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The Frequency of Geomagnetic Polarity Reversals in the Carboniferous: Insight into Earth's Deep Interior

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A b s t r a c t

Long-term variations (> 10 Ma) in Earth's magnetic field have been postulated to reflect the influence of mantle forcing, bound to changes in heat flow at the core mantle boundary. One of the best documented records of long-term changes in Earth's magnetic field is the Geomagnetic Polarity timescale (GPTS). Examination of the GPTS demonstrates that the occurrence of polarity reversals is stochastic, however there is evidence that the frequency of magnetic field reversals varies in a periodic manner. This observation is the foundation for the 200 Ma cyclicity hypothesis, which proposes that periods where the field undergoes rapid transition from a highly unstable state (high reversal frequency) to a more stable state (superchrons) is on a 200 Ma cycle, hypothesized to reflect periodic superplume growth and collapse in Earth's mantle (Amit and Olson 2015, Olson and Amit 2015). Documented transitions from a highly unstable state to a more stable state are observed between the Middle Jurassic (high-reversal frequency) and the Early Cretaceous (Cretaceous Normal Superchron). Other records of extended non-reversal have been recognized in the Phanerozoic, and they appear to follow a ~200 Ma periodicity. However, better records documenting magnetic reversal frequency preceding these intervals, particularly in the Paleozoic, are needed to appropriately test this hypothesis.

Here we present preliminary magnetostratigraphic data collected from Carboniferous age sediments outcropping in the United Kingdom (Cumbria and Scottish Borders), which span the 40 Ma preceding the Permo-Carboniferous Reverse Superchron (PCRS). The PCRS is an extended period of reverse polarity that begins around the Mississippian-Pennsylvanian boundary (~323 Ma) and extends into the Permian, covering an interval of ~50–60 Ma (Davydov *et al*. 2012). Besides the PCRS, there is only one well-constrained period of polarity reversal history in the Carboniferous ~333–327 Ma (Opdyke *et al*. 2014). Records of polarity patterns for other parts of the Carboniferous exist, but many of these records are derived from regional-based studies which lack the means to confidently correlate the records to the global framework (Hounslow *et al*. 2004). Furthermore, there is evidence that many of these records are biased by remagnetization and do not record a Carboniferous signal. Overall, the existing magnetic polarity record for the Carboniferous is not robust

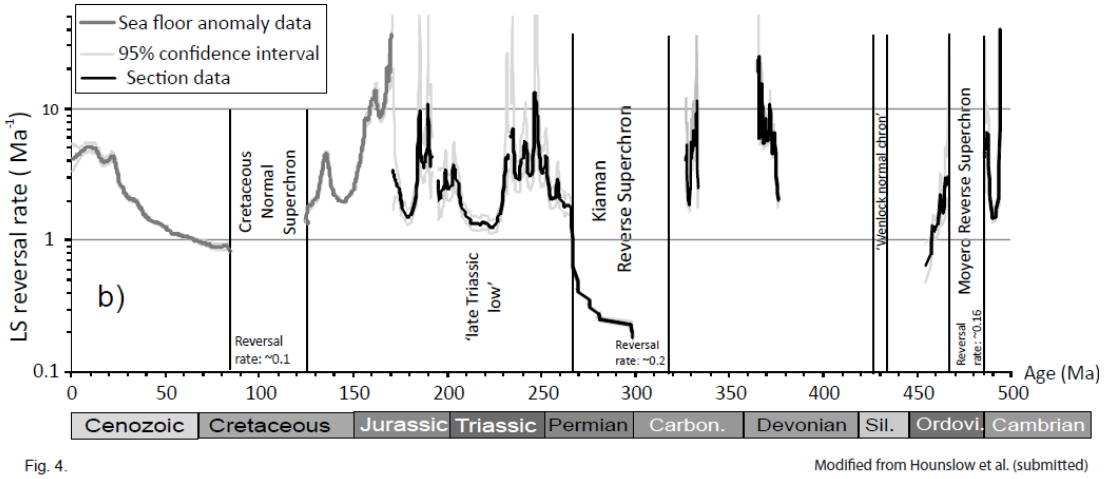

Fig. 1. Reversal rate through the Phanerozoic estimated from existing paleomagnetic data.

enough to test whether there was a period of high reversal frequency before the PCRS. By constraining the polarity reversal history in the Carboniferous between 360–320 Ma, our work will help test the 200 Ma cyclicity hypothesis, in addition to helping establish a reliable global polarity timescale for this time period.

Keywords: Paleomagnetism, magnetostratigraphy, reversals, carboniferous.

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