Coupled S and Fe isotope evidence for sulfate-driven anaerobic oxidation of methane

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Sulfate-driven anaerobic oxidation of methane (SO_4-AOM) is an important biogeochemical process in marine sediments, which prevents the release of methane to the water column [1]. During this process, hydrogen sulfide is released and eventually results in the formation of pyrite when sufficient iron is available [2]. The geochemical cycles of sulfur and iron are intrinsically linked and eventually archived in pyrite [3]. Studies on both sulfur and iron isotopic compositions of pyrite consequently provide deeper insight into SO_4-AOM in methane-bearing sediments.

In this study, we analyzed the isotopic compositions of authigenic pyrite from two seafloor sites in the Shenhu seepage area, South China Sea. Both sulfur and iron isotopic compositions of pyrite reveal similar patterns with depth in both cores, displaying an extreme variability in $\delta^{34}S$ values ranging from –47.6 to +114.8‰ [4], and a relatively wide range in $\delta^{56}Fe$ values ranging from –0.793‰ to +0.267‰ [5]. Interestingly, the enrichment of ^{56}Fe in pyrite in the deeper parts of the studied cores coincides with high pyrite abundance and corresponding extremely high $\delta^{34}S$ values of pyrite. These observations support the conclusion that pyrite formation resulted from SO_4-AOM in the sulfate-methane transition zone. Therefore, the coupled enrichments of ^{34}S and ^{56}Fe in pyrite may represent a tracer for SO_4-AOM in modern and ancient sedimentary sequences.

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