**Darwin Meets Dr Frankenstein: Using the Drake Equation to Calculate the Probability of Volcanic Lightning's Impact on Chemical Evolution**

Nitrogen and phosphorus are the two most important elements for the creation of Life. Nitrogen is contained in all aspects (structural-proteins, catalytic-enzymes and ribosomes, metabolic-ATP and information-DNA / RNA) of biomolecules that are important for one or more typically biological processes, such as cell division, morphogenesis or development. In order to be used for prebiotic synthesis, nitrogen must be converted to hydrocyanic acid, ammonia or nitrate during the nitrogen fixation process. In addition, phosphorus is present in ribosomes, ATP, RNA and DNA molecules. Phosphorus can be found in nature in the form of minerals - *apatite* ($Ca\_{5}(PO\_{4})\_{3}(F, Cl))$. In order to participate in prebiotic synthesis, phosphorus must be reduced to hydrophosphite or phosphite. Volcanic clouds of ash and gas represent a suitable environment for the synthesis of organic molecules and their rapid removal from the reaction zone (Markhinin & Podkletnov, 1977). Volcanic gases contain all the necessary components for the formation of prebiotic constituents. In addition, volcanic ash contains minerals of sufficient surface area and catalytic properties also required for prebiotic synthesis. Volcanic clouds of ash and gas represent an efficient source of energy due to high temperature and strong electrical discharges (Schwartz and Henderson-Sellers, 1983). In other words, for chemical evolution to be possible, a nitrogen fixation process is required to form hydrocyanic acid (HCN) and ammonia ((N$H\_{3}$). It is lightning that successfully produces (N$H\_{3}$and HCN (Stribling & Miller, 1987). More specifically, volcanic thunderstorms formed in volcanic clouds during high-explosive eruptions represent a significant source of reactive nitrogen and phosphorus. During these eruptive episodes, pyroclasts (rapid flows of hot gas) are formed, which further creates strong electric fields that generate lightning discharges and photochemical processes that simulate a natural chemical reactor.

Drake's equation (Dominik & Zarnecki, 2011) estimates the current number of alien species communicatively capable of searching for other intelligent species (SETI).

$$N=R\_{\*}f\_{p}n\_{p}f\_{1}f\_{i}f\_{c}L$$

$N$ represents the number of civilizations that are detectable by electromagnetic emission, $R\_{\*}$ is the formation rate of the corresponding stars, $f\_{p}$ is the fraction with planetary systems, $n\_{p}$ is the number of planets in such systems suitable for life, $f\_{1}$ is the fraction at which life actually develops, $f\_{i}$ is the fraction with the planets on which intelligent life can occur, $f\_{c}$ is the fraction of the planets that developed a civilization with the necessary signal detection technology and $L$ is the time frame during which these civilizations emit such signals. Although Drake's equation was initially designed to solve this problem, due to its key characteristics, such as identifying relevant parameters in estimating the probability of a particular phenomenon and highlighting the source of uncertainty of that phenomenon, it can also be used in a wider variety of problems. For example, Drake's equation can be used to identify the time frame in which lightning was important for horizontal genetic transfer (Kotnik, 2013).

In this presentation, I will try to present another use of Drake's equation on the example of calculating the probability of the influence of volcanic lightning on chemical evolution. In addition to the general quantitative elements of Drake's equation, the essential parameters (Navaro-Gonzalez et al., 1998) would be:

- Temperature and pressure of eruptive materials T (1700°C or more) and P (between 200 and 1000 mbar)

- Soil heat dissipation rate E (340 mW $m^{-2}$)

- Energy yield of HCN nitrogen fixation (~6x$10^{14}$ molecules $J^{-1}$)

- Phosphite saturation in volcanic minerals C$H\_{4}$ (between 1 and 10%)

In this way, we get a formula that can predict the probability of chemical evolution or prebiotic synthesis due to the influence of volcanic thunder.

**Keywords:** *nitrogen fixation, prebiotic synthesis, chemical evolution, Drake's equation, volcanic thunder*