Peculiarities of the K-silicate alteration in Elatsite porphyry-copper deposit, Bulgaria

Особености на K-силикатната промяна в медно-порфирно находище Елаците, България

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Porphyry-copper deposit (PCD) Elatsite is located at 55–65 km east from Sofia and about 6 km south from the nearest town of Etropole. The rocks, outcropping in the deposit are: (1) Lower Paleozoic metamorphic rocks (phyllites and hornfelses at the contact with intrusive rocks) exposed in the south and SE part of the deposit; (2) coarse-grained granodiorites predominate in the Vezhen pluton with rare porphyry varieties (Kamenov et al., 2002); (3) Upper Cretaceous porphyritic intrusion is formed during 5 intrusive impulses, but quartz-monzodiorite porphyrites and granodiorite porphyries dominate (Von Quadt et al., 2002). The $^{206}Pb/U^{238}$ age on zircons from the Vezhen pluton is estimated ~314±4.8 Ma (Kamenov et al., 2002) and of the Upper Cretaceous magmatic rocks – 92.10–91.42 Ma (Von Quadt et al., 2002). The hydrothermal alteration of the rocks of the Elatsite deposit is determined as: K-silicate, propylitic, K-silicate-sericitic, sericitic (Strashimirov et al., 2003; Georgiev, 2005), or K-alteration, propylitic, quartz-sericitic, phyllic-argilic (Kehayov, 2005), or K-silicate, propylitic, quartz-sericite, and quartz-adularia-carbonate alteration (Ivanov et al., 2014).

The aim of the present study is to give some petrographic and chemical peculiarities of the K-silicate, high temperature, hydrothermal alteration of the rocks in the Elatsite PCD.

The K-silicate alteration is the most common type of alteration in the deposit. It occurs in the granodiorites of Vezhen pluton as well as in the Upper Cretaceous porphyritic rocks. In the less permeable Lower Paleozoic low-grade metamorphic rocks the K-silicate alteration is rarely developed and forms thin veinlets and as small nests. The mineral paragenesis is K-feldspar, phlogopite, magnetite and small quantities of quartz and hematite. K-feldspar is characterized by the presence of small amount of albitic component and very small content or absence of the anortitic component. Phlogopite crystals are generally idiomorphic and fine-grained (up to 0.2 mm) having 3 different morphologic types: (1) as pseudomorphosis on the magmatic mafic minerals (amphiboles, biotites and rarely clinopyroxenes); (2) as "veinlets" infilling fractures; (3) uniformly distributed in milled zones.

Two types of K-silicate alterations can be determined: (1) with predominance of phlogopite (the rocks are dark-colored); and (2) with predominance of K-feldspar (pale grey colored rocks with pink nuance). Both types are presented in the granodiorites and the porphyritic rocks. In the phyllites and hornfelses the alteration is represented locally with the predominance of K-feldspar. This is related with the different mobility of K and Si on one side and Fe and Mg on the other, and also with the peculiarities of the host rocks.

Two impulses of the K-silicate alteration are determined in the Elatsite deposit (Ivanov et al., 2014). The 1st one is related with the emplacement of quartz-monzodiorite porphyry and the 2nd – with emplacement of the granodiorite porphyry. The release of the fluids from the magma, as shown by Burnham (1979) and Silitoe (2010) is discrete and realized consecutively from increasingly deeper parts of the feeding major magmatic chamber. In a determined hypsometric level, the consecutive impulses are superimposed one another. The later, crosscut the previous and the alteration is more fine-grained. In this continuity, the later released fluids, will be so with lower temperature at this same level, and provoke a new alteration on the K-silicate altered rocks. This is expressed by the chloritization of phlogopite or the overprint of quartz-sericitic alteration. The temperature of the K-silicate alteration is ~600 °C (Stefanova et al., 2014). The chloritization of the phlogopite occurs at temperature ~250–290 °C (Ivanov et al., 2014) and the quartz-sericite alterations – between 260 and 300 °C (Popov et al., 2000).

Phlogopite dominated K-silicate alteration is characterized with the phlogopite pseudomorphosis on

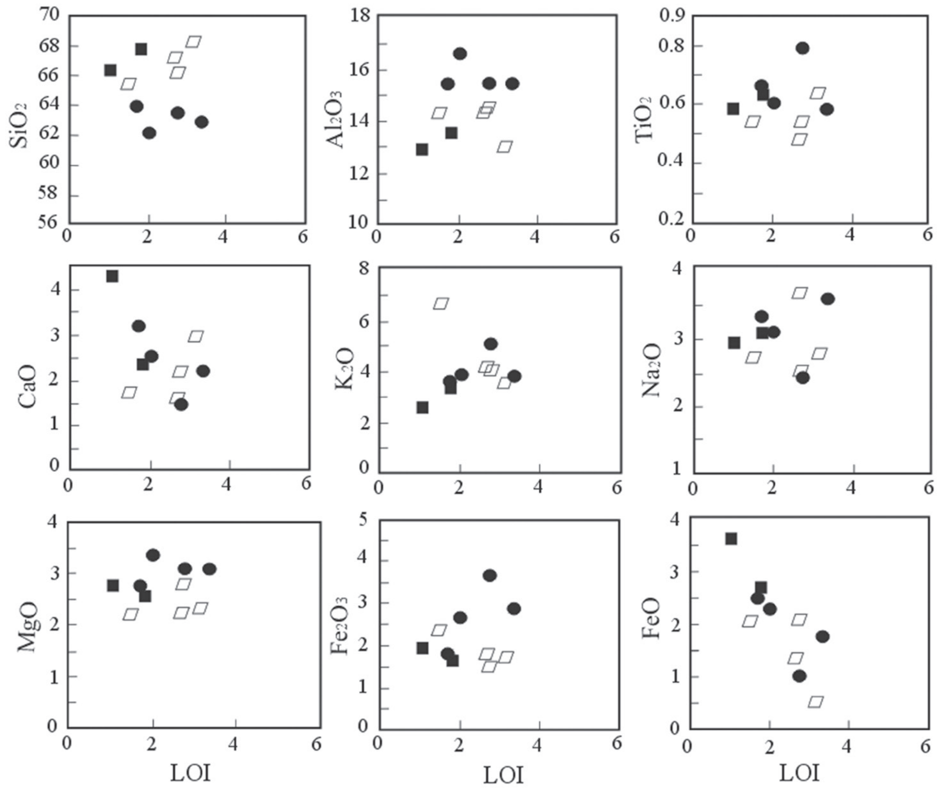

Fig. 1. Distribution of the main oxides (wt%) vs. LOI: *Black point*, rocks of the phlogopite dominated K-silicate alteration; *rhombs*, rocks of the K-feldspar dominated K-silicate alteration; *black squares*, unaltered granodiorites (Kamenov et al., 2002)

the primary magmatic mafic minerals and with many veinlets. The rocks are characterized with higher contents of Al, Ti, and Mg (Fig. 1). The higher contents of Al probably depend of later imposed quartz-sericitic alteration and those of Ti, as well as relatively higher contents of Fe_2O_3 and FeO, result from the increased presence of magnetite or rutile when the phlogopite is replaced by sericite or chlorite.

In the 2nd type of K-silicate alteration the K-feldspar predominate; its grains are anhedral, fine- to micrograined. Besides the K-feldspar this paragenesis includes smaller quantities of quartz, phlogopite, hematite and magnetite. Feldspars can be equally distributes in the rock volume or build veinlets with quartz and small quantities of phlogopite. There are higher content of SiO_2 and relatively higher values of K_2O, probably due to the higher content of SiO_2 and K_2O in feldspars compared to the micas.

References

Burnham, C. W. 1979. Magmas and hydrothermal fluids. – In: Barnes, H. L. (Ed.). *Geochemistry of Hydrothermal Ore Deposits*. New York, John Wiley & Sons, 71–136.

Georgiev, G. 2005. *Geological Model of the Elatsite Deposit*. Abstract of PhD thesis. Univ. Mining and Geology "St. I. Rilski", 50 p. (in Bulgarian).

Ivanov, Zh., R. Nedialkov, K. Bogdanov. 2014. Magmatic and ore-related breccias in the Elatsite porphyry copper deposit (PCD), Bulgaria. – In: *Proceedings of XX CBGA Congress*. Tirana, Albania, Special issue, 158–161.

Kamenov, B. K., A. von Quadt, I. Peytcheva. 2002. New insight into petrology, geochemistry and dating of the Vejen pluton, Bulgaria – *Geochem., Mineral. and Petrol.*, *39*, 3–25.

Kehayov, R. 2005. *Mineral Associations of Gold and Conditions of their Formation in Elatsite Porphyry-Copper Deposit*. Abstract of PhD thesis. Sofia University "St. Kl. Ohridski", 47 p. (in Bulgarian).

Popov, P., R. Petrunov, V. Kovachev, S. Strashimirov, M. Kanazirski. 2000. Elatsite-Chelopech ore field – In: Strashimirov, S., P. Popov (Eds.). *Geology and Metallogeny Features of the Panagyurishte Ore Region (Srednogorie Zone, Bulgaria)*. ABCD, GEODE 2000 Workshop. Borovets, Bulgaria, 19–25.

Sillitoe, R. H. 2009. Porphyry copper systems. – *Econ. Geol.*, *105*, 3–41.

Stefanova, E., T. Driesner, C. Heinrich, P. Petrov, Z. Vasilev. 2014. Melt and fluid inclusions in hydrothermal veins: The magmatic to hydrothermal evolution of the Elatsite porphyry Cu-Au deposit, Bulgaria. – *Econ. Geol.*, *109*, 1359–1381.

Strashimirov, S., K. Bogdanov, K. Popov, R. Kehayov. 2003. Porphyry systems of the Panagyurishte Ore Region. – In: Bogdanov, K., S. Strashimirov (Eds.). *Cretaceous Porphyry-epithermal Systems of the Srednogorie Zone, Bulgaria.* Society of Economic Geologist, Guidebook Series, 36, 47–78.

Von Quadt, A., I. Peytcheva, B. Kamenov, L. Fanger, A. Heinrich, M. Frank. 2002. The Elatsite porphyry copper deposit in the Panagyurishte ore district, Srednogorie zone, Bulgaria: U-Pb zircon geochronology and isotope-geochemical investigation of the magmatism and ore genesis. – In: Blundell, D. J., F. Neubauer, A. von Quadt (Eds.). *The Timing and Location of Major Ore Deposits in an Evolving Orogen*. London, Geol. Soc. Spec. Publ., 204, 119–135.