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Deep ancient fluids in the continental crust and their impact on near-surface economic, environmental and biological systems.

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With a few exceptions the mobility of water, oil and gas, provides for an ephemeral view of subsurface fluids relative to geological or planetary timescales. Aquifers supplying water for drinking and irrigation have mean residence ages from hundreds to tens of thousands of years; Hydrothermal systems can be active for hundreds of thousands to millions of years forming key mineral reserves; Sedimentary basin formation expels fluids during compaction and generates oil and gas on times scales of millions to hundreds of millions of years. Within these exemplar systems biological activity can play a crucial role by mediating system oxidation state: releasing arsenic into shallow groundwaters; precipitating ore bodies; generating methane; and biodegrading oil.

It is becoming increasingly apparent that fluids resident in fractures and porespace in the crystalline basement underlying many of these systems can have a mean residence time that ranges from tens to hundreds of millions of years [1,2] to billions of years [3,4]. These fluids are highly saline and trace element rich; they are abundant in nitrogen, hydrogen, methane and helium and can contain microbes that have uniquely adapted to these isolated environments [5]. We are actively expanding discovery of sites with fluids exhibiting extreme age and have recently shown that these systems contribute to half of the terrestrial hydrogen production; a key component in biosphere energy and carbon cycles [6]. Tectonic or thermal release of these fluids can result in helium deposits; possible ore body generation and the inoculation of near-surface systems with microbial biota protected in the deep surface; the controls and rate of fluid release to shallow systems can fundamentally change the nature of some shallow systems. These deep ancient fluids represent a little tapped scientific resource for understanding how life survives and evolves in such isolation, how life is transported and communicates in extremis together and contains geochemical signals from the ancient atmosphere [4,7]. A cornucopia of science awaits.

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