Mineral inclusions and magnetic properties of single zircon crystals from the Tanzawa tonalitic pluton

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Geomagnetic field paleointensity data provide critical information about the evolution of the core and mantle, and the state of the geomagnetic field are closely related to the condition of surface environment (Tarduno et al. 2014, 2015). Although it is essential to understand the variations in geomagnetic field intensity through the Earth history, data are still scarce to a resolve billion year-scale geomagnetic field variation. This is mainly due to the lack of well-preserved rocks for older eras, which often results in unsuccessful paleointensity experiments. To overcome this problem, recent investigates has focused on paleointensity experiments using single silicate crystals, which often accompany magnetic mineral inclusions, such as plagioclase (Tarduno et al. 2006), quartz phenocryst (Tarduno et al. 2010), pyroxene (Muxworthy and Evans 2012), olivine (Tarduno et al. 2012), and zircon (Tarduno et al., 2015, Sato et al., 2015).
Tarduno et al. (2015) demonstrated that paleointensity data of early Archean to Hedean zircons bearing magnetic inclusions from the Jack Hills conglomerate could be used to reconstruct the early geodynamo, and Sato et al. (2015) reported the rock-magnetic properties of the single zircon crystals sampled from the the Tanzawa tonalite (4-5 Ma). Sato et al. (2015) demonstrated that the various rock-magnetic properties such as natural remanent magnetization (NRM), isothermal remanent magnetization (IRM), hysteresis parameters, and transition temperature could be measured using the standard magnetometers (SQUID magnetometer, MPMS, and AGM). During their rock-magnetic measurements, many of single zircon crystals are below the limits of the sensitivity of the magnetometers employed, but for the 80 in 1037 zircons had values of M NRM $\geq 4 \times 10^{-12}$ Am^2 and M IRM $\geq 4 \times 10^{-12}$ Am^2, containing enough magnetic minerals to be measured in the DC SQUID magnetometer. According to the rock magnetic parameters, the main remanence carriers seem to be nearly pure magnetite and pyrrhotite, while direct identification of mineral inclusions in those zircons are not yet acquired.
In this study, we investigate mineral inclusions in Tanzawa zircons reported in Sato et al. (2015), with an optical microscope, Laser-Raman microspectroscopy and scanning electrom microscope equipped with EDS system. It is confirmed that zircon crystals with strong NRM intensity contain titano-magnetite and pyrrhotite. Significantly, titano-magnetite inclusions display fine exsolution lamellae indicating single- or pseudo-single-domain size. In this presentation, we will discuss the relationship between rock-magnetic properties and magnetic mineral inclusions in the Tanzawa zircons.

Keywords: Rock-magnetism, Zircon, inclusion

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