21. *Geomagnetic Anomalies related to the Magnetization of the Basalt in the Vicinity of Gembudō.*

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1. Introduction.

Gembudō is a famous rocky cave for its singular sight of columnar joints, and is situated at a distance of about 110 *kilometers* north-west from Kyoto. It is one of the outcrops of the basaltic rocks which are scattered along the catchment basin of the river Maruyama. The epoch of its ejection has not been confirmed by geologists. Topographical map and geological sketch map are shown in Figs. 1 and 2 respectively.

As for the magnetization of the basalt from Gembudō, M. Matuyama has made some studies as early as in 1929[1]. He found out a magnetization almost reverse to the present geomagnetic field which attracted attention of many geophysicists. Following his pioneer works, more detailed studies are now under way at the Geophysical Institute of Tokyo University from the view-point of rockmagnetism which has remarkably developed in these several years.

In November 1953, the writer carried out a dip-survey with a miniature earth-inductor[2] in the vicinity of Gembudō to study the relation between the geomagnetic anomalies and the reverse natural remanent magnetization of the rocks.

2. Results of dip-survey and the magnetization of the basaltic rocks.

The error of each measurement in the dip-survey was about 1 *minute* of arc. The observed values are shown in Table I and Fig. 3, in which daily variation is corrected. The normal value of dip-angle for this district is about 49°30′. As seen in Fig. 3, the differences of dip-angles for various places are not large. However we can see a

1) M. MATUYAMA, *Proc. Imp. Acad. Japan*, **5** (1929), 203.
2) T. RIKITAKE, *Bull. Earthq. Res. Inst.*, **29** (1951), 147.

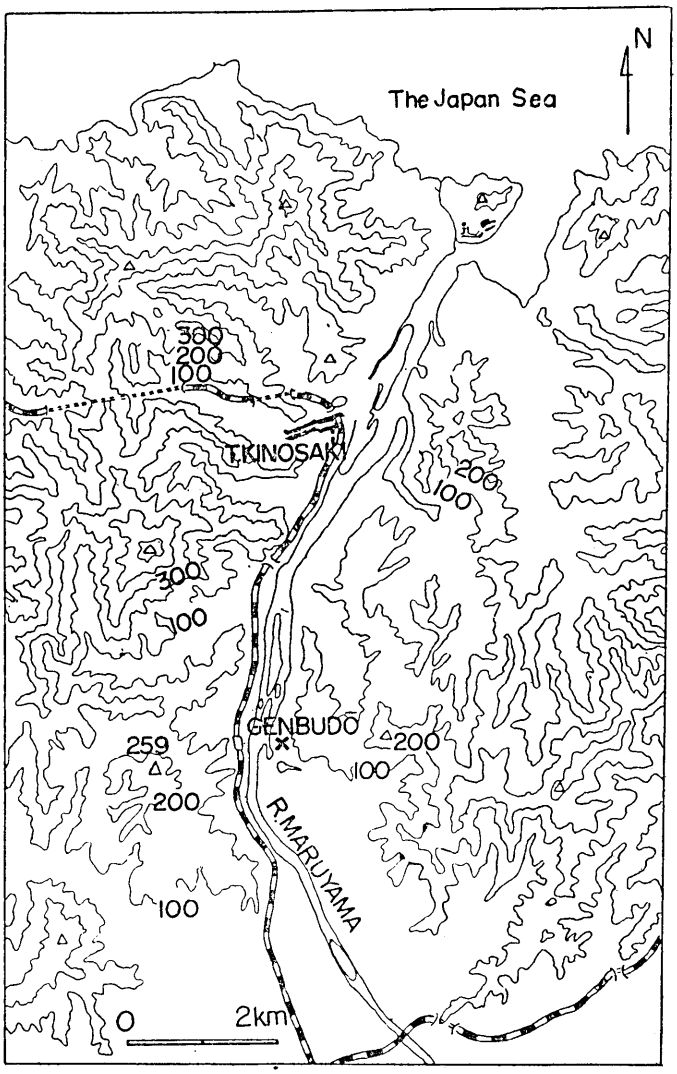


Fig. 1. Topographical map in the vicinity of Gembudō.

negative anomaly in the southern part of this region whose centre is the triangular point of which altitude is 259 *meters*.

Oriented rock samples were taken from 12 sites which are shown in Fig. 2. The columnar joints are found at the olivine basalt region in the figure. All samples were cut from these jointed basaltic rocks except samples No. 01 and No. 12 which are both augite-hypersthene

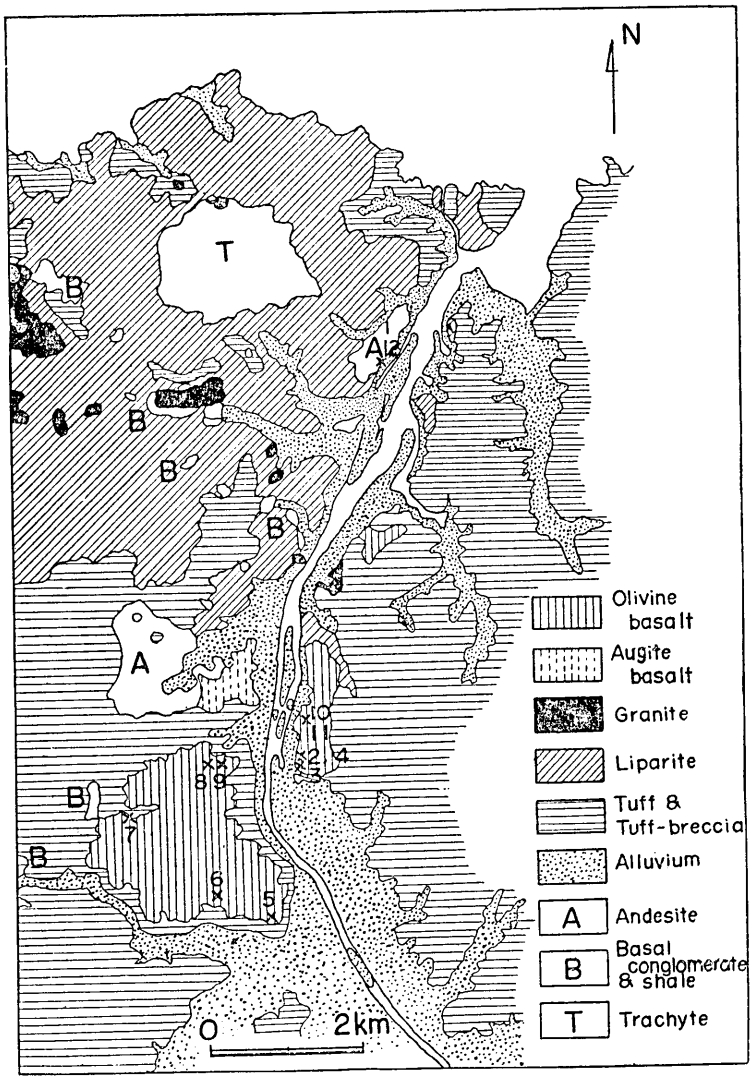


Fig. 2. Geological sketch map in the vicinity of Gembudō.
(After the Geological Institute of Kyoto University)

andesite. These rocks do not seem to be suffered from any displacements since their consolidation. The natural remanent magnetization (N.R.M.) of the samples were measured by an astatic magnetometer. The results are shown in Table II and the directions of magnetization are represented as the points in the lower hemisphere of the Schmidt's equal-area projection in Fig. 8 together with those obtained by M. Matuyama

Table I.
The observed values of magnetic dip.

Time (1953)	Locality	Approximate Altitude	Dip
Nov. 2 12^h47^m	No. 1 結村の奥	15 *meters*	49°20′
13 15	2 玄武洞の上	140	36
13 39	3 〃	160	21
14 14	4 〃	150	41
17 23	5 吊橋西口	3	19
19 33	6 城崎町小島橋	2	27
19 55	7 城崎町北方の川岸	2	31
20 15	8 〃	2	38
20 48	9 今津渡しの西岸	2	22
Nov. 3 09 08	10 滝部落	10	15
09 59	11 不動の滝の上	90	13
10 37	12 伊賀谷道の高原中央	160	23
12 14	13 伊賀谷部落	90	15
13 27	14 259 米三角点	259	48 52
15 06	15 玄武洞渡しの西岸	5	49 13
15 49	16 玄武洞前	10	25
17 04	17 結村東岸	5	29
17 25	18 結村入口	5	27
17 47	19 戸島部落	5	23
18 03	20 楽々浦	5	20
Nov. 4 06 45	21 城崎町新田橋	3	00
07 04	22 城崎町北方	3	17
09 28	23 城崎小学校	4	32
09 54	24 来日部落	5	07
11 03	25 上山部落入口	5	32
11 21	26 上山部落奥	20	12
12 15	27 赤石附近	5	18

and the Geophysical Institute of Tokyo University. Samples No. 01 and No. 12 from the northern district of Kinosaki Town are rather normal as can be seen in Fig. 8, while the other samples from the outcrops of the basaltic rocks are almost reverse to the present geomagnetic field except sample No. 06.

Taking into consideration the fact that the basalt in this district has reverse N.R.M. in general, the said negative anomaly of dip-angle seems to be caused by this anomalous magnetization. If this view-point is taken, it is likely that the basaltic rocks welled up near the 259

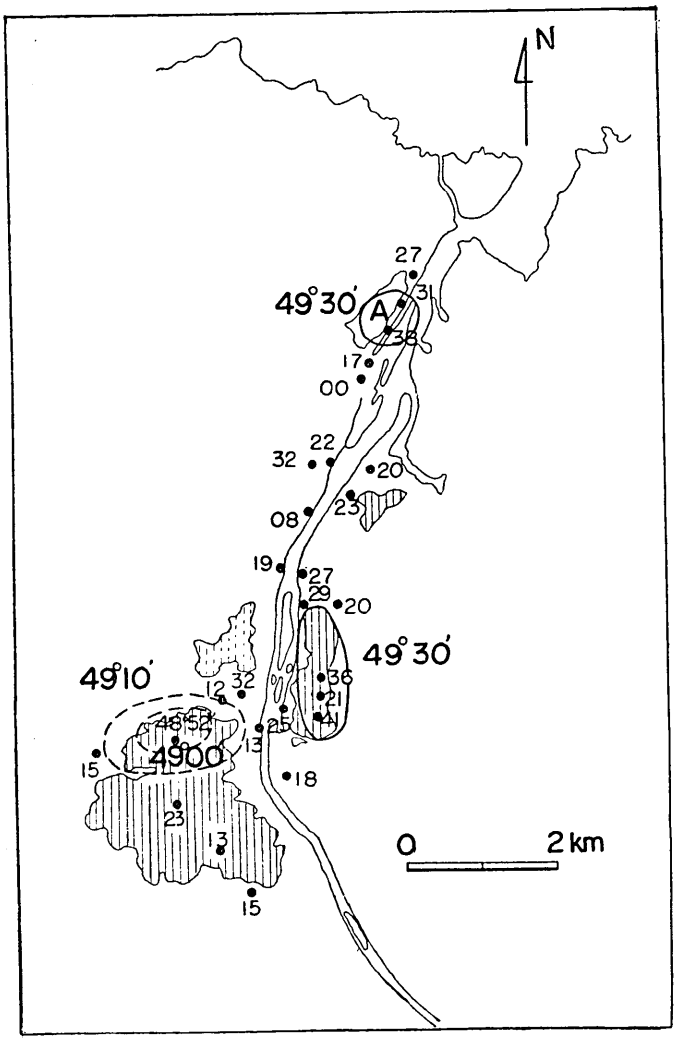


Fig. 3. Distribution of magnetic dip-angle.

meter-triangular point and flowed down to the lower regions.

The results of the experiments on the magnetic properties of the rock samples made by the Geophysical Institute of Tokyo University are shown in Figs. 9 and 10[3]. It is made clear that the reverse N.R.M. is not due to the self-reversal of thermo-remanent magnetization because

3) T. NAGATA, S. AKIMOTO, S. UYEDA, K. MOMOSE and E. ASAMI, *Tech. Comm. Palaeomagnetism*, Xth Assembly, ATME, Rome (1954), 29.

Table II.

Natural remanent magnetization of rock-samples.

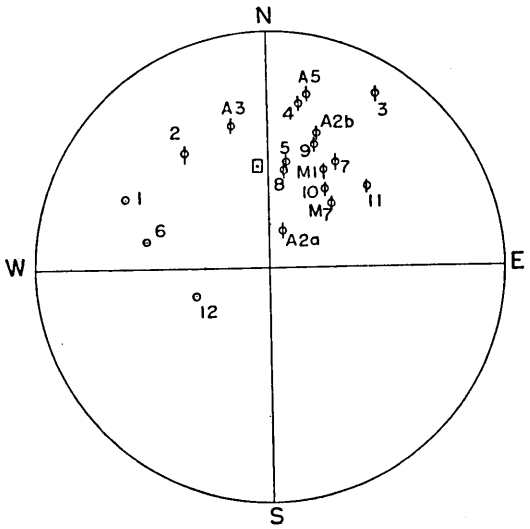
Sample No.	Locality	Decli.	Dip	Intensity in 10^{-4} *emu/g*	Rock
IY 53110201	城崎町北方	N63.5W	27.3 down	7	Augite-hypersthene andesite
02	玄武洞	S36.4E	36.4 up	10	Olivine basalt
03	青竜洞	S33.0W	11.3 up	10	〃
04	玄武洞	S11.1W	24.4 up	19	〃
05	森 津	S09.6W	45.9 up	24	〃
06	不動滝	N76.9W	40.1 down	8	〃
07	伊賀谷道	S29.4W	40.8 up	4	〃
08	上山道	S09.2W	50.1 up	6	〃
09	〃	S20.6W	36.8 up	14	〃
10	玄武洞北方	S36.0W	55.0 up	17	〃
11	〃	S50.4W	37.2 up	10	〃
12	城崎町北方	S70.9W	60.6 down	1	Augite-hypersthene andesite
SA 5207282a	玄武洞入口	S19.9W	75.0 up	7	Olivine basalt
2b	〃	S20.0W	34.9 up	14	〃
03	玄武洞奥	S14.7E	34.1 up	9	〃
05	青竜洞中央	S12.7W	42.0 up	12	〃
M1	玄武洞	S30 W	49 up	16	〃
M7	〃	S44 W	57 up	57	〃

the changes of saturated T.R.M. (J_{Tc}) with temperature are normal as shown in Fig. 9[4]. Though the rocks seem to have received no geological changes, their N.R.M.s are not always due to the T.R.M. since there is no similarity between the decay modes of N.R.M. (J_n) and saturated T.R.M. (J_{Tc}) and the ratioes J_n to J_{Tc} are rather small. Moreover, Curie point of rock-forming ferromagnetic mineral is very low as shown in Fig. 10. That is to say, the rock from Gembudō does not seem to be a very reliable tool for palaeomagnetism at the present stage.

3. Conclusion.

The relation between reverse natural remanent magnetization of the rocks from Gembudō and geomagnetic anomaly in the vicinity of the place was studied. The writer could roughly determine the negative anomaly area which is closely related to the reverse N.R.M. though the

4) T. NAGATA, S. UYEDA and S. AKIMOTO, *Journ. Geomag. Geoel.*, **4** (1952), 22.

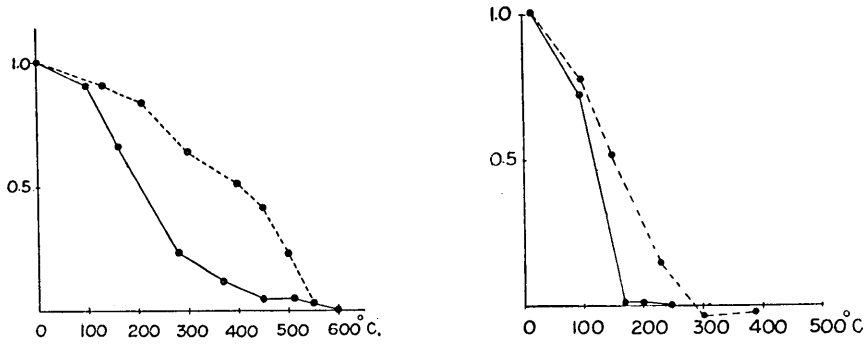


⊙ : North-seeking magnetization

ϕ : South-seeking magnetization

⊡ : Earth's present field

Fig. 8. Equal-area plot of magnetization of rock samples.

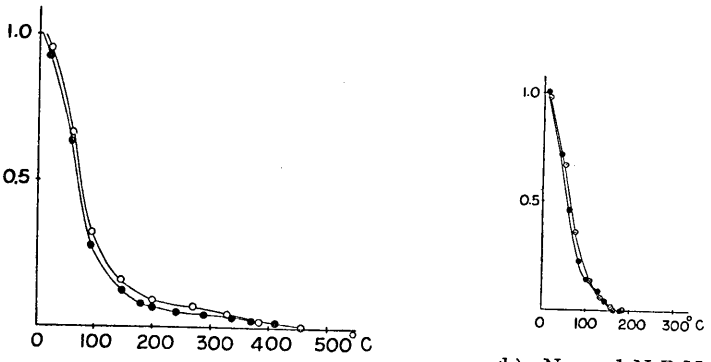


(a) Reverse N.R.M. (b) Normal N.R.M. (IY53110206)

Fig. 9. Changes of N.R.M. (J_n) and saturated T.R.M. (J_{Tc}) with temperature.
——— N.R.M. decay mode ····· T.R.M. decay mode

	J_n *emu/g*	J_{Tc} *emu/g*	J_n/J_{Tc}
a)	1.41×10^{-3}	2.76×10^{-3}	0.51
b)	1.74×10^{-3}	8.58×10^{-3}	0.20

(After the Geophysical Institute of Tokyo University)



(a) Reverse N.R.M. (b) Normal N.R.M. (IY53110206)

Fig. 10. Changes of saturation magnetization (J_s) with temperature of rock-forming ferromagnetic mineral.

o : Cooling • : Heating

(After the Geophysical Institute of Tokyo University)

origin of the reverse magnetization is still not clear. From the viewpoint of palaeomagnetism, the rocks from Gembudō do not seem to be useful because their N.R.M.s are not always due to the normal thermoremanent magnetization.

In concluding, the writer wishes to express his hearty thanks to Dr. T. Rikitake, Prof. T. Nagata, Mr. S. Akimoto and Mr. S. Uyeda for their helpful advices and criticisms. The writer's sincere thanks are also due to Mr. N. Kawai of Kyoto University and Messrs. J. Ossaka and H. Mukaiyama of Tokyo University for their geological informations on Gembudō.

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21. 玄武洞周辺の磁気異常とその玄武岩の帯磁

地震研究所 横山 泉

玄武洞はその柱状節理で有名であると同時に，その玄武岩の逆帯磁において顕著である．この逆帯磁に関連する磁気異常を求めるため，1953年11月，小型地磁気感応儀を用いて，玄武洞周辺の伏角測量を行った．同時に岩石試料12ケを採り，その自然残留磁気を測定した．

理学部地球物理学教室永田研究室における岩石磁気学的研究の成果を参考にすると，玄武洞の玄武岩は古地磁気学的には，必ずしも信頼し得る資料とはいえない．現在の段階においては，その逆帯磁は未解明に属するようである．

Fig. 4. The scene of Gembudō.

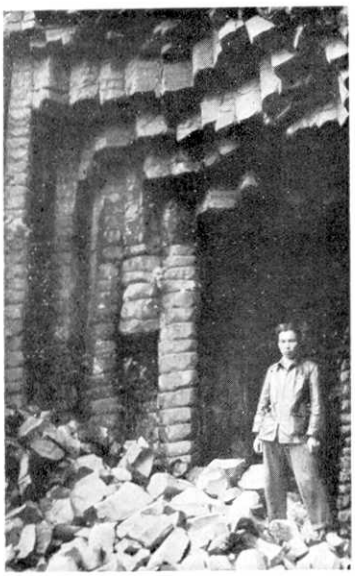

Fig. 5. The place where the rock samples No. 02 and No. 04 were taken. (Gembudō)

Fig. 6. The place where the rock sample No. 07 was taken. (Igaya)

Fig. 7. The place where the rock sample No. 09 was taken. (Kamiyama)