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Commentary

Comment on *Palaeolatitude of glacial deposits and palaeogeography of Neoproterozoic ice ages* by Ricardo I.F. Trindade and Mélina Macouin [C. R. Geoscience 339 (2007) 200–211]

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The recent paper of Trindade and Macouin [5] tends to make use of the existing paleomagnetic data to constrain both the palaeogeography and the palaeoclimate (palaeolatitudinal distribution of glacial deposits) during the late Neoproterozoic. However, data related to South China occurred in the so-called up-to-date geochronological and palaeomagnetic database for the Neoproterozoic glacial deposits are erroneous, and therefore, need to be clarified.

One of the obvious errors is about the paleolatitude of the cap carbonate above the diamictite of the Nantuo Formation. The equatorial paleolatitude ($\lambda = 3.0 \pm 4.5^\circ$) of the Doushantuo cap [4] is used to prove that the ice caps did reach the equator at about 635 Ma [5]. We wish here to emphasize that the paleolatitude of the Doushantuo cap is likely not equatorial but intermediate, and the reason will be discussed below.

Since 2004, the paleolatitude of the Yangtze Block during the Nantuo (Marinoan) glaciation was frequently thought to be low latitude [2,4,5]. However, this is unreliable, if not wrong, and these low paleolatitude points of view are all referred to the deduction made in [4].

Actually, the first paleolatitude value of South China Block (SCB) during the Nantuo (Marinoan) glaciation was determined by [6] and positively appraised by [3], in which the measured paleopole is (151.2°E, 0.2°N) and the related paleolatitude is $37 \pm 9^\circ$. Evans et al. [3] studied, however, two sets of samples collected from the Liantuo Formation in the Yangtze Gorges area, and the results from the two sets of samples are close to the Nantuo paleopole in [6]; finally, these three sets of paleomagnetic results were combined into a single paleopole for the Liantuo Formation with the age of ca. 748 Ma. Confusion about the age of the Nantuo glaciation was further induced by the suggestion that the Nantuo glaciation is pre-Marinoan [3].

Macouin et al. [4], based on the carbon isotope data and the related ages of the Doushantuo Formation, correctly argue that the age of the Nantuo glaciation is Marinoan and not Sturtian. Based on a positive fold test of the measured paleomagnetic data of the samples collected from the Doushantuo Formation and the similarities between the Australia and SCB apparent polar wander paths at Early Paleozoic, Macouin et al. [4] speculate that there is a primary remanence and conclude a paleolatitude of $3 \pm 4.5^\circ$N for the Doushantuo Formation. In addition, by all ways and means they extend the equatorial paleolatitude of the Doushantuo stage to the Nantuo glaciation: firstly, they estimate a duration of 240 ky or 4.8 Ma [4] between the measured segment and the Nantuo Formation, and secondly, extend the conjectured Paleozoic APWP northward to the 600 Ma Doushantuo pole.

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However, the whole paper purposely neglects the paleopole and paleolatitude of the Nantuo Formation cited and discussed in [3]. It is now rather certain that the inference of the low-latitude position for the SCB during the Nantuo glaciation seems unrealistic. Macouin et al. ([4] (p. 395)) confess that ''the Nantuo glacial deposits and their associated cap carbonates are remagnetized'' and ''the samples possessing primary remanent magnetizations are located between 280 and 520 m above the tillite, for a thickness of 240 m''. Therefore, the statement of Trindade and Macouin ([5] (p. 200)) that ''poles recently obtained on 'cap carbonates' from China'' is incorrect. According to the age determinations [1], the duration of the Doushantuo Formation lasts for about 84 Ma, and the time interval from the base of the measured segment at the upper part of the Doushantuo Formation to the top surface of the Nantuo Formation can be estimated at about 42 myr, and not the trivial 240 ky or 4.8 Ma given in [4]. The similarities between the Australia and SCB apparent polar wander paths from Early Paleozoic to Late Neoproterozoic also need to be reevaluated.

Contrarily, the paleolatitude of $37 \pm 9^{\circ}$ for SCB during the Nantuo glaciation is clearly stated in ([6] (p. 186)). The age of the Nantuo Formation was then primitively estimated to be 670–680 Ma or $\sim$ 730–670 Ma [6], and now it is known to be bracketed within $<$ 654 Ma [7] and 635 Ma [1]. The samples providing the paleolatitude of $37 \pm 9^{\circ}$ were collected from the top part of the Nantuo Formation in Yunnan Province ([6] (Fig. 3)) and likely correspond to the latest stage of the Nantuo glaciation. In addition, it needs to emphasize that the Nantuo pole was resolved at high unblocking temperatures and this probably indicates that the remanence resides in specular haematite, and the soft-sediment fold test on the contemporaneous sedimentary deformation structures is positive [6]. The Nantuo pole is proved to be the magnetization acquired at an early stage of lithification, and therefore it is reasonable to conclude that the paleolatitude of the Yangtze Platform during the latest stage of the Nantuo (Marinoan) glaciation was intermediate and not equatorial.

Note: The authors of the paper *Palaeolatitude of glacial deposits and palaeogeography of Neoproterozoic ice ages,* Ricardo I.F. Trindade and Mélina Macouin, did not wish to reply to this comment.

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