Geophysical Research Abstracts
Vol. 13, EGU2011-12662, 2011
EGU General Assembly 2011

Observational constraints on the onset and strength of the early Earth's magnetic field

John A. Tarduno (1), Rory D. Cottrell (2), and Martin J. Van Kranendonk (3)

(1) University of Rochester, Earth and Environmental Sciences, Rochester, New York, United States (john@earth.rochester.edu), (2) University of Rochester, Earth and Environmental Sciences, Rochester, New York, United States (rory@earth.rochester.edu), (3) Geological Survey of Western Australia, East Perth, WA, Australia (Martin.VANKRANENDONK@dmp.wa.gov.au)

Knowledge of the onset of the geodynamo is important because it allows insight into the long-term evolution of the core and atmosphere. Here we use DC SQUID magnetometry and CO2 laser heating techniques to investigate the Paleoarchean-Hadean magnetic record. The oldest field strength value based on a primary magnetization is that derived from analyses of single quartz phenocrysts bearing minute magnetic inclusions from $\sim$3.45 Ga dacites of the Kaapvaal craton (Tarduno et al., Science, 2010). These data suggest a somewhat weaker field than that of today. We test these results by new examinations of granitic rocks that are subvolcanic feeders to the Duffer Formation of the Pilbara craton. These rocks have a SHRIMP Pb-Pb zircon age of 3466 +/- 3 Ma. Preliminary analyses of unoriented single feldspar and quartz grains yield Thellier-Coe paleointensity data that pass experimental reliability criteria. Importantly, unblocking temperatures imply magnetite-like inclusions, unlike the hematite inferred by previous authors to carry secondary magnetizations in whole rock samples. Because the silicate crystals measured are unoriented, we do not as yet have constraints on paleolatitude. However, considering an equatorial paleolatitude, the field values are less than half of the present dipole field intensity; if the granite cooled at mid-latitudes, the field would have been only 25% of the modern value. These magnetic paleofield results are consistent with values from the Kaapvaal craton; together they suggest that the magnetopause was much closer to Earth during Paleoarchean times. The decreased standoff of the solar wind, together with the higher frequency of coronal mass ejections, would have promoted loss of volatiles and water from the atmosphere, whereas the low magnetic field values favor high power models for the geodynamo.