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Comparative study of K-feldspars from different hydrothermal alterations in rocks from Elatsite porphyry copper deposit, Bulgaria

Сравнително изследване на калиеви фелдшпати от различни хидротермално променени скали от медно-порфирно находище Елаците, България

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The Elatsite porphyry copper deposit (PCD) is a part of the Apuseni-Banat-Timok-Srednogorie copper belt (Popov et al., 2000). A small porphyritic intrusion, elongated in E-W direction, and many porphyritic dikes are intruded in the rocks of the basement (Popov et al., 2000; von Quadt et al., 2002).

The rocks outcropping in the deposit are: (1) Lower Paleozoic metamorphic rocks (phyllites) exposed in the S and SE part of the deposit; (2) coarse-grained, granodiorites predominate in the Vezhen pluton ($^{206}Pb/U^{238}$ age on zircons ~314±4.8 Ma) with rare porphyry varieties (Kamenov et al., 2002); (3) Upper Cretaceous porphyritic intrusion dominated by quartz-monzodiorite porphyrites and granodiorite porphyries (92.10–91.42 Ma; von Quadt et al., 2002). Using the investigations of Ivanov et al. (2014) the hydrothermal rock alterations are determined as propylitic, high temperature K-silicate alteration, Q-sericitic and quartz-adularia-carbonate (QAC) alteration.

In Elatsite PCD at least two types of secondary K-feldspars are present. First one are K-feldspars from high-temperature K-silicate alteration. The second one are the K-feldspars (adularia) from the low-temperature quartz-adularia-carbonate alteration. The two different types of alterations are well-preserved in the deposit, and can be observed in all lithological varieties. The relationship between the two alterations are ambiguous, and their products are imposed or superimposed on each other. The purpose of the present study is to emphasize some particularities concerning the distribution of the two types of hydrothermal K-feldspars (some morphological and compositional differences).

In the deposit, at least two impulses of high temperature K-silicate alteration are determined. The first one is related with the emplacement of quartz-monzodiorite porphyries, the second – with emplacement of the granodiorite porphyry (Ivanov et al., 2014). In these alterations, two varieties of K-silicate alteration are distinct: a) with predominance of secondary biotite, and b) with predominance of K-feldspars (Georgieva, Nedialkov, 2016). K-feldspars are present in both varieties. In K-silicate alteration they are dominantly subhedral, fine-grained, replacing magmatic feldspars or infilling fractures and milled zones together with secondary black mica, fine-grained magnetite and quartz. A small to moderate amount of albitic and anortitic components is characteristic for them (Table 1). The estimated temperature for the K-silicate alteration is 600–700 °C (Stefanova et al., 2014; Geogieva, Nedialkov, 2017).

In quartz-adularia-carbonate alterations adularia occurs in association with quartz, calcite, chlorite, zeolites, fluorite, chalcopyrite and pyrite. It is present in veinlets and nests. Nedialkov et al. (2012) describes adularia in matrix of magmatic and magmatic-hydrothermal breccias with chlorite, carbonate and ±heulandite. Adularia is euhedral, showing typical pseudo-rhombic limpid crystals. It shows smaller amount of albitic and anortitic component compared to the K-feldspar of the K-silicate alteration (Table 1). Two facies of low-temperature quartz-adularia-carbonate alteration are determined: a) with adularia, and b) without adularia. The presence of adularia marks the appearance of the facies with relatively higher temperature (260–300 °C). The facies without adularia is with lower temperature (90–200 °C).

In K-feldspars from K-silicate alteration are established higher contents of FeO, MnO and CaO compare to the other secondary feldspar.

On chondrite-normalized patterns of REE for K-feldspar from K-silicate alteration HREE prevail over LREE or the values are similar. Slight positive to slight negative Eu anomaly are present on these pat-

Table 1. Selected analyses of secondary K-feldspars from different types of alteration

	Adularia from quartz-adularia-carbonate alteration				K-Feldspars from K-silicate alteration			
SiO_2	62.41	69.91	63.83	64.20	63.19	63.48	69.78	68.91
Al_2O_3	20.29	18.94	19.43	19.19	20.03	20.07	18.89	18.54
FeO_{tot}	0.20	0.17	0.08	0.09	0.36	0.14	0.17	0.23
CaO	0.35	0.22	0.17	0.05	0.27	0.27	0.21	0.27
Na_2O	0.82	0.89	0.61	0.56	2.80	1.32	1.78	1.57
K_2O	14.26	14.81	15.12	15.12	11.47	12.98	13.24	15.04
An %	1.86	1.13	0.88	0.26	1.42	1.49	1.09	1.28
Ab %	7.89	8.27	5.73	5.32	26.68	13.19	16.78	13.52
Or %	90.25	90.60	93.39	94.42	71.90	85.32	82.13	85.20
Co	<1.41		<1.08	<1.07	<2.36	<1.56	9.90	
Ni	<32.84		<17.47	<18.84	68.50	<44.18	<245.56	
Cu	<4.67		<6.73	4.83	72.68	<14.80	40.78	
Zn	<10.45		<11.34	<12.21	<24.53	<17.44	62.71	
Ga	68.44		29.54	20.48	25.50	28.24	44.37	
Rb	246.61		264.37	355.37	340.54	415.97	291.99	
Sr	192.87		105.62	204.91	57.75	47.74	262.37	
Ba	3007.87		1470.98	345.26	484.62	697.86	1036.19	
Σ REE	4.35		0.00	1.34	1.40	2.59	58.18	

Oxides (in wt%) are from electron microprobe analysis; trace elements (in ppm) are obtained with LA-ICPMS

terns. The lack of Eu anomaly is probably due to the elevated oxygen fugacity during the K-silicate alteration. At this O fugacity the Eu is presented at higher valence (Eu^{3+}) and its incorporation in the K-feldspars structure is avoided. The REE chondrite-normalized patterns of adularia are relatively rough, but in general LREE values are lower than those of HREE and a clear positive Eu anomaly is present. This last peculiarity is probably related with the lower oxygen fugacity during their crystallization. The total REE content is higher in K-feldspars from K-silicate alteration compared to adularia. Adularia has higher contents of Ba, Sr, Ga and lower contents for V, Cr, Co, Ni, Cu, Zn, Rb, Nb, Pb, Th and U compared to those in K-feldspar from the K-silicate alteration.

Compared with the other alteration products (propylitic and quartz-sericitic), the alterations with K-feldspars (K-silicate and quartz-adularia-carbonate alterations) show lower contents in REE. With the decreasing temperature, the hydrothermal K-feldspars from K-silicate and quartz-adularia-carbonate alterations show also decreasing contents of An and Ab components. The geochemical peculiarities of the studied K-feldspars are also depending on the crystallization temperature, the K_2O content and the presence of the respectively concomitant ore minerals.

References

Georgieva, H., R. Nedialkov. 2016. Peculiarities of K-silicate alteration in Elatsite porphyry-copper deposit, Bulgaria. – In: *Proceedings of the National Conference "GEOSCIENCES 2016"*. Sofia, BGS, 57–58.

Georgieva, H., R. Nedialkov. 2017. Geochemical characteristics of igneous and hydrothermal biotites from Elatsite porphyry-copper deposit, Bulgaria. – In: *Proceedings of the National Conference "GEOSCIENCES 2017"*. Sofia, BGS, 51–52.

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, 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.

Nedialkov, R., N. Hadzhieva, P. Vassileva. 2012. Geology and petrography of magmatic and magmatic-hydrothermal breccias in porphyry-copper deposit Elatsite. – In: *Geology School of Bulgaria*, *The School of Prof. Z. Ivanov*. Sofia, National Museum Earth and Men, 53–56.

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.

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. – *Econom. Geol.*, *109*, 1359–1381.

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.