Xenon isotopes in Archean kerogens: on the syngenetic origin of ancient organic materials and evolution of the primitive atmosphere

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Organic matter trapped within Archean sedimentary rocks provides a unique insight into the emergence of early life [1]. However, the potential for postdepositional contributions of carbonaceous matter may question the syngeneticity of organic materials and their ancient host rocks, hence limiting the potential for dating the emergence of life on Earth. Novel criterion is therefore required to guarantee accurate dating of organic materials recovered from Archean rocks.

Organic matter was recently identified as a novel archive of the ancient atmosphere [2]. Because the isotopic composition of atmospheric Xe evolved through time by mass dependent fractionation [3], the degree of Xe isotopic fractionation in kerogens relative to modern atmosphere can provide a time stamp for the last chemical equilibration between the organic matter and the atmosphere [2]. Here, we present new Xe isotopic data for kerogens isolated from 3.4 - 1.8 Gy-old rocks, some of which are abundant in microfossils. Comparing model ages derived from Xe isotopes with the geological age of host rocks allows the syngeneticity of ancient organic materials to be tested. Implications regarding our understanding of the composition and evolution of the Archean atmosphere, as well as the time window for the emergence and diversification of life during the Archean eon, will be discussed.

[1] Delarue et al. (2016) *Astrobiol*. [2] Bekaert et al. (2018) *Sci. Adv*. [3] Avice et al. (2017) *Nature Com*.