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Helium and Hydrogen in Western Canada: Big Strides and Baby Steps

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Introduction

The Western Canada Sedimentary Basin (WCSB) has long been a region of oil and gas exploration and development, generating value for the entire country. However, for more than a decade, there has been a pivot to explore for new types of subsurface resources. These resources include critical minerals such as helium, and, more recently, natural (geological) hydrogen. Significant helium development is underway in both Saskatchewan and Alberta; in contrast, geological hydrogen exploration is still in its infancy in the WCSB.

Helium

In Canada, helium is recognized as a critical mineral that is used in many high-tech, medical, and aerospace applications. A scarce, nonrenewable element on Earth, the dominant isotope of helium is sourced from the radioactive decay of uranium (U) and thorium (Th) in the Earth's crust. Basement rocks and cratons of Proterozoic and Archean age in Western Canada are predominantly metamorphic or granitic and contain elevated concentrations of U and Th, which provide a helium source. Once generated, the helium migrates from these source rocks into overlying reservoirs, which often drape Precambrian structural closures, and are overlain by tight sealing caprocks.

Helium exploration and development is most advanced in Saskatchewan, where multiple operators are active across the southern part of the province. These operators include North American Helium, Helium Evolution, Canadian Helium, and the Weil Group. North American is the most active driller (over 100 wells) and has the largest helium land position in Canada (9 MM ha). The company brought its ninth helium production facility into service in late 2024 and is currently supplying approximately 8% of the helium demand for the North American market. This equates to 85% of Canada's total helium production.

In Alberta, multiple operators are working in the helium industry. Thor Resources is active at Knappen in the southeast, First Helium is exploring along the northern flank of the Peace River Arch, Alpha Helium to the south along the Arch, and Global Helium is active at Manyberries near Medicine Hat. Calgary-based Avanti Helium is developing prospects in the Greater Knappen area of Montana.

The Manitoba Geological Survey is employing Rock Volatiles Stratigraphy (RVS) technology to examine the lower Paleozoic section of the Williston Basin in the southwest corner of the province to characterize the potential for a subsurface helium system in Manitoba.

Helium: Development Strategies

Helium operators in the WCSB have developed two differing exploration and development strategies. In Saskatchewan and southern Alberta, operators produce helium from porous basal Cambrian sandstones and Devonian carbonates. As these targets lie below regional oil and gas source rocks, reservoirs are filled primarily with nitrogen gas and up to ~2.5% helium. These "green" helium prospects are promoted as environmentally friendly investments that emit limited greenhouse gas emissions during production.

In contrast, two helium operators in western Alberta are conducting helium exploration within the deeper, gas-prone part of the basin. Many of these deeper hydrocarbon plays (both clastic and carbonate, typically of Devonian age) feature helium concentrations comparable to those of the southern Alberta and Saskatchewan helium fairway and promise robust economics generated by producing three commodities – natural gas, natural gas liquids, and helium. By focusing on helium sourced from hydrocarbon bearing strata, opportunities can be identified which will have a natural hedge against the commodity price variability of either helium or hydrocarbons. This exploration model is termed the HeHC (helium-hydrocarbon) strategy by its proponents.

Helium: Investment and Development Headwinds

Some headwinds exist for the helium industry, both globally and within Canada. "Helium Shortage 4.0" ended with additional helium supply coming onstream, mainly in Russia and Qatar, which has led to a consequent softening of prices. Additionally, there is a lack of market transparency for helium pricing in general, as the gas is sold via private offtake agreements between buyers and sellers. For publicly traded operators, this may hold some investors back.

Helium is a gas that must be liquefied for more cost-effective shipping. A lack of domestic helium liquefaction facilities in Canada means that purified helium must be shipped as a gas into the United States to be liquefied there. The ability to liquefy helium domestically would facilitate opportunities for Canadian producers in overseas markets.

Despite helium being classified as a critical mineral, producers in Canada have fewer tax incentives than other mineral explorers to mitigate up front exploration and production costs. The Helium Developers Association of Canada (HEDAC) has submitted recommendations to the Federal Government to remedy this situation, specifically to provide helium operators those normal tax measures that are provided other mineral resource developers, specifically Canadian Exploration Expense treatment and the ability to issue flow-through shares.

Hydrogen

Hydrogen is the most abundant element in the universe and one of the most abundant elements on Earth. Whether directly burned for energy or used in a fuel cell to produce electricity, its combustion emits only water, which means it has the potential to be a significant source of clean energy. Although most hydrogen today is produced via steam methane reforming (with or without carbon capture and storage) or by electrolysis, exploration for natural (geological) hydrogen in the subsurface has risen to prominence in the last few years. Whether the latter will be a significant source of abundant low-cost hydrogen remains to be seen.

Within the WCSB, thick Phanerozoic sedimentary rocks overlie crystalline Precambrian basement. This basement is thought to be the source for naturally occurring hydrogen, particularly where the rock has an ultramafic composition. Natural hydrogen may be generated via degassing of the Earth's mantle; serpentinization; radiolysis of water; decomposition of organic matter; or cataclasis. Deep structures, including faults, allow movement of gases from the basement upwards into the overlying sedimentary column, where structural trapping and accumulation of hydrogen can occur as it migrates upwards (analogous to helium).

Two operators, REV Exploration and Max Power, are currently exploring for natural hydrogen in Alberta and Saskatchewan, respectively. REV acquired land at Aden in southernmost Alberta containing a drill-ready hydrogen prospect. Max Power drilled its first hydrogen well to the Precambrian basement at Lawson, Saskatchewan in November 2025.