Paleomagnetism of late Archean volcanic rocks in the Pilbara craton, Australia: implications for the geomagnetic field intensity

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Knowledge of the Earth's magnetic field during Archean and Proterozoic eras can provide important sources of information for understanding the internal and environmental evolution of the Earth. The long-term variation in field intensity and reversal rate is thought to reflect mode changes in powering the geodynamo. Several recent efforts to reconstruct the magnetic field of the early Earth have reported relatively low to moderate fields accompanied by occasional polarity reversals. The volume of reliable paleomagnetic data, however, is still insufficient to characterize its long-term nature.

We report new results of paleomagnetic, rock magnetic, and paleointensity investigations using two sets of late Archean flood basalts (the Mount Roe and Kylena basalts, ca. 2.8 Ga) and the Black Range dike suite (ca. 2.8 Ga) from the Pilbara craton, Western Australia. Paleodirectional data for these three sets are consistent with those from previous works interpreted as primary based on positive fold tests and a baked contact test (e.g. Strik et al., 2004; Embleton 1978). Characteristic remanences of the Mount Roe basalt in the Marble Bar Basin have obviously different directions from those of the Mount Roe units exposed in other areas in Pilbara, suggesting the presence of the lower unit of the Mount Roe basalt in the Marble Bar Basin which has an older age than 2772 Ma as previously pointed out by Strik (2003). Detailed rock magnetic experiments revealed that the main carriers of ChRM are Ti-free magnetites presumed to be PSD or MD grains for the Mount Roe and Kylena basalts, and in the PSD state for the Black Range dikes.

Thellier type paleointensity experiments for the Mount Roe and Black Range samples yielded mean virtual dipole moment (VDM) estimates which correspond to 30% and 76% of the present day value, respectively, falling into a range comparable to the Phanerozoic dipole fluctuation. The relatively low to moderate nature of the Late Archean geomagnetic field strength does not conflict with paleointensity results from the ca. 2.7 Ga Stillwater Complex (Selkin et al., 2000) and the ca. 2.8 Ga dolerite dike of Greenland (Morimoto et al., 1997).