GS2025-11

Effects of drill-cutting size and age on the reliability of measuring helium and other volatiles in samples, southwestern Manitoba (parts of NTS 62K6, 7, 11)

by M.P.B. Nicolas, C.M. Smith[1] and M.P. Smith[1]

In Brief:

- Volatile analysis of legacy drill cuttings was done on four oil wells
- Helium and hydrocarbons are found consistently throughout the Stony Mountain Fm. to Interlake Gp. Interval
- Comparisons of RVS results from drill cuttings from the 1970's to 2000's can be made with confidence

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Nicolas, M.P.B., Smith, C.M. and Smith, M.P. 2025: Effects of drill-cutting size and age on the reliability of measuring helium and other volatiles in samples, southwestern Manitoba (parts of NTS 62K6, 7, 11); *in* Report of Activities 2025, Manitoba Business, Mining, Trade and Job Creation, Manitoba Geological Survey, p. 110–119.

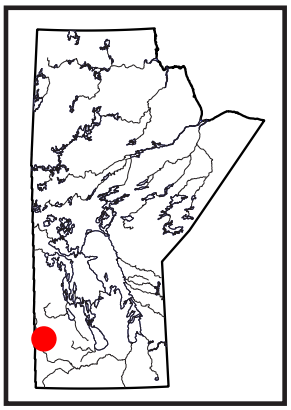
Summary

Drill cuttings from four legacy oil wells were sampled for volatile analysis using Rock Volatiles Stratigraphy (RVS). This testing was conducted to 1) evaluate the helium and hydrocarbon potential of the interval analyzed, and 2) assess how drill-cutting size, age of samples and drill-cutting technology influence the reliability of RVS results. The sampled wells are located at L.S. 2, Sec. 14, Twp. 18, Rge. 29, W 1st Mer. (abbreviated 2-14-18-29W1), 2-14-16-28W1, 12-34-15-26W1 and 2-7-16-26W1 in southwestern Manitoba. These wells were selected based on stratigraphy and geographic location, as well as age and size of drill cuttings. In this study, cuttings from the 1970s and 1990s, sampled from the Ordovician Stony Mountain Formation to Silurian Interlake Group interval, were compared. The volatile compounds measured included C1–C10 hydrocarbons, carbon dioxide, water and helium. This study found that reliable RVS results can be obtained from drill cuttings of different age and size. Low but consistent helium and hydrocarbon concentrations were identified in all samples. The ubiquity of helium and hydrocarbons in these samples suggests that the lack of identified accumulations in this interval is not related to source, generation, migration or quantity, but rather a need to identify, and explore for, reservoirs, seals and traps.

Introduction

A review of helium occurrences in southwestern Manitoba oil and gas wells indicated encouraging helium occurrences in the subsurface (Nicolas, 2018); some indicative of concentrations of economic interest. The highest and most notable values ranged from 0.3 to 2.0 mol. % helium and occurred mostly in lower Paleozoic horizons. To better understand these results, two follow-up studies were conducted to measure fluids trapped in micropore spaces in legacy drill cuttings from lower Paleozoic horizons, reported in Nicolas et al. (2023b, 2024a). For these studies, the Manitoba Geological Survey (MGS) in partnership with Advanced Hydrocarbon Stratigraphy, Inc. (AHS) studied the volatile fraction of fluids in drill cuttings from four oil wells drilled in the lower Paleozoic using a Rock Volatiles Stratigraphy (RVS) system. The analysis measured fluid, gas, hydrocarbon, rock and reservoir properties to evaluate for helium prospectivity in Manitoba and provide additional insights into local hydrocarbon systems.

The RVS system is an innovative analytical approach that provides information on the fluid history of a stratigraphic unit, and when combined with other wells, offers constraints on pore-space fluid composition and geology of an area. Nicolas et al. (2023b) described the methodology of the RVS system. The insights provided from prior RVS results detail a complex subsurface fluid system, with prolific helium generation, migration and multistratal accumulations, and a highly prospective unexplored hydrocarbon system in Devonian strata in southwestern Manitoba.



Throughout these studies, drill-cutting size has been an important factor for interpreting results. Coarser-grained drill cuttings are expected to preserve fluids in microporosity better than finer-grained drill cuttings. An attenuation of the results in fine-grained drill cuttings can occur, but when comparing trends from one well to another, that attenuation is recognizable (see Nicolas et al., 2024a for discussion on attenuation of results). AHS has done rock volatile analysis on hundreds of legacy oil wells where the age of cuttings or core appeared to not affect RVS results or the ability to get insight into the fluid system and reservoir properties of the sampled sections (Smith and Smith, 2020; Smith et al., 2021a, b, 2022a, b, 2023a, b, c; Nicolas et al., 2023b, 2024a), however a direct test of this assumption has not been completed.

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This study is two-fold: 1) identify potential helium and hydrocarbon prospects in Paleozoic horizons that act as reservoirs for migrating fluids from deeper, leaky reservoirs; and 2) test the effect of drill-cutting size and age and drill-cutting technology on the reliability of RVS results in Manitoba. For this study, a suite of 100 samples were collected over a short stratigraphic interval from four wells (25 samples per well) in a geographic area where the effects of the Superior boundary zone were deemed to be equal (Figure GS2025-11-1; Table GS2025-11-1).

Methodology

Drill cuttings from four historical petroleum exploration wells in southwestern Manitoba were selected for testing using the RVS system. The four wells sampled for this study are 1) ASM-BTO et al Gamber Prov. 100/02-14-018-29W1/00 (oil and gas well licence 2534, Manitoba Business, Mining, Trade and Job Creation, Winnipeg) at 2-14-18-29W1; 2) ASM-BTO et al Ft. Ellice Prov. 100/02-14-016-28W1/00 (oil and gas well licence 2536) at 2-14-16-28W1; 3) Chel TRC Teck Birtle Prov. 100/12-34-015-26W1/00 (oil and gas well licence 4383) at 12-34-15-26W1; and 4) Husky South Birtle 100/02-07-016-26W1/00 (oil and gas well licence 4744) in 2-7-16-26W1. The two older wells, oil and gas well licences 2534 and 2536, were drilled in 1974, and the two younger wells, oil and gas well licences 4383 and 4744, were drilled in 1993 and 1997, respectively.

The older wells had drill cuttings that were coarser grained (granule to pebble size), than those from the younger wells, which typically were medium-grained sand-sized cuttings (Figure GS2025-11-2a–d). Sampling was limited to 25 samples per well and covered the stratigraphic interval from the Stony Mountain Formation to the top of the Interlake Group, and in some wells, to the base of the Ashern Formation.

As is with all drill cuttings, the sample intervals are predetermined at the time of drilling. For the two older wells, the predetermined minimum sampling interval was 3.05 m (10 ft.) per sample vial; to collect 25 samples and cover the target stratigraphic horizons, sampling for this study was limited to one sample every 6.10 m (20 ft.). For the two newer wells, the predetermined sampling interval was 5 m, which was followed for this study. As a result, the older wells have a gap in their representative sample intervals compared to the newer wells.

The samples were sent to the AHS laboratory in Tulsa, Oklahoma, for analysis by their proprietary cryotrap mass spectrometer (CT-MS) system specially designed to analyze for C1–C10 hydrocarbons, helium, formation water, CO_2, sulphur gasses, organic acids and mechanical strength. The same volatiles were measured and the same analytical methods were used on these samples as those described in Nicolas et al. (2023b).

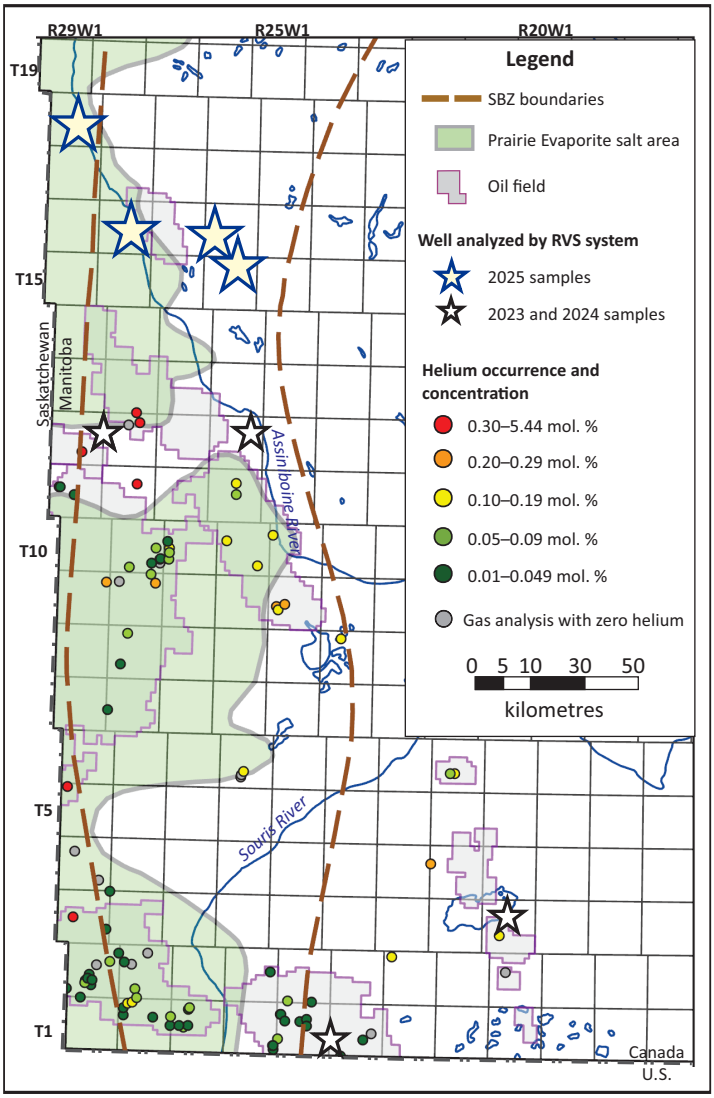

Figure GS2025-11-1: *Map of southwestern Manitoba showing the 1) locations of wells sampled in 2023, 2024 and 2025 and analyzed by the Rock Volatiles Stratigraphy (RVS) system, 2) distribution of gas analyses and helium occurrences (modified from Nicolas, 2018), and 3) locations of oil fields (Fulton-Regula, 2024). Abbreviation: SBZ, Superior boundary zone.*

Rock Volatiles Stratigraphy results

The entirety of the RVS data is available in Data Repository Item DRI2025021 (Nicolas et al., 2025[1]). A wide range of information can be extracted from the RVS data. However, this report focuses only on the data used to evaluate helium and hydrocarbon prospectivity, as well as selected data for other fluids, such as hydrocarbons, water and CO_2, as they provide additional information about the overall fluid dynamics of the basin.

[1] MGS Data Repository Item DRI2025021, containing the data or other information sources used to compile this report, is available online to download free of charge at https://manitoba.ca/iem/info/library/downloads/index.html, or on request from minesinfo@gov.mb.ca, or by contacting the Resource Centre, Manitoba Business, Mining, Trade and Job Creation, 360-1395 Ellice Avenue, Winnipeg, Manitoba R3G 3P2, Canada.

Table GS2025-11-1: List of wells sampled in southwestern Manitoba for Rock Volatiles Stratigraphy analysis. Abbreviations: PDC, polycrystalline diamond compact; TVD, true vertical depth.

Unique well identifier (UWI)	Oil and gas well licence	Easting (Zone 14, NAD83)	Northing (Zone 14, NAD83)	Year drilled	Total depth (m TVD)	Sample depth range (m TVD)	Sample interval	Stratigraphy	Comments
100/02-14-018-29W1/00	2534	332007.76	5601016.20	1974	1332.3	1149.10–999.74	~6 m (20 ft.)	Stony Mountain Fm. to Interlake Gp.	Salt-gel, starch and diesel fuel drilling mud used in deeper section; drilled with mill-tooth drill bit
100/02-14-016-28W1/00	2536	341353.60	5581038.45	1974	1284.7	1091.18–941.83	~6 m (20 ft.)	Stony Mountain Fm. to Ashern Fm.	Salt-gel and starch drilling mud used in deeper sections; drilled with mill-tooth drill bit
100/12-34-015-26W1/00	4383	358339.73	5576471.07	1993	1318.0	1110–990	5 m	Stony Mountain Fm. to Ashern Fm.	Gel chem drilling mud; drill bit undetermined but likely PDC drill bit
100/02-07-016-26W1/00	4744	354459.10	5579086.17	1997	1345.0	1145–1025	5 m	Stony Mountain Fm. to Interlake Gp.	Gel chem drilling mud; drilled with tungsten carbide button drill bit

Oil and gas well at 2-14-18-29W1 (licence 2534)

Drill cuttings collected from the well at 2-14-18-29W1 were sampled from 1149.10 m true vertical depth (TVD) in the Stony Mountain Formation up to 999.74 m TVD in the upper Interlake Group. Samples represent a 3.05 m (10 ft.) section and for this study every second vial was sampled, equating to every 6.10 m (20 ft.). Figure GS2025-11-3 shows the data logs for select analyses, including helium, as they relate to stratigraphy.

Oil and gas well at 2-14-16-28W1 (licence 2536)

Drill cuttings collected from the well at 2-14-16-28W1 were sampled from 1091.18 m TVD in the Stony Mountain Formation up to 941.83 m TVD at the base of the Ashern Formation. Each sample is representative of a 3.05 m (10 ft.) section and samples were taken every 6.10 m (20 ft.). Figure GS2025-11-4 shows the data logs for select analyses, including helium, as they relate to stratigraphy and lithology. For this well, the lithology descriptions and estimated porosity for each sampled interval are shown in Figure GS2025-11-4; this information was compiled from the technical well file (oil and gas well licence 2536).

Oil and gas well at 12-34-15-26W1 (licence 4383)

Drill cuttings collected from the well at 12-34-15-26W1 were sampled from 1110 m TVD in the Stony Mountain Formation to 990 m TVD at the base of the Ashern Formation. Samples collected represent 5 m intervals. Figure GS2025-11-5 shows the data logs for select analyses, including helium, as they relate to stratigraphy.

Oil and gas well at 2-7-16-26W1 (licence 4744)

Drill cuttings collected from the well at 2-7-16-26W1 were sampled from 1145 m TVD in the Stony Mountain Formation to 1025 m TVD in the upper Interlake Group. Samples collected represent 5 m intervals. Figure GS2025-11-6 shows the data logs for select analyses, including helium, as they relate to stratigraphy.

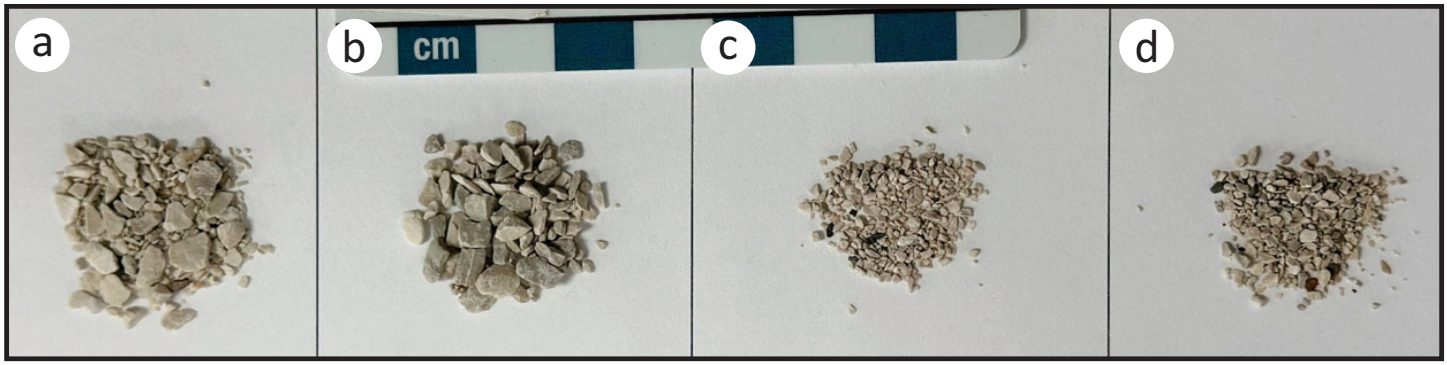

Figure GS2025-11-2: *Grain-size variations in the drill cuttings for the four wells in southwestern Manitoba sampled for this study:* ***a)*** *L.S. 2, Sec. 14, Twp. 18, Rge. 29, W 1st Mer. (abbreviated 2-14-18-29W1; oil and gas well licence 2534) at 1018.03–1021.08 m true vertical depth (TVD; sample 106-25-2534-4),* ***b)*** *2-14-16-28W1 (oil and gas well licence 2536) at 1008.90–1011.94 m TVD (sample 106-25-2536-12),* ***c)*** *12-34-15-26W1 (oil and gas well licence 4383) at 1045 m TVD (sample 106-25-4383-12),* ***d)*** *2-7-16-26W1 (oil and gas well licence 4744) at 1075 m TVD (sample 106-25-4744-11). The older (1970s) wells with coarser drill cuttings are shown in (a) and (b) and the newer (1990s) wells with finer drill cuttings are shown in (c) and (d).*

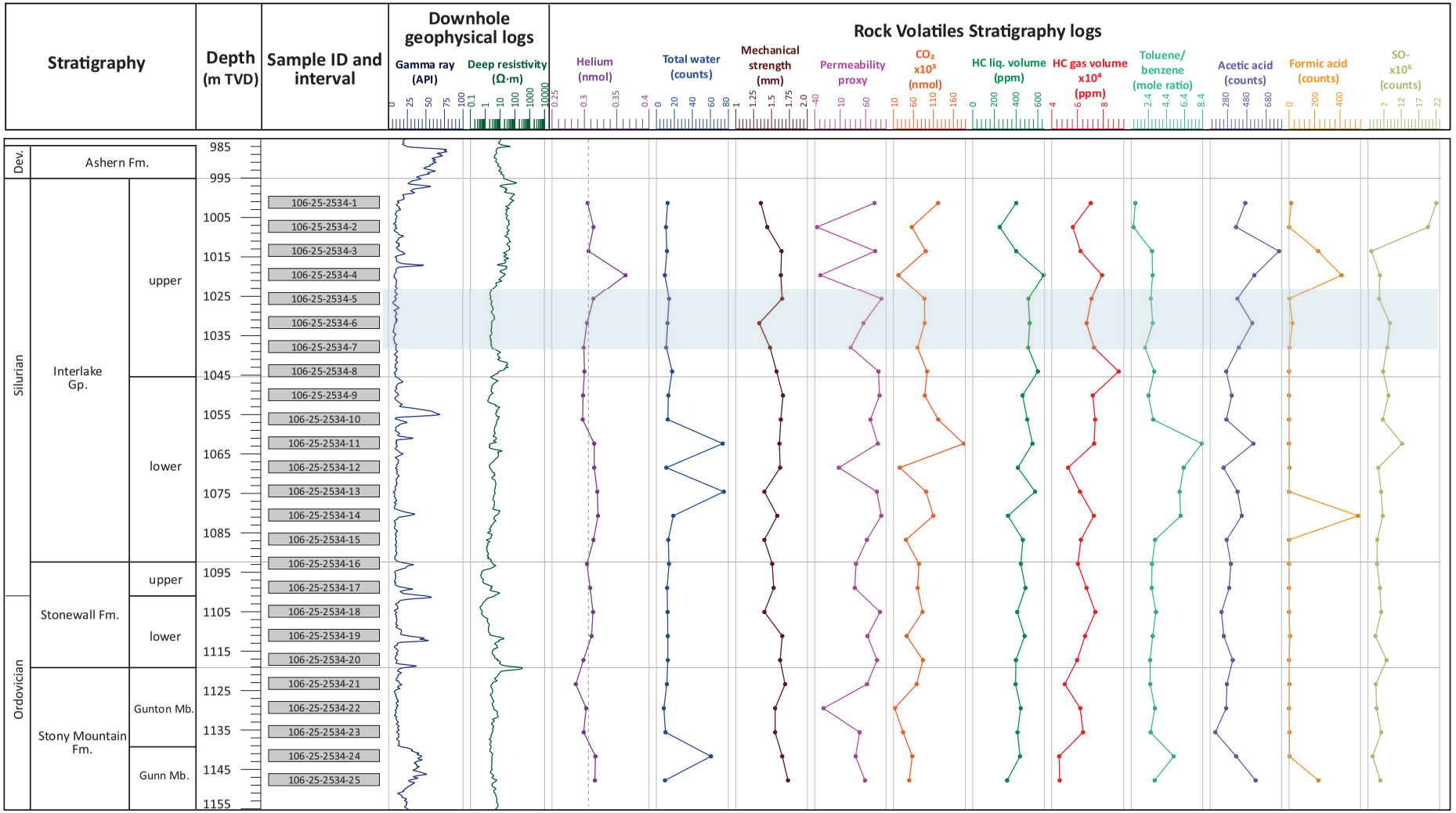

Figure GS2025-11-3: *Stratigraphy and Rock Volatiles Stratigraphy data logs for the oil and gas well at L.S. 2, Sec. 14, Twp. 18, Rge. 29, W 1st Mer. (2-14-18-29W1, southwestern Manitoba; oil and gas well licence 2534), including select downhole geophysical logs. Samples covered a 3.05 m (10 ft.) interval every 6.10 m (20 ft.). Dashed grey vertical line in helium track is the average value (0.306 nanomoles [nmol]) for all wells in this study combined. Mechanical strength of the sample increases from left to right on the mechanical strength log; the permeability proxy log indicates increased permeability from left to right. Blue-shaded band represents an interval of higher porosity and coarser-grained dolomitic textures that correlates to the shaded band in Figure GS2025-11-4. Abbreviations: Ω, ohm; Dev., Devonian; HC, hydrocarbon; liq., liquid; TVD, true vertical depth.*

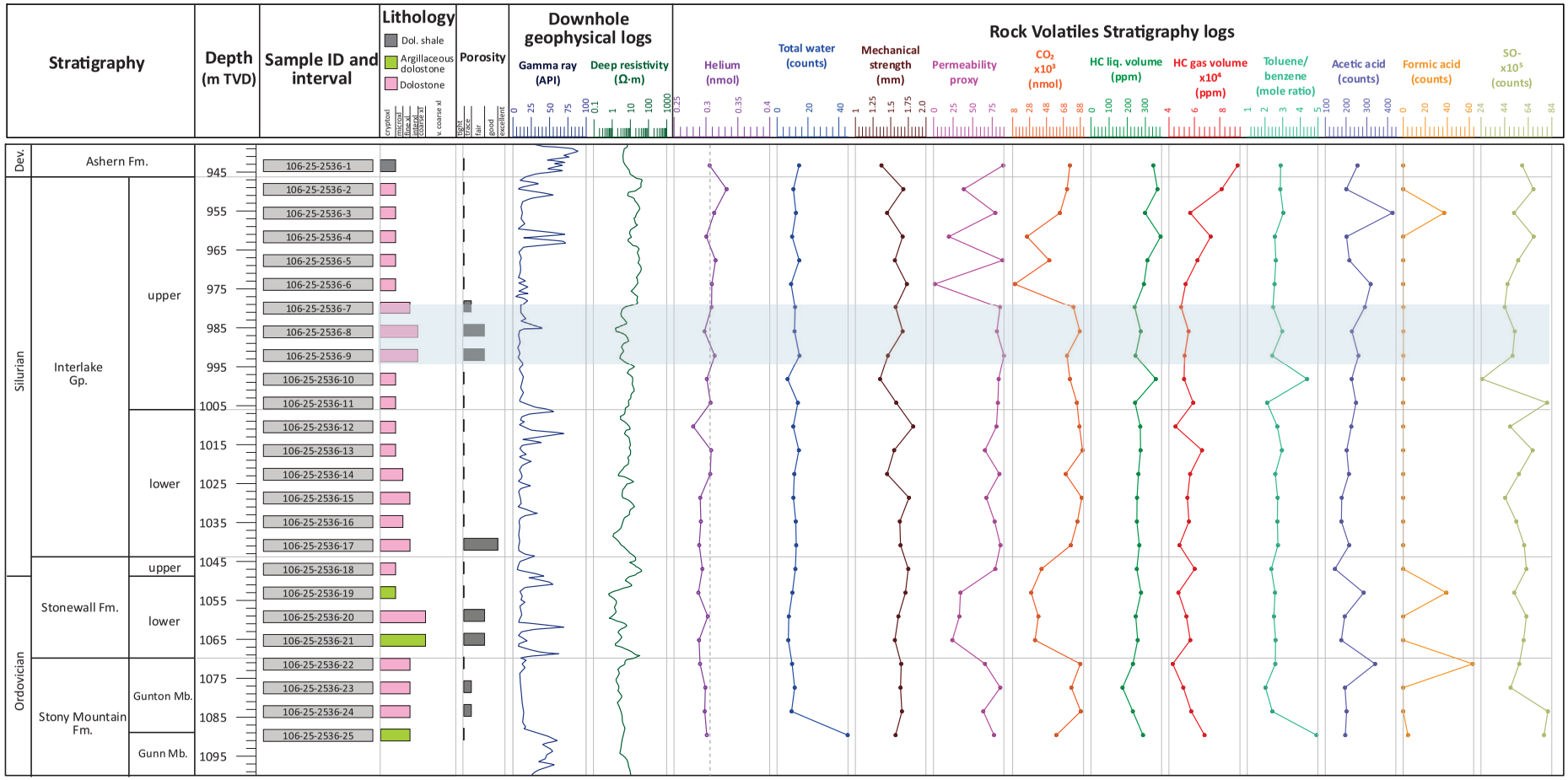

Figure GS2025-11-4: *Stratigraphy, lithology, porosity and Rock Volatiles Stratigraphy data logs for the oil and gas well at L.S. 2, Sec. 14, Twp. 16, Rge. 28, W 1st Mer. (2-14-16-28W1, southwestern Manitoba; oil and gas well licence 2536), including select downhole geophysical logs. Samples covered a 3.05 m (10 ft.) interval every 6.10 m (20 ft.). Dashed grey vertical line in helium track is the average value (0.306 nanomoles [nmol]) for all wells in this study combined. Mechanical strength of the sample increases from left to right on the mechanical strength log; the permeability proxy log indicates increased permeability from left to right. Blue-shaded band represents an interval of higher porosity and coarser-grained dolomitic textures. Abbreviations: Ω, ohm; coarse xl, coarse crystalline; cryptoxl, cryptocrystalline; Dev., Devonian; Dol., dolomitic; fine xl, fine crystalline; HC, hydrocarbon; interxl, intercrystalline; liq., liquid; microxl, microcrystalline; TVD, true vertical depth; v., very.*

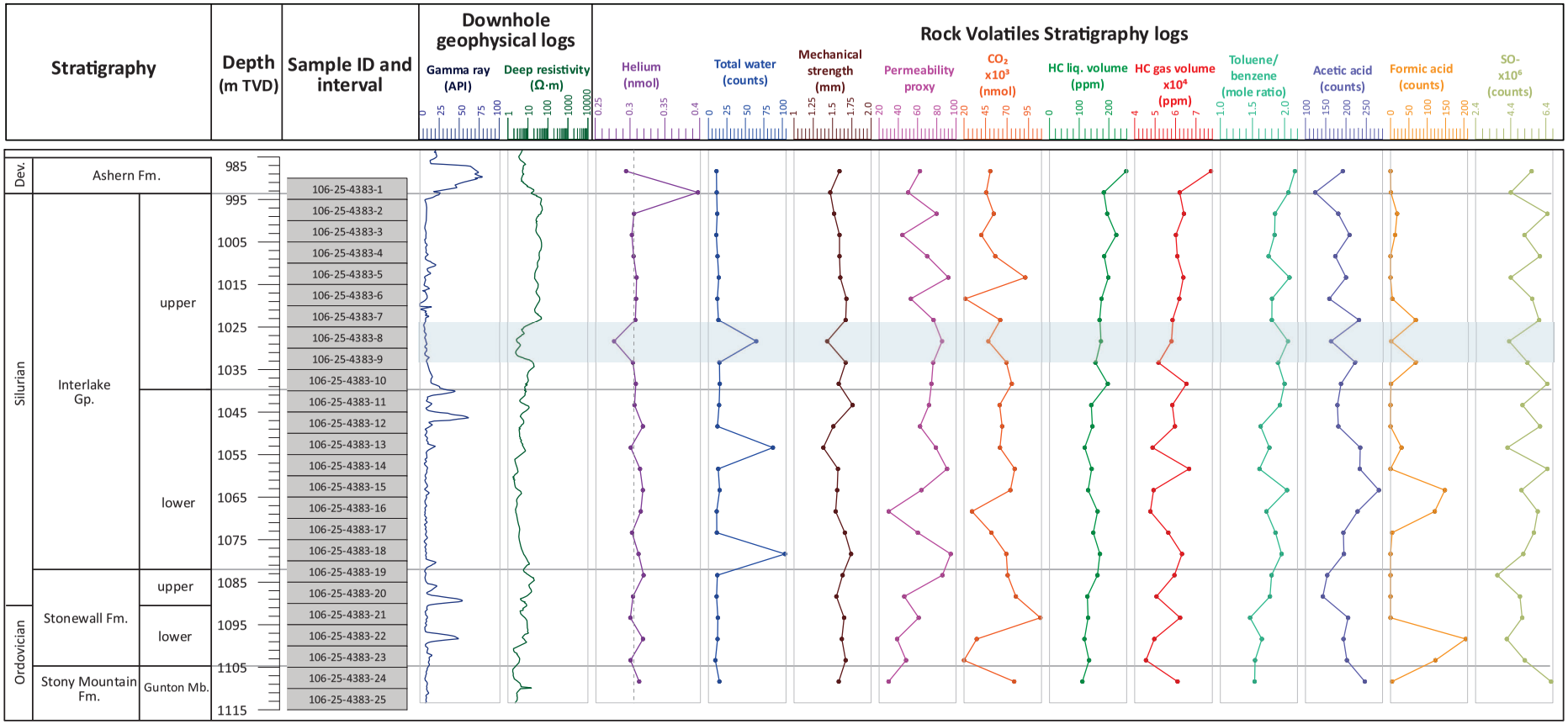

Figure GS2025-11-5: *Stratigraphy and Rock Volatiles Stratigraphy data logs for the oil and gas well at L.S. 12, Sec. 34, Twp. 15, Rge. 26, W 1st Mer. (12-34-15-26W1, southwestern Manitoba; oil and gas well licence 4383), including select downhole geophysical logs. Samples covered a 5.0 m interval. Dashed grey vertical line in helium track is the average value (0.306 nanomoles [nmol]) for all wells in this study combined. Mechanical strength of the sample increases from left to right on the mechanical strength log; the permeability proxy log indicates increased permeability from left to right. Blue-shaded band represents an interval of higher porosity and coarser-grained dolomitic textures that correlates to the shaded band in Figure GS2025-11-4. Abbreviations: Ω, ohm; Dev., Devonian; HC, hydrocarbon; liq., liquid; TVD, true vertical depth.*

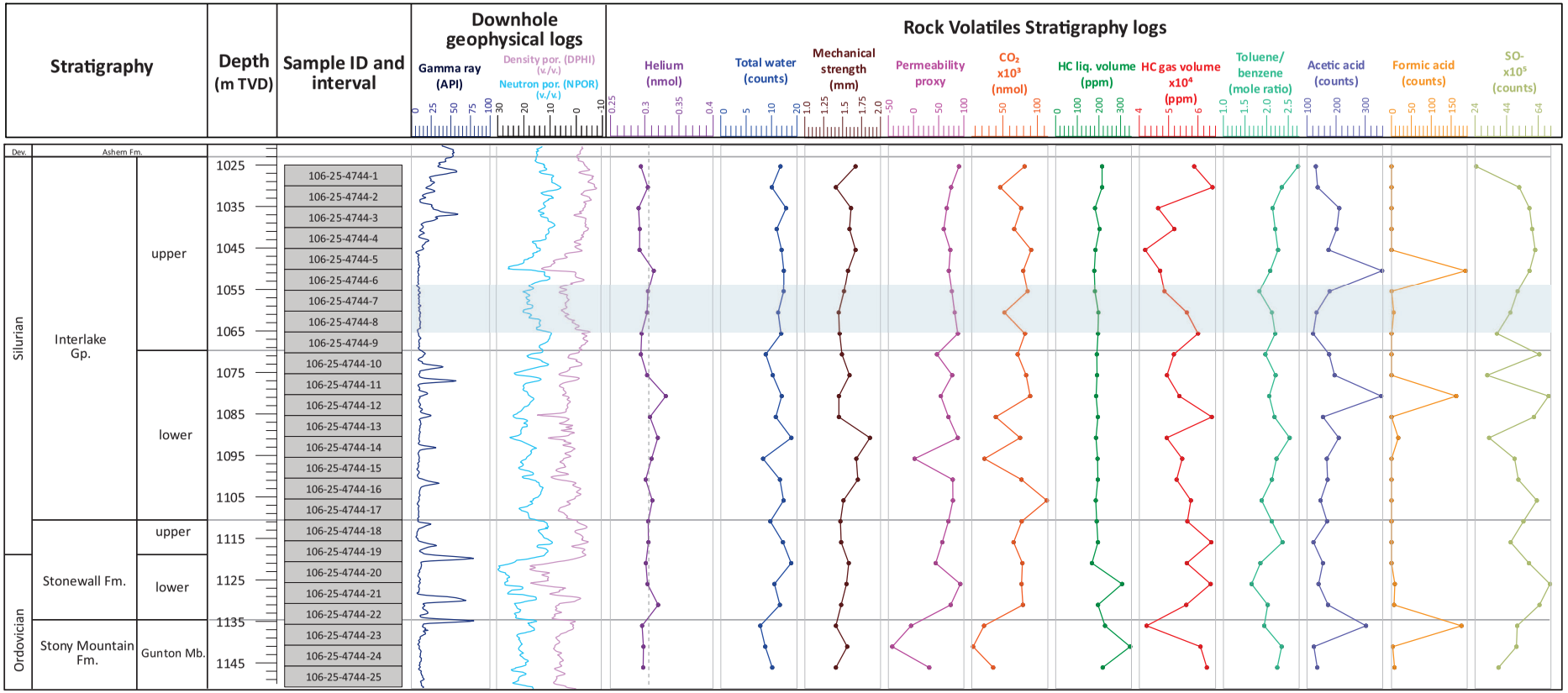

Figure GS2025-11-6: *Stratigraphy and Rock Volatiles Stratigraphy data logs for the oil and gas well at L.S. 2, Sec. 7, Twp. 16, Rge. 26, W 1st Mer. (2-7-16-26W1, southwestern Manitoba; oil and gas well licence 4744), including select downhole geophysical logs. Samples covered a 5.0 m interval. Dashed grey vertical line in helium track is the average value (0.306 nanomoles [nmol]) for all wells in this study combined. Mechanical strength of the sample increases from left to right on the mechanical strength log; the permeability proxy log indicates increased permeability from left to right. Blue-shaded band represents an interval of higher porosity and coarser-grained dolomitic textures that correlates to the shaded band in Figure GS2025-11-4. Abbreviations: Ω, ohm; Dev., Devonian; DPHI, density porosity; HC, hydrocarbon; liq., liquid; por., porosity; NPOR, neutron porosity; TVD, true vertical depth.*

Discussion

Stratigraphic homogeneity

The four wells used in this study are geographically close to each other to minimize the stratigraphic variability between each well. The strong similarities in the gamma-ray and resistivity logs, as well as the uniform thickness of each formation and member supports the assumption of stratigraphic homogeneity to minimize structural and lithological variations at the sample level (Stony Mountain Formation to Ashern Formation). As such, the lithology and porosity logs from well 2-14-16-28W1 (Figure GS2025-11-4) can be used as a proxy for the other three wells.

An example of this is a thick interval with higher porosity and coarser-grained dolomitic textures in the well at 2-14-16-28W1, shown by the blue-shaded band in Figure GS2025-11-4. Using the geophysical signature of the resistivity log as a correlation tool, this same blocky signature of lower resistivity can be found at similar stratigraphic positioning in the other three wells (blue-shaded bands in Figures GS2025-11-3, -5, -6). It is also equivalent to an interval with higher density and neutron log responses in the well at 2-7-16-26W1. This correlation indicates minor variations in the vertical positioning of this interval within the upper Interlake Group, as well as negligible variations in thickness of that unit. These differences are likely due to local facies changes and/or diagenetic porosity variations. Neither of these factors are of significance at the scale of the helium system being evaluated here.

Helium

In comparison to the RVS profiles in Nicolas et al. (2023b, 2024a), the sections analyzed are much smaller, which limits broader, large-scale observations. Despite this, none of these sections show any helium occurrences above the 0.7 nanomole (nmol) helium threshold for potential economic accumulations. This suggests that 1) helium migrating through the system is low in concentration, diffuse and/or flushed due to high permeability, 2) helium is not accumulating to any significant degree within the studied intervals, or 3) any helium generated from the Precambrian crystalline basement is trapped in deeper strata (e.g., Winnipeg Formation) or baffled, limiting the migration upward in these locations.

The helium values in all four wells are similar with an overall average of 0.306 nmol; this average is shown by the dashed grey vertical line on the helium tracks in Figures GS2025-11-3 to -6. Even though the variations from the average line are small, it is possible to identify some trends. These trends become more apparent when compared to the more pronounced trends in the helium tracks in Nicolas et al. (2023b, 2024a), particularly in the uppermost upper Interlake Group, lower Interlake Group and lower Stonewall Formation.

In previous studies, the upper strata in the upper Interlake Group commonly showed an abrupt increase in helium to approximately 2.0 nmol (Nicolas et al., 2023a, b). Although a large spike in helium is absent in this study, there is a small notable increase in the average helium value, up to a maximum of 0.3965 nmol, in the Interlake Group. In the upper Interlake Group section, this study's samples displayed similar trend lines between wells, including a small increase in the upper quarter of the upper Interlake Group section. In previous Manitoba studies, the lower Interlake Group had consistently shown above average helium values, commonly above the 0.7 nmol economic threshold. A similar pattern occurs in the lower Stonewall Formation where a small increase midway through the section consistently occurs in this and previous studies.

Radiolysis is the dominant pathway for helium generation and is also an important pathway for hydrogen generation. Nicolas et al. (2025b) modelled the hydrogen generation rate by radiolysis from Precambrian basement rocks by analyzing the lithogeochemistry of core samples (Nicolas et al., 2025a). One of the samples was from a core located at 16-18-18-29W1, just a few kilometres west of the well at 2-14-18-29W1. The geochemistry of that core sample (a granitic gneiss) indicated moderately low hydrogen generation for a felsic rock, attributed to high-grade metamorphism and weathering that reduced uranium and thorium concentrations. Lower concentrations of radioactive elements from this area may result in lower helium quantities migrating into the overlying stratigraphic section. This hypothesis is based on a single Precambrian sample, however, the Precambrian lithology in the other wells in this area is unknown, making extrapolations and assumptions on Precambrian helium contribution to the system difficult.

Hydrocarbons

All four wells indicate hydrocarbons throughout the sections studied, with hydrocarbon liquid and gas volume traces mimicking each other. The ratio of toluene/benzene is a proxy measurement used to identify zones in which large volumes of oil may have migrated. Values ≥3 are considered possible indicators, and values ≥5 are considered likely indicators, since such ratios are rare in produced crude oils. Elevated ratios suggest fractionation, with the larger, more polar toluene molecule retained in the rock matrix. Acetic and formic acid measurements can further indicate oil–water contacts (Rossini, 1960; Smith, 1968; Lord et al., 2018). The correlations of these five geochemical tracks suggest a hydrocarbon system present in the strata.

In particular, the well at 2-14-18-29W1 suggests a hydrocarbon system migrating within the lower Interlake Group as shown by the high toluene/benzene ratio between 1085 and 1055 m TVD. Coincident acetic acid and formic acid peaks at the base of that interval at 1077 m TVD suggest some accumulation may have occurred and a weak oil–water contact formed. The water content increase between 1060.70 and 1078.99 m TVD also follows this rationale. The high hydrocarbon liquid and gas volume values in the lower Interlake Group support this, how-

ever, high values also extend the hydrocarbon column higher in the strata, up to the upper Interlake Group. This may suggest a multilevel hydrocarbon system, with slow migration dominating the lower Interlake Group—slow enough to allow an oil–water contact signature to be preserved—but with accumulation of oil and gas higher up in the section. A similar hydrocarbon interpretation can be made in the same strata section in the 12-34-15-26W1 and 2-7-16-26W1 wells, but the former may be richer in lighter hydrocarbons (gas fraction).

An overall gradual increase in hydrocarbons (liquid and gas) was noted in all wells within the study area, reaching a maximum just below the Ashern Formation, similar to the findings of Nicolas et al. (2023b, 2024a). This suggests the Devonian Ashern Formation is acting as a regional sealing unit by minimizing, dampening or preventing vertical migration of hydrocarbon fluid; this is somewhat expected since the Ashern Formation is dominantly a dolomitic shale. These hydrocarbon fluids were noted, in all study area wells, to have higher concentrations than those measured for the same interval in prior studies (Nicolas et al., 2023a, b, 2024a, b). In the experience of AHS, this persistence of good quality light hydrocarbons in a sample set is what indicates proximity to a hydrocarbon resource. All the samples in this suite have this persistent signature.

In the study area, oil production is currently limited to the shallower Devonian Torquay Formation to Mississippian Bakken Formation intervals, and exploration for deeper oil resources is sparse. Previous RVS studies in Manitoba consistently indicate hydrocarbon opportunities in deeper Devonian strata, indicative of unexplored resources below current known production. At a minimum, these results indicate hydrocarbons are in this system, but economic accumulations can only be confirmed through targeted exploration.

Drill-cutting age and size

To evaluate drill-cutting age and size and their effect on RVS results, the RVS logs need to be viewed in a broader context. If results from an older well agree with those of a new well, when all else is equal, then age and size do not matter. For example, helium values show no accumulation, with background helium values that are comparable across wells regardless of the age and size of the drill cuttings. This is supported by comparing the mean and standard deviation of helium values for wells from the 1970s (2-14-18-29W1 and 2-14-16-28W1) and for wells from the 1990s (12-35-15-26W1 and 2-7-16-26W1). The wells from the 1970s have a mean concentration of 0.3057 ±0.0132 nmol and the wells from the 1990s have a mean of 0.3069 ±0.0157 nmol. A similar observation is observed with total water, mechanical strength, permeability, CO_2 and sulphate (SO-) proxy. Given that mechanical strength and permeability are directly measured from the rock and there is stratigraphic homogeneity in this suite of samples, similarities are expected. If the drill-cutting size were an issue for readings, then it would be expected for the results from older wells to deviate consistently from newer wells, however, this is not the case here. In Nicolas et al. (2023b), an attenuation of readings in newer (from the 2000s) drill cuttings that are fine grained was observed, but overall trends compared to older coarse drill cuttings were the same.

Conclusions

In the wells from this study, helium is present but no accumulations of interest occur in the Interlake Group, Stonewall Formation or Stony Mountain Formation. The same conclusion can be made for hydrocarbons. These observations do not preclude the possibility of economic concentrations above or below the sampled intervals. The ubiquity of helium and hydrocarbons in these samples indicate that the absence of economic accumulations in Ordovician and Silurian strata are not related due to limitations in source, generation, migration or quantity, but rather a need to identify reservoirs, seals and traps.

When comparing datasets from wells from the 1970s and 1990s, drill-cutting age and size does not affect the quality of RVS data or the ability to interpret and understand fluid systems. Even though attenuation of results (i.e., lower measurements) may occur in newer wells with fine-grained cuttings, overall trends of volatiles preserved in the micropores are the same as those from older, coarse-grained cuttings. Being aware that attenuation may be a factor is important when doing well-to-well comparisons with drill-cuttings–derived data. This awareness allows drill cuttings from the 1970s to 2000s to be compared directly to each other. In conclusion, these results broadly show that comparisons between drill cuttings of different ages and sizes can be made with confidence.

Economic considerations

The RVS data from these four Manitoba wells indicate that helium and hydrocarbons are present in the stratigraphic system from the Ordovician Stony Mountain Formation to Silurian Interlake Group, but not in economic concentrations. Nonetheless, the consistent detection of both fluids highlights the potential for larger accumulations of helium or hydrocarbons in unexplored horizons above or below the interval tested.

The helium in the Ordovician and Silurian strata appears to occur independently of hydrocarbons and can be produced on its own basis, as green helium. Green helium is a highly attractive target for investment and exploration, particularly in the growing market for environmentally sustainable resources.

Acknowledgments

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