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MID-PROTEROZOIC LARGE IGNEOUS PROVINCES AND ENVIRONMENTAL PERTURBATION

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During the Phanerozoic, the emplacement and weathering of some large igneous provinces (LIPs) have had profound implications for global climate and marine biogeochemical cycles. These effects have often included shallow marine anoxia, leading to metazoan extinction and enhanced burial of organic matter. These outcomes, however, stem from initial conditions unique to the Phanerozoic, and it is possible that similar LIP activity in the weakly oxygenated, bacterially dominated world of the Proterozoic would have led to different results. Here, we review the available geochemical data that underpin our perception of mid-Proterozoic (1.8-0.8 Ga) environmental conditions, emphasizing both the remarkable stability present in many records during this time and the few, apparently transient, departures from these baseline conditions. We will go on to consider feedbacks present in the Earth system that could have maintained stability over these billion years and highlight recent modeling attempts to narrow the range of environmental parameter space allowable during the time. One common result of these models is a requirement for low global productivity to maintain low atmospheric O_2. This low primary productivity is generally thought to have resulted from nutrient limitation associated with widespread anoxia in the deep ocean. Given this scenario, the weathering of a large amount of mafic material over a relatively short time span could have significantly perturbed global O_2 production. Finally, we will review an up to date record of continental LIP activity. While this record is naturally incomplete, existing remnants suggest a pulse of activity around 1.4 Ga, a time when multiple independent redox proxies point to transiently heightened biospheric O_2.

A NEW KEY PALEOMAGNETIC POLE FOR THE ~1.8 GA KAAPVAAL CRATON: IMPLICATIONS FOR THE PALEOPROTEROZOIC APPARENT POLAR WANDER AND RECONSTRUCTIONS

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Dykes are ideal targets for paleomagnetic studies because (i) they experienced a rapid cooling and represent snapshots of the Earth's magnetic field, (ii) they contain minerals which can be dated to establish their precise crystallization ages, (iii) they represent excellent time indicators of paleostress to infer plume-head impact on the crust which is pivotal for supercontinent reconstructions, (iv) individual dyke represents a single cooling unit, which limit site duplication like it can be the case for a single massive intrusion. In this study, two N-trending, one SE-trending and twenty-four NE-trending dolerite dykes intruding the Archean granitoid basement over an area of ~55 000 km^2 in the northeastern Kaapvaal craton were paleomagnetically sampled. High-stability magnetizations were isolated from twenty-seven dykes; seven of which yield precise baddeleyite U-Pb ages between 1.88 and 1.83 Ga. These remanences, which mostly occurred as positively inclined directions are interpreted as primary based on antipodal groupings as well as several positive baked contact tests. The existence of dual polarity primary remanence directions recorded by distant dykes, combined to available ages suggest that the 1.8 Ga magmatism is a widespread event in the Kaapvaal craton and involved multiple magma pulses. Combining the primary magnetization among sites and existing radiometric ages further allow us to evaluate the reversal rates of the Earth's magnetic field at the time interval spanned by the studied dykes and to constrain the existing magnetic barcode for the Kaapvaal craton. Slight grouping differences of mean sites confirm that the paleosecular variation has been adequately averaged out. Large groupings differences, however, cannot be explained by paleosecular variations and are interpreted in the context of the ~1.8 Ga true polar wander path previously reported from other cratons. Our primary directions are compiled with reliable existing results to provide the best-constrained yet developed ~1.8 Ga key paleomagnetic pole for the Kaapvaal craton. Our new key paleopole provides additional constraints for Kaapvaal craton's latitudinal drift in Paleoprotezoic, with which test the existing paleogeographic reconstructions for the Columbia/Nuna supercontinent.