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"Gold and Base Metal Deposits of the Mediterranean and the South Caucasus – Challenges and Opportunities"

Tbilisi, Georgia, November 11-15, 2012

Program & Abstracts

Tbilisi, 2012

Organizing Committee

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Only emails of the main contributor of each abstract are given.

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Program

Monday, November 12

9:00 – 9.30	Registration of Participants
9:30 -10:00	Opening Ceremony

10:00 – 12:00 First Session – General Framework of Geological Exploration and Mining Activity. Chairpersons: M. Stephen Enders, Past President & Honorary Lecturer, Society of Economic Geologists; COO of Eurasian Minerals, Inc. (USA), and Prof. Alexander G. Tvalchrelidze, Director, Georgian Minerals, Ltd. (Georgia)

10:00 – 10:30	Stephen Enders, Invited Lecturer (USA) – An Industry Perspective on the Mining and Exploration Business
10:30 – 10:50	Alexander G. Tvalchrelidze (Georgia) – Reserve Reporting Standards: Black Holes in Information Shearing between the Western and the Ex-USSR Countries
10:50 – 11:20	Venelin Jelev (Bulgaria) – Strategies of International Mining Companies in Bulgaria
11:20 – 11:40	Irakli Kandashvili and Alexander G. Tvalchrelidze (Georgia) – Comparative Analysis of the Western and the Post Soviet Mining Codes: Strategy of Harmonization
11:40 – 12:00	Discussion

12:00 -12:20 Coffee Break

12:20 – 14:00 Second Session – Metallogeny, Gold and Base Metal Deposits of Mediterranean. Chairpersons: Dr. Duncan Large, Consulting Geologist, Eurasian Minerals, Inc. (Germany), and Prof. Shota Adamia, Consulting Geologist, Caucasus Mining Group (Georgia)

12:20 – 12:40	Shota Adamia, Guram Zakariadze (Georgia), Mark Sosson (France), Nino Sadradze, and Sergo Nadareishvili (Georgia) – Late Mesozoic – Cenozoic Evolution of the South Caucasus and Adjacent Areas
12:40 – 13:00	Duncan Large (Germany) – Tethyan Zinc-Lead Metallogeny in Europe and the Mediterranean Region
13:00 – 13:20	Ilkay Kuşcu (Turkey) – Tethyan Evolution and Major Ore-Forming Events in Turkey
13:20 – 13:40	Robert Moritz, Johannes Mederer (Switzerland), David Selby (UK), Maria Ovtcharova (Switzerland), Rafael Melkonyan, Samvel Hovakimyan, Rodrig Tayan (Armenia), Nino Popkhadze, Vladimer Gugushvili (Georgia), and Vagif Ramazanov (Azerbaijan) – Mesozoic and Tertiary Cu-Au-Metallogeny of the Lesser Caucasus: New Age Constraints
13:40 – 14:00	Petr Morávek and Mirko Vaněček (Czech Republic) – Gold Deposits of the Bohemian Massif

14:00 – 15:00 Lunch

15:00 – 17:00 Third Session – Metallogeny, Gold and Base Metal Deposits of the Mediterranean and the Lesser Caucasus. Chairpersons: Prof. Kamen Bogdanov, Professor of Sofia University "St. Kl. Ohridski" (Bulgaria), and Dr. Pavel Reichl, Managing Director of European Metals Plc (Czech Republic)

15:00 – 15:20	Antoneta Seghedi (Romania) – Petrology and Mineral Deposits of the North Dobrogea Orogen and the East Moesian Platform

15:20 – 15:40	Kamen Bogdanov (Bulgaria) – Gold and Base-Metal Deposits of Bulgaria
15:40 – 16:00	Pavel Reichl (Czech Republic) – New Exploration Projects in the Erzgebirge, Czech Republic
16:00 – 16:20	Vasif Babazade (Azerbaijan) – Metallogeny of Azerbaijan and Prospects of Exploration & Prognosis for Noble and Base Metal Deposits
16:20 – 16:40	Archil Magalashvili (Georgia) – Types of Gold & Base Metal Deposits of Georgia
16:40 – 17:00	Rafael Melkonyan (Armenia) – Deposits of Non-Ferrous Metals and Gold in Armenia – the Present-Day Condition and Prospects

17:00 – 17:20 Coffee Break

17:20 – 19:00 Fourth Session – Gold and Base Metal Deposits of the Lesser Caucasus. Chairpersons: Prof. Vasif Babazade, Head of Chair of Economic Geology, Baku State University (Azerbaijan), and Prof. Ilkay Cuşcu, Professor of the Mugla Sitki Kocman University

17:20 – 17:40	Vagif Ramazanov (Azerbaijan), Robert Moritz (Switzerland), Mamoy Mansurov (Azerbaijan), Pierre Hemon (Switzerland), and Samir Mursalov (Azerbaijan) – Precious and Base Metal Deposits of Azerbaijan
17:40 – 18:00	Johannes Mederer, Robert Moritz, Alexei Ulianov, Richard Spikings (Switzerland), David Selby (UK), and Sergej Zohrabyan (Armenia) – Base- and Precious Metal Mineralization in the Kapan District of Southern Armenia: Multiple Ore-Forming Events Related to the Northeastwards Subduction of the Tethys Below the Eurasian Margin
18:00 – 18:20	Nazim A. Imamverdiyev (Azerbaijan) – Late Collision-Related Ore-Magmatic Systems in the Lesser Caucasus
18:20 – 18:40	Avtandil Okrostsvaridze, David Bluashvili, and Nona Gagnidze (Georgia) – Sakeni Goldfield, Svaneti, Georgia: A New Ore Mineralization/Occurrence in the Crystalline Basement of the Greater Caucasus
18:40 – 19:00	Anar Veliyev and Mehman Talibov (Azerbaijan) – About Gadabay ore area and Gadabay gold mine (Republic of Azerbaijan)

Tuesday, November 13

10:00 – 12:00 Fifth Session – Geology, Metallogeny and Mineral Deposits of the Bolnisi Mining District. Chairpersons: Prof. Mirko Vaněček, Past President of the Czech Association of Economic Geologists (Czech Republic), and Prof. Vladimer Gugushvili, Consulting Geologist, Caucasus Mining Group (Georgia)

10:00 – 10:20	Vladimer Gugushvili and Zurab Kutelia (Georgia) – Porphyry Gold-Copper System of the Bolnisi Mining District and Analysis of Two Types of Gold Mineralization
10:20 – 10:40	Ramaz Migineishvili and Mikheil Chokhonelidze (Georgia) – Volcanogenic Copper-Gold Deposits of the Bolnisi Ore District
10:40 – 11:00	Stefano Gialli, Robert Moritz (Switzerland), Nino Popkhadze, Vladimer Gugushvili, Ramaz Migineishvili (Georgia), and Jorge Spangenberg (Switzerland) – The Madneuli Polymetallic Deposit, Georgia: Evidence for Magmatic Input in a Submarine Hydrothermal System and a new Chlorite Proximity Indicator for Gold Ore

11:00 – 11:20 Nino Popkhadze (Georgia), Robert Moritz (Switzerland), Tamara Beridze, Vladimer Gugushvili, and Sophio Khutsishvili (Georgia) – Principal Volcano-Sedimentary Facies Types of the Madneuli Copper-Gold-Polymetallic Deposit, Bolnisi District, Georgia

11:20 – 12:00 General Discussion

12:00 – 12:20 Coffee Break

12:20 – 14:00 Poster Session. Chairpersons Prof. Venelin Jelev, Manager, Balkan Minerals Development Ltd (Bulgaria), and Dr. Archil Magalashvili, Strategic Projects Manager, IDS Borjomi Georgia Ltd.

1. Pierre Hemon, Robert Moritz (Switzerland), and Vagif Ramazanov (Azerbaijan) – The Gedabek Ore Deposit: Mineralization, Alteration and Fluid Evolution of a Lower Cretaceous Epithermal System within the Lesser Caucasus of Western Azerbaijan
2. Mamoy I. Mansurov (Azerbaijan) – Ore-Magmatic Systems of the Mrovdag Raising
3. Avtandil Okrostsvaridze, Karlo Akimidze, Archil Akimidze, David Bluashvili, Nona Gagnidze, and Giorgi Boychenko (Georgia) – Thorium and Bismuth Ore Mineralization of the Greater Caucasus Kakheti Segment
4. Alexci Tsitskishvili, Mirian Gagnidze, and Tina Shengelia (Georgia) – Geological Structure of the Chovdar Gold Deposits, Azerbaijan

14:00 – 15:00 Lunch

15:00 – 17:00 Round Table “Exploration of Noble and Base Metal deposits in the South Caucasus – Opportunities and Challenges”. Chairpersons Dr. Eric Jensen, General Manager of Exploration, Eurasian Minerals, Inc. (USA), and Dr. Zurab Kutelia, President, Caucasus Mining Group (Georgia)

17:00 – 17:20 Coffee Break

17:20 – 18:30 Discussion and signature of the Resolution: International Workshop “Gold and Base Metal Deposits of the Mediterranean and the South Caucasus – Challenges and Opportunities” to Governments of South Caucasus Countries. Chairpersons: M. Stephen Enders, Past President & Honorary Lecturer, Society of Economic Geologists; COO of Eurasian Minerals, Inc. (USA), and Prof. Alexander G. Tvalchrelidze, Director, Georgian Minerals, Ltd. (Georgia)

Abstracts

Late Mesozoic – Cenozoic Evolution of the South Caucasus and Adjacent Areas

Shota Adamia, Caucasus Mining Group, sh_adamia@hotmail.com, Guram Zakariadze, Caucasus Mining Group, Marc Sosson, Université de Nice, Nino Sadradze, Caucasus Mining Group, and Sergo Nadareishvili, Caucasus Mining Group

Evolution of the Caucasus and surrounding areas is largely determined by their position between the still converging Eurasian and Africa-Arabian lithosphere plates, within a wide zone of continent-continent collision.

The region during Late Mesozoic-Early Cenozoic belonged to the Tethys Ocean and its Eurasian and Africa-Arabian margins. Within this zone a system of island arcs and back-arc basins, etc. existed, which are characteristic of the pre-collisional stage of evolution. During the syn-collisional (Oligocene-Middle Miocene) and the post-collisional (Late Miocene-Quaternary) stages back-arc basins were inverted to form fold-thrust belts of the Greater and the Lesser Caucasus and, in between, the Transcaucasian intermontane depression (foreland).

Existing data allow the division of the region into two large-scale geological provinces: southern Tethyan and northern Tethyan ones, located to the south of and to the north of the Lesser Caucasian ophiolite suture, respectively. The ophiolite belt represents a part of the Izmir-Ankara-Erzincan (or North Anatolian) and Khoy (Iran) ophiolite zones, interpreted by some authors as the main suture of the Mesozoic Tethys.

The Caucasus is divided into several main tectonic terrains. Sub-platform and fold-thrust units may be distinguished: the Scythian (pre-Caucasus) young platform, the fold-thrust mountain belt of the Greater Caucasus, the Transcaucasian massif (TCM), the Achara-Trialeti and the Talysh fold-thrust mountain belts, the Artvin-Bolnisi rigid massif, the Loki Karabagh-Kaphan fold-thrust mountain belt, the Lesser Caucasus ophiolitic suture, the Lesser Caucasus part of the Taurus-Anatolia-Central Iranian platform, and the Aras intermontane depression. The youngest structural unit is composed of Neogene–Quaternary continental volcanic formations of the Central Anatolia-Armenian and Javakheti plateaus (highlands) and extinct volcanoes of the Great Caucasus – Elbrus, Chegem, Keli, and Kazbegi (Mkinvartsveri).

The TCM during the Mesozoic – Early Cenozoic represented an island-arc-type structure. Suprasubduction extrusive and intrusive activities lasted throughout the entire Mesozoic – Eocene. Back-arc basins of the Greater Caucasus separated the TCM from the southern shelf of the Scythian platform. At the Cretaceous – Paleogene boundary within the Greater Caucasus and the Transcaucasus existed both shallow water, normal marine island-arc type Artvin-Bolnisi (and Loki-Karabagh) basin that accumulated calc-alkaline and sub-alkaline volcanics, and deeper Achara-Trialeti and Talysh troughs superimposed on the Transcaucasian island arc as a result of the Cretaceous–Eocene back-arc rifting.

Oligocene is traditionally considered as a beginning of syn-collisional (or orogenic) stage of development of the Caucasus. Oligocene-Lower Miocene deposits resulted from accumulation in semi-closed euxinic basins of the Paratethys, only locally are represented by volcano-sedimentary formations. Starting from the Late Miocene (c. 9–7 Ma) and as far as the end of the Pleistocene, in the central part of the region, occurred volcanic eruptions in subaerial conditions.

More or less intensive manifestations of syn/post-collisional magmatic activity are found within all tectonic units of the Caucasus, however, the most intensive magmatic occurrences show up within the rigid platformal units: (1) in the Lesser Caucasian part of the Taurus-Anatolian-Iranian platform, and (2) in the Artvin-Bolnisi rigid unit of the Transcaucasian massif. The Late Cenozoic calc-alkaline to shoshonitic volcanic belt runs from Turkey via Caucasus into Iran. Outcrops of these magmatic rocks are exposed along the boundaries of the main tectonic units of the region.

Several geodynamic models have been proposed for the genesis of collision-related magmatism in continental collision zones, in particular, for the Eastern Anatolian Plateau, whose direct prolongations are represented by volcanic high plateaus of the Lesser Caucasus. Some of them may be relevant to the Eastern Anatolian-Caucasian Late Cenozoic collision zone – for example, the detachment model of the last piece of subducted oceanic lithosphere to explain the Late Miocene–Quaternary calc-alkaline and sub-alkaline volcanism, and the lithosphere delamination model for explanation of the Pliocene-Holocene volcanism of the Greater Caucasus.

On the example of precious and rare metals deposits of the region it is possible to make assertion on genetic relationship between precollisional, syn- and postcollisional magmatic activity, metallogeny and geodynamic evolution of the region. Metallogeny of the precollisional epoch was conditioned by Late Mesozoic-Early Cenozoic subduction of the oceanic crust of the Neotethys beneath the Eurasian active continental margin; syn- and postcollisional metallogeny was associated with slab break off (e.g. Turkey, South Caucasus, Iran) and lithospheric delamination (e.g. Greater Caucasus).

Metallogeny of Azerbaijan and Prospects of Exploration & Prognosis for Noble and Base Metal Deposits

Vasif M. Babazade, vbabazade@mail.ru and Shakhla F. Abdullaiyeva, Baku State University

The territory of Azerbaijan embraces a part of Alpine-Himalayan folded belt. The most important tectonic event, which determined the geological structure of this segment, was convergent interaction of the South Caucasus continental and Iranian oceanic microplates. During collision of continental blocks at the South Caucasus obduction of the oceanic crust on marginal parts of continental blocks took place, resulting in formation of the Lesser Caucasus (Geycha-Akerian) suture, which is presented by a band of tectonic mélange at surface. Within the latter ultramaphic rocks are followed by chromite magmatic deposits. However, much more prospective are obducted during Eocene – Oligocene basite-ultrabasite complexes intruded with granites (Tutkhun gold-bearing field) and granodiorite porphyry dikes (Zod, Soyutlu, Damirchidam, Konur gold deposits) as well as volcanic & tectonic depressions hosting both quartz-gold (Agduzdagh, Ketidagh) and mercury-antimony deposits (Agyatagh, Shurbulah, Lev). All the mentioned types of deposits are located within the Tutkhun-Agduzdagh block, along the marginal rift and intrablock faults. In the same time within the Daralagez uplifted block (Miskhano-Zangezur Zone) formation of the Megri-Ordubad batholith was followed by gold-bearing copper molybdenum porphyry (Geydagh, Misdagh, Diakhcai, etc.), gold-copper-molybdenum (Agyurt), gold-sulfide (Munumdara), gold-quartz-sulfide (Pyazbashi, Shakardara), gold-copper (Kyalyaki), and gold-polymetallic (Uchrdagh) deposits related to the endo- and exocontact band of the pluton.

Deposits of the pre-collision (partly, of the collision) stage within the Lesser Caucasus Orogen originated during Middle Jurassic – Late Cretaceous and were related to the island arc environment. These mineralizations are presented by epigenetic gold & base metal ores linked with with volcanic

& plutonic activity. At the Early Alpine tectonic & magmatic stage (Jurassic – Early Cretaceous) fragments of the paleoisland arc (Somkhito-Karabakh Zone and its Kaphan Block, displaced to south-west along the Araz sunlongitudinal lineament) survived the same development history and are characterized by the same metallogeny. Here complexes of island arc volcanic depressions are typical, which host pyrite (Chiraghdarasi, Toganaly), base metal copper sulfide (Kedabek, Shamlug, Kaphan, etc.), copper-arsenic (Bitti-Bulagh), base metal barite polymetallic (Chovdar, Madneuli, Bolnisi Group, Daghkesaman), and porphyry copper (Karadagh-Kharkhar Group) deposits. The great majority of gold-bearing island arc mineralizations are related to huge fault structures.

In the folded-thrust Alpine zone of the Greater Caucasus Southern Slope Lower Jurassic litho-geodynamic complexes, formed in paleodepressions of the marginal sea, are presented by black slates enriched with tholeiitic basalts. They host a group of synsedimentary gold-bearing base metal sulfide copper-polymetallic and superimposed epigenetic copper-pyrrhotite deposits (Fisilchai, Katekh, Katsdagh, Mazymchai, etc.). It is suggested that a sialic basement with a thin sedimentary cover existed under the Filizchai deposit during ore formation. Ore hosting organogenous black slates bear low grade gold mineralization. They were formed in axial zones of marginal sea basins. They have low carbonate content; potassium prevails sodium, and they are intruded with Middle Jurassic diabase dikes and Neogene granitoids. Drudjin sutural zone, which hosts a number of gold occurrences (Gyzylgaya, Aglyg-Filfilli, Vandam-Galadjyk, Bash-Lay, etc.) seems to be the most prospective. Extension of the mineralized zone is 700-1,500m and more, their thickness varies from 10-15 to 30 m, and gold grade is 0.4 to 1, seldom 8-20 g/t. Gold-hosting carboniferous slates are distinguished by high organic carbon content, which varies from 1 to 6-8% with the maximum of 11.04%. Contents of sulfides, presented mostly by pyrite (95-98%) with minor chalcopyrite, galena, sphalerite, etc., vary within a wide range. Carboniferous slates, in addition to gold, are also enriched with silver (up to 20 g/t), copper, zinc, selenium, etc. Dimension of gold nuggets are about 1.5-2 microns.

Signs of Mezo-Cenozoic gold-bearing conglomerates were determined in Mount Talysh, in the Tutkhun River Basin (the right inflow of the Terter River). Here gold was identified in both the matrix and the debris of conglomerates. Some indications on gold presence in this sequence in Levchai River basin also exist.

Noble metallic mineralizations may be divided into gold with silver deposits (Chovdar, Tutkhun, Zod, Vezhnali, Mumundara, Agyurt, Pyazbashi, etc.), essentially gold-bearing with silver deposits (Daghkesaman, Kedabek, Gosha, Kyzylbulagh, etc.), essentially silver-bearing with gold deposits (Filizchai), essentially gold- and silver-bearing deposits (Karadagh, Kharkhar, etc.), low-grade gold- and silver-bearing deposits (Geydagh, Misdagh, etc.), essentially silver-bearing with low grade gold deposits (Danaeri, Bashlishlagh, etc.), with unknown gold presence – gold-bearing black slates of the Drudjin suture zone, plutonogenic, volcanogenic hydrothermal, volcano-sedimentary genetic types.

Gold and Base-Metal Deposits of Bulgaria

Kamen Bogdanov, kamen@gea.uni-sofia.bg, Sofia University “St. Kl. Ohridski”

The territory of Bulgaria covers the western segment of the global Tethyan-Eurasian Cu-Au Belt that extends to the east through Turkey, Georgia, Iran, Pakistan, China and Malasia. The most important gold, copper and base-metal ore deposit types in Bulgaria that occur in the Srednogorie zone and the Rhodopes (Fig. 1) include: Copper-gold deposits (Cu-porphyry, IRG (Au-Bi-W type); Epithermal gold (HS) and (LS) type; Mesothermal Cu-vein type, and Base-metal (Pb-Zn-Ag) deposits (mesothermal veins and replacement type).

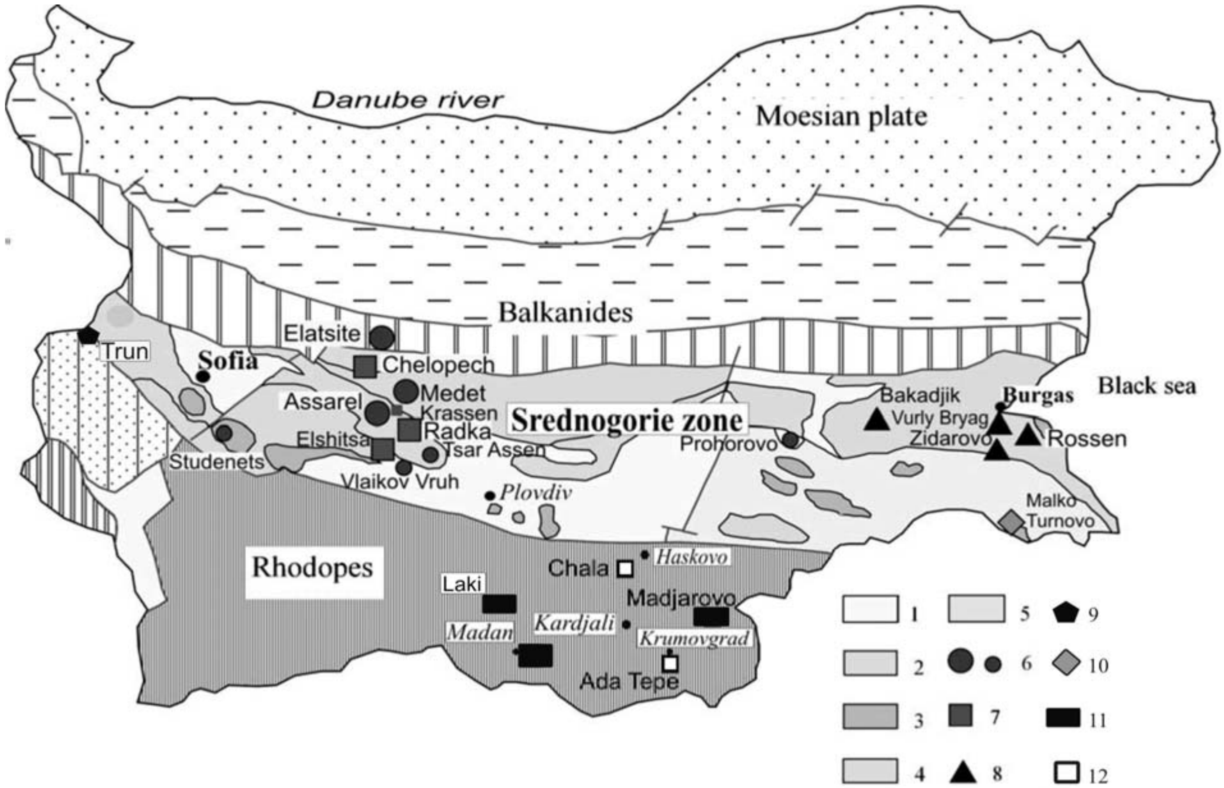


Fig.1. Gold, copper and base-metal deposits of Bulgaria.

1- Cenozoic sediments; 2- Late Cretaceous volcanic rocks; 3- Late Cretaceous intrusions; 4- Paleozoic granites and metamorphic rocks; 5 – Paleozoic and Mesozoic metamorphic rocks; 6- Porphyry copper deposits; 7- HS and IS epithermal deposits; 8- Vein copper deposits; 9– IRG deposits 10- Skarn deposits 11--Pb-Zn-Ag (base-metal) deposits.12-LS epithermal gold deposits

The Srednogorie zone (Fig. 1) developed during the Mesozoic as a Cu-Au-rich, andesite-dominated magmatic arc, characterized by obvious affiliation of Cu-Au porphyry, mesothermal and epithermal ore deposits with magmatic complexes, while the base-metal (Pb-Zn-Ag) deposits related to post-orogenic extensional magmatism and core complexes formation are most typical for the Rhodopes.

The Panagyurishte ore district is located in a 30 x 50 km N-NW trending belt in the Central Srednogorie, Bulgaria (Fig.1). The porphyry - copper deposits (Elatsite, Medet, Assarel, Tsar Assen and Vlaykov Vruh are connected to subvolcanic granodiorite porphyry intrusions, while the Cu-Au epithermal deposits Elshitsa, Radka, Krassen and Chelopech (Fig. 1) are related to andesite - dacite magmatic activity that took place about 82 - 94 m. y. ago.

Discrete magmatic complexes host intermediate (IS) to high sulphidation (HS) epithermal deposits(Elshitsa, Radka, Krassen, Chelopech) . The mineral assemblages of the ores at the Elshitsa, Radka and Krassen are linked by similar ore mineralogy and differ by the amount of tennantite, bornite, enargite and trace minerals of Ga, Ge, In, Bi, Se and Te. Chelopech HS epithermal deposit (Measured & indicated resources 29,87Mt @ 4.09 g/t Au, 10,58g/t Ag and 1,31%Cu) is a significant gold producer (93,8M oz Au and 36,8M pounds Cu for 2011) in Bulgaria and Europe. Native gold is abundant in the enargite-pyrite, bornite-tennantite and galena sphalerite-chalcopyrite assemblages.

Elatsite (154 Mt @ 0.33% Cu and 0.15g/t Au) and Assarel (142 Mt @ 0.41% Cu) are two of the Au and largest operating Cu-porphyry deposits in Europe. In the PGE-bearing porphyry system of Elatsite, merenskyite ($PdTe_2$), is documented as the main PGE-carrier. The new discovered IRG deposits (Rui, Logo, Zlata,KD,K2) at Trun area (Fig. 1) contain an inferred resource of 51,5Mt @ 1,45g/t Au and 11,7 g/t Ag for 74,89 tons of contained gold and 601,2 tons of silver.

Large Pb-Zn-Ag vein and carbonate replacement deposits hosted by high-grade metamorphic rocks in the Madan ore field (Fig.1) are the most important source for Pb-Zn and Ag in Bulgaria. They are related to metamorphic core complexes formation and post-extensional dome uplift, while the base-metal (Pb-Zn-Cu-Ag) and low sulphidation (LS) epithermal gold deposits in the eastern part of the Rhodopes are related to post-orogenic extensional magmatism.

More than 40 Pb-Zn-Ag deposits of vein and johannsenite-rhodonite skarn type occur in the Madan and Laki ore fields. They consist of quartz, pyrite, galena, sphalerite, tennantite, Mn carbonates, barite that have been deposited at the temperature range 350-105 ^{o}C as a result of fluid boiling ,interaction and neutralization in marble horizons. LS to IS epithermal Pb-Zn, gold vein and replacement type are also characteristic for Chala (1,16Mt @ 8,81g/t Au and 4,51g/t Ag), Zvezdel-Pcheloyad (2,05Mt@ 1,52Au and 63,4g/t Ag) and Madjarovo (5,1Mt@ 3,8g/t and 6 g/t Ag) ore fields in the Eastern Rhodopes (Fig. 1). LS type Ada tepe (Fig.1) gold deposit (Measured & indicated resources 7,9Mt @ 3,5g/t Au, 2,0g/t Ag) that occur in continental sedimentary rocks is related to low angle detachment faulting and metamorphic core complex formation.

An Industry Perspective on the Mining and Exploration Business

Stephen Enders, mse@renrespartners.com, Past President & Honorary Lecturer, Society of Economic Geologists

Exploration is a probabilistic business that requires making many "shots on goal", managing the cost of failure, getting to good decisions quickly, and sharing risk and opportunity with others. Ore deposits are rare occurrences, where the probabilities for making a material discovery for most companies are on the order of 1:1,000 to 1:10,000.

Exploration success requires more cooperation and collaboration than competition. The oil business has been using this model for years in addition to its well known reliance on 3-D seismic. Exploration risks, opportunities and synergies can be shared through exploration syndicates and major/junior alliances. This allows for individual companies to invest in many more exploration prospects to build a portfolio of properties that allow the probabilities of success to work in their favor.

Governments set the rules and create an environment that provides the fundamental framework that is either favorable for responsible mineral resource development or not. Governments need to provide clear policies, transparent processes, fair ground rules, certainty of timeframes and incentives for exploration and mineral resource development. Pre-competitive geoscience information as well as high-quality and up-to-date databases on mineral resources, mine production statistics and current land status information help promote a healthy industry. Governments with regulations that require data and project reports to be filed in an open repository for others to use will help build success. Favorable taxation policies can provide incentives for exploration, research and innovation.

The mining business has a long history of innovation over the last 150 years, and it is ever more important that continue today. The new approaches and innovations required for the continued supply of mineral resources consumed today and ever increasing demand in the future, will require significant financial resources from individuals, the mineral industry and the government for exploration, research and development. There is also a strong and increasing demand around the world for innovation to discover new ore deposits, to renew and extend the lives of the existing mines and processing facilities, and to address the challenges and opportunities in energy use, environmental stewardship and social responsibility.

There is a huge opportunity space available to us based on collaboration and cooperation rather than competition. This requires a mind-set change and realization that we are all in this together. We will create far greater good and benefit by working together than by struggling individually. Given the low probabilities of success in exploration and research, it is essential that we collaborate more – and not just between ourselves, but across disciplines and industries, and with robust governmental support. The key to all of this is execution. That means once a healthy debate has been held, decisions must be made, and actions must be taken.

The Madneuli Polymetallic Deposit, Georgia: Evidence for Magmatic Input in a Submarine Hydrothermal System and a new Chlorite Proximity Indicator for Gold Ore

Stefano Gialli, sgialli@tiscali.it, University of Geneva , Robert Moritz, University of Geneva, Nino Popkhadze, Tbilisi State University, Vladimer Gugushvili, Caucasus Mining Group, Ramaz Migineishvili, Caucasus Mining Group, and Jorge Spangenberg, University of Lausanne

The Late Cretaceous Madneuli polymetallic deposit is located in the Bolnisi district, southern Georgia. The Bolnisi district is situated in the Somkheto-Karabakh island arc of the Lesser Caucasus, which extends towards the West in the Eastern Pontides, Turkey. The origin of the Madneuli deposit is controversial. In order to constrain its genesis, we have undertaken a detailed study of ore paragenesis and alteration combined with a stable isotope investigation and an evaluation of the sulfidation state of the ore forming fluids. Moreover, a geochemical proximity indicator to ore has been investigated, in order to provide a useful tool for further exploration in the area for similar deposits. The presence of clear submarine sedimentary structures and microfauna found in the immediate host rock of the orebodies, supports an evident submarine origin for the volcaniclastic succession hosting the Madneuli deposit.

Two different ore types are recognized in the Madneuli open pit (Fig. 1):

a) A subvertical stockwork part, constituted mainly of pyrite, chalcopyrite and sphalerite with enargite in the core of the system. Quartz and abundant barite are the main gangue minerals. A stratiform, massive sulfide orebody and sandstone lenses cemented by barite are located on the top of the stringer zone; the massive sulfide body is characterized by a sphalerite, galena, chalcopyrite, pyrite and tennantite-tetrahedrite assemblage. The alteration halo surrounding this ore zone is composed of a strongly silicified core, grading out into a quartz-sericite-pyrite zone and an outer quartz-chlorite-sericite zone. Drilling has intersected a Late Cretaceous granodiorite to quartz-diorite porphyry intrusion, 800-900 m below this ore zone.

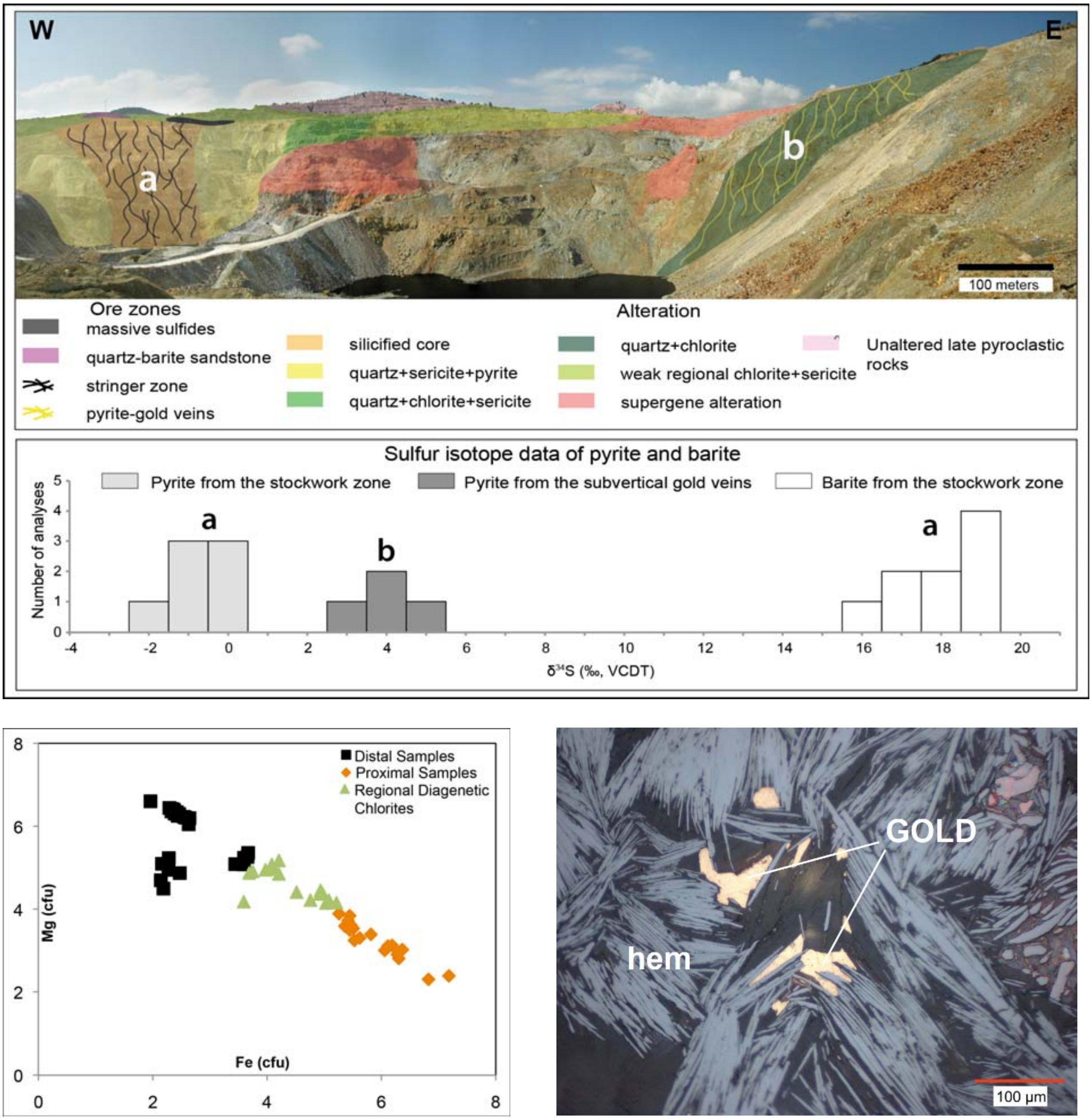


Fig. – 1) Correlation between ore zones, hydrothermal alteration distribution and sulfur isotopic composition of pyrite and barite in the Madneuli open pit. 2) Mg/Fe cation plot of chlorites. 3) Gold intergrown with hematite from the subverical gold veins in the eastern flank of the pit

b) Subvertical pyrite-chlorite-hematite-gold±chalcopyrite veins occur on the eastern flank of the open pit and are mainly mined for gold. Native gold is associated with telluriumbismuthite contained in pyrite, or as intergrowths with hypogene hematite (Fig. 3). Silicified platy calcite occurs locally and documents boiling conditions. The alteration assemblage is formed by quartz-chlorite-pyrite and confined to the immediate proximity of the veins.

Pyrite from the stockwork and massive sulfide orebodies has δ^{34}S values from -2 to 0‰, and pyrite from the gold-bearing subvertical veins has δ^{34}S values between +3 and +5‰. Barite from the stockwork area and the sandstone lenses has $\delta^{34}S$ values between +16 and +19‰. Calculated $\delta^{18}O$ and δD mean values of the fluid in equilibrium with sericite from the stockwork (Fig. 1, zone a) are +5‰ and -60‰ respectively and plot along the border of the magmatic water field, while $\delta^{18}O$ and δD values from the gold-bearing subvertical veins yield an array of data points between magmatic values and the marine water field.

Microprobe analyses of chlorites were carried out on samples from different zones of the open pit and outside the pit, to calculate the Fe/Mg ratio. There is a sharp Fe-enrichment in chlorites with proximity to the subvertical gold veins (Fig. 1, zone b). These results can be used to help exploration for similar deposits in the area.

The negative sulfur isotope values in pyrite, the oxygen-hydrogen isotope data close to the magmatic water field, the presence of enargite in the stringer zone (Fig. 1, zone a) and the high sulfidation state of the ore forming fluid (calculated using the Fe/Zn ratio of sphalerite in equilibrium with pyrite) are evidence for a magmatic input, akin to interpretations proposed for submarine mineralizing systems in the Western Pacific. The data obtained for the stringer zone area, together with the stratiform massive sulfide body and the barite sandstone lens of the Madneuli ore deposit, are consistent with submarine ore formation processes, with an important magmatic input. Further studies are required to constrain the genetic relationship between the western and eastern ore zones of the open pit (see a and b in Fig. 1): were they formed by a different evolution of the same ore forming fluid, or do they record two different mineralizing events?

Porphyry Gold-Copper System of the Bolnisi Mining District and Analysis of Two Types of Gold Mineralization

Vladimir Gugushvili, vgug34@yahoo.com, and Zurab Kutelia, Caucasus Mining Group

Bolnisi Mining District consists of porphyry gold-copper, barite-base metal, epithermal low-sulfidation gold mineralizations and belongs to a typical porphyry-epithermal system. Its deposits and occurrences are distributed in Late Cretaceous calc-alkaline volcanic series. The volcanic activity and mineralization related to island arc geodynamic development at the late stage of subduction of the Tethian slab.

Upper Cretaceous volcanic series within the Bolnisi Mining District are broken up by synvolcanic and synmagmatic tectonic activity: tumescence, cauldrone subsidence, hydrothermal eruption, etc. on the numerous blocks uplifted and subsided. At the same time, the area of the Bolnisi Mining District is divided into two “giant” blocks, along the regional fault related to disruption of the slab at the late stage of subduction. The south-eastern block was uplifted towards north-western. The younger – Campanian volcanics and ores were eroded from uplifted block and preserved on the subsided.

Thus, in the uplifted block preserved only Santonian mineralization dated 88-90 Ma, whereas the subsided block contains Campanian ores – 79-81 Ma. Accordingly, the Bolnisi Mining District is divided in two ore clusters – the Santonian one: Madneuli and Tsiteli Sopeli and the Campanian one: Sakdrisi and Khrami.

Disrupture of the subducting slab in Campanian lead to contamination of volcanics with mantle components as shown on discriminate diagrams of Nb-Y and Rb (Y+Nb) compiled according Pearce method, where Sakdrisi and Bectakary rhyolites dated of 72-73 Ma, disposed on ORG field, whereas rhyolites of Madneuli and Tsiteli Sopeli, dated 87 Ma – on VAG. Further mantle influence strengthened in Campanian alkaline olivine basalts of the Shorsholeti suite overlain volcanics of subsided block contained Sakdrisi – Khrami ore cluster.

Bolnisi ore district is represented by two different types of mineralization. The first one is characterized by two stages of hydrothermal activity: acid leaching with silicification and argillization of host rocks as preore stage and overlapped mineralization, the second one occurred without preore acid leaching with mineralization coincided to hydrothermal alteration of host rocks. The first type mainly occurred in Madneuli – Tsiteli Sopeli, the second one – in Sakdrisi – Khrami ore clusters.

However, the both types belong to a typical porphyry system and are characterized by mineralization zoning with lower proper sulfide zone, overlain by epithermal nonsulfide zone, where gold mineralization related to stockworks of quartz-chalcedony veinlets or to quartz-barite veins overlapped secondary quartzites (Madneuli – Tsiteli Sopeli cluster) and to gold-bearing adularization, baritization and silicification in metasomatic zone of Sakdrisi – Khrami cluster. The type of proper sulfide zone in the clusters also are different, so in Bektakary, Imedi, Darbazi, Bneli-Khevi and Samgereti deposits the proper sulfide zone is represented by base metal, with high temperature silicification and propillitization (350°C – 400°C) with epidote, zoisite, prehnite and actinolite, whereas in Madneuli and Tsiteli Sopeli synore alteration revealed in sericitization, carbonatization and chloritization (T< 300°C). The proper sulfide zone of the Sakdrisi – Khrami cluster is significantly enriched in gold – averagely 5-7 g/t, whereas in the proper sulfide zone of the Madneuli – Tsiteli Sopeli cluster average gold content does not prevail 1 g/t.

The genesis of mineralization and ore-metasomatic zoning of the Bolnisi Mining District may be explained and confirmed by rock-fluid geochemical equilibration model proposed by Mernagh and Bierlein. According their model the formation of high temperature proper sulfide zone and gold precipitation is related to decay of gold-bearing hydrosulfide complexes in carbonate solution with low fO_2 and CO_2, CH_4 and H_2S evaporation. Further, carbonate fluids were continuing gold transportation till the temperature limit 230°C, then gold precipitation began at the background of adularization and silicification.

Ore-metasomatic zoning revealed in the Sakdrisi – Khrami cluster may be related to mantle influence on the Campanian volcanism and explained by differences of the hydrothermal activity and mineralization in ore clusters of the Bolnisi Mining District. The mantle influence was continuing and strengthened in the Campanian high titaniferous alkali olivine basalts of the Shorsholeti Suite, which overlays volcanics of the Gasandami suite hosting the Sakdrisi – Khrami cluster. The ore-metasomatic zoning is related to increasing temperature of fluid in proper sulfide and the alkaline metasomatism (adularization) in nonsulfide zone depends on mantle influence. On the other hand, ore-metasomatic zoning is not characteristic of the Madneuli – Tsiteli Sopeli cluster connected to Turonian-Santonian volcanic activity without mantle influence. Here acid leaching process precedes mineralization.

The Gedabek Ore Deposit: Mineralization, Alteration and Fluid Evolution of a Lower Cretaceous Epithermal System within the Lesser Caucasus of Western Azerbaijan

Pierre Hemon, hemon.pierre@gmail.com, University of Geneva, Robert Moritz, University of Geneva, and Vagif Ramazanov, Baku State University

The Gedabek-Karadagh ore district is one of the main producing mining districts of Western Azerbaijan, and is the largest porphyry-epithermal ore field of the country. It belongs to the Lesser Caucasus, located within the Tethyan metallogenic belt. It is emplaced within the Jurassic-Cretaceous Somkheto-Karabakh magmatic arc, resulting from the subduction of the Tethys Ocean along the Eurasian margin.

The Gedabek ore deposit has been exploited since the 19th century, first for copper and silver, and nowadays for gold by open pit mining. This deposit is still controversial, and previously, it was classified as a porphyry deposit, and more recently as a high-sulphidation epithermal deposit. The ore body consists of a flat lens-shaped silicified-body emplaced between Middle Jurassic andesitic volcanoclastic rocks and a Late Jurassic granodiorite. Several generations of mafic to intermediate dikes, as well as dikes with a breccia texture, crosscut the volcanoclastic rocks and the granodiorite. Their relationship with the mineralizing process is still unclear.

This study aims at constraining the tectonic setting of the deposit using lithogeochemistry of the various magmatic country rocks, characterizing the hydrothermal alteration and the ore paragenesis, as well as the nature of the fluids involved in the ore formation processes.

Lithogeochemistry based on immobile elements suggests a sub-alkaline magmatic setting with basaltic to andesitic compositions. Our study questions the primary magmatic nature of the so-called “quartz-porphyry” intrusion, which hosts the main orebody, and rather suggests that this rock is the product of extensive silicification. Field observations reveal a strong lithological control (more permeable horizons) for silicification processes, as well as the propylitic alteration, within bedded pyroclastic rocks. X-Ray diffraction analyses revealed a late argillic alteration crosscutting the silicified body with the presence of dickite and kaolinite.

A preliminary petrologic study allowed us to distinguish two main mineralization events. An early pervasive silicification composed of microcrystalline quartz and adularia, associated with disseminated pyrite and low ore grades. A later semi-massive to vein-type mineralization composed mainly of sphalerite and chalcopyrite, and subsidiary fahlore, galena and arsenopyrite. Chalcocite and covellite are spatially associated with chalcopyrite and sphalerite, and are attributed to secondary enrichment of hypogene origin, as indicated by the presence of rare enargite.

Rare native gold has been observed associated to the second event. But ICP-AES analyses yield a strong correlation between Au, Bi and Te, distinctly higher than between Au and Ag. It suggests an association of Au and Ag mainly with Te-Bi enriched minerals rather than in electrum or native gold. Variable but high contents of volatile elements (Te, Se, Hg, Sb, As) are consistent with a shallow epithermal environment.

Petrological observations and microprobe measurements of the FeS content of sphalerites indicate an intermediate sulphidation state of the fluids, following the quartz-adularia-sericite-calcite paragenesis, with an evolution from lower toward higher sulphidation state.

Late Collision-Related Ore-Magmatic Systems in the Lesser Caucasus

Nazim A. Imamverdiyev, inazim17@yahoo.com, Baku State University, and Shakhla F. Abdullayeva, Baku State University

Geodynamic conditions of the late Cenozoic magmatic manifestations in the region are linked with collision of the Eurasian and Afro-Arabian lithosphere plates. The Late Cenozoic post-collisional volcanism of the Lesser Caucasus evolved in Azerbaijan in two main pulses. The volcanic sequence of the early phase is represented by an intermediate to felsic, calc-alkaline association formed during the late Miocene – Early Pliocene. The volcanic sequence of the late phase is a mafic to felsic mildly alkaline association formed during the late Pliocene – Quaternary. In Azerbaijani part of the Lesser Caucasus the late Cenozoic collision-related volcanism started from the Middle Miocene when in fanks of molassic troughs (Nakhchyvan, Garadag) were formed trachyandesites and alkaline basalts (age 14-15 Ma) were formed. In the Late Miocene (Sarmatian-Meotian-Pontian) differentiated andesite-dacite-rhyolite (central part of the Lesser Caucasus – Agdzhagyz and Basarkechar suites) and andesite (Nakhchyvan-Bichenag series) association originated related to high-K subalkaline and calc-alkaline series. In the Upper Pliocene – Quaternary, on one hand, volcanics of ultraacid composition – rhyolites and their volcanic glasses were formed, and on the other hand, mid alkaline basaltoids – trachybasalt-basaltic trachyandesite-trachyandesite differentiated series appeared.

Gold, mercury, apatite-magnetite deposits are connected with Late Cenozoic volcanic series of the Lesser Caucasus. The revealed correlation between late Cenozoic volcanic series, petrogeochemical types of volcanic association and ores clearly reflect a conducting role of volcanism of this period in formation of above mentioned deposits.

Agduzdag ore-magmatic system. Within the studied area the majority of the gold deposits developed within Agduzdag ore field. It confined to the western part of the Kelbajar troughs and is controlled by the junction near Kazyhanly-Agduzdag-Komurdag meridian and near fault zones. Significant role in the structure of the ore field belongs to north-eastern faults (Tartar, Shirvan), which controls both intrusive and subvolcanic bodies and ore occurrences. The north-westward faults are weak and have low ore contents. In the fault zones primary rocks are extensively altered and transformed into quartzites and propylites. Hydrothermally altered and associated with gold-silver mineralization are related to the marginal part subvolcanic bodies. A considerable part of Au-Ag mineralization is concentrated in quartz and hydrothermally altered longitudinal north-eastward tending zones. Mineralized zones in the most developed subvolcanic rhyolite and dacite dikes reveal paragenetic relationship of gold mineralization with Late Miocene volcanism. Within the limits of the investigated area the significant part of gold deposits are related to the Agduzdag ore field. Within the latter more than 60 quartz veins and of hydrothermally altered zones are known, which are actually concentrated in Agduzdag, Vagif, Fizuly, Ketidag, Shirvan, Zeylik ore deposits. Mineralization is presented in quartz veins, stockworks and complex metasomatic bodies.

Agyatag ore-magmatic system. Mercury deposits within the margins of the investigated area are basically concentrated in the Agyatag ore field. It is necessary to note that in spite of the fact that the rocks of various age since ophiolite complex up to Miocene-Pliocene formations participate in structure of ores field, the majority of the researchers suggest that mercury deposits of Azerbaijan are due to areas of intensive development of Miocene-Pliocene volcanism.

Mercury deposits and occurrences within the studied area are mainly concentrated in the Agyatag ore field. Mercury mineralization is located at the junction of the south-west wing of the Almaly-

Geydari anticlinorium with Kelbajar superimposed trough. Approximately 150 m thick Miocene-Pliocene andesite, andesite-dacite, dacite and rhyolite tufolavas are the youngest formations of the ore field. Mercury mineralization is mainly accumulated at the intersections of the major faults with minor en echelon discontinuities. These faults were active in Miocene-Pliocene time. According Nasibov, mercury is related to hyperbasites and Miocene-Pliocene volcanics. Indeed, in the rocks of andesite-dacite-rhyolite formation in the north-western part of the Agyatag deposit grade of mercury, as well as of As, Pb, Zn, Cu increases.

Nakhchivan ore-magmatic system. Within the Nakhchivan district a number of metallic and mineral resources related to the Late magmatism is encountered. The Lower Pliocene andesite, andesite-dacite, diorite intrusions and dikes are followed by deposits of quartz-copper-plutonic formation of hydrothermal type (Kalaki, Danakert, Ayridag, Shakardara), mercury, antimony and arsenic ores of the hydrothermal-volcanic type (Darrydag, Salvarty, Ortakend, Nagadzhir, etc.) as well as by occurrences of manganese (Bichenag, Alyachi), native copper (Halhal, Asadkaf, Kyzyldzha, etc.) of the exhalation-sedimentary origin. For the Neogene volcanism minor manifestations of sulfur ore (Gyumur) are characteristic.

Darrydag Sb-As deposit is located within the sublatitudinal uplift of the same name. Here during Miocene-Pliocene Cretaceous-Paleogene basement was complicated by folding and secondary faulting creating a favorable environment for emplacement of mineralization. Realgar-orepigment ores form stockworks, antimonite breeding clusters, and realgar impregnation.

Thus, Au-Ag, Hg, Hg-Sb-As ores have a paragenetic connection with lavas, rhyolitic tuffs, dacites, andesites and their subvolcanic formations of Miocene-Pliocene age. In a zone of fissures these rocks are subject to hydrothermal. This feature is sharply expressed in Agduzdag and Agyatag ore fields.

Strategies of International Mining Companies in Bulgaria

Venelin Jelev, vjjelev@yahoo.com, University of Mining and Geology – Sofia

Bulgarian territory was mining land from ancient times. The earliest mining activity was dated 4000 years BC. Thracian, Greek and Roman gold rush followed later. During the Ottoman empire the mining was limited and was done exclusively by Saxon miners. Till the end of socialist era, Bulgaria had well-developed mining industry. It was concentrated mainly in Banat-Srednogorie mettallogenic belt as well as in Rhodope metallogenic zone. The mineralizations in the first one are featured by Late Cretaceous volcanic and intrusive activity but in the second one – by Paleogene magmatic activity. The main producer of copper and gold were the mines of Panagyurishte and Burgas ore regions including 3 big porphyry-copper deposits (Medet, Assarel and Elatsite) and a number of small massive-sulphide or vein type deposits. Lead-zink commodity was yielded in many deposits from Central Rhodope area (Madan, Rudozam, Zlatograd) and Eastern Rhodope region (Kardzhali, Madzharovo, Spahievo etc.). The ores were processed in 3 big smelters. All the mining activity during this period was completed by state mining enterprises.

After the dramatic changes at the end of 80-ies the mining branch collapsed. The invasion of the Russian metals on the free world market reduced significantly metals cost. Most of the ore mines were abandoned but some of them were privatized. Bulgarian government withdrew entirely from investments in prospecting, exploration and mining. Unfortunately, instead of conservation of the mines with non-exhausted reserves, most of the ore mines were demolished.

Political changes at the end of last century initiated the harmonization of Bulgarian legislation with the West European one. The foreign investors were encouraged and many international companies start working in Bulgaria. One of them bought Chelopech gold-copper mine. Apart from developing and running of the existing mine, the company started investing in prospecting of several areas and succeeded in one of them. In 2002 its efforts resulted in discovery of „Khan Krum" gold deposit. This was very important event not only because of deposit size (27 Mt gold reserves) but because it was a new genetic type (sediment-hosted epithermal low-sulfidation) almost unknown in Bulgaria. This discovery resulted in rapid increase of permits for prospecting and exploration exclusively with foreign investors. The most prospective areas in Srednogorie and Rhodope Mts. have been occupied. Unfortunately, the „gold rush" gradually decreased with the increase of the problems („Odyssey") related to „Khan Krum" concession. The high economical value of this deposit induced political, environmental, ethnic, nationalistic etc. problems. As a result, the concession procedure continued 7 years. As a result many of the international companies relinquished their tenements.

Until 2010, only foreign companies invested money in prospecting and exploration. Since then, two big Bulgarian mining companies start also to develop this activity. Obviously, the reason is the high gold price on the world market. The problem is that they are „jumping" over everything with „smell of gold". These companies apply for and include in their portfolio prospects with unproven reserves or even resources. The present-day conjuncture demonstrates that they hardly ever will manage to prove real industrial reserves in the frame of the licensed period. Probably, these companies rely on the state bureaucracy in order to postpone the work program fulfillment for „better times". Apart of Dundee Precious which created a subsidiary (Balkan Minerals and Mining) with stable position in the branch, there will be no room for junior companies not only in mining but in prospecting and exploration as well.

Another challenge for the foreign investors in mining is the week government inclined to step-back in order to satisfy different political, environmental etc. interests (e. g. moratorium for the prospecting of shale gas, „pending" position about the construction of a new nuclear power-station etc.). The most indicative for the attitude of the government to the mining industry is the fact that the mining strategy of Republic of Bulgaria is designed by representatives of private companies.

Beyond the political challenges, there are geological prerequisites for new discoveries. Most of the gold-bearing deposits are found as a result of regional geological mappings in scales 1:200 000; 1:100 000 and 1:25 000 as well as accompanying or follow-up regional and detail prospecting and exploration works. Regardless of the high rate of geological study of the Bulgarian territory, the possibilities to discover new gold (copper-gold) deposits are not exhausted due to several reasons, as follows:

- during the prospecting and exploration of ore mineralization in Bulgaria from 1950 until 1990 it is not paid relevant attention to the gold and silver;
- during this period most of the gold analyses were semi-quantitative;
- a concept and methodology for prospecting of new types gold mineralizations has been elaborated;
- new technologies for mining and dressing of gold-bearing ores have been invented.

Most of the gold-bearing deposits in Bulgaria are discovered by direct field indicators, including ancient (Thracian or Roman) excavations („roupes"), quartz veins with or without visible sulphide mineralization, strongly hydrothermally altered rocks etc. Hardly new (unsampled) quartz veins or zones of visible hydrothermal alteration could be found on Bulgarian territory. It is considered that the known deposits and ore occurrences are very well evaluated (even over-explored). The perspectives to reveal new vein, massive-sulphide or porphyry-copper gold-bearing mineralizations of industrial interest are very low. It is likely such gold-bearing ore mineralization to exist in the frame of the ore fields with proven gold potential but only in depth - fact that makes them unattractive at the current conjuncture. Having in consideration the present-day market it is also not profitable to invest in additional exploration of the known deposits and occurrences. The most perspective (profitable) investment aiming revealing of gold deposit of industrial interest (about 1 Moz) is in searching of epithermal low-sulphidation gold deposits due to the following reasons:

- until 2000 such ore type is not purposefully searched on the territory of Bulgaria;
- it is proven the low-sulfidation epithermal gold deposit „Khan Krum" in East Rhodopes;
- there are direct data for existence of similar ore type in other areas (Stremtsi, Obichnik, Ribnovo etc.);
- there is a theoretical model for generation of such type deposits and methodology for its recognition and prospecting;
- there are many indirect indicators (volcanic structures, favorable lithologies, characteristic detachment faults etc.) for existence of such ore type in other places;
- the proof of new deposits of this type requires minimum investments;
- laboratory reduction of limits of Au detection (from ppm to ppb);
- new field and laboratory methodology for detection of buried ore deposits (MMI).

Low-sulfidation epithermal gold deposits could be expected in favorable lithological levels in the periphery (distal part) or basement of the volcanic edifices. On Bulgarian territory, the most perspective areas are situated around the volcanic structures of Late Cretaceous, Paleogene and Late Paleozoic age.

The areas around the Paleogene volcanic structures have got priority due to the fact that namely here the first industrial gold deposit of this type was discovered. Special attention deserves the recently proven gold mineralization on a large area in Timok zone of Eastern Serbia. It represents a stockwork zone developed in the limestones (Jurassic-Lower Cretaceous) from the basement of Late Cretaceous volcanoes of Banat-Srednogorie zone, large part of which is situated on Bulgarian territory.

Comparative Analysis of the Western and the Post Soviet Mining Codes: Strategy of Harmonization

Irakli Kandashvili, `Irakli_legalgeorgia@yahoo.com and Alexander G. Tvalchrelidze, Georgian Minerals` Ltd.

Globalization of mining and metallurgic sectors enabled the world finance institutions to elaborate a comprehensive tool for world-wide registration of available natural resources and to design strategic approaches for their synergetic amalgamation into global development schedules. Thus, the UN framework classification for energy and mineral resources was created.

In addition to the UN classification, which was designed, let repeat once more, for global registration of mineral resources and which is absolutely useless for routine mining activity, Russian, USA, European, Chinese, Australian, etc. resource classification schemes do exist.

In the Soviet Union natural resource has always been considered as a political-economic notion, which enabled the immense country to survive separately from the civilized world, behind the "iron curtain". Primacy belonged to industrial and, of course, military security whereas economy of natural resources played the secondary role.

According to the Anglo-Saxon approach a natural resource or a commodity produced from it represents a specific form of tangible immovable property, and as such it is subject to market relations.

It is well known that in the USSR mineral deposits were appraised according to so-called "*Geological-economic conditions*" among which the most important criterum was the "*Minimum industrial grade*" of ores. This criterion entirely differs from the cut-off grade of the western resource appraisal codes as far as the former describe the minimum grade of ores when extraction of a metal from ores is *technically* feasible whereas the cut-off grade implies the minimum grade of ores when extraction of a metal from ores is *economically* feasible.

In the western countries absolutely different system of resource estimation is widespread**Error! Reference source not found.**. All the three-dimensional space of a deposit is divided into primary blocks the volume of which roughly corresponds to the volume of eventual daily capacity of the mine.

Hereby, should be mentioned that Georgian legislation on Earth's Interior, is wider than the simple mining code as far as it settles all relations arisen in course of exploitation and/or investigation of the earth's crust.

The main provisions of this legislation are as follows:

- Earth's Interior on the sovereign territory of Georgia, within its territorial sea, continental shelf, and the exclusive economic zone represents the National Endowment and is protected by the State. Earth's Interior is a property of State. Usage of Earth's Interior is not free.
- Earth's interior represent a part of the earth's crust situated on the earth's surface or in ground layers and aquifers or under ground layers and aquifers and it is available for exploitation and/or investigation.
- There are two types of mineral deposits: (1) natural deposits, and (2) technogenic deposits. The latter type represents accumulations of mineral resources in wastes, damps, tails, heaps, natural and/or artificial aquifers originated as a result of mining.
- Usage of Earth's Interior implies:
  - Investigation of the Earth's Interior
  - Mining
  - Processing of mineral resources
  - Usage of natural cavities other than mining shafts, adits, pits, etc. as well as building of underground construction including those which aim storage of mineral resources and wastes

- ➢ Acquisition of geological, mineralogical, paleontological collections and museum specimens
- ➢ Usage of Earth’s Interior is subject to licensing.

No licensing is needed for regional geological, geophysical surveys as well as for scientific investigations. No licensing is needed for non-commercial usage of mineral resources of local importance in household works if these mineral resources are situated on private lands.

Usage of Earth’s Interior is allowed within the margins of a specially allocated mining allotment (mining lease). Beyond the margins of this lease usage of Earth’s Interior is banned.

Licenses for exploration and mining are sold on auctions. However, the Georgian legislation does not distinguish fees for two types of licensing: a) for mining, and b) for exploration with subsequent mining. Moreover, the legislation does not recognize a “discovery”. Thus, geological and mining companies encounter irresistible conflict of interests: for instance, if a discovery is maid during regional works, which do not need licensing, the discoverer has no priority in auctions, and the license may be bought by another company. On the other hand, license fee for exploration is too high (500 GEL/ha), and such a framework prevent launching of huge exploration campaigns.

Thus, the mining legislation should be urgently updated. Main trends of the new Mining Code should be as follows:

- Update resource classification according to the JORC Code
- Introduce Institute of Competent Persons
- Distinguish three types of licenses: a) for preliminary exploration, b) for exploration, and c) for mining
- Introduce acceptable fees for each category of licenses and introduce the rule, according to which changes in license category is registered due to payment of the additional fee without auction
- Introduce the notion of a “discovery” and give priority in licensing to the discoverer
- Create a new State Agency on Mineral Resources and give the Statute of Pulic Regulatory Agency to it.

Such a new legislation will greatly support development of the mining business.

Tethyan Evolution and Major Ore-forming Events in Turkey

Ilkay Kuşcu, ikuscu@mu.edu.tr, Mugla Sitki Kocman University

Turkey, as an integral part of great Tethyan-Eurasian Metallogenic Belt (TEMB), forms the boundary between the African and Eurasian plates in the Eastern Mediterranean, and is in continental collision with Eurasia and Afro-Arabia at the Pontides, Bitlis-Zagros sutures, and Aegean subduction zone. It is a metallogenic and geodynamic province hosting variety of precious and base metal mineral deposits including epithermal, porphyry, skarn, volcanogenic massive sulfide, and orogenic gold types. This province has been regional or district-scale target of several major companies that have provided relatively enough basis for understanding the source and type of alteration patterns. As being part of the TEMB, it shares many characteristics similar to other countries along this belt, and was formed since the Late Cretaceous, as the Arabian and African plates began to collide with the

Eurasian plate during the opening, final closure and terminal suturing of the Tethys (Neotethys) Ocean between Late Cretaceous to Quaternary period. This collisional assemblage generated a highly fertile metallogenic environment with a wide spectrum of gold –copper and base metal deposits including porphyry Au, Cu-Au and Cu–Mo, gold in skarns, epithermal Au, volcanogenic massive sulfide (VMS), orogenic Au, listwaenite-hosted, and placer Au. These deposits are spatially and temporarily associated with igneous activities clustering in narrow arc segments, and post to late-orogenic extensional settings, and are direct consequences of three subduction events in response to the closure of the Vardar-Izmir-Ankara (VIAE), NeoTethys oceans and Eastern Mediterranean (Aegean) sea. The closure of these oceans took place in three periods; 110-70 Ma in the VIAE ocean, 83-70 Ma in NeoTethys ocean and 28-12 Ma in the Aegean sea.

The Ar-Ar geochronology of the fresh magmatic and hydrothermal mineral separates are consistent at least 6 major magmatic episodes, spatially and temporally associated with 6 ore-forming events in the entire Turkey. These episodes mimic the successive events in continent-continent subduction setting starting from subduction, intra-ocenaic subduction, collision, and post-collisional subduction. Consequently, the major ore-forming episodes in Turkey suggest a successive geodynamic evolution in time from subductional to collisional and to post-collisional settings in response to closure of the NeoTethyan oceanic lithosphere, continental collision between Afro-Arabian and Eurasian plates, final suturing of the NeoTethys ocean between Late Cretaceous and Late Miocene time interval. This interval involves (1) the closure of the VIAE (the northerly marginal oceanic domain), (2) southerly ocean NeoTethys (A narrow embayment at the northern promontory of the Arabian plate), and (3) closure of the remnant of NeoTethys ocean after the final suturing of VIAE an southerly oceans. After the terminal suturing of the southerly ocean, the remaining NeoTethyan oceanic lithosphere began to subduct underneath the Anatolides during Late Eocene-Early Oligocene time interval. The closure of this basin is still continuing at the modern Aegean-Mediterranean sea. The earliest ore-forming episode in Turkey took place in Late Cretaceous (110-70 Ma) time. This episode marks the onset of subduction and closure of the marginal oceanic domain (VIAE ocean), and intra-oceanic subduction. These events resulted in voluminous magmatic arc in two stages; early stage characterized by calc-alkaline volcanic-volcanoclastic sequences associated with Kuroko type Pb-Zn VMS deposits particularly at the eastern Pontides, and late stage characterized by intrusive complexes associated with porphyry Cu-Au, Cu, and skarn Fe-Cu deposits throughout the Pontides. The second major episode marks the onset of extensional, post-collisional events after final suturing of the VIAE ocean. This episode lasted between Middle Paleocene-Middle Eocene (57-37 Ma) time interval. This episode is characterized by post-collisional adakitic magmatic suites associated with low sulfidation epithermal Au and porphyry Mo, Cu-Mo deposits at the Pontides, calc-alkaline adakitic intrusive suites associated with skarn Cu-Fe and porphyry Cu-Mo deposits at the Southeastern Anatolian Orogenic Belt, calc-alkaline H-type intrusive complexes associated mostly with skarn Pb-Zn, Fe and porphyry Mo-Cu deposits at Central Anatolian Crystalline Complex, calc-alkaline intrusive suites associated with skarn Fe-Cu and porphyry Cu-Au deposits at Biga Peninsula. The third major episode marks the onset of a new subduction in response to closure of the remaining NeoTethys ocean along the Helenic-Aegean arc between Late Eocene-Early Miocene (28-23 Ma). This period is characterized by calc-alkaline volcano-plutonic complexes throughout the western Anatolia and Biga Peninsula and is associated with porphyry Cu-Au, low and high sulfidation epithermal Au-Ag deposits). The fourth episode corresponds to a major extension in response to a roll-back and accompanied core-complex development in western Anatolia during Early Miocene (22-20 Ma). This period is characterized by calc-alkaline volcanic and volcano-plutonic associations, and appears to be the most prospective time interval that resulted in generation of porphyry Cu-Au, IOCG and low and high sulfidation epithermal Au-Ag, intermediate sulfidation Au-Ag-Pb-Zn, and skarn type Pb-Zn deposits. The fifth episode corresponds mostly to core-complex extension and initiation of slab-tear along the Helenic-Aegean subduction during Middle Miocene (20-15). This episode is characterized by calc-alkaline volcano-plutonic complexes associated with low and high epithermal Au-Ag deposits mainly at Biga Peninsula, low sulfidation epithermal Au and porphyry Cu deposits at eastern Anatolian Accreationary complex, high sulfidation epithermal Au and porphyry Cu-Au deposits at central Anatolia. The last episode is related to an extensional tectonics due to transform faults and STEP faults at the expense of a slab-tear or break-off event in the present Helenic-Aegeana subduction system during Middle-Late Miocene (14-11 Ma). This episode is characterized mostly by alkaline volcanic and volcanoclastic sequences associated mainly with Au-only porphyry systems within the western Anatolia, and also by calc-alkaline volcanic-volcanoclastic sequences associated mainly with Cu-Au porphyry systems at the central Anatolia.

Tethyan Zinc-Lead Metallogeny in Europe and the Mediterranean Region

Duncan Large, dlarge@eurasianminerals.com, Eurasian Minerals Inc.

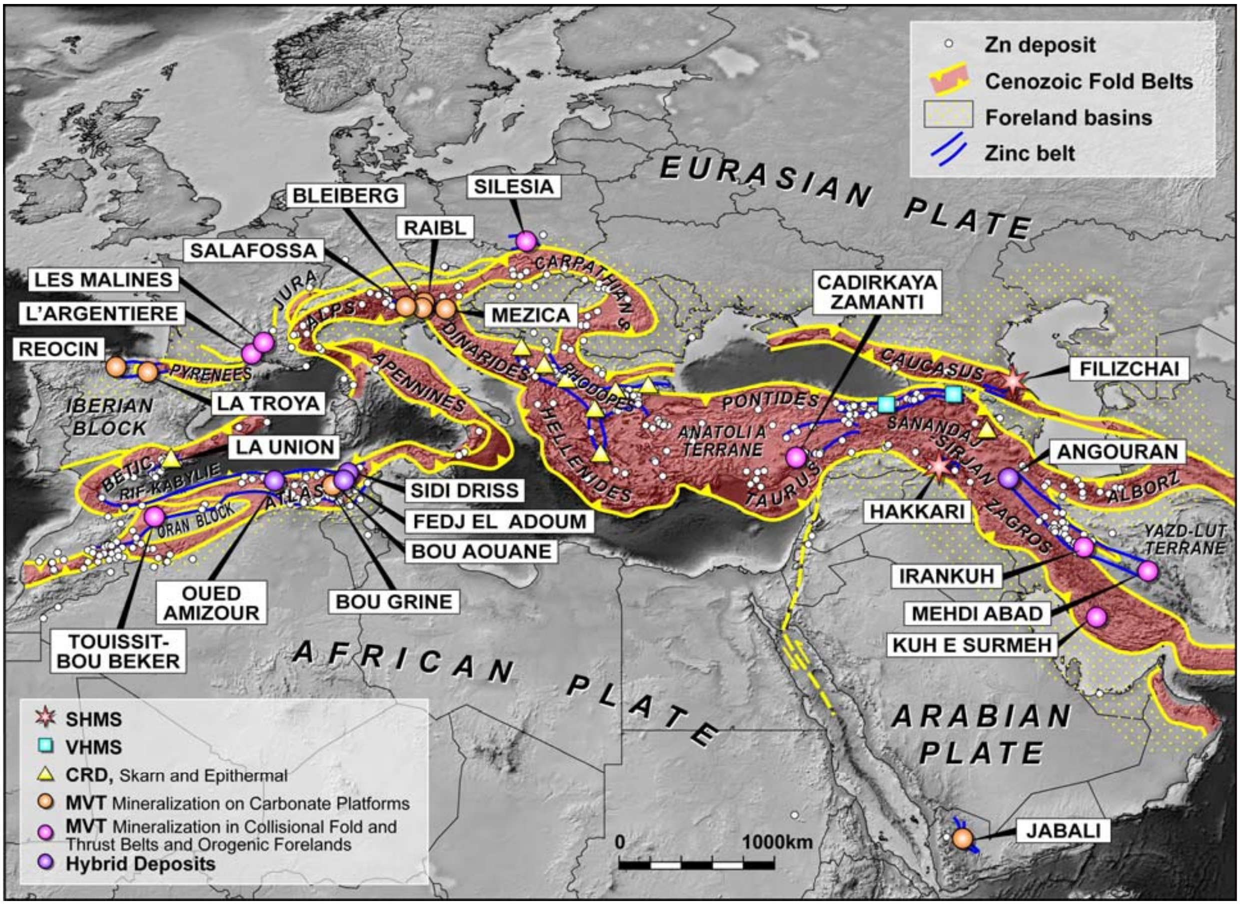
The Tethyan belt occurs throughout the circum-Mediterranean region and eastwards into Turkey, from where it extends into Iran and Pakistan, to China and Southeast Asia. The belt is characterized by rift zones with bimodal volcanic rocks and thick clastic sedimentary rock fill, passive-margin basins with platform carbonates, and calc-alkaline island-arc volcanic rock sequences. It is known primarily for its copper and gold endowment, but it includes several large and globally significant zinc-lead provinces. These include the Basque–Cantabrian basin (Réocin) in northern Spain; the Atlas lead-zinc district in Morocco, Algeria and Tunisia; the zinc-lead-silver deposits in the Balkans, including the Trepča district in Serbia/Kosovo, extending in to Macedonia, Greece, Bulgaria and NW Turkey; and the zinc districts in central Anatolia, Turkey, and Iran.

Late Carboniferous to Triassic rifting in northern Gondwana and opening of the Neotethys Ocean marks the commencement of the most significant zinc-lead metallogenic cycle, and initiated the break-up of Pangea. Rifting migrated eastward and broad Permian to Cenozoic carbonate shelf and passive-margin basin sequences were deposited. Cretaceous to Cenozoiccollision is associated with basin inversion and uplift on the Tethyan margins. Cretaceous and Cenozoic magmatism is also associated with the compressional event.

Significant factors influencing zinc-lead metallogeny in the belt include:

- Deposition of extensive and thick carbonate shelf sequences on the passive margins of migrating cratonic domains, dominating much of the Mesozoic and Cenozoic successions. This provided ideal host rocksfor MVT (Mississippi Valley type) and other styles of carbonate-hosted zinc-lead mineralization.
- Development of rift-sag basinal sequences at various stages of Tethyan evolution in favorable settings for the formation and preservation of SHMS (sediment-hosted massive sulfide or 'Sedex') deposits.
- Emplacement of intrusive and volcanic complexes in convergent and post-collisional arc settings, favorable for formation of high-temperature zinc-lead carbonate-replacement (CRD or manto) and skarn deposits due to the prevalence of calcareous sequences.
- Subsequent uplift and oxidation resulting in the development of economically significant non-sulfide ("oxide") zinc deposits throughout the belt.

Much of the belt is poorly explored for a range of geographical and political reasons, and significant new discoveries are to be expected if the opportunities are created to support systematic modern exploration.



Types of Gold & Base Metal Deposits of Georgia

Archil G. Magalashvili, archilmag@gmail.com, IDS Borjomi Georgia Ltd

In the last two decades significant progress has been made in the classification, definition and understanding of the main gold & base metal deposit types. However, unified models for such deposits are not fully defined yet and still are subject of controversy. The main reason of this lies in wide variety of real (not theoretical) geological settings, uniqueness and rarity of the long-term stability of geological processes lead to the formation of "pure line" deposits. Such circumstances are the main cause a wide spread occurrences of immature and/or transitional and hybrid deposits in which primary and principal ore-forming processes are hardly recognizable. This is especially true for Georgia – geologically most diversified and complex part of the Caucasus characterized by-turn as a region of quite complicated geodynamic history with collision, accretion, subduction and extensional events associated with respective magmatism and surficial processes.

The offered presentation is dedicated to the attempt to describe and classify main types of Georgian gold & base metal deposits on the basis of modified Lindgren's classification with some amendments have made recently for the basic models for major gold deposit types.

This description of Georgian gold & base metal deposits has to be considered as a first step towards creation of Caucasus and maybe whole Tethyan orogenic belt regional mineral-deposit models as it was made under the leadership of USGS for Northeast Asia and some other regions.

Ore-Magmatic Systems of the Mrovdag Raising

Mamoy I. Mansurov, mamoy_mansurov@mail.ru, Baku State University

Locke Garabagh paleoarc covers a vast area in the north-eastern part of South Caucasus, adjoining its northern part to the Kura intermountain basin. This zone is a major uplift composed of northwest-trending folded Precambrian metamorphic complex overlied with Mezo-Cenozoic volcanic-sedimentary rocks and intruded with Jurassic plagiogranites, gabbros, and granitoids. Wide distribution of granitoids and calc-alkaline volcanics, along with other factors, proves that the area has experienced a complete cycle of the Cimmerian precollision stage and has the character of an island arc, probably related to subduction of the Lesser Caucasus under the Transcaucasian microplate.

Mrovdag uplift, situated on the southern periphery of this zone, is mainly composed of Middle Jurassic volcanics. It has an asymmetric structure sublatitudinally displaced to the south upon the Cretaceous Geycha-Akeri Zone. The most elevated part of the structure hosts quartz diorite, gabbro-diorite and gabbro intrusions and related deposits and occurrences of different minerals that together compose an intrusive complex of the ore-magmatic system (OMS).

The Koshkarchay OMS is located in the central part of the north-western flank of the Mrovdag uplift. The geological structure of the OMS is composed of Koshkarchay Lower Bajocian igneous, volcanic and pyroclastic formations of basic and intermediate composition belonging to the andesite-basalt and consistently differentiated basalt-andesite-rhyolite complexes. Volcanic sequences are intruded with the Lower Bajocian Koshkarchay intrusive complex represented by the Koshkardag, the Odzhagdag and the Koschkarchay granitoid massifs. The Koshkarchay OMS includes the Koshkarchay porphyry copper deposit, the Damerin copper-molybdenum-cobalt occurrence, as well as numerous geochemical anomalies of Cu-Mo-Pb-Zn. Koshkarchay deposit is mainly composed of the Bajocian volcanic formation, intruded by the Koshkarchay granitoids. The site is cracked with fissures of north-west, circum-meridian, north-eastern and sub-latitudinal directions. Many of them, representing the tail of the main ore-controlling fault, are followed by a zone of silicified, sericitized, chloritized, epidotized rocks, representing the ore-hosting environment for porphyry copper and polymetallic mineralizations. Economic ores are surrounded with quartz-chlorite-sericite facies of secondary quartzites. Stockwork vein & disseminated ores are mainly present at the deposit. Stockwork body is confined to the endo- and exocontacts of the intrusive.

Sarysu occurrence of copper, sulfur, and pyrite ores is located in the north-eastern part of the district, 2-2.5 km northward from the Koshkarchay porphyry copper deposit. Here the steep ore zone is generally traced on about 1.5 km in the contact part of the intrusion and has a thickness from 5-10 to 50-100 m.

Chanahchy copper ore occurrence is composed of volcanic-sedimentary rocks (tuffs, tufokonglomerates, diabase porphyry tuffaceous breccias, rarely sandstones, etc.) of the Lower Bajocian age, intruded by dikes of gabbros and gabbro-diabase,s seldom quartz diorites. Chanahchy manifestation consists of six thin zones of hydrothermally altered rocks to mark the center lane anticlinal structure near latitude. Hydrothermalites predominantly expressed silicification, kaolinization and composed of quartz-kaolin facies quartzites. Mineralization in areas represented by thick impregnated pyrite, rarely with a few nests isolations chalcopyrite, galena and sphalerite.

Kyzylarhach OMS covers the Kyzylarhach group of porphyry copper and copper occurrences (Kyzylarhach, Dzhamillibulag, Kechaldag, etc.) as well as hosts the Elbekdash polymetallic occurrence. This OMS is located around a large stratovolcanos' vent facies, which were subject to intense fumarolic acid alterations. Manifestation zone is controlled by Middle Jurassic kaolinized and silicified porphyries.

The Elbekdash ore occurrence is located on the southern slope of the Mrovdag ridge. Structurally, the manifestation is confined to the Elbekdash syncline. Ore zone is controlled by a semi-ring faults, along which a network of interlayer cracks is developed. Copper-polymetallic mineralization is mostly represented by dissemination and veinlet type and is confined to the reef limestones alternating with volcanic rocks. Mineralization is unevenly distributed within the limestone body.

Base- and Precious Metal Mineralization in the Kapan District of Southern Armenia: Multiple Ore-Forming Events Related to the Northeastwards Subduction of the Tethys Below the Eurasian Margin

Johannes Mederer, johannes.mederer@unige.ch, University of Geneva, Robert Moritz, University of Geneva, Alexey Ulianov,University of Lausanne, Richard Spikings, University of Geneva, David Selby, University of Durham, and Sergej Zohrabyan, Institute, of Geological Sciences of the National Academy of Sciences of Armenia

The relatively underexplored Lesser Caucasus hosts a variety of ore deposits that formed during successive geodynamic settings and have so far received only little attention in Western literature. Several metallogenic events have been distinguished in the Lesser Caucasus and range in age from Middle Jurassic to Neogene. In this contribution we focus on the ore deposits of the Kapan district which are hosted by Middle Jurassic rocks.

The Kapan mining district in south-eastern Armenia is situated in the Lesser Caucasus which forms part of the Tethyan metallogenic belt. Middle Jurassic to Lower Cretaceous volcanic and volcaniclastic rocks with calc-alkaline signature are the dominant rock types in the area and are genetically related to the northeastwards subduction of the Tethys below the Eurasian margin (Figure 1). Three major ore deposits with different mineralization styles occur in the Kapan district. The Centralni West, Centralni East and Shahumyan deposits are hosted by Middle Jurassic andesitic to dacitic lava flows, breccia lavas, tuffs, ignimbrites and subvolcanic quartz-dacite intrusions. Middle Jurassic ore-bearing rocks and hosted mineralization were partially eroded before volcanic and volcaniclastic rocks of Upper Jurassic age were unconformably deposited on top of the Middle Jurassic sequence. The Centralni West deposit is characterized by massive east-west striking veins and stockwork style mineralization within sericite-chlorite-carbonate altered volcaniclastic rocks. Chalcopyrite and pyrite with minor sphalerite, fahlore and galena in a gangue of quartz and carbonate are the dominant minerals. The Centralni East deposit is characterized by a higher sulfidation state mineral assemblage that includes pyrite, colusite, fahlore, chalcopyrite and minor enargite, luzonite and galena. Stockwork style mineralization occurs within argillic altered lava flows and tuffs. At the polymetallic Shahumyan deposit, steeply dipping east-west striking veins with phyllic alteration halo are hosted by a subvolcanic quartz-dacite intrusion. Major ore minerals in the veins are chalcopyrite, pyrite, tennantite-tetrahedrite, sphalerite, galena and different gold- and silver tellurides.

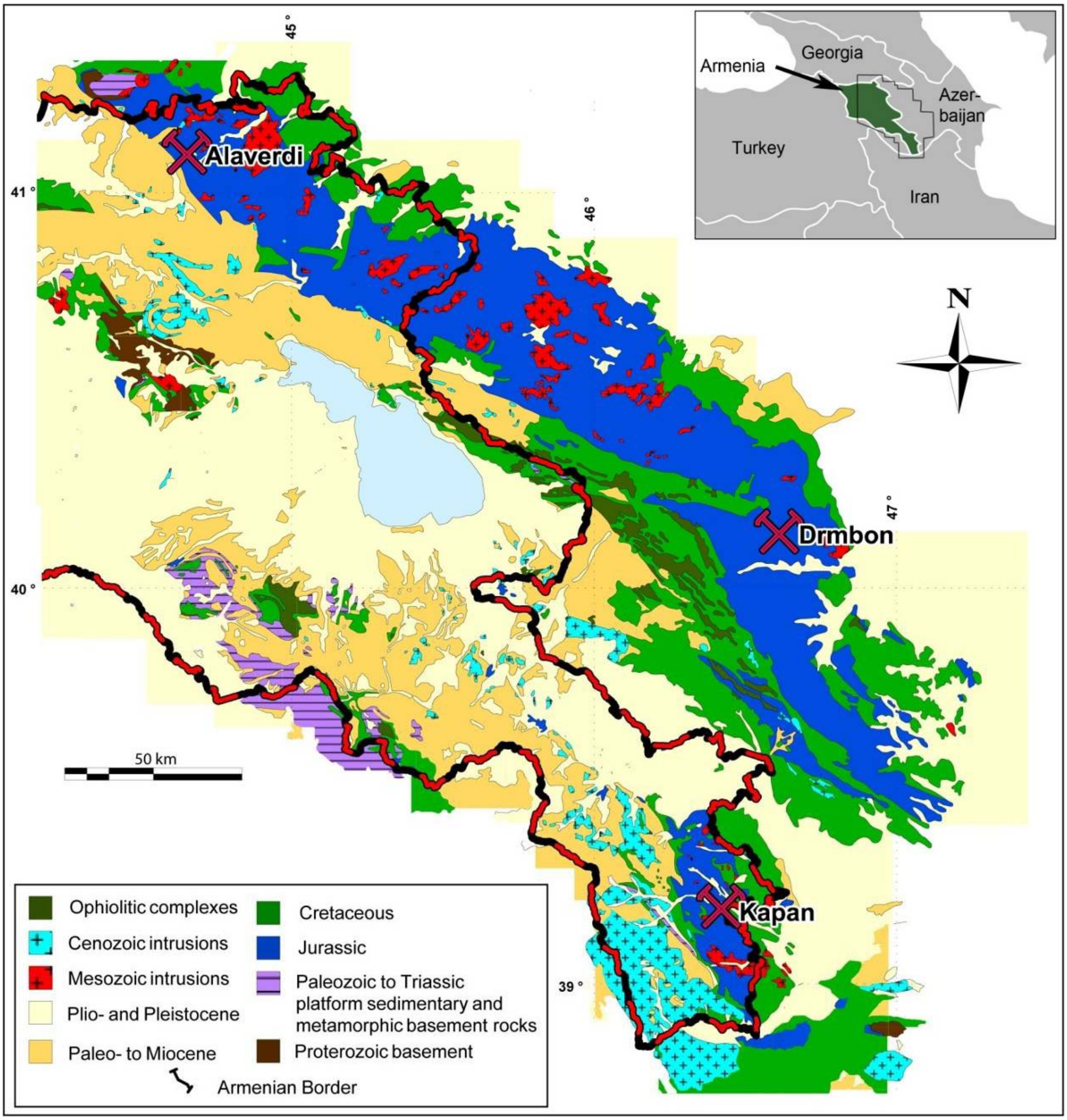


Figure 1: Simplified geological map of the Lesser Caucasus. The Alaverdi, Drmbon and Kapan deposits are hosted by Jurassic volcanic and volcano-sedimentary rocks of the northwest-southeast striking paleo-island arc (shown in blue and green). Compiled from maps by Bingäl (1989), Emami et al. (1993), Lotfi et al. (1993), Gudjabidze (2003), Kharzyan (2005) and Bairamov et al. (2008).

Intrusive rocks are rare in the district but 6 samples were collected for zircon U-Pb dating by LA-ICP-MS. Rounded granodiorite clasts from a hydrothermal pebble dyke were dated at 165.6±1.4 Ma. Two gabbro stocks were dated at 137.7±1.2 and 131.5±1.6 Ma and diorite and granite from the composite Tsav intrusion were dated at 136.2±0.8 and 133.6±1.7 Ma, respectively. An Eocene age of 50.82±1.0 Ma was obtained from a gabbro stock in the west of the area. $^{40}Ar/^{39}Ar$ dating of hydrothermal muscovite yielded a mineralization age of 161.78±0.79 Ma for the Centralni West deposit. Re-Os dating of pyrite from the Centralni East deposit yielded a mineralization age of 144.7±4.2 Ma. An

$^{40}Ar/^{39}Ar$ age of 156.14±0.79 Ma was obtained from magmatic-hydrothermal alunite which is associated with advanced argillic alteration in the upper part of the Shahumyan deposit.

Our dating results indicate different pulses of ore formation in the district over a protracted period of at least 17 Ma. The obtained Middle Jurassic U-Pb zircon ages from intrusive rocks in the district reflect subduction-related magmatism in the Lesser Caucasus. The Eocene gabbro stock represents a post-collisional magmatic event in the Kapan district with respect to the collision between the South-Armenian Block and the Eurasian margin.

Deposits of Non-Ferrous Metals and Gold in Armenia – the Present-Day Condition and Prospects

Rafael L. Melkonyan, ramelk@sci.am, Institute of Geological Sciences, National Academy of Sciences of Armenia

Mining industry, and first of all its branch related to deposits of base metals and gold, plays an important role in the economy of Armenia. These deposits are emplaced within the Somkheto-Karabakh (SK), Amasya-Sevan-Agari (ASA), Tsaghkounk-Zanghezour (TZ) and Kapan (K) terranes.

The highly prevailing share of the explored reserves of copper (~7 million tons) and molybdenum (~750 thousand tons) concentrate in the southern segment of the TZ terrane, within the Zanghezour ore district. Those are primarily a giant deposit of Kajaran (ore reserve of ~ 1 billion 700 million tons, Cu ~4.2 million tons, Mo ~ 650 thousand tons) and also medium size deposits of Agarak, Dastakert and Aighedzor, and numerous ore occurrences, all formed during the post-collision stage of the regional development. The isotope age estimates (*Rb-Sr* isochrons) of the rocks, as well as the *Re-Os* ages of molybdenite estimated under the SCOPES project, bear evidence of the three stages distinguished in the formation of the Zanghezour copper-molybdenum deposits: Middle-Late Eocene (Agarak, Dastakert, Aighedzor), Early Oligocene (Kaler), and Late Oligocene – Early Miocene (Kajaran). Their development is associated with corresponding same-age complexes of the gabbro-monzonite-granite-granodiorite series. The Kaler deposit, more strictly ore occurrence, is associated with pegmatites and has no commercial importance. The principal role in the spatial distribution of mineralization is assigned to the structural factor, mainly to the sites of jointing or intersection of large sub-meridian discontinuities with latitudinal zones of fracturing.

Formed in the island-arc settings, copper-molybdenum deposits of the SK terrane (Teghout, Tsaghkashat, Shikahogh and other) have a Late Jurassic age, according to the *Re-Os* estimates, and are related to intrusions of the quartz-diorite-tonalite formation. Among the copper-molybdenum deposits of Armenia, Teghout (ore reserves of ~ 455 million tons, ~ 1 million 600 thousand tons of copper, and ~ 98 thousand tons of molybdenum) is the second richest deposit after Kajaran. Fundamental differences between the formation models proposed for the Kajaran and the Teghout deposits are related to the age and composition of ore-bearing complexes, mineral composition of the ores, and sources of water and sulfur of the hydrothermal fluids.

Conventional sources of copper in Armenia have been earlier represented by copper-pyrite deposits such as Alaverdi, Shamlough, and Kapan. These deposits and many ore manifestations are confined to complex volcano-dome structures and are emplaced within the differentiated Middle-Jurassic volcanic series. Presently, the contribution of the listed deposits in the total balance of copper reserves is insignificant.

Gold (G) and gold-polymetallic (GP) deposits and occurrences have been established in all terranes; however, their overwhelming majority is concentrated within the TZ and ASA terranes (Sotk, Meghradzor, Toukhmanouk, Lichkvaz-Tey, Amulsar, Armanis, etc.). Their ages are constrained within the Late Eocene-Miocene interval, with the Late Jurassic age established only for the Shahoumyan GP deposit in the Kapan terrane. The total explored reserves of gold are estimated at ~ 320 ton, of which ~50 tons are found in complex deposits. Gold deposits are mainly represented by gold-sulfide-telluric, gold-sulfide, gold-lead-antimony, and gold-scheelite formations with predominance of gold-sulfide deposits (Amiryan).

More than 200 deposits and manifestations of *Cu, Mo, Au, Pb* and *Zn* are currently known in Armenia; the mined ones include two copper-molybdenum deposits (Kajaran, Agarak), seven gold-ore deposits (Sotk, Armanis, Toukhmanouk, M'hart, Mehradzor, Lichkvaz-Tey, Shahoumyan), and one copper-pyrite deposit. Mining licenses have been issued for 6 copper-molybdenum, 3 gold, and one copper-pyrite deposits, while geological explorations have been licensed for more than 30 gold, and 35 copper-molybdenum, copper and polymetallic occurrences. Considering, on one hand, the total number of known *Mo*, *Cu*, *Au*, *Pb*, and *Zn* deposits and occurrences, and, on the other hand, the list of operated (mined) deposits and occurrences licensed for geological exploration, it becomes clear that at more than 100 targets any geological prospecting or exploration activities are not carried on. In the meantime, current market trends determine intensification of prospecting and exploration activities at the gold manifestations. More than 10 deposits of coals and shales, containing high concentrations of *Au*, *Ag*, and *Pt*, may become promising and innovative targets. Further increase of copper and molybdenum reserves may be related to ore occurrences of copper-molybdenum formations within the TZ and SK terranes.

Volcanogenic Copper-Gold Deposits of the Bolnisi Ore District

Ramaz Migineishvili, Caucasus Mining Group, ram_migi@yahoo.com, and Mikheil Chokhonelidze, Caucasus Mining Group

The Bolnisi ore district is located in the Southern Georgia in the Artvin-Bolnisi Unit of the Transcaucasus, which was formed in the framework of an active margin of the Eurasian continent. Several dozens of copper-gold-barite-polymetallic ore occurrences and deposits of the Bolnisi ore district are genetically and spatially tied to the products of subduction-related Late Cretaceous calc-alkaline volcansm. They were formed in transitional shallow submarine to subaerial settings equivalent to epithermal conditions. Here we highlight the general characteristics of some deposits of the Bolnisi ore district to demonstrate the two principal styles of Cu-Au commercial mineralization.

The Sakdrisi deposit is controlled by a north-east trending fault that is thought to be a segment of a large volcanic caldera. The southern wall of this fault consists of dacitic tuffs and tuffites. The upper stratigraphic horizon of these rocks is intensively altered to quartz-hydromica-kaolin-chlorite metasomatics. These rocks are intersected by dykes and stocks of andesite-basaltic, as well rhyodacitic compositions. Metasomatics as well as tuffs and tuffites host gold-bearing veinlets and small veins of quartz-pyrite-chalcopyrite (at the lower level of the deposit), quartz-chalcedony and quartz-barite composition (at the upper level). Molybdenite, markasite, enargite, petzite, covellite, bornite,chalcosite, alunite, gypsum, calcite are minor minerals of ores. The northern wall of the Sakdrisi fault consists of ignimbrite and rhyolite lavas. These rocks are ore-free, but ignimbrite contains ore clasts. Sakdrisi has been in operation since 2010.

Davit-Garedji deposit is hosted by the following rocks (from lower to upper stratigraphic levels): ignimbrites, tuffites, carbonate and terrigene sediments. This deposit is capped by a quartz-biotite trachydacite and trachyrhyolite extrusive body. Carbonate and terrigenous sediments contain barite-silver and barite-manganese lenticular bodies as well as quartz-adularia metasomatics. Gold in these bodies has low grade. The lower level of the Davit-Garedji deposit occupies gold-bearing vein-disseminated polymetallic ore zone. The ore hosting metasomatics has quartz-chlorite-hydromica-carbonate-albite-adularia composition. Ore mineralogy is characterized by barite, quartz, sphalerite, würtzite, galena, chalcopyrite, pyrite, manganite, pyrolusite, vernadite, manganocalcite, hematite. Petzite, tetradymite, realgar, argyrodite, argentite, polybasite, stephanite, kustelite, electrum are minor minerals in this ore.

Kvemo Bolnisi deposit occurs within tuffs and tuffites overlain by felsic ignimbrites. Tuffs and tuffites are intersected by synvolcanic dykes of andesites and rhyolites as well as by intrusions of plagiogranite-porphyry composition. Here vein-disseminated ore bodies of copper-sulfide, gold-polymetallic, barite-silver composition are presented. They are controlled by faults. Gold is also hosted by quartz-sericite-kaoline-chlorite metasomatics. Pyrite, chalcopyrite, sphalerite, galena, arsenopyrite, hematite, quartz, calcite, barite are main constituents of the ore.

Tsiteli Sopeli deposit is hosted by agglomerate-lapilli and fine-grained rhyodacitic tuffs, which are intersected by subvolcanic bodies of trachyrhyolites, rhyolithes and andesite-dacites. These tuffs are hydrothermally altered to quartz-sericite-kaoline-chlorite-hydromica-carbonate metasomatics. Vein-disseminated ore zones are controlled by local faults. Iin general, chalcopyrite, pyrite and quartz dominated the ore, and bornite, sphalerite, galena, calcite are also present here. Chalcosite, molybdenite, azurite, covellite, malachite, calaverite, sylvinite, tetradymite, enargite and native gold are rare.

Madneuli Cu-Au deposit has been in operation since 1975. Geological section of the deposit is built of tuff strata of dacitic composition, breccia-conglomerate apron, as well as rhyodacitic ignimbrites and rhyodacitic extrusion at the top of the section. At the deposit there are two silica-rich bodies (quartz-sericite-chlorite) occupying distinct stratigraphic levels. These bodies also contain minor chalcedony, opal, alunite, kaolinite, pyrophylite and jarosite. Beneath the Madneuli deposit, 800-900 metres in depth from the present day surface, there is an intrusive body of granodiorite-porphyry and quartz-diorite-porphyry composition. Lithofacies architecture of the Madneuli deposit shows some intermittent phases of local uplifts and subsidence occurred in relatively shallow water setting (<200 m) to form its dome structure.

Madneuli deposit contains both epigenetic and syngenetic types of ore mineralization. The former holds the most part of the Cu-Au reserve and is represented by both vein-disseminated and breccia ores. Breccia ores are thought to be formed by fragmentation of host silica-rich bodies due to boiling of ore-bearing hydrothermal solutions. Epigenetic ore zone shows vertical mineralogical zoning from high-temperature (280-345°C) copper-rich ore (at the base) to comparatively low-temperature (<280°C) barite-polymetallic and barite ores (at the top). Syngenetic ore mineralization of the deposit is comparatively small in scale and is situated on the top of the epigenetic ore zone. These ores are composed od syngenetic stratiform bodies of barite and barite-polymetallic compositions. Besides the main ore-forming minerals (chalcopyrite, sphalerite, galena, barite, pyrite, chalcosite, covellite, quartz), the following minor minerals are identified at the deposit: brongniardite, tetradymite, aikinite, pavonite, emplectite, bismuthite, enargite, tennantite, freibergite, tetrahedrite, calaverite, krennerite, petzite, dyscrasite, bournonite. These minerals occur in close association with chalcopyrite but paragenetically were imposed later. Isotopic data suggest that the components of ore-bearing fluids could be derived from a complex combination of the following heterogeneous sources: (1) a crystallizing magma of synvolcanic intrusive; (2) host volcanic rocks; (3) meteoric water; (4) coeval seawater.

Two generations of gold are established in the Bolnisi ore district: (1) early fine gold is coeval with main sulfides, and (2) later gold formed after the main sulfides and presented by native gold in close association with rare-metallic group of minerals (sulfobismuthites and tellurides) and thread-like (1-2 mm thick) veinlets of bluish-grayish quartz, widespread in silica-rich bodies.

The Campanian formation age of the Madneuli deposit has been identified based on fossil nannoplankton. These data may have a practical implication for subsequent exploration in the Bolnisi ore district.

Tonnage and size of the Madneuli deposit is much larger than that of any other deposit of the district.

The Sakdrisi, Davit-Garedji, Kvemo Bolnisi, Tsiteli Sopeli deposits as well as a number of other copper-gold occurrences of the Bolnisi ore district can be assign to a volcanogenic epithermal deposits. The Madneuli Mine possesses a number of characteristics that are, in part, typical of VMS deposits, and, in part, resemble those of epithermal deposits. On the other hand, it differs from either type of deposits in a number of important attributes. Therefore, the Madneuli is viewed as an example of VMS-Epithermal transition deposits.

Gold Deposits of the Bohemian Massif

Petr Morávek, Czech Gold Association, Mirko Vaněček, mirko.vanecek1@geology.cz, Czech Association of Economic Geologists

The metallogenic province of the Bohemian Massif was since more than 3,5 thousand years one of the most important sources of gold in Europe. The Hercynian-consolidated Bohemian Massif forms the major part of the Czech Republic. The most significant gold deposits of the Bohemian Massif occur in three main regions:

- on the boundary of the Moldanubicum and Bohemicum in the Central and SW Bohemia with the prevalence of gold-quartz mineralization;
- in the Silesicum with the prevalence of gold associated with stratiform sulphidic base-metals mineralization, or with the gold-sulfides-quartz mineralization;
- in the Lugicum gold-arsenic mineralization in carbonatic rocks.

Main gold districts and deposits in the Central and SW Bohemia are as follows:

Jílové:

The Jílové district is situated in the Upper Proterozoic volcano-sedimentary belt. Jílové represented the largest gold deposit in the Middle Ages with the total production of approximately 10 t of gold. In the 20th century the deposit was mined during relatively short period (production of 1.1 t Au). The gold mineralization forms three morphologic types:

- veins associated with overthrust zones up to 7 km long, with an average grade 4-10 g/t;
- stockworks associated with lamprophyre and porphyry dikes with average grades 2-4 g/t;
- irregular disseminated and stockworks mineralization of considerable thickness, with average grade 1-2 g/t.

Psí Hory District:

The newly discovered gold district is located in the central part of the Jilove belt. The mineralization of vein up to stockwork type is related to the E-W trending dilation zone intersecting the volcano-sedimentary complex and the marginal part of granodiorite of the Central Bohemian Pluton. The Čelina and Mokrsko deposits were explored in detail. The zone of gold mineralization , forming a network of steep parallel quartz veinlets up to thicker veins, attains the thickness of several tens of meters, and up to 200 m on the Mokrsko West deposit situated in granodiorite. Average gold grade vary from 1.5 to 3 g/t through the entire thickness of the ore zone. The Mokrsko West represents the largest gold deposit of the Bohemian Massif with estimated reserves of 98 t of Au in 67.3 mil. t of ore.

Krásná Hora District:

The Krásná Hora district is situated in the Central Bohemian Pluton. The Au-Sb mineralization is associated with lenticular quartz veins usually up to 1 m thick and frequently extensively affected by tectonics. The gold distribution is rather irregular, with 4 g/t in average. Recently the Sb-Au ores were mined in 1985-1992. The production of gold is estimated to be between 12th and 18th century about 1.5 t, in 20th century 0.5 t.

Petráčkova Hora Deposit:

The Petráčkova hora deposit is situated near the boundary between Bohemicum and the Central Bohemian Pluton. The gold mineralization with accompanying chalcopyrite and scheelite is bound to the complex of magmatic, volcanogenic and plutonic rocks intruded into the weakly metamorphosed volcano-sedimentary rocks. The gold deposit is considered to be of porphyry ore type. The gold ore reserve is estimated to 30.7 Mt with average grade of 1.08 g/t.

Roudný Deposit:

The Roudný gold deposit was extensively mined to the end of 19th and in the beginning of 20th century with the total production of gold about 6 t. Host rocks are represented by biotite-sillimanite gneisses in various degree of migmatization, penetrated by granitic rocks. The stockworks mineralization occurring in areas of crossing of tectonic zones is usually several metres thick (max. 20 m). Gold grade was often high (over 1000 g/t), 10 g/t in average.

Kašperské Hory District:

The Kašperské Hory district is situated in SW Bohemia in the Moldanubicum. Two types of mineralization are present:

- Au-quartz mineralization of stratabound and vein type (irregular lenticular veins forming zones up to 30 m thick
- scheelite mineralization associated with mafic rock layers is up to several meters thick. The tungsten grade ranges up to several % of W, with 1.3 % W in average.

The estimated reserves of the main Kasperske Hory East deposit reach 8.2 M t of gold ore containing 49.4 t of Au and 3.1 Mt of tungsten ore with 41,600 tons of W.

Main gold districts in the Jeseniky Mts. (Silesicum) are as follows:

Zlaté Hory District:

The Zlaté Hory base metal district with gold consists of copper ore deposits, base metal deposits and gold-zinc deposit of Zlaté Hory West. The mineralization is located in the volcano-sedimentary formation of Devonian age consisting mostly of chlorite-sericite schists and quartzitic rocks. It is formed by disseminated and massive sulphides (mainly pyrite, pyrrhotite, chalcopyrite, and sphalerite). Gold is present mostly in pyrite and chalcopyrite, partly in quartz too. During 1990-1994 was extracted 664 th. t of ore grading 2.37 g/t Au and 1.17 % Zn from the Zlate Hory West deposit. In the same period 1.18 t of gold in concentrate was produced. In the remaining reserve is reported to be 7.9 t of gold in ore with average grade of 1.3 g/t Au.

Suchá Rudná District:

The Suchá Rudná district is situated on the boundary of the Devonian volcano-sedimentary sequence and the Lower Carboniferous flysch sediments. Numerous veins and stockworks of the district have been mined in Middle Ages. A new type of gold mineralization hosted by black schists has been discovered recently. The contrast gold mineralization is formed by disseminated sulfides and quartz-sulfide veinlets with abundant arsenopyrite.

Main gold deposit in the Lugicum is presented by:

Zloty Stok Deposit:

The deposit is situated in Poland. It has been mined during more than 1000 years. In 1481-1738 9.1 t of gold was produced. Later the deposit was during 150 years the main source of arsenic in Europe and gold was extracted as by-product (30-70 kg/year). In 1964 the mine was closed. The entire production of gold from the deposit is estimated to be 16.580 t. The mineralization of disseminated type is formed by four main ore bodies up to 30 m thick, it is located in partly serpentinized carbonate rocks. In the first half of 20^{th} century the ore with 6 % of As grading 3-5 g/t of gold was mined.

Due to the exploration program carried out in the Czech part of the Bohemian Massif in 1975-1994 about 392 t of gold in ore reserves and resources was found. The main explored deposits Mokrsko West (98 t of Au) and Petráčkova Hora (30 t of Au) can be mined by open pits, on the Kašperské Hory East deposit (50 t of Au, 42 th. t of W) underground operation should be considered. In the case of their exploitation the profit after taxation is estimated to be about 150 million USD/year. In addition the present level of gold prices enable to work deposits with reserve of about 10 t of gold. In the Bohemian Massif nearly ten of such a size deposits are already known or are registered as prognostic resource.

Mesozoic and Tertiary Cu-Au-Metallogeny of the Lesser Caucasus: New Age Constraints

Robert Moritz, University of Geneva, Robert.Moritz@unige.ch, Johannes Mederer, David Selby, University of Durham, Maria Ovtcharova, University of Geneva, Rafael Melkonyan, Institute of Geological Sciences, National Academy of Sciences of Armenia, Samvel Hovakimyan, Institute of Geological Sciences, National Academy of Sciences of Armenia, Rodrig Tayan, Institute of Geological Sciences, National Academy of Sciences of Armenia, Nino Popkhadze, Tbilisi State University, Vladimer Gugushvili, Caucasus Mining Group, and Vagif Ramazanov, Baku State University

Recent regional studies, and new Re-Os and U-Pb age data presented in this contribution have allowed us to constrain the relationship of the geodynamic evolution and the formation of metallogenic belts in the Lesser Caucasus, characterized by an evolution from Jurassic-Cretaceous subduction environments to Neogene, postcollisional events.

Jurassic-Cretaceous northeastward subduction of the Tethys below Eurasia resulted in the formation of island arcs along Eurasia (Somkheto-Karabakh belt and Kapan block). Initial ore formation resulted in copper-rich pyrite massive ore lenses and veins, and polymetallic, Au- and Te-bearing veins, which are still somehow enigmatic, and which are hosted by Middle Jurassic volcano-sedimentary formations. Published $^{40}Ar/^{39}Ar$ mineralization and K-Ar ages fall between 162 and 141 Ma. A distinct event at the transition between the Late Jurassic to Early Cretaceous resulted in the formation of porphyry-Cu, precious metal epithermal and skarn deposits, with molybdenite Re-Os ages of 145.9Ma at Teghout (northern belt) and 133.3 Ma at Khar-Khar (central belt), and a pyrite isochron Re-Os age of 144.7 Ma at Centralni Eastin the Kapan block.

During the Late Cretaceous, abundant felsic to intermediate volcanic and sub-volcanic rocks with a composition transitional between calc-alkaline and tholeiitic, were deposited in a mostly shallow submarine setting during local extension of the Somkheto-Karabagh island arc and its Variscan basement (Bolnisi Mining District). These rocks host bimodal-felsic volcanogenic massive sulfide deposits with transitional features to epithermal gold deposits, as recognised elsewhere in the Turkish Eastern Pontides. New U-Pb zircon TIMS ages of 86.6 to 87.1 Ma for dikes crosscutting the host rocks confirm the Coniacian-Santonian age attributed to the magmatic and ore forming events.

After Late Cretaceous collision of Gondwana-derived terranes (e.g. South Armenian block) with the Eurasian margin, the Tertiary metallogeny of the Lesser Caucasus was dominated by the formation of various epithermal gold and Mo-Cu porphyry deposits (including the world-class Kadjaran deposit). The most important mineral district is the composite Meghri pluton, southern Caucasus, marked by Eocene to Miocene calc-alkaline to alkaline mafic to felsic magmatic suites. U-Pb zircon TIMS ages confirm the pulsating nature of magmatism with an early Eocene event (40-45 Ma) followed by Oligocene (30-32 Ma) and Miocene (20-23 Ma) events. Re-Os molybdenite dating of Mo-Cu porphyry deposits indicates discrete ore forming events at 40-44 Ma (Agarak, Aygedzor, Dastakert), 31 Ma (Kaler) and 27 Ma (Kadjaran, Paragachay), overlapping with magmatic events. Eocene events of the Meghri pluton are correlated with peak Eocene magmatic activity reported along Iran and linked to subduction of the Neotethys, whereas the Neogene magmatism and ore formation in the Lesser Caucasus are attributed to postcollisional events following the closure of the Neotethys between Arabia and Eurasia.

Sakeni Goldfield, Svaneti, Georgia: A New Ore Mineralization/Occurrence in the Crystalline Basement of the Greater Caucasus

Avtandil Okrostsvaridze, okrostsvari@gmail.com, David Bluashvili, Georgian Technical University, and Nona Gagnidze, Ilia State University

The Greater Caucasus represents a Phanerozoic collisional orogen, which extends for more than 1,200 km between the Black and the Caspian Seas in a NW-SE direction. In its construction, two major structural stages are distinguished: the Pre-Alpine crystalline basement and Alpine volcanic-sedimentary cover. Basement complex (200 km x 40 km) is mainly composed of Precambrian to Paleozoic amphibolites, crystalline schists, gneisses, migmatites, and granitoids.

The Alibeg thrust (SW-NW, $<50-60^0$) is the main structure of the Svaneti region (Fig. 1), along which the S type granite-migmatite complex (ca.318±8 Ma; Rb-Sr age) is thrust onto the Sakeni diorite-quartz-diorite I-type igneous complex (ca.310±5 Ma; Rb-Sr age). Within the structurally deformed zone with a thickness of as much as 400-600 m, the rocks are brecciated and mylonitized, and greisen alteration is developed (Okrostsvaridze, 2007).

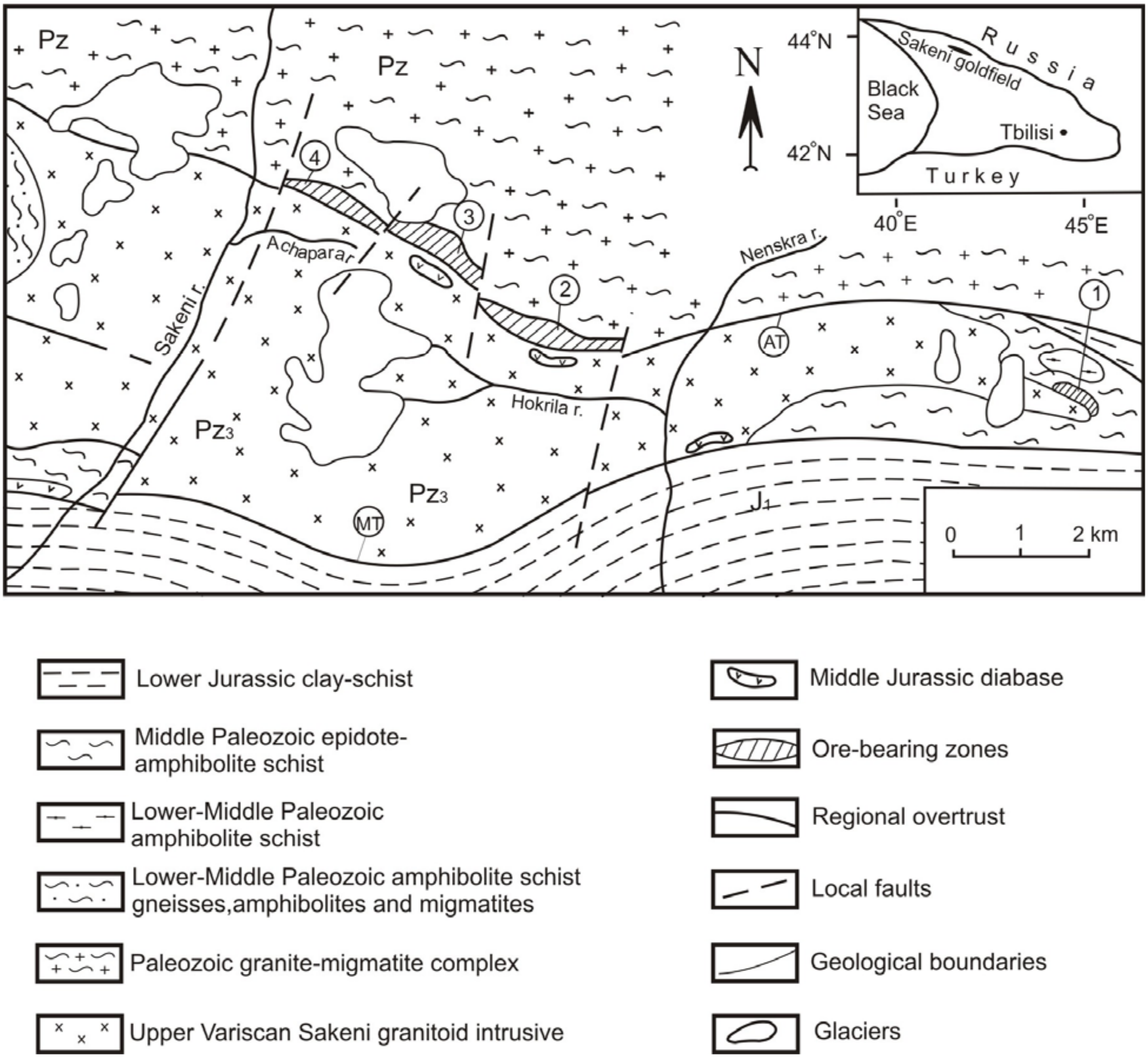


Fig.1. Geological map of the Sakeni gold goldfield and recognized gold occurrences

Ore-bearing zones: 1-Kakrinachkuri, 2-Hokrila, 3-Memuli, 4-Achapara; Regional thrust: MT–Main thrust, AT-Alibeg thrust.

As a result of our (2000-2010) research in the Svaneti region, a new gold district was discovered along the Alibeg thrust zone, which we have named the “Sakeni Goldfield”. In course of our field works, more than 1200 samples were collected. They were submitted for chemical analyses in “AcmeLabs” laboratory(Vancouver, Canada) for ICP-MS tests.

Presently, 4 gold-bearing occurrences are located in the Sakeni Goldfield: Kakrinachkuri, Hokrila, Memuli, and Achapara. They are localized along the northern margin of the Sakeni intrusion and controlled by the Alibeg thrust while intersecting Alpine fault systems. The mineralized zones are due to the deformed and greizenized rocks of granite-migmatite complex and include veins, pods, and stockworks. Gold occurs in quartz-scheelite, quartz-pyrite-arsenopyrite, and quartz-stibnite assemblages. The highest gold grade (15-30 g/t) is fixed in the quartz-pyrite-arsenopyrite association.

The Hokrila occurrence is the best studied area of the goldfield. It is exposed on the left bank of the Hokrila River, can be traced for 2.3 km along strike, and has a maximum width of ~500 m. The gold grade in the quartz-pyrite-arsenopyrite assemblage locally reaches 30 g/t, and averages 6.11 g/t. The gold grade in the stibnite-rich mineralization is 1.23 g/t to 2.33 g/t, but Sb concentration reaches 5-6%. Quartz-scheelite associations are located only in the western part of the goldfield, the most uplifted part of the Hokrila area, where W concentration reaches 2.21%.

As a result of our investigations, a preliminary simplified genetic model for the occurrences of the Sakeni Goldfield was drawn. Syn-orogenic thermal events activated a fluid system that mobilized metals from the Sakeni intrusive complex. Fluid was migrated along the Alibeg thrust fault, and mineralization was localized along structural barriers within the thrust body itself. We assume that the goldfield represents a post-magmatic gold-quartz-low sulfide hydrothermal system, which is characteristic of many orogenic gold deposits.

Thorium and Bismuth Ore Mineralization of the Greater Caucasus Kakheti Segment

Avtandil Okrostsvaridze, Ilia State University, Karlo Akimidze, Tbilisi State University, Archil Akimidze, Tbilisi State University, David Bluashvili, Georgian Technical University, Nona Gagnidze, nonagagnidze@gmail.com, Ilia State University, Giorgi Boichenko, Ilia State University

The Greater Caucasus is the northernmost fold system of the Caucasus orogen, which is linked to the southern margin of the Eurasian continent at more than 1200 km. Currently the Greater Caucasus is an expression of continental collision between the Arabian and Eurasian lithospheric plates.

The southern slope in the eastern part of the Greater Caucasus (Kakheti Region) is mainly composed of Lower-Jurassic clay-shales, in which sandstones and volcanic-sedimentary rocks occur in small quantities. This complex of sediments in Middle Jurassic was intersected by felsitic quartz porphyries, granite porphyries and gabbro-diorite intrusives.

The Stori River canyon cuts the above mentioned slope and at 3.5 km distance exposes the contact level of the mentioned sedimentary and magmatic rocks. In this section clay-shales underwent intense hydrothermal silicification, carbonatization and sulfide mineralization. This process was particularly intensively revealed in brecciaed zones, where sometimes thick sulfide ore lodes were formed. Our studies have shown that in the described hydrothermal alteration process this rock complex was enriched with thorium and bismuth up to industrial grade (Th @ 100-200g/t; Bi @ 200-900g/t). This enrichment was especially intensively pronounced in quartz-pyrrhotite-copper-pyrite veins, where the grade of these elements reaches the level of the world class deposits (Th @ 0.33842%; Bi @ 0.4806%).

Chemical analyses of these elements have been performed in Vancouver “ACMELABS” laboratory, Canada, using the ICP-OSL method.

Principal Volcano-Sedimentary Facies Types of the Madneuli Copper-Gold-Polymetallic Deposit, Bolnisi District, Georgia

Nino Popkhadze, nino_popkhadze@yahoo.com, Tbilisi State University, Robert Moritz, University of Geneva, Tamara Beridze, Tbilisi State University, Vladimer Gugushvli, Caucasus Mining Group, Sophio Khutsishvili, Tbilisi State University

Cretaceous Madneuli barite-gold-copper-polymetallic mine is the major ore deposit of the Bolnisi Mining District. The Bolnisi volcanic-tectonic depression is part of the Artvin-Bolnisi Unit, which is characterized by an arc association formed mainly during the Liassic-Campanian interval. It is located between the southeastern Black Sea-Adjara-Trialeti Unit to the north and the Bayburt-Karabakh Unit to the south. It represents the central part of the Eastern Pontides (Fig.1). The latter lies within a larger metal rich tectonic corridor, that stretches from southern Georgia and northern Armenia to Bulgaria and Romania.

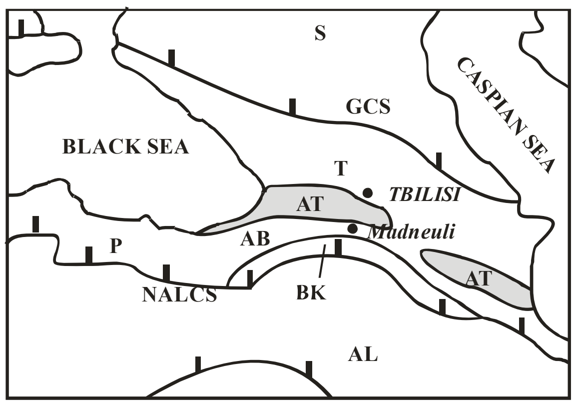


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Fig.1. Location of the Madneuli deposit (adapted from Yilmaz et al. 2000). Abbreviations: S – Scythian Platform; GCS – Greater Caucasus Suture; T – Transcaucasus; AT – Southern Black Sea Coast-Adjara-Trialeti Unit; AB – Artvin-Bolnisi Unit; P – Pontides; BK – Bayburt-Karabakh Imbricated Unit; NALCS – North Anatolian-Lesser Caucasian Suture; AI – Anatolian-Iran Platform.

Stratigraphic relationships and textural characteristics for host rocks of the Madneuli deposit are best exposed in some–key areas. Identification and characteristics of facial units are based on detailed studies of the open pit each level. The different units vary in composition and texture. In our study for the first time eight lithofacies were assigned to the Madneuli deposit. Further detailed studies are in progress. (Table 1).

Table 1: Summary of the main volcano-sedimentary facies of the Madneuli deposit

Lithofacies	Characteristics	Interpretation
Rhyolite pyroclastic lava-flow with flow foliation	There are shards of felsic rocks within the flow foliations. Porphyry structure with plagioclase, feldspar and quartz phenocryst. Groundmass is perlitic, amygdales are filled with quartz. Locally strongly silicified	Coherent facies of domes (cryptodomes) or volcanic sills

Columnar jointed ignimbrite	The shapes of columnar jointed ignimbrite are rectangular. Groundmass is typically perlitic, with a spherulitic texture of the volcanic glass, with oval shaped quartz crystals in it. High temperature devitrification of volcanic glass	Depositional setting below a storm-wave environment
Fine-grained accretionary lapilli tuffs and tuffs with bioturbation	Massive or normally graded. Recrystallized volcanic glass in the groundmass. Lapilli of various sizes, oval shapes, filled with quartz. Lapilli-rim type, with a core of coarse-grained ash, surrounded by a rim of finer grained ash	Shallow water sedimentation; in part water settled volcanic ash
Water-settled pyroclastic fall deposit	Inner flow stratification within a single layer shows fine-grained lamination, normal grading and lamination, thick units with clasts and reverse graded at the top and fine-grained pelitic in the upper part	Resedimentation of shallow submarine pyroclastic flow; down-slope transport by high concentration turbidity current (Cas and Wright 1991).
Rhyodacitic intrusion	Massive. Evenly porphyritic groundmass micropoikilitic, rarely pumiceous	Coherent facies of lavas or dome
Non-stratified rhyolitic to dacitic breccias facies	Massive, poorly sorted, clast-to matrix supported. The fragments of the rocks are slabby, irregular, blocky and oval shapes. Locally this unit is silicified and altered	Autoclastic breccia from the margins of subaqueous lavas or cryptodomes
Hyaloclastite	Carapace andesitic breccia flow. Hyaloclastite – with pillow like shapes and glass-like selvages. Groundmass with a perlitic structure. Fractures are defined by chlorite, and glass is replaced by quartz, feldspar, sericite and epidote	Lobe hyaloclastite facies, reflects a continuous evolution of textures and structures that formed during extrusion in response to rapid chilling and quench fragmentation of lava by water or by wet hyaloclastite formed from previous lobes (Gibson., et al, 1999)
Ignimbrite	Ignimbrite with welded structure contains lapilli and crystal shards or lapilli and matrix. Crystal shards are plagioclase, orthoclase, and quartz. Shards with cuspate and platy shapes. Some places are strongly silicified	Subaeral ignimbrite (?)
Paperite	Wet sediment- hot lavas. Fluidal character.	Magma-unconsolidated sediment mingling. Mingling occurred at the margins of intrusions or lavas within the sbmarane volcanic succesuins.

High proportion of volcanic glass, which is common in subaqueous lavas, abundant pumiceous ash and lapilli, absence of subaeral lithic clasts, a relatively good hydraulic sorting, and various forms of bioturbation, which are systematically associated with wavy parallel, graded tuffs and with accretionary lapilli tuffs are evidence for shallow marine conditions of depositional setting of the Madneuli host rocks. Such a setting suggests that the Madneuli deposit was mostly formed under subaqueous conditions, as is common for volcanogenic massive sulfide deposits, and contradicts some previous investigations suggesting mostly subaeral conditions during some of the Madneuli host rocks and ore deposit formation.

Precious and Base Metal Deposits of Azerbaijan

Vagif Ramazanov, vramazanov@rambler.ru, Baku State University, Robert Moritz, University of Geneva, Mamoy Mansurov, Baku State University, Pierre Hemon, University of Geneva, and Samir Mursalov, Baku State University

Azerbaijan hosts important precious metal (Au) and base metal (Cu, Pb, Zn) deposits, which are well represented in both the Greater and the Lesser Caucasus.

The gold deposit types of the country are quite diverse, and include gold and polymetallic sulfide deposits, quartz and quartz carbonate veins, copper and molybdenum porphyry deposits, and deposits hosted by black shale sequences. Gold is generally accompanied by sulfobismutites, and tellurides. Different ore types are recognized with different types of hydrothermal alterations and include: gold-quartz-sulfide (Vejnali, Tuthun, Pyazbashi etc.), gold-sulfide (Munundara, Agyurt etc.), gold-sulfide-quartz-carbonate (Zod Soyutlu,Geydara, Arhachdara etc.), gold-quartz (Agduzdag, Shirvan, Ketidag etc.), gold-quartz-polysulfide (Dagkesaman, Farahli, Uchgel etc.), six gold-pyrite subtypes: a) with predominant pyrite (Chiragidzor, Toganaly etc.), b) gold-chalcopyrite (Kedabek, Kyzylbulag etc.), and c) gold-quartz-pyrite (Kosha, Itkyrylan etc.), subformations of gold-silicification (Chovdar), gold-copper-porphyry (Karadag, Harhar, Damirli, Geydag, Diahchay etc.), and "Black shale" (Greater Caucasus) gold type deposits.

The vast majority of the identified ore districts of Azerbaijan fit into different classes of hydrothermal deposits. Thus, if the low-sulfide-quartz deposit formation of the Ordubad ore district are plutonic-hydrothermal, the deposit type of the Agduzdagskoy Group in the central part of South Caucasus, which is closely associated with young acidic volcanic formations, belongs to the medium-low-temperature genetic volcanogenic type. If we consider that this includes widely developed pyrite-type gold deposits (Kedabek, Gosha, Kyzylbulag), gold-polymetallic ore deposits hosted by Cretaceous troughs in the northeastern part of the Lesser Caucasus (Dagkesaman, Uchgelskoe, Farahlinskoe, Odundagskaya groups, etc.), as well as a number of identified and projected gold occurrences are linked to silicification, then surely this genetic type of the Lesser Caucasus is more widely developed. Pyrite formation encompasses a large group of variable compositions: pyrite , pyrite- copper, copper-zinc, copper and arsenic. Gold in pyrite ores is present a small amount, but in chalcopyrite, copper-arsenic ores its content may be close to economically interesting concentrations. Gold in sulfide ores associated mainly with sulfides - pyrite, chalcopyrite, arsenopyrite and fahlore ores. The gold content in the oxidation zone of massive sulfide deposits are 5-10 times higher than in the primary ores and in the zone of secondary sulfide enrichment.

The main types of copper deposits are copper-pyrite and pyrite-polymetallic. The largest volume of pyrite of the Somkheto-Karabakh area is associated with andesitic volcanism, including dacite-andesite and dacite-rhyolite formations. The pyrite ores are associated with acidic volcanic formations of the

Later Bajocian age, forming a broad front around volcanic structures at a distance of 5-15 km from the eruptive centers in the ores, associated with economic concentrations of copper and zinc. Formation of hydrothermal pyrite spans a relatively long period and during numerous stages of mineralization. Lead-zinc deposits in Azerbaijan are closely associated with deposits of pyrite, chalcopyrite, copper-arsenic and copper-porphyry, quartz-sulfide gold and other formations, which suggest the regularity of their occurrence, is a result of a single, but long process of ore genesis. On the southern slope of the Greater Caucasus, hosted by terrigenous rocks, there is the Filizchay pyrite-polymetallic ore deposit types, which are characterized by a high abundance of pyrite, with rare pyrrhotite. The age of the deposit is Lower and Middle Jurassic (Pliensbachian-Toarcian, Aalenian). The deposits are spatially and genetically related to subalkaline basaltic magmatism. The deposits are polygenic and polychronic, an early stage of pyrite formation was contemporaneous with sedimentation and volcanism, followed by a second generation of hydrothermal pyrite, accompanied by base metals.

Polymetallic deposits are widespread in Ordubad (Agdara, Nasirvaz, Ortakend, Bashkend etc. Middle Eosen in volcanic-sedimentary formations), in Sharur-Julfa (Gyumushlugskoe lead-zinc deposit in carbonate deposits of Givetian stage), the Kazakh (Dagkesaman, Avey, Farahli, Odundag, Alpout and others, volcano-sedimentary sequence of the Upper Cretaceous in close spatial association with volcanic bodies of albitophyre), in Gedabay (Novo-Ivanovskoye Shekarbek, etc., in silicified zones associated with Late Bajocian quartz-porphyry) ore areas. The upper volcanic sequences also contain pyrite-barite-polymetallic ores (Chovdar, Danaeri, Bashkishlak, etc,).

New Exploration Projects in the Erzgebirge, Czech Republic

Pavel Reichl, pavel@europeanmet.com, European Metals Plc.

The Erzgebirge (Krusnehory in Czech, Ore Mountains in English) is a historic mining districtstraddling the German and Czech Republic border. More than 300,000 tons of tin,and significant amounts of silver and uranium were mined in the district. Mining ceased in 1990.

The Erzgebirge is a WSW-ENE-trending tectonic block (120km by 45km) belonging to the Saxothuringicum of the European Variscides. The Erzgebirge orogen forms an anticlinorium with Proterozoic to mid-Paleozoic metamorphic rocks intruded by Variscansyn-kinematic to post-kinematic plutons. The anticlinorium axis plunges ENE and the youngest rocks are preserved in the eastern part of the anticlinorium.

The main metallogenic types in Erzgebirge include:

- Granite-related tin:
  - Greisen subtype (tin-tungsten-lithium; examples are Cinovec, Altenberg)
  - Stockworks and sheeted veins (tin-zinc-indium-gallium; examples are Geyer, Krupka)
  - Breccia pipes (tin-copper; examples are Seiffen, Sadisdorf, Gottesberg)
- Silver-lead-zinc veins in gneiss (Freiberg)
- U-Ag-Bi-Ni-Co veins and stockworks in schist (Jachymov,Marienberg).

The mineralization is spatially and genetically linked with various phases of Variscan magmatic activity related to the evolution of the Variscan collisional orogen.

Following a hiatus of 20 years, exploration seems to be returning to theErzgebirge on both sides of the border. In contrast to the post-war period, when all exploration was funded by the State (GDR and Czechoslovakia), today's exploration is funded by private investors.

Current exploration focuses on tin, tungsten, lithium, indium, niobium, tantalum and scandium, for the following reasons:

- Tin is important for the growing electronics industry and its price has been rising steadily, reflecting a market with deficit.
- Tungsten, indium, niobium, tantalum and scandium are metals of new technologies, identified as critical metals for Europe by the European Commission.
- Lithium might be produced economically if it is a by-product. European markets demand a secure supply source.

An example of the exploration revival in the Erzgebirge is a Czech private company thathas been granted two exploration licenses, covering the Cinovec and Zlaty Kopec projects.

Cinovec (Zinnwald) is a text-book example of a granite-hosted tin deposit, similar to the deposits in Cornwall, Portugal or SE Asia. About 70% of the deposit lies in the Czech Republic, with the remaining part extending north to Germany. About 40,000 tons of tin was produced at Cinovec.

The Cinovec deposit is hosted in the apical part of its relatively small granitic cupola (age 297 Ma), cutting into a rhyolite (age 311 Ma). The cupola daylights over an area of about 1.3 by 0.3 km. It hosts quartz veins with coarse cassiterite and wolframite, and large bodies of greisen with fine grained disseminated cassiterite, wolframite, and lithium-rich mica zinwaldite.

The host granite intruded along a structure (extensional regime) in the late stage of the orogeny. It can be classified as S to A type. The highly evolved peraluminous dry magma turned increasingly enriched in volatiles and metals during fractional crystallization. Tin and tungsten deposition accompanied a process of overprint of the granite, causing blastosis of quartz, topaz and mica, as well as alkali input and formation of albite and microcline granite. Further alteration lead to the origin of massive greisens and veins in cooling cracks. Cinovec type greisen is pervasively altered granite in which feldspars and micas are transformed into quartz-topaz-lithium mica-sericite-fluorite-cassiterite-wolframite mass.

In the 1970 large greisen-hosted tin mineralization was identified in the southern extension of the Cinovec deposit, about 300 meters below the current surface. A deposit called Cinovec South was delineated by predominantly underground exploration. The State C2 resource for Cinovec South was estimated at 53.4Mt grading 0.189%Sn, 0.039%W and 0.177%Li.

In 2011 and 2012, the current license holder compiled available historic data and produced a JORC Code compliant resource estimate. Using a 0.2% tin cut-off, the Cinovec South is estimated to contain 28Mt of mineralized rock averaging 0.4% tin (0.6% tin equivalent with lithium and tungsten credits), or over 100,000 tons of contained tin, making Cinovec one of the largest undeveloped tin deposits in the world. The lithium resource stands at 37 Mt averaging 0.8% Li_2O.

The Zlaty Kopecproject is located in the western part of the Erzgebirge. The tin-zinc-copper mineralization is hosted by magnetite skarn forming conformable lenses in phyllite and amphibole schist. In the 1970s a resource estimate was prepared for 1.3 Mt grading 0.93%Sn, 0.5%Zn and 0.04% Cu. The skarn is highly enriched in indium. The area is underlain by albite granite that was intersected by drilling and constitutes a Cinovec-like blind target.

Petrology and Mineral Deposits of the North Dobrogea Orogen and the East Moesian Platform

Antoneta Seghedi, seghedi@geoecomar.ro, National Institute of Marine Geology and Geoecology – GeoEcoMar

Situated in the Carpathian foreland, Dobrogea is a relatively small highland area surrounded by the Black Sea and the Danube. Two crustal faults, Peceneaga-Camena and Capidava-Ovidiu, divide this area into three tectonic blocks. Central and South Dobrogea belong to the Paleozoic Moesian Platform. The North Dobrogea corresponds to the exposed part of the Cimmerian North Dobrogea Orogen, considered the westward prolongation of the Caucasus – South Crimea orogenic belts. Main petrologic provinces within the Moesian Platform and the North Dobrogea Orogen include the Archean-Paleoproterozoic-Late Neoproterozoic basement of South Dobrogea, the Neoproterozoic volcano-sedimentary basement of Central Dobrogea, the Paleozoic granitoids of the North Dobrogea Orogen and the Permo-Triassic volcanic and subvolcanic complexes connected to the Alpine intracontinental rifting. Dobrogea is rich in both metallic and industrial minerals and has an ancient tradition of mining and ore processing dating back to the bronze age. The Moesian platform contains iron and copper ores, while the early Alpine belt of North Dobrogea is characterized by minor Ba, Cu, Pb, Zn, Fe mineralizations. The aim of this paper is to review the main petrologic provinces of Dobrogea and the mineral deposits connected to them.

The oldest basement rocks in Romania were intercepted in South Dobrogea by boreholes exploring a magnetic anomaly SE of Capidava-Ovidiu Fault, at depths of 430-600 m beneath the platform cover. The basement includes an orthogneiss complex (Ovidiu Gneisses), a banded iron formation (Palazu Group BIF) with a low-pressure ampibolite facies metamorphism and a very low grade basic volcano-sedimentary succession (Cocoşu Group). Based on petrological features and K-Ar data, the orthogneisses were ascribed to the Archean, the BIF to Paleoproterozoic and the volcano-sedimentary succession to the Neoproterozoic. The main lithological types of the BIF are amphibolites and magnetite-bearing quartzites, with interbeds of carbonates, quartzitic rocks and graphitic micaschists, which suggest sedimentary bedding. Detailed mineralogical and chemical studies revealed that banding is produced by alternating layers with various amounts of quartz, magnetite, hornblende, cummingtonite, almandine, biotite, dolomite and ankerite. The carbonate beds consist of tremolite, ferrosalite ± diopside. The protolith of these rocks is a banded chert sequence, including cherts and clayey or shally muds, interpreted as former abyssal oceanic sediments related to sea-floor spreading. Based on lithological features, the Palazu Group was correlated to the Krivoi Rog series from the Ukrainian shield.

The Late Neoproterozoic Altin Tepe Group of Central Dobrogea, represents a volcano-sedimentary succession metamorphosed to paragneisses and amphibolites in intermediate pressure amphibolite facies conditions. The rocks are exposed in an antiformal fold south of the Peceneaga-Camena Fault. Along its tectonic contact with the Ediacaran Histria Formation turbidites, the Altin Tepe Group develops a wide mylonitic zone in epidote-amphibolite facies conditions. An important deposit of stratiform massive sulfide was identified in mylonitic rocks on the southern limb of the Altin Tepe antiform. The Cu-pyrite ores form several „en-echelon" subvertical lens-shaped bodies of massive sulphides (pyrite, chalcopyrite, magnetite, subordinate pyrrhotite, sphalerite, galena,), surrounded by an impregnation halo of pyrite. Gold occurences as fine grains are associated with the sulphides and gangue minerals (quartz, barite, sericite and chlorite). Vlad & Borcoş interpret the massive sulphides as Cyprus-like type mineralization, possibly equivalent to sea-floor spreading-related metallogenesis.

In North Dobrogea, Late Paleozoic calc-alkaline granitoids develop on large areas, intruding both Neoproterozoic greenschist facies quartzites and phyllites (Boclugea Group) and terrigenous clastics and volcaniclastics of the Carapelit Formation, loosely ascribed to Permo-Carboniferous.

Quartz-veins within the Carapelit formation contain Cu mineralizations with no economic significance. The veins are probably related to the post-magmatic activity of the Hercynian plutons, considering that incipient greisenisation processes are recorded in several granitic bodies, indicated by the presence of fluorite, lithium-bearing micas, cassiterite and tourmaline. Detailed studies in the Pricopan Hercynian massif revealed two types of mineralizations: greisen type with Sn, W, Mo and low-temperature hydrothermal, with Au, Bi, Fe+ Cu, Pb, Zn, Bi sulphosalts and sulphotelurides in quartz gangue.

Alpine metallogenesis in North Dobrogea is related to intracontinental rifting. Late Permian crustal thinning is suggested by the emplacement in the Paleozoic deposits of alkaline plutonic-hypabissic associations as a ring complex of quartz-syenites, monzogranites, alkali-granites and alkali-rhyolites. The alkali-granites show scarce greisen associations (fluorite, tourmaline, Li-mica and cassiterite), while skarns (calcite, barite, tremolite, diopside, epidote) are recorded in the neighboring Devonian limestones. A bimodal Triassic volcanism of the basalt-ryolite association developed in the entire area of North Dobrogea in connection with intracontinental rifting: basalt-rhyolite dyke-swarms were emplaced in various rocks of the Hercynian basement; rhyolitic ignimbrites, flows and air-fall tuffs, along with basaltic pilow-lavas, dykes and small gabbroic intrusives are interbedded with the Triassic limestones. Field relations indicate that rhyolites were emplaced during the Late Skythian (Spathian) and basalts during the Late Skythian-Anisian. Rhyolites show a calc-alkaline geochemistry, while basalts are tholeiitic, derived from a MORB-type asthenospheric mantle source variably influenced by a plume-type component.

Within the Late Skythian limestone turbidites of the Somova Formation, stratabound Ba-Pb-Zn and Fe ores are associated with the igneous rocks. Stratiform sedimentary barite with subjacent Pb-Zn ores formed inside minor submarine depressions in the Somova-Cortelu area; subsequent small-sized Ba-Pb-Zn veins (in steep-dipping fractures along anticline crests) and stockworks (in K-altered rhyolites) were also found. Infiltration skarns of Rio Marina type occur in Spathian turbidites at Iulia. The mineralization consists of centimetric layers of hematite (mushketovite, martite), interlayered with thinner garnetiferous bands (andradite, grandite, hematite, magnetite, quartz, calcite, vesuvianite, epidote, antigorite, with subordinate dolomite, talc, montmorillonite). The skarn deposits contain hematite-magnetite as result of Fe mobilization from the basement, where muscovite-quartzites are locally rich in magnetite. An alternative interpretation for the Iulia ores is sedimentary-exhalative.

The metallogenetic potential of Dobrogea has formed in three main cycles. The Proterozoic cycle includes iron and copper, with medium size accumulations. Even if Palazu Mare ferous accumulations are the largest in Romania, they cannot be mined due to their depth and special hydrogeological conditions. The Altin Tepe deposit, the third largest copper reserve in Romania, was mined until exhaustion during 1956-2001. The Hercynian mineralizations have no economic significance. The Alpine cycle barite deposits at Somova were mined and exhausted; Triassic iron deposits at Iulia were explored by boreholes and underground mining works during 1951-1990, when it was finally concluded that they lack commercial importance.

Geological Structure of the Chovdar Gold Deposits, Azerbaijan

Alexsi Tsitskishvili, atsitskishvili@eurasianminerals.com, Georgian Minerals, Ltd., Mirian Gagnidze, Caucasus Mining Group, and Tina Shengelia, State Agency for Natural Resources

Chovdar gold deposit is situated in extreme eastern edge of Pontide – Lesser Caucasus regional Alpine tectonic belt. Metallogenically, the deposit belongs to the Dashkesan Mining District of the Somkhito-Karabakh structural zone.

Enclosed rocks are presented by a wide spectrum of Middle Jurassic volcanic and volcanic-sedimentary rocks with complex facial transitions both along the strike and down dip. Calc-alkaline basic and acid volcanics and tuffs prevail; breccia andesite lavas and tuffs as well as dikes are sparse.

Ores are hosted by quartzites, which were formed from different, mainly acid, regionally propylized rocks. Silicification degree of quartzites is different. Quartzite outcrops form knolls of different sizes, which often are bricciated and dismissed along small faults.

In general, the quartzite massif forms a mushroom-shaped body with several stringers at different hypsometric levels. The upper level is characterized by the manto form and practically entirely coincides with the oxidation zone. At deeper horizons quartzites create both seam-shaped and lenticular bodies. Vuggy silica, nodular and opal-like quartz, pyritization, and brecciation near faults is a characteristic feature of gold-bearing quartzites.

Volcanic rocks are cut with essexite-diabase porphyry and trachite dikes. These dikes have different orientation and create en echelon assemblages.

Rocks are crumpled into asymmetric linear and brachimorph folds, which, in general, have north-westward strike and gentle (10-30°, seldom – more) dipping of wings.

North-western, north-eastern, sublatitudinal, and sublongitudinal different scale faults are present at the deposit. Among them the most important are both north-western faults controlling barite mineralization, and north-eastern faults, with which gold mineralization of the Chovdar deposit is linked.

During the endogenous activity SiO_2 saturated fluids migrated upward along fissures due to high temperatures and pressures; afterward they penetrated into subhorizontal interlayer cavities, fissures and other holes and deposited ores.

After quartzite formation successive precipitation of Fe, S, Cu, Zn, Pb, Au, Ba took place from the residual solution enriched with ore elements. At the same time, Cu, Zn, Pb contents in fluids compared with other elements were essentially low.

At the final stage of deposit formation surface solutions penetrated into its upper horizons. Due to their circulation, the oxidation zone was formed, which is enriched with melnicovite-pyrite, hematite, goethite, bog iron, and jarosite.

Gold of the deposit is mainly fine dispersed.

Reserve Reporting Standards: Black Holes in Information Shearing between the Western and the Ex-USSR Countries

Alexander G. Tvalchrelidze, sandro@eurasianminerals.com, Georgian Minerals, Ltd.

Our infantile euphoria caused by destruction of the Berlin Wall is entirely forgotten nowadays. The whole geopolitical space, recently known as the "*communist block"*, has survived a severe economic and political crisis, the consequences of which were absolutely unforeseen. This crisis had had its objective roots. First of all, the real globalization could begin only after the collapse of the communist block, when the globe became unipolar. Mr. Zbigniew Brzezinski had designed main geostrategic imperatives, which should ensure primacy of the USA in the coming unipolar world. Among others, first, amalgamation of the post-Soviet countries into the international commodity markets via implementation of global projects, and, second, global expansion of the USA economic model and financial instruments were mentioned. The USA consecutive administrations followed these recommendations and included the world financial and social institutions like the World Bank, the International Monetary Fund and the United Nations Development Programme (UNDP). Ultimately, these states were included into the world financial and mercantile markets. However, these relations immediately begin to break when commodities and commodity markets are implied, and this misunderstanding originates from different philosophical understanding of a commodity as such.

In the Soviet Union a commodity has always been considered as a political-economic category, which enabled the immense country to survive separately from the civilized world, behind the "iron curtain". Primacy belonged to resource, industrial and, of course, military security whereas economy of commodities played the secondary role. According to the Anglo-Saxon approach a natural resource or a commodity produced from it represents a specific form of tangible immovable property, and as such it is subject to market relations. For instance, a commodity or a natural resource may be sold, alienated, leased, landed, mortgaged, taken or given as warranty, devised to any person, given for exploitation, capitalized, etc.

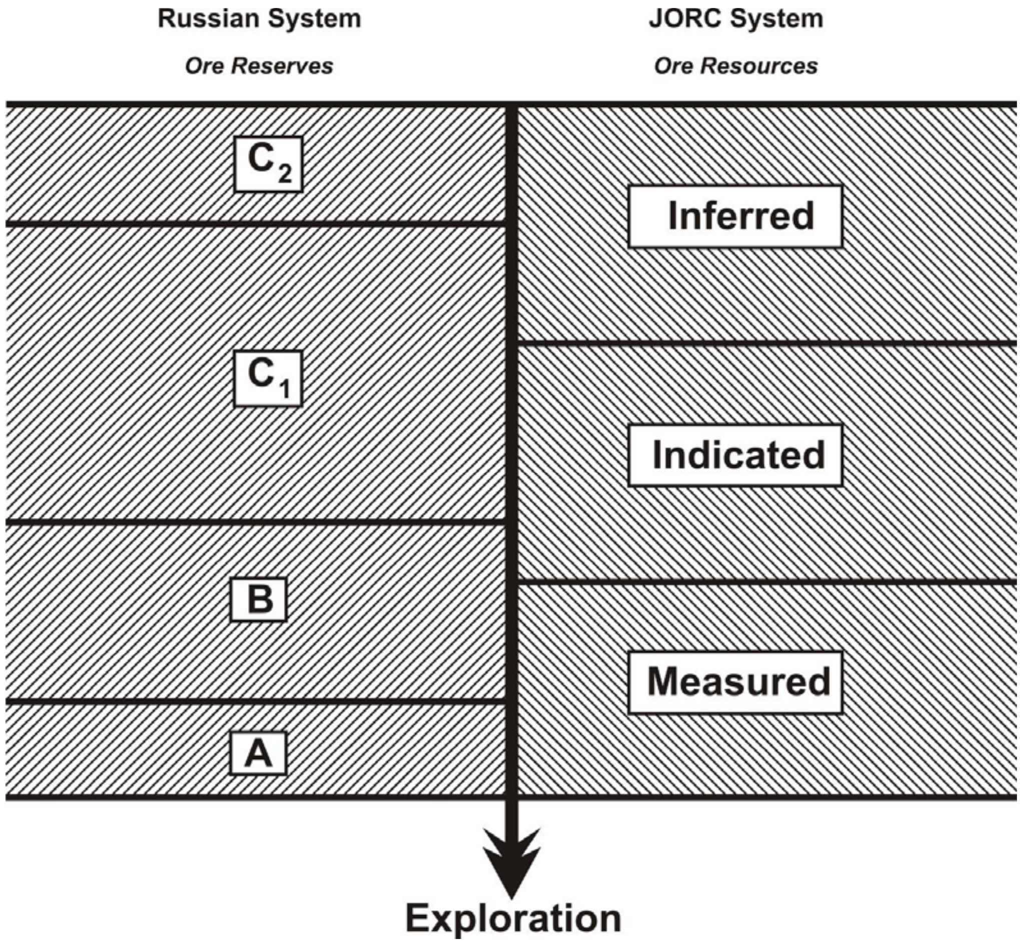
The Russian mineral reserves classification was elaborated in early sixties of the recent century and, then, twice updated in 1981 and 2007. This classification is based on several features: (i) classification divides mineral reserves into booked or balance reserves (those reserves, which may be mined under the stated economic and technical conditions and which are added to the State Balance Sheet of Mineral Resources) and unbooked or off-balance reserves (those reserves, which may not be mined under the stated economic and technical conditions but which may in future became of a industrial interest); (ii) According to complexity of the geological structure, mineral deposits are classified onto four groups: 1st group unites deposits with simple geological structure and large reserves; 2nd group joins deposits with complex geological structure and large reserves; 3rd group emphasis deposits with very complex geological structure and medium or small reserves; 4th group amalgamates small deposits; (iii) Booked reserves are divided into A, B, C_1 and C_2 categories; (iv) Reserves of the A category shall be calculated in the 1st group of deposits; this category shall meet the following requirements: dimensions and position of the orebody in space are assessed, features and regularities of spatial variations of mineral composition are determined, natural and technical types of ores are determined and delineated; composition, physical and technologic properties of ores are determined, types and grades of economic and poisonous compounds are determined, their distribution in natural ores and products of their processing are investigated, contour of reserves are delineated between drill holes and adits; (v) Reserves of the B category shall be identified in the 1st

and the 2nd groups of deposits; this category shall meet the following requirements: dimensions and position of the orebody in space are assessed; main features and regularities of spatial variations of mineral composition are determined, natural and technical types of ores are determined and delineated, if possible, main features of composition, physical and technologic properties of ores are determined, mineral types and grades of economic and poisonous compounds are determined, contour of reserves are delineated between drill holes and adits; (vi) reserves of the C_1 category shall be identified in the 1st, 2nd and 3rd groups of deposits;. this category shall meet the following requirements: dimensions and position of orebodies in space are assessed, main features and regularities of spatial variations of mineral composition are determined, possible discontinuity of orebodies is assessed, natural and technical types of ores are determined, general features of composition, physical and technologic properties of ores are determined, contour of reserves are delineated between drill holes and adits; (vii) Reserves of the C_2 category shall be identified in the 1st, 2nd, 3rd and 4th groups of deposits; this category shall meet the following requirements: dimensions and position of orebodies in space are assessed based on geological, geophysical and geochemical data and are confirmed by a limited number of bore holes and adits, contour of reserves are assessed based on a limited amount of drills and adits and results of geophysical and geochemical works.

In the JORC system there is a pronounced difference between ore reserves and mineral resources. Ore reserves imply a quantity of recoverable ores, which may be mined and recovered taking into consideration a number of modifying factors such as mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. Mineral resources imply a quantity of ores in earth's crust. Mineral resources are divided into: (i) inferred mineral resources: a part of mineral resources for which tonnage, grade and mineral content may be estimated with a low level of confidence they are inferred from geological evidences and are based on reliable exploration, sampling and testing; (ii) indicated mineral resources: a part of mineral resources for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with reasonable level of confidence, they are based on exploration, sampling, the locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed; (iii) measured mineral resources: a part of mineral resources for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with high level of confidence, they are based on exploration, sampling and testing information gathered from outcrops, trenches, pits, workings and drill holes, the locations are situated closely enough to confirm geological and grade continuity.

Difference between two systems is shown on the Figure below.

Hence, there are two essential differences, which lead to a lot of misunderstandings between the western investors and state bureaucrats from the governmental agencies of the Newly Independent States. In the Russian system metal inventory, which may be extracted from the earth's crust, is referred to as the "*Reserves*". In the JORC system this metal inventory is referred to as the "*Resources*". The second difference is much more complex and could not be mitigated by simple organizational measures. In the olden Soviet and the modern Russian systems reserves are approved by a special state agency like the Russian State Commission on Reserves. Its decision has absolutely no power for western financial institutions and mercantile and commodity exchanges. In the JORC system resources and reserves are signed by a Competent Person, who has the needed authority for the mentioned institutions. This difference is an insuperable obstacle for capitalization of mineral resources and commodities from the Newly Independent States at international commodity markets.



At the same time, good management and intelligent capitalization of natural resources and corresponding commodities at international commodity markets is the most efficient measure for accelerated economic development of the Newly Independent States. Hence, the black holes in the legislation and, generally, in the philosophy of commodities is an insuperable obstacle towards international commodity markets. Without solving the problems discussed in the paper, direct access to commodity and mercantile exchanges for national mining companies from Newly Independent States would be banned.

About Gadabay ore area and Gadabay gold mine (Republic of Azerbaijan)

Anar Veliyev and Mehman Talibov, anar.veliyev@aimc.az; mehman.talibov@aimc.az, Azerbaijan International Mining Company, Ltd.

Gadabay ore area is located in the territory of Shamkir ascent of the Lok-Aghdam structural-formation area in the Lower Caucasus Megaanticlinorium. The ore region has a complex geological structure, and its has become complex with the intrusive masses and faulting structures of different ages and different composition. Lower Bayous is essentially composed of an uneven interlacing of diabase and andesite seals, aglomerate tuffs, tuff-gravelites and aleurolite. Tuff rocks of the Lower Bayous were exposed to severe metamorphism (skarning and corneous) as a result of the impact of Upper Bayous volcanism and Upper Jurassic aged intrusives. Only sub-volcanic fascia of the Upper Bayous in the

Gadabay mine has been recorded (rhyolit and rhyo dacite, quarts –porphyry). Rocks related to the Bat stage have developed mainly in the northern and southern edges of Shamkir ascent.

Gadabay ore area and Shamkir ascent in general is complex in terms of its tectonic structure and its magmatism is complex too. Magmatic processes in this region have occurred intensely in several phases. In the ore area there are 3 phases of magmatism: Bayous, Bat and Upper Jurassic phases. The Bayous phase is divided into two autonomous sub-stages: Lower Bayous aged rocks – middle and base composition pyroclastic volcanic and volcanic sedimentary rocks – occupy the central portion of Shamkir ascent, and have become complex with intrusive and sub-volcanic complexes and faulting structures with different ages and different morphology. Acid composition products of the Upper Bayous magmatism is represented by very broad and all fascias within Gadabay ore area. It can be considered that the magmatic center of the Upper Bayous period is located in the Shamkir ascent. Andesite, partially andesite-bazalt composition products of the Bat phase of magmatism, as well as various composition pyroclastic materials and lava flows Upper Jurassic phase are spread mainly in the side lines of Shamkir ascent. Along the faults and in the areas between them, rocks along micro cracks have become strongly quartz, caoline, sericite and in most cases derivative quartzite. Faulting structures have not caused Lower Bayous rocks to become too composite. The main complexity were generated by rhyolit, rhyo-dacite and quartz –porphyry composition Upper Bayous aged sub-volcanic masses which occurred along the Gadabay-Bittibulaq depth faulting point and which began to cool down in the area that is close to the surface. These magmatic masses were deprived of high pressures but were in contact with the magmatic source which had not yet cooled down. High temperature hydrothermal solutions that were separated from the magmatic source moved along the sub-volcanic mass cracks and contacts and created hydrothermal metasomatic alterations of various types within them and in the surrounding rocks. Rhyolits and rhyo dacites transferred to various types of derivative quartzite, and the surrounding rocks turned into derivative quartzite, skarn rocks and hornstones depending upon petrographic, mineralogical and lythological compositions. However the processes mentioned above did not occur all through the subvolcanic masses and contact rocks. These processes occurred in such areas where there was a constant contact (open channel or open contact zone) between the sub-volcano and magmatic source. One of such areas was the Misdagh area in which Gadabay gold deposit (mine) is located. When sub-volcanic masses began to cool down dynamic forces constantly influenced some of its regions, in particular the regions that were in active contact with the sub-volcanic source, and dense crack points and damage regions started to emerge here. Such regions were very favourable for the movement of hydrothermal solutions that were rich in chemical elements. In subsequent stages, hydrothermal solutions which were separated from the magmatic centre and moved along the sub-volcanic cracks and contact areas led to the creation of golden copper-pyrite stocks of different sizes emerging along the upper contact of the sub-volcano. Created inside the derivative quartzite in the areas with few cracks and no upper closed screens tiny chords around these stocks were limited ore masses.

In the contract area there are other prospective ore appearances such as Maarif, Maskhit, Shakarbay, Cholpan, Ertapa and so on. Currently geological evaluations are being conducted in these appearances.

Azerbaijan International Mining Company, Ltd. is operating under the Agreement on Production Sharing Agreement signed between “R.V. Investment Group Services LLC”, USA and state company “Azergizil” of the Republic of Azerbaijan. Gadabay gold mine is located in Gadabay Contract Area – one of the six contract areas which have no connection with each other.

The deposit has a relatively small size and was defined as a gold-porphyry deposit which is within the passage between golden composition copper-gold and gold-porphyry types and it has developed inside the prospective Tethys structural stripe which includes several world scale porphyry and epithermal gold deposits. Along the breakings and breaking zones inside the deposit, four parallel gold zones have been identified in structural intervals, mainly in the direction of north west and south east with a length of around 800 meters, width of 400 meters and mainly a thickness of 30 meters.

Gold is often encountered in the form of electrum and autonomous gold in connection with copper ore. Pyrite, as well as oxidized products such as hematite and limonite often fill open spaces and are common along cracks. Chalcopyrite, as well as malachite and azurite are more common; chalcosite, bornite and covellin also relatively common in that area.

Oxidizing zone above the ore zone has been interpreted. Usually below that zone is a sulphate zone. A mineralized structure has been identified that is interpreted as a feeding zone and intersects with the main zone which lies horizontally and under a high angle.

Updated information has been based on the latest evaluation of ore resources related to the classification categories “Proved” and “Probable” in accordance with JORC-2004 code in 2012 by "CAE Mining International Limited" company.

The processing variants contemplated for oxide and sulphate ore of expected “Proved” and “Probable” reserves of ore and limitations connected with the amount of useful components in the ore:

- pile weathering process of oxide ores, $0{,}3 \leq$ Au q/t $< 1{,}0$;

- weathering process of oxide ores by mixing (agitation) method,$1{,}0 \leq$ Au q/t $< \infty$;

- weathering process of sulphate ores by mixing (agitation) method, $1{,}0 \leq$ Au q/t $< \infty 4$

- floating process of sulphate ores, $0{,}3 \leq$ Au q/t $< 1{,}0$.

Calculation of ore reserves is based on 0,3 q/t external amount of gold and is limited by the surface topography dated 30 December 2011 within recent optimal quarry project, initial surface topography, as well as open quarry works.

Renewed reserves on Gadabay deposit (C1 – proved + probable; C2 – measured + indicated):

Category	Type of ore	Reserve, mln. t	Amount of useful components in ore			Reserves of useful components				
			Au,q/t	Ag, q/t	Cu, %	Au		Ag		Cu, 1000 ton
						ounce	ton	ounce	ton	
C1	Oxide	9,62	1,10	9,78	0,24	340759	10,60	3025875	94,1	23,60
	Sulphate	10,69	1,17	9.15	0,33	403269	12,54	3149656	97,95	35,89
Total:		20,31	1,14	9,46	0,29	744038	23,14	6175531	192,06	59,48
C2	Sulphate	16,80	0,57	4,50	0,13	310344	9,65	2433020	75,67	22,29

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TSX.V: EMX
NYSE MKT: EMXX
Frankfurt: 6E9

52-week High: $2.86 / Low: $1.66

Building Wealth via Discovery, Growth and Royalties.

An extraordinary 50.6 troy ounce gold nugget from the Koonenberry Gold Project in New South Wales, Australia.

Conspicuous copper staining leached from the surrounding copper- and molybdenum-rich host rocks at the Copper Basin Project in the Bradshaw Mountains of Arizona, USA. This project is joint ventured with earn-in partner Vale S.A., the second largest mining company in the world.

A diamond-core drilling rig and crew at work on Kucukhugla Tepe (Kucukhugla Hill), Akarca Gold-Silver Project, western Anatolia, Turkey. This project is joint ventured with earn-in partner Centerra Gold, Inc.

- ***Prospect Generator and Royalty Company Focused on the Discovery of Gold and Copper***
- ***Expanding Royalty Portfolio with a Multi-Million Dollar Cash Flow Stream***
- ***150+ Properties Worldwide, 35+ Joint Ventured***
- ***Joint Venture Partners Include Newmont, Vale, Freeport-McMoRan, Antofagasta , Centerra Gold, Entrée Gold, Inmet and More***
- ***$40 Million in the Treasury Coupled with a Low Cash-Burn Rate***

Eurasian Minerals is a prospect generation exploration and royalty company. The company is focused on the discovery of gold and copper and enjoys a multi-million dollar cash flow stream. Often referred to as a "Junior company with a Major's portfolio," Eurasian Minerals has property portfolios in Turkey, the western United States, Scandinavia, Haiti and Australia, as well as other locales.

For more information, contact:
Scott Close, Investor Relations
+1 303.973.8585.

www.EurasianMinerals.com

+1 303.973.885 | 543 Granville St., Suite 501 Vancouver, BC Canada V6C 1X8