Extreme fractionation of REE and some transition metals in the natural high-temperature vapor systems

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Principal pecularities of mineral precipitation from high-temperature gas fluids are considered on the example of the Kudryavy volcano (Kuril Islands, Russia). Unusual association of Gd and Y titanates, Ce-aluminosilicate, ferberite, scheelite, povellite, various chlorides and oxychlorides was found in sublimates precipitated at about 650°C in the Dome fumarolic field. Mineral phases contain up to 45 wt.% Gd and 34 wt. % Y and correspond to formulas $Gd_3Ti_4O_{12}$ and $YTiO_4$, respectively. Numerous fine grains (less than 50 mkm in size) of Gd-Zr oxide in association with Ce-monazite, ZrO_2, molybdates, tungstates and oxychlorides occur at about 500°C in the Molybdenic fumarolic field. Plate crystals of $Cu_3(Au,Ag)_2$ alloy crystallized also in this temperature zone. The surface of Gd-rich phases is covered with the smallest spherical particles of native molybdenum, the interior of grains was established in polished sections also contains round inclusions and finest impregnation of native molybdenum. Morphology of HREE phases and their intergrowths with native molybdenum and others minerals indicates that they were precipitated in situ by means of crystallization from vapor. The results of ICP-MS analyses of high-temperature gas condensates as well as INA analyses of precipitations from serial zones in silica tubes also revealed selective fractionation and HREE enrichment.

Formation of native Mo in sublimates, as well as native modes of other transition metals, is explained by passing of the gas transport disproportiation reactions with coeval deposition of the zero-valent modes and formation of volatile compounds. As a result nonequilibrium association of native Mo, MoS_2 and Ca-molybdates occurs among the sublimates. Selective brine–vapor fractionation and HREE enrichment of gas phases confirmed also by experiments (Shmulovich et al., 2002) can play important role in formation of similar mineral associations with REE phases and native elements (including PGE and Au) in the real ore deposits at supercritical conditions of mineralization (Waterberg, Sukhoi Log etc.).

Reference

Shmulovich et al., (2002), Contr. Min. Petr., 144, 257-273.