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A preliminary study on the geomagnetic paleointensity experiments using single zircon crystal

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Geomagnetic paleointensity data provides critical information such as thermal evolution of the Earth [1]. Also a state of geomagnetic field closely relates to a surface environment [2]. It is pivotal to know the variation of geomagnetic field intensity throughout the history of the Earth.

Paleointensity have been intensively recovered from whole rock samples for several decades [3]. Recently, high-sensitivity superconducting quantum interference device (SQUID) magnetometer has enabled us to measure natural remanent magnetization (NRM) of single silicate crystal extracted from a rock sample [4], increasing the success rate of the paleomagnetic experiments. However, until now, we have not yet obtained enough data to resolve billion-year-scale geomagnetic field variation, and need to obtain more paleointensity data, especially older than 5 Ma [3].

In the present study, we focus on a single zircon crystal. Since river sand originates in rocks widely distributed in river basin, detrital zircons in the sand have various ages [5]. If the geomagnetic paleointensity can be measured using the single zircon crystal, we will probably obtain paleomagnetic data enough to resolve the long-term geomagnetic field variation.

Zircon crystals used in this study were sampled from sands of Nakagawa River, Tanzawa Mountain. We have conducted a suite of basic rock-magnetic measurement on assemblage of 26 zircon crystals: isothermal remanent magnetization (IRM) acquisition, stepwise alternating field demagnetization (AFD) of saturation IRM (SIRM), and low-temperature cycle using a Magnetic Property Measurement System (MPMS). Magnetic properties of the zircon crystals have been resulted in as follows: (1) the crystals contain nearly pure magnetite (Fe_3O_4), and they are in both single-domain (SD) and multi-domain (MD) states, (2) SIRM intensity is about 1 x 10^{-3} Am^2/kg (1x10^{-3} Am^2/kg x 1 mg = 1 x 10^{-9} Am^2), and (3) SIRM has high-coercivity fraction up to 20 mT.

Existence of the SD magnetite contained in the zircon crystals has the potential to recover the paleomagnetic information. Taking into account the existence of MD magnetite, stepwise-demagnetization after low-temperature demagnetization (LTD) is an efficient approach for paleomagnetic measurement. Now, our plan is to conduct LTD/stepwise-AFD measurement of NRM and IRM for single zircon crystal by using SQUID magnetometer. On the basis of the rock-magnetic studies and the NRM/IRM measurements, we will discuss the feasibility of the paleointensity experiment using single zircon crystal.

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