High-resolution Geomagnetic Field Records Decipher the Possible Precession links since about 340-kyr in a maar lake sediment sequence in tropical Asia

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A series of paleomagnetic works relying on the ocean sediments present some significant astronomic periods, such as a 100 kyr quasi-period and 41 kyr obliquity signal. These studies provide the new insights unscrambling what and how the earth magnetic field changed in despite of the ongoing debating. Numerical studies of recent years also reveal the possibility of the precession drive the dynamos and influence the magnetic field. However, the less of reliable high-resolution paleomagnetic records besides of relative paleointensity reduce its credibility. Here, we present some detailed rock magnetic and paleomagnetic studies on the continuous 40-m-thick sediments in two parallel cores retrieved from Tianyang Maar lake, southern China. The new results would contribute to discuss the correlation of paleomagnetic field with the astronomical factors.

Tianyang Maar lake is located in the southern part of the Leizhou Peninsula. The maar lake has a surface area of ~ 7.3 km² surrounded by a 40 - 60 m high crater rim composed of basaltic breccia and tuff. Two new parallel cores, TY08 and TY15 (~ 10 m apart), were extracted from center of the crater in 2008 and 2015, respectively, using a rotary borer consisting of a stainless steel outer tube and a plastic inner tube to minimize sediment disturbances and contamination. The sediments of two cores can divided into three zones: about upper 15.59 m was composed of varying colors clay and the middle part (15.59-21.94 m), was dominated by the grey and greyish-brown fine to coarse sand with occasional gravels, embedded a thick grey clay layer; the lower part (21.94-40.0 m) shown as the dark grey and black organic-rich clay.

The paleomagnetic results show that the natural remanent magnetization (NRM) of the sediments is mainly contributed by magnetically soft minerals, and the sediments have fairly documented geomagnetic field variations. A chronology is constructed using multiple methods, including radiocarbon dating, optically stimulated luminescence dating and terrestrial-marine pollen correlation. The 340-kyr paleomagnetic inclination record displays patterns similar to those seen in regional records over a large spatial scale (> 3000 km), implying that these records may reflect large-scale core dynamics on timescales of $10^4$ - $10^5$ years in this low-latitude region. The Tianyang inclination record exhibits a negligible inclination anomaly ($\Delta I = -0.08^\circ$) and features six anomalous inclination events, which are assigned to the Laschamp, Blake, Fram Strait II/6a, Iceland Basin, Mamaku and 9α excursions respectively. The spectral and singular spectrum analysis (SSA) exhibit...
that the inclination does not show the significant signal of 100-kyr periodicity, however, the closed precession period is obvious in the third components of inclination (PC3). PC3 component shows nearly synchronous variations with the precession parameter while the opposite correlation appeared under the condition of eccentricity minima strong. This corresponding pattern hint us that astronomical parameters have the essential influence to the earth magnetic field, however, the different moving may forc or constrain the earth magnetic behavior.