

## Magneto- and climatostratigraphy toward the onset of the Quaternary in East Asia

Masayuki Hyodo<sup>1\*</sup>

<sup>1</sup>Kobe University

The lower boundary of the Quaternary and Pleistocene was newly defined at the base of the Gelasian, which is correlated with the lower boundary of marine oxygen isotope stage (MIS) 103, just above the Gauss-Matuyama magnetic polarity boundary (GMB). In this paper, we review studies on magnetic polarity stratigraphy of Plio-Pleistocene terrestrial deposits in the Chinese Loess Plateau and the Japanese Islands, to examine paleoclimate across the GMB and beginning of the Quaternary, correlated with marine oxygen isotope records.

Marine oxygen isotope data from benthic foraminifera mainly reflect ice volume changes. Based on the benthic marine oxygen isotope stack orbitally tuned (Lisiecki and Raymo, 2005), the ice volume being constant since about 5 Ma ago, with a sharp maximum at 3.3 Ma in age, began to increase at about 3 Ma. After talking a large increase during a period of MIS G6-G4 at 2.73-2.68 Ma, the ice volume oscillated with two obliquity cycles of MISs G3-G1, followed by the MIS 104 glacial centered at 2.60-2.61 Ma. The GMB occurred during MIS 104.

In the Chinese Loess Plateau, the orbitally tuned magnetic susceptibility stack, a proxy of summer monsoon intensity, shows a sudden and large decline of summer monsoon at 2.73-2.70 Ma, which must be correlated with the increased ice volume period of G6-G4. The small peaks of summer monsoon at 2.69 Ma and 2.65 Ma are correlated with G3 and G1, respectively. The first (lowest) loess layer L33, overlying the loess/red clay boundary, has the coarsest quartz grains, and very small susceptibility. The climate of L33 was very cold and dry, with an extremely intensified winter monsoon, correlated with the MIS 104 glacial. The detailed magnetic polarity stratigraphy at 2-5 cm intervals in depth reveals the Gauss-Matuyama transition ranges in depth from about 40 cm to 210 cm above the lower boundary of L33, and paleosol S32 correlated with the interglacial of MIS 103 lies 140 cm above the end of the transition. In the Honshu Island, a large plant replacement occurred in forests during the MIS 104 (L33) glacial; many warm-moist elements became extinct were replaced by new cool to cold-dry ones. Thus, it may be a "super-glacial". In the Tokachi plain, Hokkaido, the cool-temperate deciduous forest of *Fagus* that replaced a boreal coniferous forest at about 3.7 Ma continued until about the GMB, while the ice volume gradually increased in the late Pliocene. These facts suggest that the linear intensification in summer monsoon from 3.5 Ma to 2.75 Ma in the Chinese Loess Plateau reflects a monotonic increase in precipitation, keeping high temperatures without significant changes. The long-term trend of wetting was disrupted by the sudden cold-dry climate of G6-G4, and completely terminated by the super-glacial of MIS 104 (L33). The termination of the super-glacial opened the Quaternary dominated by 41 ka cyclicity in climate.

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