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Discovery

Russian new gold-cobalt-uranium-manganese-iron and graphite giants in the Jewish Autonomous Region (Far East)

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ABSTRACT
Geologic-tectonic features of location, mineralogical and geochemical data of the complex iron ores and metal resources in the giant ore field and graphite deposit of the Bureya craton in the Far East are examined. The deposits are very interesting objects for economic collaboration with countries of the Asian-Pacific Region for conducting geologic prospecting, mining and building of a metallurgical plant.

Key words: giant deposits, complex metal resources, geologic prospecting, and ore mining.

1. INTRODUCTION
Scientific investigations conducted recently in the southern part of the Bureya massif made it possible to detect the giant ore field of iron ores, the South – Khingansky, containing a wide complex of valuable metals. Extra-large resources of the Soyuznoe graphite

deposit are also confirmed. These deposits are located in the southern part of the Khingansk iron ore basin with many deposits of the ferruginous quartzite (Zhirnov, 2008). They are not known in the foreign press. Therefore, information about them could be very useful for East Forum in Vladivostok on September 3-5 this year.

2. SOUTH – KHINGANSKY DEPOSIT OF COMPLEX ORES

The scientific novelty of the new discovery is determined by two factors. First, superlarge resources of iron ores and gold in the ore field those are comparable only with the largest gold-iron ore giants of the Russia's Kursk iron ore basin: the Mikhailovsky and Stoilensky deposits holding gold resources up to 1,000-2,000 t (Chernyshev, 2010). Second, the iron ores of the new area contain an unusually wide complex of satellite metals – Mn, Ni, Co, V, Au, Ag, Pt, U, Mo, and Y. Regarding the composition of the complex ores, this deposit has no equal in Russia among metamorphogenic type deposits. This is the world-class object with its resources sum cost of $US 200 billion.

The ore field was prospected and partly explored for manganese ore about 70 years ago (1942-1955). The manganese ore resources at one of the sites of the field (4 km long) were explored down to a depth of 170-350 m and sanctioned by the USSR Mineral Resources State Commission in 1956 (8 million t). The rest of the field (with a sum length of the ore bodies equaling 90 km) was only investigated by trenches from the surface, in some cases, by individual holes down to a depth of 80-170 m (Chebotarev, 1958). Since that time, the deposit and the ore body as a whole have been named in the scientific literature as small manganese deposit.

The ore field is located in the Proterozoic longitudinal graben 70 km long, which was forming long (AR-O) among Archean anticlinorium structures, strongly granitized in the Paleozoic. The axial part of the graben is composed of dolomite and flanks - carbonaceous and chert shales of Vendian-Cambrian age. The rocks are steeply inclined and vertical drop. The sides of the graben are cut by large longitudinal faults, which control the position of the deposit's ore thick bodies. Transverse and diagonal faults divide the ore-bearing thick sequence into a number of tectonic blocks, differently mineralized.

The ore field consists of two main meridionally-striking parallel ore zones 60 km long, separated from one another by 5-7 km, in the side parts of the graben (Figure 1). 90% of each ore body is ferruginous ores. The manganese stratum occupies the marginal position in the lying side of the ore bodies.

Figure 1 The position of the ore-bearing graben in the geologic structure of the region (Chebotarev, 1958; Zhirnov, 2008; Zhirnov, et al., 2012). 1 – Neogene-Quaternary loose rocks; 2 – clay shales, sandstone, and dolomites ($€_1$); 3 – dolomites and schists (V) of the Murandava Formation; 4 – coaly clay shales of the Igincha Formation (R); 5 – Lower Proterozoic metamorphic rocks; 6 – Paleozoic granitoids; 7 – iron ore zones; 8 - gold-uranium-vanadium zone (U); 9 – ground type highways.

The thickness of the iron ore bodies varies from 10 to 50 m, and it reaches 100-150 m in the bulges. The composition of the iron ores is magnetite-hematite; and on the flanks, hematite. The structure of the ores is banded due to intercalation of iron and quartz (often chalcedony) layers 0.5-2 cm thick on the average. The texture of the ores is fine-grained (0.05-0.5 mm). Non-metallic minerals are represented by opal, chalcedony, fine-grained quartz, and dolomite, less often, rhodochrosite, sericite, chlorite, fluorite, and barite.

Iron content of the iron ores is up to 30-35%, manganese in the manganese ore layer, 8-26% and more, 17.1% on the average (Chebotarev, 1958).

The manganese ore stratum in the lying side of the deposit is represented by braunite, hausmannite- braunite, and braunite-hematite ores, also banded addition. The thickness of the stratum varies from 1-3 to 8 m. Characteristically, the iron ores contains universally impregnation and small pockets of sulfide minerals – pyrite and chalcopyrite, and manganese ores also contain nickel and cobalt minerals – linneite and millerite. Nickel content in the ore, according to the average furrow coring and testing (547 samples) ranged from 0.03 to 1% (mean 0.1 ± 0.15%), cobalt - reaches 0.3% or more, on average - 0 06% (Chebotarev, 1958). Iron ore 60% composed of ore minerals, manganese ore - by 85 - 90%.

The depth of mineralization expansion, determined by single holes (at the prospecting site), reaches 500 m (Figure 2); the probable depth is about 1-2 km. By the size of the ore-bearing structure and the scale of ore resources, the deposit is similar to the Krivorozhskiy iron ore basin, where the depth of exploitation reached 1.4 km (Zhirnov, 2008).

The commercial iron ore reserves of 12 ore bodies (of 20 recognized) of Category C-2 down to a depth of 50-100 m are 292 million t (Chebotarev, 1958). The reserves and resources of satellite metals – nickel, cobalt, and iron in many ore bodies (including those in the explored Serpukhovo-Poperechnoe body) were not taken into account in the course of prospecting, and noble metals were not determined.

At present, iron ore reserves down to a depth of 500 m have been identified by direct calculation based on the known parameters of ore bodies on the surface. They amount to 3 billion t (Zhirnov, et al., 2012).

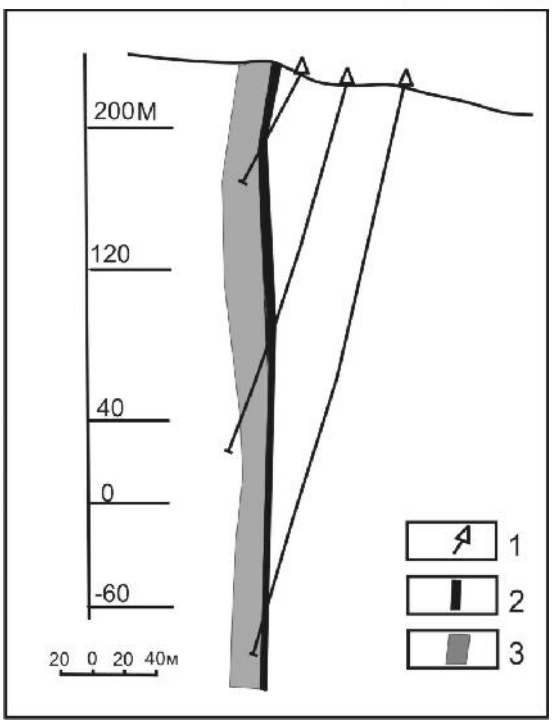

Figure 2 The section of the Poperechnoe's ore body. By (Chebotarev, 1958) the simplification. 1 – Bore holes; 2 – manganese ore stratum at the eastern side of the iron ore body; 3 - Iron ore body.

Manganese ore resources in the marginal stratum of iron ore bodies with Mn content of 8% and above have been estimated at 200 million t. Commercial ore resources with Mn content over 15% are expected to a level of 50 million t. Nickel and cobalt are present only in manganese ores irrespective of the level of manganese content of the ores. But they are also found in large quantities (Table). Gold was predicted in the study graben earlier (Gurskaya, 2000).

Recently identified noble metals are present in iron and manganese ores. According to the atomic absorption analysis, gold content in 30 geologic samples weighing 2-15 kg varies from 0.05 to 1-2g/t, and in single samples, up to 14.9 g/t (Zhirnov, 2008; Zhirnov et al., 2012). Gold and platinum (sperrylite) diagnostics is confirmed by evidence of the mineralogical sample analysis and study of metal grains by the JSM-35C scanning electron microscope (Moiseenko et al., 2005).

According to technological investigations of a large bulk sample taken in 2000, gold is chiefly concentrated in the magnetic fraction -1.25+0.2 mm. Gold grains are small belonging to 0.1+0.02 mm class. The grain form is isometric, less often, step-type and angular. Gold assay is high – 890–920 units.

Gold grains from the oxidized ores are relatively large, on a level of 0.1-0.4 mm, and are distinguished by bright yellow color, whereas gold grains from the primary ores are characterized by non-bright, dead yellow coloring (Moiseenko et al., 2005).

The ores are likely to contain two gold generations- early, syngenetic with respect to the formation of ferruginous quartzites; and late, conditioned by superposition of Mesozoic quartz-sulfide mineralization on the ores.

On the northern side of the Eastern iron ore zone, the Pompeevskaya uranium-bearing zone with complex mineralization of a different type has been recognized. It stretches for 15 km, and its thickness is ≤ 80–100 m (Figure 1). The ore body proper is represented by hydrothermally altered (silicification, albitization, and pyritization) rocks, developed on the contact of coaly clay shales and brecciated coaly dolomite rocks of the Murandava Formation. The altered rocks are superimposed by streaky-impregnated mineralization, represented by brannerite and uraninite. Uranium content is 0.05 to 0.08%; occasionally ≤ 0.1–0.2%. The ores exhibit considerable concentrations of widely developed associated metals: vanadium (≤ 1%), molybdenum (0.05%), silver (4.6-11.7g/t), platinum (0.12 g/t), gold (0.45-1.2 g/t), and yttrium (≤ 0.3% (Gurskaya, 2000). The preliminary estimate of uranium ore resources is up to 40 thousand t (Zhirnov et al., 2012).

The sum cost of metal resources in the complex iron ores in this ore deposit has been estimated at $US 200 billion (Table).

Table

Resources metals in the manganese-iron ores of the deposit and their cost

Metals	Resources	Cost of 1 t, $US (Nezhensky, 2013)	Resources value of the earth, billion $US	%	Category of resources
Iron ores	3 billion t	40	120,0	58.3	P-1
Commercial manganese ores.	50 mln t	200	10.0	5,0	P-1
Nickel	300 thoud. t	7500	2,25	1,1	P-1
Cobalt	100 thoud. t	35 000	3,50	1,8	P-1
Gold	1000 t	1 g = $US 50	50,0	24,3	P-2
Platinoids	300 t	1 g =$US 50	15,0	7.4	P-2
Uranium	40 thoud. t	100 thoud.	4.0	2.1	
Total			205.7	100	

The above ores are quite similar to those from some iron ore deposits of China as regards their complex character, which is probably conditioned by their position in one large metallogenic province (Mineral deposits of China, 1999).

The South - Khingansky iron ore deposit is located in a rather favorable geographic and economic place near the newly built Kimkan-Sutara ore-dressing and processing enterprise, in the northern part of the Khingansk's iron ore basin.

The ore field of complex ores is quite a favorable and promising target for cooperation with Asian-Pacific countries in the area of geologic prospecting of this ore field, construction of an ore-dressing and processing enterprise and a metallurgical plant. The ore field is a rather favorable subject for application of high technologies of the Asian-Pacific countries in different areas of geologic prospecting and mining. For example, in terms of the use of modern high-performance equipment for the rapid exploration of the ore field, for a large amount of accurate and express analysis of geological samples and the use of high technology in the field of enrichment of complex ores and extraction of many valuable metals.

3. SOYUZNOE GRAPHITE DEPOSIT

Soyuznoe graphite deposit was explored in 1936-1940 the last century, near the mouth of the small Belaya River, on the left mountain slope of the large Amur River (Figure 3).

The length of the explored deposit is 500 m, width is 160-200 m, and depth of exploration and estimation of reserves are 70-150 m (Onihimovsky, Belomestny, 1996). Explored reserves approved by the State Reserves Committee of the USSR in the amount of 8.7 million t (Onihimovsky, Belomestny, 1996). Graphite field extends far to the northeast, and possible resources of graphite in it estimated at about 1 billion tons.

In 2003-2004, Birobidzhansky geological enterprise conducted a search operation (under my direction) on the northern flank of the deposit, in the area about 2 km long, adjacent to the state road. This area is represented by a high mountain, which is higher the previously explored field in 200m. Three long ditches (550-1500m) had been passed through the mountain. As a result, under a layer of loose rocks was found a very broad body of graphite - 300-500m (see Figure 3).

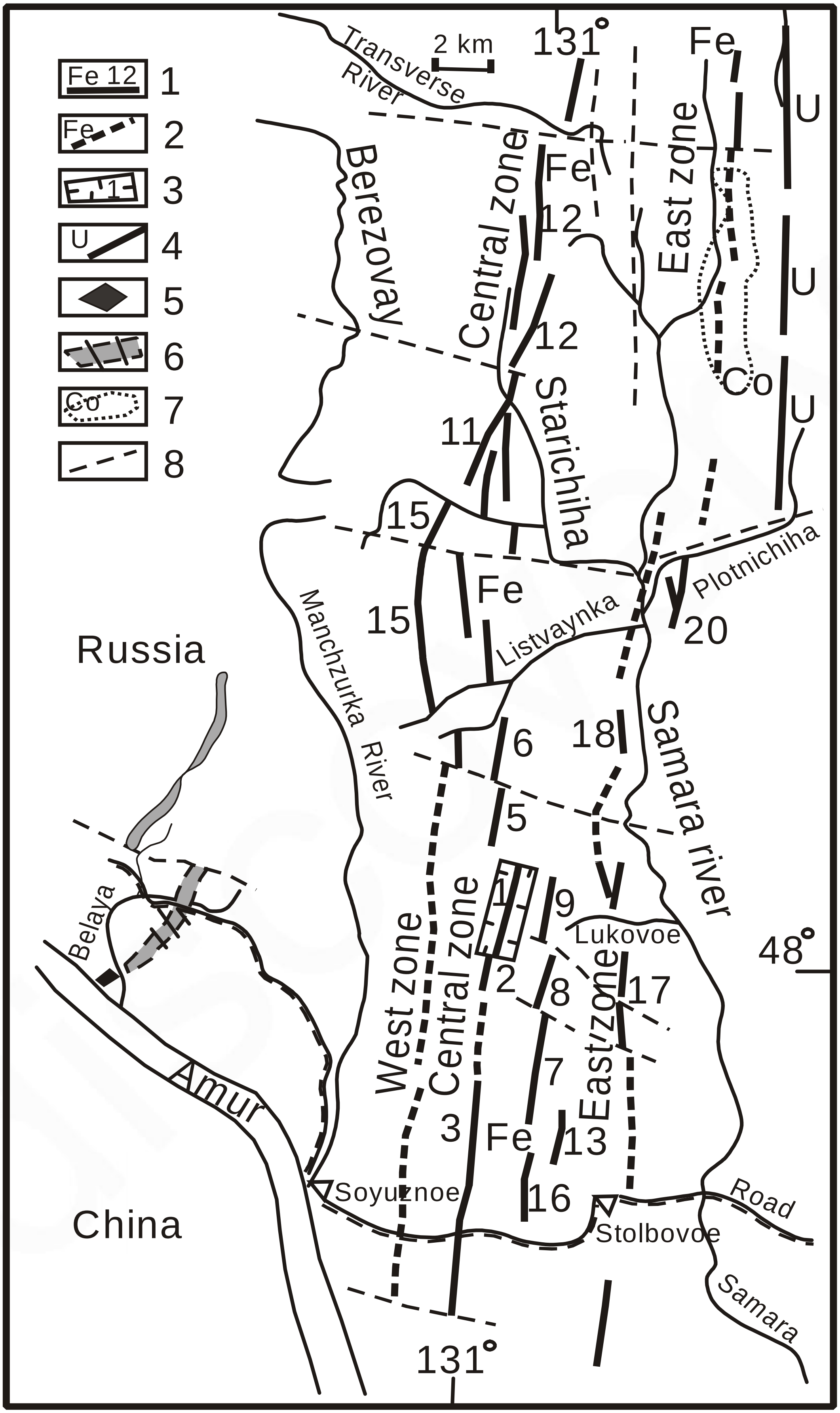

Figure 3 Arrangement ore bodies of the South – Khingansky deposit complex ores (right) and the Soyuznoe graphite deposit (left), near the mouth of the river Belaya (Chebotarev, 1958; Onihimovsky, Belomestny, 1996; Zhirnov et al., 2012). 1 - manganese-iron

bodies (and their numbers), opened from the surface by trenches; 2 - iron bodies established to a depth of 300m magnetic geophysical survey; 3 - Poperechnoe manganese-iron body (№ 1), explored in 1950-1955 and transferred under the license to the Chinese company in 2005 for ore mining (mining has not yet begun); 4 - uranium ore zone of vanadium, molybdenum, gold, silver; 5 - Soyuznoe graphite deposit, explored in 1936-1940; 6 - the northern part of the Soyuznoe field, which is studied from the surface in a few ditches in 2003-2004 years; 7 - cobalt geochemical anomaly; 8 – faults.

Projected reserves of graphite, calculated according to the analysis of samples from these trenches, up 37 million t to a depth of 50 m (Cherepanov, 2014). If you perform a geological prospecting by an additional ditches and drilling a series of wells to a depth 200 - 300m, the reserves of graphite in this area could reach 400 million t (to a depth of 200 m from the surface).

On the basis of such large reserves of graphite can create a mining enterprise with a very long period of existence (at least 100 years). Now one Russian small firm (Dal'grafit) is showing interest to this project.

4. CONCLUSION

1. The South - Khingansky ore field of ferruginous quartzite is characterized by complex composition of the ores (Fe, Mn, Ni, Co, Au, Pt, Ag, U, and Y), huge extent (60 km), large thickness of the ore bodies at the level 10–150 m, and great depth of ore distribution (≥ 0.5-1.5 km). The iron ore resources calculated down to the depth of first-priority exploitation, 500 m, are estimated at 3 billion t.
2. Regarding the ore composition, characteristic commercial metals, volume of metal resources, and their cost, this ore field is similar to the largest metamorphogenic deposits of Russia, Ukraine, and China. However, a wide range of the associated value metals in manganese - iron ores - the main feature of this deposit. At present it is the most promising ore deposit in the Russian Far East - the world-class object.
3. The cost of resources of complex ores is estimated at $US 200 billion. Regarding the value of the ores, the most significant are iron and noble metals, which account for 82% of the total value of the ores.
4. The Soyuznoe graphite deposit is characterized by the presence of giant ore body (width 200-500m), localized in a small compact space. It is characterized by super large resources of graphite. But you must perform geological exploration of the deposit and confirm the exact reserves in the State Reserves Committee of Russia before 0construction of the mining enterprise and production of graphite.
5. The above super-large deposits of valuable minerals can be to important objects for innovation in economic relations with countries of the Asia-Pacific region in terms of geological survey, ore mining and of the creation of metallurgical plant for the rational extraction of many valuable metals.

These important objects are recommended for discussion at the East Forum of the Asia-Pacific countries on September 3-5 this year in Vladivostok as investment objects.

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