Rock-magnetic properties of single crystals separated from granitic rocks: A guide for selecting samples for paleointensity determination

*加藤 千恵[1]、佐藤 雅彦[2]、山本 裕二[3]、綱川 秀夫[1]、Kirschvink Joseph[4,5]
*Chie Kato[1], Masahiko Sato[2], Yuhji Yamamoto[3], Hideo Tsunakawa[1], Joseph Kirschvink[4,5]

1. 東京工業大学地球惑星科学専攻、2. 東京大学地球惑星科学専攻、3. 高知大学海洋コア総合研究センター、4. カリフォルニア工科大学、5. 東京工業大学地球生命研究所
1. Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2. Department of Earth and Planetary Science, University of Tokyo, 3. Center for Advanced Marine Core Research, Kochi University, 4. California Institute of Technology, 5. Earth-Life Science Institute, Tokyo Institute of Technology

Single silicate crystals containing magnetic inclusions have the potential to yield good paleointensity data since they are more resistant to alternation such as weathering and thermochemical alteration during laboratory heating, and tend to have a narrow size distribution of exsolved ferromagnetic minerals (e.g. Tarduno et al., 2007, 2010, 2015; Tarduno and Cottrell, 2006; Usui and Tian, 2017; Sato et al., 2015; Fu et al., 2017). Single crystals could provide successful results even from samples which give unsuccessful results by the conventional whole-rock measurements. Recently, we performed paleointensity experiments by the Tsunakawa-Shaw method (e.g. Tsunakawa and Shaw, 1994; Yamamoto et al., 2003) on single plagioclase crystals separated from the middle Cretaceous Iritono granite. The obtained paleointensity was consistent with the whole-rock value previously reported by Tsunakawa et al. (2009). We have concluded that paleointensity experiments on single crystals separated from granitic rocks could be an effective mean to investigate the long-term evolution of the geomagnetic field.

Here we report the rock-magnetic properties of the same single plagioclase samples used in our paleointensity experiments. An alternating gradient magnetometer and magnetic property measurement systems were used for magnetic hysteresis loop and low-temperature magnetometry measurements. The natural remanent magnetization (NRM), isothermal remanent magnetization (IRM), thermal remanent magnetization (TRM), and anhysteretic remanent magnetization (ARM) were measured using superconducting quantum interference device magnetometer. The results indicated that the magnetic carrier of the plagioclase samples was Ti-poor titanomagnetite in the single domain to pseudo-single domain states. For some samples, ARM and TRM anisotropy were measured. The ARM anisotropy was large compared to that of the whole-rock sample, and the anisotropy degree and directions of the anisotropy axes were similar for ARM and TRM. Large remanence anisotropy of the sample could affect the paleomagnetic records (Veitch et al., 1984; Selkin et al., 2000; Paterson, 2013; Usui et al., 2015). The possibility of cancelling the anisotropy effect on paleointensity by using the anisotropy tensor and averaging a number of samples is discussed.

Additionally, magnetic hysteresis loop and low-temperature magnetometry measurements were performed on plagioclase samples separated from 22 granitic rocks. We found that granites in the magnetite end of the magnetite/ilmenite series that also have relatively low susceptibility have the highest potential for paleointensity determination. We recommend focusing future studies on this subset of intrusive bodies.

