქროზე, ვოლფრამსა და სპილენძზე (ზემო სვანეთი, ზემო რაჭა, მთიანი კახეთი); 3. შიდაფილაქნური რიფტოგენული ვულკანური სტრუქტურები, სპეციალიზირებული ვულკანოგენურ-ეპიგენეტურ პოლილითონურ, სპილენძპორფირულ, ოქროს, აგრეთვე სკარნულ რკინამადნიან გამადნებებზე (აჭარის, გურიის და თრიალეთის ეოცენური მადანგამოვლინებები საქართველოში); 4. რკალგაღმა დეპრესიების წარმონაქმნები სპეციალიზებულია ვულკანოგენურ-ეპიგენეტურ სპილენძის, ბარიტ-პოლილითონურ და ოქროს გამადნებებზე (გვიანცარცული საბადოები: მადნეული, წითელი სოფელი, საყდრისი და ბექთაკარი). კავკასიონის სამხრეთი ფერდის გამოვლინებები მიეკუთვნება ოქროს საბადოების ტიპს, რომელიც გავრცელებულია ნახშირბადიან ტერიგენულ წყებებში; აჭარა-თრიალეთში, როგორც ჩანს, ჩვენ გვაქვს საქმე ოქრო-სპილენძ-პორფირული საბადოების მოშორებულ ზედა დონესთან, ხოლო ბოლნისის რაიონში ოქრო კონცენტრირებულია გაკვარცებულ ზონებში ვულკანოგენურ სპილენძის საბადოებზე. ჩვენი გათვლით, საქართველოს ოქროს პოტენციალი აღწევს 306 ტონას. პოტენციალის რეალურ მარაგში გადაყვანისთვის საჭიროა ჩატარდეს ძებნა- შეფასებითი და საძიებო სამუშაოები ოქროს შემცველ უბნებზე.

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