Hadean to Eoarchean stagnant lid tectonics recorded by the paleomagnetism of zircons

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Because Earth is the only known planet to host both plate tectonics and life it is sometimes concluded that the two phenomena are related. While life is thought to have originated by the Eoarchean (or earlier), the onset of plate tectonics remains unknown, with proposed initiation ages ranging as old as the Hadean. Paleomagnetism can be used to distinguish between mobile and fixed lithospheres, but studies have been impeded by the high-grade metamorphism and deformation that makes most rocks older than Paleoarchean in age unsuitable for analysis. However, select detrital zircons can preserve primary magnetizations, providing an opportunity to conduct direct tests. Here we examine the zircon paleomagnetic history recovered from Western Australia which provides evidence for near constant paleolatitudes between ca 3.9 and ca. 3.4 Ga. We further assess this record with select zircons bearing primary magnetic inclusions from South Africa, which yield magnetizations consistent with this history. The simultaneous recordings of the magnetic field by zircons from two continents with vastly different Phanerozoic geologic histories provide further support for the primary record of the zircon magnetizations, and for a pre-Paleoarchean stagnant lid regime of Earth. These data also indicate that life on Earth originated and was sustained without plate tectonic-driven geochemical cycling.