Natural (White) Hydrogen Exploration and Development in Alberta, CANADA

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Introduction - Alberta Hydrogen Plans

National hydrogen strategies are emerging globally, increasing investment and deployment across the hydrogen value chain. Research from Rystad Energy indicates that by the end of 2023, 40 companies were actively seeking natural hydrogen deposits, up from just 10 in 2020 (OilPrice.com, 2024[i]). According to ARPA-E[ii], today, about 100 entities around the world are involved in natural hydrogen exploration. Over 30 countries now have dedicated hydrogen strategies, with a 2020 report identifying 228 large-scale hydrogen projects across various sectors—126 expected in Europe, 46 in Asia, 24 in Oceania, and 19 in North America (Magill, 2021[iii]).

Hydrogen is vital for reducing emissions and transitioning to clean energy. It is projected to meet up to 24% of global energy demand by 2050 (Government of Alberta, 2021[iv]). Interest in hydrogen is shifting from passenger vehicles to heavy-duty applications. It is growing in shipping and aviation, although slow market penetration has led to the cancellation of some projects (International Energy Agency, 2024[v]).

In 2020, Alberta's Recovery Plan sought to integrate hydrogen into its energy systems, with clean hydrogen expected to provide significant environmental and economic benefits (Government of Alberta, 2021). As one of the largest hydrogen producers, Alberta plans to invest $57 million through Emissions Reduction Alberta (ERA) and Alberta Innovates in 28 projects focused on the hydrogen economy and emission reductions (Alberta Innovates, 2024[vi]).

Why Natural Hydrogen

Current hydrogen production technologies fail to meet zero-emission standards due to significant carbon emissions, high costs, or both. In contrast, natural hydrogen, which freely degasses from below the Earth's surface, is constantly available without expensive refining or purification infrastructure. Due to effective emissions management by drilling companies, its net carbon footprint can be zero or negative.

Here’s a brief overview of the costs associated with different types of hydrogen:

Green Hydrogen is produced through electrolysis using renewable electricity to split water into hydrogen and oxygen. Around $7 per kilogram, its cost is highly dependent on electricity prices but decreases as renewable energy costs drop (Winterbourne, 2024[vii]).

Blue Hydrogen relies on natural gas and carbon capture and storage (CCS), making it expensive at $200 per barrel of oil equivalent, compared to oil prices of $58.37 per barrel. This cost reflects both fossil fuel inputs and the complexities of CCS (Winterbourne, 2024). Besides, there is evidence of significant carbon trace associated with "blue" hydrogen manufacturing processes (R. Howarth, M. Jacobson, 2021[viii]).

Grey Hydrogen, which constitutes about 95% of global hydrogen production, is made through either Steam Methane Reforming (SMR) or pyrolysis of natural gas without CCS, resulting in significant CO_2 emissions. It costs approximately £1.50 to £2.50 per kilogram, but its environmental impact reduces its attractiveness (Winterbourne, 2024).

White Hydrogen offers a cheaper alternative, potentially costing below £0.82 per kilogram by leveraging underground reservoirs and near-end users. Additionally, helium, which can be associated with hydrogen, may present a valuable commercial opportunity.

Avalio Pty Ltd. is positioned to leverage its expertise in natural hydrogen resources[ix]. At the same time, Tesseral AI's Seismic Wave Duplex Migration (DWM)[x] technology could enhance the identification and quantification of these resources.

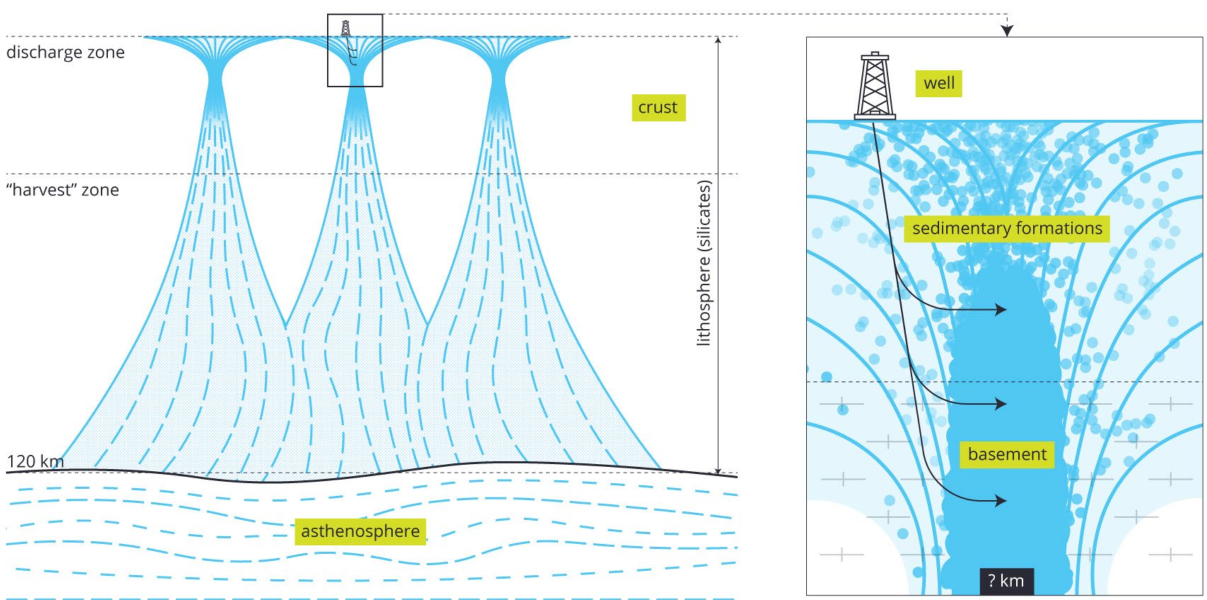

Fig. 1. Modified from: V. Larin, N. Larin, 2008. Hydrogen De-Gassing on the Russian Platform: Pluses and Minuses, ***https://hydrogen-future.com/en/list-c-phenomen-en/75-page-id-22-en.html***

Avalio Pty Ltd. and Tesseral AI are teaming up in Alberta to work with local stakeholders to identify and evaluate geological structures that allow hydrogen to surface and assess their production potential. While our preliminary research is promising, a detailed desktop study and field data acquisition are essential for the project's success.

Theory / Method / Workflow

Our expertise is rooted in the scientifically validated Primordially Hydridic Earth (PHE) concept, developed over 50 years ago to study natural hydrogen as a deep-seated resource that rises to the surface over time. Our research has led to a strong portfolio of intellectual property and the discovery of multiple natural hydrogen conduit structures worldwide.

By leveraging the insights from the PHE concept, we can effectively predict and assess natural hydrogen resources. Our "bottom-up" exploration strategy targets potential sites throughout a project to minimize risks for our venture partners and ensure that investment decisions are based on sound, scientifically justified data.

The flowchart explaining Phases 1 through 4 is depicted in Fig. 2:

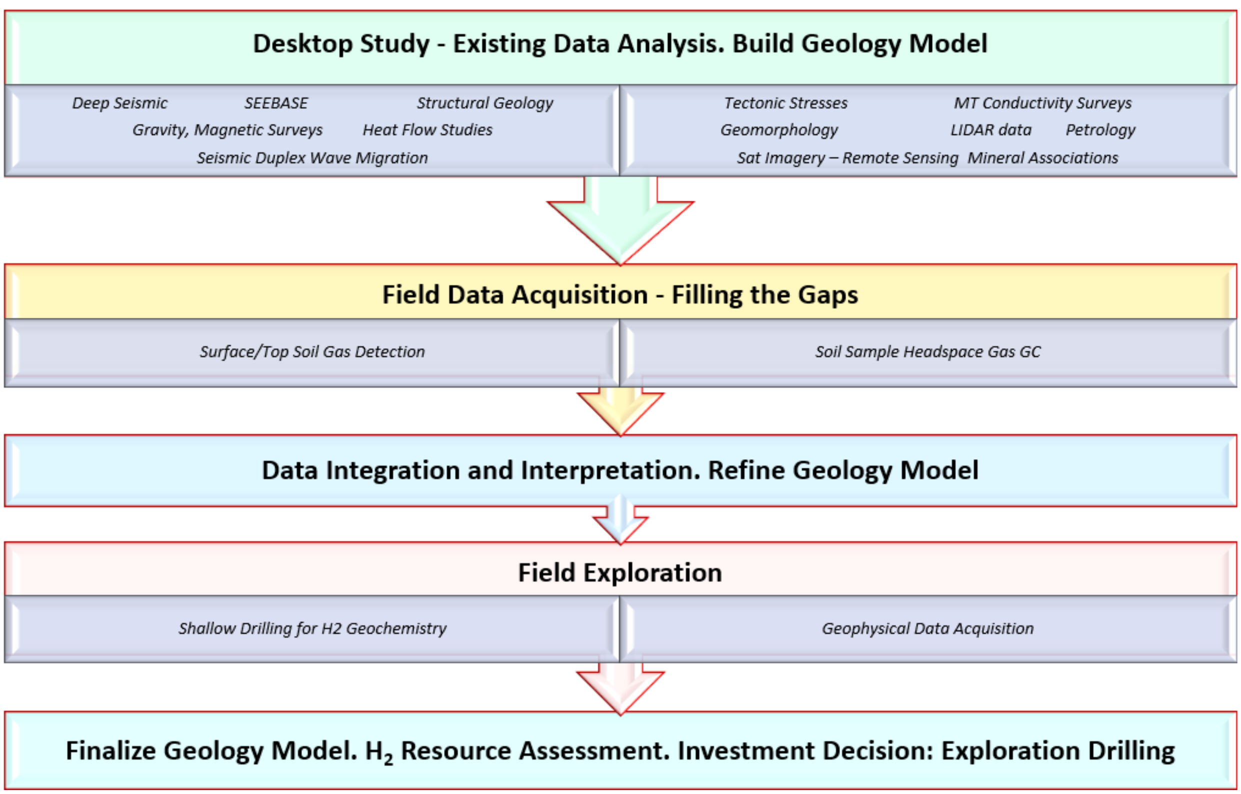

Fig. 2. The Avalio Pty Ltd. natural hydrogen exploration strategy flowchart.

Seismic data acquisition and interpretation are vital for exploring natural resources, including hydrogen. However, due to their unique structures, seismic techniques cannot be applied in the same way as in the petroleum industry and need adaptation.

DWM technology is increasingly vital for effectively utilizing seismic methods in the natural hydrogen sector. It enables the modeling and visualization of (sub)vertical dislocations, which dip between 60° and 90°, such as tectonic faults and shear zones (see Fig. 3A). Identifying these dislocations is crucial, as they may act as migration paths for natural hydrogen (see Fig. 3B). Conventional seismic methods cannot adequately model these features.

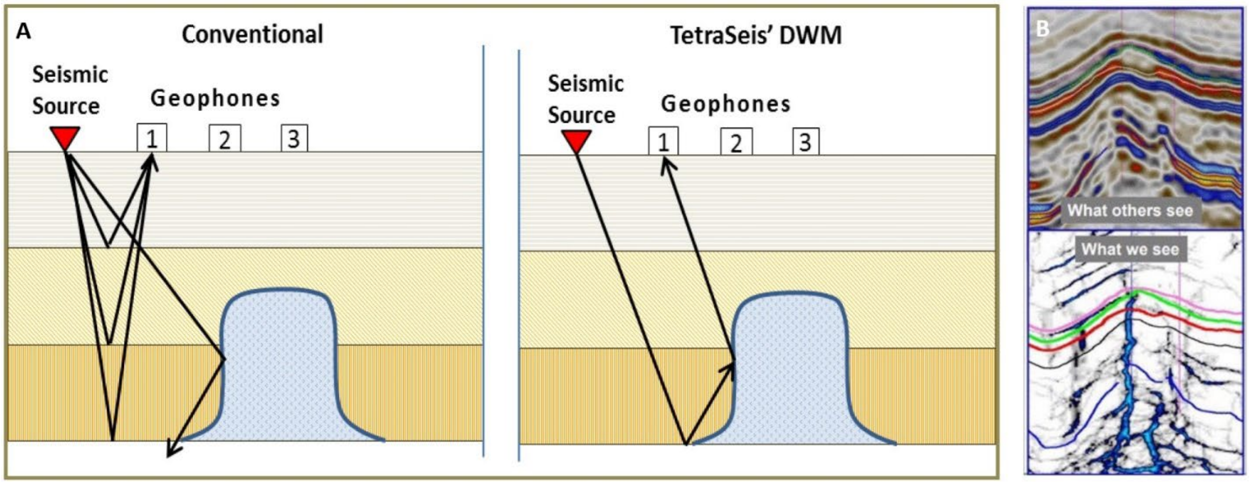

Fig. 3. DWM technology for natural hydrogen exploration. A. The advantage of the DWM compared to conventional seismic methods; B. Demonstration of the sample DWM product – (sub)vertical fluid migration paths imagery using the DWM.

Utilizing existing data arrays for DWM imagery can provide financial benefits, given that the data meets specific technical requirements. This method saves time and costs by eliminating the need for new data acquisition, allowing projects to progress more swiftly.

Results, Observations, Conclusions

We use proprietary algorithms and technology to identify geological structures that may yield natural hydrogen. Our experience and scientifically validated approach ensure reliable results. By employing a multidisciplinary strategy and our in-house developed exploration techniques, we provide solutions for the global demand for affordable, carbon-neutral hydrogen close to potential buyers.

Novel/Additive Information

Based on our preliminary survey, we have identified several areas in Alberta with potential for natural hydrogen exploration. This presentation will summarize our key findings and the exploration process. This exploration could create significant economic opportunities by providing carbon-neutral hydrogen to meet energy and industrial needs.

Acknowledgments
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