SOME CONSIDERATIONS REGARDING OXYGEN COMPOSITION IN THE LUNAR SOIL.

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Introduction: From the analyses of the Geotail Mission, Seki et al. [1] suggested that about 10 % of O^+ ions escaping from the terrestrial upper atmosphere encountered the lunar surface, which may be discernible if their isotopic composition were distinct from oxygen implanted on lunar soils by SW [2]. If confirmed, the existence of terrestrial oxygen would impose unparalleled means to trace the evolution of biotic oxygen atmosphere in the Earth through lunar soil studies. Here, we examined possible oxygen isotopic fractionation in the upper atmosphere above 100 km.

Methods: Current information on the isotopic composition of O either by measurements (e.g. [3]) or theoretical calculation is limited to < 100 km, and is not useful in accessing the isotopic characteristics of oxygen ions, of which escaping must start above 100 km. We made 1D numerical photochemical model on the isotopic composition of O^+ including oxygen and nitrogen chemistry with ion, neutral, and electron processes in the altitude 100-800km. In order to examine the isotopic composition of O^+ (which includes ^{16}O, ^{17}O, ^{18}O) at >100 km, we solved 60 sets of photochemical reaction equations including oxygen isotopes for 21 molecular species, atoms, ions, and electrons. Here, we considered the following three major reactions.

$$^{i}O^{+} + {}^{16}O^{16}O \rightarrow {}^{16}O^{16}O^{+} + {}^{i}O$$

reaction rates are k_i, where i = 16, 17, 18.

Since reaction rates are not known, we examined the dependence of the isotopic composition of O^+ on relative magnitude of reaction rates k_{17}/k_{16} and k_{18}/k_{16} on the above reactions. Although the basic scheme of our calculation is standard and similar to those by previous workers [e.g. 4], our calculation is the first attempt in examining the isotopic composition of O^+ in high altitude (>100 km).

Results and conclusions: We found that O^+ number density overwhelms that of O_2^+ above ~ 300 km, being consistent with the observation that Earth escaping ions are essentially O^+.

Around 300 km where O^+ number density reaches maximum, $\Delta^{17}O$ values show > 20‰, provided that the reaction rates in the reactions for k_{17}, and k_{18} are smaller by 10% than that of k_{16}. We are currently investigating to see if this much difference in reaction rate is theoretically feasible.

References: [1] Seki K. et al. (2001) *Science* 291:1939-1941. [2] Ozima M. et al. (2007) *LPSC XXXVIII*, 1129-1130. [3] Boering K. A. et al. (2004) *GRL* 31:LO3109. [4] Lyons J. R. (2001) *GRL* 28:3231-3234.