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Reconstruction of protoplanetary disk magnetic field from chondrule measurements of the Aba Panu meteorite

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The planets of the solar system formed as a result of the dynamical evolution of a protoplanetary disk composed of nebular gas and dust. Therefore, understanding material dynamics within the protoplanetary disk is essential to understanding planet formation. Research on material transport in such disks has primarily been conducted through chemical and isotopic analyses of meteorites, as well as numerical simulations based on those findings. Recent magnetohydrodynamic (MHD) simulations suggest that the primary mechanism driving material transport (accretion) in disks is the interaction between ionized gas and magnetic fields present in the protoplanetary disk. Nevertheless, observational data on magnetic fields in protoplanetary disk remain scarce (Weiss et al., 2021). Several studies have investigated the nebular magnetic field based on the paleomagnetism of chondrules. Fu et al. (2014) and Borlina et al. (2021) reported magnetic fields on the order of tens of μ T, while others argued that reconstruction is not feasible (Gattacceca et al., 2019), or suggested values of only a few μ T (Fu et al., 2020). However, these estimates involve large uncertainties due to limitations in experimental and analytical methods. the nebular magnetic fields were derived from a very small number of chondrules—fewer than ten grains—resulting in significant variations in the reported values and raising concerns about their accuracy and reliability. To address these issues and place new constraints on the accretion rate of the early solar system, we conducted remanent magnetization measurements on the Aba Panu ordinary chondrite, which has undergone minimal aqueous alteration on its parent body and has experienced little terrestrial weathering due to its recent discovery in 2018. The fragment of Aba Panu meteorite was crushed, and then, the chondrules were collected under a stereoscopic microscope. Natural remanent magnetization (NRM) was measured for 216 chondrule grains using a 2G SQUID magnetometer at Tokyo University of Science. 90 out of 216 grains showed NRM intensity larger than the detection limit of the SQUID magnetometer. Stepwise alternating-field demagnetization (AFD) measurements were conducted for 19 chondrule grains with NRM intensity larger than 1 × 10-11 Am2. As the results, the part of grains showed the stable NRM components. This study plan to conduct the paleointensity measurements based on the anhysteretic remanent magnetization, saturation isothermal remanent magnetization, and thermoremanent magnetization. In this presentation, we will report the results of NRM and paleointensity measurements and will discuss the magnetic field and accretion rate conditions of early solar system.