Sulphides of contemporary land and submarine hydrothermal systems of Kamchatka

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There are more than 200 hydrothermal springs in Kamchatka: most are parts of active geothermal systems or near active volcanoes, with Paratunsky, Mutnovsky, Pauzhetsky and Viluchinsky the largest. The Piip Volcano was discovered during marine investigations and is situated to the south of the western part of the Aleutian Island Arc. Products of its modern hydrother&nal activIty were sampled during deep water research using the submersible 'Mir'.

Several minerals are deposited in their discharge zones, including carbonates, sulphates, quartz, opal, apatite, sassolite, native elements, sulphides and clay minerals. Among sulphides, pyrite (Py), marcasite (Ms), sphalerite (Sf), chalcopyrite (Cp), galena (Gn), arsenopyrite (Asp), and cinnabar (Cb) were detected. Investigation of the sulphides was carried out by microprobe and electron scanning microscopy. Most sulphides have different habits and complicated heterogeneous compositions and microstructures.

Pyrite displays many variations in habit, microstructure and composition. For example, it forms idiomorphic crystals and aggregates inside complicated (ionic sieve type) structures of clayey montmorillonite-kaolinite particles from 0.005–1.5mm in size, framboid and oolite-like separations in a quartz-adularia-carbonate matrix, and as peculiar micropipes around the remains of plants found in

hot springs. These micropipes are formed of microlayers of opal, pyrite and apatite. It can also show heterogeneous structures ranging from the classic concentric zonal layering to complicated mosaic sub-blocks, depending on the distribution of trace elements such as As, Sb, Hg, Cu, Mn, Au, and Ag. Concentrations of these elements lie within the following limits: As - 0.01–11.2%, Hg - 0.01–19.5%, Cu - 0.00–2.6%, Ag - 0.00–3.9%, Sb - 0.00–1.469%, Au - 0.00–0.45%.

Pyrite from the Kireunsky Springs forms spheres enriched in Hg (to 19.5%) and As (to 4.3%). Pyrite from calcite-aragonite pipes and other products of contemporary activity of the Piip submarine volcano showed unusual concentrations of Ag (to 3.9%), Sb (to 1.46%), Cu (to 2.6%), together with As levels of up to 3.1% and Hg up to 1.6%.