Experimental study on synthesis of Ammonia and Organic Nitrogen species by Photochemistry on Terrestrial Planets

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Nitrogen fixation and subsequent abiotic synthesis of organic nitrogen is important for origin of life on Earth and other terrestrial planets. Particularly, a planet where atmospheric CO_2 pressure is low, UV may penetrated down to the surface and can directly photolyze liquid water. Thus UV-induced photochemistry may have been more important. However, little is known about abiotic nitrogen fixation by UV light under various redox condition. We have examined the nitrogen photochemistry at the surface of water. In our experiment, initial gas contains N_2O or N_2 with or without CO/CO_2 under the presence of liquid water. The results showed that NH_3, methylamine, glycine and other amino acids was produced from $N_2O + CO + H_2O$, whereas only trace amount of NH_3 was formed from $N_2 + CO + H_2O$. When gas phase do not contain CO, nitrate and nitrite were produced instead of NH_3. A numerical model including over 300 photochemical reactions was constructed, and can qualitatively explain the formation of NH_3 from N_2O. However, the concentration of NH_3 in the model is order of magnitude lower than the observed amount in the experiment, suggesting that current photochemical model still lack a key reaction to produce NH_3. The results showed that ammonia can be formed by photochemistry starting from N_2O, which may provide important insights on the origin of life on terrestrial planets.