17. *Geomagnetic Studies of Volcano Mihara. The 6th Paper.*

(Continuous Observation of Changes in Geomagnetic Declination during the Period from 1951 to 1954)

By Izumi YOKOYAMA,

Earthquake Research Institute.

(Read Feb. 22, 1955.—Received March 31, 1955.)

The studies on the changes in the geomagnetic field have been conducted in relation to the activities of Volcano Mihara since the 1950 eruption as has been reported in the previous papers[1]. On repeating dip surveys over the volcano, T. Rikitake found out a remarkable decrease in the geomagnetic dip-angle amounting to as much as 30 *minutes* of arc at its maximum during the early stage of the eruptions. Under the assumption that the changes are caused by the demagnetization of the volcano probably due to the temperature rise in the interior of the volcano, the demagnetized region was obtained as a sphere with a radius of 2 *km* at a depth of 5 *km* under the volcano for the first approximation. Since the discovery of strong magnetization of volcanic rocks, this sort of change in the geomagnetic field has been deemed to occur on occasions of volcanic eruptions especially on volcanoes composed of basaltic rocks which contain a large amount of titano-magnetite. For example, a local anomalous change was observed at the time of the 1940 eruption of Volcano Miyakeshima[2] though we have not yet been able to examine the changes in detail. In the case of Volcano Mihara, however, we could carry out many sorts of geomagnetic study from which we can say something about the general feature of local anomalous change in regard to volcanic activities.

In order to trace rigidly the changes in the geomagnetic field in

1) T. RIKITAKE, *Bull. Earthq. Res. Inst.*, **29** (1951) 161, 499.
T. RIKITAKE, I. YOKOYAMA, A. OKADA and Y. HISHIYAMA, *Bull. Earthq. Res. Inst.*, **29** (1951), 583.
I. YOKOYAMA, *Bull. Earthq. Res. Inst.*, **32** (1954), 17, 169.

2) R. TAKAHASHI and K. HIRANO, *Bull. Earthq. Res. Inst.*, **19** (1941), 82, 373.
T. NAGATA, *Bull. Earthq. Res. Inst.*, **19** (1941), 335.
T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **19** (1941), 356.
Y. KATO, *Proc. Imp. Acad. Japan*, **16** (1940), 440.

relation to activities of Volcano Mihara, a continuous recording of declination has been carried out at the station No. 37 Nomashi village since April, 1951. Judging from the declination chart, this part of the island seems to be sensitive to changes in geomagnetic declination provided the changes are caused by the increase or decrease in magnetization of the volcano.

From the weekly record, hourly values are read off with which daily means are obtained and the semi-monthly means are calculated in order to see the gradual changes. The elimination of the errors due to transient magnetic disturbances such as magnetic storms is made by comparing the observation with that of Kakioka Magnetic Observatory, the standard observatory in Japan. The differences between them are tabulated in Table I and plotted in Fig. 1 together with their original

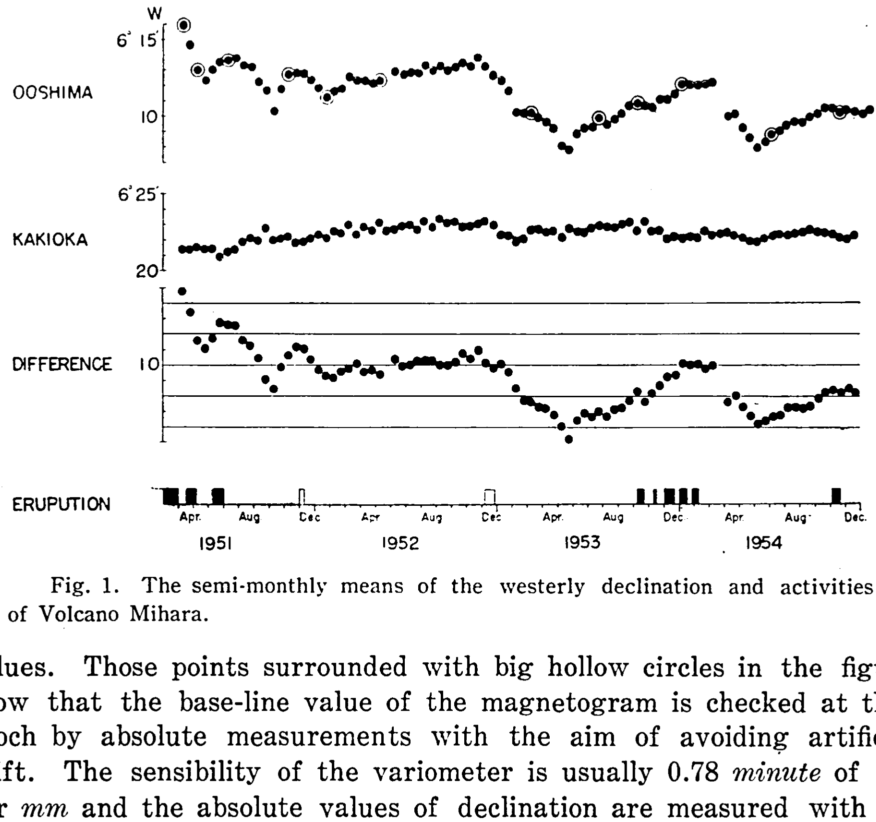

Fig. 1. The semi-monthly means of the westerly declination and activities of Volcano Mihara.

values. Those points surrounded with big hollow circles in the figure show that the base-line value of the magnetogram is checked at that epoch by absolute measurements with the aim of avoiding artificial drift. The sensibility of the variometer is usually 0.78 *minute* of arc per *mm* and the absolute values of declination are measured with an accuracy of 0.1 *minute* of arc for a single observation[3]. This degree

3) I. YOKOYAMA, *Bull. Earthq. Res. Inst.*, **31** (1953), 211.

Table I. The semi-monthly means of the westerly declination at Ooshima and Kakioka.

(Difference values for the periods of no observation are suitably corrected.)

Period	Ooshima	Kakioka	Difference
1951			
Apr.	6° 15′.8w	6° 21′.4w	−5′.4
	14.8	21.4	6.6
May	13.1	21.6	8.5
	12.4	21.4	9.0
June	13.1	21.4	8.3
	13.6	20.9	7.4
July	13.7	21.2	7.5
	13.9	21.4	7.5
Aug.	13.4	21.9	8.5
	13.3	22.2	8.9
Sept.	12.4	22.0	9.6
	11.8	22.8	11.0
Oct.	10.4	22.0	11.6
	12.1	22.1	10.2
Nov.	12.6	22.2	9.4
	12.8	21.8	8.9
Dec.	12.9	21.8	9.0
	12.4	22.1	9.7
1952			
Jan.	11.9	22.3	10.4
	11.3	22.1	10.8
Feb.	11.7	22.6	10.9
	11.6	22.4	10.6
Mar.	12.6	22.9	10.3
	12.4	22.4	10.0
Apr.	12.6	22.9	10.5
	12.2	22.6	10.4
May	12.7	23.1	10.7
	....	22.6	....
June	13.0	22.7	9.7
	12.8	23.0	10.2
July	12.9	23.0	10.1
	12.9	22.7	9.8
Aug.	13.4	23.2	9.8
	13.1	22.9	9.8
Sept.	13.4	23.4	10.1
	13.2	23.1	10.1
Oct.	13.4	23.2	9.9
	13.5	22.9	9.3
Nov.	13.4	22.9	9.6
	13.9	23.0	9.1
Dec.	13.3	23.3	10.0
	12.7	23.0	10.2

(to be continued.)

(continued.)

Period	Ooshima	Kakioka	Difference
1953 Jan.	6° 12′.4w 11.8	6° 22′.4w 22.3	−10′.0 10.5
Feb.	10.3 10.7	21.9 22.6	11.6 12.3
Mar.	10.3 9.8	22.7 22.7	12.4 12.7
Apr.	9.8 9.2	22.5 22.6	12.8 13.3
May	8.1 7.9	22.2 22.8	14.0 14.9
June	9.0 9.3	22.6 22.5	13.6 13.2
July	9.5 10.1	22.8 23.0	13.4 13.0
Aug.	9.5 9.9	22.9 22.9	13.4 13.0
Sept.	10.2 10.8	23.0 23.2	12.8 12.4
Oct.	11.0 10.8	22.7 23.2	11.7 12.4
Nov.	10.7 11.0	22.6 22.6	11.9 11.4
Dec.	11.1 11.5	22.1 22.2	10.8 10.7
1954 Jan.	12.1 12.1	22.1 22.2	9.9 10.1
Feb.	12.1 12.1	22.2 22.6	10.0 10.3
Mar.	12.3	22.4 22.5	10.1 ....
Apr.	10.8 10.3	22.5 22.4	12.4 12.0
May	9.4 8.8	22.2 22.0	12.8 13.4
June	8.2 8.3	22.0 22.1	13.9 13.6
July	9.1 9.2	22.4 22.4	13.4 13.2
Aug.	9.6 9.8	22.4 22.5	12.8 12.8
Sept.	9.7 10.0	22.5 22.8	12.8 12.7
Oct.	10.3 10.5	22.6 22.5	12.3 11.9

(to be continued.)

(continued.)

Period	Ooshima	Kakioka	Difference
Nov.	6° 10′.7w 10.4	6° 22′.4w 22.2	−11′.7 11.8
Dec.	10.6 10.4	22.1 22.3	11.6 11.9

of accuracy is perhaps the highest one under the circumstances. The results shown in Fig. 1 are thought to be quite reliable because of the frequent absolute measurements. The activities of the volcano are shown in an arbitrary scale at the bottom of the figure. The period when eruptions were observed on the summit is marked with a black column, while the white one shows the period when we observed groups of earthquakes or tremors of volcanic origin and topographical deformations in the crater though no eruption was reported. The 1951 eruption had reached its final stage when the continuous observation was commenced. The volcano did not show any apparent activities in 1952, though it erupted again in October, 1953. This activity continued intermittently until February, next year and about 1.5×10^6 *tons* of new lava welled up on Jan. 27. A minor eruption, which turned to be the last activity, was observed in November, 1954.

As is clearly shown in the figure, the declination at Nomashi Station tends towards the west whenever the volcano becomes active and returns eastward after the subsidence of activity. As for the general tendency during the whole period, a gradual eastward drift of several *minutes* of arc is noticeable. The change observed here firmly supports the physical interpretation concerning the relation between magnetization and internal temperature of the volcano as discussed in the previous papers. It has also been proved that the changes in the declination observed at the station harmonize with those in any geomagnetic components which are obtained by examining the repeated geomagnetic surveys over the volcano.

The proposed theory suggests that the change at another station on the east side of the island should be in the opposite direction. Although it is not easy to add a new station owing to unavoidable circumstances in Ooshima Island, it is possible to compare the changes at the two stations on both sides of the island using the results of absolute measurements. A few observations at the same epoch on both sides of the island have been made. The changes at the two stations compared with Kakioka, the semi-monthly means for Nomashi and the instant values for Zoo (east side), are plotted in Fig. 2. Black circles in the figure show the values corrected by the difference of secular variation between Kakioka and Ooshima Island. It is noticeable that the declination has been drifting to the opposite direction on both stations. Thus the proposed physical theory seems to be approximately acceptable.

Summarizing the results mentioned above, we can definitely say that local anomalous changes of a particular type take place in relation to the volcanic activities of Volcano Mihara. But we can not say that the geomagnetic phenomena related to active volcanoes are wholly understood at the present stage of investigation. Further considerations, especially concerning the mechanism of apparent demagnetization or magnetization in the interior of volcanoes should be made in future studies.

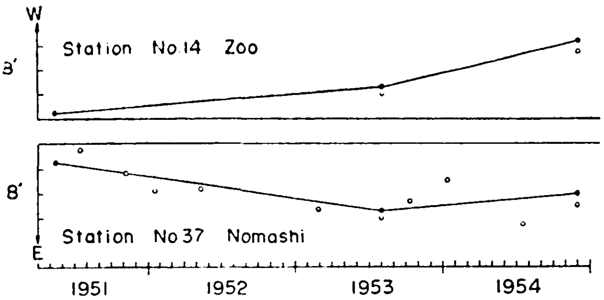

Fig. 2. The changes of westerly declination at two stations in Ooshima Island.

In conclusion, the writer must say that he is deeply indebted to Dr. T. Rikitake, to whom his sincerest thanks are due. To Prof. T. Nagata for his helpful advices, the writer's cordial thanks are also due. The writer also wishes to express his hearty thanks to Messrs. T. Yanai and H. Sasahara for the patience and enthusiasm with which they assisted the writer in the observations.

17. 三原山の地球磁気学的研究 第 6 報 (1951～1954 年間の偏角変化の連続観測)

地震研究所 横 山 泉

火山活動にともなう地球磁場の変化に関する研究は，三原山の 1950–51 噴火を契機として第二段

階に入つた．全島伏角測量および三成分絶対測定と平行して，この変化の推移を詳細に吟味するために，偏角変化の連続観測を 1951 年 4 月から大島西海岸の野増村で始めた．この結果の一部は既に報告してあるが，1951–54 年間の結果をまとめてこゝに報告した．また西側の変化に対する東側の変化を吟味することは有意義であるので，野増村と動物園との絶対測定の値を比較した．まだ資料は少いが，大体両者は反対方向に変化するとみなされる．

以上の結果から，三原山の火山活動にともなう地球磁場の変化が確認され，それはまた火山内部の状態に関する吾々の物理学的解釈を一応支持するものである．しかしながら火山内部の帯磁の変化と熱的状態との関係は簡単なものではないようである．この議論は今後行う予定である．