R004-06
D 会場 ： 11/25　PM1（13:45-15:45）
15:15〜15:30:00

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Reconstructing the Noachian Martian dynamo from crustal magnetic anomalies

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Magnetic field observations of Mars revealed that there are strong magnetic anomalies arising from the crustal remanences, which is estimated to be about 10 times as strong as the Earth's crustal magnetization. The strong crustal remanences require a particular origin such as the strong dynamo field of the ancient Mars, the high concentration of ferromagnetic mineral in the Martian crust, and so on. However, the exact mechanism responsible for this phenomenon remains unclear. Plagioclase, one of the common constituents of terrestrial crustal rocks, sometimes contain fine-grained magnetite crystals exsolved from Fe-bearing magmatic plagioclase at subsolidus condition. The natural remanent magnetization carried by exsolved magnetite in plagioclase is a likely candidate for the source of Martian magnetic anomalies: the crustal remanence must persist for over 4 Gyr to account for the observed anomalies, and exsolved magnetite satisfies this condition (Sato et al., 2018). In this study, a suite of experiments (magnetic measurements, synchrotron radiation study, and microscopic observation) and calculations (thermodynamic calculation with the rhyolite-MELTS program) were carried out to estimate the concentrations of exsolved magnetite in the Martian crust. The results indicate that Martian crustal rocks contain high concentrations of exsolved magnetite. Thermoremanent magnetization (TRM) acquisition experiments on plagioclase samples revealed that exsolved magnetite efficiently acquires TRM. These findings suggest that the Martian crust exhibits a high remanence acquisition efficiency. Based on this efficiency and the crustal remanence values derived from magnetic anomaly observations, the paleo-planetary magnetic field intensity on Mars during the Noachian period is estimated to have been 10－ 20 μT. Using dynamo scaling laws (Olson and Christensen, 2006; Christensen et al., 2009), this study estimates both the heat flux at the core－mantle boundary (CMB) and the morphology of the Martian magnetic field during the Noachian. The estimated CMB heat flux of 20－ 30 mW/m^2 is consistent with thermal evolution models based on 3D spherical simulations (Thiriet et al., 2019). This heat flux corresponds to a dynamo state characterized by a non-reversing dipole for both dynamos powered by bottom heating and internal heating (Yan et al. 2023). Based on the inferred state of Mars's magnetic field during the Noachian period, we examine the evolution of the planet's magnetic field and its implications for the history of atmospheric water loss, as inferred from oxygen escape rates.