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Sedimentary porewater geochemical profiles in the geological past archived in authigenic pyrite

ZHOU WANG

China University of Geosciences, Wuhan

Marine authigenic pyrite has been widely used to reconstruct depositional and diagenetic environments in modern and ancient oceans. Geochemical heterogeneity of pyrite at micrometer scale, however, complicates the interpretation of stratigraphic variations in geochemical signatures of pyrite. Despite such heterogeneity, geochemical data of authigenic pyrite can provide useful information about ancient diagenetic environment and porewater geochemistry. We conducted *in situ* geochemical measurements of sulfur isotopic compositions and trace element contents of rod-like authigenic pyrite nodules from latest Miocene and middle Pleistocene deep-sea sediment cores. The results show remarkable geochemical heterogeneity between and within pyrite nodules, but reveal a consistent pattern of radially increasing $\delta^{34}S$ values accompanied with increasing [Ba] and [Mn] but decreasing [Mo] and [Ni] from the center to the outer rim of the pyrite nodules. We hypothesize that these geochemical gradients reflect porewater geochemical profiles, which were recorded during the centrifugal growth of the pyrite nodules as they were buried in progressively greater depths in the sediment. Analogous to tree rings that record paleoenvironmental variations through time, authigenic pyrite has the potential to capture porewater geochemical profiles in sediment column. This study highlights the geochemical complexity of authigenic pyrite and cautions its simplistic application in paleoenvironmental studies, but it also illustrates the importance of authigenic pyrite as a valuable archive of local porewater geochemistry in the geological past.