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The role of redox conditions in controlling the marine organic abundance in Lower Yangtze Formation, South China

Y. Huang (1,2), Z. Zhang (1,2), L. Zan (3), W. Li (1,2)

(1) State Key Laboratory of Petroleum Resources and Prospecting (China University of Petroleum, Beijing), Beijing 102249, China, (2) College of Geosciences, China University of Petroleum (Beijing), Beijing 102249, China, (3) Sinopec East China Company, Nanjing 210011, China

Reconstruction redox conditions have been the subject of intense studies in recent years because they play a significant role in the preservation of organic matter. Based on a series of analyses of conventional cores (119 samples) and outcrops (75 samples), including total organic content (TOC), gas chromatograph-mass spectrometry (GC/MC), and detailed observations under microscope, the present study attempts to (1) investigate the biomarkers which can directly reflect the redox conditions in sedimentary records; (2) address the controlling mechanisms of redox conditions on the preservation of organic matter in the study area.

The integrated core and outcrop data indicate that Permian-Early Triassic, Lower Yangtze Formation is a mixed siliciclastic/carbonate succession, formed in shallow-marine environments, which is characterized by the bioclastic limestones at its base (Early Permian) upward into coal-bearing mudstones (Late Permian), and finally into widespread occurrence of Early Triassic limestones. Phytane (Ph) formed by the processes of dewatering and reduction of the alcohol, whereas the oxidation of the alcohol results in Pristine (Pr). It is widely accepted that the reduced oxygen environment is commonly rich in dibenzothiophene, the oxidizing environment, however, is generally dibenzofuran-rcih. The five biomarkers, Pr, Ph, dibenzothiophene, dibenzofuran, and fluorine, were identified and then determined from the core and the outcrop samples by the GC/MC. The average rate of Pr/Ph is 0.85 in the limestones developed during Early Permian and Early Triassic, and is 1.17 in Late Permian coal-bearing mudstones. The dibenzothiophene accounts for 55.7% of the compounds consisting of dibenzothiophene, dibenzofuran and fluorine in the limestones (formed during Early Permian and Early Triassic) and 41.7% of Late Permian coal-bearing mudstones. This, coupled with the fact that limestones commonly developed in a much deeper-marine conditions than those associated with coal-bearing mudstones, suggesting that: (1) Early Permian and Early Triassic show the clear reduced oxygen environments; (2) The water depth of the sedimentary environment plays a significant role in controlling the redox conditions. It is, thus, likely that these biomokers imply the sedimentary environment of redox conditions in which they formed.

The integrated data indicate that the abundance of organic matter is closely linked to the redox conditions where limestones or coal-bearing mudstones developed. The relationship of TOC and the biomarker parameters, Pr/Ph and the percentage of dibenzothiophene, reveal that a reduced oxygen environment most probably results in more abundant organic matter. The average value of TOC is 2.36% in Late Permian, and 0.70% in Early Permian and Early Triassic, suggesting that the abundance of organic matter in Late Permian coal-bearing mudstones is more abundant than it associated with Early Permian and Early Triassic limestones. Considering that the fragments of algae are the major component for hydrocarbon generating as observed under microscope, indicating that Late Permian, which shows the oxidizing sedimentary environments, most likely favor the production of significant amounts of organism. Such depositional settings, in contrast, against favor the prevention of organic matter. A hypothesis, thus, can be made that both the paleoproductivity and the redox conditions play the significant role in controlling the abundance of organic matter in shallow-marine environments.