TWO STAGES OF GOLD MINERALIZATION WITHIN SAKDRISI DEPOSIT (BOLNISI MINING DISTRICT, GEORGIA).

V. I. GUGUSHVILI[1], R. AKHVLEDIANI[1], M. NATSVLISHVILI[2] and I. HART[2]

[1]Geological Institute Ac. Sci. of Georgia, 1/9, M. Alexidze str., 380093, Tbilisi, Georgia

[2]*Australian–Georgian Joint venture Trans–Georgian resources 85, Z. Paliashvili str., 380062, Tbilisi, Georgia*

Abstract: The gold mineralization is related to course grained quartz veins and brecciated zones within the argilized and silicificated layered acid tuff and tefroits. The new prospecting criteria and age of gold origination were determined. The chemical composition of fluid inclusions from the mineralized zones indicates, that gold generation is related with alkaline carbonic acid solutions. The optimal conditions for gold mineralization coincides with the hydrothermal activity, which revealed in siderite-hydrobiotite alteration formed in two stages at 240^0-250^0C and 100-140^0C. The latter is related to low temperature quartz-barite veins.

Key words: gold mineralization, argilization, siderite, hydromica.

The Sakdrisi gold base metal deposit is located in Bolnisi Mining District (Lesser Caucasus). The latter consists of the several base metal gold vein and stockwork styles of deposit. The most significant among them are Madneuli, Tsiteli sopeli and Sakdrisi. Sakdrisi Deposit lately became interesting especially for gold mineralization. The Bolnisi mining district is located in Artvin Bolnisi zone which is included within Alpine Tethian Belt and is continuing to eastern Pontides. It lies within a larger metal rich tectonic corridor stretching from southern Georgia and Northern Armenia into Northern Turkey (Pontides), Bulgaria (Srednegora) and Romania (Balkan Region). This tectonic corridor developed during the subduction and collision of the Afro-Arabian (southern) plate beneath the Euro-Asian (northern) plate resulting in closure of the northern branch of the Tethys.

Mineralization within this corridor is widespread and includes such deposits as Chelopech Elshitsa and Medet (Bulgaria), Murgul, Artvin-Borchka, Cheratepe and Chaely (NE Turkey), Zod and Kafan (Armenia) and Madneuli, Dambludka, Sakdrisi (Georgia). The deposit styles within this corridor includes kuroko-style Cu-Pl-Zn-Ag-Ba-Au deposits porphyry Cu-Au deposits, hydrothermal and stockwork vein Au deposits and stockwork Cu-Pb-Zn-Au-Ba deposits.

The predominant styles of mineralization within the mining district are gold and basemetal vein and stockwork style of deposit. These deposits are mainly upper Cretaceous in age and are hosted within Cretaceous volcanics.

The Bolnisi district consists of a number of suites of Upper Cretaceous sediments, volcanogenic sediments and intrusive rocks of acid to intermediate and basic composition unconformable overlying a Paleozoic basement. The Upper Cretaceous suits are interpreted to have formed in an EW-striking "volcano-tectonic depression" bound by Paleozoic granitoid bodies, namely the Loki Massif to the south and Khrami Massif to the NW. The depositional environment for the sedimentary and volcanic rocks alternated between shallow marine and terrestrial. The stratigraphe throughout the region is relatively unreformed apart from minor folding and faulting associated with local tectonic events.

Within Bolnisi mining district economic reserves of gold mineralization are contained in hydrothermal argillites and silicified rocks-'secondary quartzites". The latters also contain mineable reserve of copper-pyrite and barite-polymetallic mineralization (± gold). The average gold content in the ores is approximately 4-5 ppm, whereas in the "secondary quartzites" it is 1.3 ppm. Deposit this fact the main reserves of gold mineralization here are associated with secondary quartzites and hydrothermal argillites. This is due to large volume and relatively even distribution of the gold grade through the secondary quartzites.

Nevertheless the gold concentration is related to numerous quartz-chalcedony veins and stringers formed dense net within hydrothermal argillites and silicified rocks and Sacdrisi deposit is not exception from this style.

The Sakdrisi deposit was initially investigated as a copper-pyrite and barite-polymetallic deposit only. Detailed investigation on the Sakdrisi occurrence during the last ten years has revealed its potential for gold mineralization (23.5 mt@ 1.03 g/t Au). The deposit is located within Upper Cretaceous volcanic units. The upper stratigraphic horizonts of this sequence are represented by rhyolitic ignimbrites and pumiceous pyroclastic flows (K-Ar age-77.6 Ma). These are intruded by rhyolitic and rhyodacitic extrusive domes (K-Ar age 72-71 Ma). The host rock within the mineralized envelope are severally structurally disrupted and discordantly overlain by the ignimbrites mention above (fig.1). These host units comprise tuff layers that are intensely silicified and argillized producing hydrothermal argillites with K-Ar age 83.6-82.1 Ma. The gold mineralization is localized in these highly altered rocks, whereas the overlying ignimbrites are unaltered and contain no mineralization (fig 1).

The structure of the Sakdrisi are is dominated by northeast striking faults, which are thought to be syn-vocanic ruptures controlling the primary mineralization. The gold mineralization at

Sakdrisi is contained within course quarts subvertical veins and laterally spread out to wall rock altered zones.

Within the main deposit area the layered tuff horizon (Mashavera suite) is mainly argillizied. The acid tuffs and tefroits are substituted mixed layered hydromica (illite-montmorillonite), kaolinite, dickite and quartz agglomeration. This process has a regional character and precede the specific wall rock alteration developed around the gold bearing course quartz veins and brecciated zones. Sakdrisi Deposit is divided on five sites according the faults distribution the sites (1-4) include the comparatively high temperatured quartz veins (240^0-250^0C T of homogenization of fluid inclusion in quartz). Whereas the site 5 is characterized by low temperatured quartz-barite veins (>150^0C). The goldbearing quartz veins frequently include chalcedony. Here we established zoning of gold mineralization within goldbearing quartz veins. The deepest zone coincides with wall rock epidotization (inclusion T - 320-400^0C). It is chacterized by poor gold content. The gold grades in these zones are very low --0.012-0.06 ppm.

The highest gold content (3.44-16.61 ppm) found within the intermediate hydrobiotite zone (inclusion T--240-250^0 C). Wall rock alteration printed on the host rocks (hydrothermaly argillized tuffs) hydrobiotite, siderite, hydromuscovite assemblage with intensive silicification.

The upper most goldbearing zone inclusion (T – 100-140^0C) occurs in the Sakdrisi site 5. It is revealed in quartz-barite part of the veins and brecciated zones (Au -- 1.41-3 ppm). The ore wall altered halo is characterized by intensive silicification, sometimes participate the hydrobiotite and siderite masses.

The low temperature quartz-barite zone observe also in the neighbor Kvemo-Bolnisi deposit, where its thickness is 95 m and average gold content is 6.4 ppm. Temperature zoning of the goldbearing quartz veins accompanied with zonality in wall rock alteration. The deepest zone (T 320-400^0 C) coincides with epidotization, chloritization and sideritization. The next, intermediate, zone (T-- 240-250^0 C) is characterized with wall rock of hudrobiotite, hydromuscovite, siderite assamblage, in the Sakdrisi site1 also chloritization (clynochlore) is manifested. The wall rock alteration of this stage is chacterized by intensive silicification and pyritization. The uppermost zone (T - 100-140^0C) represents of quartz-barite veins is related with intensive silicification, converted wall rocks into monoquartzites, also pyritization and sometimes siderite substitution.

Usually in the gold bearing quartz vein chalcedony occur. The participation of chalcedony evidenced gold mineralization. In the neighbor Madneuly deposit the gold mineralization related to network of chalcedony stringers into the silicificated rocks ("secondary quartzites").

The wall rock alteration around goldbearing quarts veins may be served as prospecting criteria. The most interesting among them is siderite and hydrobiotite accompanied the richest zone of gold mineralization. The siderite itself developed along goldbearing quartz veins from top to bottom. In the richest intermediate zone it is associated with hydrobiotite. The wall altered zones are goldbearing themselves. It is illustrated on the fig.2 where the gold reserves include both quartz veins and wall altered zones.

On the site Sakdrisi 3 drillhole intersects granodioritic intrusive and hornfelsed zone. These rocks are intensely altered and exebit replacement by quartz, epidote and actinolite. A similar association has been recognized within the Madneuli deposit (Gugushvili & Omiadze1988). The intrusive and zone of hornsfels both contain only minor amounts of gold (0.04-0.07 ppm). The granodiorite intrusive may represent an apophyse of the volcanic chamber and be the source of hydrothermal solution that has defined the hydrothermal alteration and gold mineralization at the Sakdrisi deposit.

The investigation of the fluid inclusions has shown that goldbearing solutions correspond to carbonic acid composition and are therefore comparatively alkaline. The presence of siderite and hydrobiotite in mineralized bodies confirms of carbonic-acid composition of the solutions. The fluid inclusions from mineralized zones indicate the presence of silica gel material. As previously mentioned the Madneuli gold mineralization is contained within the secondary quartzites and is associated with chalcedonic veinlets. The similarities suggest that the goldbearing fluids at Madnenli may also have had a carbonic acid composition.

It has been determined experimentally that carbonic acid solutions are capable of leaching gold from goldbearing sulfides such as - pyrite chalcopyrite and arsenopyrite (N. Cotov et al, 1995).

The relation the gold precipitation from carbonic acid solution and correlation between the gold mineralization and the sericite - ankerite - siderite assamblage has also been observed at the Marjabehal deposit in Central Asia. This deposit was formed under similar conditions to those found at Sakdarisi. The temperatures obtained for the homogenization of gas-liquid inclusions in quartz was 320^0C, 275^0C and 180^0C, with the most favorable temperature for gold generation being 275^0C (Kotov et al,1995). The formation of the gold mineralization at this deposit appears to be very similar to Sakdarisi, both in the temperature of mineralization and the style of wall rock alteration associated with mineralization.

Similarly in the west Tethyan region the Furtei Gold deposit (Sardinia) two stages of the gold mineralization were determined related to the carbonic-acid gold bearing solutions the first stage of gold precipitation related to grade 190^0C-280^0C and second stage is low temperatured (100^0C) fluids are related to barite precipitation in the surficial part of mineralization (Riggieri et al, 1997).

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Fig. 1. Crosssection on Sakdrisi site 3,4 on the bases of the drill holes. 1. ignimbrite, 2. limestones and dolomites, 3. argillized tuffs and tuffites, 4. oxidized and silicificated tuffs, 5. silicificated and pyritized tuffs, 6. faults, 7. gold mineralization.