Content of microelements in hydrothermal and lake waters of Ksudach Volcano Caldera (South Kamchatka)

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Ksudach Volcano is a caldera-type volcano (Fig. 1). This type of volcanoes is characterized by intensive and continuous volcanic activity accompanied by intensive degassing (Selyangin, 1987). The last caldera eruption occurred in 1907. It was a directed blast eruption (similar to the eruption of Bezymianny Volcano) that partially destroyed the basement of Shtyubel Cone. Nowadays the crater is field by a lake. The volcano erupted a large amount of volcanogenic material (Dubik, 1971; Melekestsev, 1987). The erupted material and modern gas-hydrothermal activity in the caldera are of special interest. Low temperature low-alkaline thermal sources discharge pressure waters from the hydrothermal system of the caldera (Pilipenko, 2001). These thermal sources discharge in the north-west part of Klyuchevoye Lake, in so called Goryachy Plyazh (Hot Beach), in the area of the intrusion Nezametnaya (Shtyubelevsky thermal springs). The Crater Lake Shtyubel still manifests signs of activity. Echolocation investigations (Nikolaev, 1995) evidence for gas effluxes rising from the bottom of the lake (*Fig. 1*). We revealed high concentrations of N_2, CO_2, He, CH_4, and hydrocarbons (Pilipenko, 2001). We revealed that in surface waters of the Crater Lake Shtyubel the concentration of SO_4^{2-} is threefold and the concentration of Ca is tenfold compared to Dubik, 1971. These elements concentrations also agree with the data on S/Cl ratio in the same water (Nikolatyeva, 2007). Fluid flows rising from the bottom of this Crater Lake resulted in these anomalies.

Microelements composition in natural waters of this caldera is understudied. Pilipenko, 2001, was the first who has mentioned high concentrations of Fe, Mn and Zn in the layer of water and Fe, As and Hg in bottom sediments of Shtyubel Lake. To defined chemical composition we collected water samples from Ksudach Volcano Caldera. ICP-MS method allowed determining microelements concentrations in thermal sources and crater lakes of the caldera. These data analysis evidences that Goryachy Plyazh (Hot Beach) and Shtyubelevsky thermal springs supply lakes of the caldera with mineral elements. Atmospheric precipitations reduce microelements concentration in Sulphatny sources and surface waters of Shtyubel and Klyuchevoye Lakes. These thermal sources transport 200-300 times bigger Mn and Li, 30 times bigger Al, Sr, Zn and Sc, 10 times bigger Ge and Rb compared to the background values. Fe, Cr, Sr and Ti are maximally transported from Sulphaty Sources; As and Zr from Shtyubelevsky Springs and Shtyubel Lake; V from Pemzovy brook. Besides we reveal small amounts of Re and In in the Crater Lake Shtyubel and in the head of Tyoplaya River.

Figure 2 shows content of rare earth elements (REE) in volcanogenic hydrothermal sources and lake waters of Ksudach Caldera normalized to REE composition in chondrites. We used also the data on REE composition in ocean fluid (Dubinin, 2006) and the data on thermal sources in Uzon and Akademiya Nauk Calderas. It is evident, that ocean fluid is characterized by insignificant Eu maximum (?), whereas other types of hydrothermal sources are characterized by negative Eu anomaly and less evident decrease of heavy REE content. High content of Li, Fe, As, Sr, Zn, Re and other microelements in thermal sources and Shtyubel Lake evidences for transportation of these elements by fluid flows from the upper crust magma chambers beneath the caldera. The transportation of REE in the form of chloride complexes is probably carried out by deep high-temperature thermal sources of Cl-Na type. All other types of hydrothermal sources make up the above mentioned sources in the near-surface conditions. We can not exclude that dissolution from wall-rocks influences on the concentration of REE in carter lakes. In the nearest future we are going to study wall-rocks microelements content. The ore formation processes are characteristic for calderas of this type. Ore is formed here simultaneously with volcanic processes in caldera lakes, where solutions are boiling in the area of hydro-chemical barriers and unloading ore at the bottom of the lake.

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References:

1. Dubik, Yu.M., Menyaylov I.A., 1971. Ksudach Caldera gas-hydrothermal activity. Bull. Volcanol. (Stancii) 47, 40-43.
2. Dubinin, A.V., 2006. The geochemistry of the rare earth elements (REE) in an ocean. Nauka, Moscow, p. 360.
3. Melekestsev, I. V., Sulerzhitsky L.D., 1987. Ksudach Volcano (Kamchatka) over the last 10 000 years. Volcanol. Seismol. 4, pp. 28-39.
4. Nikolaev A.S., 1995. The list of echolocation records for waters biophysical heterogeneities in Kamchatka lakes. Investigations of biology and dynamics of population for commercial fishes in Kamchatka Shelf. Vol., 4, pp. 12-15.
5. Nikolaeva A.G., 2007. Results of hydro-geochemical observations of thermal manifestations in Ksudach Volcano Caldera, South Kamchatka, (on data of 1937-2006). Volcanism and related processes. Proceedings of the scientific conference dedicated to the 100th anniversary of March 28-29, 1907 Ksudach Volcano eruption, Petropavlovsk-Kamchatsky. pp. 18-36.
6. Pilipenko G.F., Razina A.A., Fazlullin S. M., 2001. Hydrothermal sources of Ksudach Volcano Caldera. Volcanol. Seismol. 6, pp. 43-57.
7. Selyangin O.B., 1987. Geological structure and evolution of the caldera complex of Ksudach Volcano. Volcanol. Seismol. 5, pp. 16-27.

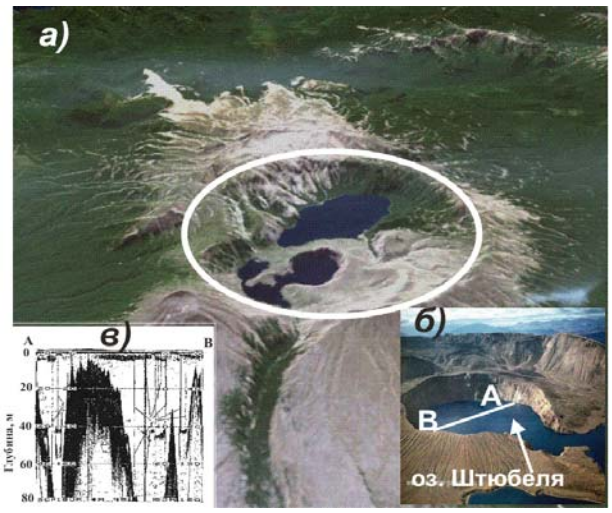

Fig. 1. Ksudach Volcano Caldera from the west-north (a), Shtyubel Crater is in the right bottom corner of the figure (b), lateral hydroacoustic profile A-B with effluxes plumes (c) (1991).

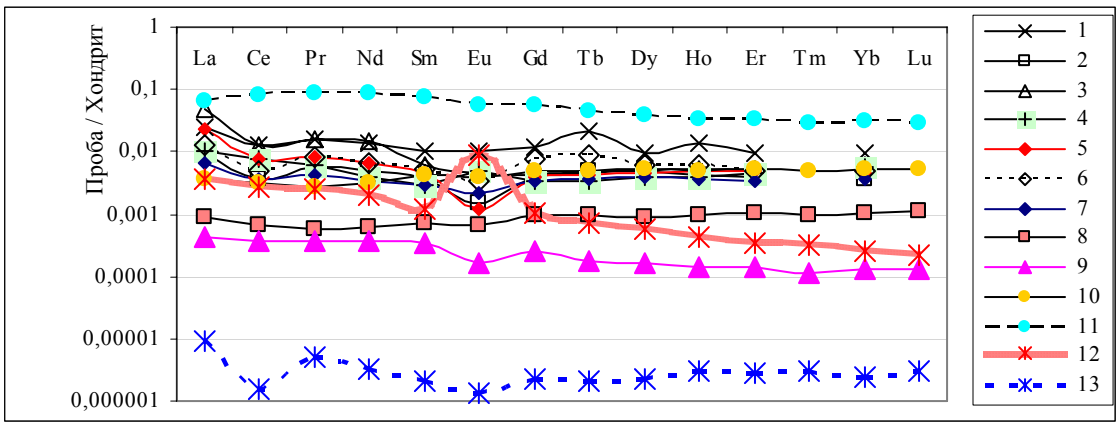

Fig. 2. The graphic of REE content in hydrothermal sources and lake waters of Ksudach Caldera (mcg/l). 1 –Goryachy Plyazh (Hot Beach) sources; 2 – the central part of the lake Klyuchevoye; 3 – Shtyubelevsky thermal springs; 4 – the central part of the lake Shtyubel; 5 – the central part of the lake Maloye; 6 – Pemzovy brook; 7 –Sulphatny sources; 8 – Antimonitovye sources; 9 – Piipovsky (Akademiya Nauk Caldera); 10 – Banny Brook (Caldera Uzon); 11 – Troitskogo Lake (Maly Semiatchik Volcano); 12 – underwater hydrothermal fluid (13º East-Pacific Raising); 13 – sea water.