Trace and Rare Earth Elements in surface waters of Kuril Islands (Russia)

V.A. CHUDAEVA[1], O.V. CHUDAEV[2], K. SUGIMORI [3], M. MATSUO[4] AND A. KUNO[4]

[1]Pacific Institute of Geography, Vladivostok, Russia (valchud@hotmail.com)
[2]Far East Geological Institute, Vladivostok, Russia (chudaev@fegi.ru)
[3]Toho University, School of Medicine, Tokyo, Japan (kensan@med.toho-u.ac.jp)
[4]Tokyo University, Tokyo, Japan (kuno@dolphin.c.u-tokyo.ac.jp)

Kuril Islands – is area of volcanic activity in the eastern part of Russia. Acidic sulfate hydrothermal activity and underground water discharge in the areas with fumarole activity significantly change the surface water content, introducing a wide variety of elements, particularly trace elements compare to fresh waters.

The values of pH of studied waters are mostly acidic (pH up to 2.5-1.8) with low oxygen concentration, high mineralization and concentrations of trace and REE elements.

In total the composition of the surrounded surface waters reflects the composition of the thermal springs, discharge on the areas and has essentially different concentrations of REE as well. The highest concentration of Zn was found in Goriachee Lake of Golovina Caldera (1400μg/l). This lake has also a high concentration of Mn (up to 2600μg/l).The highest concentrations of dissolved Cu (>20μg/l), V(>400μg/l), Cr (19μg/l), Fe (49 mg/l) and Mn (3.2 mg/l) were found in stream water of north-eastern field of Ebeko volcano; Si, Al, Sr, Ge, Sc, Ga, Th and U were also common here.

Depending on the proximity of the stream to active areas, the waters have essential different concentrations of REE which vary in light or heavy group contents.

Maximum concentrations of REE are typical in the stream draining north-eastern fumarole field of Ebeko Volcano where contents of La reach >20 ppb and Ce up to 48 ppb. Normalized with NASC concentrations of REE in studied waters show more often enrichment in heavy REE with positive Eu anomaly. For surface waters positive correlation of REE and Fe (dissolved) was found in the Kislaya River, where the highest concentrations of Fe is typical. Correlation of REE and Mn appears only in the upstream of Kislaya River. Correlations of LREE and Al, Si in surface waters were similar to the springs of the same areas.

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Mixing it up in the early solar system

F.J. CIESLA

Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road NW, Washington, DC 20015 (fciesla@ciw.edu)

The collection of a CAI-like particle dubbed ‘Inti’ by the Stardust spacecraft demonstrates that large-scale transport occurred in our solar nebula [1]. Whatever dynamic process was responsible allowed grains that formed or were processed at one location of the solar nebula to be transported tens of AU to another location where they were accreted into the planetesimals and primitive bodies that grew there. Currently, the leading candidates for explaining the large-scale transport recorded by the cometary grains are ballistic launching by protstellar jets [2], diffusion within the disk due to turbulence [3], and mixing due to gravitational torques produced by transient spiral arms in a marginally unstable disk [4].

Whether these models can explain the transport needed to carry high temperature materials out to the regions where comets formed while still allowing for for the chemical and isotopic variations recorded by primitive materials and the different chondrite groups [5, 6] is the subject of ongoing study. This requires understanding the specific predictions that each model makes about the growth and chemical evolution of primitive materials and testing these predictions against available data. Meteoritic materials serve as hard constraints on these models, though, uncertainties in the interpretation of the data they provide—partly due to millions of years of processing in the solar nebula followed by alteration on meteorite parent bodies—has not allowed us to rule out any of these models thus far. Observations of protoplanetary disks are improving, as better resolution is being achieved providing more detailed chemical and spatial information, and may provide the key information to determine how our own solar nebula evolved.

I will highlight some of the differences in the predictions of these models and discuss how these predictions compare to the latest cometary, meteoritic, and protoplanetary disk observations.

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