The first billion years of the geodynamo

*John Anthony Tarduno[1,2,3], Rory D Cottrell[1], Richard K Bono[1], Eric Thern[4], Hirokuni Oda[3]

1. University of Rochester, Department of Earth & Environmental Sciences, 2. University of Rochester, Department of Physics & Astronomy, 3. Geological Survey of Japan, AIST, 4. Curtin University of Technology, Dept. Imaging and Applied Physics

Paleomagnetic data from single silicate crystals hosting magnetic inclusions, and rocks whose magnetization is dominated by single silicates with magnetic inclusions, provide a consistent picture of a strong geomagnetic field, within 50% of the present day field strength, during Archean to Paleoarchean times (3.45 Ga) without sign of interruption (although large time intervals remain unsampled). Paleomagnetic investigation of Eoarchean to Hadean zircons, bearing magnetic inclusions from the Jack Hills (JH) of Western Australia, suggest the presence of an even older geodynamo, as old as 4.2 Ga. The natural remanent magnetizations of these these zircons are reproducible, when measured with an ultrasensitive small bore SQUID magnetometer and a scanning SQUID microscope. New Li data suggest that Hadean zircons studied by Tarduno et al. (2015) have not been reheated above ~500 ˚C since their formation, supporting prior conclusions based on SHRIMP analyses that these zircons preserve a primary remanence. Novel techniques developed by our group provide evidence for multiple magnetic source regions within these zircons. New paleomagnetic data from an Eoarchean to Hadean-bearing zircon locality of the Southern Cross Terrane of Western Australia, >400 kilometers from the Jack Hills, pass a microconglomerate test, yield preliminary paleointensities of ~4-27 microTesla, and thus further support the presence of a very ancient geodynamo. Here we will review the Archean to Hadean geomagnetic record, our recent tests of its fidelity, and its implications for the early evolution of the core and atmosphere.

Keywords: Geodynamo, Hadean, Zircons, Core, Paleointensity, Magnetic shielding

