Multi-Sensor Core Logger Analysis of Hutchinson Test #1 Drill Core (API # 15-155-21458)

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Energy & Stratigraphy

Kansas Geological Survey

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Drill Core Identifying Information and Analysis Parameters

LEASE: Hutchinson Test

WELL # 1

KID # 1024492453

API # 15-155-21458

Project: EMRI Salt (Trace Element Characterization of Permian Evaporites)

Date(s) Analyzed: 01/08/2026–02/24/2026
Diameter: 4 in.
Geometry: Whole core
pXRF mode: Geochem (3-Beam) on Vanta M-Series
Geochemical reference materials: OREAS 463, SCo-2, STM-1
Analysis Interval: 10 cm

Sensor Count Times (sec)
Density: 30
Magnetic Susceptibility (point sensor): 10
Gamma Ray: 120
pXRF (per beam): 60

Completion date of data processing: 03/13/2026
Data processed by: Rachel L. Smith (kgs-enstrat-lab@ku.edu)

All dates are in MM/DD/YYYY format.

All depths reported are initial core depths, and no depth shifts have been applied.

Acronyms, Abbreviations, and Symbols	
Term	**Description**
API	American Petroleum Institute units
GRM	Geochemical reference material
KGS	Kansas Geological Survey
LOD	Limit of detection
MSCL	Multi-Sensor Core Logger
PRM	Petrophysical reference material
pXRF	Portable X-ray fluorescence spectrometer
RSD	Relative standard deviation
Vp	P-wave velocity
Vs	S-wave velocity

1. MSCL Overview

This report provides an overview of the Hutchinson Test #1 Multi-Sensor Core Logger data acquisition methodology and data quality assessment. The Geotek Ltd. Multi-Sensor Core Logger (MSCL) at the Kansas Geological Survey (KGS) is equipped with seven sensors and a high-resolution line scan camera (up to 1,000 pixels per cm over the full core width). The sensors obtain the following data types: density, P- and S-wave velocity (*Vp*, *Vs*), impedance, core thickness, magnetic susceptibility, natural gamma (API, spectral potassium, uranium, thorium), visible and near-infrared light (VNIR), short wavelength infrared light (SWIR), and bulk surface geochemistry (pXRF). Magnetic susceptibility data are obtained using a Bartington MS2E (point) or MS2C (3-in. or 4.75-in. loop) core logging sensor. Bulk geochemistry is collected using an Olympus Vanta M-Series portable X-ray fluorescence spectrometer (pXRF). The spectrophotometry (VNIR, SWIR) data are collected by a Malvern Panalytical LabSpec 4 Hi-Res Analytical Spectral Device (ASD). The KGS has three scintillation detectors on its MSCL, allowing for lower natural gamma analysis count times. The natural gamma, density, sonic (*Vp*, *Vs*, impedance), and core thickness sensors were developed by Geotek Ltd. An in-depth explanation of the function of these sensors can be found in the Geotek MSCL-S Manual (Geotek Ltd., 2023). The MSCL is a semi-quantitative analytical instrument capable of acquiring a variety of data types at a high sampling resolution. These data are best suited for observing relative trends within the core and identifying areas of interest for further sampling.

2. Calibration

Density is recalibrated at the beginning of each new core project and at the beginning of every week thereafter. The factory calibration of the magnetic susceptibility sensor is checked weekly, while a factory calibration check (CalCheck) of the pXRF is performed at the beginning of each core project. These results are recorded and tracked over time. The spectrophotometer is calibrated daily on Spectralon. The sonic sensors do not require calibration (Geotek Ltd. Multi-Sensor Core Logger – Standard Manual, 2023). The natural gamma API (American Petroleum Institute units) calibration and ambient background radiation measurements are performed at the beginning of each new core project. API calibrations are conducted using Geotek's custom-made petrophysical reference materials (PRM). These PRM are 30-cm-long sections of granite, dolomite, and slate (fig. 2). Geotek produces PRM for the following core diameters: 1.87 in. (NQ), 2.5 in. (HQ), 3 in., 3.35 in. (PQ), 4 in., and 5.25 in. At the beginning of each core project, the set of PRM closest to the diameter of the project core is chosen. The natural gamma detectors' energy calibration is evaluated for drift weekly by counting for 5 minutes on the International Atomic Energy Agency (IAEA) Potassium Sulfate (IAEA-RGK-1) and Thorium Ore (IAEA-RGTh-1) reference materials and recalibrated as needed (>2% difference from expected

values). The natural gamma background radiation measurement is also checked weekly to ensure it is below approximately 50 counts per second.

3. Procedure

Each day, all sensors are tested to ensure the MSCL is fully functioning. Next, the reference core thickness (RCT) point is measured on the slate PRM and the spectrophotometer is calibrated. Then, a section of PRM and geochemical reference materials (GRM) are run through the sensors (fig. 2) to monitor the data quality (tables 1, 3, and 4). A silica blank is run first to monitor the state of the pXRF's prolene dust film. When one or more elements besides silicon or LE (light elements) consistently report on the blank, the film is replaced. Next, the three GRM are analyzed in the same order every day. The KGS has developed 3D-printed pieces that match each PRM diameter to hold the silica blank and GRM. This allows the blank and GRM to be analyzed with the PRM, greatly increasing day-to-day efficiency as well as simplifying data reduction. The PRM are always analyzed in the same order (granite, dolomite, slate) and are marked to ensure they are placed in the same orientation every day. Therefore, any variations in the PRM data are not due to a change in the analysis point location or PRM orientation (e.g., rotation of the PRM). All analysis points are taken within the middle 10 cm of the PRM, but the reported analysis point values (e.g., GR9-4B analysis point 29) are derived from their distance (in centimeters) from the start of the reference material section (i.e., GR9-4B analysis point 29 is 29 cm from the start of the section). The reported analysis point locations serve to demonstrate any changes in the selected locations from one project to the next (often as a result of procedural improvements), so that the behavior of each specific analysis point location on a PRM can be appropriately characterized over time across multiple projects.

Next, cores are loaded onto the MSCL in sections up to 155 cm in length, and analyses from each sensor are taken every 10 cm with the following count times: gamma density (30 sec), natural gamma (120 sec), magnetic susceptibility (10 sec), and pXRF (60 sec per beam). The starting depth, length of each section, and analysis point depths are notated in a section tracking sheet in Microsoft Excel. At this time, any point that is determined to pose an issue to certain sensors (e.g., cracks interfering with pXRF, density, *Vp*, *Vs*, or other results) is flagged in the spreadsheet for removal during data processing (see section 4 for details). At the end of the day, the GRM and PRM sections are run again to monitor drift and ensure the sensors continued to function properly throughout the day. If anomalous reference material values are reported for a day's work, the core will be reanalyzed if possible; otherwise the affected data are removed from the dataset.

3.1. Portable X-Ray Fluorescence Spectrometer (pXRF)

The Vanta M-Series pXRF is equipped with a rhodium anode and used on Geochem (3-beam) mode (Beam 1, 10 kV; Beam 2, 20 kV; and Beam 3, 50 kV) with a graphene detector

window. Each analysis point is analyzed for 60 seconds per beam exposure. The 3-beam analysis resolves major elements (Mg, Al, Si, P, S, Cl, Fe, K, Ca, and Ti), minor elements (Sr, V, Cu, Ni, Cr, Mn, and Pb), trace elements (Ba, Ce, La, Nd, Y, Co, Zn, As, Zr, Mo, Nb, Ag, Cd, Sn, Sb, Hf, Th, U, W, and Bi), and an aggregated "light elements" (H to Na). Detection limits (LOD) for these elements on the Vanta can be found in table 2.

4. Data Reduction

After the entire core has been analyzed, the data are collated using Python (v3.12.7), the reference materials are evaluated for anomalous values, and points with known issues (e.g., cracks) are removed from the dataset. This is because core defects that may pose issues to one sensor (e.g., cracks on core surface for pXRF) will not interfere with the measurements of others (e.g., natural gamma). When data are removed, they are replaced with a data substitution code indicating the reason for removal. Table 5 lists the data substitution codes and their explanations. A selection of data was plotted using Strater 5® by Golden Software (fig. 1). All depths reported are initial core depths and no depths shifts have been applied.

In Hutchinson Test #1, 19 *Vp* measurements greater than 10,000 m/s were identified as clear outliers and removed from the dataset along with their corresponding P-Wave amplitude and impedance values (see section 4.2.3. for details). These outliers and their depths are available in table 6. The summary tables of the GRM (table 1) and PRM (tables 3 and 4) results are presented here and with the Hutchinson Test #1 dataset (1024492453_HutchinsonTest_1_MSCL_Data_20260313.xlsx), but the full results are made available separately. For the full geochemical reference material results and calculations, see "1024492453_HutchinsonTest_1_MSCL_GRMTable_20260313.xlsx". For the petrophysical results and calculations, see "1024492453_HutchinsonTest_1_MSCL_PRMTable_20260313.xlsx".

4.1. Geochemical Data Quality Assessment

The averages, standard deviations, relative standard deviations (RSD), and percent differences are calculated for each element per GRM (table 1). OREAS 463, SCo-2, and STM-1 were selected as the GRM for this project because these three offer the best elemental coverage out of any possible GRM combination available in the KGS collection. However, silver, cadmium, mercury, and selenium are unmonitored on the pXRF using this combination. In addition, bismuth, antimony, and tungsten are barely above LOD (bismuth and antimony LODs are 2 ppm; tungsten LOD is 1 ppm) in OREAS 463 (bismuth, 2.93 ppm; antimony, 2.14 ppm; tungsten, 2.45 ppm). Therefore, silver, bismuth, cadmium, mercury, selenium, antimony, and tungsten values should be taken with caution.

In addition, the Hutchinson Test #1 GRM results illustrate issues with cobalt, chromium, nickel, and sulfur. Cobalt is not detected on OREAS 463, whose expected concentration is 13.5 ±

0.61 ppm, but is detected on STM-1, whose expected value is below LOD. Nickel is not detected on OREAS 463 either (expected concentration of 76 ± 4.4 ppm). In addition, nickel is only detected in 17 of the 50 assays of SCo-2 and averages 9.4 ± 1.8 ppm — a third of the expected concentration (27.8 ± 0.04 ppm). This suggests the pXRF may be under-detecting nickel. Chromium is not detected on SCo-2, whose expected concentration is 68.29 ± 1.21 ppm, but reports (1,861 ± 135 ppm) well above the expected concentration for OREAS 463 (460 ± 86 ppm). Sulfur was only detected once on STM-1 (5,908 ppm), well above its expected concentration (43 ppm). For OREAS 463, sulfur was detected in 22 of 50 assays and shows extreme variability (113.2% RSD). It also averages much higher concentrations (2,032 ± 2,301 ppm) than expected (624 ± 46 ppm).

Overall, barium, lanthanum, and cerium are notably lower than expected. It is worth noting that lanthanum does average higher (37.4 ± 2.3 ppm) than expected in SCo-2, but this is likely due to the proximity of the known concentration (28.43 ± 0.36 ppm) to the detection limit (20 ppm). Therefore, lanthanum concentrations nearing 20 ppm may be inflated. Similarly, thorium reports higher than expected for SCo-2 (34.3 ± 3.7 ppm average; 9 ± 0.09 ppm expected) and STM-1 (50.2 ± 5.1 ppm average; 31 ± 3 ppm expected) but averages as expected for OREAS 463 (291.4 ± 20.6 ppm average; 291 ± 10 ppm expected). Therefore, thorium concentrations at or below those reported for STM-1 (maximum of 62.43 ppm) are likely inflated and should be taken with caution. Lastly, uranium was not detected on OREAS 463 (7.55 ± 0.37 ppm expected) despite being analyzed in all 50 assays of both SCo-2 (7.0 ± 1.2 ppm average; 3.2 ± 0.05 ppm expected) and STM-1 (10.3 ± 1.7 ppm average; 9.1 ± 0.1 ppm expected). The high uranium percent difference for SCo-2 (118.3%) illustrates the difficulty in accurately measuring very low elemental concentrations with a pXRF.

In conclusion, caution is advised when evaluating Ag, Bi, Cd, Hg, Se, Sb, W, Co, Cr, Ni, and S concentrations in the Hutchinson Test #1 dataset. Barium, lanthanum, cerium, and nickel are likely under-reported, while thorium values of 62 ppm or less are likely inflated. Finally, all concentrations near the limits of detection should be treated with caution (e.g., uranium and lanthanum).

4.2. Petrophysical Data Quality Assessment

4.2.1. Core Thickness

The reference materials reported three distinct populations of core thickness measurements: 9.7–9.9 cm, 9.9–10.2 cm, and 10.2–10.5 cm. The RSD of the PRM analysis points are still relatively low (approximately 1.8%; table 3.1) and this issue has been previously observed on this set of PRM (up to 3% RSD). Other smaller PRM sets typically exhibit an average RSD of < 0.2%. A definitive cause of the 4-in. PRM core thickness variability has not yet been identified. It is possible (though unlikely) that the technician did not position the reference core

thickness (RCT) point correctly during startup. In such cases, the MSCL measures a core deviation distance on something other than the RCT point located at the center of the slate PRM (SL5-31), whose known diameter is 9.871 cm. The false core deviation is assigned a distance of 9.871 cm, thus offsetting the core thickness measurements and, to a lesser extent, the density, *Vp*, *Vs*, and impedance results (all of which are calculated using core thickness). The impact on Hutchinson Test #1's core thickness results is noticeable (fig. 1), but the effects on the other data types are much more subtle.

4.2.2. Density

The PRM density values show some variability, with RSD ranging from 3.86% to 4.12% (table 3.1). This is higher than the 2.3–2.7% RSDs observed by the KGS on past projects of similar core diameters. The known ranges of densities of granite (2.50–2.81 g/cc), dolomite (2.28–2.90 g/cc), and slate (2.70–2.90 g/cc; Oldenburg et al., 2017) are noticeably higher than our reported averages (2.36 g/cc, 2.26 g/cc, and 2.48 g/cc, respectively). Therefore, the Hutchinson Test #1 density results are very likely lower than they should be. The user is heavily advised to take this into consideration, along with the variability caused by the core thickness issues discussed in section 4.2.1., when working with these density data.

4.2.3. Vp, Vs, and Impedance

The RSD for *Vp*, *Vs*, and their respective amplitudes and impedances (table 3.1) are elevated due to multiple outliers. Twelve GR9-4B and nine D9-1 points have a *Vp* > 7,400 m/s, far outside the expected *Vp* ranges of granite (4,500–6,000 m/s) and dolomite (3,500–6,500 m/s; Oldenburg et al., 2017). Three SL5-31 points of *Vp* < 4,300 m/s fall below the typical range of 5,000–7,000 m/s that the KGS has observed for slate PRM. Twenty-five GR9-4B and two D9-1 points have S-wave amplitudes of 0, while eight *Vs* outliers (>3,600 m/s) occurred on analysis point 95 of SL5-31. The typical *Vs* of analysis point 95 of SL5-31 is approximately 2,600 m/s. Because impedance is calculated from *Vp* and density, these results are also affected by the *Vp* outliers. Removing all outliers greatly improves the RSD (table 3.2). None of these outliers occur at every PRM point in either the beginning or end of day PRM runs. Nor is there an instance of a single PRM having outliers for all six of a single day's analyses. Therefore, the outliers do not affect the validity of the *Vp*, *Vs*, and impedance data.

These PRM outliers are likely caused by failures to properly pick the wave arrival times during analysis, which is a common issue with this sensor. The MSCL user must visually assess the waveforms and manually select both wave arrivals within approximately 30 seconds. Because picking every wave arrival is extremely tedious, the wave arrivals for Hutchinson Test #1 were only adjusted when there was a lithologic change observed in the core. This is a potential cause for Hutchinson Test #1's 19 *Vp* outliers (table 6). These outliers have velocities greater than 10,000 m/s and were removed from the dataset along with their corresponding

amplitudes and impedances. Given the known issues with this sensor and the potential variability caused by the core thickness issues discussed in section 4.2.1., the user is advised to always use the *Vp*, *Vs*, and impedance data in conjunction with other data types (e.g., natural gamma).

4.2.4. Magnetic Susceptibility

The SL5-31 magnetic susceptibility results are very consistent, illustrated by the small RSD in table 3.1. However, the GR9-4B and D9-1 magnetic susceptibility RSD are much higher (12.69–27.55% and 108.25–115.82%, respectively). The variability in GR9-4B may be a result of the point sensor's sensitivity to the heterogeneous texture of GR9-4B. The variability observed in D9-1 suggests that magnetic susceptibility may be less precise on similar lithologies (e.g., carbonates).

4.2.5. Gamma Ray (Natural Gamma)

The API values of the PRM are consistent, as demonstrated by their low relative standard deviations (table 4). GR9-4B and SL5-31 have very low percent differences for API as well, but D9-1 does not. The inflated D9-1 API values are due to their proximity to both GR9-4B and SL5-31. Their API values are much greater, so the detectors pick up decays from GR9-4B and SL5-31 and attribute them to D9-1. This is a known issue that the KGS is actively seeking to improve.

Like the API values, the D9-1 spectral potassium, uranium, and thorium values are inflated by the proximity of D9-1 to GR9-4B and SL5-31. The SL5-31 spectral uranium RSD are also noticeably greater than that of GR9-4B (table 4), indicating a higher degree of variability and possibly lower reliability of the spectral uranium results. The negative percent differences for GR9-4B and SL5-31 demonstrate that spectral potassium, uranium, and thorium are underestimated, resulting in the negative values seen in Hutchinson Test #1 (fig. 1).

Spectral potassium, uranium, and thorium are not plotted with the pXRF potassium, uranium, and thorium results because of the under-detection of spectral uranium and thorium along with the issues identified with the pXRF uranium and thorium results discussed in section 4.1. As for potassium, the pXRF results are much lower than the spectral potassium results at depths of approximately 300–510 ft. This has been observed in other 4-in. diameter cores and may be caused by the differences in the pXRF and natural gamma sensor's areas of acquisition. The pXRF analyzes a quarter-sized point at the surface of the core, while the natural gamma sensor acquires counts from an entire 8.5-in. length of the core. For cores with large diameters, the elemental concentrations at the surface may not accurately reflect the whole rock geochemistry.

4.2.6. Spectrophotometry

The reflectance percentages of the PRM are consistent, indicated by their relatively low relative standard deviations (table 3.1). However, the final spectrophotometry data point of each day, SL5-31 analysis point 95, was not recorded. This is a common issue with the MSCL, but the cause is yet to be determined. The missing value was flagged with the ER data substitution code to indicate an instrumental malfunction occurred. Several Hutchinson Test #1 spectrophotometry data points were determined by the technician to be unsuitable and removed from the dataset (data substitution code TR). These points were taken on the orientation lines, which biased the spectrophotometry results.

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			Ag	Al	As	Ba	Bi	Ca	Cd	Ce	Co	Cr
OREAS 463	Observed	Average (ppm)	5.8	36541	15.3	517	BDL	10725	34.4	2343	BDL	1861
		SD	0.5	4426	3.3	72	BDL	1391	6.7	296	BDL	135
		n	4	50	45	50	0	50	50	50	0	50
		RSD (%)	8.1	12.1	21.9	13.8	N/A	13.0	19.5	12.6	N/A	7.3
		Percent Difference	N/A	-33.2	-51.2	-54.4	N/A	-9.9	N/A	-64.2	N/A	304.6
	Expected	**Average (ppm)**	**N/A**	**54700**	**31.3**	**1135**	**2.93**	**11900**	**N/A**	**6540**	**13.5**	**460**
		SD	*N/A*	*1210*	*1.75*	*46*	*0.18*	*720*	*N/A*	*220*	*0.61*	*86*
SCo-2	Observed	Average (ppm)	BDL	48028	11.6	303.2	BDL	25501	13.0	49.1	17.5	BDL
		SD	BDL	2477	0.8	27.6	BDL	1329	2.7	7.3	4.3	BDL
		n	0	50	50	50	0	50	15	25	50	0
		RSD (%)	N/A	5.2	6.7	9.1	N/A	5.2	20.6	14.9	24.6	N/A
		Percent Difference	N/A	-30.9	-1.4	-47.7	N/A	-9.4	N/A	-9.9	61.6	N/A
	Expected	**Average (ppm)**	**N/A**	**69492**	**11.75**	**580**	**N/A**	**28159**	**N/A**	**54.47**	**10.8**	**68.29**
		SD	*N/A*	*219*	*0.2949*	*3.336*	*N/A*	*100*	*N/A*	*0.4452*	*0.1378*	*1.21*
STM-1	Observed	Average (ppm)	3.87	60236	4.1	353.4	BDL	6422	12.3	137.4	10.1	BDL
		SD	N/A	3709	0.9	39.0	BDL	550	2.4	18.0	4.0	BDL
		n	1	50	47	50	0	50	18	50	48	0
		RSD (%)	N/A	6.2	21.5	11.0	N/A	8.6	19.6	13.1	39.3	N/A
		Percent Difference	N/A	-38.1	-11.8	-36.9	N/A	-17.6	N/A	-47.2	N/A	N/A
	Expected	**Average (ppm)**	**BDL**	**97384**	**4.6**	**560**	**BDL**	**7790**	**BDL**	**260**	**BDL**	**BDL**
		SD	*BDL*	*1217*	*N/A*	*60*	*BDL*	*429*	*BDL*	*18*	*BDL*	*BDL*

Table 1. Comparison of standards run as unknown during MSCL analysis (observed) to their reported values (expected). SD is standard deviation. RSD is relative standard deviation. BDL is below detection limit. All values are in parts per million. OREAS 463 expected values are from OREAS (Ore Research & Exploration Pty Ltd., 2025), SCo-2 from USGS (2022), and STM-1 from Smith (1995).

			Cu	Fe	Hg	K	La	Mg	Mn	Mo	Nb	Nd
OREAS 463	Observed	Average (ppm)	49.7	293455	14.1	1411	1709	9765	632.6	48.8	1352	1293
		SD	11.8	21205	N/A	561	215	2874	56.5	5.4	117	172
		n	50	50	1	3	50	42	50	50	50	50
		RSD (%)	23.7	7.2	N/A	39.8	12.6	29.4	8.9	11.1	8.7	13.3
		Percent Difference	-23.5	-12.0	N/A	29.5	-64.2	-3.3	-43.5	-14.4	-9.6	-64.2
	Expected	**Average (ppm)**	**65**	**333300**	**N/A**	**1090**	**4773**	**10100**	**1120**	**57**	**1495**	**3611**
		SD	*3.2*	*10790*	*N/A*	*90*	*277*	*690*	*80*	*3.6*	*73*	*108*
SCo-2	Observed	Average (ppm)	11.9	31159	6.3	16205	37.4	5956	328.2	2.3	9.3	87.7
		SD	2.9	709	0.8	483	2.3	1296	14.5	0.9	1.0	12.3
		n	50	50	12	50	9	46	50	18	50	2
		RSD (%)	24.8	2.3	12.9	3.0	6.1	21.8	4.4	37.3	10.4	14.0
		Percent Difference	-49.5	-4.1	N/A	-20.5	31.5	-65.3	-1.5	95.0	-17.6	N/A
	Expected	**Average (ppm)**	**23.53**	**32475**	**N/A**	**20371.89**	**28.43**	**17187**	**333**	**1.2**	**11.25**	**BDL**
		SD	*0.4149*	*111*	*N/A*	*65*	*0.3583*	*135*	*4*	*0.0487*	*0.1699*	*BDL*
STM-1	Observed	Average (ppm)	5.5	33981	6.6	30500	80.7	3590	1585.4	17.4	278.6	89.5
		SD	2.4	501	1.2	668	10.4	N/A	31.2	1.9	1.9	8.3
		n	46	50	26	50	50	1	50	50	50	8
		RSD (%)	44.2	1.5	17.5	2.2	12.9	N/A	2.0	10.7	0.7	9.2
		Percent Difference	20.3	-6.9	N/A	-14.2	-46.2	N/A	-6.7	228.4	3.2	13.3
	Expected	**Average (ppm)**	**4.6**	**36510**	**N/A**	**35530**	**150**	**BDL**	**1700**	**5.3**	**270**	**79**
		SD	*N/A*	*699*	*N/A*	*581*	*6*	*BDL*	*120*	*N/A*	*12*	*7*

Table 1 — continued

			Ni	P	Pb	Pr	Rb	S	Sb	Se	Si	Sn
OREAS 463	Observed	Average (ppm)	BDL	2341	101.7	353.8	12.1	2032.7	42.8	BDL	69784	44.7
		SD	BDL	332	10.0	54.5	0.4	2301.6	0.6	BDL	11202	7.1
		n	0	50	50	50	5	22	2	0	50	50
		RSD (%)	N/A	14.2	9.9	15.4	3.5	113.2	1.5	N/A	16.1	15.9
		Percent Difference	N/A	-60.3	-21.8	-64.1	98.6	225.8	1898.6	N/A	-45.7	74.6
	Expected	**Average (ppm)**	**76**	**5900**	**130**	**986**	**6.11**	**624**	**2.14**	**N/A**	**128500**	**25.6**
		SD	*4.4*	*540*	*5*	*36*	*0.58*	*46*	*0.22*	*N/A*	*3920*	*2.47*
SCo-2	Observed	Average (ppm)	9.4	333.9	22.8	85.9	99.7	7536.1	21.3	BDL	170729	7.5
		SD	1.8	33.5	1.1	N/A	1.7	1009.1	N/A	BDL	9685	1.5
		n	17	50	50	1	50	50	1	0	50	10
		RSD (%)	19.6	10.0	4.9	N/A	1.7	13.4	N/A	N/A	5.7	19.5
		Percent Difference	-66.3	-57.7	13.4	N/A	-1.3	N/A	N/A	N/A	-41.0	N/A
	Expected	**Average (ppm)**	**27.8**	**789**	**20.08**	**BDL**	**101**	**N/A**	**BDL**	**N/A**	**289203**	**BDL**
		SD	*0.4372*	*5*	*0.2652*	*BDL*	*0.8617*	*N/A*	*BDL*	*N/A*	*397*	*BDL*
STM-1	Observed	Average (ppm)	BDL	623.7	17.4	96.8	109.2	5907.9	BDL	BDL	188404	7.2
		SD	BDL	42.5	1.1	9.1	1.4	N/A	BDL	BDL	10756	2.2
		n	0	50	50	3	50	1	0	0	50	18
		RSD (%)	N/A	6.8	6.1	9.4	1.3	N/A	N/A	N/A	5.7	30.7
		Percent Difference	N/A	-10.6	-3.4	N/A	-7.5	13639.4	N/A	N/A	-32.4	5.6
	Expected	**Average (ppm)**	**N/A**	**698**	**18**	**N/A**	**118**	**43**	**BDL**	**N/A**	**278592**	**6.8**
		SD	*N/A*	*44*	*1.8*	*N/A*	*6*	*N/A*	*BDL*	*N/A*	*2290*	*N/A*

Table 1 — continued

			Sr	Th	Ti	U	V	W	Y	Zn	Zr
OREAS 463	Observed	Average (ppm)	762.7	291.4	12353	BDL	210.6	19.7	151.1	306.8	452.3
		SD	66.3	20.6	774	BDL	37.3	2.0	13.5	24.9	43.5
		n	50	50	50	0	50	4	50	50	50
		RSD (%)	8.7	7.1	6.3	N/A	17.7	10.0	8.9	8.1	9.6
		Percent Difference	-18.3	0.1	41.0	N/A	-35.6	703.0	-14.1	-21.5	76.7
	Expected	**Average (ppm)**	**934**	**291**	**8760**	**7.55**	**327**	**2.45**	**176**	**391**	**256**
		SD	*67*	*10*	*1630*	*0.368*	*26*	*0.38*	*10*	*30*	*25*
SCo-2	Observed	Average (ppm)	195.7	34.3	3080	7.0	128.6	7.1	24.2	106.4	173.0
		SD	2.6	3.7	82	1.2	20.3	0.9	1.1	2.4	2.6
		n	50	50	50	50	50	21	50	50	50
		RSD (%)	1.3	10.8	2.7	17.2	15.8	13.2	4.5	2.2	1.5
		Percent Difference	0.5	281.6	-9.1	118.3	9.9	N/A	4.8	9.7	-5.5
	Expected	**Average (ppm)**	**194.7**	**9**	**3388**	**3.2**	**117**	**N/A**	**23.1**	**97**	**183**
		SD	*1.493*	*0.09076*	*12*	*0.0544*	*1.196*	*N/A*	*0.2586*	*0.856*	*1.502*
STM-1	Observed	Average (ppm)	733.4	50.2	778.3	10.3	BDL	10.0	42.7	233.3	1307
		SD	5.0	5.1	54.4	1.7	BDL	2.0	1.3	3.3	7
		n	50	50	50	50	0	46	50	50	50
		RSD (%)	0.7	10.2	7.0	16.2	N/A	20.2	3.0	1.4	0.5
		Percent Difference	4.8	61.9	-7.2	13.0	N/A	N/A	-7.1	-0.7	8.0
	Expected	**Average (ppm)**	**700**	**31**	**839**	**9.1**	**8.7**	**N/A**	**46**	**235**	**1210**
		SD	*30*	*3*	*60*	*0.1*	*N/A*	*N/A*	*5*	*22*	*120*

Table 1 — continued

Element	Limit of Detection (ppm)
Ag	1
Al	125
As	1
Ba	10
Bi	2
Ca	20
Cd	1
Ce	30
Co	2
Cr	10
Cu	2
Fe	15
Hg	1
K	15
La	20
Mg	1800
Mn	5
Mo	1
Nb	2
Nd	50
Ni	4
P	20
Pb	2
Pr	35
Rb	1
S	15
Sb	2
Se	1
Si	190
Sn	2
Sr	1
Th	2
Ti	20
U	1
V	5
W	1
Y	1
Zn	1
Zr	1

Table 2. Vanta M-Series limits of detection in parts per million using Geochem (3-beam) mode with a graphene detector window.

Name	Analysis Point		Core Thickness (cm)	P-Wave Amplitude	P-Wave Velocity (m/s)	S-Wave Amplitude	S-Wave Velocity (m/s)	Density (g/cc)	Magnetic Susceptibility (SI x 10^-5)	Impedance ($x10^3 kg/m^2 s$)	Spectrophotometer Reflectance (%): Red (595 - 700)	Spectrophotometer Reflectance (%): Green (515 - 595)	Spectrophotometer Reflectance (%): Blue (400 - 515)
GR9-4B	29	Average	10.160	0.086	4618	0.048	2446	2.35	5.24	10867	38.4	37.5	34.8
		SD (n=50)	0.186	0.026	421	0.025	1115	0.09	1.45	958	2.1	2.3	2.3
		RSD (%)	1.828	29.725	9	51.484	46	3.86	27.55	9	5.5	6.1	6.6
	31	Average	10.159	0.103	5112	0.060	2563	2.36	3.66	12062	38.9	37.3	33.8
		SD (n=50)	0.185	0.024	1675	0.030	1092	0.09	0.69	4083	2.1	2.4	2.5
		RSD (%)	1.825	23.271	33	49.454	43	3.87	18.86	34	5.5	6.3	7.4
	33	Average	10.161	0.084	5187	0.058	2593	2.36	7.94	12247	41.1	39.8	36.0
		SD (n=50)	0.185	0.015	1528	0.027	1105	0.09	1.01	3613	2.9	2.9	2.8
		RSD (%)	1.822	17.699	29	46.884	43	3.96	12.69	30	7.0	7.2	7.7
D9-1	57	Average	10.029	0.111	5757	0.073	3100	2.25	0.82	12953	75.4	69.3	57.7
		SD (n=50)	0.185	0.014	2306	0.013	453	0.09	0.95	5038	1.7	1.5	1.3
		RSD (%)	1.848	12.494	40	18.054	15	4.09	115.82	39	2.2	2.2	2.3
	59	Average	10.031	0.108	5192	0.075	3084	2.26	0.86	11703	74.6	68.5	56.2
		SD (n=50)	0.185	0.012	1172	0.013	450	0.09	0.99	2502	1.7	1.6	1.5
		RSD (%)	1.844	11.013	23	16.922	15	4.12	115.27	21	2.2	2.3	2.6
	65	Average	10.029	0.098	5533	0.076	3042	2.27	0.82	12488	75.7	69.4	56.8
		SD (n=50)	0.185	0.012	2329	0.008	124	0.09	0.88	5043	1.8	1.8	1.7
		RSD (%)	1.844	12.243	42	9.879	4	4.10	108.25	40	2.4	2.6	2.9
SL5-31	89	Average	10.154	0.178	6798	0.057	2900	2.47	42.61	16814	19.1	19.5	19.7
		SD (n=50)	0.185	0.023	407	0.014	315	0.10	1.16	1120	2.9	2.9	2.8
		RSD (%)	1.827	13.155	6	24.479	11	3.98	2.71	7	15.1	14.9	14.1
	91	Average	10.151	0.186	6750	0.062	2874	2.48	39.11	16713	18.3	18.8	19.3
		SD (n=50)	0.185	0.027	388	0.019	257	0.10	0.93	1054	2.5	2.5	2.4
		RSD (%)	1.824	14.602	6	31.027	9	4.03	2.38	6	13.8	13.4	12.4
	95	Average	10.154	0.178	6559	0.054	2818	2.48	37.94	16239	16.2	16.8	17.4
		SD (n=50)	0.186	0.011	391	0.016	435	0.10	1.02	1057	2.2	2.2	2.1
		RSD (%)	1.830	6.341	6	30.385	15	4.11	2.70	7	13.4	13.0	12.1

Table 3.1. Comparison of results for petrophysical reference materials run during MSCL analysis. SD is standard deviation. RSD is relative standard deviation. GR9-4B is granite, D9-1 is dolomite, and SL5-31 is slate. Analysis point values are derived from their distance (in centimeters) from the start of the reference material section (see section 3 for details).

Name	Analysis Point		Core Thickness (cm)	P-Wave Amplitude	P-Wave Velocity (m/s)	S-Wave Amplitude	S-Wave Velocity (m/s)	Density (g/cc)	Magnetic Susceptibility (SI x 10^-5)	Impedance (x10^3kg/m^2s)	Spectrophotometer Reflectance (%): Red (595 - 700)	Spectrophotometer Reflectance (%): Green (515 - 595)	Spectrophotometer Reflectance (%): Blue (400 - 515)
GR9-4B	29	Average	10.160	0.088	4560	0.057	2892	2.35	5.24	10738	38.4	37.5	34.8
		SD (n=50)	0.186	0.024	85	0.014	459	0.09	1.45	314	2.1	2.3	2.3
		RSD (%)	1.828	27.095	2	24.417	16	3.86	27.55	3	5.5	6.1	6.6
	31	Average	10.159	0.107	4604	0.072	3031	2.36	3.66	10852	38.9	37.3	33.8
		SD (n=50)	0.185	0.020	87	0.015	136	0.09	0.69	336	2.1	2.4	2.5
		RSD (%)	1.825	18.810	2	20.575	4	3.87	18.86	3	5.5	6.3	7.4
	33	Average	10.161	0.088	4657	0.069	3067	2.36	7.94	10981	41.1	39.8	36.0
		SD (n=50)	0.185	0.012	86	0.010	140	0.09	1.01	337	2.9	2.9	2.8
		RSD (%)	1.822	13.304	2	14.649	5	3.96	12.69	3	7.0	7.2	7.7
D9-1	57	Average	10.029	0.113	5216	0.075	3162	2.25	0.82	11758	75.4	69.3	57.7
		SD (n=50)	0.185	0.011	99	0.008	135	0.09	0.95	400	1.7	1.5	1.3
		RSD (%)	1.848	9.695	2	10.742	4	4.09	115.82	3	2.2	2.2	2.3
	59	Average	10.031	0.109	4916	0.076	3145	2.26	0.86	11122	74.6	68.5	56.2
		SD (n=50)	0.185	0.010	96	0.007	134	0.09	0.99	336	1.7	1.6	1.5
		RSD (%)	1.844	8.936	2	8.750	4	4.12	115.27	3	2.2	2.3	2.6
	65	Average	10.029	0.100	4958	0.076	3042	2.27	0.82	11249	75.7	69.4	56.8
		SD (n=50)	0.185	0.010	94	0.008	124	0.09	0.88	359	1.8	1.8	1.7
		RSD (%)	1.844	10.109	2	9.879	4	4.10	108.25	3	2.4	2.6	2.9
SL5-31	89	Average	10.154	0.179	6850	0.057	2900	2.47	42.61	16943	19.1	19.5	19.7
		SD (n=50)	0.185	0.023	169	0.014	315	0.10	1.16	656	2.9	2.9	2.8
		RSD (%)	1.827	13.084	2	24.479	11	3.98	2.71	4	15.1	14.9	14.1
	91	Average	10.151	0.187	6801	0.062	2874	2.48	39.11	16839	18.3	18.8	19.3
		SD (n=50)	0.185	0.026	143	0.019	257	0.10	0.93	570	2.5	2.5	2.4
		RSD (%)	1.824	13.911	2	31.027	9	4.03	2.38	3	13.8	13.4	12.4
	95	Average	10.154	0.179	6612	0.057	2640	2.48	37.94	16369	16.2	16.8	17.4
		SD (n=50)	0.186	0.011	122	0.014	144	0.10	1.02	526	2.2	2.2	2.1
		RSD (%)	1.830	6.393	2	24.673	5	4.11	2.70	3	13.4	13.0	12.1

Table 3.2. Comparison of results for petrophysical reference materials run during MSCL analysis after removing outliers. The affected RSD (highlighted in yellow) show a significant decrease from those in Table 3.1. SD is standard deviation. RSD is relative standard deviation. GR9-4B is granite, D9-1 is dolomite, and SL5-31 is slate. Analysis point values are derived from their distance (in centimeters) from the start of the reference material section (see section 3 for details).

Name	Analysis Point		Gamma Ray (API)	K from Gamma Ray (wt%)	U from Gamma Ray (ppm)	Th from Gamma Ray (ppm)
GR9-4B	29	Average	173.8	5.1	11	19
		SD (n=50)	5.1	0.3	1	1
		RSD (%)	3.0	6.3	14	5
		Expected Value	171.7	5.2	11	20
		Percent Difference	1.2	-1.2	-5	-2
	31	Average	174.7	5.1	11	19
		SD (n=50)	5.4	0.3	1	1
		RSD (%)	3.1	5.3	13	4
		Expected Value	171.7	5.2	11	20
		Percent Difference	1.8	-1.1	-4	-2
	33	Average	173.7	5.1	11	19
		SD (n=50)	5.1	0.3	1	1
		RSD (%)	3.0	6.5	11	5
		Expected Value	171.7	5.2	11	20
		Percent Difference	1.1	-1.9	-1	-3
D9-1	57	Average	38.3	0.58	1.31	2.0
		SD (n=50)	1.6	0.22	0.90	0.7
		RSD (%)	4.2	37.90	68.62	34.3
		Expected Value	26.3	0.10	0.7	0.4
		Percent Difference	45.7	477.14	87.2	410.3
	59	Average	35.1	0.39	1.09	1.4
		SD (n=50)	1.9	0.22	0.96	0.6
		RSD (%)	5.4	55.67	88.28	43.5
		Expected Value	26.3	0.10	0.7	0.4
		Percent Difference	33.4	287.01	55.3	261.1
	65	Average	34.8	0.38	0.92	1.5
		SD (n=50)	1.9	0.21	0.87	0.6
		RSD (%)	5.6	55.71	94.86	41.5
		Expected Value	26.3	0.10	0.7	0.4
		Percent Difference	32.2	283.83	30.9	287.5
SL5-31	89	Average	109.0	3.5	2.62	13.9
		SD (n=50)	3.5	0.3	1.17	0.8
		RSD (%)	3.2	8.5	44.51	6.1
		Expected Value	102.4	3.5	2.9	14.2
		Percent Difference	6.5	-1.0	-9.5	-2.1
	91	Average	110.6	3.5	2.64	14.0
		SD (n=50)	3.6	0.3	1.20	0.8
		RSD (%)	3.3	8.6	45.61	6.1
		Expected Value	102.4	3.5	2.9	14.2
		Percent Difference	8.0	-0.1	-8.9	-1.6
	95	Average	110.3	3.3	2.17	13.6
		SD (n=50)	4.2	0.3	0.90	0.9
		RSD (%)	3.8	9.3	41.65	6.5
		Expected Value	102.4	3.5	2.9	14.2
		Percent Difference	7.7	-5.0	-25.1	-4.4

Table 4. Comparison of petrophysical reference materials run as unknown during MSCL analysis (observed) to their reported API and spectral potassium, uranium, and thorium values (expected). SD is standard deviation. RSD is relative standard deviation. Expected values are provided by Geotek Ltd. and are unique to each reference material. GR9-4B is granite, D9-1 is dolomite, and SL5-31 is slate. Analysis point values are derived from their distance (in centimeters) from the start of the reference material section (see section 3 for details).

Code	Explanation
ABR	pXRF aborted measurement because the total counts detected on Beam 1 were below the abort threshold (e.g., 50,000 counts).
AMP	Amplitude of 0 reported, indicating invalid *Vp* or *Vs* results. Because impedance is calculated from *Vp* and density, a *Vp* amplitude of 0 will invalidate its corresponding impedance.
BDL	Below detection limit of the pXRF.
CER	Spectrophotometry calibration cap was not removed, resulting in invalid reflectance values greater than or equal to 100%.
EE	Edge effect. This point is within 6 cm of a section edge, which results in an underrepresented natural gamma response (API, spectral K, U, and Th).
ER	Error. Instrument malfunction led to these data not being collected or reported.
HNG	This point was determined by the lab technician to only be appropriate for the natural gamma sensor and horizontal sensors (e.g., core thickness, density, *Vp*, *Vs*, impedance, loop magnetic susceptibility). Typically, this is due to an imperfection in the core that would not allow for good coupling between the vertical sensors and the core surface.
NA	Not analyzed.
NG	This point was determined by the lab technician to only be appropriate for the natural gamma sensor (API, spectral K, U, and Th). Typically, this is due to cracks or other imperfections in the core.
NV	Not verified. Data from reference materials were either not collected or inconclusive.
OUT	Outlier identified during data processing.
TR	Technician removal. Point determined to be an outlier in the lab by the technician during analysis.
VNG	This point was determined by the lab technician to only be appropriate for the natural gamma sensor and vertical arm sensors (e.g., pXRF, point magnetic susceptibility, spectrophotometer). Typically, this is due to a side crack or void in the core.

Table 5. Data substitution codes and their explanations for data removal.

Outliers Removed from Dataset				
Depth	Date	P-Wave Amplitude	P-Wave Velocity	Impedance
ft	MM/DD/YYYY		m/s	$x10^3 kg/m^2 s$
515.16	01/27/2026	0.0817	15004.21	29086.08
515.49	01/27/2026	0.0941	13770.62	26750.87
521.77	01/27/2026	0.0767	18920.21	38830.49
597.48	01/30/2026	0.0602	13867.19	26099.59
601.73	01/30/2026	0.055	20513.51	39182.64
602.39	01/30/2026	0.0374	14040.9	26628.16
603.06	02/03/2026	0.0525	16251.9	30831.73
648.89	02/05/2026	0.0687	10134.05	19556.35
649.54	02/05/2026	0.069	11224.27	21825.01
652.50	02/05/2026	0.0601	13387.6	25793.26
653.30	02/05/2026	0.0561	14933.62	28756.51
671.78	02/06/2026	0.0669	16546.9	32484.88
672.43	02/06/2026	0.0632	13796.03	26625.23
672.76	02/06/2026	0.0494	13581.49	26210.88
715.53	02/11/2026	0.0685	11050.96	21787.38
715.86	02/11/2026	0.0684	12983.77	25675.88
716.51	02/11/2026	0.0793	12692.68	25022.85
741.22	02/12/2026	0.0761	13300.38	25821.67
806.70	02/18/2026	0.1028	10583.51	23227.66

Table 6. *Vp* and corresponding impedance and amplitude outliers removed from the Hutchinson Test #1 dataset. See section 4.2.3. for more information.

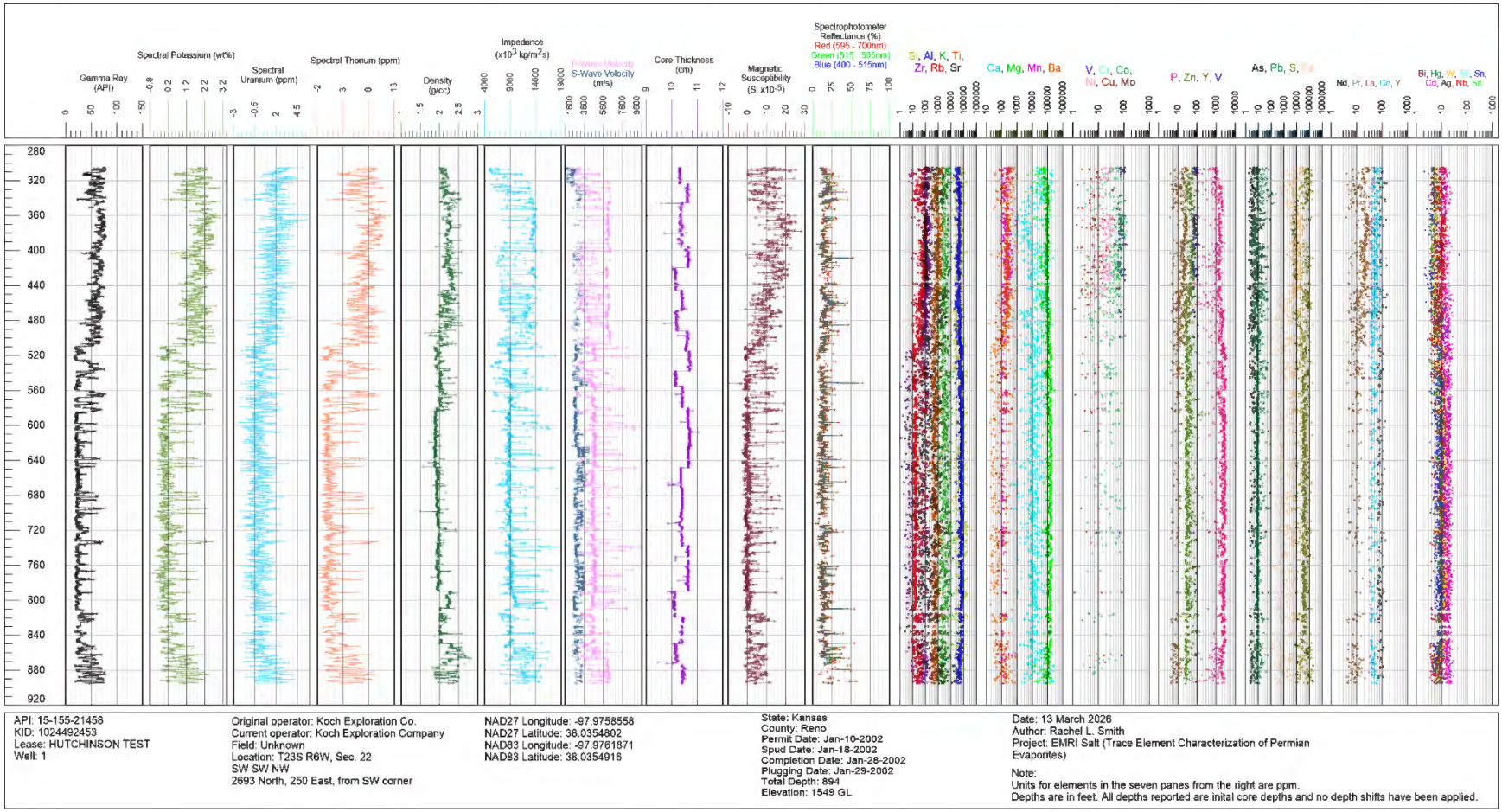


Figure 1. Hutchinson Test #1 MSCL data plotted with depth using Strater 5® by Golden Software. See "1024492453_HutchinsonTest_1_MSCL _Figure1_20260313.pdf" for a higher-resolution figure.

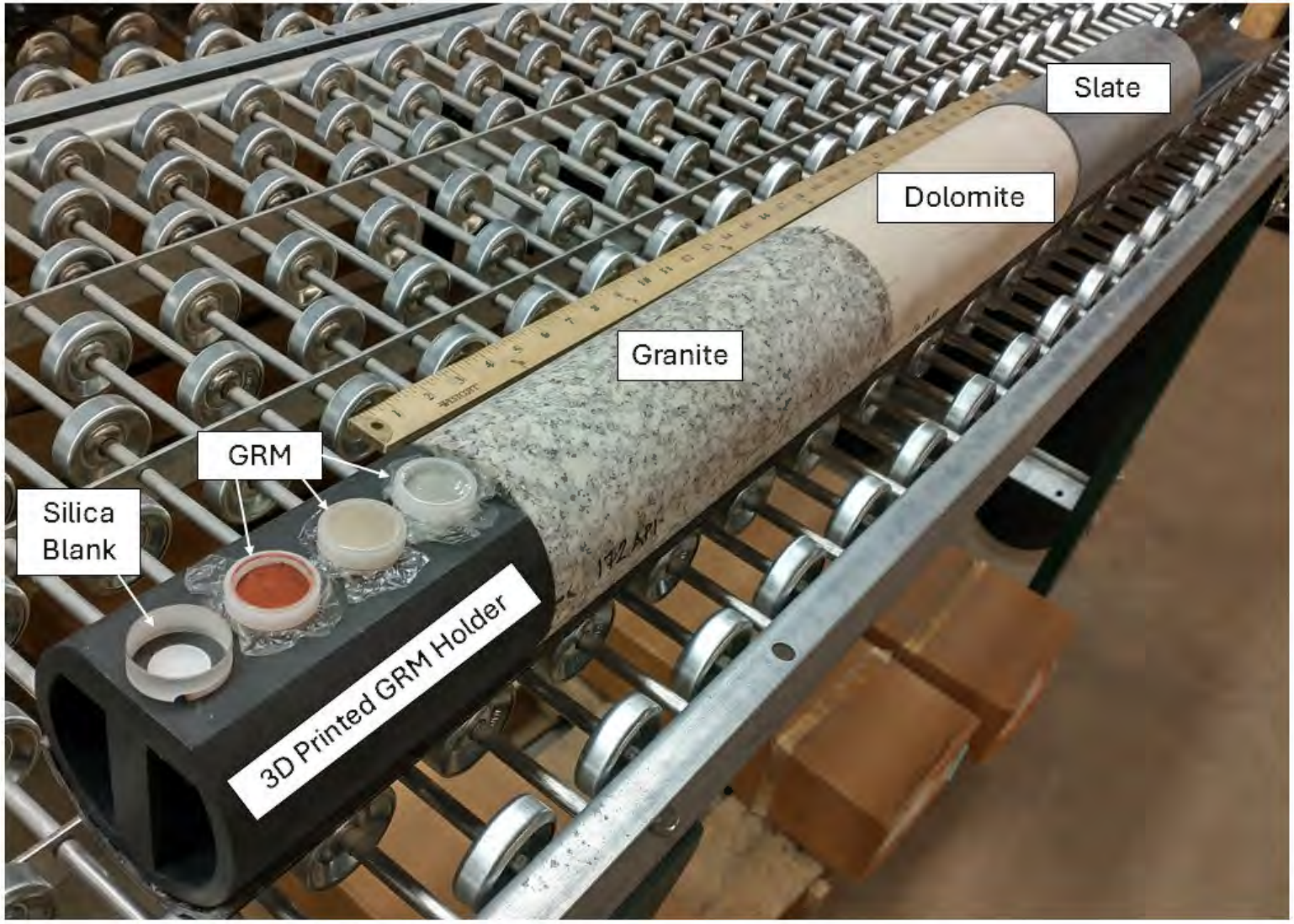


Figure 2. The reference material section setup for 4-in. diameter core. Geochemical reference materials (GRM) are in front, beginning with a silica blank. The petrophysical reference materials are 30-cm-long sections of granite, dolomite, and slate, which follow the GRM.