# 相転移残留磁化の基本的性質に関する研究

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# Basic properties of the transformation remanent magnetization (TrRM)

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Recent explorations of Mars and Moon have observed many magnetic anomalies which probably recorded ancient magnetic fields. Many authors have pointed out a correlation between magnetic anomaly patterns and geological features, especially impact craters. For example, the lunar magnetic anomalies seem to be located at antipode of the lunar basins. They might be caused by basin-forming impacts to have resulted in acquisition of shock remanent magnetization (SRM) under some ambient field. In contrast, several basins are likely to be absent from crustal magnetization, suggesting demagnetization of the crust due to the impact under nearly zero field, that is to say, zero SRM (Acuna et al., 1999). In this case, there would be no core dynamo field at its formation.

Although impact-origin magnetic signatures can give key information of the planetary dynamo evolution, details of SRM acquisition have not been revealed yet. One of the plausible mechanisms of SRM is transformation remanent magnetization (TrRM). However, there have been only a few systematic studies of TrRM concerning the planetary magnetism (Ozima et al., 1963; Dickinson and Wasilewski, 2000; Dunlop 2007). Thus we have conducted experiments of TrRM to know its basic properties.

There are many kinds of magnetic minerals contained in the crust of the terrestrial planets: magnetite, hematite, kamacite and so on. In the present study we focus on the transition of magnetite and hematite, Verwey transition ($T_V$ = 120 K) and Morin transition ($T_{Morin}$ = 260 K), respectively. The Verwey transition is considered as the first order transformation from cubic to monoclinic phase while the crystallographic easy axis of hematite changes at $T_{Morin}$.

In the experiment, natural samples were cooled down to 77 K or 10 K and warmed back to room temperature in a weak DC field or zero filed. There are three types of transformation remanences: (1) transformation remanent magnetization (TrRM) by cooling and warming in a constant DC field, (2) transformation warming remanent magnetization (TrWRM) by cooling in zero field and warming in a DC field, and (3) transformation cooling remanent magnetization (TrCRM) by cooling in a DC field and warming in zero field. We measured all types of transformation remanences and checked the basic rules of the rock magnetism.

Major remarks concluded and suggested in the present study so far are:

(1) Drastic changes in magnetization intensity were observed at the temperature of Verwey transition, and it is confirmed that transformation remanences were acquired at $T_V$.

(2) The observed directions of TrRM, TrWRM, and TrCRM of magnetite are parallel to the ambient field. Thus the parallelism to the ambient field is satisfied with the transformation remanences.

(3) The observed intensities of TrRM, TrWRM, and TrCRM of magnetite are proportional to the ambient field intensity. Thus the proportionality to the ambient field is satisfied with the transformation remanences.

(4) The observed intensities and coercivity spectra of TrRM of magnetite are almost the same as the anhysteretic remanent magnetization (ARM) of the MD grains. This suggests that acquisition mechanism of TrRM is analogous to that of ARM. This may be caused by that domain structures are completely reset in both acquisitions of TrRM and ARM.

Our results imply that the magnetic anomaly originated from the transformation remanences could record the ancient magnetic field of the terrestrial planets similarly to thermoremanent magnetization (TRM) of igneous rocks.