



Lightning in anoxic atmosphere of early Earth

Yuriy Serozhkin

V. Lashkaryov Institute of Semiconductor Physics, 41 Prospekt Nauky, Kyiv 03028, Ukraine

e-mail: yuriy.serozhkin@zeos.net

The terrestrial lightning a long time are considered as one of components determining a physical state and chemical structure of an atmosphere. Liebig in 1827 has considered a capability of nitrogen fixation at discharges of lightning [1]. Recent investigations have achieved that production rate of NO_x due to lightning at $3 \cdot 10^6$ ton/year (Lamarque et al. 1996) [2]. After Miller's experiments the lightning discharge are considered as one of the energy sources for synthesis of biochemical compounds both in Earth's atmosphere and in atmospheres of others bodies of Solar system [3... 7].

At an estimation of influence and degree of thunderstorm activity in atmosphere of the early Earth, and in particular, that is important for an estimation of a role of electrical discharges during formation of biochemical compounds in anoxic atmosphere are possible to formulate two questions:

- from what moment of time there were conditions for electrical discharges in an atmosphere;
- up to what time, and how we can trace existence of lightning.

The modern thunderstorm activity is determined by presence of water in an atmosphere and on a surface of the Earth, and also physical properties of the atmosphere (pressure, temperature, gradient of temperature). The hydrosphere already existed approximately in the same volume during the early Earth. The chemical structure of an atmosphere plays a role through influence on temperature and gradient of temperatures. For example, the increase of concentration CO_2 gives to global warming. On some estimation in modern conditions the climate warms by 3.8 degrees will increase quantity of lightning at 50 % [Colin Price, 2004].

It is necessary to tell that the electrostatic charging of thunderstorm clouds not received

a satisfactory explanation. One of not explained properties is the formation at the altitude 6 . . . 8 km at temperature about 15° the negatively charged layer by thickness some hundreds meters. At this altitude at such pressure the water can exist in three phases. In this layer because of interaction of the ice crystals with snow pellets there is a separation of charges.

Apparently, we should orient by existence of such requirements, as requirements necessary for formation unlike charged regions in clouds and development of electrical discharges.

What tracks of thunderstorm activity it is possible to search in the past?

It is know that the cloud - ground lightning frequently tracks in ground, so-called fulgurites, the alloyed fragments of surface, in which has struck the lightning. There are two classes of fulgurites: sand fulgurites and rock fulgurites. Since fulgurites are real glasses, they are very resistant to weathering and are usually well preserved for a long period of time. For this reason they are used as paleoindicator. It would be interesting to study the opportunity of definition of the lightning stroke date.

References

1. von Liebig, J. Am. Chem. Phys. **38**, pp.329-333 (1827)
2. Lamarque et al. 1996 *J.Geophys. Res.*101, 22955-68
3. Miller, S. L. *Science* **117**, 528 (1953)
4. C. Chyba, C Sagan. "Electrical energy sources for organic synthesis on the early Earth". *Orig Life Evol Biosph.* 1991;Vol. 21:pp3-17.
5. Navarro-Gonzalez R, Ramirez SI, de la Rosa JG, Coll P, Raulin F. "Production of hydrocarbons and nitriles by electrical processes in Titan's atmosphere". *Adv Space Res.* 2001, 27(2), pp.271-282.
6. Desch, S.J., Borucki, W.J, Russell, C.T. and Bar-Nun A, „Progress in planetary lightning”, *Rep. Prog. Phys.* **65** (2002), 955-997
7. W. I. Chameides, J.C. G. Walker, A. F. Nagy, "Possible Chemical impact of planetary lightning in the atmosphere of Venus and Mars" *Nature*, 280, 820-822, 1979.
8. Colin Price, NATO Advanced Study Institute on Sprites, Elves and Intense Lightning Discharges, Corte in Corsica, July 24-31, 2004