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MEMOIRS OF THE COLLEGE OF SCIENCE, UNIVERSITY OF KYOTO, SERIES B,
Vol. XXVI, No. 2 Geology and Mineralogy, Article 10, 1959

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(Received Oct. 19, 1959)

Abstract

On the basis of a combined effect of the piezo and the chemical remanent magnetism, an explanation is given to account for the acquisition of the remanent magnetism of crystalline schists whose directions are found to be parallel to their schistosity plane.

Study in the magnetism of dynamo-metamorphic rocks in Japan has been carried out by the present author since 1955. More than 100 rock samples of crystalline schists were collected from the so-called Sambagawa metamorphic zone which is one of the members composing the Median Line. Measurements of remanent magnetism of these samples were done and the following facts have been found:

Of these samples more than 90 pieces are found to have no remanent magnetism and only 16 pieces are observed to possess remarkable remanent magnetism. And the ferromagnetic minerals in 8 of these 16 samples have been found to have composition of nearly pure magnetite and the remaining 8 nearly pure hematite. In either of those two cases the directions of magnetism are found to be *always lying* in the plane of schistosity (Fig. 1).

The temperature at which the recrystallization to form schists and at the same time ferrites has taken place is generally accepted by petrologists to have been not greater than 400°C. On the other hand, the Curie point of magnetite is 575°C and that of hematite 670°C, and therefore these observed remanent magnetism must have been acquired at temperatures lower than these Curie points. Hence, it is reasonable to assume that the remanent magnetism of the crystalline schists under consideration is not thermoremanent magnetism and is a kind of chemical remanent one that has been proposed by G. HAIGH[1] of London University and also by T. NAGATA and K. KOBAYASHI[2),3] of Tokyo University.

Next, N. KAWAI[4] and H. DOMEN[5] have recently found that magnetite and hematite both having positive magneto-striction can acquire remanent magnetism whose direction coincides with the direction of a line of intersection of a plane perpendicular to one-directed pressure applied to the specimen and the plane of

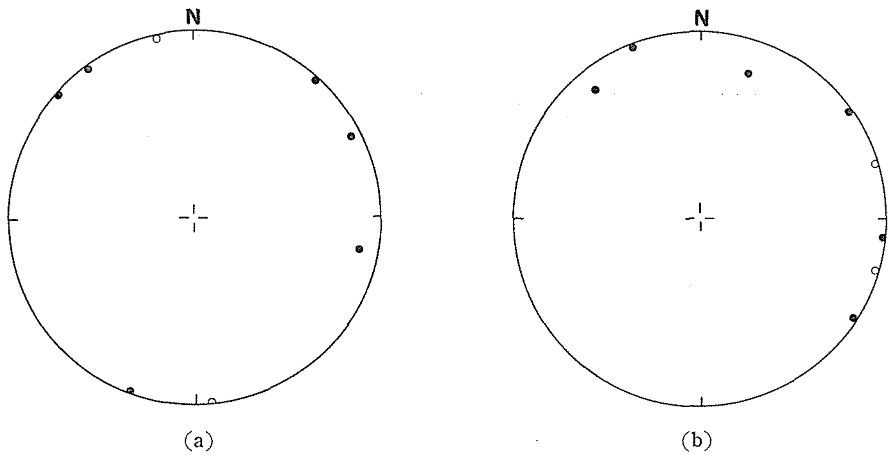

Fig. 1. Direction of magnetization of crystalline schists with (a) "magnetite" and (b) "hematite". The equatorial plane of this Schmidt's projection is the plane of schistosity. Hollow circles represent positive magnetic poles appearing on upper hemisphere. Full circles represent positive magnetic poles appearing on lower hemisphere.

geomagnetic meridian. Thus, only the component of the geomagnetism parallel to the former plane can be fossilized. This kind of magnetization was called by them piezo-remanent magnetism.

On the other hand, N. KAWAI *et al.*[6] have recently examined the effect of one-directed pressure upon acquisition of magnetism during dehydration by heating of clay sediments or hydroxides such as goethite (αFeO(OH)). The results show that the dehydrated material (α hematite)* possesses the magnetism whose direction is also parallel to the component of the applied field which is parallel to the plane perpendicular to the pressure.

It is a well known fact among the petrologist that the crystalline schists have developed their schistosity under one-directed pressure which acted during the recrystallization. Hence, it is likely that the origin of magnetism of schists is the combined effect of the piezo-remanent magnetism and the chemical one, and that the direction of magnetization coincides with that of the component of geomagnetic field in the schistosity plane.

Finally, the positive magnetic poles of the 8 magnetite-bearing specimens and those of the 8 hematite-bearing specimens are found to distribute along the equator of which the plane is taken to be the schistosity plane, as shown in Fig. 1. This peculiar distribution becomes reasonable when we consider that those specimens were taken from several different localities in which relative rotational movements

* $2\alpha FeO(OH) = \alpha Fe_2O_3 + H_2O$

of the schistosity plane might have taken place after the original magnetization which had been produced by the recrystallization.

The palaeomagnetism is indeed an important and interesting problem of the present earth science. But, it is not a easy work to infer the direction of the geomagnetic field in the geological past from data of metamorphic rocks. And especially the magnetism of dynamo-metamorphic rocks like crystalline schists can hardly be utilized in favour of the palaeomagnetism, because not only the component of geomagnetic field perpendicular to the schistosity plane could not be fossilized at the time of magnetization, i.e. at the time of recrystallization, but also the relative rotational movements of the schistosity plane might have taken place after recrystallization.

Acknowledgements

The present author wishes to express his gratitude to Professor N. KUMAGAI under whose supervision this work has been done, and to Lecturer N. KAWAI under whose general direction it has been carried out, for their continued help and interest. Author's acknowledgement is also to the Grant in Aid for Fundamental Scientific Research of the Ministry of Education.

References

1) G. HAIGH: Phil. Mag. **3**, 267, (1958).
2) T. NAGATA and K. KOBAYASHI: Proc. Japan Acad., **34**, 269, (1958).
3) K. KOBAYASHI: Jour. Geomag. Geoele., 10, 99, (1959).
4) N. KAWAI: Jour. Geomag. Geoele., **9**, 140, (1957).
5) H. DOMEN: Bull. Fac. Education, Yamaguchi Univ., **7**, 41, (1958).
6) N. KAWAI, H. ITO, K. YASKAWA and S. KUME: Memo. Coll. Sci., Univ. Kyoto, Series B, **26**, 235, (1959).