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# Deep fracture fluids isolated in the crust since the Precambrian

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**Introduction:** Water bearing macrosystems that have been isolated from the surface and preserved on geological timescales (>10Ma) are seemingly rare. Nevertheless, the unique insight they provide into the evolution of chemolithotrophic life makes these systems important areas of study. The Witwatersrand Basin in the South African Precambrian Crystalline Shield provides the case type [1,2]. Here, we have determined the noble gas concentration and isotopic composition of 6 gas samples, co-produced with water, from deep exploratory boreholes in a producing mine in the Timmins region of the Canadian Precambrian Crystalline Shield.

**Results:** We show that $^{124,126,128}Xe$ excesses in the Timmins mine fluids can be linked to Xe isotope changes in the ancient atmosphere [3] and can be used to calculate a minimum mean residence time for this fluid of ~1.5Ga. We also resolve in all samples a clear $^{129}Xe$ signal in excess of atmospheric values. Mass fractionation and U fission can be excluded as sources of $^{129}Xe$, and a mantle source is unlikely. We postulate $^{129}Xe$ is sourced in carbon rich metamorphic material of sedimentary origin and extracted by fluid migration processes at ~2.64Ga. Neon isotopic compositions are similar to the Witwatersrand study and are used to validate the closed system assumption for the radiogenic noble gases [1]. Closed system radiogenic noble gas residence times are 1142±64,5 1655±789, 1498±784, 1610±825Ma for $^{4}He$, $^{21}Ne$, $^{40}Ar$, $^{136}Xe$ respectively. Combined together, these complementary strands of evidence lend further support to the hypothesis that ancient pockets of water can survive the crustal fracturing process and remain in the crust for billions of years [4].

**References:** [1] Lippmann-Pipke et al. (2011) *Chem. Geol.* **283**, 287-296. [2] Lin et al. (2006) *Science* **314**, 479-482. [3] Pujol, M. et al., (2011). *Earth Planet. Sci. Lett.* **308**, 298-306. [4] Holland et al., (2013) *Nature*, *in press*.