

Volatiles analysis of drill cuttings to evaluate helium prospectivity in Manitoba

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Summary

The helium prospectivity of southwestern Manitoba was evaluated from volatiles analysis, using the Rock Volatiles Stratigraphy (RVS) system developed by Advanced Hydrocarbon Stratigraphy, Inc. (AHS). Drill cuttings from four legacy oil wells (100/09-06-002-26W1/00, 100/01-25-04-23W1/00, 100/13-24-012-27W1/00 and 100/16-29-012-29W1/00) were analyzed for a wide range of volatile compounds, including C1–C10 hydrocarbons, carbon dioxide, water and helium. During a first run of sampling and analysis, drill cuttings were sampled from the Precambrian basement to the Interlake Group or Dawson Bay Formation in three of the wells, at intervals defined by the drill cuttings recovered. These first three wells showed signs of helium accumulation with economic potential (Nicolas et al., 2023a); results are still pending for one newly added well (1-24-4-23W1). From these first three wells, the well at 9-6-2-26W1 had the highest helium values ever measured by the RVS system to date in any legacy sample for which self-sourcing of the helium—formed by radioactive decay of in situ uranium- and thorium-bearing basement rocks or shale—was not possible. These high values indicate an active prolific helium system in southwestern Manitoba. Additionally, analysis of the RVS data indicates bypassed deep hydrocarbon system opportunities in Manitoba.

Success from the first run of samples has led to a second run, whereby two of the three first-run wells had their sampling extended up to the Bakken Formation, and a new well, further to the east and with moderate helium show, was added with sampling from the Precambrian basement to midway through the Lodgepole Formation. Preliminary results will be presented.

Methodology

Drill cuttings from four legacy petroleum exploration wells in southwestern Manitoba were sampled for testing by the RVS system. This work was done in two rounds, with the first consisting the three wells located at 9-6-2-26W1, 13-24-12-27W1 and 16-29-12-29W1, and the second round adding a well at 1-25-4-23W1. Sampling intervals were limited to the cuttings vials in storage, with sampling intervals ranging from 3 m (10 ft) to 6 m (20 ft).

Samples were sent to the AHS laboratory in Tulsa, Oklahoma, for analysis by their proprietary cryotrap mass spectrometer (CT-MS) system. This system is designed to analyze for C1–C10

hydrocarbons, helium, formation water, CO₂, sulfur gases, organic acids and mechanical strength. Nicolas et al. (2023a) describes sampling rationale and full methodology.

Results

The results of the RVS data from the first run of samples showed evidence of helium accumulation, as well as indications of bypassed deep hydrocarbon system opportunities in Manitoba. A helium reading above 0.7 nmol helium on an RVS log indicates a potential economic accumulation of helium, however, correlation and interpretation with other RVS data must be done to narrow down the true potential pay zone. These data tables have been published in Nicolas et al. (2023b). Data from the second run of samples is pending.

RVS data is best viewed as downhole-style logs, and example of this is shown in Figure 1; complete RVS logs for the first three wells can be viewed at Nicolas et al. (2023a).

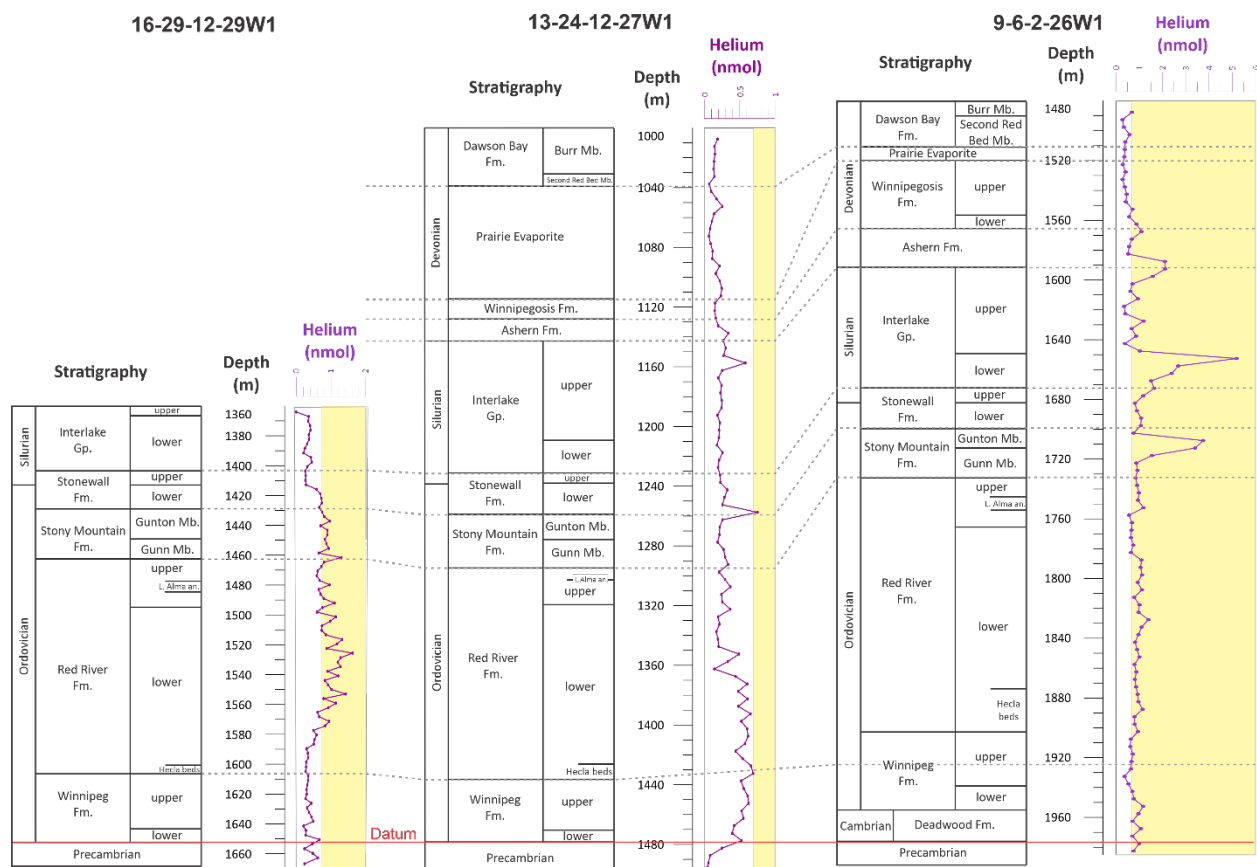


Figure 1: Stratigraphy and Rock Volatiles Stratigraphy (RVS) helium data log for three oil wells. Yellow highlighted area on the helium track shows values ≥ 0.7 nmol.

Interpreting RVS data is complex and requires taking several factors into account, such as drill cuttings size and quality and rock properties (permeability and porosity). These factors have a strong effect on the RVS results, and must be taken into account when analyzing the data. For

example, results from samples with larger cuttings (coarse-grained sand to pebble-sized) pieces – which are common in older wells (16-29-12-29W1; 9-6-2-26W1) – are more reliable and return the best results, while samples with smaller cuttings (coarse- to medium-grained sand) – common in modern wells (13-24-12-27W1) – return results that are more attenuated. This attenuation must be considered when comparing results between wells of different drilling age. Nicolas et al. (2023a) includes full details on these results and the interpretation of the data.

Conclusions

The first run of three wells show signs of helium accumulation of varying degrees. The well at 9-6-2-26W1 has returned the highest helium values measured by the RVS system to date in legacy samples for which self-sourcing of the helium from in situ uranium- and thorium-bearing basement rocks or shale was not possible. This indicates an active prolific helium system, but while these results are encouraging, they do not guarantee commercial helium production. Helium target zones in this well include the Red River Formation and the Winnipeg–Deadwood formations intervals. The well at 16-29-12-29W1 also shows good indications of potential helium target zones within the Red River Formation. At first glance, the data from the well at 13-24-12-27W1 suggests that there is no helium target zone, since most helium values fall below the 0.7 nmol helium threshold, however, if the effect of drill cutting size on the RVS analysis is taken into consideration, there is an expectation of an attenuation of results from these samples, the Red River Formation could be a zone of interest. (Nicolas et al, 2023a)

The success of the first round of samples lead the way for the second round of testing, which has been conducted going up-hole from the shallowest sample in the first run, with the addition of a new well added for analysis. Preliminary results of the second round of results are pending.

If the helium data from RVS analysis are considered as minimum values, all three wells from the first run have helium target zones in the Red River Formation. In the deeper basin, an additional target zone would be the porous strata of the Deadwood Formation immediately overlying the Precambrian basement. (Nicolas et al, 2023a)

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References

- Nicolas, M. P. B., Smith, C. M. and Smith, M. P. 2023a: Volatiles analysis of drill cuttings to evaluate the helium prospectivity of southwestern Manitoba (parts of NTS 62F2, K3); *in*, Report of Activities 2024, Manitoba Economic Development, Investment, Trade and Natural Resources, Manitoba Geological Survey, p. 93-104.
- Nicolas, M. P. B., Smith, C. M. and Smith, M. P. 2023b: Rock Volatiles Stratigraphy data from drill cuttings from three wells in southwestern Manitoba (parts of NTS 62F2, K3); Manitoba Economic Development, Investment, Trade and Natural Resources, Manitoba Geological Survey; Data Repository Item DRI2023014, Excel file.