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Constraints on Earth's oldest magnetic field

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The strength of the Earth's early geomagnetic field is of importance for understanding the evolution of the Earth's core, surface environment and atmosphere. Palaeomagnetic and palaeointensity data from rocks formed near the boundary of the Proterozoic and Archaean eons (˜2.5 Ga), show many hallmarks of the more recent geomagnetic field: Reversals are recorded and available palaeointensity values are similar to those from younger rocks. Interestingly, palaeosecular variation data indicate a dipole-dominated morphology, possibly more dipolar than that seen in the 0-5 Ma geomagnetic field (Smirnov and Tarduno, GRL, 2004). This is consistent with some numerical geodynamo simulations with a smaller inner core. Here we discuss efforts to see through the ubiquitous low grade metamorphism that effects Archean rocks to obtain even older records of the magnetic field. Specifically, we use a CO2 laser heating approach and direct-current SQUID magnetometer measurements to obtain palaeodirections and intensities from single silicate crystals that host magnetite inclusions. We have found 3.2 Ga field strengths that are within 50% of the present-day value. This contrasts with some prior assertions that the mid-Archean field was some 10 times weaker than present-day (the prior studies were derived from rocks with secondary thermochemical remanent magnetizations rather than primary thermoremanent magnetizations). We will discuss our efforts to examine even older records potentially preserved in rocks of the Kaapvaal Craton of southern Africa, the hypothesis of a null field at 3.8-3.9 Ga (Ozima et al., 2005) and the implications of these results for core evolution. (References: Smirnov, A.V. and Tarduno, J.A., Secular variation of the Late

Archean-Early Proterozoic geodynamo, GRL, 31, L16607, 2004; Tarduno, J.A. et al., Geomagnetic field strength 3.2 billion years ago recorded by single silicate crystals, Nature, 446, 657-660, 2007; Ozima, M., et al., Terrestrial nitrogen and noble gases in lunar soils, Nature, 436, 655-659, 2005).