



## **Constraining the India-Asia collision by retrieving the paleolatitude from partially remagnetized Paleogene volcanics in the Nanmulin Basin (southern Tibet)**

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Determining paleolatitudes of the Lhasa terrane (southern Tibet) using paleomagnetic inclinations is key to constraining the paleogeography and timing of the collision between India and Asia. However, paleolatitude estimates vary widely from  $5^{\circ}\text{N}$  to  $30^{\circ}\text{N}$  due to unrecognized rock magnetic biases such as inclination shallowing in sedimentary rocks or poor averaging of secular variation in volcanic rocks. Here, we investigated Paleogene volcanics of the Linzizong Group from southern Tibet in the Nanmulin Basin that had previously yielded low paleomagnetic inclinations ca.  $10^{\circ}\text{N}$ . Using proper paleomagnetic sampling and measurement protocols we observe similar shallow inclinations. However, sampled sections with different bedding attitudes yield a negative fold test indicating that the isolated remanent magnetizations do not have a primary origin. Detailed rock magnetic analysis, end-member modeling, and petrographic investigation reveal that most of the section has been variably remagnetized due to low-temperature alteration of magmatic titanomagnetite and formation of secondary hematite, which occurred after tilting of the strata. We show that the observed paleomagnetic inclinations vary according to a linear trend with the degree of remagnetization. Accordingly, we can estimate that the primary pre-tilting thermoremanent magnetization has an inclination of  $38.1^{\circ}$  ( $[35.7^{\circ}, 40.5^{\circ}]$  within 95% confidence limit), corresponding to a paleolatitude of  $21.4^{\circ}$  ( $[19.8^{\circ}, 23.1^{\circ}]$  within 95% confidence limit). This is consistent with results from pristine volcanic units and inclination-shallowing corrected sediments of the upper Linzizong Group  $\sim 200$  km to the east [Dupont-Nivet et al., *Geophysical Journal International*, 182, 1189-1198; Huang et al., *Geophysical Journal International*, 194, 1390-1411]. Our results demonstrate that previously reported low paleolatitudes of the Lhasa terrane can be an artifact of unrecognized remagnetization. Furthermore, we show that original paleolatitudes can be recovered from partially remagnetized volcanics. Collectively, these results suggest that the India-Asia collision began at  $\sim 20^{\circ}\text{N}$  by 45–55 Ma.