Ponomarchuk V.A., Sotnikov V.I., Shevchenko D.O., Berzina A.N. $^{40}Ar/^{39}Ar$ diagnostics of the multi-stage evolution of ore and metasomatic processes in the Cu-Mo porphyritic ore deposits

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A deciphering of thermodynamic parameters of hydrothermal and metasomatic processes in Paleozoic and Mesozoic Cu-Mo porphyritic ore deposits of the Central Asian orogenic belt (Siberia, Mongolia) is complicated by a multi-stage (periodicity of 10-30 Ma) development of ore-bearing porphyritic magmatism. The characteristic feature of this magmatism is a sequence quartz diorite-granodiorite-granite accompanying each impulse of magmatism. The subsequent impulse results in changing of the previous geological situation during magma and fluid formation and modification of consolidated magmatic rocks and metasomatic derivatives. Because of spatial coincidence of different by age metasomatic minerals, the diagnostics of contemporary metasomatites regarding the imposed endogenic processes is actual in the reconstruction of the metasomatic columns.

The Sorskoe Cu-Mo porphyritic ore deposit (Kuznetskii Alatau) show temporally different rock assemblages of several magmatic complexes accompanied by ore and metasomatic formations on the relatively restricted area. A total age interval of individual endogenic events is 481-356 Ma [1]. The major industrial Cu-Mo stockwork ore deposit is related to the evolution of the Sorskii porphyritic complex (two impulses at 357-356 Ma and 398-388 Ma). Its formation is preceded by long-time evolution of multi-stage granite magmatism, whose some impulses resulted in Cu-Mo skarn formation (Martangiiskii Complex, 481-451 Ma) and quartz-feldspar metasomatites with dispersed molybdenite and chalcopyrite (Tigertyshskii Complex, 423-420 Ma). The earliest K-feldspartization is developed in relation with the Martangiiskii granites and is expressed in the formation of extensive K-feldspatized rocks, whose composition is close to syenites. Metasomatic K-feldspar is developed gradually form the periphery of plagioclase grains penetrating into them (not by front) forming antiperthites of replacement. As K-feldspartization becomes more extensive, the antiperthites become coarser, while plagioclase is preserved as small resorbed relics in K-feldspar. The anorthite component is distinctly seen on the diagrams $^{38}Ar/^{39}Ar(Ca/K)$ by the elevated ratios Ca/K (see Fig. 1) and the age, which is more ancient than matsomatism. Degree of ordering of K-feldspar is variable, but does not exceed 0.3-0.4. That differs the metasomatic K-feldspar from the monoclinic magmatic K-feldspar. Similar K-feldspartization is often observed at the exo-contacts of garnet-pyroxene-magnetite skarns with chalcopyrite-molybdenite bodies. K-feldspar from these metasomatites show an $^{40}Ar/^{39}Ar$ age 442.9±3.9 Ma (Fig. 1, diagram K560).

Another style of formation is characteristic for quartz-K-feldspar metasomatites of the Tygertyshskii Complex. The metasomatites form lenses and large-scale stockwork bodies in the zones of intensive fracturing. K-feldspar forms prismatic crystals of 3-5 cm in size. It is usually has no lattice, degree of ordering varies from 0.00 to 0.40, that corresponds to high orthoclase. Despite euhedral shape, it is difficult to separate K-feldspar (even in the charge of 30 mg). All studied samples of K-feldspar show complicated $^{40}Ar/^{39}Ar$ spectra, where several endogenic events are observed. The typical diagram $^{40}Ar/^{39}Ar$ for K-feldspar K546/10 (Fig. 1) shows a time of two metasomatic events of 424.1 and 411.6 Ma.

During K-feldspartization, related to the formation of ore-bearing porphyritic complex (388±2 Ma from the $^{40}Ar/^{39}Ar$ diagram 84, Fig. 1), the initial K-feldspar (e.g. K-feldspar K546a on Figure 1) is affected by significant alteration. It is intensively pelitized, becoming of dark-red color. Degree of ordering increases. As an intensity of metasomatism increases, the initial high orthoclase transforms into intermediate triclinic orthoclase and, subsequently, into intermediate microcline. Potassium content increases as well. Isochrone age of the most altered K-feldspar K546a, i.e. 381±3 Ma (Fig. 1) coincides with the above time of emplacement of the earliest porphyrites.

Along with the age determinations of metasomatic K-feldspars, a ratio Cl/K ($^{38}Ar/^{39}Ar$) was measured from the neutron-induction reaction $37Cl(n, \gamma, \beta^-)^{38}Ar$ using the method of [2]. Independently on the age, uniform low ratio Cl/K ~0.003 was obtained. It corresponds to low content of Cl in the matasomatic solutions. That is in agreement with the fluorine specialization, which is characteristic for the Sorskoe ore deposit. In the Zhirekenskoe Cu-Mo porphyritic ore deposit (Transbaikalie), which is characterized by the chlorine specialization, the ratio Cl/K is 0.0074 for the earliest (166.2±1.3 Ma) metasomatic K-feldspars (Fig. 1, S-513/3). For the latest (162.4±0.6 Ma) K-feldspars (S-513/1), this ratio is 0.0020. The Cl/K diagram for the sample S-513/1 shows an inhomogeneity of K-feldspar alteration, preserving the initial values in the high and low-temperature fragments of the spectrum.

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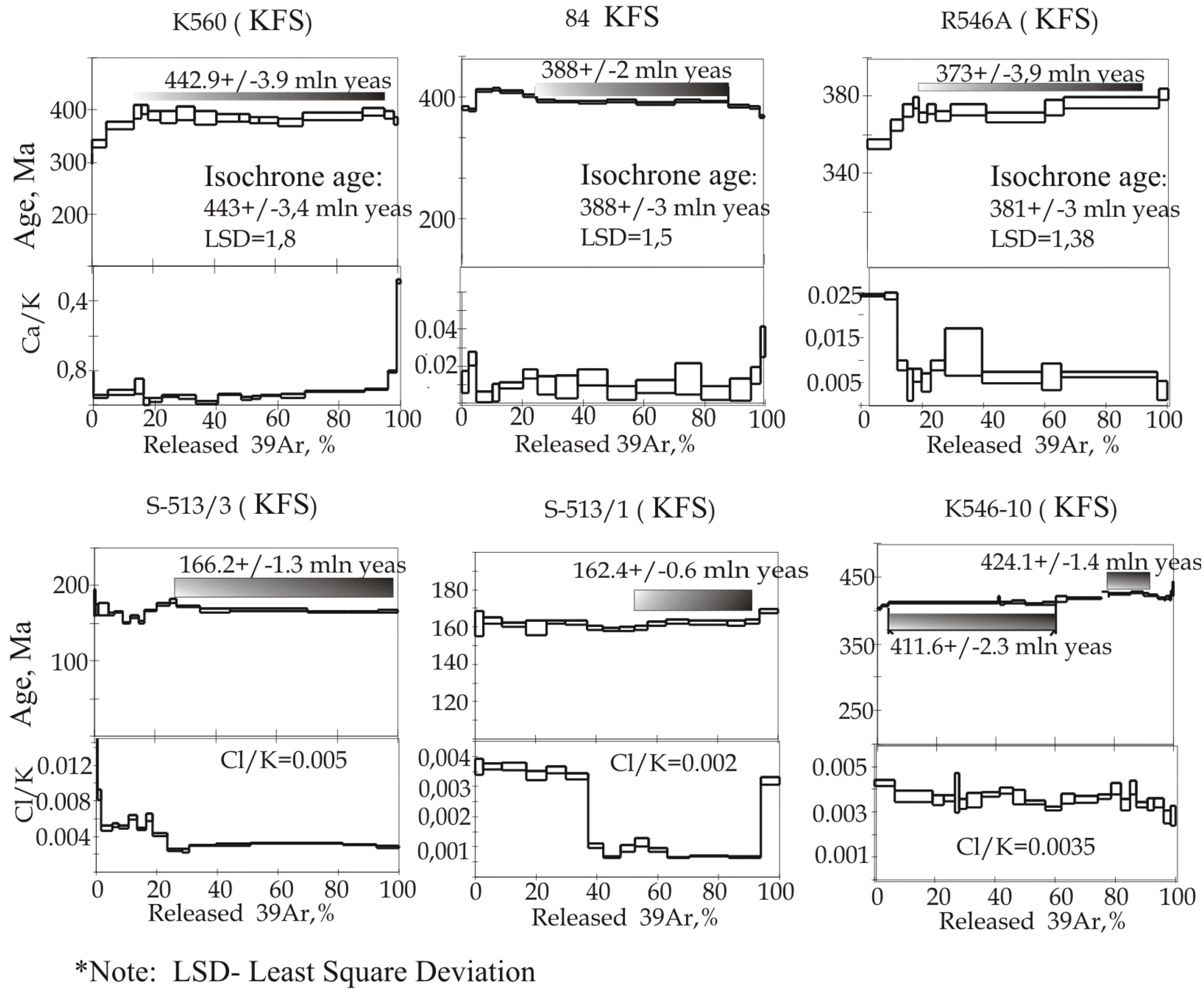

Fig.1. $^{40}Ar/^{39}Ar$, Ca/K, and Cl/K diagrams for metasomatic K-feldspars of the Sorskoe and the Shakhtaminskoe Cu-Mo porphyritic ore deposit. Mineral charges are 30-40 mg. A vertical size if rectangles on the spectrum denotes an accuracy. Shaded stripes mark fragments of the spectrum, which is used for dating.