4. *Magnetic Survey in the Area of Topographical Deformation of Volcano Usu.*

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The present activity of Volcano Usu started on 27 of Dec., 1943, with numerous earthquakes at its north-western foot. At the end of February in 1944, however, the active centre of the earthquakes removed to the eastern foot of the volcano, where the ground began to upheave simultaneously. After the seismic activities and the remarkable upheaval had lasted for six months, the first explosion took place near the centre of the upheaved area, on 23 of June, 1944.[1]

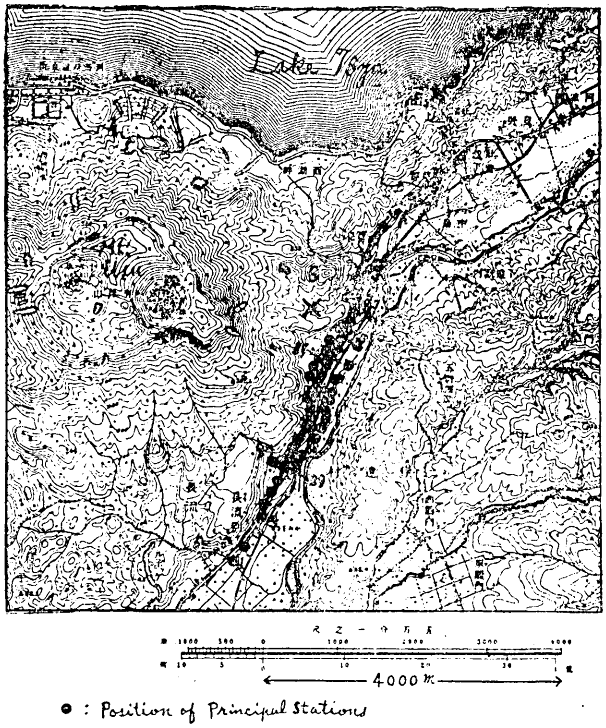


Fig. 1

The magnetic survey with the Askania magnetometer of Schmidt type was carried out by the present author in the upheaved area, during the period from 11 to 23 of April, 1944. Along the road running from north to south through the area, the relative intensities of the vertical component (Z) of geomagnetic field were measured at 100 stations within the distance of about 7km.. The standard station, where the measurements were repeated twice a day, morning and evening, was placed about 3 km southwards the upheaved centre (the station No. 3). At many other stations, the measurements were repeated two or three times during this period. [Fig. 1.]

The scale value (S) and the temperature coefficient (k) of the magnetometer used here are as follows,

$$S=43.5^{\gamma} \text{ per 1 scale division,}$$
$$k=2.77^{\gamma} \text{ per } 1^{\circ}\mathrm{C}.$$

To all observed values at every station, the temperature correction according to $k=2.77^{\gamma}/^{\circ}$, and the correction of daily variation of general geomagnetic field basing on the observation of the Mitsui Geophysical Observatory, Izu Peninsula, were applied. Thus, all measured intensities of Z were reduced to the values of 21^{st} 12^{h} of April, whereas the values of 16^{th} and 17^{th} of April at some stations just measured greatly deviate from their mean values, as indicated in Fig. 2. Fortunately, at the stations No. 29 and No. 87, Dr. Nagata's absolute measurements were carried out, and it is much indebted to his kindness that these values could be plotted in the same illustration figure. Such a magnetic intensity variation seems to be correlated with the volcanic or seismic activities, because sensible earthquakes took place frequently between 14^{th} and 17^{th} of April and the most intense one occurred at 20^{h} 25^{m} of 15^{th} of April, when our survey was being carried out. The intensity of this earthquake was II degree of the C. M. O. intensity scale of Japan at Date-Monbetsu about 8 km southwards the upheaved centre.

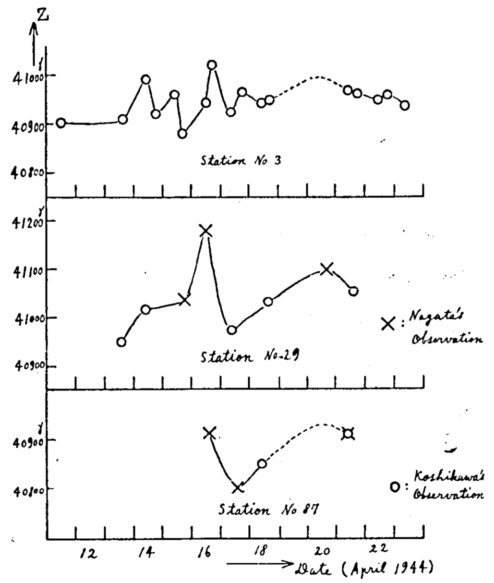


Fig. 2

Taking into account the above mentioned variation of Z, the mean value of Z of each station was calculated, and thus the magnetic profile as indicated in Fig. 3 (a) was obtained. Basing on this magnetic profile, confirming the subterranean mass distribution, Tsuboi-Nagata's analytical method was used.[2]

If the intensity of magnetization of the subterranean mass is represented as

$$J(\xi)=\sum_{m} a_m \cos m\xi+\sum_{m} b_m \sin m\xi,$$

the magnetic anomaly due to this mass will be written as in the form,

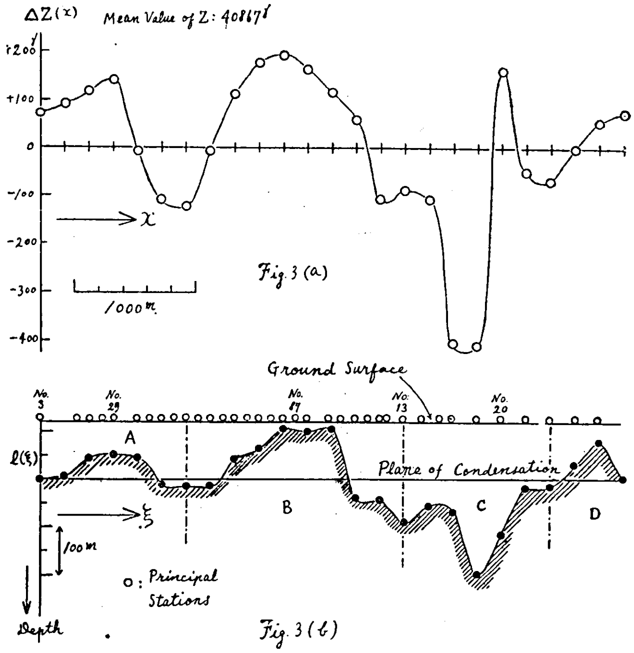
$$Z(x)=\sum_{m} \alpha_m \cos mx+\sum_{m} \beta_m \sin mx.$$

Thus, there exist the relations

$$a_m=\frac{e^{md}}{2\pi m}(\alpha_m \sin\theta-\beta_m \cos\theta)$$

$$b_m=\frac{e^{md}}{2\pi m}(\alpha_m \cos\theta+\beta_m \sin\theta), \quad (m \geqq 1),$$

where, d is the depth of a plane where the subterranean mass is condensed, and θ denotes the dip angle of magnetization.



By means of Fourier analysis of the magnetic profile, α_m and β_m are known, then a_m and b_m can be calculated by assuming d. And

$$J(\xi)=(\kappa\rho-\kappa_0\rho_0)\,F\cdot l(\xi),$$

where κ and κ_0 denote the magnetic susceptibilities of lower mass and of superficial layer respectively, whereas ρ and ρ_0 are the densities of them. F is the total intensity of general magnetic field, and $l(\xi)$ displays the elevation of the subterranean mass above the condensed plane.

The present author, assuming the various values of d, calculated $J(\xi)$, whereas, if d is larger than 200 m, Fourier coefficients (a_m, b_m) of higher order become very large, and $J(\xi)$ profile seems, therefore, unreasonable. On the other hand, the susceptibility of the subterranean mass must be larger than 9×10^{-3} C. G. S., if d is smaller than 50 m, because the maximum l is smaller than or equal to d. It is difficult to obtain such a value in ordinary rocks. Its largest value is about 7.5×10^{-3} C. G. S. even in basic rocks. Hence, 120 m was adopted as the intermediate value of d.

Comparing the normative magnetite of the somma lava of this volcano and with that of other volcanoes (Mt. Fuji, Mt. Asama, etc.),[(3)(4)] and refering to Y. Harada's observation in the vicinity of the Lake Toya,[(5)] only about 1 km. from this area, 1.6×10^{-3} C. G. S. was selected as the most suitable value of κ. Then, adopting the following values

$$F=0.49 \text{ C. G. S.} \qquad \theta=56^\circ\ 30'^{(6)}$$
$$\kappa=1.6\times10^{-3} \text{ C. G. S.} \qquad \rho=2.8$$
$$\kappa_0=0.2\times10^{-3} \text{ C. G. S.} \qquad \rho_0=2.3,$$

$l(\xi)$ was calculated and illustrated in Fig. 3 (b).

The ground was raised in the parts of A and B shown in the Fig. 3 (b), and the deformation was most remarkable in B during this period. The part C corresponds to the mineral spring zone of Fukaba. The present author formerly reported that the negative anomalies of Z were observed frequently in the area of hot or mineral springs and the part C just corresponds to this case. The place where the explosion took place later is situated on the western side of the surveyed route, about 500 m from the station No. 13, the boundary position of the parts B and C in the Fig. 3 (b). As to the form of the part D, the marginal part, it is difficult to discuss, because of some errors, in the nature of this analysis, will be introduced.

Thus, we come to a conclusion that such an underground basic rock as the somma lava which lies in the depth of about 120 m was elevated by active magma, and the ground deformation took place in the parts of A and B.

In conclusion, the writer wishes to express his sincere thanks to Professors Ch. Tsuboi and T. Nagata who gave him kind advices.

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