Evaluating the paleomagnetic evidence for early dynamos

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Recent paleomagnetic studies have presented evidence for early magnetic fields on a range of Solar System bodies. Unidirectional magnetization observed in the Allende (CV3.6) and Kaba (CV3.1) chondrites has been interpreted as a record of dynamo activity [1, 2]. If correct, this implies that the accretion of the CV parent body was a protracted process where chondritic material accreted onto earlier-formed, fully differentiated object. Among planet-sized bodies, a recent study of single zircons from the Jack Hills of Australia has suggested that a core dynamo with lower than modern strength existed since 4.2 Ga [3]. If confirmed, this observation would have broad implications for the thermal state of the early Earth.

We will review the available paleomagnetic evidence relevant to the existence of early dynamos on the CV parent body and on the Earth. In parallel, we will describe and assess alternative, non-dynamo interpretations for these observations. Importantly, we will present high-resolution magnetic maps of Kaba acquired using the quantum diamond microscope (QDM), which can quantify the unidirectionality of magnetization in ≤10 μm-thick alteration veins. Because these features post-date impact-driven compaction, a unidirectional magnetization cannot be the result of impact-heating recording impact-generacted magnetic fields and therefore favors other mechanisms such as a dynamo. Second, we will present new measurements of both ferromagnetic mineralogy and natural magnetization in Jack Hills zircons to test the assertion that the geodynamo was present at 4.2 Ga.

[1] Carporzen, L. et al. (2011) *PNAS* 108, 6386. [2] Gattacceca, J. et al. (2016) *EPSL* 455, 166. [3] Tarduno, J.A. et al. (2015) *Science* 349, 521.