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# Potential of post-impact hydrothermal minerals as paleo-atmospheric proxies: The case of Rochechouart (France)

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Planetary atmospheres are important reservoirs controlling many parameters defining a planet's habitability (*e.g.* [1]). Temporal changes of the elemental and isotopic composition of volatile elements in the Earth's atmosphere reflect the entire geological history of our planet [2]. However, paleo-atmospheric proxies are scarce and prevent from drawing a clear picture of Earth's evolution through geological time.

In this study, we explored the potential of post-impact hydrothermal minerals as new paleo-atmospheric proxies. We measured the elemental and isotopic composition of Ne, Ar, Kr, and Xe in fluids released from fluid inclusions contained in quartz and carbonate crystals from hydrothermal veins and breccia fillings from the 206.92 ± 0.32 Myr old Rochechouart impact structure in France [3]. Petrographic observations reveal the presence of primary fluid inclusions within quartz and carbonate samples (Fig. 1). Fluid inclusion assemblages indicate coeval trapping of liquid + vapor, liquid-only, and vapor ± liquid inclusions. This is possibly indicative of the boiling of an aqueous fluid at low-pressure conditions under a high geothermal gradient. Noble gas analyses confirm a strong atmospheric signature for the fluids. For neon, only two samples show deviations relative to air, one with a contribution from nucleogenic Ne and one showing mass-dependent isotopic fractionation of Ne isotopes, maybe due to diffusive loss from this sample. $^{38}Ar/^{36}Ar$ ratios are air-like and $^{40}Ar/^{36}Ar$ ratios cluster around 300. The isotopic compositions of Kr and Xe are identical, within errors, to the composition of the modern Earth's atmosphere (Fig. 2).

Results obtained in this study demonstrate the promising potential of post-impact hydrothermal minerals as paleo-atmospheric proxies.

[1]Dehant et al. (2019) *Space Science Reviews* 215, 42. [2] Catling & Zahnle (2020) *Sci. Adv.* 6, eaax1420. [3] Cohen et al. (2017) *Meteorit. Planet. Sci.* 52, 1600–1611;

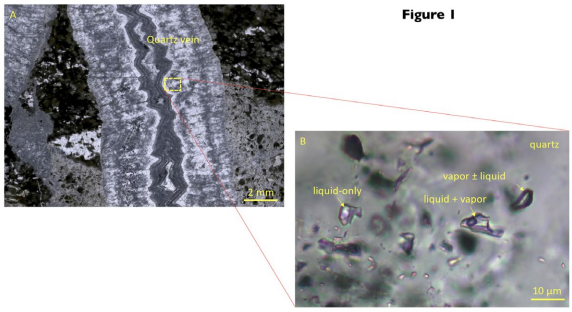


**Figure 1** Petrographic observations. A: Quartz vein cutting through hydrothermally altered host rocks. Alternative clear and dark sectors indicate variable abundances of fluid inclusions. B: Fluid inclusion assemblage indicative of coeval trapping of liquid + vapor, liquid-only, and vapor ± liquid inclusions.

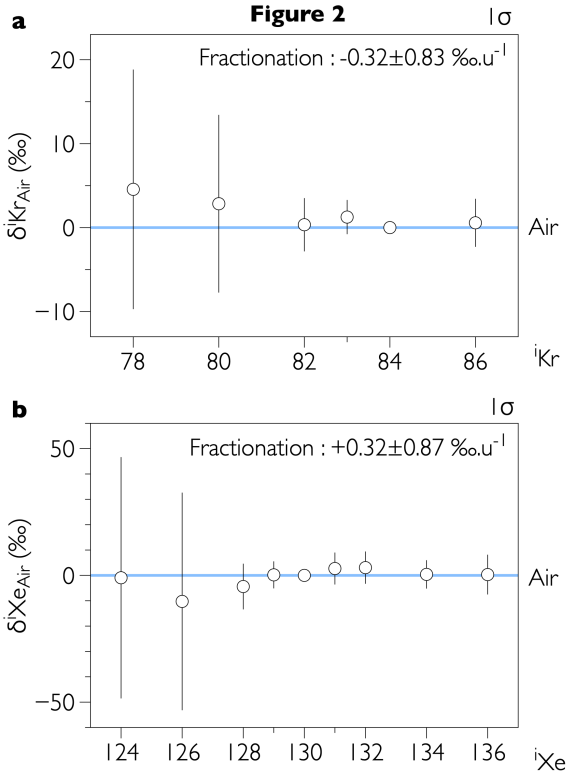


**Figure 2** Average isotopic composition of krypton (a) and xenon (b) of gas released from five samples from Rochechouart (error at 1s).