The geologic evidence for the chaotic behavior of solar planets and its constraint on the third order eustatic sequences during the end of the LPIA

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A high-resolution (948 samples) measurement of anhysteretic remanent magnetization (ARM) was performed on ~200 m thick Early-Middle Permian Maokou Formation at Shangsi section, South China. The ARM variation within the sedimentary rocks is periodical and the wavelengths of cycles represent the ratio of 20:5:2:1 throughout the formation, corresponding long eccentricity, short eccentricity, obliquity and precession in hierarchical domain.

According to conodont biostratigraphic record (Fang et al., 2012), the Maokou Formation ranges from the late Kungurian to early Capitanian stage coeval to the end of the Late Paleozoic Ice Age. The strong obliquity (~44 and ~33 kyr) signal indicates the wining and waxing of ice sheet in the eastern Australia during the end of the Late Paleozoic Ice Age (LPIA) exert a significant effect to global climate.

The Late Paleozoic era lacks accurate Earth's orbital parameter model, but the 405 kyr eccentricity have been consistent throughout the geologic time by the virtue of stable orbit of Jupiter (Laskar et al., 2004). The periodic g_2-g_5 term is well expressed in the ARM series and used as the astronomical metronome to calibrate three conodont zones and correspondingly providing the estimated durations of Roadian, Wordian, and Capitanian stage are ~4020.5 kyr, ~2575.3 kyr and ~1170 kyr, respectively.

The ~2.2 and ~1.8 Myr cycles within Maokou Formation corresponding to g_4-g_3 are a little shorter than the ~2.4 Myr detected in Cenozoic era, which indicates the instability of the g_4-g_3 due to chaotic motion of the solar planets. The ~1.1 and ~0.9 Myr explained as s_4-s_3 also behaved as reduced periodicity. The 2:1 secular resonance

of g_4-g_3 and s_4-s_3 could be observed throughout the section suggesting the movement of the Earth and Mars kept the resonance (s_4-s_3)-2(g_4-g_3)=0 during the end of the LPIA.

The long-term obliquity appears to keep pace with the global third order depositional sequences indicating their astronomical origin. The mismatch between them would be explained by several possibilities: astronomically, the fluctuation of the s_4-s_3 term caused the variation of every orbitally induced third order eustatic cycle; climatically, g_4-g_3 and s_4-s_3 could alternatively control the glacioeustatic signal during deglaciation; tectonically, the germination of the NeoTethys disordered the glacioeustatic signal in the low latitude region. The local sea-level sequences have a barrier of performing the global correlation because of the interferential eustatic signals induced by mantle plume event of Emeishan large igneous province (LIP) nearby.

References

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