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Ferruginous conditions in different lacustrine basins in China

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Anoxic waters are known to foster preservation of organic carbon. Conditions when dissolved ferrous iron accumulates in anoxic strata (ferruginous) were once widespread in paleo oceans, but today are found only in rare meromictic lakes. The rates of carbon preservation in such lake environments, both modern and ancient, are not well understood. Owing to their smaller size, lakes experience more frequent and stronger redox shifts than oceans. When a lake environment is influenced by geological events such as volcanism, hydrothermal fluids intrusions, or ocean transgression, the process of organic matter preservation and burial becomes more complicated. Here, we used major and trace elements, iron speciation, organic carbon isotope ($\delta^{13}C_{org}$), and pyrite sulfur isotope data ($\delta^{34}S_{py}$) to determine the relationship between organic carbon preservation and anoxic conditions in fine-grained sediments from different lacustrine depositional environments (Early Permian, Middle Triassic, Late Cretaceous and Middle Eocene) of China. Our findings suggest that conditions in these paleolakes were mainly ferruginous, and were accompanied by high preservation of organic matter in sediments. Despite potential inputs of S by volcanism, hydrothermal fluids input, or transgression, bacterial sulfate reduction depleted sulfate sufficiently to maintain ferruginous conditions. We further propose that ferruginous conditions may have been common in ancient large lacustrine systems across diverse palaeogeographic settings. Given the large size (up to 370,000 km^2; comparable to the modern Black Sea) of such areas, they may have been significant for the global long-term storage of organic carbon, with sizeable effects on global geochemical cycles.