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Rapid 90° Swinging of Rodinia Between 800-700 Ma: New Palaeomagnetic Constraints from South China

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Numerous alternative configurations have been proposed for the Neoproterozoic supercontinent Rodinia. Most of the models were largely based on geological correlations, and reliable palaeomagnetic results for the Neoproterozoic were insufficient to distinguish between those models. However, more recent data from Australia have been used to argue against the SWEAT and AUSWUS fits.

We report here a new palaeomagnetic pole from the Xiaofeng dyke swarm in central Yangtze craton, South China, which we dated at 802 ± 10 Ma using the SHRIMP U-Pb zircon method. Together with new understanding regarding the timing of the continental collision events in South China, India, East Antarctica and Australia, these data enable us to re-examine the Rodinia configurations and possible positions of South China in the supercontinent.

Stepwise demagnetisation of samples from fifty-four dykes/sites in the Yangtze Craton revealed a dominantly steep upward remanent direction after removing a recent magnetic component. Both rock magnetic observations and the lack of magnetic overprint in the study region argue for a primary origin for the remanence, whereas the gently dipping Sinian succession that overlies the dykes provides a good palaeohorizontal constraint that is consistent with at most gentle tilting during pre-Sinian exhumation.

This new palaeomagnetic pole places South China at between ca. 55° and 70° palaeo-latitude, in par with high palaeolatitude indicated by a similar-aged pole for India. Although no reliable palaeomagnetic data of that age are available for Australia, a reported pole from the ca. 820 Ma (?) Wooltana Volcanics would place Australia in a high-latitude position too. However, coeval poles from Laurentia indicate a low-latitude position that would separate Laurentia significantly from the high-latitude continents.

A number of possible interpretations can be explored:

(1) South China and India, with or without Australia, were together in a high-latitude position at around 800 Ma, whereas Laurentia, Australia (?) and other continents were together at a low-latitude position. This implies that there was no single supercontinent (e.g., Rodinia) during the Neoproterozoic, contrary to some strong geological evidence;

(2) If we ignore the ca. 820-800 Ma poles from Laurentia which are not regarded as of high quality, it is possible to reconstruct a Rodinia by matching the paired ca. 820-800 Ma and ca. 750-700 Ma poles from South China, India, Australia (ca. 820 Ma pole unreliable) and Congo, as well as the ca. 725 Ma pole from Laurentia and the Grenville-aged poles from both Laurentia and Australia. However, the ca. 770-700 Ma poles appear to distribute along a great circle.

This latter interpretation implies that Rodinia underwent rapid rotations between ca. 800 Ma and ca. 750-700 Ma around an axis close to Greenland at the palaeo-equator, similar to the rotations underwent by Gondwanaland during the Palaeozoic. Such rapid swinging of palaeopole positions between the Earth's rotation axis and the palaeoequator is typical of true polar wander around an equatorial prolate axis of the Earth's nonhydrostatic geoid developed beneath a supercontinent. If this is correct, one should reconstruct the supercontinent by matching the swaths of poles between continents rather than matching within narrow age windows.