Can organic haze and O2 plumes explain patterns of sulfur mass-independent fractionation during the Archean?

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The existence of mass-independently fractionated sulfur in Archean rocks is almost universally accepted as evidence for low atmospheric O_2 and O_3 concentrations at that time. But the detailed patterns of the $\Delta^{33}S$ values and of the ratios $\Delta^{33}S/\delta^{34}S$ and $\Delta^{36}S/\Delta^{33}S$ remain to be explained, and the mechanism for producing the mass-independent fractionation remains controversial. Here, we explore the hypothesis that the relatively low $\Delta^{33}S$ values seen during the Mid-Archean, 2.7-3.5 Ga, were caused by the presence of organic haze produced from photolysis of methane. This haze helped shield SO_2 from photolysis, while at the same time providing surfaces on which unfractionated short-chain sulfur species could condense. The evolution of oxygenic photosynthesis, and the concomitant disappearance of organic haze towards the end of the Archean allowed more negatively fractionated S_4 and S_8 to form, thereby generating large positive fractionations in other sulfur species, including sulfate and H_2S. Reduction of this sulfate to H_2S by bacteria, followed by incorporation of H_2S into pyrite, produced the large positive $\Delta^{33}S$ values observed in the Neoarchean rock record, 2.5-2.7 Ga.