geoconvention
Calgary • Canada • May 12-14 2025

Searching for Natural Hydrogen Opportunities in Alberta

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Introduction

Alberta has more than 540,000 wells and there are hundreds of wells with indications of hydrogen significantly above background readings. Natural hydrogen is present within the basin, it does migrate through the sedimentary column and is trapped in all types of reservoirs.

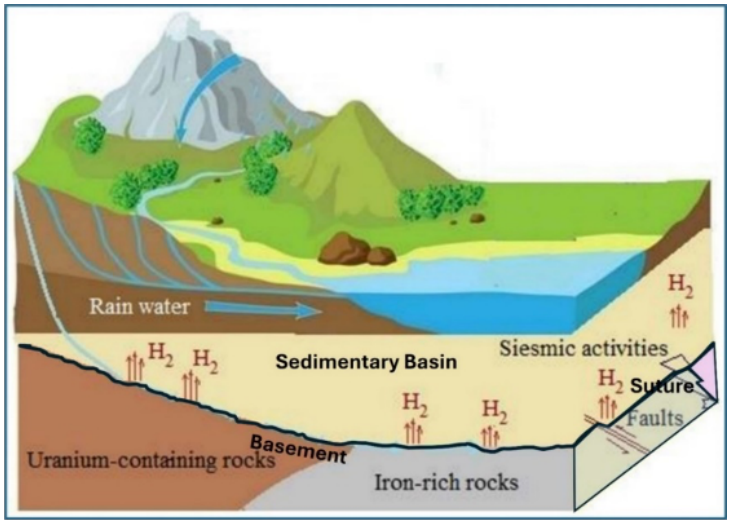

Figure 1 illustrates the potential sources of hydrogen considered by our company to be present in Alberta's Precambrian Basement: 1. Ultramafic and other iron rich rocks 2. Basement geo-bodies enriched in Uranium and other radioactive elements, and 3. Deep crustal and mantle degassing on fracture and suture zones reaching into the basin's sedimentary fill (modified after Knez and Zamani, 2023).

Natural hydrogen in the Alberta Basin mainly comes from three specific processes:

1. **Serpentinization of Mafic and Ultramafic Rocks.** Mafic and ultramafic rocks are composed of mineral phases rich in iron–magnesium–calcium. These rocks comprise peridotites, encountered mostly in the Earth's mantle, and gabbros, found underground in the vicinity of volcanoes and in oceanic crust near mid-ocean spreading centers. Gabbros are also found on continental shields and within mountain chains, conserved in ophiolite and greenstone belts that mark locations of suture zones, sites where ancient oceans have closed during subduction and collision (Zgonik, 2020; Milkov, 2022).

2. **Radiolysis of Water**. Radiolysis is the splitting of chemical molecules under the influence of natural or induced ionizing radiation. The dissociation of chemical bonds happens when a strong energy flux is directed to a certain chemical substance. The radiolysis of water is a phenomenon known for more than one century and it is well understood (Draganić, 2005). Radiolysis can be produced in laboratories and specialised plants, and takes place naturally in the atmosphere, hydrosphere, and Earth's subsurface (Draganić, 2005; Le Caër, 2011). In subsurface radyolisis is produced by radioactive U and Th present in rock formations.

3. **Deep Earth Degassing**. Degassing of primordial hydrogen has been present in the Earth since its formation (Larin, 1993; Gilat and Vol, 2005, 2012; Larin et al., 2015; Yang et al., 2016). Larin (1993), hypothesized that the Earth's core consists of iron and silicon hydrides and thus contains a significant amount of hydrogen, which is gradually released and seeps into the atmosphere. But the theory of this vast, deep deposit of hydrogen is still controversial. However, there are clear records and indications that streams of hydrogen generated in the deep mantle, and even core regions may rise in the melts and then along major faults, suture zones, volcanoes, plate boundaries, failed rift zones and present-day central axis of mid-ocean ridges (Larin et al., 2015; Zgonnik, 2020 and 2022; Lefevre et al., 2022; Milkov, 2022).

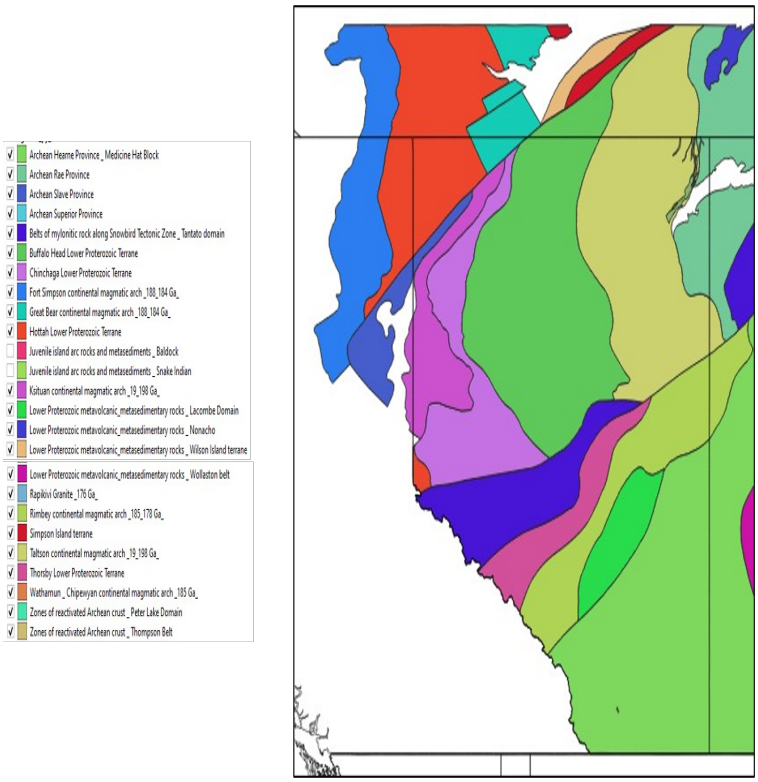

Figure 2: Basement Terrains of Alberta (after WCSB Atlas and AGS).

Archean-aged rocks forming several of the Alberta Basin basement domains are the source rocks for hydrogen. Reactivations of faults and fractures due to the British Columbia accretion collisions of the Laramide Orogeny from the Early Cretaceous to the Oligocene (~75 to 23 million years ago) created additional migration pathways for the generated hydrogen. Alberta's complex geology and tectonics have provided pathways for the hydrogen's upward migration from the basement, throughout geologic time, and this migration continues today (Figure 2).

Methodology

Northern Hydrogen's exploration efforts have been to determine if there are potential areas within the province containing higher concentrations of hydrogen, trapped either as distinct pools or associated within oil and gas pools that could be accessible through either conventional or unconventional drilling techniques and could potentially be commercially exploited. Multiple clastic and carbonate formations were identified with porosity and permeability near or above potential hydrogen source rocks in the basement, making them viable candidates for hydrogen migration, trapping and accumulations of hydrogen gas.

Challenges

We then examined Alberta's extensive well database, consisting of over 540,000 wells, and selected wells with indications of hydrogen in gas tests and categorized the data into three groups: erroneous data, chemically generated shows, and apparent hydrogen shows. This process helped to identify locations and trends with potential hydrogen accumulations and to understand the nature of hydrogen presence in different geological formations. Using this approach, we were able to determine the most promising areas in the Western Canada Sedimentary Basin, and other basins in Alberta.

Apparent hydrogen shows are wells where we cannot explain the test results other than to indicate geologically sourced hydrogen. Most of these wells show some tests, either upon drilling, in an exploration well, or within the production stream as gas or associated gas, where there is a measurement of hydrogen well above the normal background readings of ~0.01%, with 100 to 1,000 times the background of hydrogen within the sample.

Northern Hydrogen also developed an initial commercial hypothesis for natural hydrogen in Alberta, including sources, migration, trapping mechanisms, and production techniques, and a first-cut economic model.

Conclusions

Northern Hydrogen findings confirm that hydrogen is present within the basin, it does migrate through the sedimentary column and is trapped in reservoirs. We have also realized that there are many places where the public data from well tests, and gas sample analysis, is deceiving, inaccurate or simply missing. There are areas within the province that need more investigation and may turn out to be capable of sustained hydrogen production.

Acknowledgements

The authors would like to thank Alberta Innovates, the Geological Survey of Canada, the Alberta Geological Survey for the support and discussions throughout our project.

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