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Liquid hydrocarbon seeps on Mars hypothesis: A link between geology and life

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Abstract

We focus on hydrocarbons and their connection with life and we make a small introduction to hydrocarbons in the solar system. We discuss the potential liquid hydrocarbon seeps on Mars and the possible origin for these seepages (primordial, abiogenic, biogenic). In addition, we ask the questions whether Mars could hold a deep subsurface biosphere and if there could be a relationship between this hypothetic biosphere and geological processes such as hydrocarbon maturation.

Background

The chemistry of life, as we acknowledge, is a chemistry based on the element carbon (C). Hydrocarbons are molecules constituted by the elements hydrogen (H) and carbon (C) and they can be found throughout the solar system.

We have previously considered the possibility of liquid hydrocarbon seepages on Mars. In fact, we proposed that the numerous dark slope streaks near the Martian equatorial region and a variety of dark features found on the Martian South Pole, seen in Mars Orbital Camera (MOC) images, could be potential liquid hydrocarbon seeps (Direito and Webb, 2007). At this moment, we will explore the relation between geology and life applied to these possible liquid hydrocarbon seeps phenomena.

Most of the following on Mars is based on analogy with planet Earth. Indeed, we focus on the possibility of liquid hydrocarbon seepages on Mars using terrestrial oil as a reference.

Discussions

There are two main theories for the origins of terrestrial oil: the biogenic theory and the abiogenic theory. The biogenic theory states that the organic compounds that generate the oil are derived from the remains of ancient living matter. On the other hand, the abiogenic theory for oil and gas formation (Mendeleev 1877, Sokoloff 1889, Kudryavtsev 1959, Robinson 1966, Gold 1992, Gold 1999), argues that the terrestrial oil and natural gas are originated from deep carbon deposits derived from hydrocarbons from the initial formation of the Earth. We will call these hydrocarbons primordial in origin. Therefore, we consider that the Martian liquid hydrocarbon seeps might be biogenic, primordial or abiogenic in nature, or even a mixture of these.

But could Mars hold a deep subsurface biosphere? On Martian surface, the low atmospheric pressure, the UV radiation, and its oxidizing properties currently generate an inhospitable environment that is incompatible with life. However, the same does not apply to the Martian subsurface environment. Thomas Gold (1992) defended that subsurface life may be widespread within the solar system because many of its planets, while having harsh surfaces, have suitable conditions below the surface.

Could there be a relationship between this hypothetic Martian biosphere and geological processes such as hydrocarbon maturation? Hydrocarbon reservoirs may be a rich carbon source for potential life forms. In fact, geologists know the existence of active microbial communities in terrestrial oil reservoirs since 1926 (Bastin *et al*., 1926).

On Earth, organic matter during burial produces the volatile fatty acid (VFA) acetate, providing a potential energy source for a deep biosphere (Wellsbury *et al*., 1997). Indeed, VFAs are also present at elevated concentrations in deep terrestrial oil-reservoir-formation waters (Wellsbury *et al*., 1997). Wellsbury *et al*. (1997) showed that relatively low-temperature heating during sediments burial amplifies the biological accessibility of sedimentary organic materials. Micro-organisms may well continue to use buried organic matter that is made more accessible due to heating, even in the oil generation temperatures range. Therefore, the terrestrial deep biosphere may play an important role in organic matter maturation (Wellsbury *et al*., 1997). Similarly, we assume the same could occur on Mars.

References:

Bastin, E. S., Greer, F. E., Merritt, C. A., and Moulton, G. (1926). The presence of sulphate reducing bacteria in oil field waters. Science 63, 21–24.

Direito, M. S. and Webb, M. E. (2007). Search for oil reservoirs on Mars (European Astrobiology Network Association 2006 Meeting Abstracts). International Journal of Astrobiology 6(1), 62-63.

Gold, T. (1992). The deep, hot biosphere. Proceedings of the National Academy of Sciences USA 89, 6045-6049.

Gold, T. (1999). The deep hot biosphere, Springer-Verlag, New York.

Kudryavtsev, N. A. (1959). Geological proof of the deep origin of Petroleum. Trudy Vsesoyuz. Neftyan. Nauch. Issledovatel, Geologoraz Vedoch. Inst. 132, 242-262.

Mendeleev, D. (1877). L'Origine du pétrole. Revue Scientifique, 2e Ser., VIII, 409-416.

Robinson, R. (1966). The origins of petroleum. Nature 212, 1291-1295.

Sokoloff, W. (1889). Kosmischer Ursprung der Bitumina. Bull. Soc. Imp. Natural Moscau, Nouv. Ser.3, 720-739.

Wellsbury, P., Goodman, K., Barth, T., Cragg, B. A., Barnes, S. P., and Parkes, R. J. (1997). Deep marine biosphere fuelled by increasing organic matter availability during burial and heating. Nature 388, 573-576.