POSTER

Structural Model of Peschanka Porphyry Cu-Au-Mo Deposit, Western Chukotka, Russia

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Introduction

The Peschanka porphyry Cu-Au-Mo deposit is situated in western Chukotka, Russia 250 km southwest of the town of Bilibino (Fig. 1). The deposit was discovered in 1973 and explored in the 1970s–1980s. The follow-up exploration is currently carried out by the Baimskaya Mining Company under the guidance of the Regional Mining Company, LLC.

The estimated by IMC Montan mineral resources in the Peschanka deposit to October 2011 at the 0.40 % copper equivalent cut-off, include:

- Indicated Resources of 1.2 billion metric tons grading 0.53% copper, 0.29 g/t gold, 0,014% molybdenum, and 2.6 g/t silver contained 6.39 million metric tons of copper, 345.7 metric tons of gold, 165,4 thousand metric tons of molybdenum and 3141.5 metric tons of silver.
- Inferred Resources of 40.7 million metric tons grading 0.59% copper, contained 0.239 million metric tons of copper.

The deposit is not yet constrained at depth or on its flanks. Based on drill data, mineralization can be traced to a depth of 750 m. Further exploration will likely increase resources at least 10 Mt Cu and 500 t Au.

Figure 1. Location of the Peschanka deposit

The newly obtained data allowed us to specify geology of the deposit and to designe it's structural model to understand the regularity of ore mineralization distribution and tectonic conditions of deposit forming.

Geology, Alteration and Mineralization

The Peschanka deposit is localized in the Baimka ore zone (trend) controlled by the deep fault that transects the outer

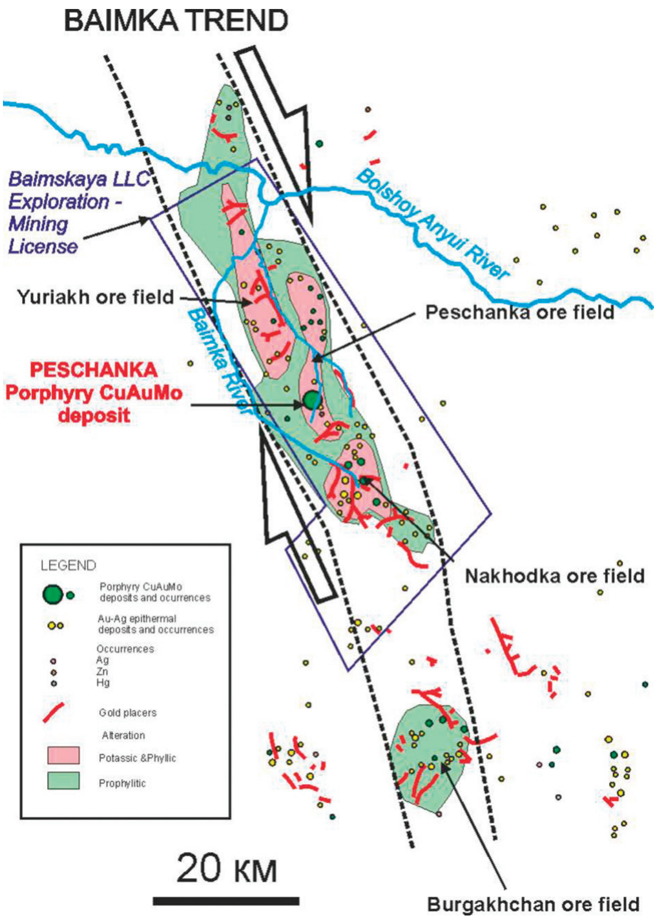

Figure 2. Location of the Peschanka deposit within the Baimka trend

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part of the Cretaceous Okhotsk–Chukotka magmatic belt of the Andean type (Figs. 1, 2). The ore-bearing, metasomatically altered Early Cretaceous intrusive rocks of the Yegdygkych pluton comprise monzodiorite and monzonite, quartz monzonite, and syenite porphyries (Fig. 3,4,5).

The porphyry intrusions occupy about 10–15% of the volume of ore-bearing rocks.

The veinlet - stringer–disseminated mineralization forms a linear stockwork extending for 7000 m from the south to the north and reaching 700–1500 m in width. The stockwork is broken by transverse and diagonal strike-slip faults into three blocks. Vertical, inclined, and horizontal zones with high-grade mineralization are traced within the stockwork.

The ore stockwork coincides in outlines with the aureole of potassic (quartz–biotite–K-feldspar) metasomatic alteration. The earlier, preore quartz–epidote–actinolite–chlorite–prehnite–albite propylitic alteration forms an outer aureole 1 km wide; altered rocks of this type are sporadically noted within potassic aureole. The later ore-bearing quartz–sericite–illite–chlorite phyllic alteration superimposed upon both propylitic and potassic altered rocks mainly remains within outlines of the latter as numerous metasomatic lenses and zones (D-type veins) controlled by fractures and faults. The phyllisite zones and veinlets often inherit linear zones of potassic feldspathization. The zones of phyllic alteration vary from 1 mm to 1–20 m and greater in thickness and extend along the strike and down the dip for tens and hundreds of meters making up a stockwork with predominance of the NE-trending nearly vertical altered zones (Fig. 6). Multitude of such zones and veinlets occur at the deposit.

Mineralized phyllisite bodies display ore zoning. Bornite and chalcopyrite (azurite, malachite, Mn oxides in the supergene oxidation zone) dominate in their marginal parts and the narrow adjacent zone of quartz–K-feldspar metasomatic rocks, whereas pyrite (limonite in oxidation zone) prevails over bornite and chalcopyrite in axial parts of phyllic zones. The zones of phyllic alteration reveal banding and locally developed foliation caused by nonuniform distribution of metasomatic and ore minerals in combination with cleavage and shear fractures. Lenses of massive quartz, as a rule, barren are often associated with thick phyllisite zones. Tourmaline is noted sporadically in various parts of the deposit.

The axial parts of zones are often composed of postmineral tectonic breccia, cataclasites, and mylonites. These tectonites consist of fragments of mineralized metasomatic rocks cemented by kaolinite (argillic alteration). Large crystals of

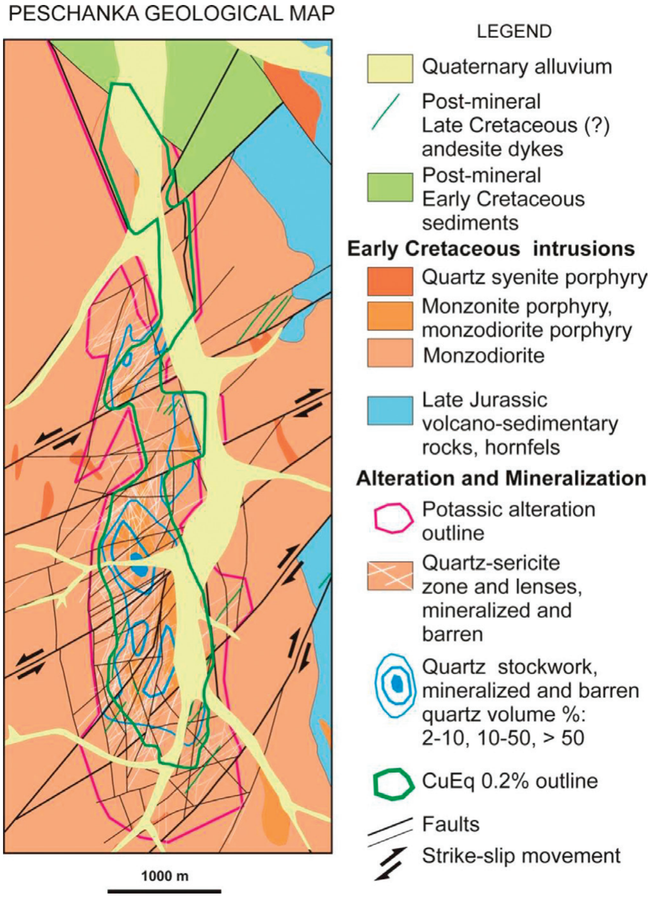

Figure 3. Geological map of the Peschanka deposit

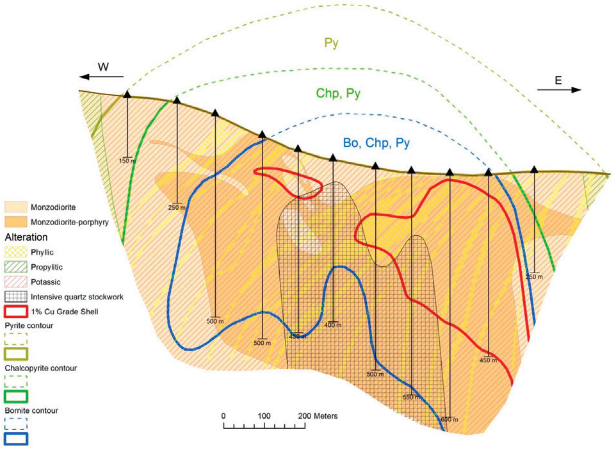

Figure 4. Main Ore Body geological cross section

Figure 5. Main Ore Body copper grade block model cross-section

newly formed pyrite are frequent. The fractures controlling the zones of phyllic alteration are characterized by strike-slip, thrust, and normal kinematics.

Propylites, potassic metasomatic rocks, and phyllisites are crosscut by dilation veinlets and veins of gray quartz occasionally thin-banded due to the uniformly distributed finely dispersed molybdenite. The veinlets make up a tight stockwork in the central part of the deposit. The reticulate structure of the stockwork with 4–6 veinlet systems is predominant. The gray quartz may be ore-bearing or barren. Sulfides are localized in the selvages of veins and veinlets, as well as in microfractures and cataclastic zones, where fragments of gray quartz are cemented by chalcopyrite, bornite, molybdenite, pyrite, white quartz, and calcite.

The linear quartz stockwork extending almost continuously from the south to the north throughout the deposit was formed in the stress field of the near-horizontal latitudinal extension. Hydraulic fracturing under excess pressure of hydrothermal solutions also could facilitate formation of the stockwork.

The hypogene veinlet-stringer–disseminated sulfide mineralization, which is hosted in quartz–biotite–K-feldspar metasomatic rocks, phyllisites, and less frequently in propylites, is mainly controlled by phyllisite zones as the most permeable conduits and quartz stockwork. The major ore minerals are bornite, chalcopyrite, and pyrite; molybdenite, fahlore, sphalerite, galena, magnetite, and hematite are less abundant. The sequence of mineral assemblages correspond to several stages of ore deposition developed largely after completion of metasomatic alteration and formation of quartz stockwork.

The bornite core in the central part of the deposit is surrounded by consecutive bornite–chalcopyrite, chalcopyrite, chalcopyrite–pyrite, and pyrite zones, which are outlined by a dominating mineral in the sulfide assemblage. Bornite and chalcopyrite occur in the zones of potassic and phyllic alteration. The bornite rich mineralization coincides generally with the richest part of the ore body. The orebody steeply plunges to the east. A narrow high-grade ore shoot (up to 1.85–8.5% Cu in 2 m-long core samples) occurs in its eastern part indicating the ore channel. (Fig. 4, 5).

Pyrite dominates in the marginal and upper parts of the ore stockwork and is widespread beyond its limits in silicified propylites (pyritic halo). Phyllisite zones at the flanks of deposit are devoid of sulfide mineralization

Micrograins of free gold (0,0012 -0,4 mm in size) are identified largely in bornite, chalcopyrite, fahlore and rarely in pyrite

The late pebble dikes and dike-shaped bodies of hydrothermal breccia located in various part of the deposit consist of angular and rounded fragments of metasomatic rocks varying in size from fractions of a millimeter to 1–3 cm and cemented by quartz, bornite, chalcopyrite, and magnetite.

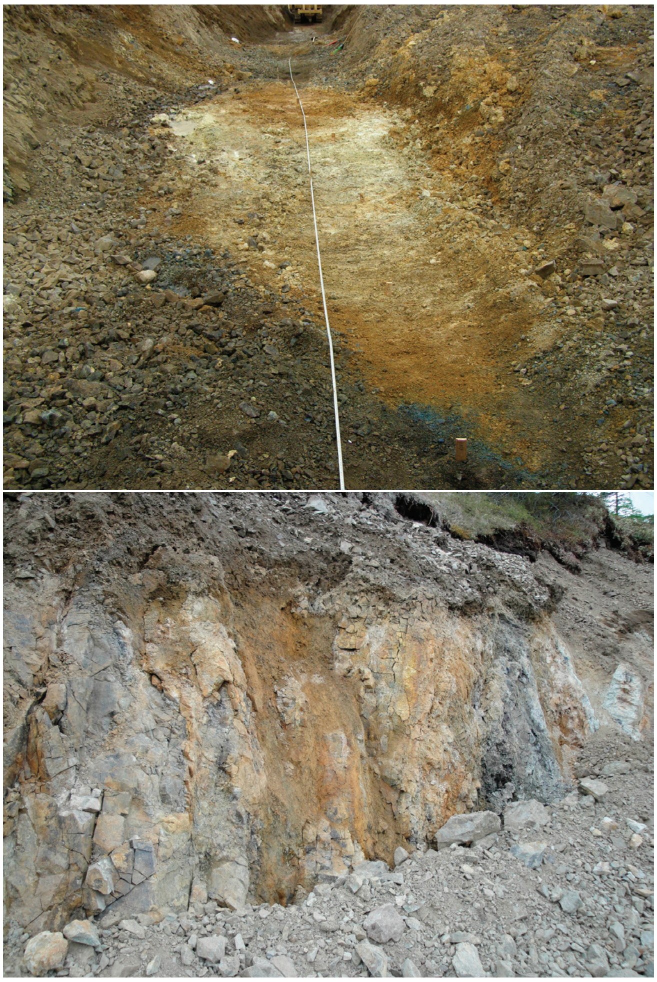

Figure 6. Ore bearing qartz-sericite zones (D-veins) in the trenches.

The youngest Au-bearing galena–sphalerite–fluorite–calcite veins up to 10–30 cm thick commonly inherit zones of phyllic alteration.

Postore calcite, gypsum, and anhydrite veinlets are noted. Some faults are healed by barren or slightly mineralized Late Cretaceous (?) andesite dikes.

Supergene mineralization in oxidation zone comprises malachite, azurite, cuprite, and copper wad. Secondary chalcocite, covellite, and bornite are rare minerals.

The deposit is marked by intense negative magnetic anomaly coinciding with anomalies of induced polarization and low resistance. According to the data of audiomagnetotelluric sounding, an extensive anomaly of low resistance corresponding to the ore stockwork is traced to a depth greater than 800–1000 m. The interpretation of these anomalies allows us to suggest that ore-bearing metasomatic rocks extend to a depth of ~1000 m and probably deeper.

The U–Pb zircon age of monzodiorite pertaining to the Yegdygkych intrusive complex is estimated at 142 Ma (Moll-Stalcup, 1995). The Rb–Sr age of metasomatic potassium feldspar and biotite from the Peschanka deposit is 135.9 ± 6.1 Ma (I.A. Baksheev, oral communications).

Structural Control of Hypogene Ore Mineralization

Sulfide veinlets and stringers are synkinematics and were formed in the process of deformation and development of ore stockwork. They are often lenticular, en echelon arranged, and related to the extensional structures displaying strike-slip, thrust, and normal displacements (Fig.7, 8).

The linear, steeply dipping zones of high-grade copper mineralization striking in the meridional direction, as well as diagonal and low-angle ore zones were formed as a result of reactivation of previously existed permeable zones. The ore-bearing hydrothermal solutions migrated through these conduits into the quartz–sericite and quartz stockwork, precipitating ore minerals (Fig.6).

Strike-slip slickensides along selvages of quartz–sericite zones and crosscutting fractures are considered to be a structural assembly of postmineral NE-trending left-lateral strike-slip dislocations conjugated with the NW-trending right-lateral offsets along the Baimka Fault Zone. We observed one of sutures of this fault zone in the Omchak River valley, where a zone of shearing (SC-tectonites) and folding (folds with horizontal and vertical hinge lines) more than 100 m in thickness is traced in the Upper Jurassic pyritized black siltstone.

Cu, Mo, Au Distribution in the Ore Stockwork

Analysis of the Data Bases of core samples and channel samples allowed us to reveal some statistic dependences and to interpret them geologically. The main conclusions are:

- Mostly Cu, Au and Mo peaks coincide with D-veins bearing intervals and quartz-sulfide veining intervals (Fig.9);
- Steeply-dipping north-east trending phyllic zones are the most ore controlling (Table 1).
- The highest grades of Cu, Au, Mo are related to north (strike azimuth is 0-20), north-east-east (60-80) and south-east (140-160) trending phyllic zones, which are

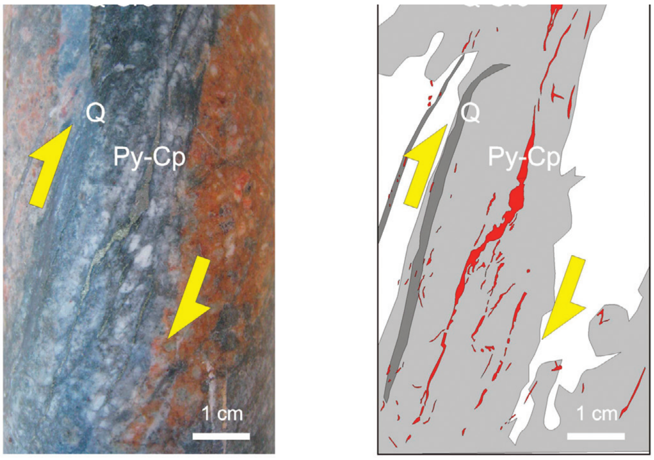

Figure 7. Hole CP10-203, 155 m. Echelon-like syn-kinematics sulfide (pyrite-chalcopyrite) strings inside the quartz-sericite lense (D-vein)

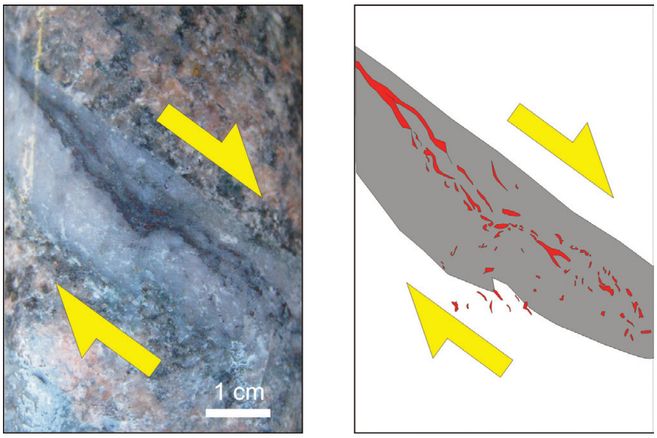

Figure 8. Hole CP10-203, 269.4 m. Syn-kinematic bornite-chalcopyrite strings cross the quartz veinlet from its upper boundary to lower one, that indicates the more younger age of strings relative quartz

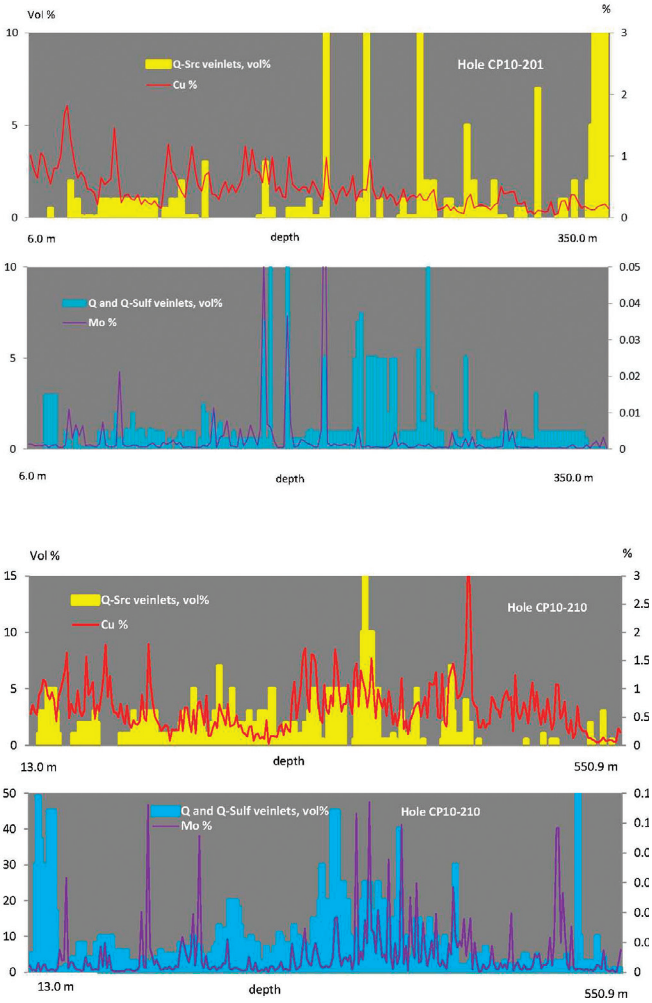

Figure 9. Relationship graphs showing Cu-Mo grades versus volume percent of D-veining (linear phyllic alteration) and quartz/quartz-sulfide veining in 2-m length core samples

AZ / DIP	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
0-20	0.00	0.00	0.00	0.00	0.00	0.40	1.32	1.62	0.00
20-40	0.00	0.00	0.00	0.00	0.00	1.24	0.54	1.89	2.21
40-60	2.24	0.00	0.00	0.00	0.38	0.11	4.21	3.65	1.50
60-80	0.00	0.00	0.87	0.12	0.00	1.71	3.18	2.17	3.06
80-100	0.00	0.00	0.33	0.34	0.00	1.66	2.52	2.83	5.86
100-120	0.00	0.09	0.00	0.00	0.00	0.00	1.14	3.30	0.94
120-140	0.00	0.00	0.00	0.00	0.04	1.02	1.98	18.51	8.75
140-160	0.00	0.00	0.00	0.00	1.41	0.36	3.40	14.12	8.64
160-180	0.00	0.00	0.00	0.00	0.00	0.00	2.77	6.52	0.48
180-200	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.68
200-220	0.00	0.00	0.00	0.00	0.00	0.00	0.18	2.12	0.05
220-240	0.00	0.00	0.44	0.00	2.57	1.99	3.74	1.22	0.58
240-260	0.00	0.00	0.79	0.79	0.00	5.13	9.56	9.05	0.00
260-280	0.00	0.00	0.00	2.38	2.63	11.23	8.18	3.78	1.19
280-300	0.00	0.00	1.63	0.77	1.23	6.07	20.24	6.68	0.63
300-320	1.58	0.00	0.72	3.59	3.52	11.77	22.94	3.75	3.35
320-340	0.00	0.00	0.93	7.24	9.43	9.02	39.64	13.93	1.38
340-360	0.00	0.00	0.00	6.86	3.83	9.90	8.04	5.93	1.32

Table 1. The additive index of copper grade in various oriented phyllic zones

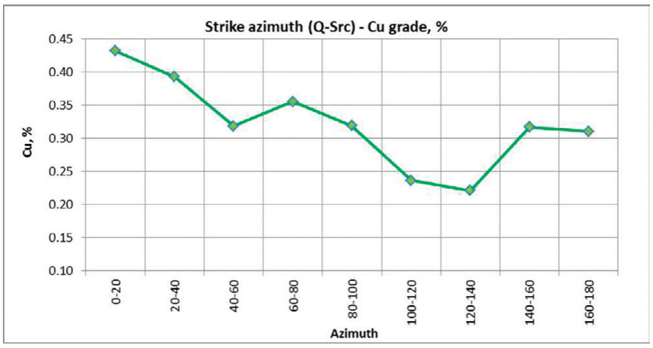

Figure 10a

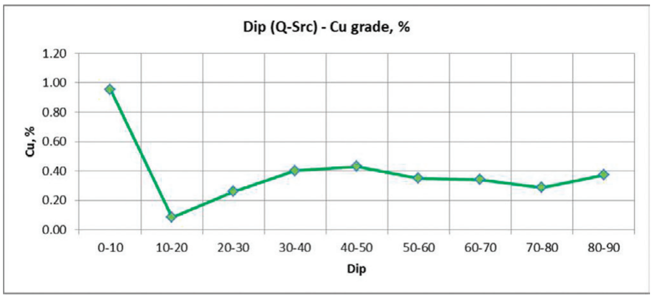

Figure 10b

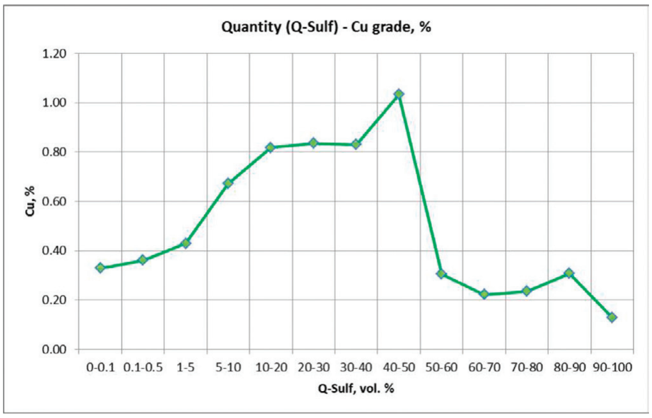

Figure 10c

Figure 10. a) the relation between copper grade and different strike azimuths of phyllic zones, b) the relation between copper grade and different dip angles of phyllic zones, c) the relation between copper grade and volume percentage of quartz-sulfide veinlets

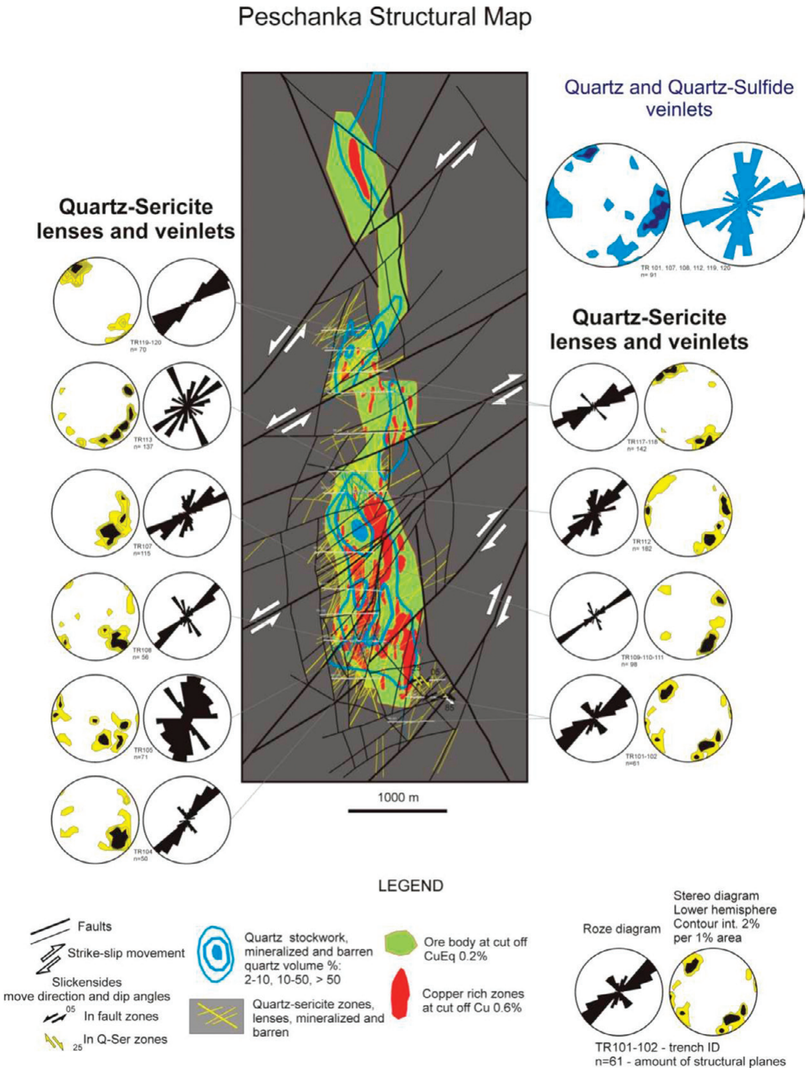

Figure 11 (left). Structural map, rose diagrams and stereo diagrams of the Peschanka deposit

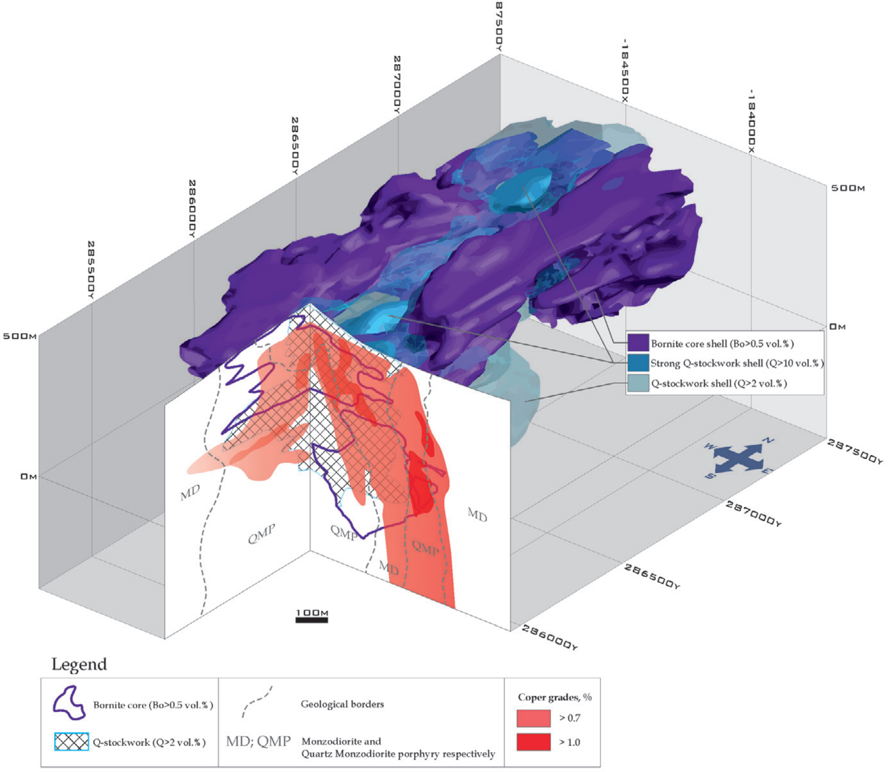

Figure 12 (right). Spational relationships of bornite mineralization and quartz stockwork wthin the Main Ore Body

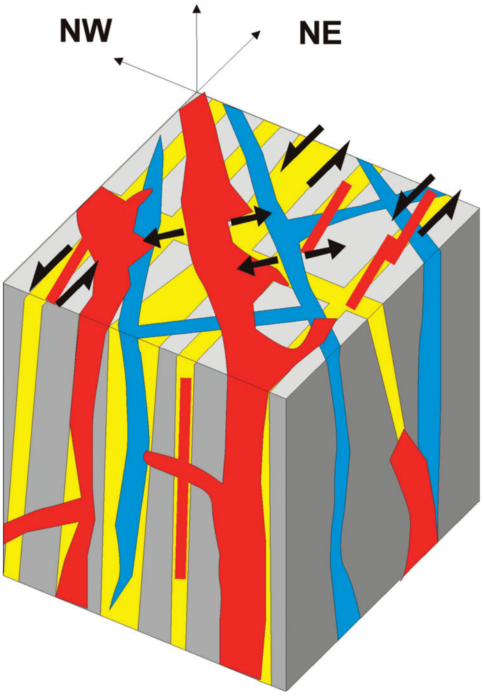

Figure 13. Conceptual model of the Peschanka stockwork: yellow – quartz-sericite zones, blue – quartz stockwork, red –hypogene sulfide mineralization, black arrows - kinematics

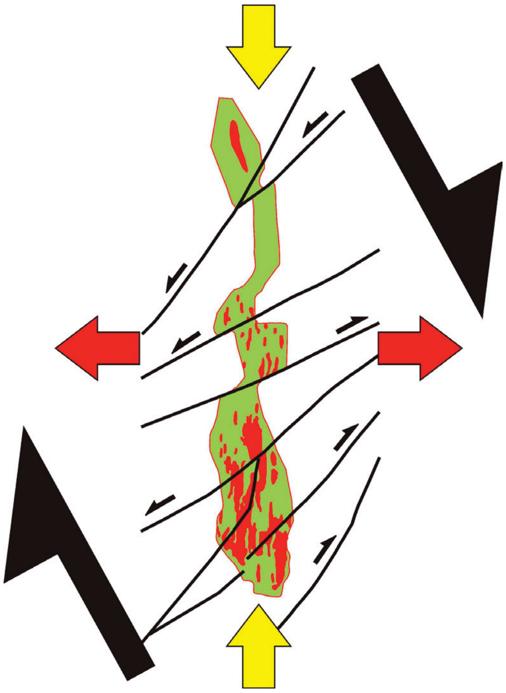

Figure 14. Structural model of the Peschanka deposit. Explanation see in the Figure 12

interpreted as tension fracture, sinistral strike-slip fault and dextral strike-slip fault respectively (Fig. 10a).

- Copper grade does not depend on slope angle of ore bearing phyllic zones (Fig. 10b).
- Average grade of Cu, Au, Mo in quartz-sulfide stockwork is directly-proportional to total percentage volume of thin veinlets. Average grade of Cu, Au, Mo decreases in thick quartz veins, because of their bad penetration for ore fluids (Fig. 10c, volume percentage which bigger than 50% corresponds to thick quartz veins).

Structural Model of the Peschanka Deposit

Relationship and kinematics of faults, ore bearing zones, veins and veinlets within the Peschanka linear stockwork are shown on the structural map and structural stereo diagrams (Fig.11) and on the stockwork conceptual model (Fig 13).

Spatial relationships of sulfide mineralization and quartz stockwork are different. Figure 12 demonstrates the relationship between Q-stockwork and copper mineralization. The bornite core (quantity characteristic of the core based upon holes logging) which has strong spatial correlation with Cu ore body and marks rich copper zone within the Peschanka stockwork. As shown in picture below host rocks of monzodiorite massif and porphyry intrusions are overlapped by quartz stockwork and late hypogene copper mineralization. Rich copper mineralization appears mostly in low intensive Q-stockwork as well as in host rocks. The most intensive Q-stockwork zones are absolutely barren, that could be explained by low penetrability of these zones along with subsequent ore mineralization. Penetration zones were migrating within the stockwork through the different stages of deformation that's explanation of how spatial discordance of ore-shoots and intensive quartz stockwork zones.

In accordance with the strike-slip fault model, the meridional permeable zones started to form during emplacement of porphyry dikes and stocks and remained active during metasomatic alteration of host rocks, development of quartz stockwork, and ore deposition; eventually they were sealed by postmineral andesite dikes. In fact, the closely spaced permeable zones make up the local Peschanka Fault Zone formed under horizontal extension and meridional compression within the regional right-lateral Baimka Strike-Slip Fault Zone (Fig. 2). The echeloned meridional extension zones in the Baimka Fault Zone control localization of the Early Cretaceous plutons, porphyry dikes and stocks, metasomatic and mineralized zones. Taking together, they make up ore–magmatic porphyry systems, and the Peschanka deposit is one of them.

Conclusion

The proposed strike-slip fault structural model (Fig. 14) is a good basis for reliable forecast of porphyry copper mineralization at deep levels of the Peschanka deposit (indirectly supported by geophysical data) and in the Baimka tectonic zone as a whole.