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As-bearing potassium feldspar – a product of fumarole exhalations and gas-rock interactions at the Tolbachik volcano, Kamchatka, Russia

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Potassium feldspar is abundant in products of active fumaroles at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption (1975-1976), Tolbachik volcano, Kamchatka, Russia. The most intriguing fact is that the mineral here strongly differs chemically from potassium feldspar of all other geological formations. It demonstrates wide compositional variations and is typically enriched with As^{5+} and sometimes contains significant amounts of P, Zn, Cu, Fe and S. Filatovite $K[(Al,Zn)_2(As,Si)_2O_8]$, the arsenate analogue of orthoclase, was discovered here (Vergasova et al., 2004).
Samples from the Arsenatnaya fumarole located at the summit of the Second scoria cone (Pekov et al., 2014) contain, as our data show, complete solid-solution series between As-free potassium feldspar and filatovite.
Potassium feldspar crystallizes in the Tolbachik fumaroles as a result of two processes: direct deposition from fumarolic gas and interaction of this gas with basalt scoria at temperatures not lower than 500°C. Exhalation feldspar occurs as incrustations sometimes consisting of well-formed prismatic crystals up to 1 mm long. Potassium feldspar produced by gas-rock interaction process replaces basalt and volcanic scoria. Cases of selective replacement of plagioclase in basalt for As-bearing potassium feldspar were observed.
Potassium feldspar from the Arsenatnaya fumarole contains (our electron microprobe data, wt.%): SiO_2 19.4–65.2 (corresponds to 1.05-3.01 atoms per formula unit = *apfu*; formulae are calculated on the basis of 8 O *apfu*), Al_2O_3 14.3–30.6 (0.80 –1.95 apfu), As_2O_5 0.00–34.2 (0.00–0.97 *apfu*), P_2O_5 0.00–2.5 (0.00–0.10 *apfu*), SO_3 0.00–3.2 (0.00–0.11 *apfu*), Fe_2O_3 0.00–3.1 (0.00–0.11 *apfu*), ZnO 0.00–0.81 (0.00–0.03 *apfu*), CuO 0.00–2.1 (0.00–0.08 *apfu*). In feldspar structure all these constituents occupy tetrahedrally coordinated sites in the AlSi-framework (Filatov et al., 2004). Chemical variations of extra-framework cations in potassium feldspar from Arsenatnaya are significantly less (wt.%): Na_2O 0.03–1.18 (0.00–0.11 *apfu*), CaO 0.00–1.79 (0.00–0.09 *apfu*). A continuous solid-solution series belonging to potassic feldspar itself (i.e. with Si>As in atom proportions) demonstrates the following compositional range (our data for samples from Arsenatnaya): $(K_{0.95}Na_{0.02})_{\Sigma 0.97}[Si_{2.94}Al_{1.01}Cu_{0.06}P_{0.01}]_{\Sigma 4.03}O_8$ – $K_{1.02}[Al_{1.95}Si_{1.05}A_{s0.97}P_{0.01}S_{0.01}Zn_{0.01}]_{\Sigma 3.99}O_8$. All intermediate members of this series show stable feldspar-type stoichiometry caused by major substitution scheme $2Si^{4+} \leftrightarrow Al^{3+} + As^{5+}$. In its generalized form, this scheme can be written as $2Si^{4+} \leftrightarrow (Al,Fe)^{3+} + (As,P)^{5+}$.

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