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Hydrogen and Helium: Is There an Analogue Relationship in Saskatchewan's Uranium Deposits?

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Summary

Helium, which is currently produced in Saskatchewan, is generated through the radioactive decay of uranium and thorium. When the unstable radioactive isotope transforms to a more stable isotope, an alpha particle (which consists of two protons and two neutrons) is emitted from the parent element; this alpha particle then takes up two electrons from the surrounding groundmass or pore space constituents (gas and/or liquid) and becomes a helium molecule. This process is a precursor to primary migration that includes diffusion or advection of the helium into adjacent pore spaces. With the help of a carrier gas (e.g., nitrogen) and associated buoyancy drive, or by continued diffusion, helium continues its upward migration in a secondary phase and is either trapped in the subsurface or released to the atmosphere if a suitable trap is not available. Hydrogen in the subsurface can be generated through several processes, but the radiolysis of water due to the same radioactive decay of uranium and thorium, as well as potassium, is currently considered as one of the major natural sources. Hydrogen, like helium, most likely migrates through the stratigraphic column via buoyancy and diffusion.

Whereas helium is inert and does not react with any mineral or organic matter, hydrogen is very reactive and can be readily consumed or altered throughout the subsurface, including (but not exclusively) by carbon molecules in hydrocarbon-rich rocks, which consume available hydrogen to form longer chain hydrocarbons (Hand, 2023). However, not all is destroyed in the subsurface as evidence of hydrogen seeps exists globally, with some accumulations capable of producing hydrogen for local consumption. Although we currently are not aware of any hydrogen seeps in Saskatchewan, the element is found in the subsurface throughout the Phanerozoic rocks of the Western Canada Sedimentary Basin and may be related to radiolysis, to deep structures or to iron rich basement rocks.

Gas analyses from the deeper portion of the Phanerozoic strata in southwestern Saskatchewan's helium play area have elevated hydrogen (>10%) and are loosely associated with elevated helium (>0.3%). These occurrences, along with hydrogen found adsorbed onto clay minerals overlying uranium deposits in the Proterozoic sandstones of the Athabasca Basin (Truche et al., 2018), provide evidence that this relationship may be a tool to help explore for hydrogen and helium deposits in Saskatchewan.

References

Hand, E. (2023): Hidden hydrogen; Science, v.379, p.630-636.

Truche, L., Joubert, G., Dargent, M., Martz, P., Cathelineau, M., Rigaudier, T. and Quirt, D. (2018): Clay minerals trap hydrogen in the Earth's crust: Evidence from the Cigar Lake uranium deposit, Athabasca; Earth and Planetary Science Letters, v. 493, p.186-197.