Rock-magnetic study of the oblique anhysteretic remanent magnetization

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Anhysteretic remanent magnetization (ARM) has been widely used in the rock magnetism, the paleomagnetism and the environmental magnetism, since it is one of the most basic remanences of rocks. ARM is a magnetization acquired in a strong and decreasing alternating field (AF) biased by a weak and steady field (SF) parallel to the AF. As a result, ARM is oriented in the SF direction. If SF is applied in a direction oblique to the AF, the sample acquires oblique ARM (OARM). Thus the ordinary ARM is only a specific OARM and is sometimes called parallel ARM. Since ARM is a powerful tool for the study of the magnetism, OARM is expected to be more useful. However, there have been only a few studies of OARM. The previous studies reported that OARM shows shallower angles than the applied SF direction and variable intensities with respect to samples. This suggests that OARM potentially gives more information about magnetic properties of the sample. Therefore, we have conducted systematic study of OARM with special reference to the basic rules of magnetizations, proportionality and parallelism to the ambient field.

Using 11 igneous rock samples with different rock magnetic properties, we measured OARMs for the bulk and two components separated by the low temperature demagnetization (LTD) method. Our results indicate that OARMs have almost the same intensity as parallel ARM while perpendicular ARMs (OARM of 90 degree) have harder coercivity spectra than parallel ARMs. OARMs basically satisfy the proportionality and parallelism to the ambient field regardless of rock types and LTD properties. However the parallelism does not persist for individual coercivity fractions applying AF demagnetization of the bulk OARM. The failure of the parallelism is strongly dependent on the sample. This suggests that coercivitiy spectra of OARM can give more information about magnetic properties such as grain size and shape of magnetic minerals.

In addition, we propose the composition rule of OARM in which OARM induced in an arbitrary steady field can be decomposed to parallel and perpendicular ARMs as orthogonal components. According to this rule, the failure of the parallelism for individual coercivitiy fractions is caused by difference of gains between parallel and perpendicular ARMs. It is remarked that OARM measurement yields both of parallel and perpendicular ARMs for samples simultaneously. Thus OARM is regarded as a more powerful tool for the rock magnetic and paleomagnetic studies than parallel ARM. The relationship between the composition rule and the coercivity distribution will be discussed.