

## C- and S-isotope study on depositional environment of late Cryogenian Mn carbonate, Datangpo Fm., South China

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The Datangpo manganese carbonate deposit overlies diamictite of Tiesi'ao Formation (equivalent to Sturtian) and occurs at base of Datangpo Formation which underlies diamictite of Nantuo Formation (equivalent to Marinoan). Considerable  $^{13}\text{C}$ -depleted Mn carbonate and highly  $^{34}\text{S}$ -enriched pyrite from the base of the Datangpo Formation document unique oceanic chemical environment before the final oxygenation of the Earth's surface.

The observation of most  $\delta^{18}\text{O} > -10$  and no linear correlation between  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  suggests that C-isotope compositions of the Mn-carbonate are unaltered by late diagenesis. The  $\delta^{13}\text{C}_{\text{car}}$  values (meanly  $-7.2\%$ ) below the mantle or crust values ( $-5\sim-6\%$ ) are consistent with the early diagenetic model for stratiform Mn carbonate deposit, which argues participation of carbon derived from bacterial remineralization of organic matter during Mn-carbonate precipitation. However, the relatively small standard deviation ( $0.81\%$ ) of  $\delta^{13}\text{C}_{\text{car}}$  values indicates carbonate precipitation occurs near the water-sediment interface rather than in the occlusive pore water, thus the  $\delta^{13}\text{C}_{\text{car}}$  values were inherited from the bottom water. The best-fitting line ( $r^2=0.69$ ) of  $\delta^{13}\text{C}_{\text{car}}$  vs. fractionation ( $\Delta$ ) between carbonate and organic carbon yields a slope=0.78 and an intercept of  $-26.94$ , which cannot be readily explained by steady-state model of carbon cycle. Therefore, we suggest that negative  $\delta^{13}\text{C}_{\text{car}}$  excursion was resulted from oxidation of part of a large dissolved (including suspended) organic carbon reservoir. In addition, large  $\Delta$  values (meanly  $25.3\%$ ) imply high  $\text{CO}_2$  concentration in the atmosphere.

High  $\delta^{34}\text{S}$  values of pyrites within the Mn-carbonate indicate extremely  $^{34}\text{S}$ -enriched sulphate in a restricted basin. The pyrites probably precipitate in the relatively occlusive pore water beneath sea water with low sulfate concentration, which is consistent with the observation of large and scattered pyrite framboids that are symbolic of diagenetic formation beneath dysoxic bottom waters.

In conclusion, the Mn-carbonate deposit at the base of Datangpo Formation records abundant paleoenvironmental information, such as high  $\text{CO}_2$  concentration in the atmosphere and low sulphate concentration in the ocean after the Sturtian ice age, considerable  $\text{O}_2$  concentration in the atmosphere which caused the ocean chemocline moving to the water-sediment interface in the outer shelf, large dissolved organic carbon reservoir which was partly oxidized by Mn oxides and  $\text{SO}_4^{2-}$  enzymatically near and below the chemocline. (This study is supported by NSFC grant 40572017.)

## Authigenic carbonates in the Chinese loess-paleosol sequence: Morphologic and isotopic study

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Carbonate is a common component in the eolian loess-paleosol sequences, north China. Usually carbonate content is about 10 wt% in loess while lower (e.g. 0-3 wt %) in paleosol due to pedogenic leaching (Liu, 1985). Carbonate is easily leached out and accumulated in the loess profile. In this study we found at least six types of authigenic calcium carbonate accumulation in the Luochuan loess-paleosol sequence: coatings, rhizoconcretions, fossil snail shells, pseudomyseliums, nodules and nano-scale rods. Various carbonates have different morphologic features and isotopic compositions (Table 1), showing different forming conditions. Among them, carbonate nodules were precipitated under multi-alternations of heavy rainfall and intense evaporation without biological processes. Other authigenic carbonates may form from biological-controlled or biological-induced interactions. Detailed study on these authigenic carbonate can provide a reasonable way to trace the biogeochemical process in the loess sequence.

**Table 1** Stable isotopic composition of some types of authigenic carbonates in the Luochuan loess-paleosol sequence, China

Authigenic Carbonates	$\delta^{18}\text{O}$ (‰ PDB)	$\delta^{13}\text{C}$ (‰ PDB)
Rhizoconcretion (L1)	-9.0 ~ -8.0	-5.9 ~ -4.4
Fossil Snail Shell (L1)	-9.4 ~ -6.3	-9.7 ~ -6.9
Coatings (L1)	-9.5 ~ -8.0	-9.0 ~ -8.0
Nodules (S1) <sup>a)</sup>	-9.0 ~ -9.8	-5.6 ~ -4.2
<2 $\mu\text{m}$ samples (L1)	-7.7 ~ -6.9	-6.1 ~ -5.2
<2 $\mu\text{m}$ samples (S1)	-6.7 ~ -6.4	-10.1 ~ -8.9

<sup>a)</sup>Han *et al.*, 1995

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