Structure characters of continental red beds and their implications in the bottom of late Cretaceous Yaojia Formation in the Songliao Basin, NE China

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High-resolution sequence stratigraphy, geochemistry and sedimentology studies were carried out on late Cretaceous Yaojia Formation in the Songliao Basin, northeast China indicated three types continental red beds occur at the bottom of the Yaojia Formation.

The type I is mainly characterized by pure and compact red mudstone formed in flooding plain or shallow lacustrine environments, there observed some Ostracoda fossils in the latter, which displaying features indicative of autochthonous deposits and oxidation during depositional process. The type II is featured by vermiculated red bed indicated gradually oxidation soil-forming process caused by groundwater gradual permeation during strata uplifting. The type III is composed of upper red mudstone and lower grey calcareous sandstone characterized by foaming encountered hydrochloric acid, which elucidates groundwater dissolving and schlepping calcium from mudstone permeates through red mudstone into lower grey sandstone after upper red mudstone stratum uplifts above groundwater table.

Because of gradually change of the underthrust angle of Pacific plate to Eurasian plate since 88Ma, the distinct regional characteristics of continental red beds are slowly thinning from east to west in the Songliao Basin shows that eastern stratum uplifting is fiercer than in west. Meanwhile, seismic reflection images show that the boundary surface between the Qingshankou and Yaojia formation is characterized by large scale truncation unconformity. We draw a conclusion that the continental red beds is a widespread second-order sequence boundary showed a long time exposure and oxidation process in early Yaojia Formation. The continental red beds are important for division of sequence stratigraphy and depositional system.

Evidence from Mo isotopic compositions for “A whiff of oxygen” before the Great Oxidation Event

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A high-resolution profile of Mo isotopic compositions has been obtained from a ~90 m continuous drill core recovered from the 2.5 Ga Mt McRae Shale in the Hamersley Basin, Western Australia, by the NASA Astrobiology Institute in 2004. 35 bulk samples reveal a large variation in δ98Mo, ranging from 0.99‰ to 1.86‰. Relatively low and invariant δ98Mo, clustering around 1.1‰, appears in the lower pyritic black shale unit (S2), followed by a gradual rise upcore. The largest δ98Mo occurs within the upper pyritic black shale unit (S1) which also shows Mo enrichment relative to S2. In the rest of S1 and the overlying carbonate/marl unit, δ98Mo declines while fluctuating heavily.

These sediments were likely deposited under locally euxinic conditions that facilitated quantitative Mo scavenging, and so the shift in δ98Mo from S2 to S1 probably reflects change in the isotopic composition of Mo entering this basin.

The previous finding of Mo and Re enrichments within S1 relative to S2 and the upper continental crust is interpreted as the evidence for a “whiff” of oxygen in the environment before the Great Oxidation Event [1]. The heaviest Mo isotope values are coincident with the metal excursion horizon and there is a mild correlation between bulk δ98Mo and Mo concentration (r²=0.56) through the core. Therefore, we hypothesize that increasing P O2 not only enhanced the rate of oxidative weathering, thus elevating the input of dissolved Mo to the ocean, but also led to increased formation of Mn oxides that trapped isotopically light Mo. This process generates isotopically heavy Mo in seawater today [2].