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The end of the atmospheric xenon Archean's evolution: a study of the Great Oxygenation Event period

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Several geochemical tracers (S, C, O, Xe) underwent irreversible global changes during the Precambrian, and in particular during the Great Oxygenation Event (GOE), between the Archean and Proterozoïc eons [1].

Xenon is of particular interest as it presents a secular isotopic evolution during the Archean that ceased around the time of the GOE. In this regard Xe is somewhat analogous to mass-independent fractionation sulfur (MIF-S) in that it can be used to categorically identify Archean atmospheric components [2]. Xe isotopes in the modern atmosphere are strongly mass-dependent fractionated (MDF-Xe), with a depletion of the light isotopes relative to the heavy ones. There was a continuous Xe isotope evolution from primitive Xe to modern Xe that ceased between 2.6 and 1.8 Ga [2] and this evolution has been attributed to coupled H^+-Xe^+ escape to space [3].

The purpose of this project is to document the noble gas composition of paleoatmospheric noble gases trapped in well-dated hydrothermal quartz fluid inclusions with ages covering the Archean-Proterozoic transition.

Our preliminary results from 2441 ± 1.6 Ma hydrothermal quartz veins from the Seidocherka sedimentary formation (Imandra-Varzuga Greenstone belt, Russia) indicate that Xe isotopes are marginally fractionated in favour of the light isotopes by 2.06 ± 1.80 (2σ) ‰.u^{-1} relative to the modern atmosphere. However, younger pods quartz from the Ongeluk formation (Kaapvaal Craton, South Africa) which formed at 2423 ± 3 Ma is similar to modern Xe (0.6 ± 2.1 (2σ) ‰. u^{-1}). Thus, the fractionation process appears to have stopped between the formation of these two samples, which is shortly after the final appearance of MIF-S in the geological record (2.45 Ga). For Xe, massive escape of H^+ advocated to lift Xe^+ through the atmospheric column might have ended up due to oxidation.

[1] Catling & Zahnle, 2020, *Sciences Advances* 6, eaax1420. [2] Avice et al., 2018, *Geochimica et Cosmochimica Acta* 232, 82-100 [3] Zahnle et al., 2019, *Geochimica et Cosmochimica Acta* 244, 56-85.