「新火山の地中構造の決定に関する地震探査の応用」

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DETERMINATION OF THE UNDERGROUND STRUCTURE OF THE NEW VOLCANO OF MT. SHOWA BY THE SEISMIC PROSPECTING

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INTRODUCTION

Mt. Usu, near Doya Lake in Hokkaido, Japan, is a famous active volcano which spreads over the three villages Datemachi and Sobetsumura in Usugum, and Abutamachi in Abutagun. On 28 December 1945, the land near Yanagihara, at the foot of Mt. Usu, suddenly started rising, accompanied by numerous local earthquakes. The centre of this underground activity gradually shifted northward and finally erupted near Kyu-Fukaba, thus forming a new volcano, Mt. Showa.

The volcano was named "Showashinzan" by T. Ishikawa(1) and its type determined as "Pseudobelonite" by H. Tanakadate.(2) Dr. T. Fukutomi and T. Ishikawa have jointly published the details of this volcanic activity.

In order to determine the underground structure of this new volcano, we experimented the seismic prospecting at the above named area. The results are as follows:

GEOLOGICAL STRUCTURE

The geological structure of Mt. Usu has previously been reported by Dr. T. Kato,(3) Dr. T. Harada, S. Sasaki, T. Ishikawa, and K. Fukutome,(4)(5) J. Okamoto. The lithological research of the new lava was made by K. Yagi. According to K. Yagi,(6) the lava is hypersthene andesite, while phenocrysts of felspar and hypersthene, and groundmasses of felspar, quartz and crystobal appear under the microscope. He Concluded that this eruptive rock was nearly Felspar-Rhyolite.
Showashinzan before the eruption is shown in Fig. 1, but it is yet a question whether the Toyoura-Beds or the rhyolite exist under these deposits. We found a great amount of the sedimentary rocks, pumice, tuff, and brick clay on the top of the central dome.

According to H. Tanakadate, the “Roof Mountain” of Showashinzan is a cryptodome, the same as Konpirayama, Higashimaruyama, Nishimaruyama, Ogariyama and Shinzan, all forming the foot of Mt. Usu, and the dome spine of Showashinzan was formed by lava which gushed forth after threading its way underground through the cryptodomes. But, we cannot determine the truth of this statement without performing seismic prospecting. We tried seismic prospecting to see whether a cryptodome actually exists, and if it does, to determine its form, size and depth, and on the other hand, to survey the underground structure of the uplifted area, along the line connecting Yanagihara and Fukaba.

THE SEISMIC METHOD USED AND ITS RESULTS

We used the displacement seismometer of the Hagihara type (magnification-40,000) and the velocity seismometer constructed by our institute (magnification-100,000) for this survey. The position of the survey line is illustrated in Fig. 2. The time distance curve of IIa and IIb proves that the stratified plane under the “Roof mountain” inclines downward towards the foot of the mountain from the central dome. We set dynamite on both sides of the seismometer, with...
The position of the surveying-line of seismic prospecting
(The map is surveyed by T. Fukutomi)

Time-distance curve on the Roof Mountain (E.W.)

By Velocity Seismograph

Fig. 2

Fig. 4

the velocity of the seismic wave, which refracted through the dome, is observed as 2150 m/sec. according to the time distance curve of Fig 3, I.

It is possible that the high temperature of the dome (900°C~1000°C) and the high viscosity of the acid lava, will cause a decrease in the wave velocity. The relation between the viscosity and the temperature of the rocks, reported by K. Kagi, that the viscosity increases in proportion to the temperature of the rocks. N. L. Bowen has published a similar report. As the result of an experiment on the relation between the elasticity and the temperature of the rocks, Dr. S. Kusakabe concluded that the elastic modulas decreases in inverse proportion to the temperature. For instance, in the case of sandstone, the elastic modulas decreases at the ratio of Ca, 0.5%/degree. Also, now, if

\[ \lambda, \mu : \text{Lame's Constant} \]

\[ \lambda', \mu' : \text{volume or equi-volume Viscosity} \]

\[ \rho : \text{density} \]

\[ V : \text{displacement Component of } x \]

put in

\[ n_1 = \sqrt{\frac{\lambda + 2\mu}{\rho}} \]

\[ W_1 = \frac{\lambda_1 + 2\mu_1}{2\rho} \]

\[ u = A e^{\frac{x}{\gamma}} e^{-\gamma n_1} \]

generalized

\[ u = \frac{1}{\pi} \int_{-\infty}^{\infty} dx \cos \frac{a_1 + 2\mu_1}{2\rho} \]

as mentioned above, Dr. K. Sezawa shows that the increase viscosity results in the
decay of the seismic wave. The rather small velocity of seismic wave refracted through the dome, 2150m/sec. mentioned above, is explained by these theories.

According to the time-distance curve, obtained in the survey of the gradual uplifted area near Kyu-Fukaba in Sobetsumura and Yanagihara and illustrated in Fig 5 or No. III, the upper stratum, consisting of tuff, and tuffaceous sand, tuffaceous shale, forms a dome. We also ascertained that the cryptodome exists at least 150 underground from the surface of the uplifted centre, if it does exist.

**CONCLUSION**

As the result of seismic prospecting, we concluded that the underground structure of the "Roof mountain" inclines downward in all directions from the central dome. This is illustrated in Fig 7. Moreover, the stratified plane is probably sandstone or andesitic tuff inclines 3°~8° in the dip. The depth is thought to be about 30m just under the spot.
ON THE MECHANISM OF THE FORMATION OF THE SHOWA NEW MOUNTAIN OF USU VOLCANO, HOKKAIDO, JAPAN.

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A new parasitic volcano appeared on the west side of volcano Usu, Hokkaido, Japan in 1944, the 19th year of Showa. To the end of 1943 many 'small earthquakes were felt and an area of 2 km² near Yanagihara in the valley of the river Sobetsu was raised since the beginning of 1944. After the upheaval in this area nearly ended, another area a little north of Yanagihara and west of Fukaba began to rise in June of 1944. (see Fig. 1).

On June 23, 1944 when the upheaval reached 50 m or more, eruptions took place on the top of the elevated area. The upheaval continued further forming a hill of about 150 m above its original level with craters on its top.

On 20th Dec. 1944 Mr. Masao Mimatsu, the