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Palaeomagnetic, geochronological and geochemical study of Mesoproterozoic Lakhna Dykes in the Bastar Craton, India: Implications for the Mesoproterozoic supercontinent

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ABSTRACT

Palaeomagnetic analysis of the Lakhna Dykes (Bastar Craton, India) yields a palaeopole at 36.6°N, 132.8°E, dp = 12.4°, dm = 15.9°, and the U–Pb zircon age obtained from one of the rhyolitic dykes is 1466.4 ± 2.6 Ma (MSWD = 0.21, concordia age based on two analyses with identical Pb/U ages), similar to previously published U–Pb ages. Major and trace element analyses of the Lakhna Dykes show shoshonitic and high-K calc-alkaline affinities consistent with a subduction related characteristics suggesting an active continental margin setting. This is in keeping with the Palaeo- to Mesoproterozoic tectonic environments in the eastern Indian margin. The new 1460 Ma Indian palaeopole was used to test possible palaeopositions of India within the Mesoproterozoic supercontinent Columbia. Of the four palaeomagnetically permissible reconstructions, juxtaposing western India against south-west Baltica is geologically the most reliably constrained and best fitting model. Our preferred reconstruction implies a long Palaeo- to Mesoproterozoic accretionary orogen stretching from south-eastern Laurentia through south-western Baltica to south-eastern India. Breakup of India and Baltica probably occurred in the Late Mesoproterozoic, but additional constraints are needed.

1. Introduction

An increasing number of publications indicates a growing interest in the Mesoproterozoic palaeogeography and to a hypothetic pre-Rodinian supercontinent variously called Nuna, or Columbia, or Hudsonland (e.g., Condie, 2000; Evans and Mitchell, 2011; Hoffman, 1996; Meert, 2002, 2012; Pesonen et al., 2003; Pisarevsky and Bylund, 2010; Rogers and Santosh, 2002, 2009; Wingate et al., 2009; Zhao et al., 2004). One of the main reasons for the Columbia hypothesis lies in the widespread evidence for 2.1-1.8 Ga orogens in the majority of Mesoproterozoic continents (e.g., Condie, 2000; Zhao et al., 2004 and references therein) and the suggestion that some or all of these orogens resulted from a supercontinental assembly. Unfortunately, most Columbia reconstructions are highly speculative and sometimes technically incorrect mostly due to a deficit of high quality Late Palaeoproterozoic and Mesoproterozoic palaeomagnetic data. For example, Evans and Pisarevsky (2008) argue that out of 600 published 1600–1200 Ma palaeopoles (Pisarevsky, 2005) for all Precambrian cratons, only eight satisfy all necessary reliability criteria. A few more recently reported palaeomagnetic poles (e.g., Bispo-Santos et al., 2008, 2012; Halls et al., 2006; Lubnina et al., 2010; Pisarevsky and Bylund, 2010; Salminen and Pesonen, 2007) have improved the situation somewhat, but there are still not enough poles to construct an adequate Apparent Polar Wander Path (APWP) for any one craton, let alone the globally disparate cratons. However, the presence of pairs of precisely coeval palaeopoles from the same two cratonic blocks can provide a palaeomagnetic test of the assumption that these two continents drifted together as parts of a larger supercontinent (Buchan, 2007; Evans and Pisarevsky, 2008). Luckily there are a few such pairs between 1800 and 1000 Ma: there are reliable palaeopoles from both Laurentia and Baltica at 1780–1740 Ma, 1480–1460 Ma and 1270–1260 Ma (see Table 2 of Pisarevsky and

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