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Simply hot air: A review of the helium potential of western Canada, applying learnings from the US and other helium resources

Jon Noad
Sedimental Services; University of Alberta

Summary

Data indicates that the world's supply of helium may last for less than 25 years. Western Canada holds significant reserves, in a variety of plays and settings. This paper describes how helium is sourced, where it can be found and compares Canadian reservres with those of the US and elswewhere globally. These compariosons may open up new exploration plays for this rare gas.

Introduction

Helium is the second lightest element, and is a non renewable resource. It has many applications, most famously in MRI devices. There is currently significant commercial interest in helium, with some authors suggesting that the world may only have 25 years of supply left. Currently the US accounts for 34% of the world's reserves, and 76% of annual global production (2012 figures). Canada lies fifth in the list of international helium resources. Global demand is around 6.2 BBcf/year. Helium behaves much like hydrocarbons such as natural gas, and cannot be made artificially. Much of the world's helium has been produced as a by product of the extraction of natural gas in the American southwest. It is considered that western Canada holds commercially significant helium reserves, along with the expertise to access them at a relatively low cost.

How helium accumulates

To accumulate helium in commercial quantities, there are typically three main requirements:

- Granitoid (or similar) basement rocks rich in uranium and thorium; these basement rocks should be fractured and faulted to provide escape paths for the helium
- Porous sedimentary rocks above the basement faults that are capped by impermeable anhydrite or halite
- The seal is the most important element; it must be impermeable enough, and strong enough, to trap the helium. Shale is too porous to act as a seal.

Transport of helium is poorly understood. Theories suggest that helium requires a "carrier gas" (nitrogen) so that it can flow. Helium is always found in association with nitrogen, supporting this theory. Recent work also indicates that helium has to be dissolved in groundwater and then transported until it reached a suitable trap in which the helium could be drawn from the water.

Helium in the US

Geological conditions in Texas, Oklahoma and Kansas make the natural gas in these areas some of the most helium-rich in the United Sates. Other international reserves tend to be at lower concentrations than those in the US. The US produces around 40% of the world's helium. Most helium production in the US

occurs in the Hugoton Panhandle. Other producing natural gas fields include Panhandle, Greenwood and Keys Fields, found in Texas, Oklahoma and Kansas. The major producing fields in the US are: the Hugoton Field in Oklahoma; the Panhandle West and Cliffside Fields in Texas and the Riley Ridge Field in Wyoming. Most of these fields are dedicated to helium production, rather than it being produced as a secondary gas.

The US National Helium Reserve

The US established the National Helium Reserve in 1925, and it was used extensively in military airships in WW2. It became even more important in the Cold War, when helium was used to purge rocket fuel in ICBM's. The National Reserve was situated in a disused, porous gas field 30 miles north of Amarillo. A billion cubic metres (half the world's reserves) are now stored in this cluster of mines, which extend for more than 200 miles from Amarillo to Kansas. The Reserve is managed by the Bureau of Land Management (BLM).

A law was passed in the US in 1996 (the Helium Privatization Act) that made helium too cheap to recycle. The law stipulated that the US National Helium Reserve, stored in a disused underground gas field near Amarillo, Texas, must all be sold off by 2015, irrespective of market price. The amount of helium sold should follow a straight line, with the same amount sold each year, regardless of demand. This has led to the "squandering" of this precious reserve, according to Professor Richardson, professor of physics at Cornell, NY State. He believes that the price should be at least 20 times higher, to encourage recycling of the helium, and that party balloons are way too cheap in price.

Helium in Canada: Saskatchewan

Helium enriched natural gas occurs in Upper Cambrian silicified siltstones and mudstones overlying a pronounced basement topographic high (the Aikens anomaly) some 15 km North of Swift Current. The origin of the helium is thought to be a late Hudsonian volcanic-plutonic centre developed to the west of Swift Current. This was later dissected by erosion, and covered by clastic sediments during a Cambrian transgression. Circulating formation fluids carried helium from the subcrop of uranium-rich porphyritic granites along the unconformity to the highest points of the topography.

A gas field was discovered in 1963 near Swift Current, containing 1.38% helium, and a plant was built and operational by the end of 1963. This was the first commercial plant outside the US. It was small, with a capacity of only 12 Mcf/year, and was ultimately decommissioned in 1977. Little helium activity in the province followed for many years. However, Saskatchewan issued 59 permits and leases for helium in 2016, its busiest ever period.

In February 2016, Weil Resources announced their plans to construct a $10 MM helium processing facility to supply helium markets throughout North America. The plant is located near Mankota, SK, some 150 km SE of Swift Current, and was supplied by Germany's Linde Group. The plant has a capacity exceeding 40 Mcf/year. The feed is from two 1960's wells that were re-entered by Weil in 2013, at a cost of some $1.7 MM per well. The southwest region of Saskatchewan has several wells with higher helium concentrations which, combined with their widespread distribution, indicates the potential for further exploration and development.

Quantum Helium Management Corporation, a BC company, have been producing helium from a well in SW Saskatchewan since 2013. It is planning a further two plants in Saskatchewan and Alberta. Another company, North American Helium Inc., was reported as drilling an exploration well for helium at Battle Creek, in the extreme SW corner of Saskatchewan, in February 2016. Navis Resources are also investing in properties with helium potential.

Helium in Canada: Alberta

Helium shows relatively high concentrations in north central Alberta in the Devonian, and in southern Alberta in the Mannville. Interpretation of isotopic data for helium suggests that the helium observed in Devonian units originates from deep crustal sources, probably the Precambrian basement, which mix with atmospheric sources. In contrast, high helium and nitrogen concentrations in the Mannville are the result of entry of meteoric water. A similar pattern is observed for nitrogen in the Colorado Group and correlations with hydrocarbon gases suggest the high nitrogen content is related to bacterial accumulations of natural gas.

Helium has ben reported from many natural gases in Alberta, but the largest known reserve is in the Medicine Hat field, where the helium concentration is approximately 0.2%. An ancient report suggests that the Bow island Fields had helium concentrations of 0.33%, leading to the construction of an experimental plant in Calgary in 1919. The Foremost Field, 40 miles south of Bow Island, was reported to host helium at 0.2%, with wells producing 15 Mcf/day of natural gas.

Helium in Canada: British Columbia

The Slave Point, Jean Marie (Redknife) and Wabamun formations of northeastern British Columbia preferentially have helium associated with many of their natural gas pools. The mechanism for this accumulation appears to be flow in hydrothermal brines from helium-enriched basement granitic rocks along deeply seated faults. Separately, the Evie member of the Horn River Formation also has anomalous helium accumulation in its shale gas related to uranium decay in organic-rich shales. The highest helium concentration is recorded in the Wabamun Formation, with 0.24%, but with a small estimated OGIP.

Conclusions

It is considered that significant potential remains in this region. Mapping out basement geology, combined with gravity and magnetic data to identify basement faulting, could significantly expand the potential sources of helium. Once this is completed, the search for overlying porous sediments, with a robust seal, should allow some exploration plays to be developed. Currently Saskatchewan is considered most prospective, with many of the reported Albertan helium values requiring close examination.