

Characteristics of massive lacustrine petroleum source rocks of Upper Cretaceous from Songliao Basin, China

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Songliao Basin is the largest petroleum producing basin in China and the characteristics of its organic rich source rocks deposited during the Upper Cretaceous has significant implication in the understanding of this massive lacustrine source rocks formation. A continuous profile of core samples has been investigated in terms of the abundance of organic matter, biomarkers and hydrocarbon composition and Rock-Eval pyrolysis. The results show that the two sets of source rocks are mainly associated with the member 1 and the lower part of member 2+3 sections of Qingshankou Formation and the member 1 section of Nenjiang Formation. The set of source rocks of Qingshankou Formation extended a thickness of 153.64 meters with a total organic carbon (TOC) of 2.76% to 5.24%, and the soluble organic matter (SOM) of 0.76-1.7%, while the source rocks of Nenjiang formation has a thickness of more than 100m with TOC ranged from 1.52 to 8.01%. HI index of the organic rich source rocks are mainly in the range of 400 to 700mg/gTOC with a hydrocarbon potential of 14.91 to 27.02mg/g, while HI index of non-source rocks are mostly much less than 300mg/gTOC. These two sets of petroleum source rocks are dominated by type I and II organic matter with similar parent organic matter inputs as the Nenjiang formation show a slightly high plant input. The abundance and quality of organic matter in the sediments of the profile are mainly controlled by the original burial and preservation condition other than primary productivity of biomass in the water system. In general, the variation on the abundance and quality of organic matter on the profile may reflect a similar variation in the paleoenvironmental changes.

This study is supported by State '973' Project (2006CB701404).

A 1D global box model for mercury stable isotopes

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Mass-independent fractionation (MIF) of isotopes in natural terrestrial geochemical processes was first observed in 1983 for oxygen and in 2000 for sulfur isotopes. Recently mercury (Hg) was added to this shortlist when isotopic anomalies were observed for Hg's two odd isotopes, ¹⁹⁹Hg and ²⁰¹Hg, in biological tissues [1]. Mercury MIF in nature has thus far been shown to result mainly from inorganic Hg^{II} and methylmercury (MeHg^{II}) photoreduction in aquatic systems¹. It was shown that during Hg photoreduction, the residual Hg^{II} (aq) and MeHg^{II} (aq) become progressively enriched in the odd ¹⁹⁹Hg and ²⁰¹Hg isotopes relative to what one expects from classical mass dependent isotope fractionation. Assessing the impact of aquatic Hg photoreduction on global reservoir MIF signatures requires evidence of 1. ^{odd}Hg isotope depletion in the atmospheric Hg⁰ (g) pool, and 2. ^{odd}Hg isotope enrichment in the surface and/or deep ocean Hg^{II} pool. Both of these have now been estimated from negative $\Delta^{199}\text{Hg}^{\text{II}}$ anomalies in atmospheric Hg scavenged by lichens and peat [2], and positive $\Delta^{199}\text{Hg}^{\text{II}}$ in the marine foodchain.

In order to illustrate how mercury MIF may be of use in better understanding the global Hg cycle, a 1D Hg isotope box model was constructed, based on the GEOS-Chem global Hg inventory and fluxes [3]. The 1D model consist of 10 different boxes representing the atmosphere, ocean mixed layer, deep ocean, continental soils, and deep sea sediments, for various chemical Hg species. The isotope mass balance assumes that only aquatic Hg photoreduction induces MIF. Model output indicates that steady-state MIF anomalies in the atmospheric and ocean reservoirs are of the same order of magnitude as the recent mercury MIF observations for marine and atmospheric environments: predicted atmospheric Hg⁰ (g) and Hg^{II} (p) have steady state $\Delta^{199}\text{Hg}$ anomalies of -0.7 ‰, similar to measured lichen $\Delta^{199}\text{Hg}$ values that range from -0.2 to -1.0 ‰. Predicted marine colloidal Hg^{II} (aq) has $\Delta^{199}\text{Hg}$ of +0.4 ‰, similar to inferred marine $\Delta^{199}\text{Hg}^{\text{II}}$ of +0.5 ‰.

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