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Paleomagnetism and U–Pb age of the 2.4 Ga Erayinia mafic dykes in the south-western Yilgarn, Western Australia: Paleogeographic and geodynamic implications

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ABSTRACT

We present results from a paleomagnetic study of the previously undated Erayinia dykes intruding the south-western Yilgarn Craton. The U–Pb TIMs baddeleyite age of these dykes is now 2401 ± 1 Ma, which is about 10 m.y. younger than the 2418–2410 Ma Widgiemooltha dyke swarm. The paleomagnetic study isolated a stable primary remanence with steep downward direction, and the paleomagnetic pole (22.7° S, 150.5° E, A_{95} = 11.4°) is similar, but not identical to that of the previously studied Widgiemooltha dykes. We interpret this difference as the result of the movement of the Yilgarn Craton toward the pole at ~1°/m.y. angular speed, which is comparable with tectonic plates' velocities during the Phanerozoic. Paleomagnetic polarities of Widgiemooltha and Erayinia dykes suggest that at least one geomagnetic reversal occurred between these two magmatic events. The estimated amplitude of geomagnetic secular variations at c. 2400 Ma is slightly higher than predicted by the existing models for the last 5 m.y. at the c. 64° latitude. The paleomagnetic data and patterns of c. 2.6–2.1 Ga mafic dyke swarms permit the recently suggested reconstruction of the Paleoproterozoic supercontinent.

1. Introduction

The popular hypothesis of supercontinental cycles (e.g. Condie and Aster, 2010; Nance and Murphy, 2013 and references therein) predicts the assembly of a supercontinent in Siderian time (2.5–2.3 Ga). This supercontinent is usually called Kenorland (Williams et al., 1991), but Bleeker (2003) suggested the existence of the Sclavia supercraton, while another supercraton, Superia, which included the Superior, Karelia and Hearne cratons, has been postulated by Bleeker and Ernst (2006). Söderlund et al. (2010) provided some evidence that the Zimbabwe and Yilgarn cratons could also have formed part of Superia. On the other hand, Condie et al. (2009) demonstrated that the global distribution of U–Pb ages of subduction-related granitoids and of detrital zircon suggest slowing down or even cessation of the plate tectonics between 2.45 and 2.20 Ga. If true, this would be inconsistent with the formation of a supercontinent during the Siderian time. As paleomagnetism is the only method for quantitatively formulating and verifying pre-Mesozoic continental reconstructions, and the only tool for analysing the ancient geomagnetic field, any new paleomagnetic data from well-dated Siderian rocks provide important clues for a better understanding of the abovementioned models. However, Early Proterozoic paleomagnetic data are scarce. Evans and Pisarevsky (2008) included only five reliable 2500–2300 Ma paleomagnetic poles from four cratons (Dharwar, Karelia, Yilgarn and Superior) into their synthesis.

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