COMETARY PETROLEUM IN HADEAN TIME?

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Introduction. Kerogens are abundant by-products of incomplete combustion, pyrolysis and radiation reprocessing of almost any kinds of organic precursors. In the absence of microorganisms, kerogen is one of the most durable and insoluble organic materials. On Earth, important substances are derived from some parent kerogen. They include petroleum and varieties of activated carbon. We question below whether the constituent kerogen of large unmelted Antarctic micrometeorites (AMMs), which was identified from C/N ratios measured with a nuclear microprobe [1] might have been involved in the making of abiogenic crude oil in Hadean times, prior to ~4 Ga. As AMMs are probably cometary dust particles [2, 3], this petroleum would have a "cometary" origin.

Delivery of micrometeorite kerogen to the Hadean oceanic crust. We predict that a huge mass (~5 10^{24} g) of juvenile micrometeorites (JMMs) was accreted by the Earth, during the first ~200 Ma of the post-lunar period – see Ref. 2. Recent AMMs flux measurements [4] show that at least ~20 wt.% of the micrometeorites survive unmelted upon atmospheric entry [4]. As their kerogen represents about 2.5 wt.% of carbon, this amounts to a total mass of kerogen on the early Earth's surface (~2.5 10^{22}g) equivalent to a ~40 m thick global layer. A large fraction of the unmelted JMMs were deposited on the early oceanic crust, which was formed very soon after the formation of the Moon around ~4.4 Ga ago.

A slow burial in deep sea sediments that mimics that of dead plankton. On the Earth, bitumen- and kerogen-rich shales are the source rocks of petroleum. In the biogenic scenario most petroleum exploited today was derived from tiny plants and organisms (i.e., plankton) that thrived in the top layers of the oceans during the Jurassic. When they die they accumulate on the sea floor (like kerogen-rich unmelted micrometeorites), where they get steadily buried in sediments. At depths larger than a few hundreds meters, their residual organics yield kerogen whereas sea sediments are transformed into shales. Then, at larger depths in the "*oil window*" (between ~0.5-5 km), the heat and pressure break down kerogen to form petroleum.

Surprisingly, kerogen-rich micrometeorites would have followed an abiogenic fate that surprisingly well mimics the biogenic fate of dead plankton. This led to the abiogenic formation of crude oils at a time of intense impact fracturing, prior to ~4 Ga ago. This likely led to some giant spills of the abiogenic petroleum that could have formed kinds of gigantic mega-films of oil on the oceans, which did capture unmelted micrometeorites and various micrometeoritic "smoke" particles released upon atmospheric entry. Did this "*dusty black tide*" cosmic machinery open new reaction channels in the prebiotic chemistry of life?

References: [1] Matrajt G. et al. 2003. *MAPS* 38: 1585-1600. [2] Maurette M. 2006. *Micrometeorites and the Mysteries of our Origins* (Springer Berlin Heidelberg), pp. 1-330. [3] Maurette M. and Kurat G., this volume. [4] Duprat et al, this volume.