# Abstract


Geologic evidence demonstrates that 3.5 Gyr ago the planet Mars held liquid water on its surface, active volcanoes and a denser atmosphere. These conditions are alike to those present on early Earth when life arose. Therefore the volcanic environment of early Mars was reproduced experimentally. The purpose was to determine the role of volcanic lightning in the production of reactive nitrogen, a key element for life. Volcanic lightning may have been produced during explosive eruptions that were common in Mars as is shown by numerical simulations and observational evidence. The volcanic gas composition was derived from an accretional model of Mars and the carbon-nitrogen ratio of Martian meteorites. Volcanic lightning was simulated by a hot plasma produced by focusing a high-energy infrared laser in a closed flask that contained a gas mixture. Various nitrogen mixing ratios were considered in order to obtain a relationship between the products with nitrogen and the amount of $N_2$ in the sample. In order to have a closer reproduction of volcanic environments, a series of experiments included basalt for its ablation. The analysis of products of the simulation was performed using a gas chromatograph coupled to an infrared detector and a quadrupole mass spectrometer. The products detected were hydrocarbons and hydrogen cyanide (HCN), the only nitrogenated compound. HCN is a key molecule for prebiotic chemistry because it forms amino acids and nitrogenated bases. Energy yields of this compound have a lineal behavior as function of the amount of $N_2$. The abundance of HCN formed is similar in the experiments that include basalt ablation and in those where only the gas mixture was irradiated, so these last experiments are a good reproduction of volcanic environments. The amount of energy available in volcanic lightning is calculated to be ~ $8 \times 10^{17}$ J $yr^{-1}$ that may produce about $10^{11}$ g $yr^{-1}$ of HCN. Endogenous and exogenous sources of reactive nitrogen were calculated. The most relevant are the endogenous ones, among which storm and volcanic lightning produced the most important quantities of nitrogen available for prebiotic synthesis. Storm lightning would generate NO which would be converted to ammonia by reacting with $Fe^{+3}$ and water. Ammonia and HCN would react producing compounds important for life.