PALAEOMAGNETIC STUDIES ON SOME MESOZOIC ROCKS IN JAPAN

Part 1. OSHIMA, KITAKAMI District NE. Japan

by

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(with 5 Text-Figures)

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Introduction

Until present, from a view point of palaeomagnetism, very few investigations have been made on the Japanese rocks. Accordingly the author intended to take up this problem since some time ago, as a part of project for palaeomagnetic study of the Japanese igneous rocks being scheduled by Prof. MINATO. Suitable rocks for this project were already sampled from various localities, and measurement for them is mostly finished, except for certain specimens for which laboratory work is now still going on.

In the present paper, the result of palaeomagnetic study on the Neocomian rocks, sampled from the small island Oshima, south Kitakami mountains, NE. Honshu, Japan will be briefly given. Further, informations of various rocks of different stratigraphical horizons will be outlined in a series of later papers. This is the first note of them. Situation of palaeomagnetic pole and palaeo-latitude determined by the present study seem to well coincide with the result already reported by NAGATA et al. (1961), in which they described the palaeomagnetic properties of some Jurassic and Neocomian rocks, also developed in the Kitakami mountains.

The present author came, however, to hold a different view from NAGATA et al. regarding the period of change in polarity of geomagnetic pole during the Jurassic -Cretaceous time, for which he wishes to briefly stated in this note.

Short geological account on the island Oshima

Small island Oshima is situated immediately southeast of Kesennuma city,

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Miyagi prefecture, facing the Pacific. There, the Lower Cretaceous covers unconformably the Jurassic, although both formations apparently show similar synclinal structure. The synclinal axis called Amikisaka synclinal axis (SHIIDA 1940), across somewhat central part of this island. Further, Tertiary deposits, called Sanganda formation, mainly consisting of gravels, covers the various older formations developed in this island.

Of them, the Jurassic deposits are mainly composed of white arkose sandstones and dark blue shales in thin alternation, with marine fossils and poorly preserved plant remains.

The Cretaceous deposits, now in problem, may be divided into two formations. The lower formation has been named the Kanaigaura formation, and is composed mostly of volcanic rocks, while the upper is Oshima formation in which sedimentary rocks occupy the main part. The samples for this study were collected from the Kanaigaura formation. The age of this formation is generally believed to be the Lower Neocomian. Because, the Kanaigaura formation covers the upper Jurassic Kogoshio and Mohne formation, as above stated, and is covered by the Oshima formation of which the age, so far as the fossil evidence is concerned, is believed to be the Hauterivian to Barremian. (YABE and SHIMIZU, 1925)

Sampling and measured rocks

More than 100 oriented specimens were collected from 4 localities in all; the sampling localities and their stratigraphical positions are shown in the index map and table (fig. 1). The writer thinks, they would be better divided into 4 groups, based on the lithologic nature besides the difference in localties and their stratigraphical horizons.

0–1 group of the specimens here disgnated, were collected from the lava flow of olivine basalt, locally intercalated by thin reddish basaltic tuffs 20–30 cm in thickness. The stratigraphical horizon of this flow seems to represent the middle part of the Kanaigaura formation. The presence of the tuffs is good aid in tilt correction of measured direction of magnetization.

0–2 group of the specimens were collected from pyroxene andesite, typically cropped out not far from a small village called Uranohama, and which is observed to intrude both the Kanaigaura and Ohsima formations. The age of intrusion of this rock is accordingly not certain, although it might be eventually post Neocomian and pre-Tertiary.

0–3 group of the specimens, here provisionally named, were sampled from the basaltic tuff cropping out widely near the cape Matsunosaki, the stratigraphical horizon of which is lower part of the Kanaigaura formation.

0–4 group of the specimens were collected from the same basaltic tuff with the preceding group in lighology, but the sampling locality is different. Further,

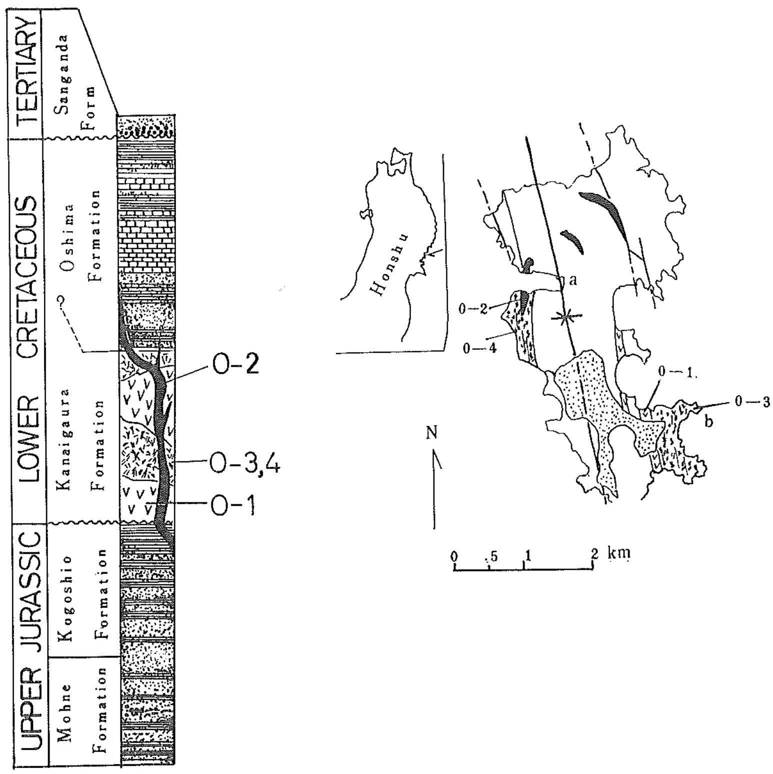

Fig. 1
Stratigraphical positions and localities of the sampled rocks. 0–1 (lavaflow of olivine basalt), 0–2 (pyroxine andesite dyke), 0–3,4 (basaltic tuff), a-Uranohama, b-Matsunosaki

this group can be stratigraphically a little higher than the preceding.

Result of measurement on N.R.M.

The measurement was carried on at the palaeomagnetic laboratory, Department of Geology and Mineralogy, Hokkaido University, by means of an astatic magnetometer. The direction of magnetization for each specimen is plotted on WULF's net. As shown in fig. 2 and table 1, it may be noted that the inclination of 0–1 and 0–3 groups are extremly low and negative. On the contrary, 0–2 specimens whose age may be eventually a little younger than the other groups, show rather gentle inclination and indicate to be positive. Further, the inclination of 0–4 group indicates negative. Both 0–3 and 0–4 groups are apparently similar in lithologic nature, but their stratigraphical positions may be slightly different, as already stated.

The change of polarity of the geomagnetic field may have accordingly occurred during the Lower Neocomian.

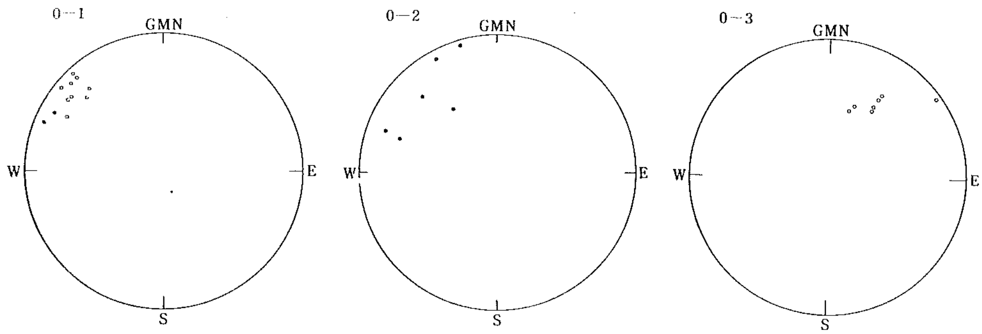

Fig. 2
Direction of magnetization of the specimens collected from 0–1, 0–2 and 0–3 site. white circle; upper hemisphere, solid circle; lower hemisphere

Table 1. The direction and intensity of N.R.M. of sampled rocks.

Sampling group	Declination	Inclination	α_{95}	Intensity ($\times 10^{-4}$ e.m.u./gr.)	Jn/J_{Tc}
0-1	N 51 W	−3	6	6.2-11	0.7
0-2	N 44 W	12	22	14-26	0.4
0-3	N 34 E	−23	11	6-8.3	1.0
0-4	N 2 E	−41	18	1.6-6.1	0.6

Result of the Stability Test of the Rock Magnetism

The stability of the natural remnant magnetization was tested after measurement for the representative rock specimens for each group.

The test of thermo-demagnetizations of the N.R.M. (Jn-T) and of the T.R.M. (J_{TC}-T), A.C.-demagnetizations of N.R.M. and T.R.M., and X-ray analyses were applied. As a result, the ratio of N.R.M. and T.R.M. distributed between 0.4 and 1.0, a mean value being 0.7. The Curie point of ferromagnetic minerals ranges from 500°C to 580°C; this suggests that these ferromagnetic minerals of the sampled rocks are almost pure magnetite or titano-magnetite which contains few Ti. As shown in fig. 3, 4 and 5, each demagnetizing curve of N.R.M. is fairly coincident with that of T.R.M. Therefore, the N.R.M. of each sampling group can be concluded to be almost stable.

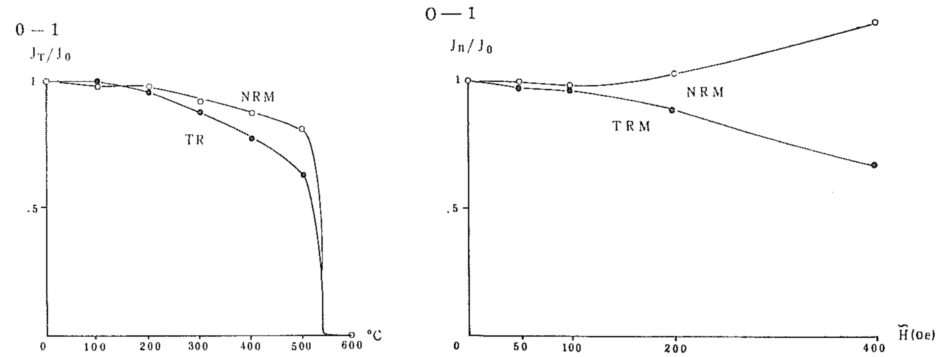

Fig. 3
Value of relative intensity of N.R.N. and T.R.M. of 0–1 group after thermo-demagnetization and AC- demagnetization.

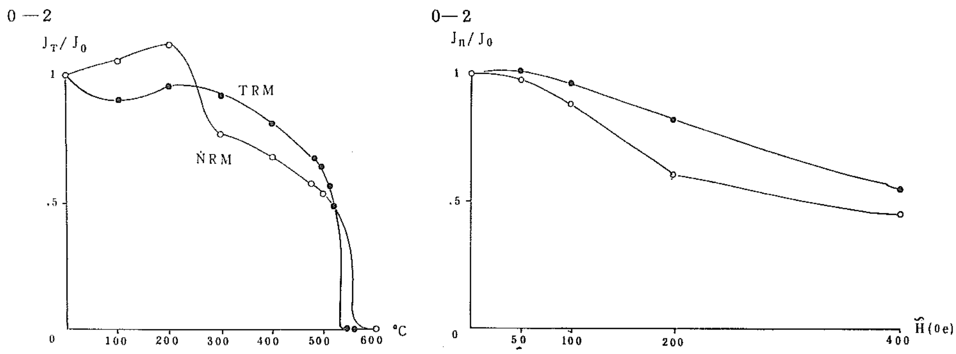

Fig. 4
Value of relative intensity of N.R.M. and T.R.M. of 0–2 group after thermo- demagnetization and AC- demagnetization.

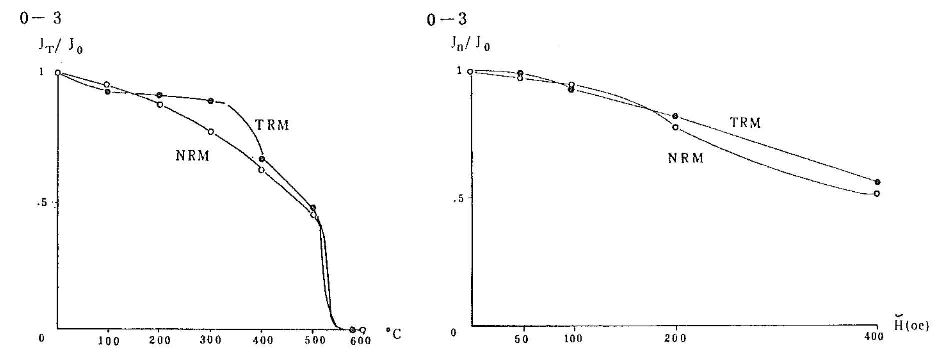

Fig. 5
Value of relative intensity of N.R.M. and T.R.M. of 0–3 group after thermo-demagnetization and AC- demagnetization.

Table 2. Palaeomagnetic pole positions and palaeo latitudes determined by the rocks in the Oshima, Kitakami district.

Sampling group	Pole postion	Palaeo latitude	δ_p	δ_m
0–1	29 S 155 W	2 S	3	6
0–2	36 N 101 W	6 N	11	22
0–3	30 S 101 E	12 S	5	11
0–4	28 S 140 W	23 S	13	22

Conclusions

The result of calculation for the virtual geomagnetic pole positions based on the measurement will be shown in table 2.

The virtual pole positions of the Lower Neocomian determined by the present study are quite different from the result reported by SASAJIMA et al. (1965), in which Aptian or Albian rock specimens collected from certain localities in SW Japan were treated. Compared to the result obtained by UENO* in respect to the Neocomian pole positions based on certain plutonics in NE Japan, the result of the present author is also remarkably different. The Lower Neocomian pole measured by the present author is located at 28°–30°S, 100°–155°W, while the poles determined by UENO was concluded to locate at 38°–63°N, 45°–47°E. This cannot be easily explained at all.

Yet, the different pole positions determined by the rocks between the Lower Neocomian NE Japan and the Aptian-Albian in SW Japan may be possibly explained by either the assumption that the polar wandering certainly occurred during the Neocomian to the Aptian, or that the crustal deformation was possibly occurred in the Japanese islands in the Late Mesozoic or in early Tertiary, as was once concluded by KAWAI et al. (1961). It may be not necessary to state that, in both cases, geocentric axial dipole field is also assumed.

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References

KAWAI, N., H. ITO and S. KUME (1961): Deformation of the Japanese Islands as inferred from Rock Magnetism. Geophys. Jour. Roy. Astro. Soc. vol. 6, no. 1, pp. 124–130

NAGATA, T., S. AKIMOTO, Y. SHIMIZU, K. KOBAYASHI, Y. SYONO and H. KUNO (1961): Palaeomagnetic Studies on Cretaceous and Jurassic rocks in Kitakami district. (abstract) Jour. Geomag. Geoelect. vol. 12, p. 168

OUKI, Y. (1956): Geology of the Kitakami Mountains. Explanatory Text of the Geological map of Iwate prefecture. (in Japanese)

SASAJIMA, S. and M. SHIMADA (1965): Palaeomagnetic Studies of the SW. Japan. Part 2 (abstract) Abstract of the paper read at the general meeting, 1965

SHIIDA, I. (1940): On the Geology in the environs of the Kesennuma, Miyagi prefecture. Jour. Geol. Palaeont. Tohoku Univ. vol. 33, pp. 1–72

YABE, H. and S. SHIMIZU (1925): A new Cretaceous Ammonite, *Crioceras ishiwarai* from Oshima, Province of Rikuzen. Japan. Jour. Geol. and Geogr. No. 3–4, pp. 85–97

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