GEOPHYSICAL AND GEOCHEMICAL STUDIES ON AN ACTIVE VOLCANO (EBEKO VOLCANO, PARAMUSHIR ISLAND)

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Abstract

Investigations on Ebeko volcano, Paramushir island are presented: microelectrotomography on a thermal field, and the results of a mercury survey in a nearby city after an ash fall. High levels of mercury vapor in the air indicate the unfavorable ecological situation of the settlement. According to the results of electrotomography, we can talk about the thermal field subsurface space: the structure of the boiling mud pots and the presence of the gas phase.

Keywords: electrotomography, gas analytics, modern volcanology, mercury observation

I. Introduction

There are not many cities in close proximity to modern active volcanoes. And, despite the small number of objects, they are not studied so well [1, 4]. In this paper the city of Severo-Kurilsk on the Paramushir island studied, with a registered population over 3000 people. Ebeko volcano is located about 7 km from the city.

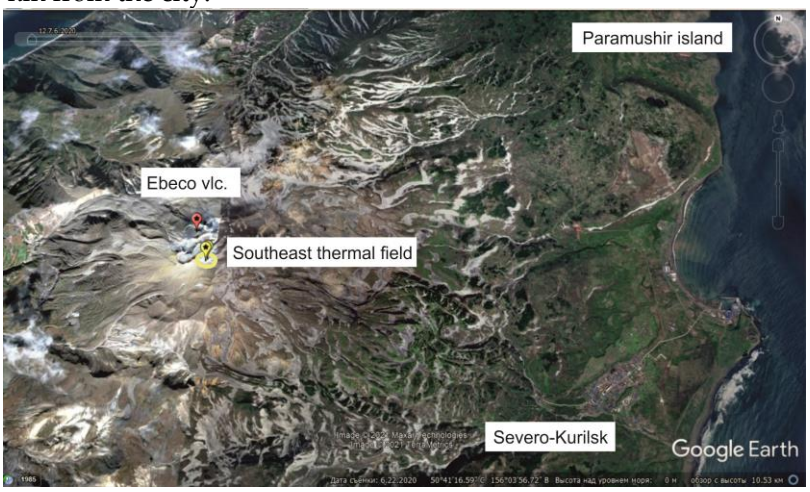

Figure 1: *Schematic map of the study area*

II. Methods

The electrical resistivity tomography (ERT) and mercury observation were carried out at the Ebeco volcano at 2021 [2].

ERT was carried out by the multi-electrode electrical resistivity and induced polarization

imaging instruments «SibER-48» (LLC «KB Electrometry», Novosibirsk, Figure 2 left) in cloudless weather with a slight wind. Directly on the Southeast thermal field of the Ebeko volcano, above the thermal cauldron, a microelectrotomography profile was made. The distance between the electrodes was 0.3 m, the profile length was ~14 m, and the effective observation depth was up to 2.5 m.

Portable automatic gas analyzer GANK-4 (LLC NPO PRIBOR GANK, Moscow, Russia, Figure 2 right) with forced air sampling is designed to measure the concentration of polluting and harmful chemicals contained in the atmosphere, in the air of the working area, in enclosed spaces and in industrial emissions [3]. GANK made a list of air analyzes directly on the thermal field of the volcano, as well as near Severo-Kurilsk.

Figure 2: *SibER-48 (left) and GANK (right)*

III. Results

July 7, 2021 at the South-Western thermal field of Ebeko volcano two microelectrotomography profiles were made. Good grounding <0.1kΩ. The sounding was carried out by the Schlumberger and dipole-dipole sequence. During further processing, despite the high-quality equipment and good grounding, the sounding data from the dipole-dipole sequence were rejected due to the large number of "overshoots" in the sounding curves.

The first profile was laid on the thermal field, the center of the arrangement was on the large fumarole (Figure 3). A gas analytical survey was also carried out there, samples of fumarolic sulfur and efflorescences around the fumaroles were taken.

Both microelectrotomography profiles are very low-resistance, which is due to the high conductivity of the medium - hydrothermally altered rocks saturated with liquid and gases.

Despite this, the most conductive zone can be distinguished in the middle of the profile: apparently, it includes a channel that feeds a large fumarole.

Based on the results of the background gas survey in Severo-Kurilsk and its environs, which was carried out for 3 days, no complex anomalies in gas content were recorded, but local excesses were recorded for some components in a number of peripheral points. At the main points, a full set of gases was measured, at the rest, a reduced list. In the area of the port and the nearby cape, elevated levels of CS_2 0.023 (port) and 0.045 (cape) mg/m^3, and phenol 0.01275 mg/m^3 (cape) were

recorded (points svg-12 and svg-13). On the river bank, near the dam to the west of Severo-Kurilsk, elevated levels of mercury and phenol (0.0108 mg/m^3) were recorded (point svg-15). In the kindergarten area, elevated levels of hydrogen sulfide and phenol were recorded, 0.012 and 0.0050 mg/m^3, respectively.

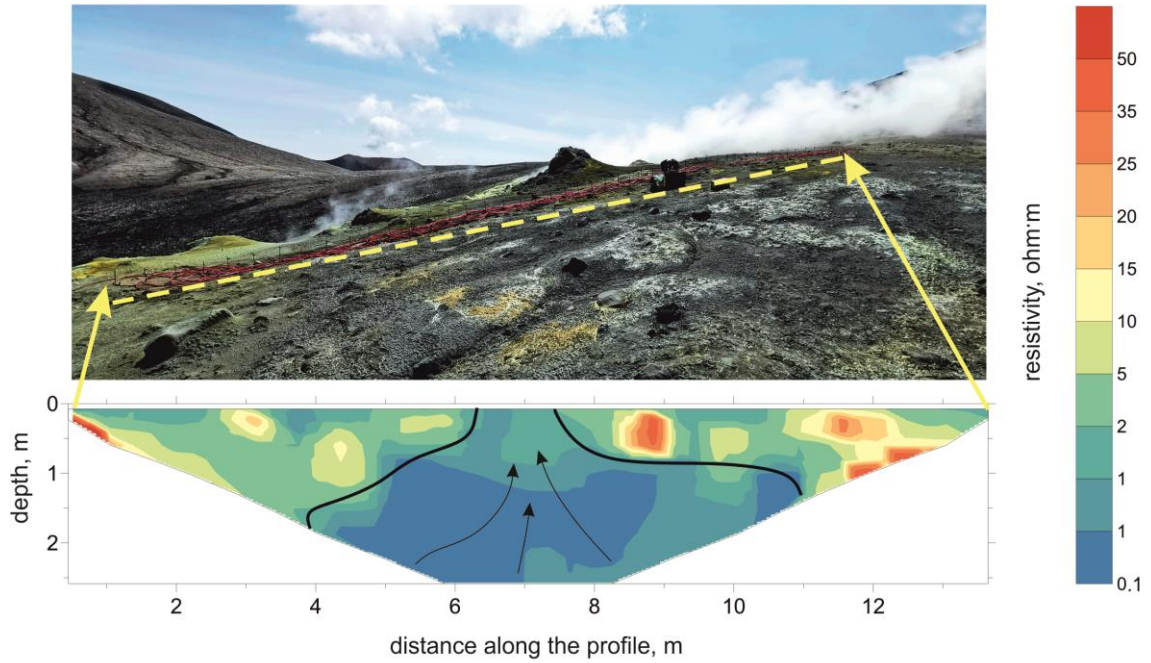

Figure 3: *Profile of microtomography No. 1. Schlumberger sequence, robust inversion*

In general, during the observation days, no increase in the content of various gases, with the exception of mercury, in the air of the city of Severo-Kurilsk associated with emissions from the active Ebeko volcano was recorded (but they are not excluded, monitoring was not round-the-clock). On the days when the survey of the background concentrations of gases was carried out, the weather conditions contributed to the demolition of the ejected materials of the volcano away from the city of Severo-Kurilsk.

An exception was an ash ejection to a height of up to 3 km, which occurred on the evening of July 12, 2021. The plume spread in a southeast direction from the volcano, and ashfall was observed on the territory of the city of Severo-Kurilsk. On the morning after the ash fall, it was decided to conduct an areal mercury survey in the city of Severo-Kurilsk. The survey was carried out during July 13, 2021. The data obtained are given in Appendix 2. and in Figures No. 6 and No. 7. An increase in the content of other gases at the site near the kindergarten was not recorded. The survey was carried out during July 13, 2021, at a height of 30 cm from the surface on roadsides, sidewalks, paths, in courtyards of houses, in areas in front of various objects.

In the case of mercury, we observe the emanation of its vapor from the fallen ash, both immediately during the ashfall and after it, and the next day after the ashfall. As a result, a critical increase in the content of mercury vapor in the air was recorded, up to 10 times the MAC of mercury in the air of populated areas (300 ng/m3).

IV. Discussion

4.1. Microelectrotomography

Based on the results of microelectromography, it can be concluded that the thermal field has a general low-resistivity setting: highly mineralized solutions are the most conductive medium,

while hydrothermally altered host rocks are hardly characterized by increased resistance.

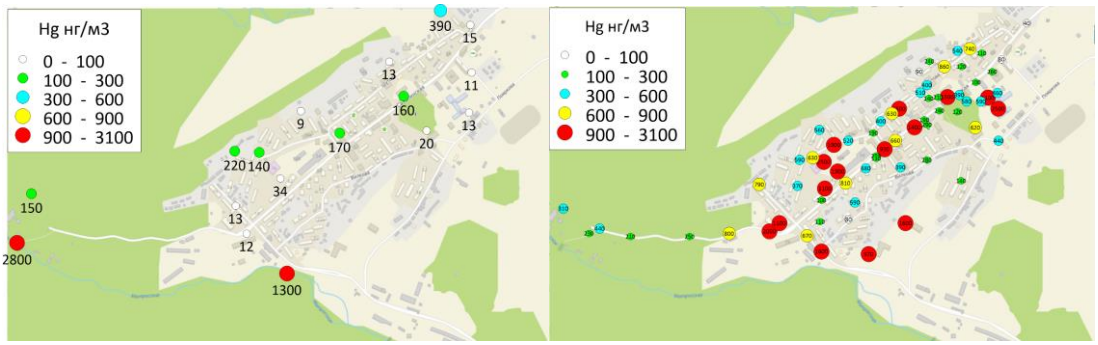

Figure 4. *The content of mercury vapor in the air in Severo-Kurilsk before (left) and after ash fall (right).*

4.2. Mercury observation

The results obtained allow us to judge the unfavorable environmental situation in the city. As a result of ashfalls, elevated levels of mercury vapor are observed in the city, of course, for a long time after the ashfall, the contents decrease to background values, but in the presence of a periodic source of pollution, it is difficult to talk about permanent pollution. An additional factor is the ash itself, which also carries potential harm. Further plans include monitoring the content of mercury vapor in the air of Severo-Kurilsk depending on ashfalls and time of day.

Acknowledgements

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