

## 23. *Geomagnetic Studies on Volcano Mihara.* *The 9th Paper.*

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### Summary

Changes in the geomagnetic declination in Oshima Island during the period 1957 to 1961 are reported. At Nomashi station no remarkable variations were observed during this period except in 1957 and 1961. In October, 1957, a minor eruption occurred, and preceding it a rapid decrease and then increase in the westerly declination was observed. Since the beginning of 1961 the westerly declination has increased gradually. In April, 1959, measurement of total geomagnetic intensity by a proton precession magnetometer was started at Nomashi station. Since its installation no conspicuous variations have been observed.

### 1. Introduction

Geomagnetic surveys over Oshima Island, repeated by T. Rikitake<sup>1)</sup> immediately after the great eruption in 1950, revealed a remarkable decrease in inclination over a few months. These changes are considered to be caused by demagnetization of basaltic rocks<sup>2)</sup>, of which the main part of the volcano is composed, when they are heated by the intrusion of lava.

For the purpose of more accurate investigation of changes in the geomagnetic field which may possibly be associated with the activity of the volcano, a continuous recording of variations in declination has been carried out since 1951 at Nomashi, situated at the western coast of the island. In 1955 the same kind of measurement was set out at the eastern side of the island, Oshima Koen (or the Zoo). If the change in the magnetic field is caused by the demagnetization process of heated

1) T. RIKITAKE, *Bull. Earthq. Res. Inst.*, **29** (1951), 161, 499.

2) T. RIKITAKE, I. YOKOYAMA, A. OKADA and Y. HISHIYAMA, *Bull. Earthq. Res. Inst.*, **29** (1951), 583.

rocks beneath the volcano, the westerly declination is expected to increase at Nomashi and to decrease at Oshima Koen at the active stage of eruption. The results of the observation from 1957 to 1961 are reported in this paper. Those before 1956 have already been published by I. Yokoyama in this bulletin<sup>3)4)5)</sup>.

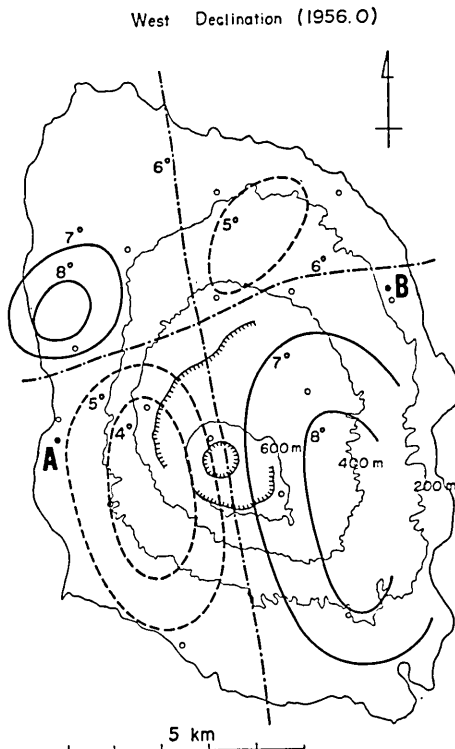


Fig. 1. Localities of the observatories and the distribution of westerly declination in Oshima Island for 1956.0 (after I. Yokoyama).

- A: Nomashi where Oshima Geophysical Observatory and the old Nomashi station are situated.  
 B: Oshima Koen (or the Zoo)

## 2. Observation of variation in the geomagnetic declination

Possible changes associated with the volcanic activities are so small in magnitude and so gradual that we need to resort to averaged values of declination for a certain period. In our study, semi-monthly means are computed from hourly values of a magnetogram and shown in Fig. 2 and in Table 1. Since the records are inevitably affected by the secular variation or by the magnetic disturbance of external origin such as magnetic storms, they are compared with the records obtained at Kakioka Magnetic Observatory, about 200 km distant from the island, and the variations peculiar to Oshima Island are computed. The observations at Kakioka and the differences between those at Kakioka and at Nomashi are also shown in

Fig. 2 and Table 1. The absolute values of declination have been checked a few times a year by a G. S. I. type magnetometer. In the Figures, the points encircled by large circles represent those values

- 3) I. YOKOYAMA, *Bull. Earthq. Res. Inst.*, **33** (1955), 251.  
 4) I. YOKOYAMA, *Bull. Earthq. Res. Inst.*, **34** (1956), 185.  
 5) I. YOKOYAMA, *Bull. Earthq. Res. Inst.*, **35** (1957), 75,567.

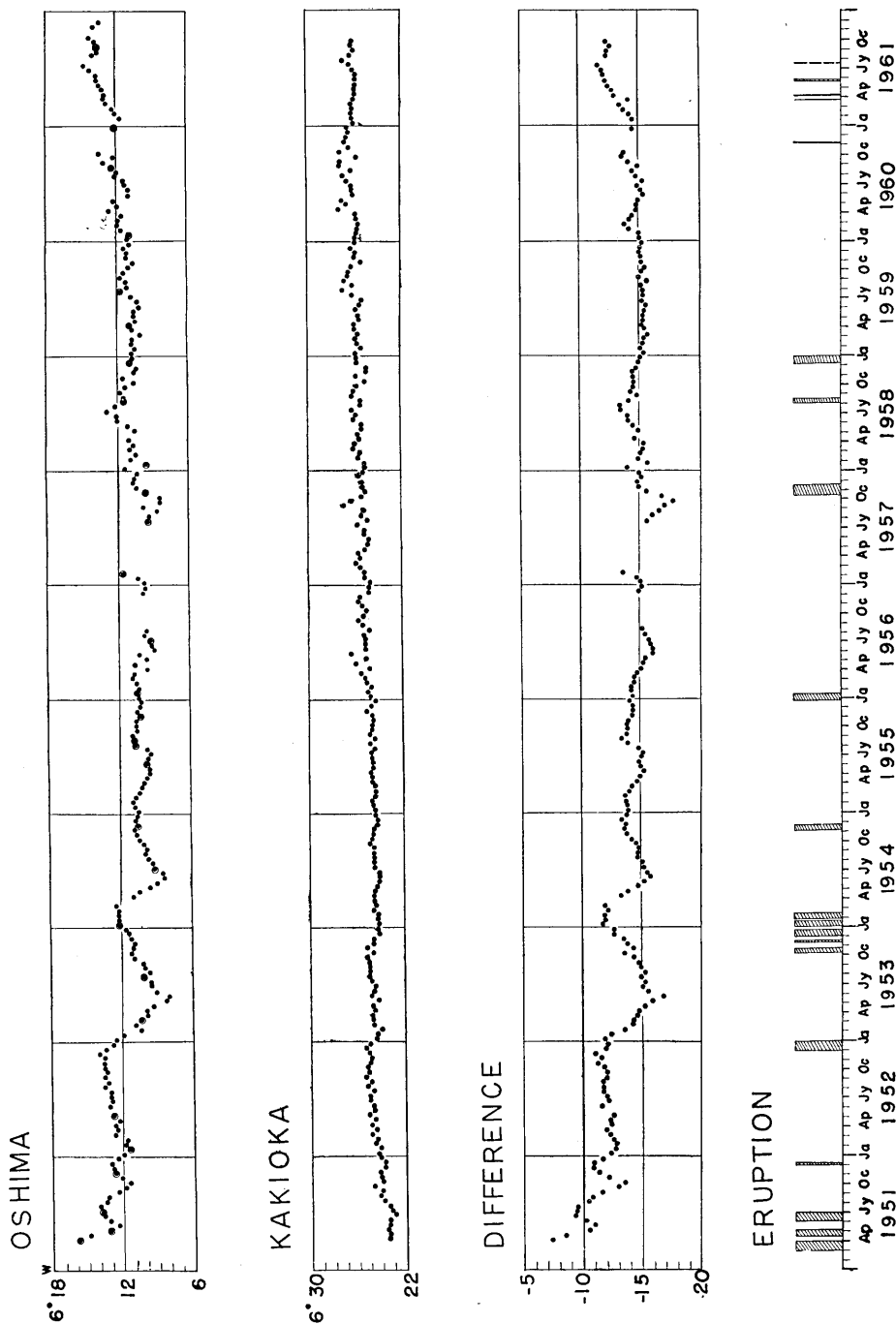


Fig. 2. Variations in the westerly declination and the activities of Volcano Mihara. From top to bottom: Variations at Nomashi in Oshima Island, those at Kakioka, differences between these two stations and the periods of eruptions.

Table 1. The semi-monthly means of the westerly declination at Oshima and Kakioka

Period	Oshima		Kakioka	Differences		
	West (Nomashi)	East (Koen)		Nomashi— Kakioka	Koen— Kakioka	Nomashi —Koen
1957						
Jan.	6°9'.7	8°47'.6	6°24'.7	-15'.1	2°22'.9	-2°37'.9
	10.2	47.7	25.2	-14.9	22.5	37.3
Feb.	11.5	48.6	25.2	-13.7	23.4	37.1
	—	48.8	25.5	—	23.3	—
Mar.	—	49.3	25.9	—	23.4	—
	—	48.9	25.6	—	23.4	—
Apr.	—	49.2	25.7	—	23.5	—
	—	48.4	25.2	—	23.1	—
May	—	48.4	24.9	—	23.4	—
	—	49.0	24.8	—	24.2	—
June	—	48.5	25.2	—	23.3	—
	—	48.6	25.2	—	23.4	—
July	—	49.6	25.8	—	23.8	—
	9.3	48.7	24.9	-15.7	23.8	39.5
Aug.	9.2	48.9	25.4	-16.1	23.5	39.6
	8.5	48.5	25.2	-16.7	23.3	40.1
Sept.	9.7	50.6	26.9	-17.2	23.7	40.9
	8.3	49.8	26.3	-18.0	23.5	41.5
Oct.	8.4	48.7	25.4	-17.0	23.3	40.3
	9.5	48.6	25.1	-15.6	23.5	39.1
Nov.	10.3	48.3	25.3	-15.0	23.0	38.0
	10.5	48.5	25.4	-14.9	23.1	38.0
Dec.	10.5	48.7	25.6	-15.1	23.2	38.3
	10.2	48.5	25.2	-15.0	23.3	38.2
1958						
Jan.	11.2	48.6	25.2	-14.0	23.3	-2°37.4
	9.5	48.1	25.2	-15.7	22.9	38.6
Feb.	10.8	47.8	25.7	-14.9	22.1	37.0
	10.3	47.7	25.5	-15.1	22.2	37.4
Mar.	10.8	47.7	26.1	-15.3	21.5	36.9
	10.5	47.6	26.0	-15.4	21.7	37.1
Apr.	10.9	47.1	25.6	-14.7	21.6	36.6
	—	47.3	25.7	—	21.6	—
May	10.4	47.0	25.4	-14.9	21.6	36.6
	11.0	47.2	25.4	-14.5	21.8	36.2
June	12.0	47.5	26.1	-14.1	21.4	35.4
	11.9	47.3	25.9	-14.0	21.5	35.6
July	12.8	47.8	26.3	-13.5	21.5	35.0
	12.1	47.5	25.5	-13.4	22.0	35.4
Aug.	11.3	48.5	25.5	-14.1	23.1	37.2
	11.4	49.8	26.2	-14.8	23.6	38.4
Sept.	11.7	50.0	26.0	-14.3	24.1	38.5
	11.2	49.4	25.7	-14.5	23.7	38.1
Oct.	10.5	49.1	25.1	-14.6	24.0	38.3
	11.4	50.6	25.8	-14.5	24.7	38.2
Nov.	10.5	49.0	25.0	-14.5	24.0	38.5
	10.3	48.9	25.0	-14.7	23.9	38.6
Dec.	10.8	49.6	25.8	-15.0	23.8	38.8
	10.6	49.5	25.8	-15.2	23.7	38.9

(to be continued)

(continued)

Period	Oshima		Kakioka	Differences		
	West (Nomashi)	East (Koen)		Nomashi- Kakioka	Koen- Kakioka	Nomashi- Koen
1959						
Jan.	6°10'6	8°49'6	6°25'9	-15'4	2°23'6	-2°39'0
	10.3	49.1	25.4	-15.1	23.7	38.8
Feb.	10.6	49.9	25.8	-15.3	24.0	39.5
	10.5	—	25.9	-15.4	—	—
Mar.	9.9	—	25.7	-15.7	—	—
	10.5	—	26.0	-15.5	—	—
Apr.	10.8	50.0	26.0	-15.2	24.0	39.6
	10.3	50.3	25.6	-15.3	24.7	40.0
May	10.4	50.8	25.7	-15.3	25.1	40.4
	10.4	51.2	25.9	-15.4	25.3	40.7
June	10.0	50.6	25.6	-15.6	25.0	40.6
	10.2	50.7	25.4	-15.2	25.3	40.5
July	10.7	51.0	26.1	-15.4	24.9	40.3
	11.6	52.3	26.9	-15.3	25.4	40.4
Aug.	11.0	51.9	26.1	-15.1	25.8	40.9
	11.1	51.6	26.8	-15.7	24.8	40.6
Sept.	11.5	51.1	26.5	-15.0	24.6	39.0
	11.3	50.1	26.5	-15.2	23.6	38.9
Oct.	10.8	49.1	26.2	-15.4	22.9	38.3
	10.4	49.0	25.5	-15.2	23.5	38.0
Nov.	11.0	50.2	26.0	-15.1	24.1	39.3
	10.9	50.6	25.9	-15.0	24.7	39.7
Dec.	11.2	50.8	26.3	-15.1	23.6	39.7
	10.7	50.3	25.9	-15.2	24.3	39.5
1960						
Jan.	10.9	50.5	25.9	-15.0	24.6	-2°39'6
	10.8	49.4	25.8	-15.0	23.6	38.6
Feb.	11.5	50.5	25.7	-14.2	24.8	39.0
	11.8	50.9	25.6	-13.8	25.3	39.1
Mar.	11.7	50.2	25.8	-14.1	24.4	38.5
	11.4	50.8	25.8	-14.4	25.0	39.4
Apr.	12.5	52.2	27.2	-14.7	25.0	39.7
	11.8	51.5	26.6	-14.8	24.9	39.7
May	12.1	51.9	27.0	-14.9	24.9	39.8
	10.8	50.9	26.1	-15.3	24.8	40.1
June	11.0	51.3	26.2	-15.2	25.1	40.3
	11.3	51.4	26.2	-14.9	25.2	40.1
July	11.3	51.5	26.6	-15.3	24.9	40.2
	12.0	52.1	26.8	-14.8	25.3	40.1
Aug.	11.8	52.1	26.3	-14.5	25.8	40.3
	12.3	—	27.2	-14.9	—	—
Sept.	13.0	—	27.1	-14.1	—	—
	12.2	—	25.8	-13.6	—	—
Oct.	13.4	—	27.1	-13.7	—	—
	—	52.2	26.4	—	25.8	—
Nov.	—	52.8	26.7	—	26.1	—
	—	53.0	26.6	—	26.4	—
Dec.	—	52.5	26.4	—	26.1	—
	12.1	52.8	26.5	-14.4	26.3	40.7

(to be continued)

(continued)

Period	Oshima		Kakioka	Differences		
	West (Nomashi)	East (Koen)		Nomashi— Kakioka	Koen— Kakioka	Nomashi— Koen
1961						
Jan.	—	8°52'.0	6°26'.0	—	2°25'.9	-2°41'.1
Feb.	6°11'.6	52.1	26.1	-14'.5	26.1	40.5
	12.0	52.4	26.2	-14.2	26.2	40.4
Mar.	12.3	52.5	26.1	-13.7	26.4	40.2
	12.8	52.8	26.2	-13.4	26.6	40.0
Apr.	13.0	52.6	26.0	-14.1	27.1	39.6
	13.0	52.8	25.9	-12.9	26.9	39.8
May	13.1	52.6	25.9	-12.8	26.7	39.6
	13.4	52.5	25.8	-12.4	26.7	39.1
June	13.6	52.3	25.8	-12.2	26.5	38.8
	13.7	52.3	25.8	-12.1	26.5	38.5
July	14.2	52.5	26.1	-11.9	26.4	38.3
	14.7	52.8	26.3	-11.6	26.5	38.2
Aug.	—	—	26.9	—	—	—
	14.0	52.7	26.3	-12.3	26.4	38.7
Sept.	13.6	52.3	26.0	-12.4	26.3	38.7
	13.6	52.6	26.2	-12.6	26.4	39.0
	13.8	52.5	26.1	-12.3	26.4	38.7

checked by the absolute measurements.

In Fig. 3, the local variations in declination at the western station in Nomashi and at the eastern station in Oshima Koen are shown after subtracting the values observed at Kakioka Magnetic Observatory from those obtained at these stations. From these Figures, we notice that the westerly declination at Nomashi had been decreasing gradually since the great eruption in 1951 and approaching a final value in 1959 or 1960, while declination at Koen shows a westward increase continuously. These phenomena can well be understood by the remagnetizing process of the volcano when a large amount of lava beneath the volcano is cooled down from above the Curie point temperature in the earth's field. When the magnetization of the volcano is strengthened by cooling of rather deeply situated lava, the lines of force at the locality of the stations concerned are attracted towards the volcano, and the decrease in the westerly declination at Nomashi and the increase at Koen may be observed.

Superposing on these slow variations we can see short period fluctuations amounting to a few minutes of arc, as in 1953-1954 and in 1957 at Nomashi, which are closely related to small-scale eruptions.

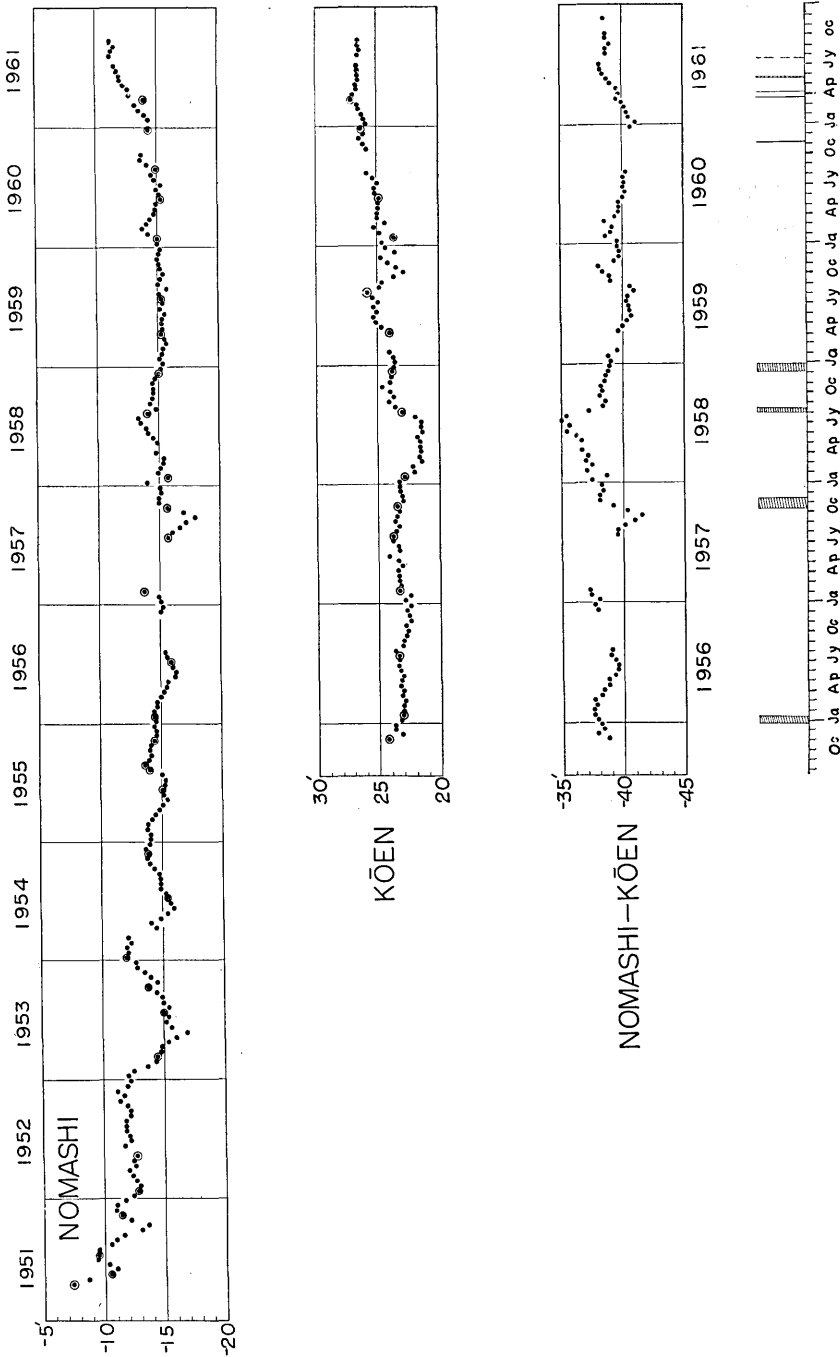


Fig. 3. Local variations in the westerly declination in Oshima Island, obtained after subtracting the variation at Kakioka Magnetic Observatory that may be regarded as a representative of a large scale variation in the central part of Japan. The differences between the observations at the western coast (Nomashi) and at the eastern side (Koen) of Oshima Island are shown together.

A remarkable variation in 1953 has already been reported elsewhere<sup>6)7)</sup>. Although we cannot see when the irregular change in 1957 began, because of the interruption of observation from February to July of that year the westerly declination decreased rapidly in August and reached a minimum value in September, and then increased by 3' within a short period of one and a half months. In course of the rapid increase in the declination, there occurred an eruption as a result of which a new crater was formed in the central cone. Although no lava flow was observed at the ground surface, it is supposed that the intrusion of hot magma from the depths might have occurred beneath the volcano and that the anomalous variation in declination was effected by the thermal demagnetization of subterranean mass.

A gradual increase in the westerly declination started in May 1960, and reached a maximum in June 1961. However it has no apparent correlation with the surface activity. On July 22<sup>nd</sup>, 1961, earthquake swarms of shallow origin at a depth of about 20km, confined within a narrow region near Oshima Island, were recorded on the seismograph and did not cease until the following day. It is, however, uncertain yet whether the increase in declination at Nomashi as stated above has some connection with these earthquake swarms or not.

On the other hand, at the eastern station in Oshima Koen, the westerly declination continued to increase gradually since its installation, except for the period from January to September in 1958. In August 1958, the crater formed by the eruption in October 1957 was enlarged to one having a diameter twice as large as before. At this time no particular variations were observed at Nomashi. Therefore nothing definite can be said as to the existence of a connection between the decrease and increase in declination in 1958 at Koen and the volcanic activity during the period concerned.

In order to see the anomalous variations connected with the volcanic activity more clearly, the difference between the observations at Nomashi and at Koen are computed and are shown at the bottom of Fig. 3. It is quite identical to the variation at Nomashi except in 1958, because declination at Koen changed rather uniformly.

### 3. Variation in total geomagnetic intensity

In April 1959 observation of total geomagnetic intensity by a proton

6) I. YOKOYAMA, *loc. cit.*, 3)

7) I. YOKOYAMA, *Bull. Earthq Res. Inst.*, 34 (1956), 21.



magnetometer was started at a new station, Oshima Geophysical Observatory, near the old station in Nomashi. Absolute value of total intensity can be measured by it with an accuracy of 1 *gamma*. As the magnetometer is not of the continuously recording system, measurements are repeated four times a day, *i. e.* at 10.00, 10.20, 10.40 and 11.00 *a. m.*, and the results of the observation are averaged into a mean total intensity from 10.00 to 11.00 *a. m.*. As in the case of the observation of declination, hourly values from 10.00 to 11.00 *a. m.* at Kakioka Magnetic Observatory are subtracted from those averaged values at Nomashi. They are tabulated in Table 2 and shown in Fig. 4.

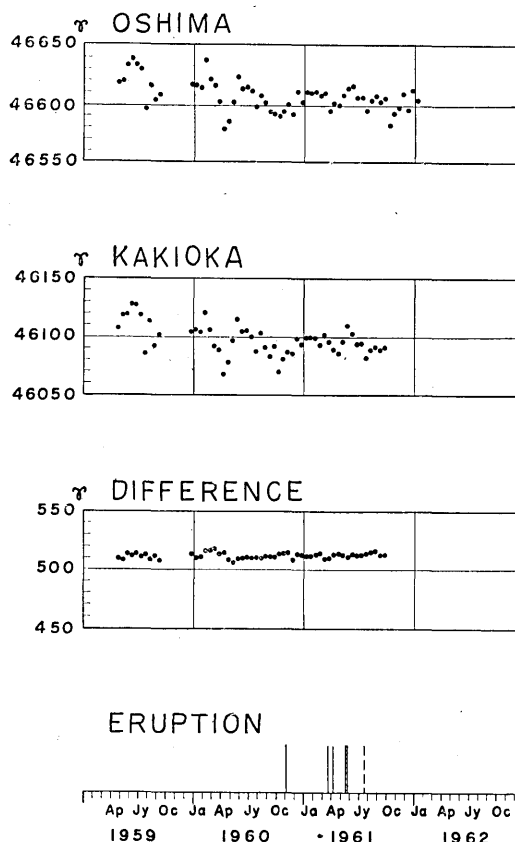


Fig. 4. Changes in the total geomagnetic intensity at Oshima Geophysical Observatory and those at Kakioka. Differences between these two stations are computed and shown in the diagram next to the bottom. The bottom diagram shows the periods of eruptions on the summit.

Table 2. The semi-monthly means of the total geomagnetic intensity at Oshima and at Kakioka  
(unit in *gammas*)

Period	Oshima	Kakioka	Oshima-Kakioka
1959	<i>r</i>	<i>r</i>	<i>r</i>
Apr.	46617.8	46107.1	510.7
May	619.2 632.7	118.1 118.7	501.1 514.0
June	638.6 633.6	127.8 126.8	510.8 506.8
July	629.3 595.9	118.1 084.9	511.2 511.0
Aug.	615.7 603.3	113.0 091.8	502.7 511.5
Sept.	607.7	100.7	507.0
Oct.	—	—	—
Nov.	—	—	—
Dec.	—	—	—
	46616.1	46103.6	512.5
1960			
Jan.	46615.8 613.8	46105.4 103.4	510.4 510.4
Feb.	637.1 620.9	120.0 105.2	517.1 515.7
Mar.	615.3 601.4	091.1 087.8	524.2 513.6
Apr.	578.0 584.7	066.7 076.9	511.3 507.8
May	601.7 622.6	095.9 114.3	505.8 508.3
June	613.1 614.1	103.5 104.0	509.6 510.1
July	611.1 598.4	100.3 087.8	510.8 510.6
Aug.	606.4 600.9	102.6 090.9	503.8 510.0
Sept.	593.2 590.9	082.1 091.0	511.1 491.9
Oct.	588.8 593.4	068.7 079.9	520.1 513.5
Nov.	599.7 591.4	086.0 084.6	513.7 506.8
Dec.	610.2 600.9	097.5 093.0	512.7 507.9
1961			
Jan.	46609.6 609.7	46098.1 098.3	511.5 511.4
Feb.	610.2 607.0	097.9 092.5	512.3 513.4
Mar.	609.4 594.1	100.6 091.3	508.8 502.8

(to be continued)

(continued)

Period	Oshima	Kakioka	Oshima-Kakioka
1961			
Apr.	46600.7 <sup><i>γ</i></sup>	46088.1 <sup><i>γ</i></sup>	512.5 <sup><i>γ</i></sup>
	598.9	085.4	513.5
May	607.7	095.4	512.3
	612.7	109.2	503.5
June	615.1	101.9	513.2
	605.3	093.3	512.0
July	605.6	093.8	511.8
	594.0	081.0	513.0
Aug.	602.4	087.9	514.5
	606.3	090.4	515.9
Sept.	601.8	089.0	512.8
	604.3	091.2	513.1

No remarkable variations in total intensity which are peculiar to Oshima Island have so far been obtained, because the volcano has not been so active as to erupt an appreciable amount of lava during the whole period of observation of total intensity.

#### 4. Concluding remarks

Generally speaking, Volcano Mihara has not been so active since October 1957 as might modify the distribution of the geomagnetic field around the volcano. Prior to the eruption in October 1957, the westerly declination at Nomashi began to decrease rapidly and recovered its normal values soon after the eruption. All these variations took place within a period of several months only. At the eastern station, Koen, however, no marked changes were observed corresponding to the variation at Nomashi. It is noticeable that, when the activity of the volcano is low as at present, the magnetic fields at both stations do not always vary in unison.

Continuous measurements of three geomagnetic components by the proton magnetometers are to be started soon at Nomashi in the hope of more accurate observation of extremely local variations.

The writers would like to express their sincere thanks to Prof. Rikitake for his kind direction and support in this continuous observation.

## 23. 三原山の地球磁気学的研究 第9報

地震研究所 { 行 武 毅  
                  { 薮 武 夫

伊豆大島においては、火山活動を地球磁気学的立場から研究するために、1951年以來、偏角の連続観測がおこなわれている。本報はその1957—1961年間の観測結果の報告である。

1951年以來、偏角は大島西岸の野増では東方に、東岸大島公園では西方へと次第に変化し、ある一定値に収束するような傾向がある。上記期間中でも、変化の全体的様子はこの傾向を破るものではないが、それに重なつて、1957年10月、野増では小噴火に関連すると思われる約3'におよぶ、急激な偏角の減少、続いて増加が見られた。また1961年には野増で次第に増加する変化が観測された。

1959年4月、野増で全磁力測定が開始され今日に至っているが、今までのところ顕著な変化は観測されていない。