Quantitative PIXE analysis of trace elements in fluid inclusions from the Kofu granite body.

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Trace metal compositions of single fluid inclusions in quartz from miarolitic cavities, pegmatites, and hydrothermal veins were analyzed by particle-induced X-ray emission (PIXE) to elucidate the compositional change of granite-derived fluids during a migration in granite body. Quartz samples were collected from a pegmatite and miarolitic cavities, hydrothermal quartz veins, and a hydrothermal Fe-Cu ore vein in the Miocene Kofu granite body, Yamanashi Prefecture, central Japan. These veins and cavities are genetically related to the biotite granite body. Quartz samples from the pegmatite and miarolitic cavities, and the most hydrothermal quartz veins include two-phase fluid inclusions, while the hydrothermal quartz veins near elevations of 1200 m and hydrothermal Fe-Cu ore vein include two-phase inclusions and polyphase inclusions including a halite crystal. Salinities (NaCl eq %) of these polyphase inclusions are 30-38%. Determined concentrations are as follows: 8 wt.% for Cl, 2-6 wt.% for K and Ca, 1000-3000 ppm for Fe and Ba, 200-500 ppm for Mn, Zn, Pb, Cu, Br, and Ge, several tens ppm for Rb and Sr in two-phase inclusions from the pegmatite, miarolitic cavities, and the most hydrothermal quartz veins; 17 wt.% for Cl, 2-3 wt.% for K and Ca, 2000-10000 ppm for Fe, Mn, and Zn, 200-700 ppm for Pb, Cu, Br, Sr, Ba, and Rb, 20-30 ppm for Ge in polyphase inclusions from the hydrothermal quartz veins near elevations of 1200 m and hydrothermal Fe-Cu ore vein. The contents of Mn, Fe, Cu, Pb, Zn, Rb, Sr, and Br increase with increasing the salinity, whereas the Ge contents decrease. The polyphase inclusions could be formed by a phase separation into vapor and high-salinity water due to boiling of the original low-salinity fluids, because the veins including polyphase inclusions also contained vapor-rich fluid inclusions derived from the vapor. The halite-bearing inclusions probably originated from decompression boiling of the miarolitic cavity-forming fluid when a part of the cavity-forming fluid adiabatically ascended along rock fractures in the biotite granite body. in addition, the high contents of transition-metal elements in the polyphase inclusions are probably attributable to the element partitioning at the time of phase separation by boiling.