Thermodynamic modelling of acid water composition of a volcano lake

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Maliy Semyichik Volcano is situated in the East Kamhatka Range and is one of the active volcanoes of the Karimsky group. The distinction of this volcano is the presence of an acid lake in the modern crater with an active fumarole on the bottom of the lake. The eruptions of such volcanoes are very dangerous, mostly because of appearance of lahars and lethal concentration of volcanic gases in the down atmosphere layers.

This paper is directed at revealing the possibility of using the most informative physical-chemical sensors for the system of uninterrupted monitoring. Collaborators of Institute of Volcanologe FEU RAS have gathered the serie of chemical analyses during the last 30 years. Systematic water analysis of volcanic lake of Maliy Semyichic (from 1965 to 1993) allow to do computer data simulation by means of graphics construction of the time concentration variation of macrocomponents in water. Also for the most representative years calculations were done with the help of the code WATEQ4F (J. Ball and K. Nordstrom). This programme is reserved for physical-chemical modelling of processes in natural waters.

Composition of waters during studying years is different, because the processes in the lake carrying with the permanent addition of material due to the fumarole activity, but there is a tendency of concentration and temperature reduction and pH increasing. Nether the less dilution background there are expressive peaks of concentration rising and pH decreasing for 1971-73 and 1985-86 years (Fig. 1). These periods are in according with the fumarole activisation. The last activisation of volcano begin-

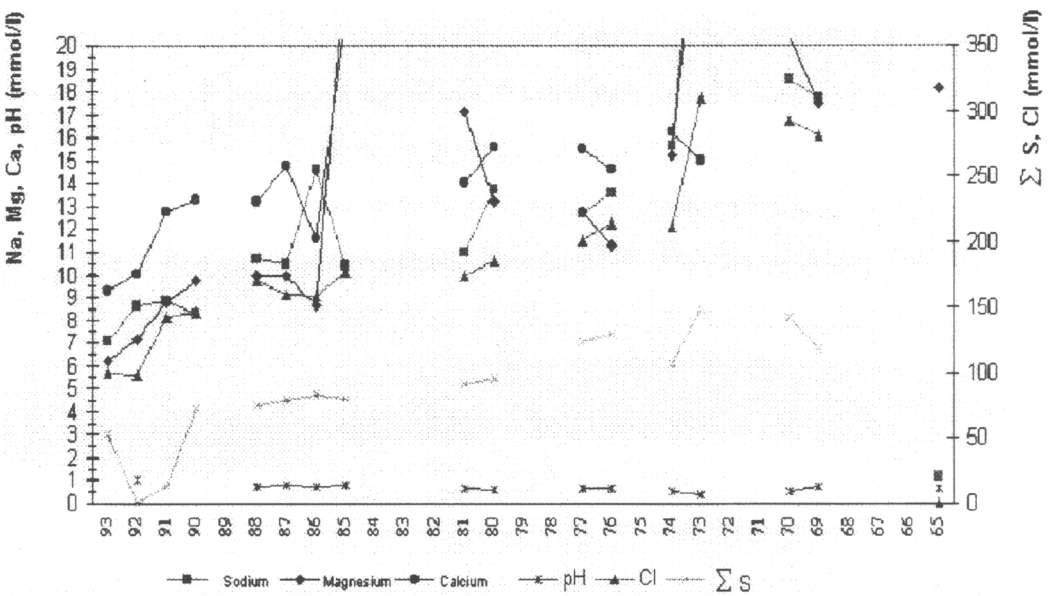

FIG. 1. The changes of macrocomponent concentrations in the waters of volcano lake.

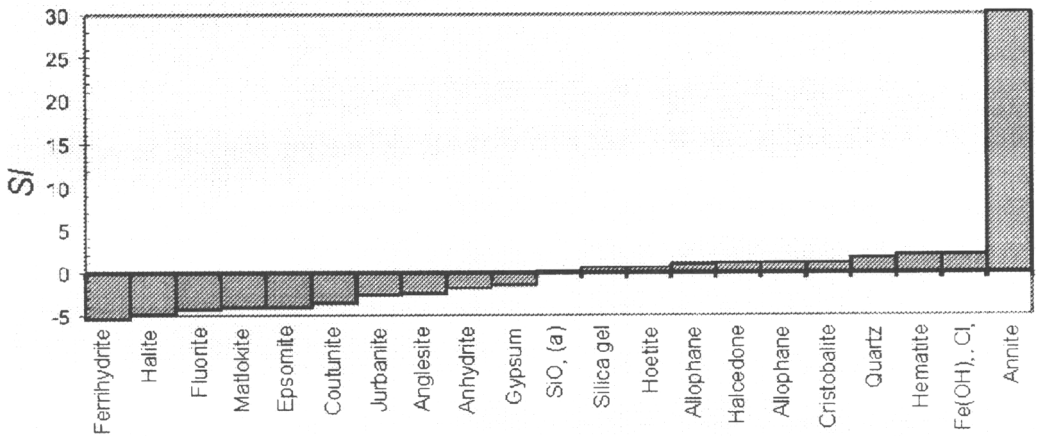

FIG. 2. Saturation state of the lake waters to several minerals phase. SI is the saturation index calculated as LOG IAP/K. Positive values indicate sursaturation, and negative values indicate undesaturation.

ning in 1997 year, caused the increasing of temperature, changing of chemical composition and rising level of the lake.

Modelling results show supersaturation of solution with respect to the same minerals (Fig. 2). There following minerals can precipitate: annite ($KFe_3AlSi_3O_{10}(OH,F)_2$), quarts, chalcedony, allophane ($Fe(OH)_{2,7}Cl_3$), hematite (Fe_2O_3), goethite (FeO(OH)). On the list of minerals presented mostly silicates and some minerals of iron. Thus composition of solution in such condition could be controlled by solubility of phases which include mostly iron and silica. The solution is undersaturated: that means that other elements do not form solid phases and present in dissolved forms fully. Calculated data show that the solution contains mainly free cations and anions. Complexed form is not exceeding 7% from total content of elements. At the same time complexes AlF2+ (to 50%), $AlSO_4^+$ (to 30%) present significant part of total Al. For iron main complexes are $FeCl^{2+}$ (to 50%), $FeHSO_4^{2+}$ (to 25%), $FeSO_4^+$ (to 20%).

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