Contributions to abiotic and biological deep carbon cycling from H_2 sources in the Precambrian continental lithospshere

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Deep saline fracture fluids have been found in billion year old rocks throughout the Precambrian shields of Canada, Fennoscandia and South Africa - geologic terrains that make up more than 70% of the Earth's continental crust. Noble gas studies have provided a range of residence times from millions of years for the subsurface fracture fluids in South Africa [1-2] to more than a billion years for fracture waters from 2.4 km depth in Northern Canada [3]. Dissolved gases in these fluids are dominated by methane and higher hydrocarbons, and up to mM concentrations of H_2, making these environments as H_2-rich as deep sea hydrothermal vents. Production of H_2 from the Precambrian continental lithosphere has doubled the estimates of H_2 produced by radiolysis and hydration of mafic and ultramafic rock compared to previous estimates that were based solely on marine hydrothermal systems [4].

Currently under investigation are the relative contribution and rates of abiotic organic synthesis driven by this H_2 supply, versus incorporation of H_2 into the biological carbon cycle via sulphate reducers and methanogens in these deep subsurface biomes. The discovery that ancient fluid environments capable of supporting life from water-rock reaction and abiotic organic synthesis can remain isolated for up to billions of years in the Precambrian crust changes our understanding of the extent of the Earth's crust that may be habitable, and the role that such potential buried biomes play in preserving, evolving and propagating life on planetary timescales.

[1] Lin et al. (2006) *Science* **314**, 479-482. [2] Lippmann-Pipke et al. (2011) *Chemical Geology* **283**, 287-296. [3] Holland et al. (2013) *Nature* **497**: 367-360. [4] Sherwood Lollar et al. (2014) *Nature* **516**: 379-382.