New sulfur isotopes 1-D photochemical model for revealing early earth's atmosphere

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Constraining the atmospheric composition of planets is essential to understanding habitability. However, the chemical composition of the early Earth's atmosphere is poorly understood. Here, mass-independent fractionation of sulfur isotopes (MIF-S) in pre-2.4 Ga sedimentary rocks provide a hint of atmospheric composition at that time. For the early Earth, it is believed that partial pressure of O_2 was very low and atmosphere was reducing. Recently, our sulfur dioxide (SO_2) photochemical experiments under carbon monoxide (CO) atmosphere reproduced the $\Delta^{36}S/\Delta^{33}S$ slope from the Archean (˜−1), which is the most basic character of Archean MIF-S (Endo et al. 2016). Moreover, it was found that the MIF-S trend depends on total pressure, indicating that MIF-S is sensitive to absorption spectral shape of SO_2 via SO_2’ s own UV absorption (Endo et al. 2019). We synthesized SO_2 isotopologues absorption spectra which reproduce the MIF-S of photochemical experiments (Endo et al. 2019). Therefore, we can predict MIF-S produced in various atmospheric compositions using the SO_2 isotopologues absorption spectra and irradiative UV spectra, and the resulting MIF-S depends on altitude. Here, we develop a 1-D (vertical) photochemical model including 4 sulfur isotopes (^{32}S, ^{33}S, ^{34}S, and ^{36}S) and very high resolution SO_2 absorption spectra (˜0.0004 nm). This new model is based on previous models including sulfur isotopes and low wavelength resolution SO_2 absorption spectra (Claire et al. 2014; Izon et al. 2017). We will present preliminary results and discuss the meaning of MIF-S in Early Earth rocks and modern atmospheric sulfates, if possible, Martian meteorites.

Keywords: Earth's Early atmosphere, Sulfur isotope

