Carbon monoxide as a key to understand early Mars and Earth

Y. UENO[1,2,3]

[1]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo, 152-8551, Japan. (ueno.y.ac@m.titech.ac.jp)
[2]Earth-Life Science Institute (WPI-ELSI), Tokyo Institute of Technology, Tokyo, 152-8550, Japan
[3]Department of Subsurface Geobiological Analysis and Research (D-SUGAR), Japan Agency for Marine-Earth Science and Technology, Natsushima-cho, Yokosuka 237-0061, Japan

Mars' atmospheric CO_2 has been enriched in ^{13}C since 4.0 billion years ago. Carbon escape into space may explain the ^{13}C-enrichment, though escape via sputtering is not applicable to the early Mars when a magnetic field was present. Alternatively, solar ultraviolet photolysis of CO_2 may cause large carbon isotopic fractionation [1], though the effect had yet to be tested based on laboratory experiment. We have conducted UV photolysis of CO_2 in laboratory and for the first time demonstrate that photolysis of CO_2 by solar-like broadband UV irradiation causes a large negative carbon isotopic fractionation ($\varepsilon < -130‰$). This result indicates that the produced CO should exhibit highly ^{13}C-depleted composition and may in turn explain the ^{13}C-enrichment of early Martian CO_2. Under a reducing atmosphere, CO is likely transformed into simple organic compounds including aldehydes and carboxylic acids. Thus, if the scenario is correct, we predict that highly ^{13}C-depleted organic matter may be deposited in early Martian sediments.

On early Earth, such an elevated level of CO may also explain the anomalous ^{13}C-depeletion in late Archean sediments from 2.7 to 2.5 Ga, which has been interpreted as the result of global methanotrophy [2]. Our recent study on sulfur photochemistry [3] also suggested that the late Archean atmosphere would have been very reducing, possibly including % level of CO or CH_4, in order to explain the S-MIF record including ^{36}S.

In summary, the atmosphere of the early Earth and Mars may have been rich in carbon monoxide, that could have played a significant role on the origin and evolution of biosphere.

[1] Schmidt et al. (2013) *PNAS* **110**, 17691-17696. [2] Hayes (1994) *Early Life on Earth* **84**, 220-236. [3] Endo et al. (2016) *EPSL* **453**, 9-22.