

Be- and Emerald deposits of the Central Urals (Russia): Conditions of formation.

E.V.Gavrilenko¹, R.Castroviejo Bolibar², B. Calvo Pérez²

1-Instituto Gemológico Español (Spain)

2-Escuela Técnica Superior de Ingenieros de Minas de Madrid (Spain)

The Be- and emerald deposits of the Emerald Mines region, in the central part of the Upper-Paleozoic Uralian orogen (Russia), are related to a major shear zone of N-S direction, where both Be-rich S-type granitoids (Carboniferous to Permian) and Cr-rich rocks (ophiolitic dunites and peridotites, Silurian to Devonian) are present.

Petrographic and mineralogical studies of emeralds and associated minerals from various deposits of the Emerald Mines region were undertaken, and detailed Fluid Inclusion (**FI**) studies in these minerals were also carried out, implying FI-petrography, microthermometry, and Raman spectroscopy (vapor phase). The following conclusions were reached:

- Be mineralization is related to granite-derived post-magmatic fluids and has a metasomatic origin. Beryl and emerald crystals develop on a solid substrate of mainly phlogopitic composition; in this process, they replace earlier minerals, partly inheriting their geochemical signature. Emerald crystals only occur if the metasomatic process develops on the Cr-rich ultramafic protolith.

- The circulation of fluids responsible for beryl and emerald formation has a pulsatory character, producing various generations of the same minerals. The mineralization develops in tectonically active conditions, with cataclasis of early beryl (emerald) and plagioclase crystals, frequently cemented by the same minerals of later generations. A rigorous FI-petrography allows to distinguish the various types and generations of FI.

- The results of the FI-study, on primary FI, show that the fluid responsible for beryllium mineralization is basically an aqueous fluid, with low concentrations of CO₂, CH₄ y NaCl. Typical compositions of the fluid correspond to the following mean values (mol %): H₂O - 92.26, CO₂ - 5.27, CH₄ - 0.15, NaCl eq. - 2.32, with density of 0.8355 g/cm³. Primary fluid inclusions homogenize to the liquid phase at temperatures between 230 and 330°C; the mean total homogenization temperature (**Th**) is 274 °C. A high

dispersion of Th values is probably due to stretching, widely observed in the FI of the deposits studied.

- The isochors calculated for primary fluid inclusions, referred to independent estimations both of the temperature (tourmaline-phlogopite geothermometer) and pressure (evaluation of the formation depth of adjacent granites), allow to estimate the range of P-T conditions of emerald formation in the Urals at 350-400°C and 1500-2000 bar.