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# 白亜紀入遠野花崗岩から分離した鉱物単結晶の岩石磁気及び古地磁気強度測定

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# Rock-magnetic properties and paleointensity of single silicate crystals separated from the middle Cretaceous Iritono granite

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Understanding the long-term evolution of the geomagnetic field is a key for constraining the thermal evolution of the deep Earth, mantle convection, and the preservation of a surface environment conducive to life. To investigate geomagnetic field behavior through geological time, granites could be good rocks to study because of their nearly continuous record and long cooling times that can average out relatively short-term fluctuations of the geomagnetic field. However, paleomagnetic measurements on whole-rock granitic samples are often disturbed by alterations like weathering and lightning, and the presence of magnetically-viscous multi-domain magnetite.

One of the approaches to avoid weathering disturbances (but not lightning) is to separate single silicate crystals from granitic rocks and conduct paleomagnetic and rock magnetic measurements on them. Recently, several research groups have investigated paleointensities from single crystals of primary minerals such as plagioclase, pyroxene, zircon and quartz for their potential to avoid difficulties that frequently plague whole-rock measurements (e.g. Tarduno et al., 2007, 2010, 2012, 2015; Muxworthy and Evans, 2012). To provide solid ground for single silicate crystal paleomagnetism, paleointensity and rock-magnetic properties of single crystals should be systematically studied and compared to those of the host granitic rock.

We studied zircons, quartzes and plagioclases separated from a Cretaceous granite sample whose whole-rock paleointensity and rock-magnetic properties were studied previously, and found to be particularly stable and reproducible (Iritono granite, 100 Ma, Wakabayashi et al., 2006; Tsunakawa et al., 2009). The reported whole-rock paleointensity was 58.4+-7.3 micro T (2 sigma, before cooling rate correction). We first measured the natural remanent magnetization intensity ($M_{NRM}$) of several hundred samples for each mineral. Rock-magnetic property measurements such as low-temperature magnetometry, stepwise thermal demagnetization and hysteresis loop measurements were performed on the samples which had significant NRM; but we only found these in the plagioclase fraction. We focused our paleointensity studies on plagioclase, which was the only suitable mineral. Measurements were carried out using the superconducting quantum interference device (SQUID) magnetometer, magnetic property measurement system (MPMS) and Alternating Gradient Magnetometer (AGM) at Center for Advanced Marine Core Research, Kochi University.

Less than 1% of the zircon and quartz grains had $M_{NRM}$ >4 pAm$^2$. Among them that did, pyrrhotite was the main magnetic carrier for the zircons, and both magnetite and pyrrhotite was present in the quartz, although the occurrence of magnetite-bearing samples was very low. In conclusion, they do not seem to be candidates for paleointensity measurements in case of the studied rock.

Twenty-three percent of the plagioclases showed MNRM high enough to study (>50 pAm$^2$). Rock-magnetic measurements suggested that the main magnetic carrier is single domain to pseudo-single domain state magnetite inclusions. We performed paleointensity measurements by the Tsunakawa-Shaw method (Yamamoto et al., 2003) to 17 plagioclase crystals. Nine samples passed the selection criteria of the paleointensity method. The obtained mean paleointensity was consistent with the reported whole-rock paleointensity though the standard deviation was relatively large (57.7+-23.3 micro T, 2 sigma). To our knowledge, this is the first report of single crystal paleoinensity study by the Tsunakawa-Shaw method. We conclude that paleointensity measurements were applicable to plagioclase, but to produce results comparable to conventional methods large numbers of crystals that cooled together would need to be studied.