
Introduction: One of the open issues on the origin of life on Earth refers to the role that the delivery of volatiles had in atmospheric evolution and ulterior appearance of life. Typical uncertainties involved with accretionary rates are several orders of magnitude wide [1], also exacerbated by the unknown number of large impacts with energy capable of causing erosion of the primordial atmosphere and hydrosphere [2]. Xe isotope data provide evidence of a 99% of the Earth’s early atmosphere being lost within the first 100 Myr [3]. The main population of impactors was presumably formed by easily disrupting ice-rich bodies that could enrich the volatile-depleted content of terrestrial planets [4]. These bodies were scattered from the outer solar system regions as consequence of the giant planets migration invoked by the Nice model [5]. We explore here the chemical conditions of the Earth’s atmosphere during the Late Heavy Bombardment (LHB) taking into account the outgassing of chondritic materials [6] and enhanced cometary flux.

Procedure: We have theoretically studied the atmospheric conditions by doing equilibrium calculations using the thermodynamic values given in [7]. Several scenarios of reducing (H2-rich) and oxidizing (CO2-rich) atmospheres are considered to study the stability of CH4 and NH3 and the formation of organic compounds. By considering the reaction: H2(g) + CO2(g) ↔ H2O(g) + CO(g) with the partial pressure of molecular hydrogen typically assumed in literature 10^-7 ≤ pH2 ≤ 10^-3 [e.g. 8] the CO2 seems to be the main oxidizing agent during the LHB. We also explore a presumable reaction in such scenario: 4H2(g) + CO2(g) ↔ 2H2O(g) + CH4(g); that, under mild surface temperatures required to keep liquid water, also produces significant methane.

Results: The methane played a key role in the Hadean terrestrial atmosphere [9]. Not only for an outgassed reducing atmosphere [6], if not even for an atmosphere dominated by CO2. The CH4 abundances estimated here (10^-4 ≤ pCH4/pCO2 ≤ 1) have UV shielding implications for atmospheric stability and production of organics [9, 10]. We envision a scenario where meteoric metals could act as catalysts for the formation of complex organic compounds during ablation processes [11] from simple precursors such as CO2 and CH4, thus promoting increasing complexity.