白亜紀入遠野花崗岩から分離したジルコン単結晶の岩石磁気学測定

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Rock-magnetic properties of single zircon crystals separated from the middle Cretaceous Iritono granite

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The existence of Earth's magnetic Field over geological time is a key factor for understanding the thermal evolution of the deep Earth, and for the evolution and preservation of a surface environment conductive to life. however, paleointensity data from volcanic rocks older than 500 Ma is too sparse to detect long-term trends in the evolution of the geomagnetic field (e.g. Tauxe and Yamazaki, 2007). As granites have a more continuous recoud over geological time, and perhaps a higher preservation potential, several groups have investigated primary minerals such as feldspar and zircon as possible archives of geomagnetic paleointensity information. Zircons in particular are resistant to most chemical alternation and weathering, and provide firm age constrains on both their crystallization time and thermal metamorphic history. Thus when weathered of otherwise separated from granite they could potentially provide consistent paleointensity data over most of geological time. however, paleomagnetic and rock-magnetic information from single zircon crystals have not yet been compared to existing data from their host-rocks, thus it is not clear whether results from individual zircons of unknown provenance can be treated in the same way as data generated by traditional whole-rock measurements.

In this study, we tried to establish a method to measure the rock-magnetic properties and possible paleointensities of single zircon crystals separated from granitic rocks. We conducted magnetic measurements of zircons from the middle Cretaceous Iritono Granite whose whole-rock analyses are reported (Wakabayashi et al., 2006; Tsunakawa et al., 2009). First, we separated the zircons form the granite sample using non-magnetic methods and tools. Next, the natural remanent magnetization(NRM) of zircons mounted on double-stick tape was measured using a 2G SQUID rock magnetometer at Kochi University. 13 out of 1156 grains (1.1%) showed NRM intensities larger than the detection limit of the magnetometer (~20 pAm^2), although we were not able to exclude variable components of the sample handling system contributing to the remanence. Following this we took the ten most magnetic zircons to a RAPID-system 2G magnetometer in a class-1000 clean laboratory at the California Institute of Technology, where we were able to mount individual zircons on ~50 um-thick, acid-washed quartz-glass fibers by small spots of cyanoacrylic cement, thereby lowering the background noise of the sample handling system to the 1 pAm^2 level after an IRM saturation pulse. Stepwise acquisition of isothermal remanent magnetization(IRM) up to 1 T and stepwise alternating field demagnetization (AFD) of IRM were applied to the zircons. In the AFD experiments, 4 grains was successfully demagnetized, while the remaining 6 grains showed unstable behavior during experiments. NRM/IRM ratios of the successfully demagnetized grains were 0.038, 0.089, 0.21, and 0.68, respectively. The IRM of zircon grains with NRM/IRM ratios of 0.089 and 0.21 systematically decreased near to the origin by AFD treatment of 100 mT. AFD curve of a zircon grain with NRM/IRM ratio of 0.038 suggested presence of high coercivity (>100 mT) component. About 40% of the IRM of other grain remained at even 400 mT. Considering the magnetic components of their host-rock, the candidates of remanence carriers of zircons could be magnetite and pyrrhotite. Therefore, the present results were interpreted as zircon grains with the NRM/IRM ratio of 0.089 and 0.21 contain magnetite, and grains with that of 0.038 and 0.68 contain pyrrhotite (or + magnetite).

We are going to apply the same measurements to further more zircon grains, and perform low-temperature measurements and chemical analysis to reveal the magnetic inclusions which carry the remanent magnetization and their variation among single zircon crystals. We will discuss the comparison of rock-magnetic properties of the whole-rock and single zircon crystals.