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Geotechnical and economic strategies in Helium exploration: A case study in the WSCB and Montana

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Introduction

The Western Canadian Sedimentary Basin (WCSB), rich with a vast resource of oil, coal, and natural gas have been exploited and developed for over a century. Helium exploration however is new in this basin and the hunt for Helium as a primary target has been gaining momentum since 2015. There is a myriad of reasons for the increasing interest in exploring for Helium reserves in North America: important market changes, including shutdown of the U.S. Helium Reserve, the emergence of high geopolitical risk to the producers in eastern parts of our globe, along with the declaration of Helium as a critical mineral in Canada, and the increasing demand for Helium in the medical, automotive, and high-tech industries.

There are several companies actively exploring and developing the Helium play in WCSB *(Fig. 1).* To date ~70 wells have been drilled for Helium, and ~15 producing wells with a total Helium production of ~380 mcf/d to year end 2022[1]. Total production in Canada represents a mere 0.25% of the total global Helium production, with Canada ranked at #9[2]. The USGS publication on Helium reserves highlights Canada with the fifth largest Helium reserves in the world and is well positioned to become a global producer and exporter of Helium in the coming decade [3].

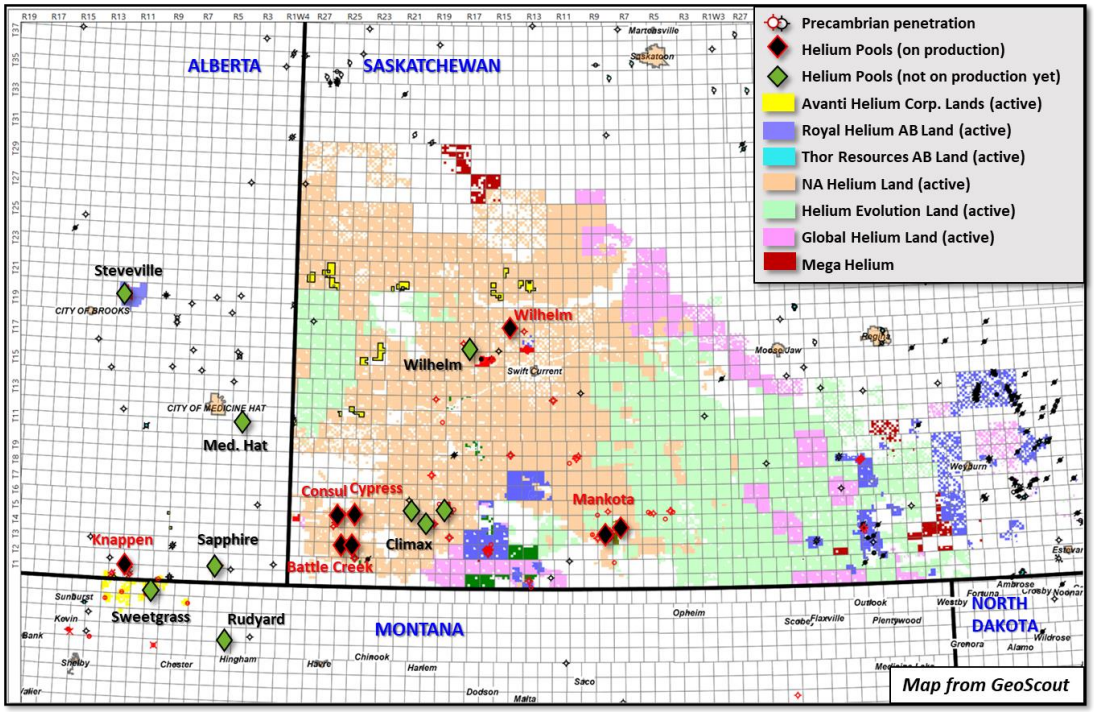

Figure 1: Helium exploration and development in southern WCSB and northwestern Montana

Technical skillset and competition with other emerging industries

As Helium exploration is new in this basin, can the experience and knowledge of oil and gas exploration be used as a template to explore for Helium? Perhaps, but there are several challenges and differences with oil and gas that must be managed. First, the market for Helium is primarily governed by private contracts and prices are kept confidential. What Helium pricing is used to run the project economics for capital investment decisions? This is a material evaluative challenge. In addition, Helium exploration has an areal and zonal overlap with other new industries like the carbon sequestration (CCS) projects, does this play compete with those projects in this region? *(Fig. 2)* Lastly, there are a few key differences in the geoscientific approach to Helium exploration—which we will illustrate in our case study.

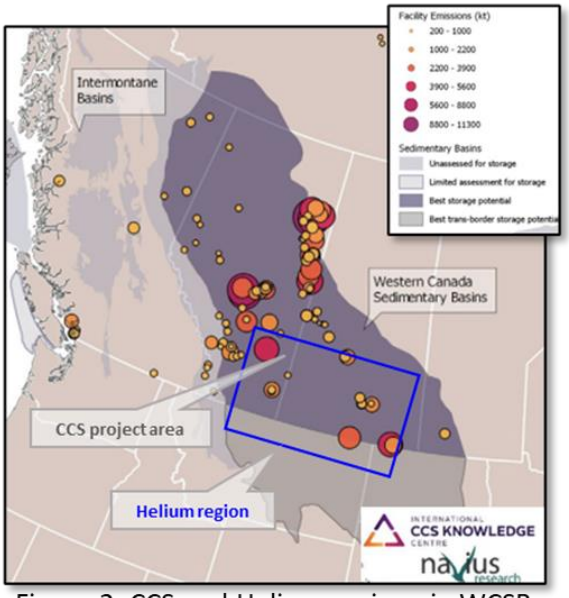

Figure 2: CCS and Helium regions in WCSB

A Case Study in WCSB and Montana

There are two main types of commercial Helium deposits, Helium produced with hydrocarbon and Helium produced primarily with nitrogen. The geographic locations of current Helium pools in in the southern regions of WCSB and Montana are rich with nitrogen with lower concentrations of methane and carbon dioxide. Considered 'green' Helium, the development in these fields will have a smaller environmental footprint and lower or net zero emissions.

Exploring for Helium takes us back to our grass root exploration in oil and gas in this basin as it is essentially a conventional play. Like a conventional gas play, a conventional Helium reservoir must have three main geological criteria: the source rock, the reservoir rock, and the cap rock. The exploration methodology and the drilling for Helium uses all the tools employed in the development of natural gas, though not all the natural gas methods are applicable to finding Helium. That is, Helium exploration requires a few additional considerations.

Exploring for Helium is technically challenging and requires significant knowledge related to Helium generation, migration, exsolution, accumulation and trapping. The key difference here is that Helium is generated differently from hydrocarbons. Rather than being a child or organic change, Helium is born of radioactive breakdown from very particular igneous and metamorphic rocks containing radiogenic elements. Therefore, Helium bearing reservoir must be connected to its radiogenic source through nearby migration pathways. And it must not be forgotten that Helium is the second lightest element in the universe. Its light, gaseous nature gives it the tendency to move upwards on a pathway to ultimately escape its reservoir, and eventually the earth. Unless it is trapped. The presence of deep-seated structure is necessarily an important geological

attribute for Helium accumulation in the reservoir and seismic mapping is critical in the technical workflow in identifying those isolated structures.

Acquisition of land for Helium exploration varies between provinces. The Government of Saskatchewan blanketed the southern region of the province for Helium exploration, providing permits that grant the right to explore for and produce Helium. In Alberta, Helium drilling rights are included in oil and gas leases. This is an important distinction. In Montana, the mineral rights are privately held by landholders, and is a time-consuming process to acquire.

Project economics are run on a price range of US$200 to $800/mcf based on recent estimates with a Helium specific crown royalty of 4.25% for Alberta and Saskatchewan. In Montana, royalty rates range from 4.25% for state owned leases to up to 25% on privately owned leases. Saskatchewan also has a more favourable jurisdiction for Helium exploration by offering a 15% transferable royalty credit rebates for eligible costs associated with new Helium processing and liquification projects, pursuant to its Oil and Gas Processing Investment Incentive program [4].

There are two key Helium target zones, the Basal Cambrian Sandstone and the Devonian Beaverhill Lake (AB) / Souris River (SK and MT). The CCS projects are also focused on the Basal Cambrian Sandstone in the same region for carbon storage. CCS explores area that is structurally quiet, and with no gas charge. Helium exploration targets area with structure and closure to trap the Helium, away from the wet zones. Although CCS and Helium may sometimes share the same reservoir zone in the Basal Cambrian Sandstone, these activities need not interfere with each other, as their relative structural locations within the reservoir are quite different. Although in most cases these two activities would not affect each other, there could be times that instead of being competitive endeavors, CCS injection and Helium extraction could act cooperatively through pressure management. This should be considered regulatorily.

Conclusion

The presentation will focus on our case study that highlights the application and modifications of oil and gas methodology in exploring for Helium and the decision analysis from initial scoping to finalizing the drill locations. It will also emphasize the non compete nature of this play with other new industries including the CCS and lithium projects.

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