Defining the residence times of fluids within Precambrian-aged systems

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More than 70% of the continental crust consists of Precambrian crystalline basement and in total, H_2 production from water-rock reaction rivals that of the marine lithosphere [1]. Fluids from these systems indicate their potential isolation over geological timescales [2]. In the South African craton, microbial life has remained isolated within these H_2, He and hydrocarbon-rich fluids over tens of millions of years [3]. These fluids therefore provide a unique window into the Earth's past and enhance our understanding of global H_2 and C cycles. Discovery of microbial biomes allows insight into their survival in the subsurface on geologic timescales and the prevalence and evolution of subsurface life. Furthermore these systems can potentially inform us about the habitability of planets such as Mars. Key questions remain regarding the global distribution of fracture systems, the timescales they operate over, and their degree of isolation. Noble gases are ideal geochemical tracers for constraining these variables.

We present noble gas data from crystalline basement fluids from two parts of the Canadian Shield. Kidd Creek (KC), the site for an earlier study [2], was resampled after 80 months at 2.4 km depth, and new samples were taken from a depth of 2.9 km. Samples were also taken from two mines from the Sudbury basin. In the deeper levels at KC, the greatest radiogenic signals ever measured are observed with $^{40}Ar/^{36}Ar$ ratios reaching 125,000 and an ^{136}Xe excess of 90%. This corresponds to an average radiogenic *in situ* residence time of 2.3 Ga. The resampled upper level meanwhile shows, as hypothesized, a reduction over time in all radiogenic excesses and a younger mean residence time of the fluids (0.4 Ga). Sudbury mines 1 & 2 have a smaller radiogenic excess relative to initial KC, with residence times of 0.3 and 0.5 Ga respectively.

[1] Sherwood Lollar et al. (2014) *Nature* **516**, 379-382. [2] Holland et al. (2013) *Nature* **497**, 357-360. [3] Lin et al. (2006) *Science* **314**, 479-482.