EXPLORATORY DRILLING FOR RARE EARTH ELEMENTS AND OTHER CRITICAL MINERALS IN LIGNITES ACROSS SOUTHWESTERN NORTH DAKOTA

by
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Abstract

Lignites that occur within narrow stratigraphic windows below kaolinitic zones of the Bear Den Member (Golden Valley Formation) and Rhame bed (Slope Formation) are enriched in rare earth elements (REE) and other critical minerals across southwestern North Dakota. These horizons are also present across much of west-central North Dakota but occur predominantly in the subsurface and thus cannot be well-characterized by surface sampling. Exploratory drilling was performed across Adams, Dunn, Hettinger, Mercer, Morton, and Stark counties to 1) establish whether these stratigraphic intervals are consistently associated with elevated REE concentrations in these areas, especially near existing lignite mining infrastructure in Mercer County, 2) expand our understanding of the maximum overall grade and thickness of enriched lignites occurring within these zones, and 3) illustrate that the extent and depth of the target horizons can be reliably predicted and intercepted via drilling, enabling successful recovery and characterization of enriched lignites.

REE-enriched lignites or kaolinitic source beds were successfully identified at 35 of the 53 drill sites. Drilling was abandoned twice due to unstable hole conditions, while glaciation, glacial outwash channels, or paleochannels appear to have eroded the kaolinitic zone and any underlying lignites at ten other locations. A weak or displaced weathering zone may be present at the remaining six sites, but coring (or additional coring) would be needed to confirm its presence. Core was recovered at 28 sites, of which 22 contained lignites, carbonaceous claystones, or non-carbonaceous claystones with samples that exceeded 300 ppm REE (including Y and Sc). A total of 262 core samples and 136 additional outcrop samples were submitted for ICP analysis. Results contain the highest yet reported dry coal basis REE concentrations for Adams (1,862 ppm), Dunn (2,321 ppm), Mercer (1,896 ppm), Slope (2,983 ppm), and Stark (3,154 ppm) counties. A 4,443-ppm sample collected from an outcrop in Morton County is the highest REE concentration yet reported from North Dakota. This sample contains 1.57% rare earth oxides on an ash basis, which is also the highest from the state.

Cores of the Bear Den Member in Mercer County and the Rhame bed in Adams County contain the most economic lignites identified from each horizon to date. An interval of lignite and carbonaceous claystone in Mercer County totaled 58.3 inches (1.62 m) and averaged 716 ppm REE. A pair of lignites totaling 54 inches (1.5 m) in thickness in Adams County averaged 639 ppm. The latter core was recovered 0.5 miles (0.8 km) away from another exhibiting similar concentrations, suggesting that enrichment may be consistent at the scale of a small mine. A core of the Bear Den Member from Hettinger County shows that claystones in these intervals, not just lignites, can incorporate as much as 1,233 ppm REE, and up to 60 continuous inches (1.7 m) can exceed 300 ppm. Mineralogical analyses of this core show that REE enrichment closely follows the kaolinite-smectite transition at the base of the weathering zone. Detailed geochemical profiles suggest that small changes in the relative position of this transition can result in significant changes to the amount of REE incorporated by underlying lignites. These profiles also suggest the Rhame bed is less intensely weathered than the Bear Den Member, and that the REE may have been sourced from the surrounding landscape and not just weathering of the immediately overlying sediment.

Acknowledgments

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Introduction

Lignite can incorporate significant concentrations of rare earth elements (REE; including La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, and Sc in this report) and other metals and metalloids in settings where it is subjected to long-term flows of weakly-enriched waters (Seredin and Dai, 2012; Murphy et al., 2023). Favorable relative abundances of high-value elements (Dy, Tb, Gd, Sc, Ga, and Ge), combined with low-cost mining and extraction techniques, are characteristics of a promising mineral ore if feedstocks of sufficient grade and thickness can be identified (Seredin and Dai, 2012; Dai and Finkelman, 2018; Laudal et al., 2018; Kay et al., 2024). Many of these elements have been deemed critical minerals - commodities which are essential to the national security of the United States – and the U.S. has attempted to identify new domestic supplies to address this strategic vulnerability (DOI, 2022).

Background

In 2015, the North Dakota Geological Survey (NDGS) began systematically sampling lignites in the North Dakota portion of the Williston Basin and analyzing their REE contents (Kruger et al., 2017). The study identified elevated REE concentrations at several sites and at several different stratigraphic positions within the Fort Union Group. Murphy et al. (2018), Moxness et al. (2021), and Moxness et al. (2022), performed more detailed sampling at many of these sites (the Harmon bed at Logging Camp Ranch, Tracy Mountain, and Mud Buttes) and concluded that REE enrichment was often topographically controlled and likely a product of the long-term weathering of stable modern landscapes. Kruger et al. (2022) suggested other instances of REE enrichment must have been produced from Paleocene weathering, and this was confirmed by Murphy et al. (2023) and Moxness et al. (2023) who reported consistent and significant enrichment in lignites below the basin's two most intensely-weathered horizons – the Bear Den Member of the Golden Valley Formation and the Rhame bed of the Slope Formation.

Lignite samples from the lower Bear Den Member reached 2,570 ppm REE on a dry coal basis, and samples below the Rhame bed were as high as 2,792 ppm. Although these concentrations are considerably higher than the grade of 300 ppm initially proposed by the U.S. Department of Energy as promising for REE in coal, a seam would need to be of sufficient thickness to produce a reliable feedstock. The thickest, most enriched lignite identified below the Bear Den Member by Murphy et al. (2023) was just 14 inches (36 cm) at an estimated 832 ppm REE, and the most economic lignite found below the Rhame bed was 17 inches (43 cm) thick, averaging 1,153 ppm REE. As these studies utilized hand sampling of outcrops, they were limited by the availability of exposures of given stratigraphic intervals. A drilling program was proposed to provide additional needed characterization data including: 1) the depth of these stratigraphic intervals in areas of poor outcrop control, 2) the consistency of the weathering intensity and development of these kaolinitic horizons (REE source rocks) across the basin, 3) the frequency of lignite occurrence (REE host rocks) below these horizons, and 4) the degree and thickness of REE enrichment in lignites and carbonaceous claystones. Funds for exploration were awarded by the North Dakota State Legislature for the FY2023-2025 biennium, and 53 holes were drilled across six counties, accompanied by additional outcrop sampling at 23 measured sections (Fig. 1).

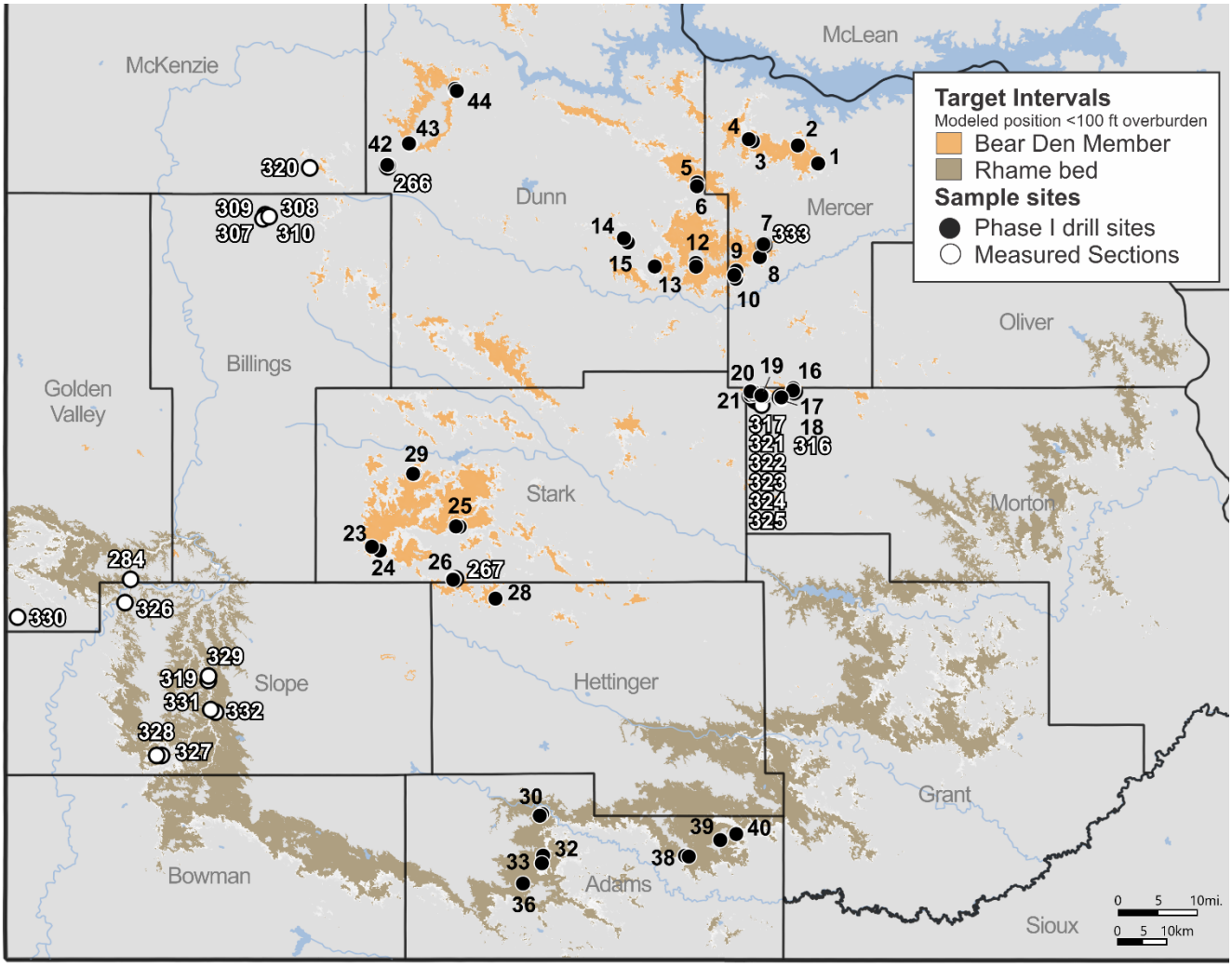


Figure 1. Map of the 53 drill sites and 23 measured sections with new samples analyzed in this report. The Bear Den Member (Golden Valley Formation) and Rhame bed (Slope Formation) are shown where modelling predicts each occurs within 100 feet (30 meters) of the surface over southwestern North Dakota.

Methods – Project Design and Drill Site Selection

The NDGS compiled subsurface models of the two stratigraphic target zones after a review of the available geologic maps, outcrops identifiable on aerial imagery, and additional field reconnaissance. Simple three-dimensional models of both weathering zones were created based on the triangulation of 314 control points (outcrop elevations) for the Rhame bed and 394 for the Bear Den Member.

Using the digitized latitude, longitude, and depth relative to LiDAR surface elevations, the positions of coals interpreted from over 19,000 geophysical logs were plotted in relation to the modeled target zones. These geophysical logs were interpreted and digitally cataloged in the late 1990s and early 2000s as part of an NDGS study on the lignite resources of North Dakota (Murphy et al., 2006). The logs were collected by the coal, uranium, and clay industries, as well as test holes drilled by the North Dakota Department of Water Resources, coal exploration holes drilled by the NDGS and the United States Geological Survey, and oil wells with gamma logs run through

Fort Union strata. The 19,000+ cataloged and interpreted logs were filtered to those that contained coals within the target intervals at depths of less than 100 feet. The target interval was set from 20 feet above to 50 feet below the modeled top of the Bear Den and Rhame bed paleosols. This 70-foot-thick interval was intentionally set wider than the anticipated 20-foot-thick zone of enrichment to account for a vertical margin of error in both the well logs and the model. These filters reduced the number of logs that were manually inspected from 19,655 to just a few hundred each for the Rhame bed and Bear Den Member.

To minimize the duration of time necessary to secure access to potential drill sites, the NDGS initially targeted potential drilling locations where both surface and mineral rights were held by the North Dakota Department of Trust Lands (Trust Lands). Subsequently, tracts with state-owned mineral rights (typically 50% ownership) and privately-owned surface were added for consideration. Finally, several private landowners of both surface and mineral estates at desirable locations for the study, and with whom the NDGS had previously worked, were contacted to inquire about their willingness to participate in the drilling program.

Access to the drilling locations was obtained by acquiring a prospecting permit from ND Trust Lands, coal exploration permits from the Department of Mineral Resources, and, when required, conditional use permits from the counties. Letters describing the drilling program were mailed to each surface owner in the spring of 2024. During the months of July and August, NDGS representatives met personally, when possible, or called each of the surface owners to obtain permission to drill. Surface owners were compensated for surface damages. For additional discussion on the strategy and techniques involved with selecting drill locations, see Moxness (2024; 2025).

Field Methods

Mohl Drilling, Inc., out of Beulah, North Dakota was awarded the drilling contract, and the logging contract was awarded to Century Wireline Services, Tulsa, Oklahoma. Two truck-mounted drill rigs were used during the project. All hole locations were cleared prior to drilling through ND OneCall. The modeled position of the target kaolinized zone was converted to an approximated depth to expect light-colored drill cuttings in the pilot holes. Cuttings were logged in 5-foot (1.5 m) intervals. All pilot holes were electronically logged, requiring drill sites to be relatively close to each other whenever possible to efficiently manage time with the one logging truck. Lignites immediately below the kaolinite, as identified from cuttings and electronic logs, were targeted for coring. A second hole was drilled a short distance away to retrieve core at 28 of the 53 sites (Fig. 2). The NDGS ran a pair of three-man crews with each drill rig to keep up with core and sample descriptions, core and sample collection, and the boxing of the cores and samples (Figs. 3 and 4). Cores were collected in 10 or 15 ft barrels (Fig. 5) and placed into three-foot-long core boxes for transport to the North Dakota Geological Survey's Core Library in Grand Forks.



Figure 2. Drilling Hole 19B in Morton County near the Hebron Brick Company's west clay pit. The pilot hole has been completed, and the drilling crew has begun to drill the core hole a short distance away.



Figure 3. State Geologist Ed Murphy (left) describes a core of the Bear Den Member in Hettinger County. Jason Mohl works to collect the next interval at rear.



Figure 4. Geologists Ned Kruger (left) and Adam Chumley (right) identify and collect core samples to submit for ICP-MS analysis.



Figure 5. Driller John Mohl inspects the contents of a 15-ft core barrel containing the 9.8 ft thick Harmon lignite and several feet of Rhame bed silcrete.



Figure 6. Geologist Levi Moxness uses a pXRF device to examine claystones at the base of the Bear Den Member for signs of yttrium enrichment.

REE concentrations in lignites and adjacent strata were estimated from cores prior to boxing using a Thermo Fisher Scientific Niton XL5 Plus portable x-ray fluorescence analyzer (pXRF; Fig. 6). Analyses targeted sections of core that contained lignites and/or carbonaceous claystones and mudstones. Benson et al. (2021) were able to develop reasonably predictive algorithms for total REE content of lignites from pXRF data, but for this project, pXRF estimations of Y from core were used to identify approximate levels of enrichment for the other REE after just a few seconds of scan time. Data from these semi-quantitative analyses with scan times of 5 to 15 seconds were not retained, but did inform decisions regarding subsequent drilling and coring, and which samples to submit for full quantitative analysis via ICP-MS.

To save project funds, the Geological Survey did not bid out the hole plugging and site restoration. Holes were plugged and the drill sites were reclaimed as soon as the drilling and coring were completed. The holes were filled with cuttings, a spider plug was placed three feet below the surface, the remaining cuttings were spread, and the location was raked. All drill sites were visited at least once more in the late fall of 2024 and underwent additional raking.

Laboratory Methods

The NDGS submitted 262 core samples and 136 new outcrop samples to Standard Laboratories for elemental analysis. Samples were prepped in Casper, Wyoming and sent to Freeburg, IL for analysis of the rare earth elements (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, Sc) and As, Be, Ce, Co, Cr, Ga, Ge, Hf, In, Li, Mn, Mo, Nb, Ni, Rb, Sb, Sr, Ta, Th, W, U, V, Zn, and Zr via inductively coupled plasma mass spectrometry (ICP-MS; ASTM D6357 MOD) and Al, Ba, Ca, Fe, K, Mg, Na, P, S, Si, and Ti via inductively coupled plasma atomic emission spectroscopy (ICP-AES; ASTM D6349). Core samples represented 2-to-12-inch (5 to 30 cm) thicknesses, and outcrop samples ranged from 1 to 6 inches (2.5 to 15 cm) in thickness, represented by at least 1,000 g (2.2 lbs.) of material. Activation Laboratories (Ancaster, Ontario) performed mineralogical analyses of 28 claystone samples using x-ray diffraction (XRD). See Appendix E for detailed XRD methods.

Additional pXRF analyses were performed on cores to characterize the chemical weathering trends and to select additional sections to submit for ICP-MS/AES analysis. Portable XRF devices radiate the targeted material, causing electrons to move from shells of a higher energy state to those of a lower energy state and subsequent emission of corresponding X-rays characteristic to specific elements. They typically operate at voltages between 15 and 55 kV and wattages of four or less (Young et al., 2016). These devices utilize energy dispersive spectroscopy, which produce lower resolution spectra than wavelength dispersive x-ray fluorescence and thus, combined with lower beam energies than laboratory units, have difficulty identifying elements with overlapping spectra. This results in higher limits of detection (LOD) and no detection of elements lighter than Mg (Young et al., 2016). Multiple studies have proposed empirically derived calibrations for pXRF devices to improve their accuracy and precision (Rousseau, 2006; Rowe et al., 2012; Hall et al., 2014; Zambito et al., 2016; Da Silva et al., 2023, and references therein). Empirical calibrations are developed by comparing pXRF data to certified reference materials or those that best represent the dominant geochemical compositions in the samples of interest. As outlined by Da Silva et al. (2023), important sources of error to correct in pXRF calibrations include matrix effects (also discussed exhaustively by Rousseau, 2006) where primary (from the pXRF) and fluorescent (emitted from the sample) x-rays can be absorbed, scattered, or enhanced by other elements in the matrix, and spectral interferences, causing element identification to be difficult. Ideally, samples should also be dried and powdered to ensure sample homogeneity or have a fresh, flat area available to scan, as rough and angled surfaces have been found to increase error (Rowe et al., 2012; Young et al., 2016; Zambito et al., 2016; Da silva et al., 2023).

As noted by Hall et al. (2014) however, these empirical calibrations are less useful for large sample sizes of heterogeneous lithologies and geochemical compositions. This report analyzed numerous cores encompassing claystones of multiple clay species, mudstones, siltstones, silcretes, and coals. As such, the NDGS used the standard factory calibration programmed into the Thermo Fischer Scientific Niton XL5 Plus device. A total of 4,860 pXRF analyses were collected, typically 10 analyses per foot of core (every 3 cm) with the analyzer set to Mining Mode with 30 second scan intervals on four beam conditions (main filter, light filter, low filter, and high filter). Analyses were performed along a face of the core that was cut with a knife to expose flat surfaces perpendicular to bedding which were free of drilling mud, although this

was often not possible for hard lignites and silcretes. Cores were allowed to air dry for several weeks prior to pXRF analysis.

Although pXRF is considered a semi-quantitative analytical method, it can detect relative changes in geochemistry over broad stratigraphic intervals which would be cost-prohibitive to characterize via ICP. Of specific interest to this project are zones of Y enrichment, which trends tightly with the other REEs. Reliable detection of other elements that are leached (or residually enriched) during weathering would also provide detailed context for how the REE contents of lignites change based on their position within the weathering profile. Because the pXRF detects some elements more reliably than others, each was first reviewed for agreement with ICP. Most core samples submitted for ICP analysis were done so prior to pXRF analysis, but 71 samples of claystone were submitted after the pXRF profiles were collected. This subset of samples enabled estimations of the accuracy of the pXRF for many elements also analyzed by ICP-MS or ICP-AES (Table 1).

This is also shown by simple linear regression in Figure 7, where pXRF results are compared to the “true” ICP values and their 1:1 trend lines. Elements with a trendline slope (*m*) nearest to 1 indicate the highest accuracy for the pXRF across the entire dataset, although it can be a product of an equal number of overestimated and underestimated analyses. A high coefficient of determination (r^2 approaching 1) suggests consistent detection, although it may be consistently inaccurate (e.g., consistent underestimation). Together, these values quantify the degree of pXRF and ICP agreement/disagreement. Median percentage error (med %Err) represents this in a less informative, but singular, value. Plots in Figure 7 have the y origin set at zero, because concentrations are expected to be zero at the origin. This also improved r^2 values for most elements, indicating a y-intercept set to the origin better represents the data.

Many elements are easily mobilized during chemical weathering (K, Mg, Ca, Na, Rb, etc.; McLennan, 1989; Nesbitt and Markovics, 1997) and would serve as sensitive weathering proxies, but not all of these are detectable via pXRF (Na), and others are detected but with low precision (Ca with an r^2 of 0.50) or overall accuracy (Mg with a *m* of 2.49). Fortunately, K and Rb show high levels of agreement between ICP and pXRF. Y serves as an excellent intermediate-solubility element, which are also leached from upper to lower portions of the profile but are redistributed to lower portions of the profile instead of leaving entirely. Benson et al. (2021) noted that pXRF values for V and Cr were closely related to Y and the other REE in Fort Union lignites. Cr and Zn appear to behave similarly to Y, but Zn shows better overall pXRF detection (*m* of 0.93). Immobile elements Ti, Nb, and Zr show the most residual enrichment in the most intensely weathered portions of the profiles, but the base pXRF calibration appears to significantly overestimate Zr in silcretes, and thus Ti and Nb are easily the most reliably detected immobile elements.

Table 1. The detection frequency of each element across 4,860 pXRF analyses (left). Select sections of core were analyzed by pXRF and then submitted for ICP analysis, enabling a comparison of the concentrations returned by both methods (right). Elements Ag-Sn (lower portion of the table) were not analyzed by ICP. The lanthanides, Be, Cs, Ga, Ge, In, Li, Na, and Sc (not shown) were analyzed by ICP (see Appendix B), but not by the pXRF.

Element	All pXRF core analyses		Core sections analyzed by both pXRF and ICP				
	analyses >LOD	% >LOD	n_{ICP}	n_{XRF}	m	r^2	med %Err
Al	4858	100	71	71	1.85	0.98	86.7
As	2413	49.7	71	17	0.49*	0.78	49.5
Ba	4321	88.9	71	71	0.33	0.95	23.8
Ca	4860	100	67	67	1.80	0.50	49.1
Co	401	8.3	71	1	-	-	-
Cr	4287	88.2	71	71	1.25	0.94	21.7
Fe	4860	100	67	67	0.72	0.95	27.3
Hf	0	0	71	0	-	-	-
K	**4860**	**100**	**67**	**67**	**1.01**	**0.99**	**3.95**
Mg	4799	98.7	71	70	2.49	0.97	168
Mn	3899	80.2	71	62	0.91	0.95	20.0
Mo	1551	31.9	71	16	0.76*	0.72	26.7
Nb	**4330**	**89.1**	**71**	**71**	**0.82**	**0.96**	**25.9**
Ni	3398	69.9	71	53	0.99	0.75	16.4
P	4356	89.6	67	61	0.91	0.95	24.5
Rb	**4323**	**89.0**	**71**	**70**	**0.93**	**0.97**	**8.55**
S	4823	99.2	67	67	8.37	0.62	899
Sb	498	10.2	71	0	-	-	-
Si	4858	100	67	67	1.15	0.99	19.2
Sr	4860	100	71	71	1.10	0.89	15.6
Ta	0	0	71	0	-	-	-
Th	4693	96.6	71	70	0.86	0.95	11.0
Ti	**4858**	**100**	**71**	**71**	**0.93**	**0.98**	**12.5**
U	4554	93.7	71	65	1.03	0.95	8.78
V	4503	92.7	71	71	0.93	0.98	9.09
W	49	1.0	71	1	-	-	-
Y	**4819**	**99.2**	**71**	**71**	**0.96**	**0.97**	**12.4**
Zn	**4268**	**87.8**	**71**	**67**	**0.93**	**0.80**	**23.2**
Zr	4575	94.1	71	71	1.75	0.75	43.6
Ag	571	11.7	0	0	-	-	-
Au	491	10.1	0	0	-	-	-
Bi	28	0.6	0	0	-	-	-
Cd	606	12.5	0	0	-	-	-
Cl	42	0.9	0	0	-	-	-
Cu	3771	77.6	0	67	-	-	-
Hg	471	9.7	0	1	-	-	-
Pb	4308	88.6	0	71	-	-	-
Pd	521	10.7	0	0	-	-	-
Re	0	0	0	0	-	-	-
Se	972	20.0	0	7	-	-	-
Sn	4211	86.6	0	70	-	-	-

n_{ICP} = the number of samples (sections of core) analyzed by ICP-MS or ICP-AES for each
n_{XRF} = the number of ICP samples with pXRF detections for each element (average of multiple scans per sample)
m = the slope of the regression line
r^2 = coefficient of determination
Med %Err = median percentage error
* Regression performed on smaller dataset due to high number of analyses less than LOD
Bold elements are relevant weathering proxies discussed in text and plotted in Results

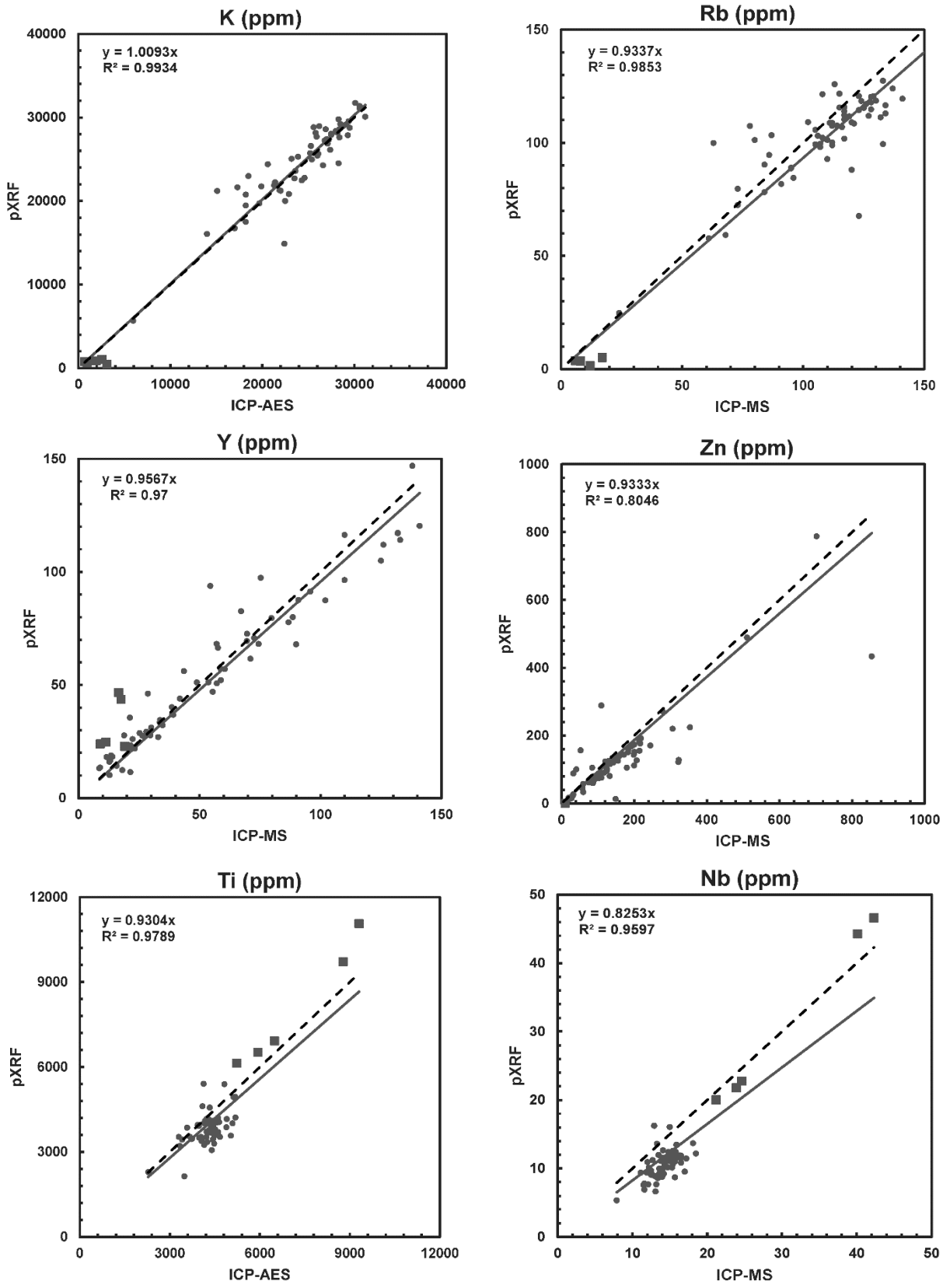


Figure 7. Concentrations determined via pXRF plotted vs ICP and 1:1 validation lines (dashed; created by placing ICP data on both axes). Y intercepts are set at the origin (0). Silcrete samples are squares.

Drilling Program Results

Of the 53 drill holes attempted, two (43B and 44B) were abandoned prior to reaching the target depth due to unstable hole conditions and risk of collapse. Of the remaining 51, kaolinitic REE source rocks of the Bear Den Member or Rhame bed were successfully intercepted in 35 holes (2, 3, 4, 5, 6, 7, 8, 9, 10B, 12, 16, 16B, 17, 17B, 18, 19, 19B, 19C, 20, 20B, 21, 21B, 25, 25B 26, 26B, 28, 32, 38, 38B, 40, 42, 42B, 43, and 44C). In ten holes (1, 10, 12B, 14, 15, 23, 30, 30B, 33, and 44), the target zone was found to have been eroded by glaciation, glacial meltwater, or paleochannel incision. At the remaining six sites (13, 24, 29, 29B, 36, and 39), the kaolinitic interval may still be present, but coring (or additional coring) would be required to confirm its presence.

Core was recovered from 28 sites, 22 of which contained lignites, paper shales, or non-carbonaceous claystones with REE concentrations (including Y and Sc) exceeding 300 ppm. The project prioritized coring at locations where pilot holes showed indications of thicker lignites directly beneath the kaolinitic intervals; therefore, no core recovery was attempted at several sites where kaolinite was present but cuttings and elogs did not suggest the presence of lignites at least one foot (0.3 m) thick beneath it. Many of these sites (4, 5, 6, 7, 8, 9, 25, and 44C) may contain thin REE-enriched lignite stringers or claystone intervals. At other locations (3, 10B, 39), thicker lignites were cored despite their stratigraphic position being too far above or below the kaolinite to have received significant REE enrichment from descending fluids.

Table 2 provides a summary of these results, which are further contextualized in the discussion that follows, with reference to the geologic variability encountered in these zones as depicted in Figure 8. Core diagrams and sample intervals can be found in Appendix A, with full elemental analyses in Appendix B. Additional interpretations for each hole can be found with drill cuttings descriptions in Appendix C.

This report expands upon the ICP-MS and ICP-AES results of 260 core samples and 43 outcrop samples submitted to the North Dakota Industrial Commission in fulfillment of Contract No. SERC-LD24-01 (Moxness et al., 2025), which contains an accounting of drilling costs. This report also contains those sample results, plus two additional core samples (19B-Y10 and 21-Y7) and 93 new outcrop samples, which were analyzed using funds other than those appropriated by the state legislature for the 2023-2025 biennium critical minerals drilling project.

Table 2. Summary of the 53 holes drilled and 262 core samples collected and submitted for ICP analysis of REE during the project.

Hole	County	Target Interval	Result (see Fig. 8 for key)	Pilot Hole Depth (ft)	Core Recovered (ft)	No. of ICP analyses	Max REE (ppm) dry whole basis
1	Mercer	Bear Den	B	322	-	-	-
2	Mercer	Bear Den	C	320	44.6	20	1,896
3	Mercer	Bear Den	F[1]	160	40	6	112
4	Mercer	Bear Den	F	160	-	-	-
5	Dunn	Bear Den	D[2] or G[2]	145	-	-	-
6	Dunn	Bear Den	D[2] or G[2]	120	-	-	-
7	Mercer	Bear Den	D[2] or G[2]	120	-	-	-
8	Mercer	Bear Den	D[2] or G[2]	120	-	-	-
9	Mercer	Bear Den	D[2] or G[2]	140	-	-	-
10	Mercer	Bear Den	B	140	-	-	-
10B	Mercer	Bear Den	D[3]	80	14.7	7	129
12	Dunn	Bear Den	D	160	26.5	3	402
12B	Dunn	Bear Den	B	80	-	-	-
13	Dunn	Bear Den	A	100	-	-	-
14	Dunn	Bear Den	B	80	-	-	-
15	Dunn	Bear Den	B	100	-	-	-
16	Morton	Bear Den	G	80	34.4	4	568
16B	Morton	Bear Den	G	120	46.2	13	743
17	Morton	Bear Den	F	120	-	-	-
17B	Morton	Bear Den	F	160	-	-	-
18	Morton	Bear Den	F	140	-	-	-
19	Morton	Bear Den	G	140	29	8	699
19B	Morton	Bear Den	D	120	40	18	594
19C	Morton	Bear Den	D	120	19	3	479
20	Morton	Bear Den	G	80	27.7	8	2,184
20B	Morton	Bear Den	G	110	40	7	445
21	Morton	Bear Den	G	80	29.2	22	1,245
21B	Morton	Bear Den	G	80	50	15	2,407
23	Stark	Bear Den	E?	120	40	2	140
24	Stark	Bear Den	E?	200	15.9	1	55
25	Stark	Bear Den	F[4]	180	36.4	9	459
25B	Stark	Bear Den	F[4]	160	-	-	-
26	Stark	Bear Den	D	140	15	2	562
26B	Stark	Bear Den	D	100	27.6	4	338
28	Hettinger	Bear Den	D	100	58.2	21	1,233
29	Stark	Bear Den	A	80	-	-	-
29B	Stark	Bear Den	A[4]	60	7.5	6	626
30	Adams	Rhame bed	E	140	-	-	-
30B	Adams	Rhame bed	E	140	-	-	-
32	Adams	Rhame bed	D[3]	120	20	3	236
33	Adams	Rhame bed	B	100	6	1	119
36	Adams	Rhame bed	A or C[2]	120	-	-	-
38	Adams	Rhame bed	C	140	53.7	23	1,862
38B	Adams	Rhame bed	C	140	30.2	19	1,449
39	Adams	Rhame bed	A or G[1]	140	29.3	2	262
40	Adams	Rhame bed	G	140	50	6	346
42	Dunn	Bear Den	C	160	40.5	9	1,990
42B	Dunn	Bear Den	C	200	35.3	12	1,647
43	Dunn	Bear Den	G	160	27.1	7	1,464
43B	Dunn	Bear Den	abandoned	80	-	-	-
44	Dunn	Bear Den	B	140	-	-	-
44B	Dunn	Bear Den	abandoned	120	-	-	-
44C	Dunn	Bear Den	D or G[2]	200	-	-	-

[1] Additional (deeper) drilling would be required to verify the presence of any lignites or claystones underlying the target zone.

[2] Coring of the target zone would be required to determine if thin lignites are present or if claystones present are REE-enriched.

[3] Potentially REE-enriched claystones were cored and are potentially enriched, but analyses have not yet been performed.

[4] Weakly REE-enriched lignites were identified in lignites overlying the target zone.

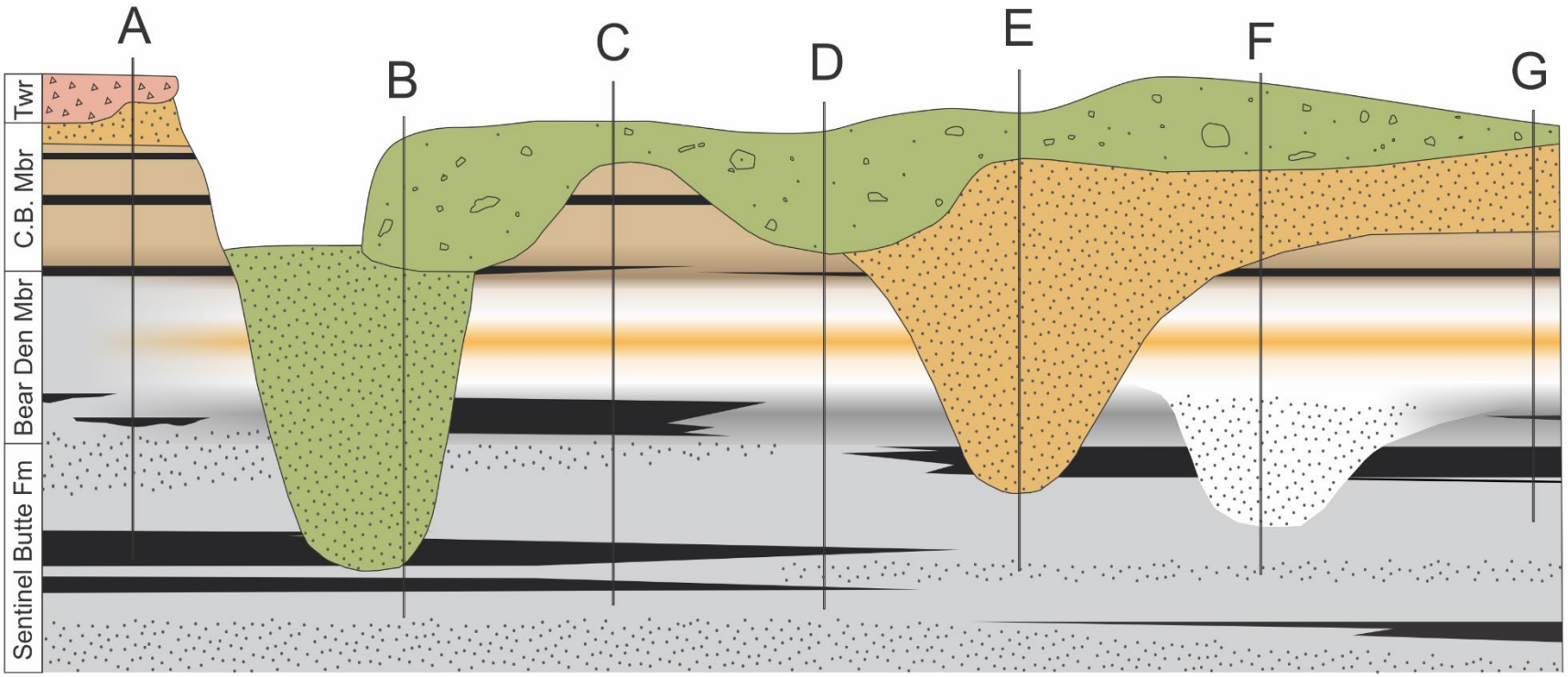


Figure 8. Diagram illustrating the range of geologic scenarios encountered during the drilling program. The diagram is based on the 44 drill holes targeting the Bear Den Member. However, the described scenarios also apply to the nine additional holes that targeted the Rhame bed. Scenario descriptions are as follows:

A) Kaolinization at the modeled depth is weak, thin, or absent. This may reflect incomplete paleopedogenesis, erosion (see Scenario E), or structural disruption. Also depicted are remnant overlying volcanic rocks (triangle symbols) of the White River Group (Twr), the weathering of which may weakly enrich underlying Camels Butte Member lignites in REEs.
B) Glacial sediments (green) occur at the modeled depth. In the northern part of the study area, Quaternary sands fill deep glacial outwash channels in topographic lows, while topographic highs are often capped by thick sequences of glacial till.
C) Thick lignites directly beneath the kaolinite incorporate significant, potentially economic concentrations of REE and other critical minerals.
D) Lignites are absent immediately below the kaolinite, but claystones in this position show moderate to significant REE enrichment.
E) Downcutting of younger channels removed the kaolinite and any underlying REE-enriched strata, leaving unweathered sandstones in its place.
F) Sandy channel facies are present in place of lignite or claystone (distal floodplain facies), the weathering of which produced a thick, bright weathering zone but a lack of lithologies capable of REE enrichment.
G) Lignites are present and may be highly enriched in REEs, but are likely too thin to be economic. This scenario may also include thicker lignites located too far below the kaolinite to have received significant REE input from descending fluids.

A. Kaolinization is Thin, Weak, or Absent at the Modeled Depth

The depth of the Bear Den Member can be reasonably approximated by triangulating a plane between surrounding outcrops. While this type of modeled surface cannot account for local fluctuations in paleotopography or structural disruptions between control points, the Williston Basin is fortunately characterized by relatively simple structure and generally conformable bedding. In cases where the Bear Den occurs at a significantly different depth than predicted, its actual position can typically be identified during drilling based on cuttings. The white to light gray coloration of the kaolinized zone (often stained yellow to orange by iron oxides) contrasts sharply with the gray-tan sediments of the overlying Camels Butte Member and the underlying Sentinel Butte Formation (Fig. 9). In such instances, visual evidence from cuttings should be considered more reliable than model-based depth estimates. This was demonstrated by the first hole drilled in the project, Hole 3 in northwestern Mercer County, an area affected by Quaternary glaciation. Hole 3 exhibited a large variance between the modeled position (110 ft/34 m) and actual position (>160 ft/49 m) of the Bear Den Member. A lignite at 114 ft (35 m) was in an optimal position to receive enrichment based on the modeled position of the Bear Den, but ultimately contained low REE concentrations, since the actual base of the Bear Den is likely over 50 ft (15 m) deeper given that white to gray claystone begins around 140 feet (43 m) depth.

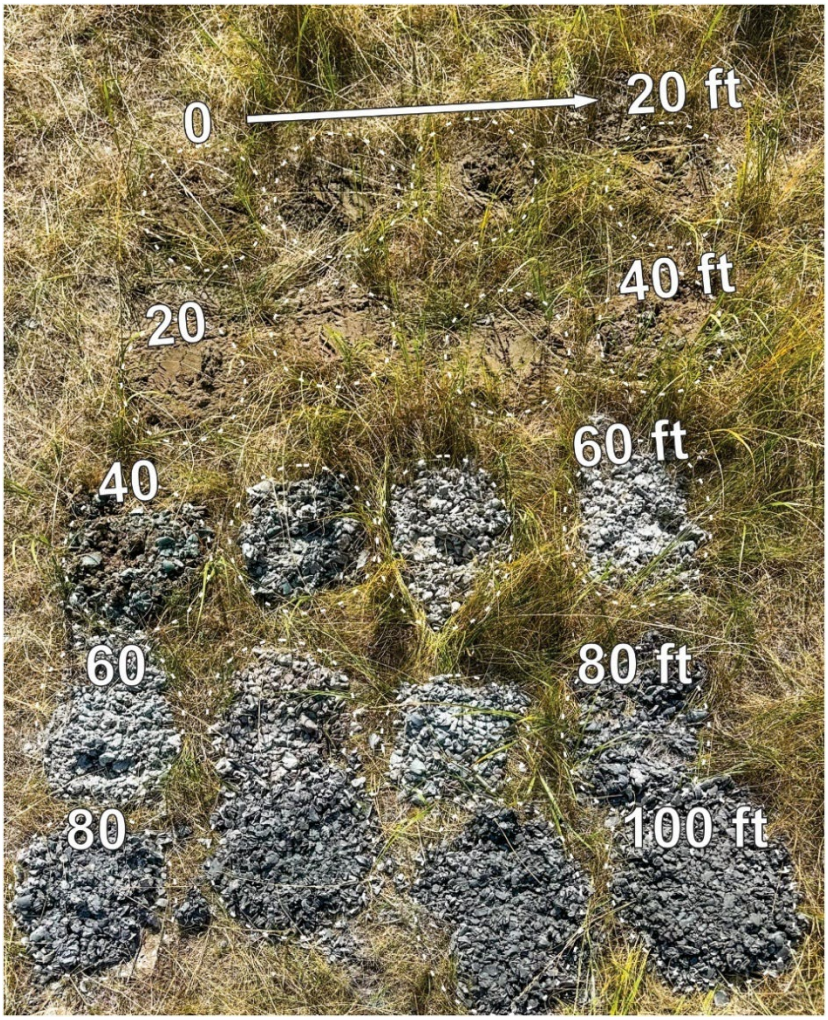


Figure 9. Cuttings from the upper 100 ft (30 m) of Hole 44C, where the Bear Den Member is readily identifiable in drill cuttings. Samples were collected at 5 ft (1.5 m) intervals and are arranged left to right, top to bottom. The upper 40 ft (12 m) consist of brown micaceous sand typical of the Camels Butte Member's channel facies. Underlying the sand is 30 feet (9 m) of brightly colored clay assigned to the Bear Den Member, which is generally white to light gray and often stained yellow or orange by iron oxides. When wet, the clay may appear faintly green—as seen here—but dries to white. Below 80 ft (24 m), the unit transitions to medium gray clay of the Sentinel Butte Formation. It is this transition that is of most interest for signs of lignites. Although absent at this locality, a lignite or carbonaceous mudstone occurring between 70 and 90 ft (21 to 27 m) depth would likely contain significant REE contents.

The Camels Butte Member is typically micaceous, so when the light-colored sediment of the Bear Den Member is not encountered at its modeled position, the presence of mica can suggest that deeper drilling is warranted. The absence of mica in such a scenario may suggest that the model overestimated the depth of the Bear Den, such as in holes 14 and 15, where the first bedrock encountered belonged to the Sentinel Butte Formation. These holes in eastern Dunn County were drilled along a broad ridge mapped as Golden Valley Formation by Hickey (1977) but not by Murphy (2004). This structural high, whether tectonic or glacial in origin, resulted in at least 85 feet of model error - the largest observed during the project.

Just to the southeast, Hole 13 was drilled much closer to control points, but the Bear Den Member was again seemingly absent. A 10-foot (3-m) thickness of “lighter-medium gray” clay was encountered at roughly the correct modeled position, but it lacked the normal bright white or even light gray color characteristic of sediment from this interval. Kaolinite is also noted for its “greasy” feel, which can be helpful for identifying ambiguously light gray cuttings, but this test is best performed on dry samples. Core provides a more complete picture of color transitions and other paleopedogenic features, but without clear signs of mica or kaolinite in Hole 13, it was decided to conserve limited project resources for other holes. This hole may represent one of the positions on the late Paleocene or early Eocene landscape that was reworked during weathering, resulting in a thinner, fainter Bear Den Member.

The Bear Den was also difficult to consistently identify across several holes drilled in Stark County. Although this area was not glaciated, it contains low-amplitude folds and troughs that prevent reliable modeling of contact elevations across long distances (see Denson and Gill, 1965; Plate 10). Adding additional complexity, a third REE-mobilizing weathering event later in the Eocene may also overprint the underlying strata of this area. Boyd and Webster (2018) described a weathered paleosol from White Butte (Stark County) at the top of the Chalky Buttes Member of the Chadron Formation, and a nearby lignite in the underlying Camels Butte Member (Golden Valley Fm.) contained REE concentrations of 839 ppm (sample 220A of Murphy et al., 2023). Weathering of the volcanic-rich White River Group is more commonly associated with uranium mobilization, but may also include REEs (Denson and Gill, 1965; Fig. 20D of Murphy et al., 2023). Hole 25 contained a lignite (Sample D) with 495 ppm REE despite no evidence of the Bear Den Member overlying it. It is possible, considering its relatively modest enrichment and shallow depth of 48 ft (15 m), that the REE were mobilized by low-intensity Quaternary weathering of the modern landscape (as outlined in Moxness et al., 2021), but the elevated uranium concentrations (273 ppm; the highest of any sample in this report) suggest influence from White River Group weathering. Samples A3 through E3 from Hole 25 are well represented in the top 15 uranium and molybdenum analyses in this report.

Wet colors of the Rhame bed (Fig. 10) are generally more subtle than those of the Bear Den Member, so using the color of the cuttings to identify its depth is more difficult. This places greater reliance on the modeled depths in choosing which lignites to core, which becomes problematic in areas far from control points. In one of the first holes pursuing the Rhame bed, Hole 36 in western Adams County, no coring was attempted as the cuttings through the modeled interval were generally gray, suggesting the model may have been in error or the Rhame bed was not developed. But drilling later that day identified lignites with significant REE enrichment despite

gray cuttings above. In this hole (38 in eastern Adams County), the presence of a silcrete (Fig. 11) and an overlying 9.8-foot-thick lignite (the Harmon bed, a major, widespread lignite in the lower Bullion Creek Formation) provided clues beyond color to successfully identify the position of the Rhame bed and underlying REE enrichment.

Using lignites like the Harmon bed to estimate distances to the underlying Rhame bed should also be approached with caution, as coal correlation in the field is subject to its own challenges. In Hole 39, 4.6 miles (7.9 km) to the northeast, the strata below a similar 12 foot (3.2 m) thick lignite interval were cored with no evidence of kaolinization or REE enrichment, but after updating the model with data from surrounding holes it appears likely that the five foot (1.5 m) thick lignite that was 40 feet (12 m) lower was actually the Harmon, suggesting the Rhame bed may occur below it but was not cored. The mixed success in identifying the Rhame bed in the subsurface illustrates both the challenges of exploration and the value of each successful hole in areas of poor stratigraphic control.



Figure 10. Dry (left) and wet (right) colors of the same section of core from the Rhame bed in eastern Adams County (Core 40 at a depth of 61.7 ft/18.8 m). Kaolinization of the Rhame bed can be inferred by a lighter color of claystones (vs the normal gray mud of the Fort Union Group), but this is difficult to see in wet drill cuttings and is still subtle in core before it dries.



Figure 11. A silcrete with fossil root casts from a depth of 69 feet (21 m) in Hole 38. Note the dark brown color of the core when wet, which dries to the light brown or tan color typical of Rhame bed silcretes. This distinctive lithology is often a useful marker for the top of the weathering zone. Sample 38W, a 4-inch (10-cm) portion of core from the photo above, contained 85.4% SiO_2 by weight.

B. Glacial Removal and Replacement

In some areas where surface elevations suggest the Bear Den should be present in the shallow subsurface, it was locally removed during Quaternary glaciation and replaced by till or sandy outwash. Glacial sediment is generally thin or absent southwest of the Missouri River, but commonly drapes uplands in McKenzie, Dunn, Mercer, and Oliver counties, with localized areas of thicker deposits. At Hole 10, drilled along a broad ridge in western Mercer County, the base of the Bear Den was modeled to occur at a depth of 60 feet (18 m), but glacial till extended to 80 feet. By moving off the ridge 0.5 miles (0.8 km) to the northwest, the till thinned to 20 feet (6 m), and the base of the Bear Den was successfully identified at a depth of 30 feet (9 m) in Hole 10B.

Conversely, the base of the Bear Den was encountered at a depth of 135 feet (41 m) in Hole 12 in eastern Dunn County. Moving to lower elevations 0.5 miles (0.8 km) south, Hole 12B was drilled in a broad valley, where the base of the Bear Den was modeled to occur at a shallower depth of 63 feet (19 m), but here a thick sequence of sand and gravel extended beyond 80 feet (24 m). Based on results from these holes and others drilled within the most heavily glaciated parts of the study area (holes 1 through 15), glacial deposits are usually less than 50 feet (15

meters) thick, but topographic highs (often thick sequences of till deposited in glacial moraines) and lows (partially-infilled proglacial river valleys) should be viewed as areas where glacial deposits are commonly thicker and the Bear Den is more likely to have been removed.

The Rhame bed was not subjected to glacial erosion within the study area. Cores from Adams County and new measured sections described from Golden Valley and Slope counties were all beyond the southwestern limit of glaciation. Light-colored siliceous sediment that has been correlated eastward from the Rhame bed type area extends into Morton and southeastern Oliver and counties (Carlson, 1983; Murphy, 2013). This area, which was not investigated during this study, was more extensively glaciated and till or outwash of considerable thickness may be encountered during exploration there. Furthermore, the Bullion Creek/Slope Formation contact is preserved below much thicker, more continuous glacial deposits across northwestern North Dakota (Bluemle, 1982), so although the Rhame bed has only been reported from the southern rim of the Williston Basin where it outcrops, it may be present but buried across the rest of the basin.

C. Successful Intercept of Thick REE-Enriched Lignites

The ultimate cutoff grade required for the economic extraction of rare earth elements from coal is dependent on numerous factors, but the U.S. Department of Energy initially proposed that a feedstock averaging 300 ppm would be a promising resource. Murphy et al. (2023) reported that lignites within or directly below the kaolinite of the Bear Den Member contain REE concentrations much higher than that (up to 2,570 ppm). Although the REE concentrations were high, the lignites that hosted them were relatively thin; too thin to pursue, especially in areas far from existing mining infrastructure. The most cumulative REE content from any individual lignite beds identified by Murphy et al. (2023) was just 10 inches (25 cm) estimated to average 717 ppm (samples for 270E2 in Morton County) and 14 inches (36 cm) estimated to average 832 ppm (266H in Dunn County). Although the high levels of enrichment in these two beds contain the same overall REE content as would a 2.0 ft (0.61 m) and 3.2 ft (0.98 m) coal averaging 300 ppm, Murphy et al. (2023) felt thicker lignites could realistically be found if exploration was not limited to a handful of accessible exposures.

Thus, a primary goal of the drilling program was to identify lignites that were not just REE-enriched but thick enough to be candidates for mining by traditional methods (generally several feet thick; >1 meter). It was also unknown whether enough REE were mobilized during these paleo weathering events to fully enrich a coal that thick, or whether enrichment would be restricted to just the upper portion of the seam in such a scenario. Core 2 in northwestern Mercer County provides the best example to date of the total REE which can be incorporated by a carbonaceous bed when it occurs within the enrichment zone below a well-developed Bear Den kaolinite. Fifteen samples representing 58.3 continuous inches (148 cm) of lignite and carbonaceous mudstone averaged 716 ppm REE on a dry coal basis (accounting for differential sample thicknesses). Figure 12 illustrates the change in concentrations with depth. Below a 2-inch (5-cm) thick roof of carbonaceous mudstone (which was also REE enriched at 464 ppm), 22.4 inches (56.9 cm) of lignite (averaging 20.5% ash by weight) contained 1,281 ppm REE. The underlying 33.9 inches contained more clay, averaging 71.6% ash, and less REE content at 358 ppm. In total, this interval contains the equivalent REE of an 11.6-foot-thick (3.53 m) lignite enriched at 300 ppm.

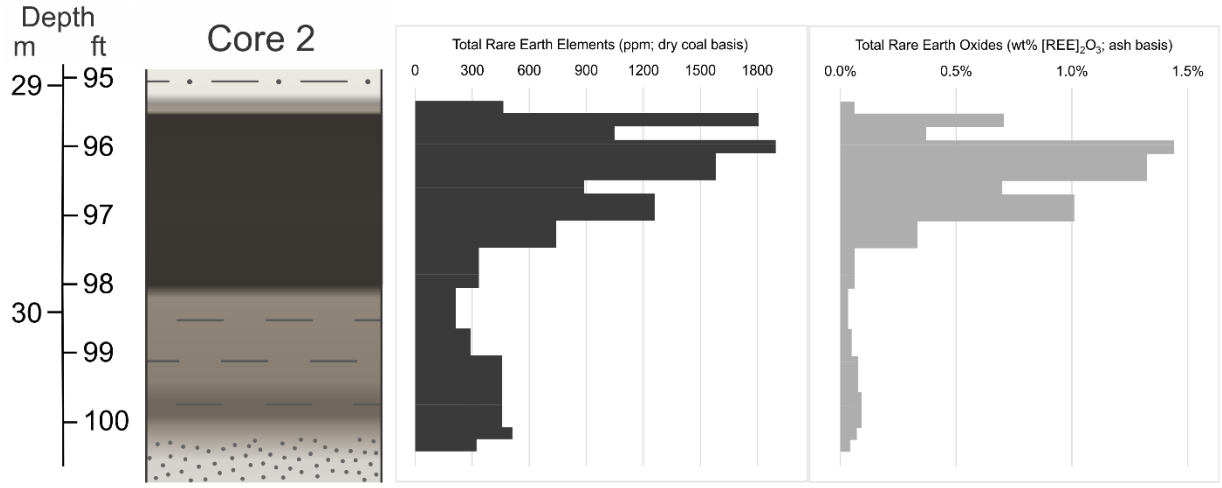


Figure 12. Diagram of a lignite from Core 2 in northwestern Mercer County (left), total rare earth element concentrations on a dry coal basis (middle), and rare earth oxide concentrations on an ash basis (right). Concentrations on the charts correspond to depths on the core diagram.

Although REE extraction is likely to be most economic from non-combusted lignite feedstocks (Laudal et al., 2018), it is noteworthy that Seredin and Dai (2012) proposed 0.1% REO (Rare Earth Oxide; $[REE]_2O_3$) as an economic cutoff grade for ash. Samples 2-B1 through 2-B7 represent 22.4 inches (56.9 cm) averaging 0.85% REO on an ash basis (including Y and Sc). The 13.4 inches (34 cm) from the center of the lignite (samples 2-B3 through 2-B6) average 1.13% REO on an ash basis. All four of these samples are amongst the highest ash-basis REE concentrations yet reported from North Dakota.

Moxness et al. (2023) also reported lignites with significant REE enrichment below outcrops of kaolinite of the Rhame bed. A lignite 17 inches (43 cm) thick averaged 1,153 ppm (284I) in southeastern Golden Valley County, and another at 22 inches (56 cm) thick was estimated at 1,254 ppm (213J) in northern Slope County. Although the total REE content of these two beds was more substantial, equivalent to 5.4 feet (1.6 m) and 6.2 feet (1.9 m) of 300 ppm coal, respectively, Moxness et al. also suggested more economic seams would likely be found over the large areas of the state where the Rhame bed is only accessible via drilling.

Hole 38 successfully intercepted a pair of lignites separated by 9.3 ft of mudstone and siltstone interburden below the Rhame bed in eastern Adams County. The upper lignite, including its REE-enriched roof and floor, totaled 30 inches (76 cm) thick and averaged 925 ppm REE. This seam alone contains the most total REE content of any lignite associated with the Rhame bed (equivalent to 7.7 ft [2.3 m] at 300 ppm), but the lower coal adds another 4 inches (10 cm) at 401 ppm. It appears the top of the lower coal marks the deepest point that REE-enriched waters penetrated in the paleo weathering profile, as the lower 26 inches (66 cm) of this bed are not REE-enriched (Fig. 13).

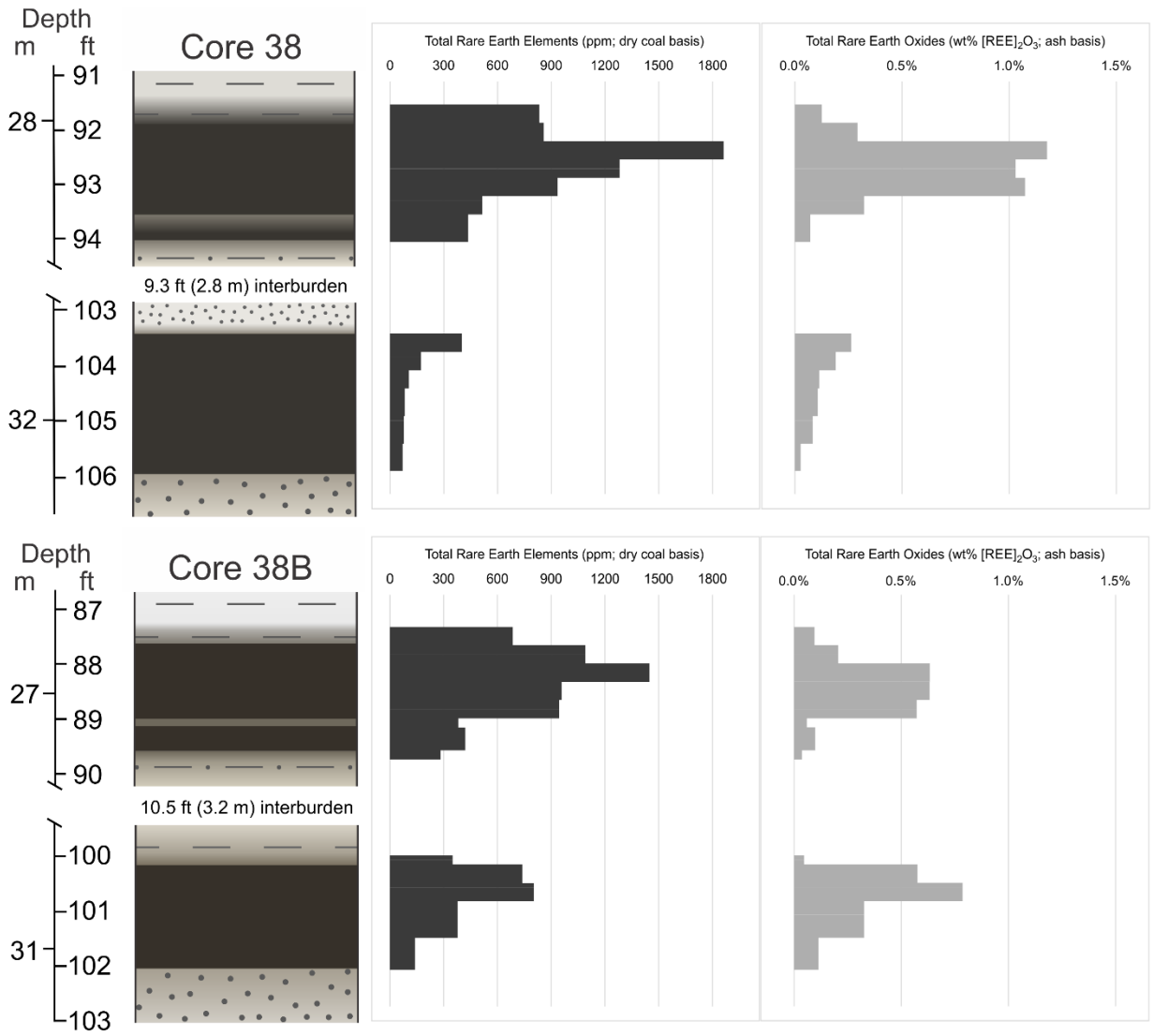


Figure 13. Diagram of two lignites from Cores 38 and 38B, 0.5 mi (0.8 km) apart in eastern Adams County. Total REE (dry coal basis) and REO (ash basis) concentrations correspond to depths on the diagrams.

To collect data on the lateral extent of these concentrations at the small mine scale, another hole (38B) was drilled 0.5 miles (0.8 km) to the west of Hole 38. The thicknesses and combined REE contents of the two lignites were similar to the first site, but interestingly, the upper seam was less REE enriched (27 inches [69 cm] at 866 ppm) and the lower lignite was more enriched (25 inches [64 cm] at 435 ppm). Including carbonaceous roof and floor material exceeding 300 ppm REE, the two seams in Core 38 represent 60 inches (152 cm) of combined thickness that averaged 531 ppm REE. The same two seams in Hole 38B totaled 52 inches (132 cm) in thickness averaging 639 ppm REE. The combined thicknesses and REE grades of the two lignites in Holes 38 and 38B contain the equivalent REE contents of 8.8 ft (2.7 m) and 9.5 ft (2.9 m) of 300 ppm lignite, respectively (Table 3).

Table 3. Lignites containing the most total REE content, considering overall thickness and grade, identified to date from the Williston Basin. Although many of these seams are very thin compared to the targets of conventional lignite mining, average REE contents are often multiples higher than the 300 ppm threshold proposed by the U.S. Department of Energy for promising feedstocks. Listed thicknesses include the entire lignite seam and adjacent clay-rich roof or floor material if it exceeds 300 ppm.

			Thickness		Avg REE	300 ppm equiv.[A]	
County	Site	Samples	in	cm	ppm	ft	m
Adams	Core 38	D	30	76	925	7.71	2.35
		E	30	76	136	1.13	0.35
		D+E	60	152	531	8.84	2.69
	Core 38B	D	27	69	866	6.49	1.98
		E	25	64	435	3.02	0.92
		D+E	52	132	639	9.52	2.90
Dunn	Section 266	H[B]	14	36	832	3.24	0.99
	Core 42	C	6	15	1391	4.45	1.36
		D	16	41	1175	5.22	1.59
		C+D	23	58	1180	7.54	2.30
	Core 42B	C	16	41	963	4.28	1.30
		D	12	30	518	1.73	0.53
		C+D	28	71	772	6.00	1.83
	Core 43	C	18	46	407	2.04	0.62
Golden Valley	Section 284	I[C]	17	43	1153	5.44	1.66
		I2[D]	18	46	1024	5.12	1.56
Hettinger	Core 28	Y[E]	60	152	715	11.9	3.63
Mercer	Core 2	B	58.3	148	716	11.6	3.53
Morton	Section 270	E2[B]	22	56	385	2.35	0.72
		G3	6	15	2139	3.57	1.09
	Core 19B	Y[E]	60	152	485	7.97	2.43
	Core 21	Y-A[E]	62	147	664	10.5	3.21
Slope	Section 97	1-17[C]	17	43	586	2.77	0.84
	Section 123	1-19[C]	19	48	396	2.09	0.64
	Section 210	J[C]	15	38	693	2.89	0.88
	Section 213	J[C]	22	56	1011	6.18	1.88
	Section 329	A	15	38	1068	4.45	1.36
	Section 332	A	10	25	2194	6.09	1.86

[A] Thickness of a seam containing equivalent total REE contents at an average grade of 300 ppm
[B] First reported in Murphy et al., 2023, also see Appendix A
[C] Reported in Moxness et al., 2023
[D] First reported in Moxness et al., 2023; also see Appendix A
[E] Predominantly or entirely claystone

D. REE-Enriched Claystones where Lignites are not Present

Typically, a thin organic horizon is at least present in the 10 to 20 feet (3 to 6 m) below the Bear Den kaolinite. Although, as discussed above, many thin seams are so REE-enriched that they may still be of economic interest, the primary goal of the drilling project was to find and recover thicker lignites in the target horizons. To that end, many holes were drilled where the Bear Den kaolinite was successfully identified, but no significant lignite was indicated by the cuttings or density log. To save time and resources for other sites with major lignites, often no core was collected. Many of these holes likely would have produced thin REE-enriched stringers of carbonaceous shale or lignite, but were beyond the resolution of the density log. In Hole 7 in northwestern Mercer County, drill cuttings from the interval through the Bear Den kaolinite showed no evidence of carbonaceous beds that were distinguishable from minor organic particulates washed down from overlying lignites higher in the hole. It was elected not to pursue core at this location, but a small surface exposure found 0.10 miles (0.16 km) to the southeast of the drill site contained a 5-inch (13-cm) thick lignite, a sample of which contained 1,264 ppm REE (sample 333A). This lignite could be observed thinning across the outcrop in the direction of the drill hole, so it may not have been encountered in the hole, but regardless, such minor lignites would be difficult to reliably detect even if they were of economic interest.

The intermittent presence of lignite below the Bear Den kaolinite raises the question of the ultimate destination of mobilized REEs in these profiles where there is no underlying lignite present. The operating assumption before the project had been that descending REE ion-adsorb to the surfaces of clay minerals at low concentrations over a broad thickness of sediment, or possibly were washed out of the profile via groundwater. The latter scenario seems unlikely as the unique soil waters acidic enough to mobilize REE would quickly buffer upon reaching unweathered smectitic parent material or a larger body of circulating groundwater. Murphy et al. (2023) noted REE enrichment in the gray claystone below the Bear Den in multiple locations (Samples 227D, 298A, 298B, and 299A at 429, 480, 400, and 485 ppm REE, respectively). These samples differ from most other REE-enriched carbonaceous claystones sampled during the project in that they are not primary organic beds (e.g., paper shale). Darker gray coloration is likely due to illuvial colloids (leached humus and clays) leached from the overlying weathering profile, but no direct link to REE concentrations could be made with so few samples. Adding further confusion, lignite stringers occuring in the middle portions of the weathering profile can discolor the lower portions with leached humus, giving a gray cast to the otherwise white kaolinite and obfuscating the exact position where REE enrichment occurs.

Hole 28 in northern Hettinger County presented an opportunity to characterize the nature of REE distribution through a claystone profile without interruption by sandy intervals or outsized REE uptake by primary carbonaceous beds. Guided by pXRF estimations of yttrium, 120 continuous inches (305 cm) of claystone (with only minor mudstone) core was split, with one half submitted for ICP-MS analysis and the other half retained to sample for clay mineralogy via XRD. ICP-MS results show 60 continuous inches (152 cm) of claystone enriched above 300 ppm REE, with a max of 1,233 ppm and an average of 715 ppm over that interval. Detailed pXRF, ICP-MS, and XRD analysis shows the 10-fold increase in REE concentrations over a short distance closely follows the color change from white to light gray to medium/dark gray at the base of the Bear Den Member where smectite replaces kaolinite as the dominant clay species (Fig. 14). This may be

due to the higher cation exchange capacity of smectites (and thus more sites for REE cations to adsorb) or it is simply a byproduct of pH buffering. Descending acidic soil waters carrying REE cations would be expected to buffer where they begin interacting with unweathered minerals (feldspars and smectites), causing REE to drop out of solution at the same position in the profile where kaolinization ends. The kaolinite/smectite ratios agree with the work of Clechenko et al. (2007), which can now be put into context with REE depletion and enrichment.

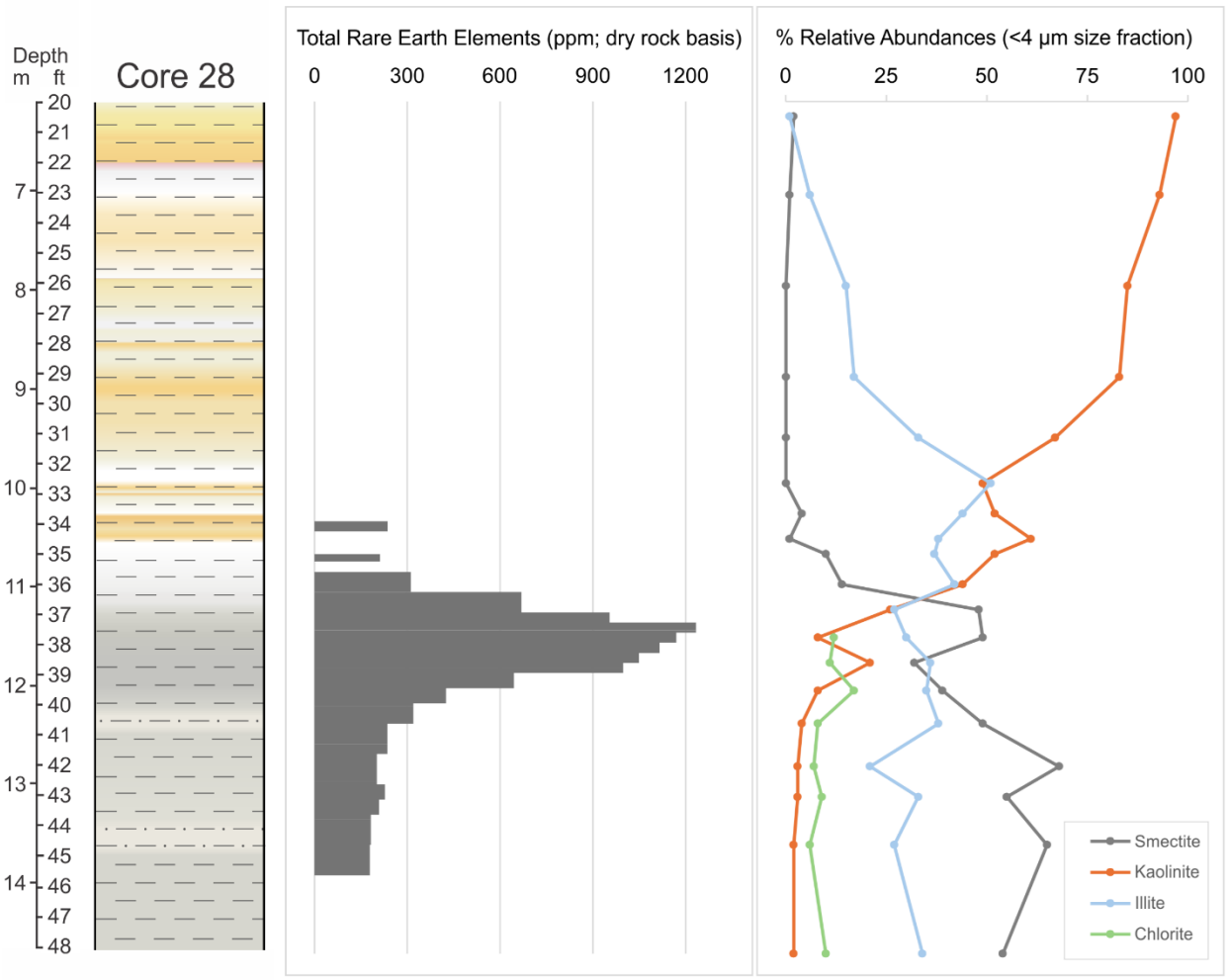


Figure 14. Rare earth element concentrations (ICP-MS) plotted alongside clay mineralogy (XRD) for Core 28 collected from northern Hettinger County. Enrichment coincides with the color change from white to gray and the relative increase in smectite marking the base of the weathering profile and deepest point of kaolinization.

With grades and thicknesses rivaling the most enriched lignites identified during the project, these claystones may also be of economic interest, considering that kaolinitic weathering profiles in South China are the world's primary source of heavy REE. These resources of clay-hosted REEs, located mostly in Jiangxi, Guangdong, and Guangxi provinces (Xu et al., 2017), are thought to have formed from the same fundamental weathering processes proposed for REE-enriched claystones in North Dakota. Tropical to subtropical climates in South China facilitate intense weathering of REE-enriched granitic intrusions, forming a deep regolith of mostly clays

and weathering-resistant minerals that can be up to 200 ft (60 m) thick, hosting ore deposits typically 33-66 ft (10-20 m) thick (Li et al., 2017 and references there-in). Studies in the last decade have identified kaolinite and halloysite as the dominant clay mineral species in these weathering profiles. The clays form from the progressive breakdown of feldspars and micas, first into halloysite, then into kaolinite, as weathering of the granite continues (Li et al., 2017; Xu et al., 2017; Li et al., 2020; Zhao et al., 2021). REE-bearing minerals also break down during this process, releasing REE ions into acidic pore waters. The pH of the waters increases as it buffers upon percolation downward, allowing progressively more REE ions to adsorb onto the clay surfaces. These enriched clay deposits are relatively low grade, between 0.05 and 0.2 wt.% REO, but are widespread and easily extractable through cation exchange reactions with dilute electrolytes (Borst et al., 2020; Kynicky et al., 2012; Li et al., 2017). Murphy et al. (2023) noted an apparent contradiction in that these sources utilize kaolinite itself as an REE ore, but in the profiles investigated in North Dakota, kaolinite serves as the source beds from which the REE were leached. XRD results from Core 28 seem to confirm that REE are inversely correlated with kaolinite at the base of the Bear Den Member, but it should be noted that much of the kaolinite in the upper part of the profiles in South China is REE-depleted, and lower portions of the profiles contain granitic bedrock with minimal smectite content. REE-enriched claystone below the Bear Den Member contains similar grades to the deposits in South China, but overall thicknesses appear an order of magnitude lower. The economics of REE recovery from these smectite-rich claystones (vs kaolinite-rich clays) is unknown but could be favorable.

No illuvial REE enrichment of claystones was identified in any of the Rhame bed cores, despite Core 40 being a seemingly likely candidate. This core contained 15 feet (4.6 m) of light-colored silcrete, claystone, and mudstone that was underlain by gray mudstone with no elevated yttrium detected by the pXRF. Similar settings below the Bear Den Member consistently produced REE-enrichment in the underlying clays, but more data is needed to make conclusions about any potential differences in the depositional environment or paleopedogenesis between the Bear Den and Rhame bed weathering profiles. See further discussion and pXRF profiles for Core 40 later in the text.

E. Removal and Replacement by Younger Bedrock Channels

The Bear Den Member was entirely eroded in places by rivers later in the Eocene. The overlying Camels Butte Member of the Golden Valley Formation contains a channel facies marked by distinctive brown micaceous sand that locally downcuts through the Bear Den. This can be difficult to distinguish from a locally erroneous model, but may be the reason the Bear Den was not identified in Holes 23 and 24 in southwestern Stark County.

Similarly, thick channel sandstones of the overlying Bullion Creek Formation can be present in place of the Rhame bed. Holes 30 and 30B in northwestern Adams County contained thick sandstones ranging from brown to gray in color at the modeled positions of the Rhame bed. This scenario was encountered relatively infrequently during the drilling project, which may attest to the relative conformability of deposition in the Williston Basin during the Paleocene and first part of the Eocene. It may also reflect bias from choosing drill locations with outcrops of kaolinite (used as model control points) in the surrounding area.

F. Weathered Channel Facies

Similar to E above, this scenario also includes the replacement of claystone or lignite at the modeled depth with a channel sandstone, but differs in that the sandstone itself is weathered, suggesting it predates the weathering event. In the case of the Bear Den, these sands were deposited during the Paleocene and weathered during the Paleocene-Eocene Thermal Maximum, whereas the channels in Scenario E were deposited later during the Eocene. These weathered channel sandstones represent the positions of rivers on the latest Paleocene landscape, which transition laterally into overbank facies (siltstones and mudstones) and eventually further to distal floodplain facies (claystones and lignites).

These sandstones often produce some of the thickest, brightest outcrops of the Bear Den Member (Fig. 15) and the Rhame bed (Fig. 31 of Moxness et al., 2023). Weakly cemented sand is easier to leach than smaller grain sizes, as it is both more permeable and dominated by light-colored quartz and feldspar grains when compared to claystone or mudstone. However, these thicker, coarse-grained profiles seem to counterintuitively be associated with lower overall levels of REE mobilization. Moxness et al. (2023) suggested that because quartz (and most feldspars) are not REE-bearing minerals, and because coarse-grained sediment contains less surface area for adsorbed REE cations, the presence of sandstone within the weathering profile significantly reduces the REE available for mobilization by weathering. Unweathered smectite- and illite-dominated claystones appear to have originally contained REE concentrations in the 175-225 ppm range, but limited analyses of Fort Union Group sandstones suggest they may contain roughly half that amount (much of which may be in weathering-resistant heavy mineral grains). It then follows that REE enrichment has so far only been found under weathered claystone and mudstone, not weathered sandstone, but these sands are a useful marker for the position of the Bear Den or Rhame bed in the subsurface.



Figure 15. Thick white- and tan-colored sandstones give the Bear Den Member a total thickness of 75 feet (23 m) at this outcrop in northwestern Dunn County, roughly three times the normal thickness where the weathering profile more commonly develops on claystone or mudstone.

This scenario was not encountered frequently during the drilling project, as the Fort Union Group is generally dominated by fine-grained lithologies. Claystone and mudstone are the most common lithologies upon which both paleosols developed, as these rock types comprise an estimated 60% to 70% of the total thickness of the Fort Union Group in North Dakota (Murphy, 2006). Light-colored channel sands appeared to be present below the kaolinite at the east pit of the Hebron Brick Company in northwestern Morton County (Holes 17, 17B, and 18), replacing the Harnisch lignite, and over 80 ft (25 m) of light-colored mud and sand was encounterd in Hole 4 (northwestern Mercer County) before moving on to the next hole.

G. Lignites are Thin or Weakly REE-Enriched (and Discussion on Predicting Enrichment)

Key refinements to the exploration model proposed by Murphy et al. (2023) and Moxness et al. (2023) involve defining the thickness and exact position of the stratigraphic window where REE enrichment occurs relative to the kaolinitic source beds. How far below the kaolinite can lignites be expected to be consistently enriched? What position would be most optimal for a lignite seam to incorporate the maximum possible REE content? If it can be demonstrated that the highest REE enrichment is reliably confined to a more restricted window (e.g., enrichment >1,000 ppm occurs almost exclusively within the ten feet [three meters] below the white kaolinite), drilling and analytical resources could be stretched much further without the need to characterize a 40-foot (12 meter) profile in each exploratory hole.

Gradational lower contacts can make it difficult to assign a consistent position to the base of the leached zone, especially where lignites occur (see discussion of leached organics giving kaolinite a gray color in Scenario D). Further, fluvial deposition dominated the ancient landscape upon which these paleosols formed and produced laterally variable lithologies within the enrichment window (see Scenario F), which in turn controls the development and expression of the paleosol. At the onset of weathering, a given peat deposit may have been buried at shallow depths at one position but is buried a few feet (~1 m) deeper on the landscape a short distance away. These effects of paleotopography ultimately produce a lignite which will occur at differing depths within the weathering profile. Although the heterogeneous nature of this stratigraphic interval can be difficult to represent on a generalized diagram meant to show REE movement within a prototypical claystone profile, it also offers opportunities to assess REE concentrations in lignites at varying positions. These variations are relevant if any more specific statement is to be made about expected REE contents with depth.

Understanding how and to where the REE were redistributed during paleopedogenesis requires closely spaced sampling over intermediate distances of a few miles (km). High frequency sampling at this scale can show the degree to which REE contents of individual lignite beds vary based on their proximity to the kaolinite. The optimal focused study area would contain a relatively consistent weathered profile (i.e., REE “source beds” with minimal variability in thickness, lithology, and degree of weathering), and carbonaceous lithologies at varying positions in the underlying strata would provide data on REE uptake vs. depth. Such an area occurs along a mesa north of Hebron, ND, where abundant outcrops provided opportunities to measure nine stratigraphic sections (270, 272, 306, 317, 321 through 325), and the relatively level upper prairie allowed for the collection of seven cores (19 through 21B). A total of 159 ICP-MS analyses and

nearly 2,000 supplemental pXRF scans of cores were performed to characterize this roughly four-square-mile (10 sq. km) area in far northwestern Morton County (Fig. 16).

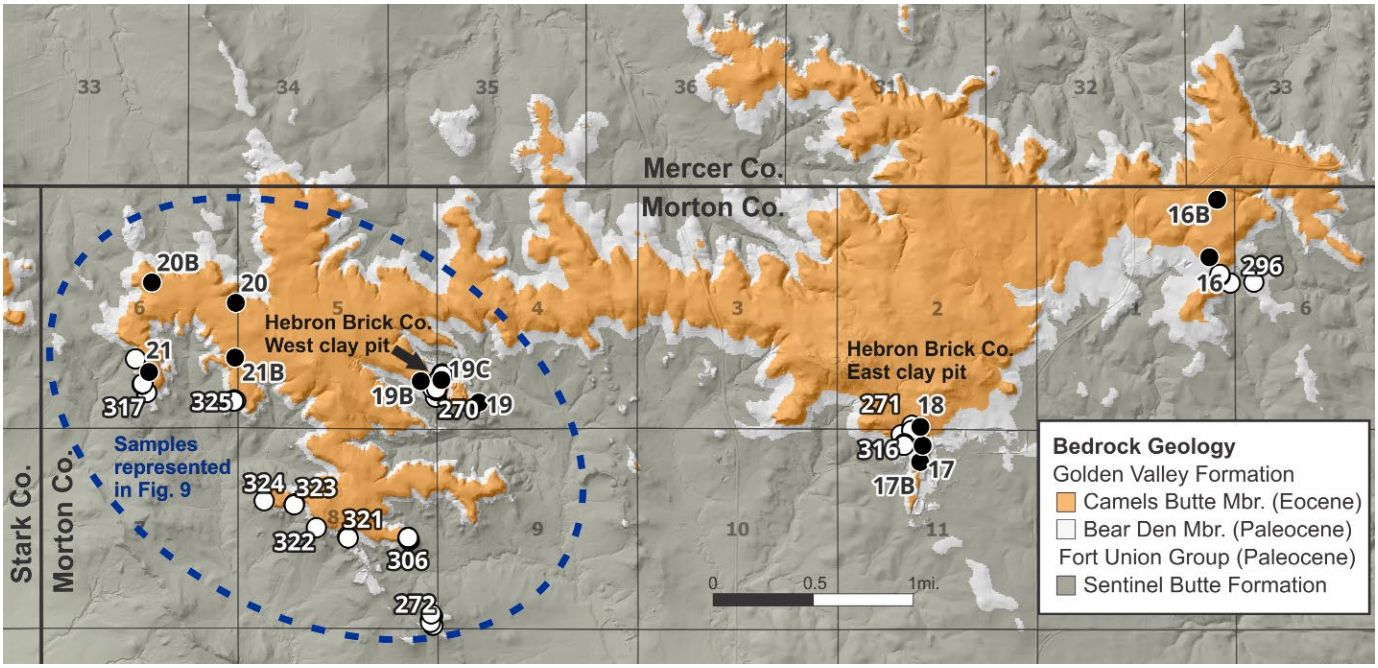


Figure 16. Locations of samples from measured sections (white dots) and drilling sites (black dots) in the area north of Hebron, ND. See Appendix A for lithologic descriptions and analytical results for new samples. See Murphy et al. (2023) for sections 271, 272, 296, and 306.

The Hebron area is of particular interest as the Bear Den kaolinite is actively mined at two locations by the Hebron Brick Co., and there is a major lignite bed just beneath it. This bed, named the Harnisch lignite, regularly exceeds 6 feet (1.8 m) in thickness and was also historically mined in multiple locations in this area. Murphy et al. (2023) sampled the Harnisch in some detail at measured section 306 and found it was not enriched at that location where it occurred roughly 20 feet (6.1 m) below the base of the kaolinite (as estimated in the field by color and texture). The Harnisch at this location appears to underlie the enrichment window by a relatively narrow margin, considering descending REE did reach the rider seams of lignite and carbonaceous shale 5 feet (1.5 m) above (sample 306E was 781 ppm REE).

Thin lignites between the Harnisch and the kaolinite in the western clay pit contained the highest REE concentrations identified by Murphy et al. (2023), and a sample from the same stratigraphic position at measured section 325 of this report contained 4,443 ppm (dry coal basis including Y and Sc) and 1.57% REO (rare earth oxide) on an ash basis, the highest concentrations identified in the basin by a significant margin. With known paleotopography-induced variations controlling the distance between the weathering profile and any given lignite, it was of significant interest to determine if the Harnisch, being a major lignite, may occur closer to the base of the Bear Den kaolinite nearby. Regionally, the intervening distance appears to decrease from east to west across the mesa, as evidenced by cores 16B and 21, collected 5.4 miles (8.7 km) apart, that exhibit lignites of remarkably similar thicknesses, but the positions of the coals differ relative to the overlying weathering profile and they contain drastically dissimilar REE contents (Fig. 17).

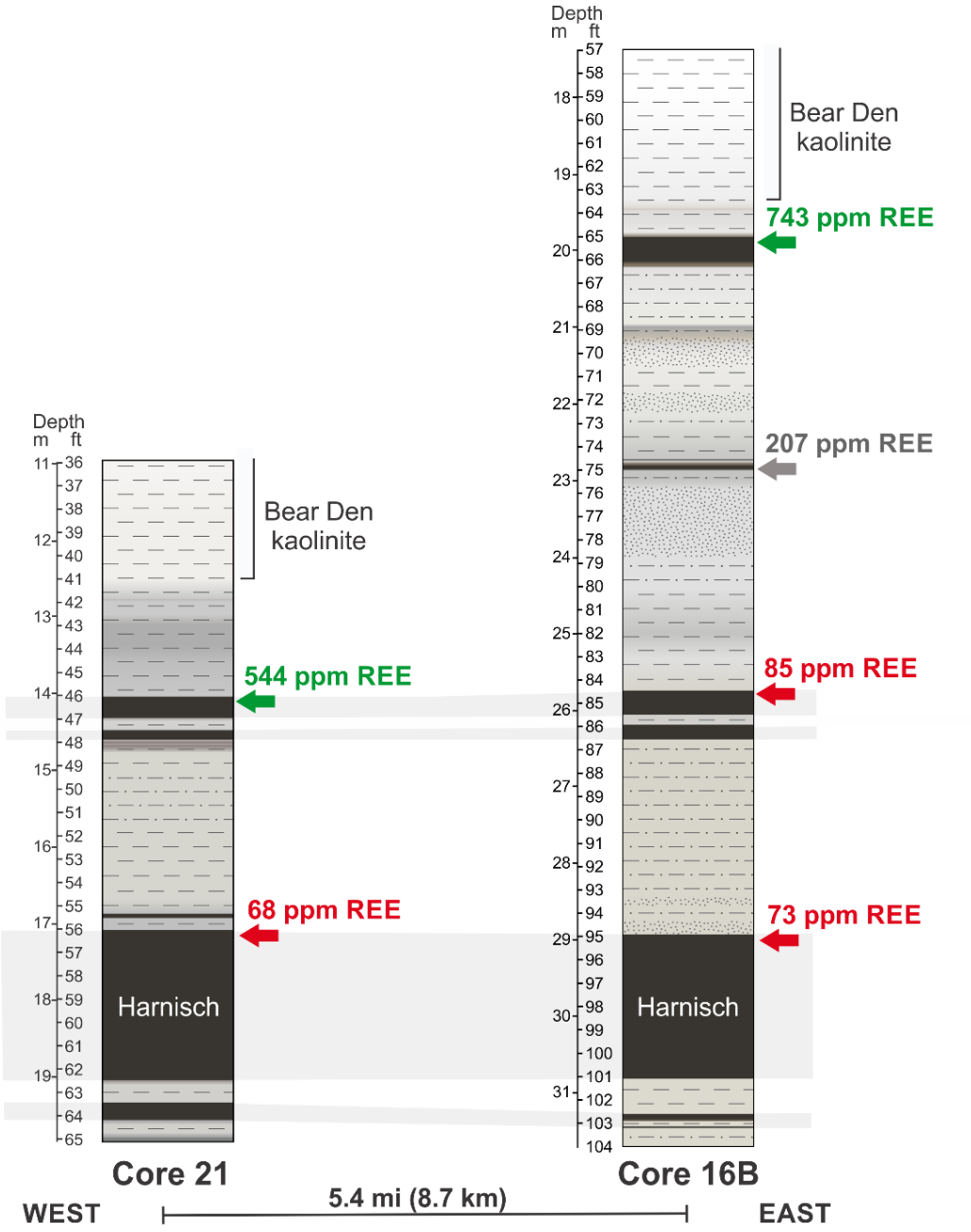


Figure 17. Cores 21 and 16B from the west and east end, respectively, of the mesa north of Hebron. REE concentrations from the top of each lignite are shown, illustrating that the most enrichment occurs directly below the kaolinite of the Bear Den Member, which occurs higher in Core 16B than in Core 21, 5.4 miles (8.7 km) away. Additional sample results can be found in Appendices A and B.

Whether the intervening thickness between the Harnisch lignite and the Bear Den continues to diminish to the west of this area will remain unknown, as this interval is eroded away between Hole 21 and Taylor, ND, some 15 miles (24 km) to the west. The narrow nature of this mesa does not allow for inference on regional north-south trends, but enrichment reaches depths very close to the Harnisch in measured sections to the south (272, 306, 322, 323) where a pair of thinner lignites separated by paper shale or carbonaceous mudstone directly overlie the Harnisch. These thinner lignites may be seperated from the Harnisch by a wedge of mudstone to the north

(sections 317, 325, and Holes 21 and 21B), and significant thicknesses of sandstone disrupt the profile in the northernmost cores (20 and 20B). This clastic wedge is represented in the diagram below, showing REE concentrations with depths relative to the sample's distance below the kaolinite (Fig. 18).

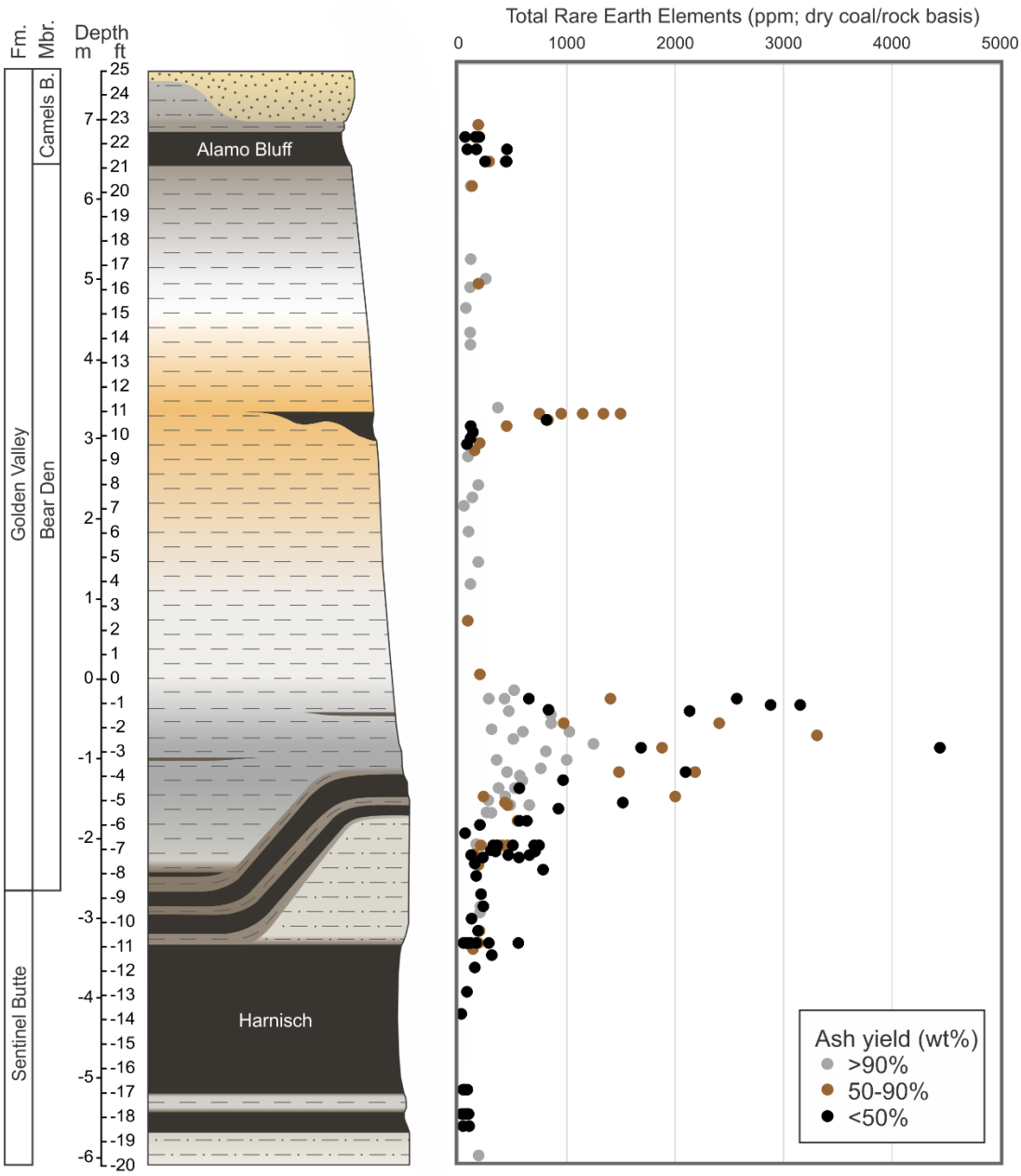


Figure 18. Generalized stratigraphic column for the area north of Hebron, ND (cores and measured sections within the blue circle of Figure 16). The REE contents of samples submitted for ICP-MS analysis between the Alamo Bluff and Harnisch lignites are plotted at depth relative to the observed color change from white to gray at the base of the Bear Den kaolinite. Samples are color-coded according to their ash yield, a rough proxy for clay content.

Figure 18 illustrates that significant enrichment is largely restricted to the six feet (1.8 m) below the base of the Bear Den kaolinite in this area. Within this zone, carbonaceous lithologies can incorporate up to 4,443 ppm REE, and even non-carbonaceous claystones can reach 1,245 ppm. When the first carbonaceous bed occurs in the interval 6 to 12 ft (2 to 4 m) below the kaolinite, its upper margin may contain elevated REE concentrations, but most of the mobilized REE cations had sorbed within the overlying claystone. A lignite within the kaolinized interval is locally present in the Hebron Brick Company's western clay pit (Figure 17 of Murphy et al., 2023; E samples of measured section 270). The upper margin of this coal is enriched at multiple locations across the pit, suggesting that although uncommon, organics interbedded with the kaolinite may preferentially incorporate REEs in an otherwise depleted part of the profile.

It appears that even minor changes in relative depths between a lignite and the kaolinite can produce significant variances in the amount of descending REE a lignite is exposed to. Core 20 and 21 were collected 0.57 miles (0.92 km) apart. A lignite with a thin claystone parting occurs in both holes, separated from the kaolinite by a short interval of gray claystone in each. The lignite in Hole 20, however, contains REE concentrations four to five times higher than the same lignite

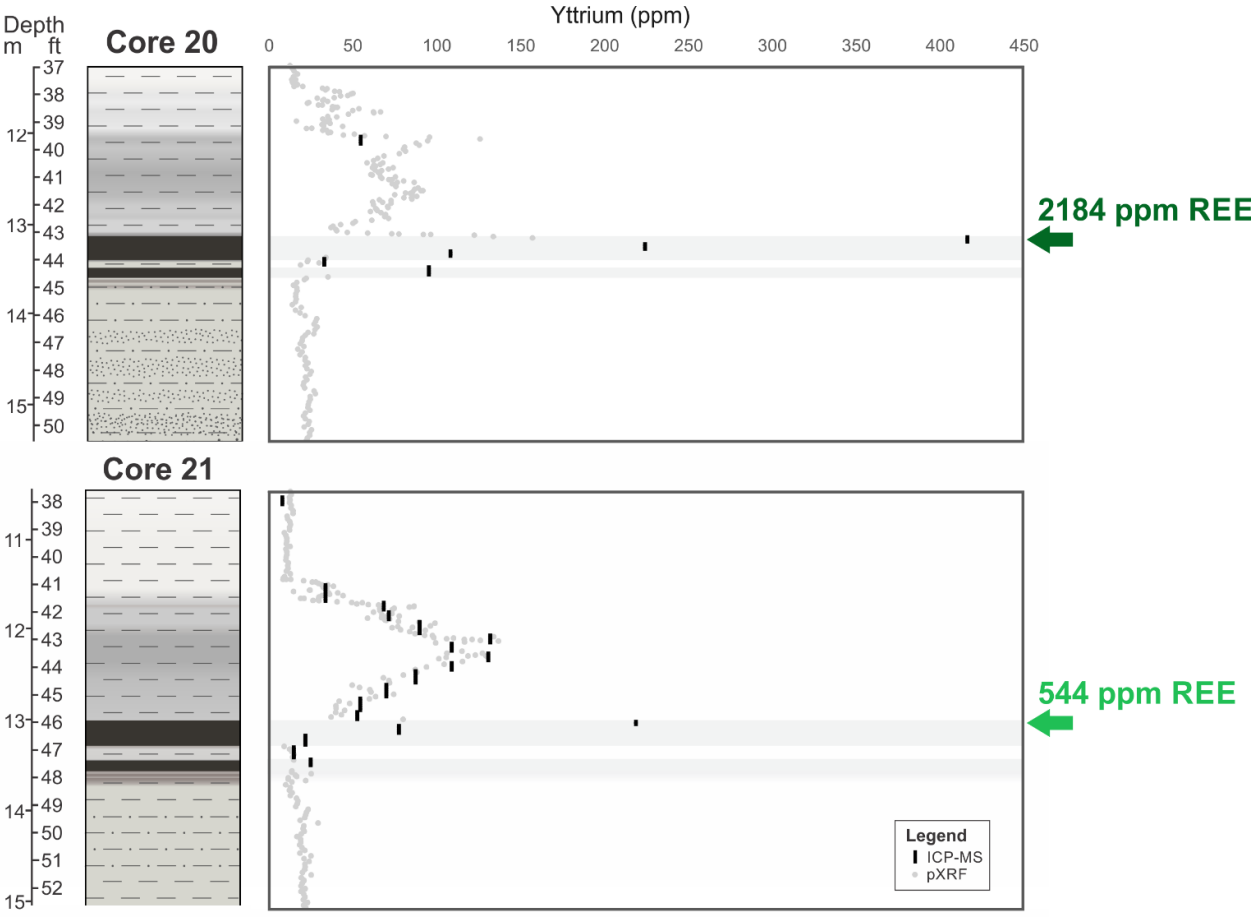


Figure 19. Concentrations of yttrium, the rare earth element most reliably detected via pXRF (gray dots) at depth through the base of the Bear Den Member in Core 20 and Core 21, collected 0.57 miles (0.92 km) apart in northwestern Morton County. Core sections also analyzed via ICP-MS are shown as black bars. The base of the kaolinized zone is present in both cores, inferred from the light color of the claystone.

in Hole 21. Detailed pXRF analyses of each core show yttrium concentrations begin increasing at nearly identical relative positions above the lignites (5.3 ft in Hole 20 and 5.2 ft in Hole 21), but that significantly more yttirum was accumulated within the overlying claystone in Hole 21, which averaged 72.3 ppm Y, while the claystone in Hole 20 averaged 60.4 ppm Y (Fig. 19). The factors controlling the lower REE cconcentrations within claystones in Hole 20, allowing more REEs to reach the lignite below, are poorly understood. Comparative XRD or grain size analysis could show that marginally higher kaolinite or silt contents limited REE adsorption in Hole 20. Analysis of the total organic carbon in each zone could show more secondary organics in Hole 21.

A detailed clay profile from core samples in Hole 21 was characterized via ICP-MS, which supports pXRF-based yttrium concentrations as a method for reliably tracing REE depletion and enrichment. Continuous sampling strategies were also employed for similar intervals where REE enrichment was identified via pXRF in Holes 19B and 28 (Fig. 20). Core 19B may be another example where the kaolinite-to-smectite transition occurs over a broader thickness of claystone, producing an asymmetric “peak” in REE distribution compared to Cores 21 and 28. Insights provided by these profiles, contextualized color and clay mineralogy, and the relative depths of REE-enriched samples across all other cores and outcrops, allow for the construction of a semi-quantitative model of REE concentrations at depth for the Bear Den Member (Fig. 21).

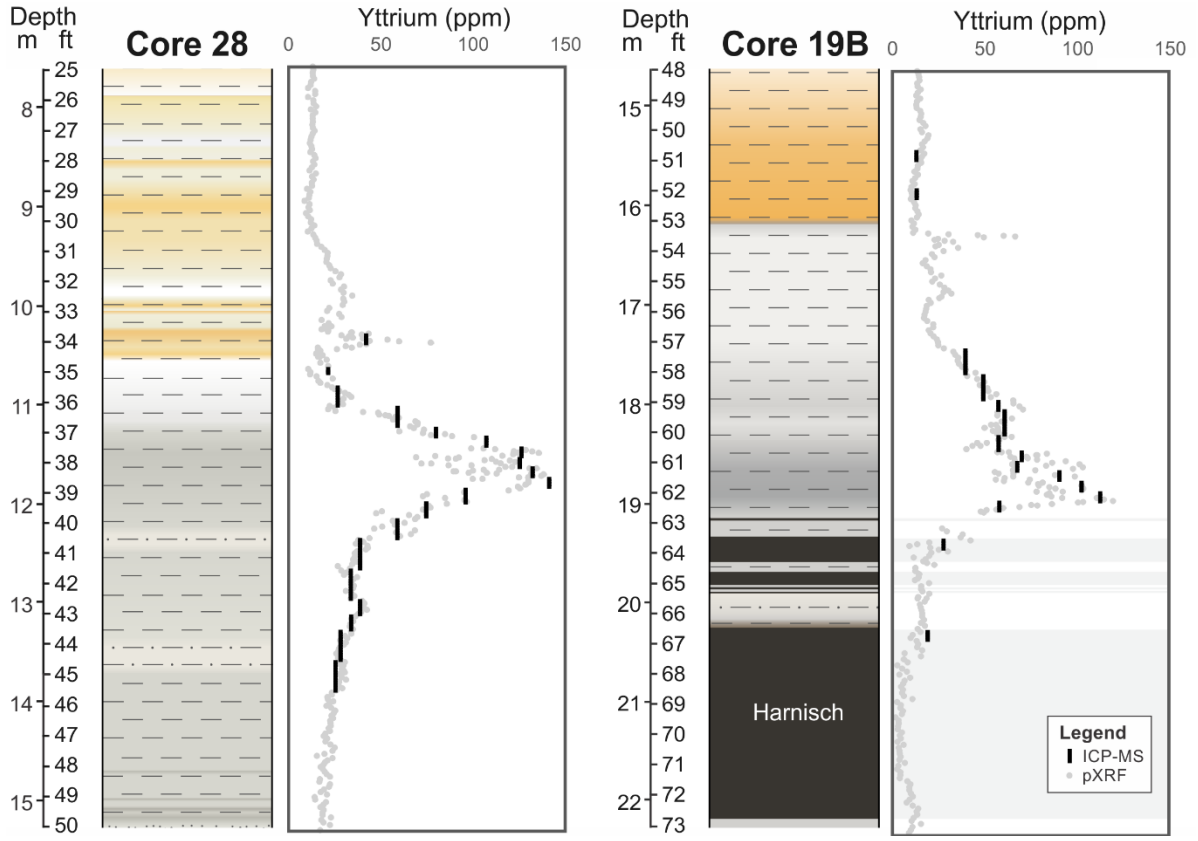
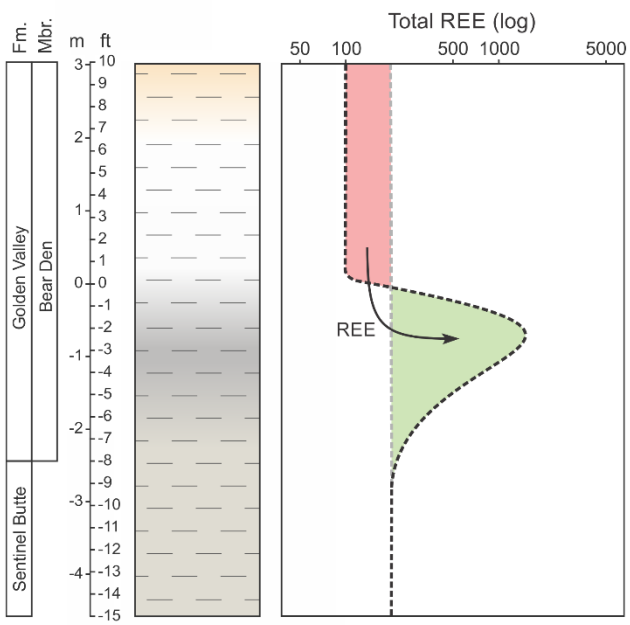
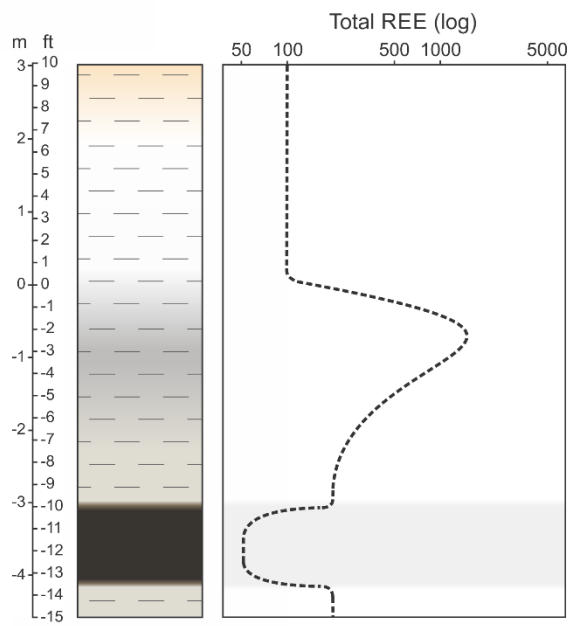


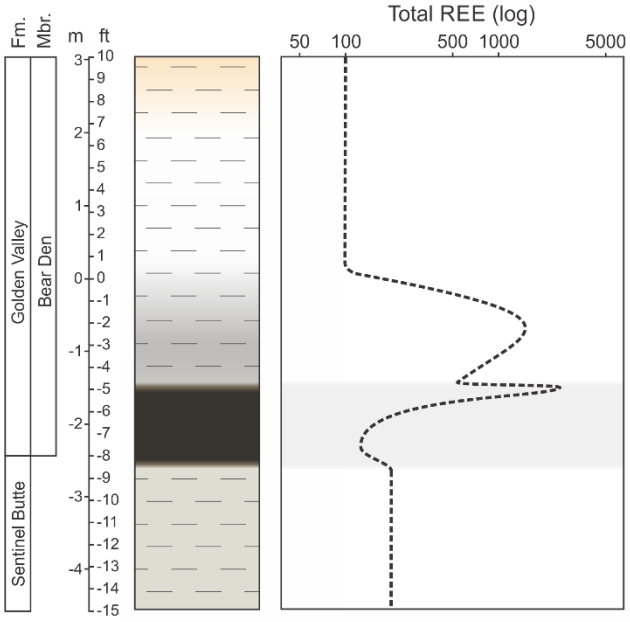
Figure 20. Yttrium concentrations in Core 28 (Hettinger County) and Core 19B (Morton County). These two profiles, along with Cores 20 and 21 (Fig. 19) illustrate that where the curve of the illuvial profile is not interrupted by lithologic heterogeneity, most of the REE enrichment is distributed over an interval of claystone roughly six feet (1.8 m) in thickness, with a peak which can exceed 1,200 ppm total REE.



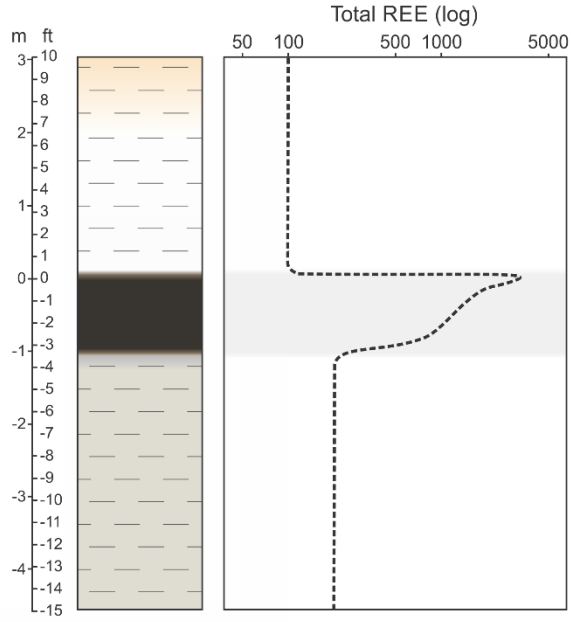
A. In profiles with no lignite near the base of the Bear Den Member, descending REE cations adsorb to the surfaces of clay minerals. The majority of the REE sorption (which can exceed 1,200 ppm) occurs through a 5 ft (1.5 m) interval coinciding with the transition from kaolinte to smectite dominated clay assemblages. The source of the REEs were the latest Paleocene smectitic claystones which contain 175-225 ppm elsewhere in the basin where unweathered. These claystones appear to have lost roughly half of their REE content during kaolinization.



B. A lignite 10 ft (3.0 m) below the kaolinite may not have received any descending REE in profiles where it had adsorbed to overlying smectitic claystones. In other profiles where the kaolinite-smectite transition is more gradual, REE enrichment can reach such depths, but only the upper few inches of lignite is slightly enriched. Coal, formed from organic matter, normally does not contain REE-bearing minerals, and thick lignites commonly contain <50 ppm unless exposed to REE-enriched fluids.



C. A lignite 5 feet (1.5 m) below the base of the kaolinite preferentially incorporated REE within organic complexes, concentrating up to 2,400 ppm in its upper margins, but the lower portion of the seam is not enriched because most of the mobilized REE adsorbed to the overlying claystone. Small differences in the position of the lignite relative to the kaolinite produce significant changes in its REE content.



D. A lignite at the base of the kaolinite may theoretically incorporate all descending REE mobilized from the overlying weathering profile. Lignites in this position can average 4,443 ppm REE across 2 inches (5 cm), 2,139 ppm across 6 inches (15 cm), and 1,249 ppm across 24 inches (62 cm). Based on the total REE observed mobilized in these profiles, a 3.3 ft (1 m) lignite (pictured) could average 1,000 ppm REE.

Figure 21. Generalized enrichment model for the Bear Den Member developed on a homogenous claystone profile, illustrating REE concentrations across four scenarios where a theoretical 3.3 ft (1 m) lignite is (A) absent, or (B) occurs at a depth 10 ft (3.0 m), (C) 5 ft (1.5 m), or (D) 0 ft below the kaolinite-smectite transition.

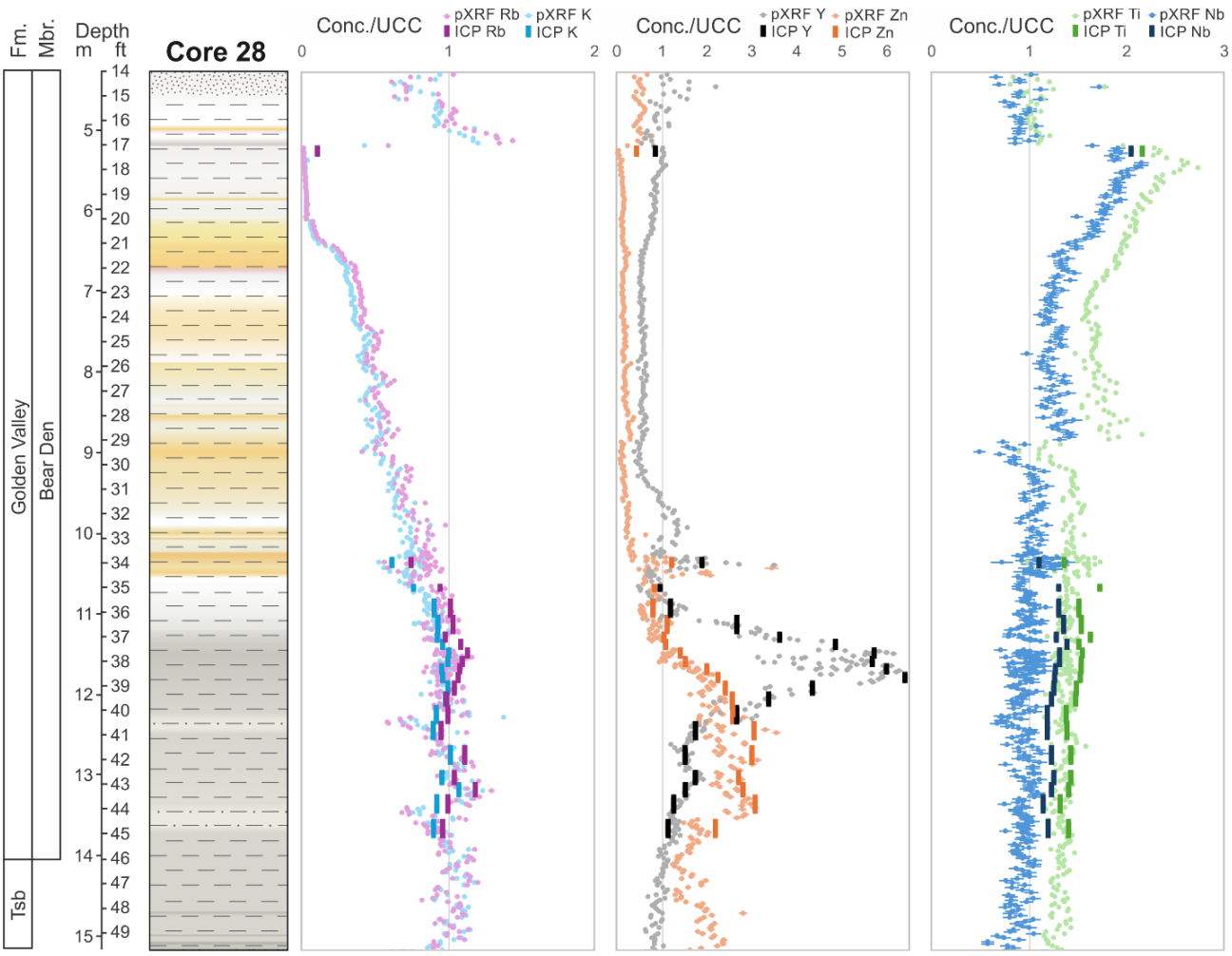


Figure 22. Concentrations for mobile (Rb, K), intermediate (Zn, Y), and immobile (Nb, Ti) elements through the Bear Den Member in Core 28. Concentrations are normalized to upper continental crust (UCC) values of McLennan (2001). Values below 1 indicate depletion; above 1 indicate enrichment.

Core 28 serves as a representative weathering profile for the Bear Den Member. The shallow nature of this core and an overlying sandstone make it difficult to say if the entirety of the weathering profile was captured in this profile, but relatively normal concentrations of mobile elements in the claystone above 17 ft (5.2 m), with a silicified zone just below (often marking the top of the kaolinite) are signs it is largely complete. In this profile, K and Rb, elements which are easily mobilized by acidic waters, are nearly completely leached from the profile from 17 to 20 ft (5.2 to 6.1 m). Concentrations are progressively less depleted with depth until about 36 ft (11 m), where they largely return to normal. This coincides with the maximum depth of weathering as inferred by the first presence of smectite and a sharp decrease in its weathering product, kaolinite. Intermediate-mobility elements Y and Zn show depletion over the same interval as K and Rb, but are not leached from the profile entirely. These elements show an interval where they are enriched before normalizing, with Zn exhibiting more depletion and deeper infiltration compared to Y. Immobile elements Ti and Nb become residually enriched as other material is leached downward. Elevated concentrations of Ti and Nb aid in differentiating intense weathering from coarser-grained lithologies, where quartz dilution leads to naturally lower concentrations of all six selected elements.

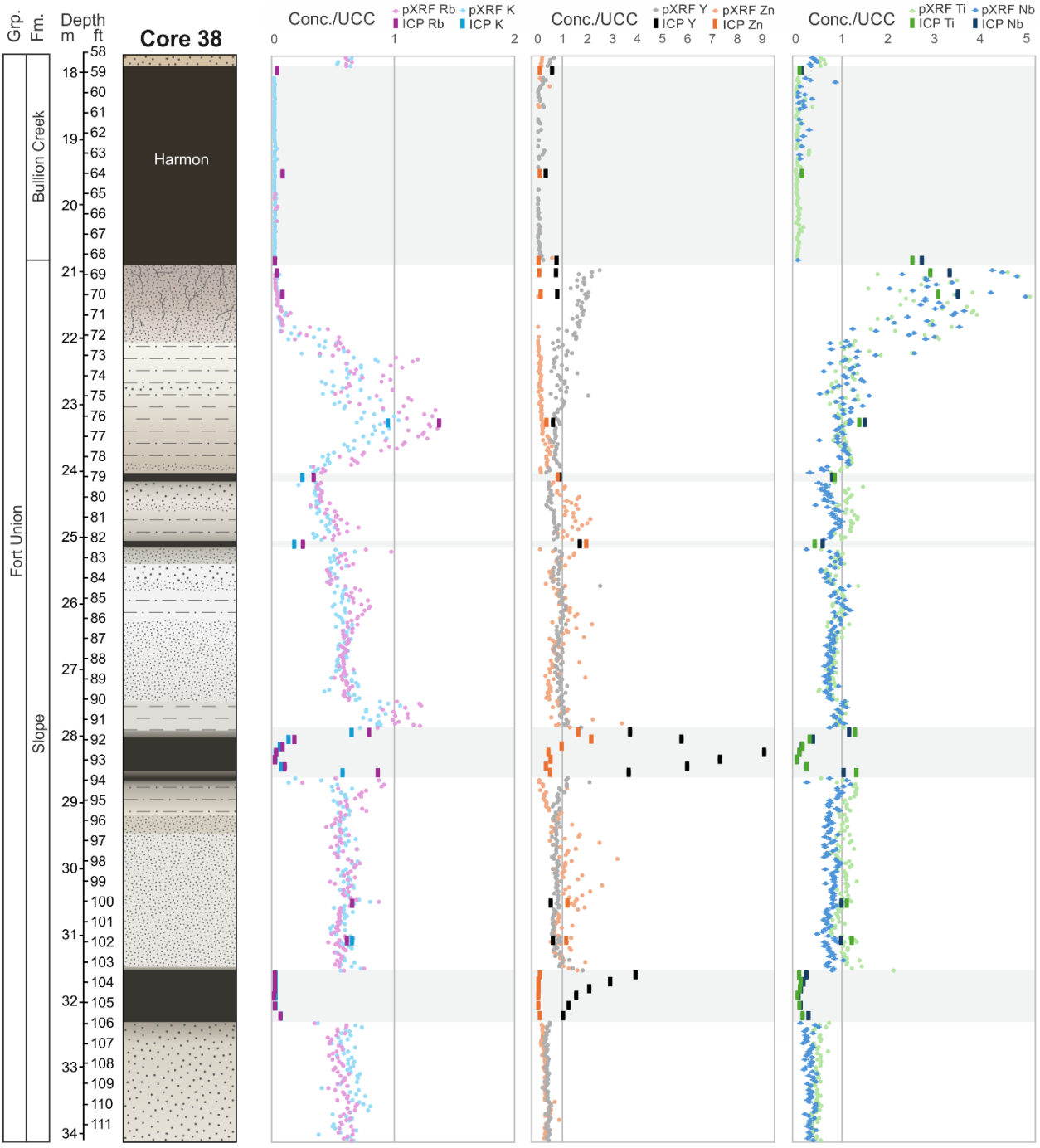


Figure 23. Concentrations for mobile (Rb, K), intermediate (Zn, Y), and immobile (Nb, Ti) elements through the Rhame bed in Core 38, collected in Adams County. Concentrations are normalized to upper continental crust (UCC) values of McLennan (2001). Values below 1 indicate depletion; above 1 indicate enrichment.

Unlike the Bear Den profiles, cores of the Rhame bed do not show zones of REE enrichment in claystones. In fact, these cores also do not show significant REE depletion in the weathered zones. Core 38 (Fig. 23) contains a major silcrete below 68 ft (21 m) depth, marking the top of the Rhame bed. The immediately underlying interval from 73 to 83 ft (22.3 to 25.3 m) appears largely unweathered, and two thin lignites in this interval are not REE-enriched. Light-colored sandstone, siltstone, mudstone, and claystone span the interval from 83 ft to 92 ft (28 m), where a lignite occurs and is significantly enriched in rare earth elements.

The thickness and degree of enrichment in this lignite, which was 30 inches (76 cm) thick and averaged 925 ppm REE, is enigmatic considering it is overlain by just 9 feet (2.7 m) of light-colored sediment. It is possible that the large amounts of REE present in this lignite were sourced from a much thicker sequence of sediment which weathered and was then eroded down to 83 ft, but the presence of the silcrete above this point suggests much of the weathering occurred later. Another possibility is that although the interval between the silcrete and 83 ft depth is not light-colored, it, too was weathered. This would provide roughly 22 ft (6.7 m) of sediment to supply REE during weathering, but would require REEs to have “bypassed” the thin upper lignites. Further, the relatively high silt and sand contents of these profiles would mean less ion-adsorbed REE were available to mobilize during weathering. Core 38B (Fig. 24), collected 0.5 mi (0.8 km) away from Core 38, shows a very similar lower profile with modestly more REE in the lowermost lignite. This lignite is overlain by siltstone in Core 38 and a claystone in 38B, but the claystone does not appear to have contributed additional REE since it is not weathered (Sample 38B-Z at 225 ppm REE).

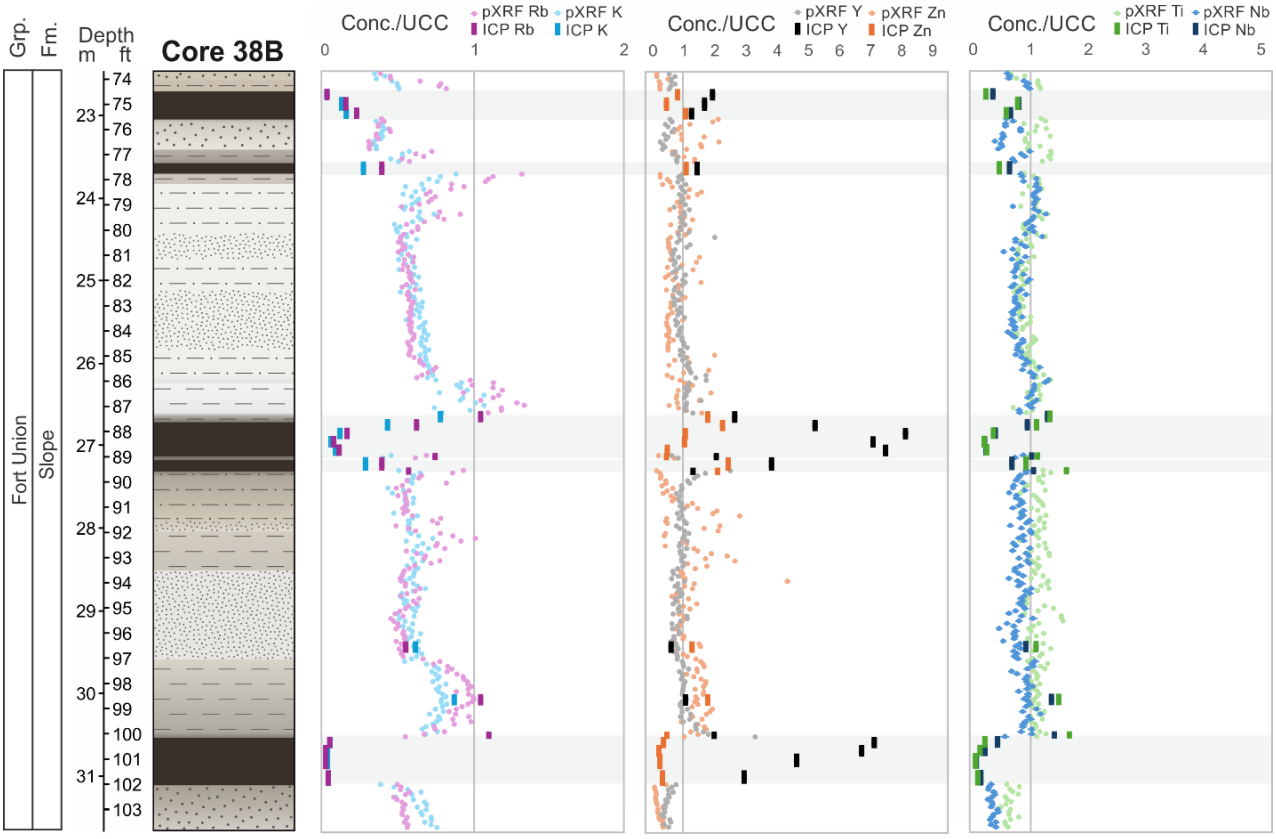


Figure 24. Concentrations for mobile (Rb, K), intermediate (Zn, Y), and immobile (Nb, Ti) elements through the Rhame bed in Core 38B, collected in Adams County. Concentrations normalized to upper continental crust (UCC) values of McLennan (2001). Values below 1 indicate depletion; above 1 indicate enrichment.

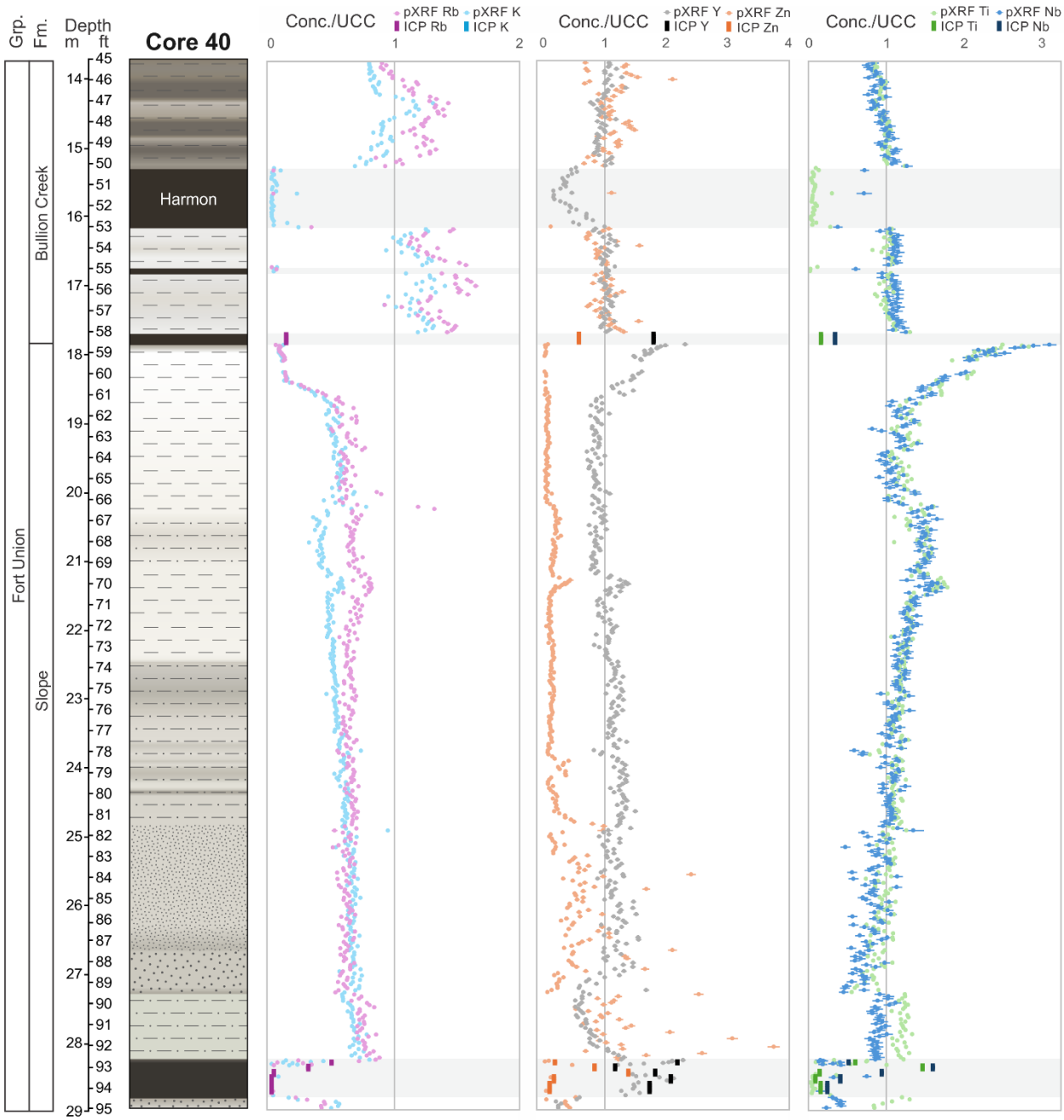


Figure 25. Concentrations for mobile (Rb, K), intermediate (Zn, Y), and immobile (Nb, Ti) elements through the Rhame bed in Core 40, collected in Adams County. Concentrations are normalized to upper continental crust (UCC) values of McLennan (2001). Values below 1 indicate depletion; above 1 indicate enrichment.

Core 40 contains a prototypical weathering zone of the Rhame bed, where a silicified zone at 59 ft (18 m) depth is underlain by 15 feet (4.6 m) of mostly white claystone. This core collected overlying claystones which exhibit normal concentrations for elements of interest, suggesting they are unweathered. The first lignite occurs 33 ft (10 m) below the top of the weathering profile, and only its upper margin is enriched (Sample 40B1 at 346 ppm REE), as would be expected for a seam at that depth, as most mobilized REE would have adsorbed within the overlying claystones. However, unlike the Bear Den profiles, the gray mudstone below the kaolinite does not contain elevated Y (Fig. 25). In fact, there appears to be little geochemical difference between the white claystones and gray mudstones outside of the silicified zone present from 59-61 ft (18-18.6 m).

Based on the three detailed profiles of cores in eastern Adams County, the mobilization and transport of REE during the weathering event that formed the Rhame bed appears unique from that which formed the Bear Den Member. The concentrations of yttrium and other mobile elements are generally less depleted through the weathered zone of the Rhame bed, suggesting less intense weathering. This is consistent with Moxness et al. (2023), who suggested it formed during a prolonged period of nondeposition, since there is no mid-Paleocene equivalent of the Paleocene-Eocene thermal maximum, the short, intense climate event which caused the deep weathering of the Bear Den Member. Despite the apparent lower degree of weathering, significant amounts of REE were still mobilized into underlying lignites. This apparent contradiction is best illustrated in Core 38, which contains a thick REE-enriched lignite without a corresponding zone of sufficiently REE-depleted sediment above. This would necessitate additional input of REE sourced from the surrounding landscape via the infiltration of enriched surface waters or lateral groundwater flow moving through the siltstones and sandstones in the (at that time) shallow subsurface. Core 40, and its “missing” REE below the weathered zone, may be an example of a landscape position that was a source of REE and contributed to the “outsized” REE contents nearby in Cores 38 and 38B.

Additional Outcrop Sampling

Appendix A contains 22 new measured sections and additional sampling at four sites (266, 267, 270, and 284-West). Table 4 summarizes sampling activity and REE results.

Table 4. Summary of 26 measured sections and 136 outcrop samples submitted for ICP-MS analysis.

Measured Section #	County	Target Interval	No. of new analyses	Max REE (ppm) dry coal basis
266	Dunn	Bear Den	6	2,321
267	Stark	Bear Den	3	3,174
270	Morton	Bear Den	16	3,154
284-W	Golden Valley	Rhame bed	3	2,070
284-N	Golden Valley	Rhame bed	4	1,570
307	Billings	Sentinel Butte	9	~253
308	Billings	Sentinel Butte	12	414
309	Billings	Sentinel Butte	7	312
310	Billings	Sentinel Butte	3	~207
316	Morton	Golden Valley	1	938
317	Morton	Golden Valley	12	742
319	Slope	Rhame bed	5	~166
320	McKenzie	Golden Valley	4	~246
321	Morton	Golden Valley	4	2,001
322	Morton	Golden Valley	1	1,539
323	Morton	Golden Valley	5	1,685
324	Morton	Golden Valley	1	3,310
325	Morton	Golden Valley	5	4,443
326	Slope	Rhame bed	1	82
327	Slope	Rhame bed	2	695
328	Slope	Rhame bed	5	731
329	Slope	Rhame bed	13	2,083
330	Golden Valley	Rhame bed	3	915
331	Slope	Rhame bed	4	1,883
332	Slope	Rhame bed	5	2,983
333	Mercer	Bear Den	1	1,264

One of the primary areas of interest for additional outcrop sampling was the Rhame bed westward and southward from Logging Camp Ranch in Slope County. Murphy et al. (2018) conducted detailed lateral sampling of the first REE-enriched lignites identified in the area by Kruger et al. (2017), which was continued by Moxness et al. (2023), who mapped the position of the Rhame bed across Ranger Township (T136N, R102W). The REE-enriched lignite below the Rhame bed thickened and thinned over this area and was often absent but exceeded 1 foot (0.3 m) at several locations. The Rhame bed outcrops to the west along the Little Missouri River and south along Deep Creek (Wehrfritz, 1978), so additional outcrop investigations were performed to determine if the lignite(s) thickened in either direction. Outcrops frequently contained lignites which were highly REE enriched, including a 2,983 ppm sample from a seam which averaged 2,194 ppm REE across its 10 inch (25 cm) thickness. This sample (332Am1) is a new high for lignite associated with the Rhame bed, and several new sites from Slope County produced lignites exceeding 1,000 ppm, but no enriched lignites thicker than 18 inches (0.46 m) were identified. Much of the sampling in Slope County was performed to identify areas that would be good candidates for drill sites. But with poor accessibility (low road density) and thin enriched lignites, it was elected to concentrate most of the drilling on the Bear Den Member and the Rhame bed to the east (Adams County), where some logs suggested thicker lignites were present. Figure 26 shows the modeled position of the Rhame bed based on extensive field reconnaissance through Slope County and adjacent portions of Billings and Golden Valley counties.

Samples of lignites below the Bear Den Member were also collected to inform drilling, especially in northwestern Morton County, where samples were enriched as high as 4,443 ppm REE (the highest from the Bear Den Member and state as a whole). Nearby drilling (Holes 19-21) was able to intercept these same REE-enriched lignites. Additional samples from measured section 266 in Dunn County were as high as 2,321 ppm and were successfully cored 0.25 miles (0.40 km) to the north in Holes 42 and 42B. New samples of a lignite in southernmost Stark County (measured section 267) were as high as 3,174 ppm REE, but this thin lignite was not present 0.33 miles (0.53 km) to the west at either core from Holes 26 and 26B. One sample (333A) from a Mercer County outcrop contained 1,264 ppm near Hole 7, and measured section 320 in McKenzie County did not contain a well-developed Bear Den profile or REE-enriched lignites.

Four measured sections (307-310) were measured through a conspicuously white interval of mudstone in northern Billings County. This bed occurs within the upper Sentinel Butte Formation, and outcrops over a distance of at least several miles in sections 15-22 of T.144 N, R.100 W. In section 16, the light-colored interval reaches thicknesses of 22 feet (6.7 m), approaching that of the Bear Den Member and Rhame bed (Fig. 27), so it was investigated as a possible third (localized) weathering profile. A lignite at the base of the light-colored sediment provided the opportunity to determine if REE had been mobilized, but no samples from this lignite exceeded 300 ppm. Two samples of the light-colored mudstone submitted for ICP analysis showed significantly higher concentrations of alkali metals (K, Na) and Mg compared to samples of white claystone from the Bear Den, and one XRD analysis showed just 2% kaolinite within the clay fraction. Other claystones from reference sections of the Bear Den and Rhame bed were submitted for XRD analysis to provide context on the typical clay species present above, within, and below the two weathering profiles. Kaolinites, along with gray clays above and below, were

submitted from section 311 (measured section 284 of Moxness et al., 2023) and section 312 (measured section 267 of Murphy et al., 2023). These two sections contain highly enriched lignites, and the XRD analyses are, as expected, characterized by high relative abundances of kaolinite in the overlying white claystone, and low levels of feldspar and smectite relative to the overlying and underlying mudstones. See the end of Appendix A for the stratigraphic context of samples submitted for XRD analysis and Appendix E for complete XRD analytical results.

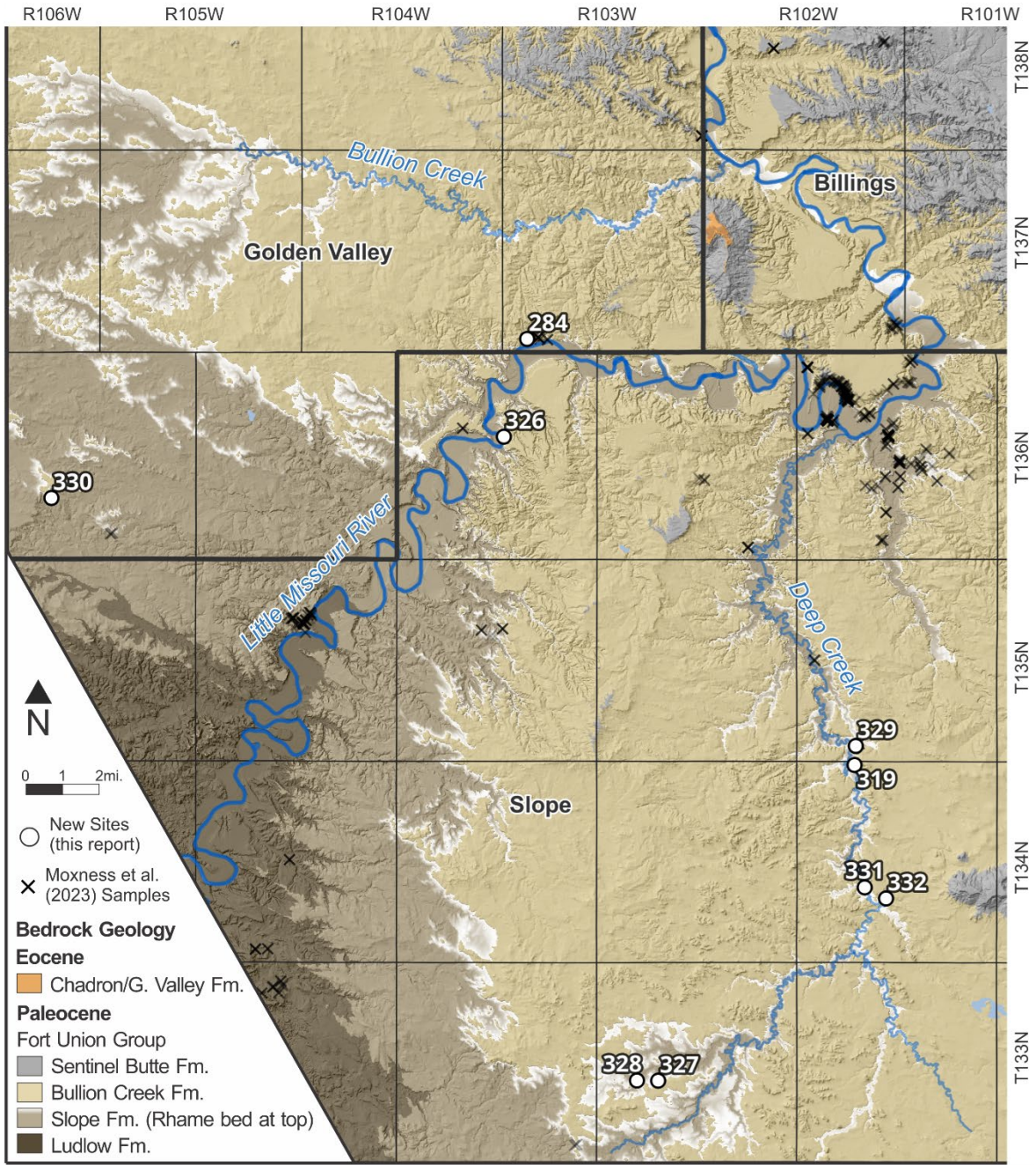


Figure 26. Bedrock geologic map of western Slope, southern Golden Valley, and southwestern Billings counties. The Rhame bed is shown in white at the top of the Slope Fm. based on its position triangulated from dozens of outcrop elevations across this area. It is well exposed across Slope and southernmost Golden Valley counties, but outcrops in only a few locations along Bullion Creek to the north.



Figure 27. State Geologist Ed Murphy (left) measures section 309 through a conspicuously light-colored interval of mudstone in the Sentinel Butte Formation in northern Billings County. Geologist Ned Kruger (right) samples an underlying lignite for its REE concentrations, which ranged from 120 to 228 ppm.

Other Critical Mineral Concentrations

Samples from this report contain the project's highest dry coal basis concentrations for every rare earth element, as well as indium (0.20 ppm), niobium (63.1 ppm), tantalum (5.49 ppm), thorium (66.9 ppm), titanium (15,500 ppm), and vanadium (635 ppm). Nickel (650 ppm) and zinc (2,510 ppm) were not previously reported, as were several other elements (Al, Ca, Fe, K, Na, P, S, Si) investigated in select samples to inform bulk chemistry. Table 5 contains a summary of all new sample analyses reported in Appendix B.

The 186 new samples in this report that exceeded 300 ppm REE (inc. Y and Sc) averaged 951 ppm REE. This subset of samples is likely to largely reflect the elemental compositions of a generic economic feedstock from the Bear Den Member or Rhame bed. The average dry coal concentrations of relevant elements in these samples are 26.4 ppm Co, 26.7 ppm Dy, 21.2 ppm Ga, 14 ppm Ge, 32.7 ppm Gd, 155 ppm Nd, 38.0 ppm Pr, 26.8 ppm Sc, and 4.74 ppm Tb, with 11.3 ppm of Th and 14.3 ppm of U. The average ash yield across these samples was 57.65%.

Table 5. Summary of all new ICP-MS and ICP-AES analyses in this report. A is atomic number.

Chemical Group	Element	Symbol	A	n	Dry Coal/Rock Basis			Dry Ash Basis		
					MAX	MIN	MEAN	MAX	MIN	MEAN
Alkali Metals	Lithium	Li	3	352	144	0.6	26.4	217	4.8	46.8
	Sodium	Na	11	118	11600	175	2850	34300	187	6120
	Potassium	K	19	118	31500	153	15900	33200	449	19100
	Rubidium	Rb	37	319	157	<1	54	250	n/a	81
	Cesium	Cs	55	319	14.7	0.02	4.14	18.6	0.14	6.47
Alkaline Earth Metals	Beryllium	Be	4	352	21.7	0.2	4.7	132	0.2	15.2
	Magnesium	Mg	12	352	17000	525	5400	50200	560	11700
	Calcium	Ca	20	118	22600	392	8400	237000	415	33000
	Strontium	Sr	38	319	1460	27	280	9930	28	956
	Barium	Ba	56	319	9350	10	640	13500	49	1250
Rare Earth Elements Lanthanides	Lanthanum	La	57	398	629	1.7	76	2370	7.7	190
	Cerium	Ce	58	398	1260	3.0	165	5360	13.6	420
	Praseodymium	Pr	59	352	167	0.3	19	579	1.4	56
	Neodymium	Nd	60	398	695	1.3	83	2350	5.9	210
	Samarium	Sm	62	352	179	0.3	20	500	1.2	50
	Europium	Eu	63	352	38.9	0.08	4.5	104	0.28	12.0
	Gadolinium	Gd	64	398	166	0.30	18	492	1.34	46
	Terbium	Tb	65	352	24.1	0.04	2.8	71.4	0.19	7.3
	Dysprosium	Dy	66	352	150	0.20	16	444	1.33	42
	Holmium	Ho	67	352	29.5	0.05	3.1	87.4	0.30	8.2
	Erbium	Er	68	398	85.7	0.15	8.4	254	0.97	22
	Thulium	Tm	69	352	11.3	0.02	1.2	33.5	0.13	3.2
	Ytterbium	Yb	70	352	70.2	0.13	7.6	208	0.87	20
	Lutetium	Lu	71	352	11.1	0.02	1.2	32.9	0.13	3.1
Transition Metals	Scandium	Sc	21	398	109	0.8	17.5	246	2.8	44
	Yttrium	Y	39	398	946	1.9	73	2800	7.6	223
	Titanium	Ti	22	352	15500	44	2690	20000	221	4400
	Vanadium	V	23	352	635	3	129	2610	15	270
	Chromium	Cr	24	352	353	2	68	2250	13	140
	Manganese	Mn	25	319	3470	11	130	4440	20	330
	Iron	Fe	26	118	281000	895	29000	379000	1800	50000
	Cobalt	Co	27	352	201	0.5	20	399	0.5	44
	Nickel	Ni	28	373	650	2	65	2680	6	150
	Zinc	Zn	30	373	2510	2	100	10600	5	200
	Zirconium	Zr	40	357	969	2.7	132	3100	13.6	290
	Niobium	Nb	41	352	63.1	0.3	10.2	111	1.5	19
	Molybdenum	Mo	42	352	211	0.4	16	999	0.4	50
	Hafnium	Hf	72	319	10	<0.2	3	25	n/a	6
	Tantalum	Ta	73	319	5.49	<0.02	0.71	7.10	n/a	1.21
	Tungsten	W	74	338	33.0	0.4	3.1	83.1	1.2	8.6
Post-Transition Metals	Aluminum	Al	13	118	121000	3310	67000	141000	5330	89000
	Gallium	Ga	31	398	48.7	1.2	18.1	202	4.9	37
	Indium	In	49	338	0.20	<0.02	n/a	0.40	<0.02	n/a
Metalloids	Silicon	Si	14	118	399000	3460	199000	408000	37200	247000
	Germanium	Ge	32	398	102	<1	11	406	n/a	32
	Arsenic	As	33	352	615	1.5	41	1230	1.5	110
	Antimony	Sb	51	352	24.6	0.11	3.7	57.3	0.62	9.1
Reactive Nonmetals	Phosphorus	P	15	118	3640	<10	325	3890	n/a	530
	Sulphur	S	16	118	132000	35	6000	860000	36	29000
Actinides	Thorium	Th	90	338	66.9	0.3	9.6	178	1.5	19
	Uranium	U	92	398	273	0.4	12	580	1.6	29

Conclusions

Exploratory drilling utilizing the exploration model proposed by Murphy et al. (2023) and Moxness et al. (2023) illustrates that the geologic framework now exists to predict and intercept critical mineral enrichment at a high success rate in the Williston Basin of North Dakota. Lignites which occur within narrow stratigraphic windows at the base of the Bear Den and Rhame bed kaolinites are shown to be enriched in REE and other critical minerals across west-central North Dakota, an area which was previously very poorly characterized. Cores from Mercer, Morton, Hettinger, and Adams counties roughly double the maximum overall grade and thickness of REE enrichment previously reported from the state. Maximum concentrations of 4,443 ppm REE in dry coal and 1.57% REO in dry ash further expand our understanding of the upper limits of rare earth element enrichment in North Dakota lignite.

Cores from this study show that when lignites are not present below the Bear Den Member, claystone can incorporate as much as 1,245 ppm REE and enrich up to 60 continuous vertical inches (1.5 m) above 300 ppm. The economics of REE extraction from these claystones are not as well understood as lignite, but these findings significantly expand the area over which REE enrichment is known to occur, as oftentimes a lignite is not present within the stratigraphic enrichment window, but claystones are. Mineralogical results from this study tie the enrichment to the kaolinite-smectite transition at the base of the weathering zone. Detailed geochemical profiles from closely spaced cores suggest that lignites occurring closest to this position receive the most leached REE content from the overlying weathering profile. Estimates of the total REE content mobilized from these profiles suggest that 3.3 feet (1 meter) of lignite in this position could accumulate an average of 1,000 ppm REE.

Cores of the Rhame bed suggest this paleosol is less intensely weathered than the Bear Den Member, despite comparable REE enrichment in associated lignites. Disproportionate REE depletion and enrichment documented within Rhame bed profiles may be evidence for lateral REE transport during weathering. This implies that lignites are not always limited to the REE received from the directly overlying profile but also received REE weathered from the surrounding paleolandscape. REE enrichment is relatively consistent laterally where the lignites are present, and individual enriched lignites can be continuous at the scale of a small mine, as evidenced by two cores a half a mile apart in Adams County. The data from these drill sites adds much-needed subsurface control on the Bear Den Member and the Rhame bed in Dunn, Mercer, Morton, Stark, Hettinger, and Adams counties. These newly described intervals of rare earth element and other critical mineral enrichment are potentially economic and warrant further exploration.

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APPENDICES

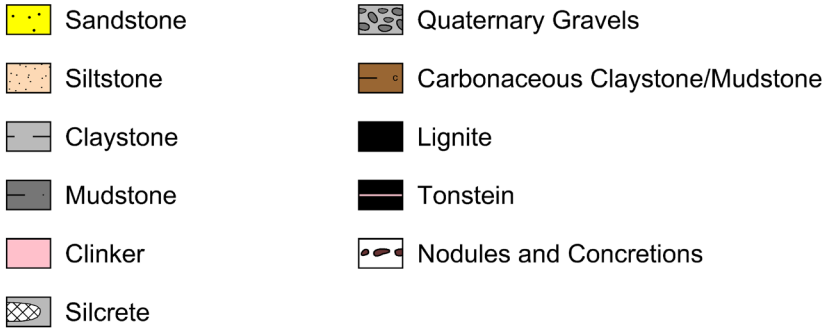
Appendix A

Cores and measured sections with select elemental analyses

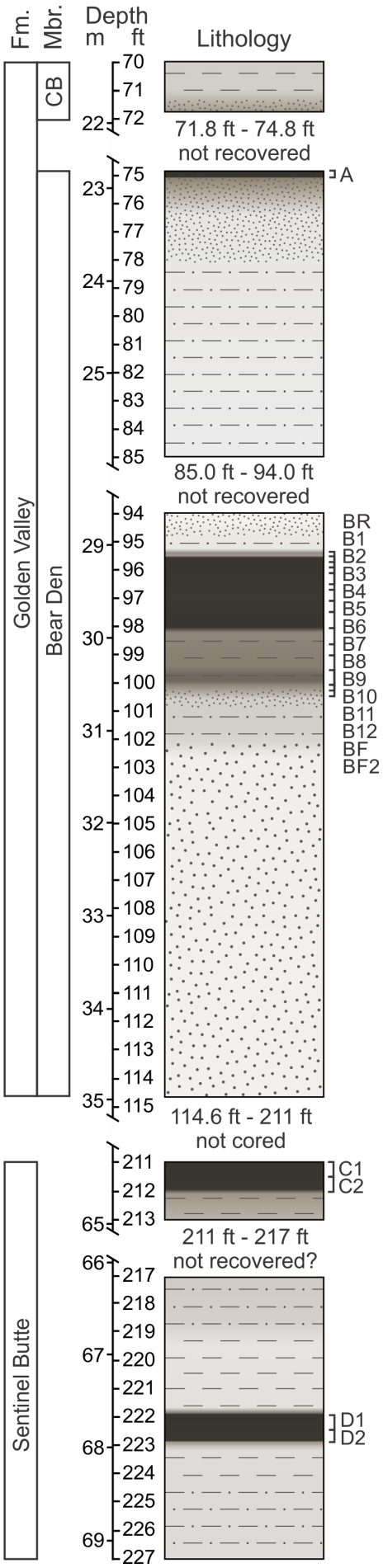
Lithology key (cores 2-43)



Lithology key (measured sections 266-333)



Colors vary according to those observed in the field (outcrops) or in the lab after drying (cores).



Core NDGS24-2

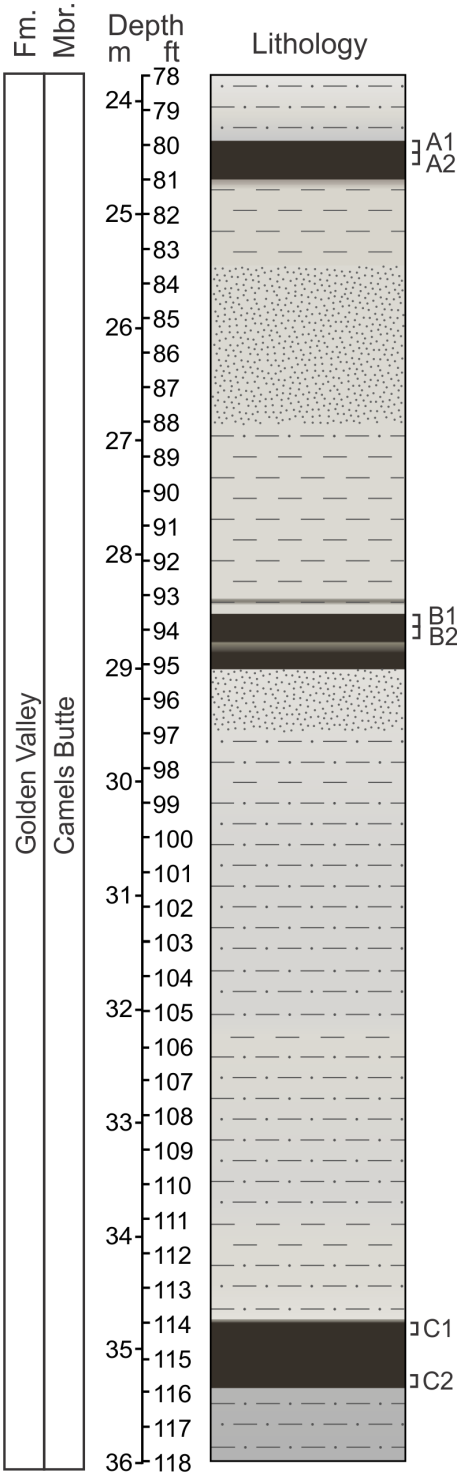
T.146N., R.89W., Sec.36, SE1/4

Surface Elevation 2,232 ft.

				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	3	8	68.84%	169	116	2.1	3.0	18.3	4.9	0.41	5.6	4.7	16.5	43
BR	2.0	5.1	90.19%	514	464	7.7	10.4	72.6	20.3	1.45	10.9	14.5	19.6	3
B1	2.2	5.7	30.30%	5965	1807	34.9	55.1	352	85.9	7.48	54.3	3.3	21.6	36
B2	2.2	5.7	33.74%	3109	1049	22.5	33.4	200	47.9	4.66	41.0	6.6	17.7	24
B3	2.2	5.7	15.55%	12194	1896	36.1	58.1	366	90.0	7.78	38.2	3.1	16.2	24
B4	4.5	11.4	14.10%	11212	1581	24.2	39.3	253	68.2	5.13	26.4	3.7	10.6	11
B5	2.2	5.7	15.03%	5912	889	14.4	22.6	143	38.5	2.97	11.6	3.5	7.4	6
B6	4.5	11.4	14.71%	8565	1260	12.2	18.5	115	39.4	2.3	7.9	4.9	6.5	4
B7	4.5	11.4	26.40%	2808	741	10.4	13.9	69.7	21.7	1.88	10.6	22.7	12.1	5
B8	6.7	17.1	65.53%	511	335	5.4	7.2	36.6	10.2	1.01	15.4	21.8	19.9	3
B9	6.7	17.1	77.87%	275	214	3.7	5.0	27.4	7.4	0.69	14.7	54.5	20.9	2
B10	4.5	11.4	71.76%	405	291	5.3	7.1	37.3	10.1	0.98	15.4	34.2	20.0	3
B11	6.0	15.2	71.18%	642	457	8.5	12.0	62.2	17.1	1.62	16.6	24.4	21.1	6
B12	6.0	15.2	59.61%	766	457	11.0	13.9	67.2	17.6	2.04	15.6	16.4	26.1	50
BF	2.0	5.1	85.66%	596	511	11.4	15.4	79.9	21.2	2.18	15.9	24.8	24.7	8
BF2	2.0	5.1	94.08%	343	323	4.8	6.9	53.0	13.6	0.92	14.3	3.5	18.9	3
C1	6	15	19.76%	638	126	4.9	4.0	13.0	3.3	0.71	8.3	5.1	8.6	5
C2	6	15	68.28%	232	158	3.6	4.6	24.1	6.3	0.65	11.2	13.4	17.2	7
D1	4	10	72.15%	207	150	3.7	4.1	20.4	5.4	0.63	15.1	15.3	19.3	3
D2	4	10	35.48%	307	109	4.2	3.2	11.4	2.8	0.59	13.5	48.4	14.5	12

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-3

T.146N., R.90W., Sec.36, NE1/4
Surface Elevation 2,290 ft.

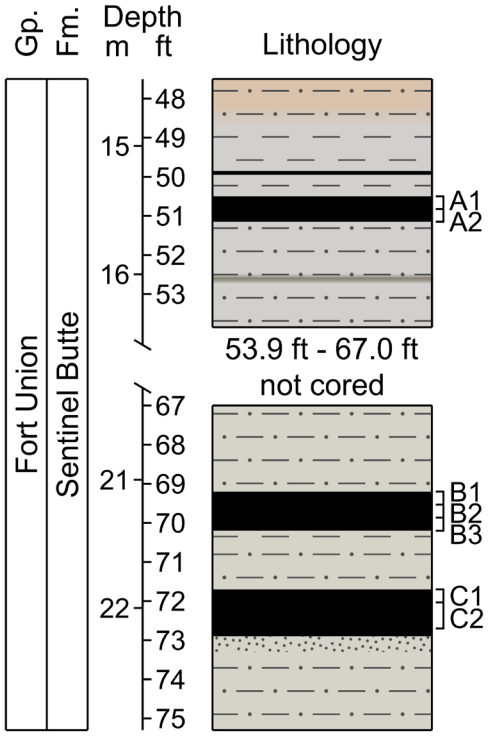
				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	4	10	25.63%	262	67	3.2	2.3	5.5	1.3	0.46	6.6	2.3	7.2	9
A2	4	10	12.53%	557	70	3.9	2.7	5.2	1.1	0.55	6.3	4.6	8.3	5
B1	4	10	18.42%	402	74	2.7	2.6	8.8	2.1	0.44	4.7	3.2	7.0	10
B2	4	10	19.91%	106	21	0.8	0.7	2.0	0.5	0.12	1.1	1.2	2.4	1
C1	4	10	30.70%	364	112	3.4	3.4	11.5	2.6	0.49	7.6	6.4	9.1	41
C2	4	10	28.33%	274	78	2.9	2.5	8.0	1.9	0.41	10.3	10.8	7.4	4

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-10B

T.143N., R.90W., Sec.30, NE1/4
Surface Elevation 2,177 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	4	10	41.91%	182	76	2.1	2.0	9.2	2.4	0.34	8.7	4.7	11.3	30
A2	4	10	10.78%	484	52	2.6	1.7	3.9	0.9	0.35	8.5	5.0	8.5	16
B1	4	10	51.09%	191	98	2.5	2.6	12.7	3.3	0.41	10.5	10.9	16.5	17
B2	4	10	19.17%	479	92	3.6	3.1	9.4	2.3	0.55	7.1	2.0	6.4	5
B3	4	10	68.37%	189	129	2.7	3.1	17.2	4.7	0.46	10.8	0.9	22.8	2
C1	4	10	39.60%	255	101	2.7	2.8	12.7	3.4	0.45	11.2	9.4	14.6	5
C2	4	10	18.19%	284	52	2.4	1.8	4.5	1.0	0.35	5.4	6.5	6.4	5

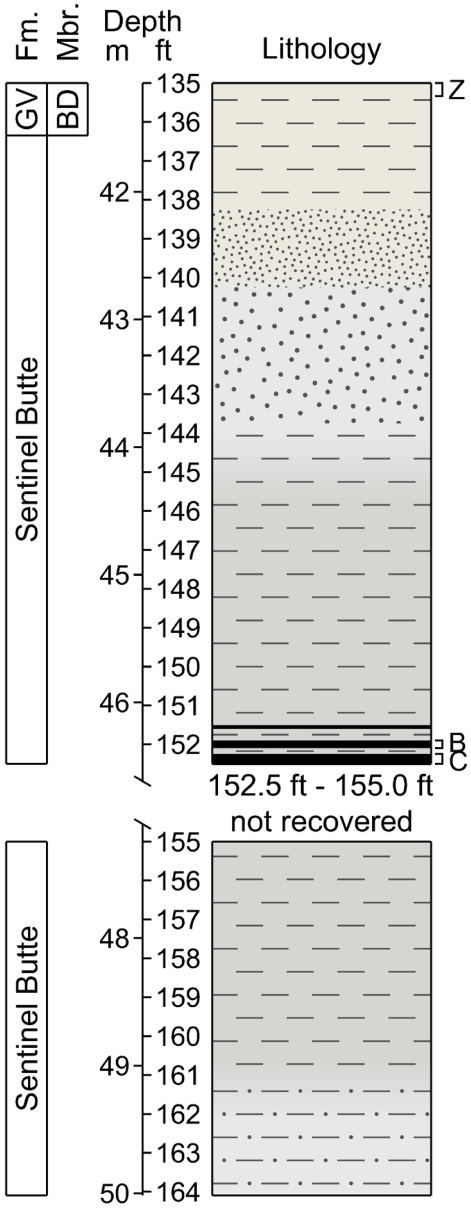
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-12

T.143N., R.91W., Sec.16, SW1/4

Surface Elevation 2,216 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
Z	4	10	91.86%	437	402	10.7	12.4	54.9	12.7	1.70	19.9	24.4	27.4	4
B	2	5	39.12%	267	105	3.3	3.0	12.6	3.2	0.51	11.6	15.3	12.3	25
C	3	8	27.92%	272	76	2.8	2.0	7.2	1.8	0.40	12.1	11.4	10.3	16

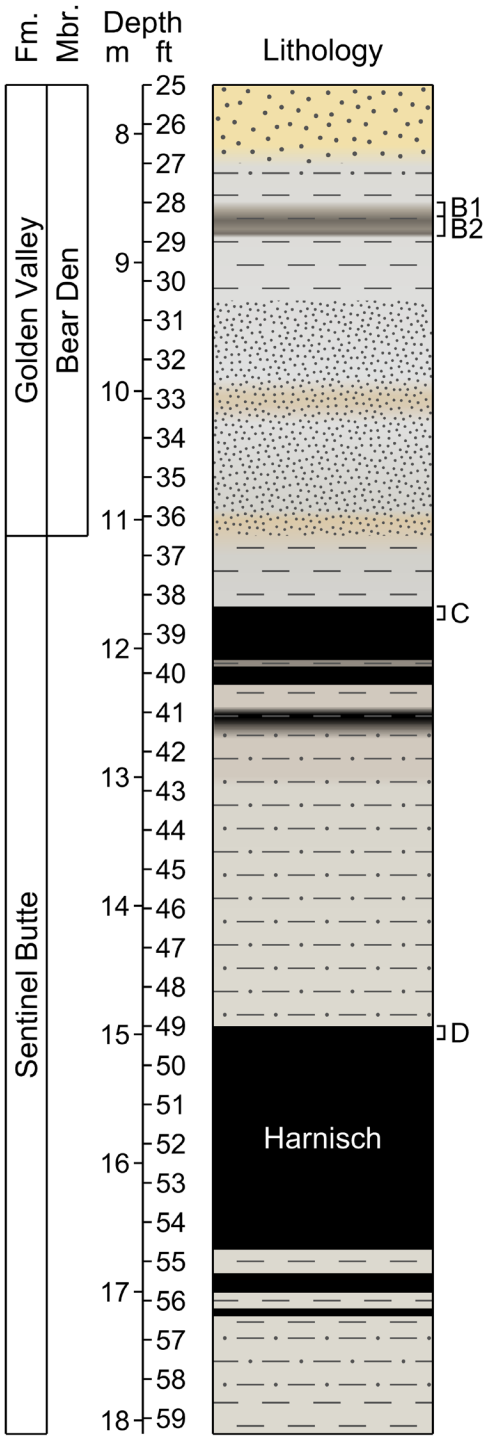
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-16

T.140N., R.90W., Sec.1, NE1/4

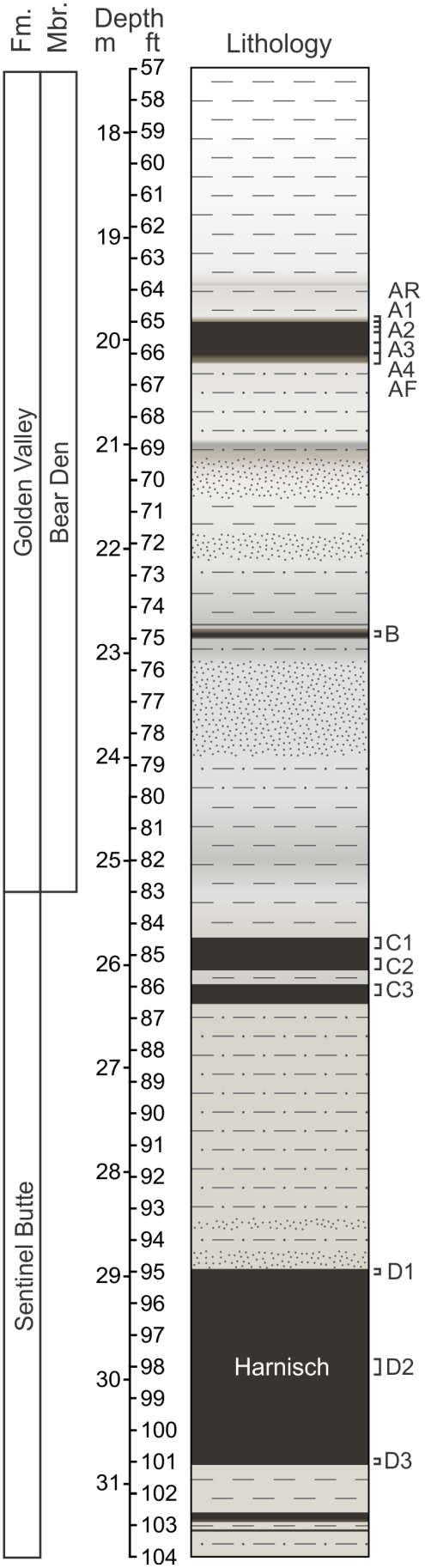
Surface Elevation 2,403 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
B1	4	10	93.54%	428	400	11.7	11.9	50.8	12.6	1.83	18.9	13.8	26.2	7
B2	6	15	81.85%	694	568	20	21.8	80.6	19.2	3.37	24.8	42.5	27.1	19
C	3.5	9	72.85%	252	183	5.1	5.1	24.0	6.3	0.81	16.5	37.6	22.6	22
D	3.5	9	38.39%	298	114	3.4	3.0	13.4	3.6	0.53	11.0	10.2	11.5	15

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-16B

T.140N., R.90W., Sec.1, NE1/4

Surface Elevation 2,419 ft.

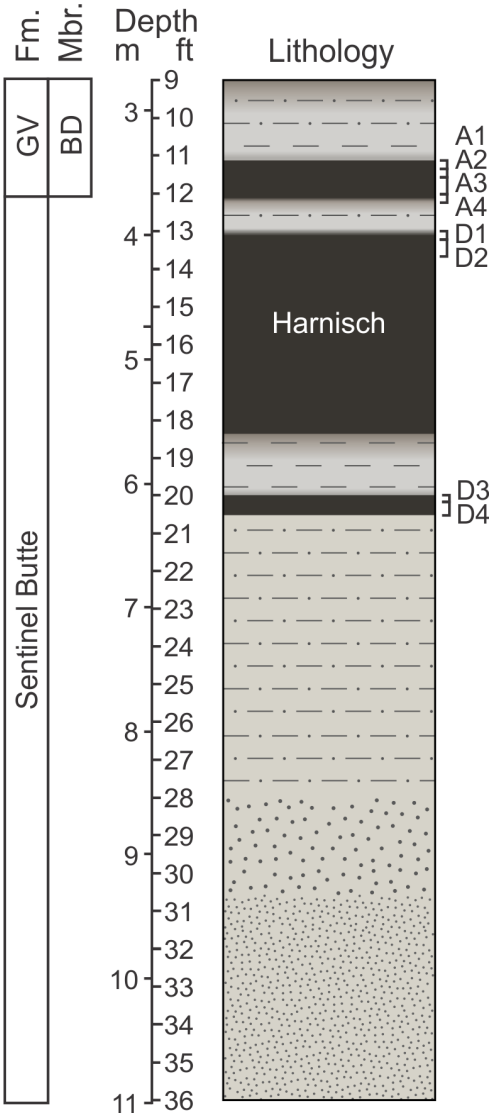
					Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
AR	2	5	87.29%	432	377	11.6	12.5	50.6	12.4	1.93	15.4	28.2	26.7	4
A1	2	5	69.71%	1066	743	25.8	25.5	83.4	19.9	4.09	17.7	20.3	35.5	7
A2	2	5	54.56%	1053	574	17.5	19.0	65.6	16.1	2.90	17.2	14.6	36.4	8
A3	4	10	75.18%	293	221	5.5	6.2	25.5	6.7	0.90	12.5	5.2	45.9	5
A4	4	10	41.23%	284	117	3.2	3.2	12.2	3.2	0.49	9.6	9.2	32.7	21
AF	4	10	84.96%	117	100	1.8	2.3	13.3	3.7	0.32	7.0	4.9	21.1	5
B	2	5	59.05%	350	207	5.8	6.3	25.6	6.4	0.96	14.6	40.0	16.4	7
C1	4	10	33.07%	257	85	2.6	2.4	9.5	2.4	0.40	12.1	11.4	10.9	10
C2	8	20	20.90%	291	61	2.2	1.8	6.8	1.7	0.33	7.3	7.2	6.8	2
C3	6.5	17	45.21%	215	97	2.8	2.6	11.6	3.1	0.44	11.6	20.5	13.5	5
D1	2	5	28.32%	256	73	2.6	1.8	6.7	1.7	0.36	11.4	5.9	13.9	32
D2	6	15	14.99%	69	10	0.2	0.3	1.3	0.3	0.04	0.8	0.9	1.4	1
D3	2	5	52.22%	231	121	2.8	3.0	16.7	4.5	0.47	11.8	14.3	14.6	3

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-19

T.140N., R.90W., Sec.4, SW1/4
Surface Elevation 2,307 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	2.4	6	34.29%	2039	699	24.4	28.7	102	23.9	4.28	30.4	64.4	13.6	6
A2	2.4	6	44.96%	669	301	9.7	11.1	40.6	10.1	1.67	12.4	29.3	9.2	3
A3	4.8	12	43.02%	272	117	2.8	3.3	15.8	4.1	0.49	8.0	8.5	11.0	2
A4	2.4	6	60.62%	303	184	4.1	5.0	25.3	6.6	0.72	18.3	13.7	17.3	3
D1	2	5	83.07%	209	173	3.1	4.0	24.4	6.8	0.56	14.3	5.6	21.6	3
D2	4	10	51.17%	247	126	3.0	3.5	17.0	4.6	0.53	9.8	6.8	11.0	2
D3	2	5	16.11%	186	30	1.4	0.9	2.3	0.6	0.18	5.7	7.3	5.1	4
D4	4	10	35.58%	261	93	2.9	2.6	11.0	2.9	0.44	11.6	6.7	9.3	14

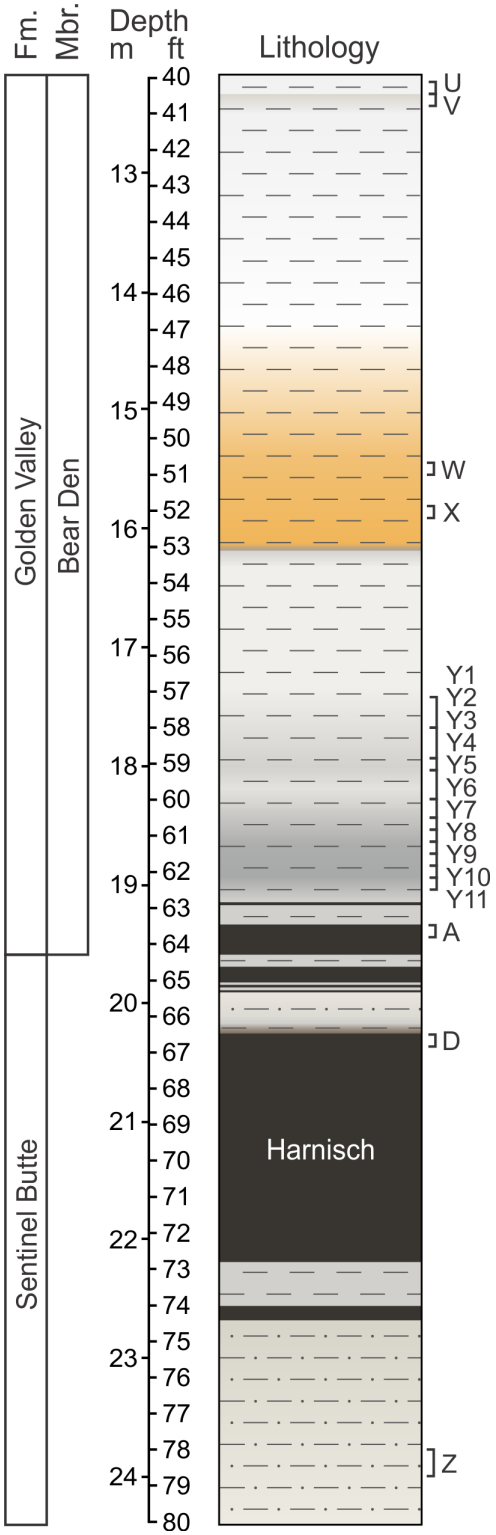
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-19B

T.140N., R.90W., Sec.5, SE1/4

Surface Elevation 2,359 ft.



				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
U	4	10	92.94%	272	252	4.1	5.7	41.1	10.3	0.78	22.0	2.5	38.9	3
V	4	10	97.08%	112	109	2.2	2.4	16.6	4.3	0.35	7.6	0.9	19.9	2
W	4	10	92.51%	100	93	2.2	1.9	9.4	2.5	0.32	19.4	1.1	21.6	2
X	4	10	93.92%	194	182	2.3	2.4	20.3	6.1	0.34	23.0	3.5	28.6	2
Y1	10	25	93.20%	550	513	10.3	14.0	88.8	23.2	1.97	17.1	67.6	24.8	5
Y2	10	25	93.23%	499	465	11.1	13.7	78.0	19.5	1.97	17.8	111	24.4	5
Y3	4	10	90.87%	654	594	13.7	20.2	111	25.6	2.61	16.2	17.3	20.2	3
Y4	10	25	94.05%	539	507	12.7	15.9	80.5	20.2	2.25	18.9	20.4	26.0	5
Y5	6	15	93.36%	378	353	9.6	11.0	49.6	12.3	1.59	20.9	52.0	25.3	3
Y6	4	10	92.87%	482	448	12.7	15.0	65.6	15.9	2.14	19.8	28.3	27.6	4
Y7	4	10	93.91%	628	590	14.5	18.2	99.0	23.3	2.54	18.8	17.2	26.2	4
Y8	4	10	93.17%	559	520	13.8	16.5	75.2	18.3	2.36	21.6	52.7	29.9	4
Y9	4	10	90.99%	476	433	12.0	12.8	54.0	13.1	1.87	22.0	26.7	29.1	4
Y10	4	10	89.21%	507	452	13.1	13.8	55.5	13.5	2.04	20.2	21.1	24.7	4
Y11	4	10	92.26%	281	259	7.1	7.6	30.8	7.5	1.12	17.2	19.2	25.2	3
A	4	10	59.07%	328	193	4.8	5.8	29.0	7.1	0.77	12.2	20.4	18.0	8
D	4	10	21.63%	359	78	3.1	2.5	8.0	1.8	0.42	12.5	8.1	11.9	41
Z	4	10	96.01%	194	186	4.0	5.0	29.3	7.2	0.68	13.2	19.7	18.0	2

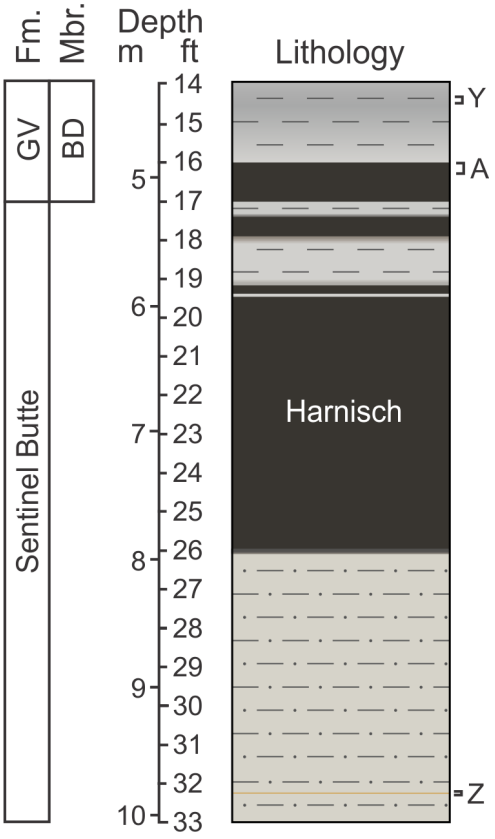
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-19C

T.140N., R.90W., Sec.4, SW1/4

Surface Elevation 2,302 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
Y	2	5	91.45%	523	479	16.3	14.9	50.7	12.1	2.42	21.0	24.4	28.3	3
A	3	8	35.22%	1015	358	12.3	10.8	28.1	6.6	1.81	17.0	27.1	13.2	24
Z	1	3	78.15%	312	244	10.3	7.7	21.6	5.1	1.40	29.4	5.9	9.3	2

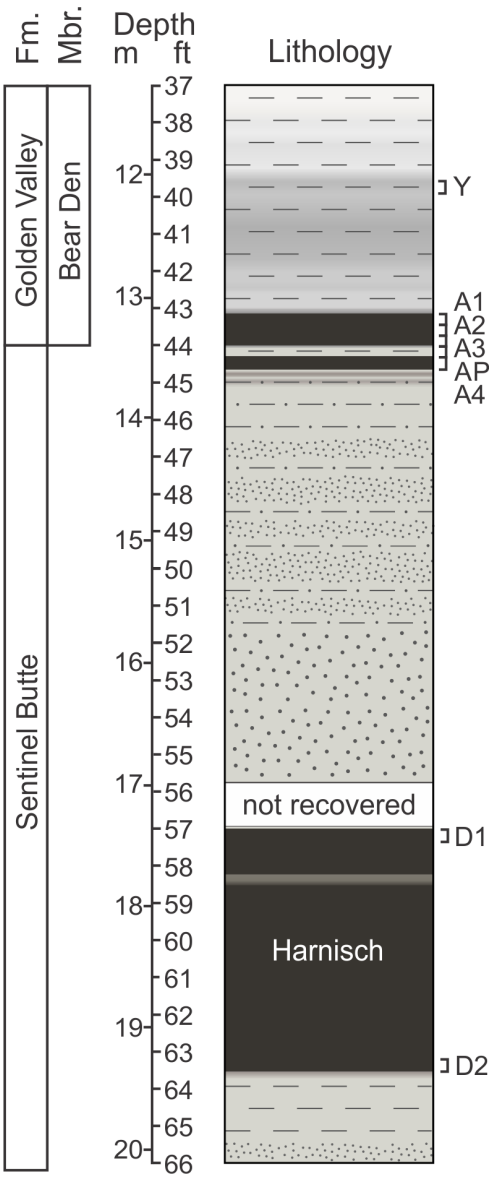
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-20

T.140N., R.90W., Sec.6, NE1/4

Surface Elevation 2,386 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
Y	4	10	93.53%	699	654	16.5	19.6	101	24.5	2.99	30.7	2.7	33.7	6
A1	3	8	66.89%	3265	2184	80.3	94.7	397	89.7	14.3	18.4	201	14.6	30
A2	3	8	25.53%	3782	966	33.0	37.8	151	35.3	5.65	10.2	31.9	8.7	9
A3	3	8	15.06%	3736	563	20.4	24.0	99.8	22.6	3.67	13.9	29.4	11.2	28
AP	3.5	9	87.91%	262	231	4.2	5.0	29.7	8.0	0.73	14.9	45.5	23.4	3
A4	4	10	66.94%	640	429	9.7	11.1	49.9	13.3	1.63	15.0	16.5	17.6	4
D1	4	10	23.43%	292	68	2.9	1.9	5.1	1.3	0.37	11.5	2.2	7.8	8
D2	4	10	17.96%	422	76	3.5	2.5	7.4	1.8	0.49	11.5	13.0	6.8	21

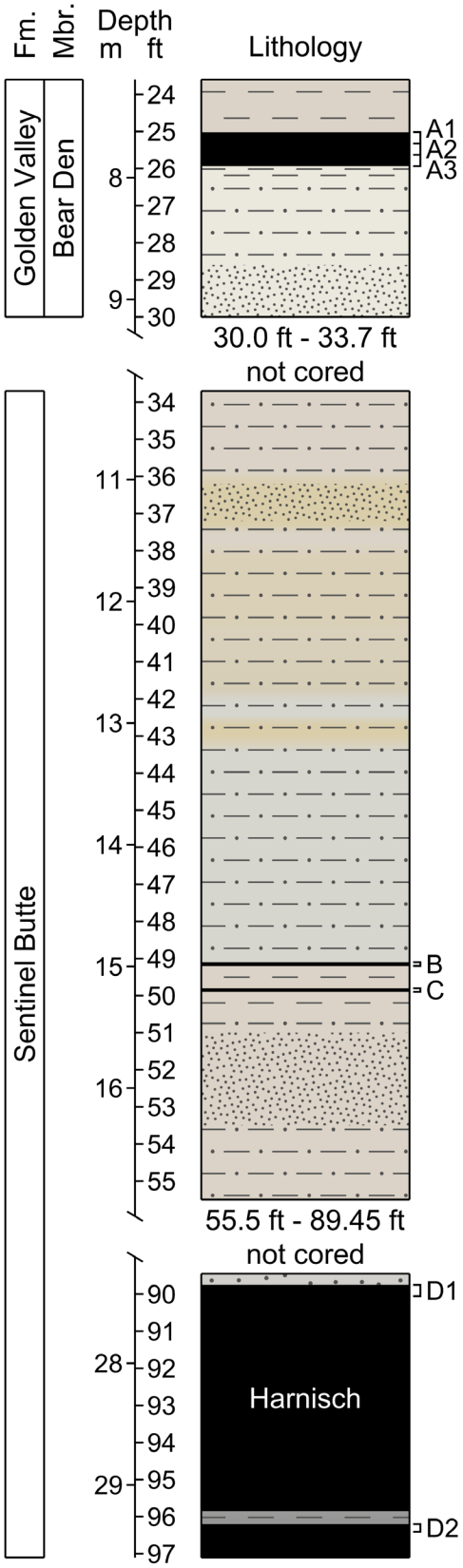
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-20B

T.140N., R.90W., Sec.6, NE1/4

Surface Elevation 2,411 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	3	8	25.62%	609	156	3.7	4.5	23.7	6.2	0.65	8.9	10.4	13.6	5
A2	5	13	12.65%	1313	166	7.2	7.4	25.9	5.9	1.23	5.6	20.4	6.2	8
A3	4	10	39.94%	1114	445	12.5	14.0	55.8	14.3	2.07	9.0	5.4	8.8	11
B	1.5	4	90.82%	111	101	2.6	2.8	13.6	3.7	0.44	7.9	8.5	16.9	14
C	1.5	4	90.45%	114	103	2.9	3.1	14.3	3.8	0.51	6.2	12.0	14.2	7
D1	4	10	26.54%	299	79	3.3	2.4	7.3	1.8	0.46	8.8	4.8	9.3	10
D2	2.5	6	35.89%	194	70	2.6	2.3	8.2	2.1	0.41	7.4	30.2	6.3	3

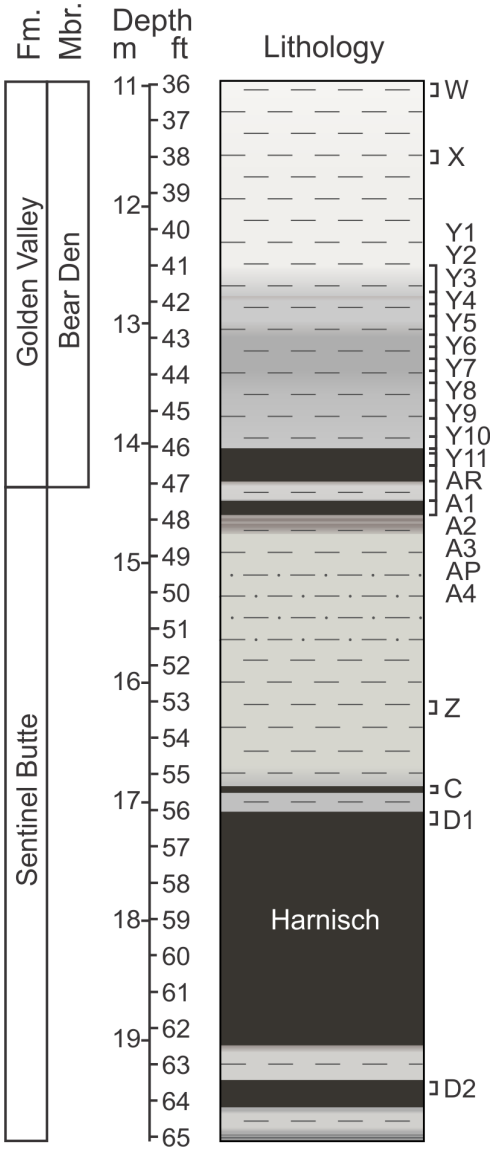
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-21

T.140N., R.90W., Sec.6, SE1/4

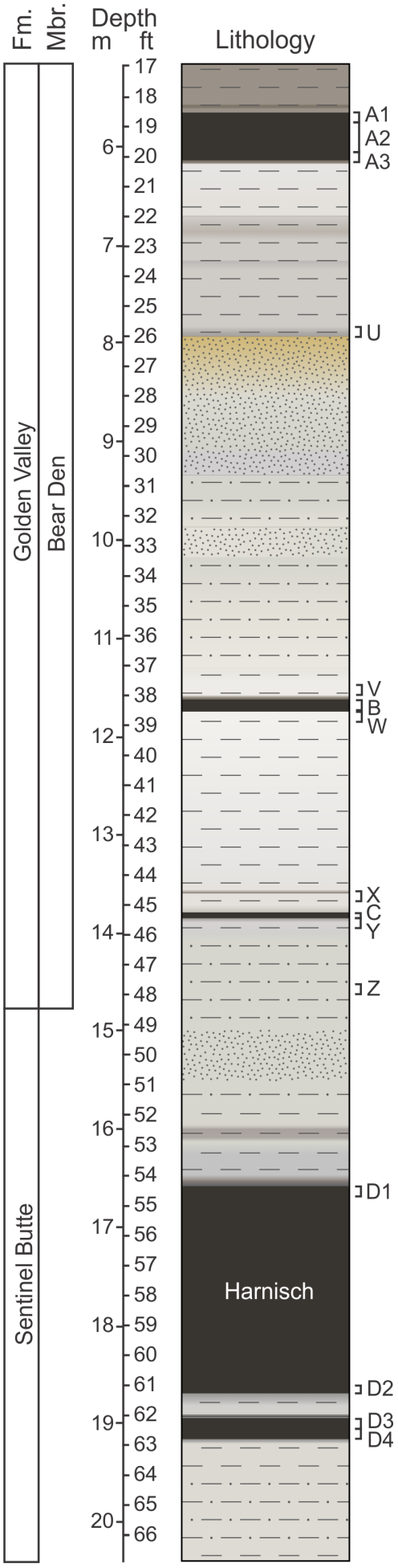
Surface Elevation 2,405 ft.



				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
W	4	10	90.93%	121	110	1.4	1.7	14.2	3.9	0.20	15.7	2.0	25.4	2
X	4	10	88.76%	96	85	1.4	1.3	9.6	2.5	0.17	17.9	3.9	24.0	2
Y1	8	20	94.21%	451	425	9.0	12.2	76.1	19.7	1.72	17.3	1.8	24.5	4
Y2	4	10	93.28%	915	853	19.0	25.7	156	37.5	3.47	20.3	4.1	29.5	4
Y3	4	10	93.70%	913	855	18.9	25.9	155	39.8	3.58	18.6	2.6	29.1	7
Y4	6	15	94.19%	1086	1023	23.3	31.0	183	46.4	4.40	19.6	2.8	28.7	7
Y5	4	10	91.14%	1367	1245	30.1	38.7	222	55.8	5.53	20.7	29.5	27.3	8
Y6	4	10	90.95%	888	807	21.4	26.5	137	33.7	3.82	22.6	87.0	30.0	6
Y7	4	10	91.43%	1070	999	26.7	33.0	163	40.8	4.69	20.1	175	25.4	7
Y8	4	10	91.87%	827	760	19.7	24.3	120	29.9	3.45	20.6	151	28.8	5
Y9	6	15	93.30%	607	566	15.7	18.2	82.9	20.3	2.63	19.0	40.4	26.7	4
Y10	6	15	92.64%	398	369	10.5	11.9	48.3	11.9	1.69	18.8	49.5	25.3	3
Y11	6	15	93.53%	295	276	6.8	7.8	34.2	8.5	1.08	17.5	40.4	25.0	3
AR	4	10	92.69%	327	303	6.2	7.7	38.9	9.5	1.05	16.4	113	24.0	2
A1	2	5	57.41%	948	544	13.6	13.4	42.7	10.4	2.06	15.7	45.7	15.7	9
A2	4	10	18.53%	1068	198	5.0	4.7	14.5	3.5	0.74	9.1	16.3	6.9	10
A3	5	13	15.72%	385	61	2.2	1.7	4.3	1.0	0.31	7.7	5.3	4.5	5
AP	5.5	14	91.61%	178	163	3.1	4.0	24.4	6.4	0.55	14.7	21.8	22.9	2
A4	3.5	9	54.43%	266	145	3.7	3.9	18.2	4.8	0.61	15.9	19.2	15.7	3
Z	4	10	94.04%	212	199	4.1	5.2	30.4	7.4	0.70	15.4	18.9	20.1	2
C	1.5	4	78.70%	246	194	4.2	5.2	28.2	7.5	0.76	15.7	16.7	21.8	3
D1	4	10	43.51%	157	68	2.2	1.9	7.8	2.0	0.33	8.3	4.0	6.1	3
D2	4	10	31.04%	279	87	2.9	2.8	11.0	2.8	0.48	9.3	15.4	7.6	2

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-21B

T.140N., R.90W., Sec.6, SE1/4

Surface Elevation 2,388 ft.

				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A1	4	10	27.67%	219	61	1.8	1.9	7.8	2.0	0.30	1.5	5.1	2.0	3
A2	12	30	22.72%	360	82	3.3	3.2	11.2	2.6	0.53	4.0	11.2	4.6	2
A3	4	10	32.04%	770	247	10.4	10.7	42.2	9.5	1.75	18.8	14.2	13.0	13
U	4	10	85.31%	216	184	4.2	4.9	26.9	6.6	0.69	15.7	16.3	21.9	9
V	4	10	92.79%	197	183	4.0	4.8	26.6	6.5	0.66	17.3	15.2	22.5	2
B	4	10	90.37%	142	128	3.3	3.6	17.3	4.7	0.55	9.6	6.7	25.9	6
W	4	10	97.22%	52	51	1.6	1.3	5.7	1.4	0.21	6.3	1.7	13.2	2
X	4	10	96.36%	289	279	4.3	5.9	41.1	11.1	0.77	5.7	3.5	10.7	2
C	2	5	54.24%	4438	2407	55.8	80.2	432	113	11.3	33.8	2.1	22.3	13
Y	4	10	93.27%	327	305	6.1	7.0	43.8	11.2	0.97	17.6	2.1	25.7	4
Z	4	10	96.18%	212	204	4.1	5.3	32.4	7.9	0.68	12.6	7.8	17.7	2
D1	4	10	16.69%	261	44	1.8	1.3	4.0	1.0	0.26	6.6	2.7	5.6	19
D2	3	8	22.62%	173	39	1.9	1.5	3.9	0.9	0.29	5.9	2.5	3.5	2
D3	4	10	19.96%	246	49	2.8	2.1	4.2	0.9	0.41	6.3	9.7	3.5	2
D4	4	10	20.07%	199	40	2.5	1.6	2.9	0.6	0.34	5.6	7.3	2.9	6

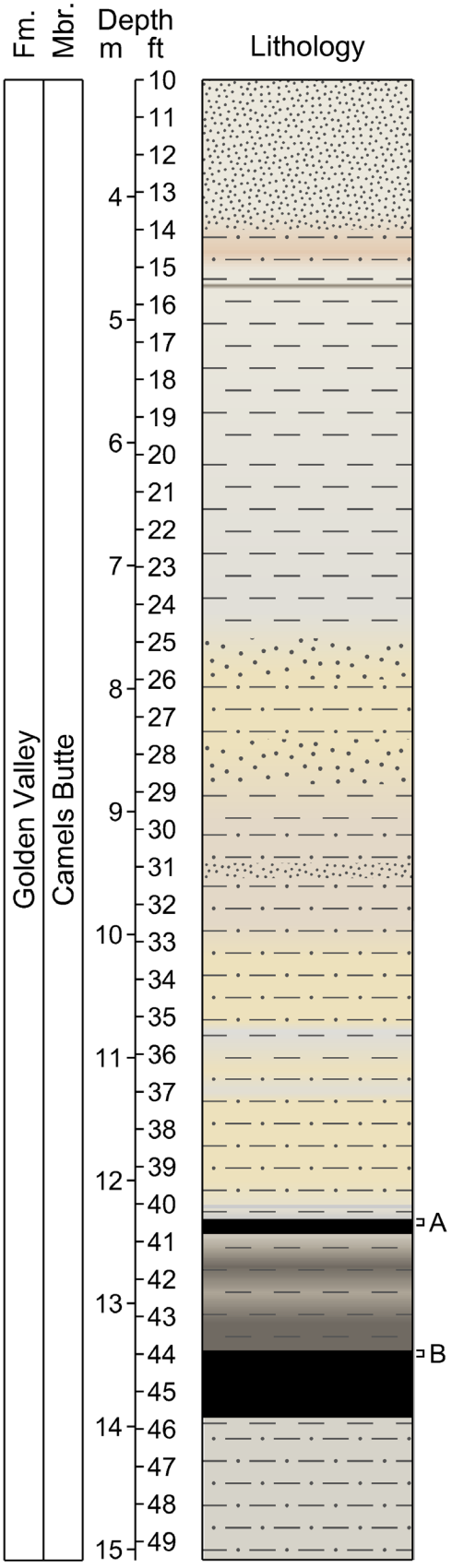
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-23

T.137N., R.98W., Sec.8, SW1/4

Surface Elevation 2,842 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	2	5	31.19%	334	104	3.9	3.2	10.9	2.7	0.59	13.5	13.5	19.9	29
B	2	5	55.22%	254	140	3.3	3.8	19.6	5.2	0.57	11.6	11.6	18.4	7

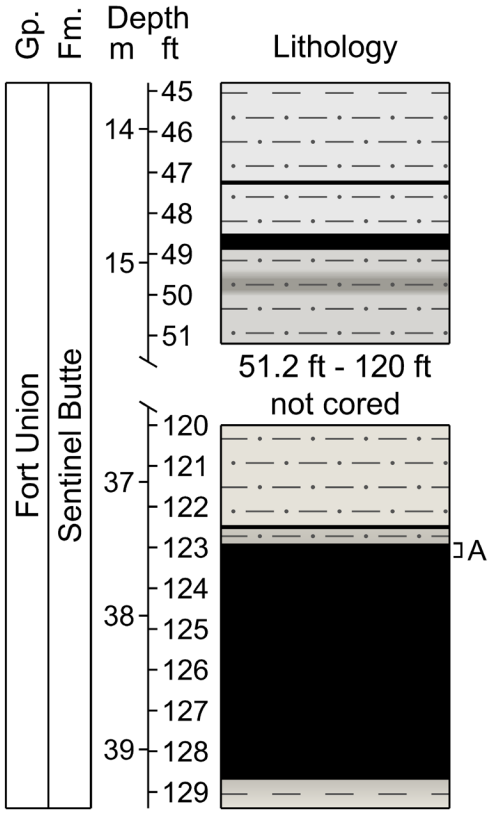
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-24

T.137N., R.98W., Sec.16, NW1/4

Surface Elevation 2,798 ft.



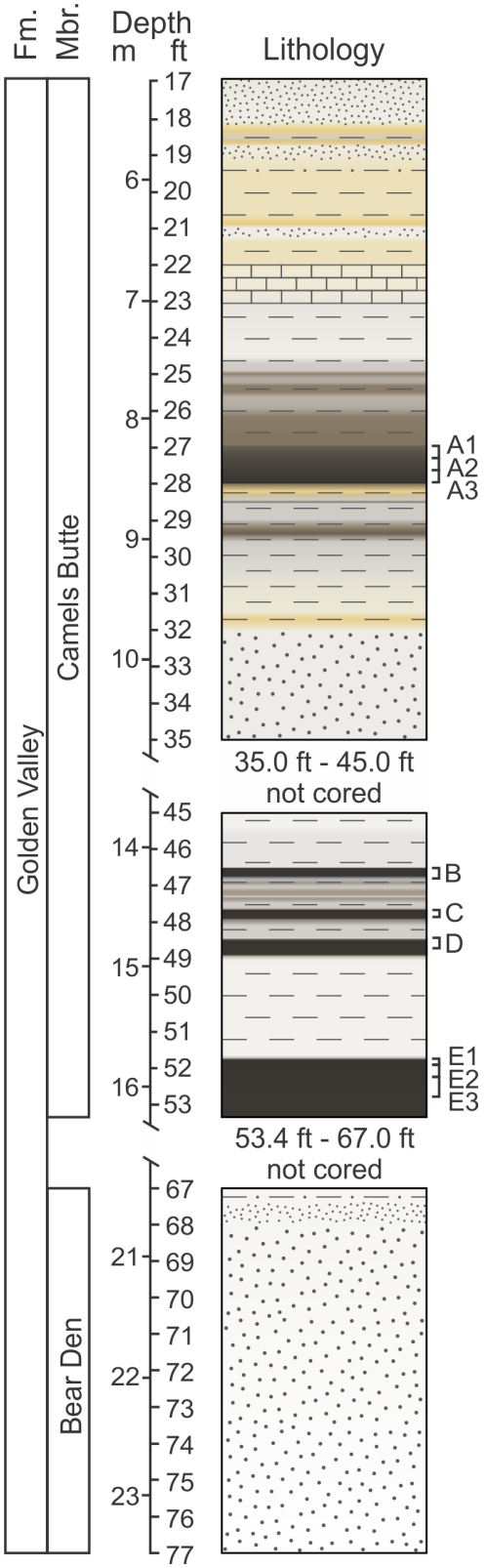
				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	4	10	36.17%	151	55	1.5	1.5	6.6	1.7	0.25	6.6	5.4	8.7	12

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-25

T.138N., R.97W., Sec.36, NE1/4
Surface Elevation 2,644 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A1	4	10	78.38%	223	175	3.7	4.7	26.2	6.9	0.67	12.3	21.3	18.5	7
A2	4	10	60.20%	307	185	4.5	5.5	27.4	7.1	0.81	10.4	52.7	15.8	11
A3	4	10	48.00%	413	198	4.6	5.7	26.7	6.7	0.82	8.9	60.2	13.2	11
B	3	8	34.91%	288	100	3.5	3.0	11.2	2.8	0.54	8.0	24.8	8.6	7
C	2	5	32.36%	554	179	6.2	7.0	29.1	7.1	1.10	11.9	6.8	12.9	6
D	3	8	53.75%	854	459	14.1	15.3	61.2	15.9	2.43	19.8	27.4	24.6	10
E1	2	5	58.35%	563	329	10.1	12.0	57.1	13.8	1.83	16.6	8.9	17.2	6
E2	4	10	37.21%	142	53	2.1	1.7	5.7	1.3	0.31	5.2	10.4	5.5	2
E3	6	15	12.21%	389	48	2.6	1.9	3.7	0.8	0.36	3.6	1.7	3.4	<1

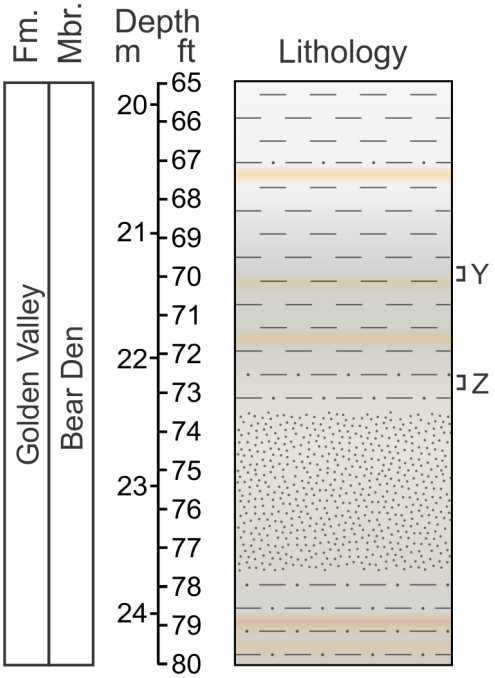
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-26

T.137N., R.97W., Sec.36, SW1/4

Surface Elevation 2,879 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
Y	2	5	93.76%	599	562	14.3	17.1	85.3	21.4	2.45	20.1	13.7	23.0	4
Z	4	10	93.77%	245	230	5.2	6.4	33.3	7.9	0.86	20.7	20.7	24.8	3

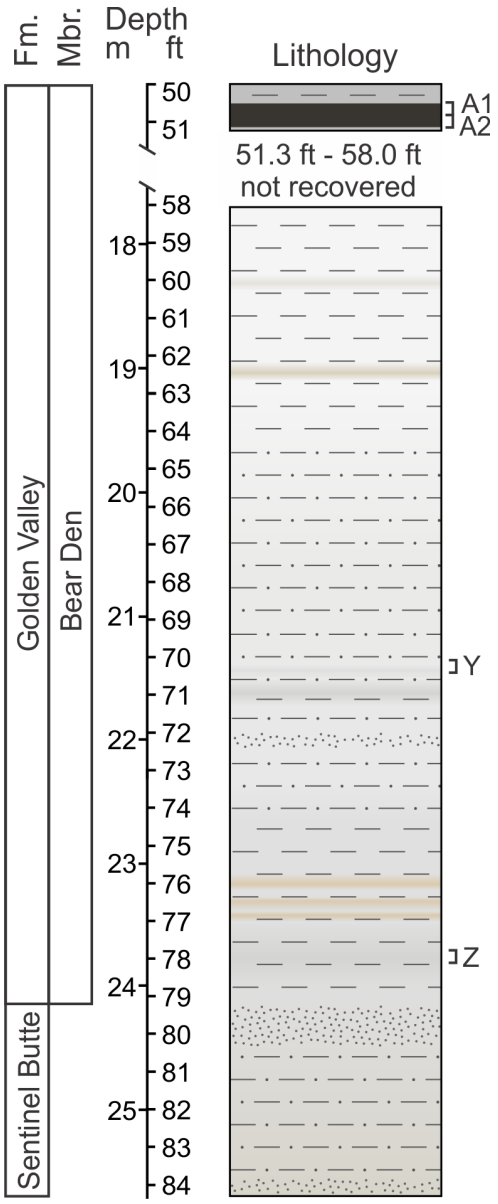
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-26B

T.137N., R.97W., Sec.36, SW1/4

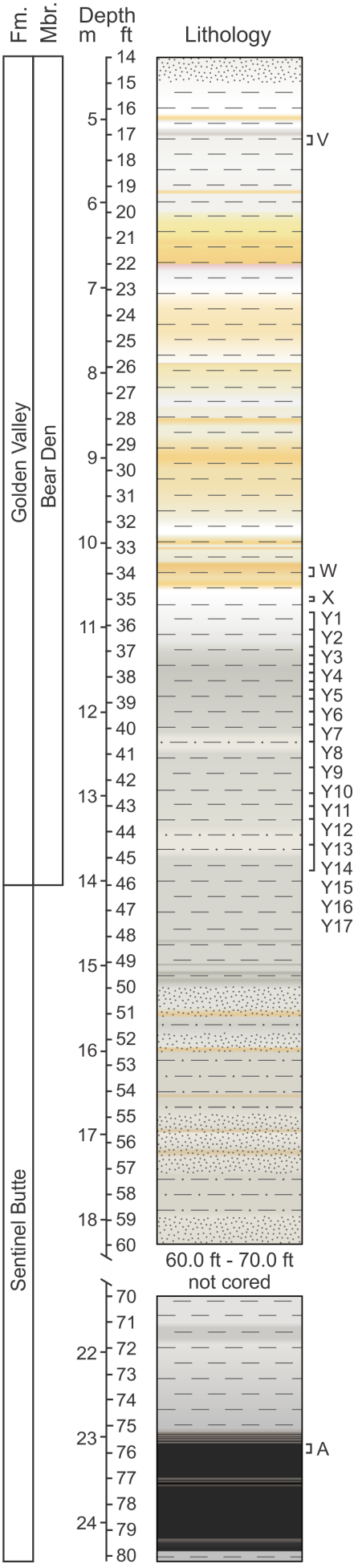
Surface Elevation 2,882 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A1	4	10	46.24%	514	238	6.0	7.9	38.4	9.5	1.10	13.3	30.6	22.1	8
A2	4	10	22.20%	689	153	5.4	5.0	18.7	4.5	0.81	15.5	7.1	28.8	35
Y	4	10	93.78%	185	174	7.7	4.7	26.0	6.3	0.63	21.4	1.8	23.1	2
Z	4	10	93.68%	361	338	7.9	8.4	38.8	9.8	1.28	18.7	21.1	22.6	3

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-28

T.136N., R.96W., Sec.16, NW1/4

Surface Elevation 2,866 ft.

				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
V	4	10	97.74%	80	78	2.2	2.0	9.1	2.3	0.32	5.6	3.1	14.0	2
W	4	10	93.47%	253	236	5.4	6.1	32.2	8.0	0.88	31.0	11.2	21.2	3
X	3	6	94.43%	224	211	3.8	5.0	34.1	8.9	0.68	16.9	13.5	24.6	3
Y1	8	20	94.24%	330	311	6.6	8.8	54.2	13.9	1.23	16.4	14.9	25.1	4
Y2	8	20	94.81%	705	669	15.5	20.8	123	30.9	2.95	18.1	19.7	26.7	6
Y3	4	10	94.07%	1014	954	22.2	30.1	177	44.6	4.24	19.3	17.5	27.4	8
Y4	4	10	94.40%	1307	1233	30.6	40.9	231	54.3	5.66	20.2	17.4	27.2	7
Y5	4	10	94.18%	1242	1170	26.8	36.2	213	52.8	5.03	22.0	21.7	28.3	8
Y6	4	10	94.27%	1183	1115	26.4	34.9	200	49.7	4.93	21.6	22.5	27.9	8
Y7	4	10	94.41%	1111	1049	26.3	33.6	182	44.4	4.78	21.1	24.9	27.6	7
Y8	4	10	94.54%	1055	997	26.1	33.2	165	39.4	4.64	20.4	25.4	26.6	7
Y9	6	15	94.91%	679	645	18.4	22.6	99.3	23.7	3.18	18.6	24.3	24.4	6
Y10	6	15	95.13%	447	425	12.2	14.2	58.5	14.2	2.03	17.6	22.2	23.0	4
Y11	8	20	95.21%	335	319	8.3	9.2	40.3	10.1	1.32	16.2	19.4	22.0	4
Y12	12	30	95.53%	247	236	5.3	6.1	31.2	8.0	0.86	16.5	22.0	21.3	3
Y13	12	30	95.56%	211	201	4.8	5.4	27.1	6.8	0.79	18.2	31.5	23.2	3
Y14	6	15	95.68%	238	228	5.5	6.4	32.1	8.0	0.96	17.1	31.5	22.0	4
Y15	6	15	95.95%	217	209	4.8	5.4	28.8	7.3	0.78	17.8	37.3	23.1	3
Y16	12	30	95.97%	190	182	4.1	4.7	25.0	6.4	0.68	16.1	40.0	20.6	3
Y17	12	30	95.88%	187	179	4.3	4.8	25.6	6.5	0.72	15.6	36.8	20.1	3
A	4	10	21.39%	511	109	3.7	3.6	14.2	3.5	0.59	8.7	4.5	7.7	11

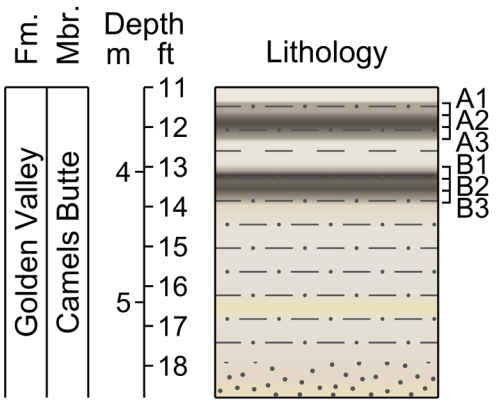
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-29B

T.139N., R.97W., Sec.30, NW1/4

Surface Elevation 2,616 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	3.5	9	91.53%	161	147	2.6	3.5	21.2	5.8	0.49	16.6	9.4	23.0	3
A2	3.5	9	85.90%	729	626	19.2	33.9	162	35.8	4.41	16.8	9.2	23.9	17
A3	4	10	90.47%	199	180	3.6	4.9	27.5	7.2	0.68	17.2	11.6	24.5	5
B1	3.5	9	90.56%	271	245	5.6	6.9	35.1	9.2	1.02	19.8	13.0	23.5	3
B2	3.5	9	91.09%	205	187	3.9	5.1	27.7	7.4	0.72	17.6	12.1	23.4	5
B3	4	10	86.53%	242	210	5.4	6.7	32.7	8.3	1.00	15.6	8.0	22.3	15

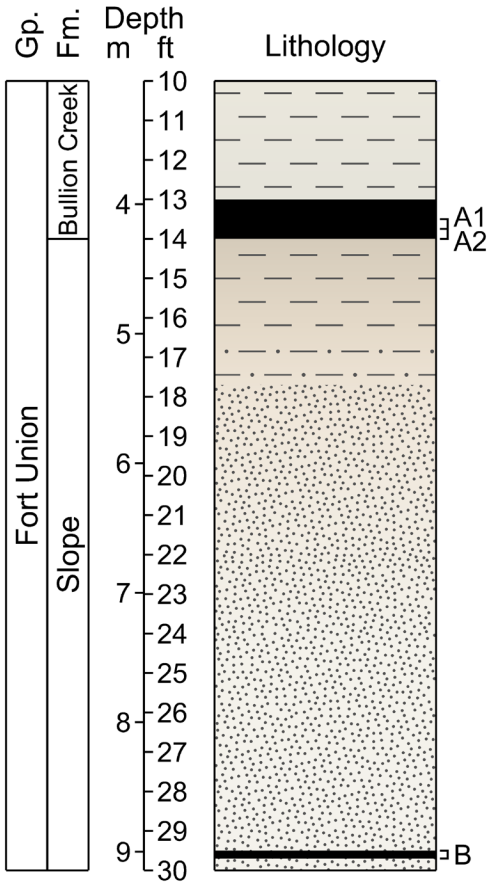
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-32

T.131N., R.96W., Sec.36, NW1/4

Surface Elevation 2,701 ft.



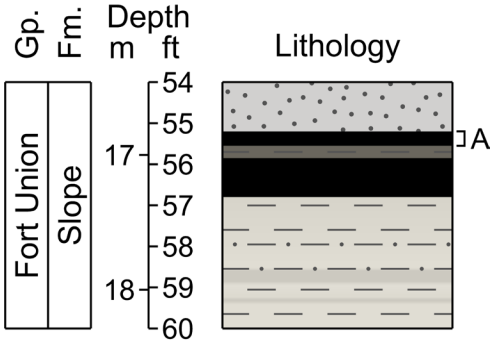
				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A1	3	8	61.44%	264	162	4.3	4.6	21.6	5.8	0.73	10.8	9.0	16.7	18
A2	3	8	77.35%	124	96	3.4	2.7	10.9	3.0	0.50	5.0	6.6	5.2	7
B	3	8	91.96%	257	236	5.6	6.5	35.0	8.5	0.87	18.5	123	26.9	4

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-33

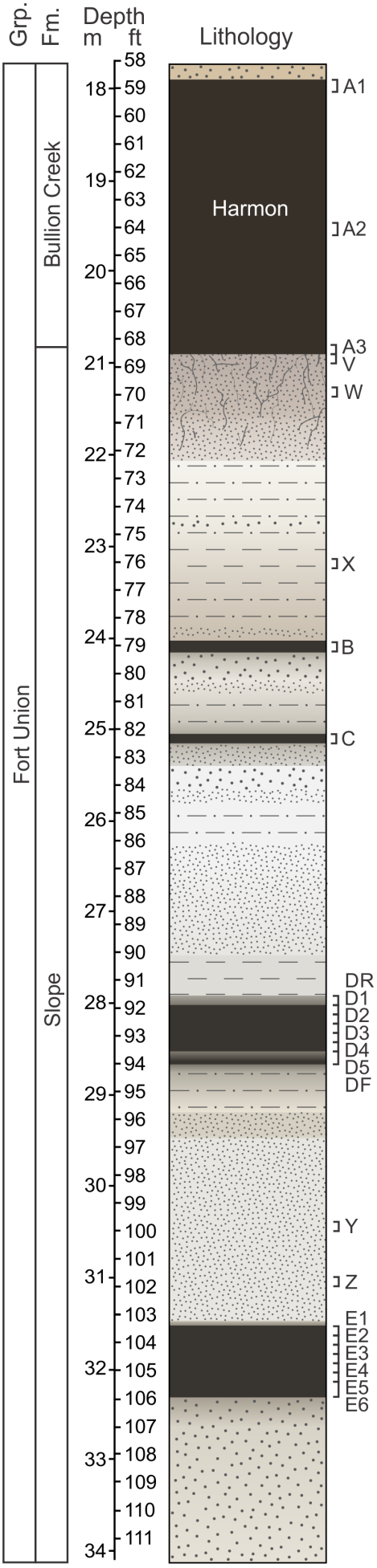
T.131N., R.96W., Sec.36, SW1/4
Surface Elevation 2,707 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	4	10	55.59%	214	119	3.3	2.7	12.9	3.6	0.48	13.8	2.6	13.6	7

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-38

T.131N., R.93W., Sec.36, NE1/4

Surface Elevation 2,594 ft.

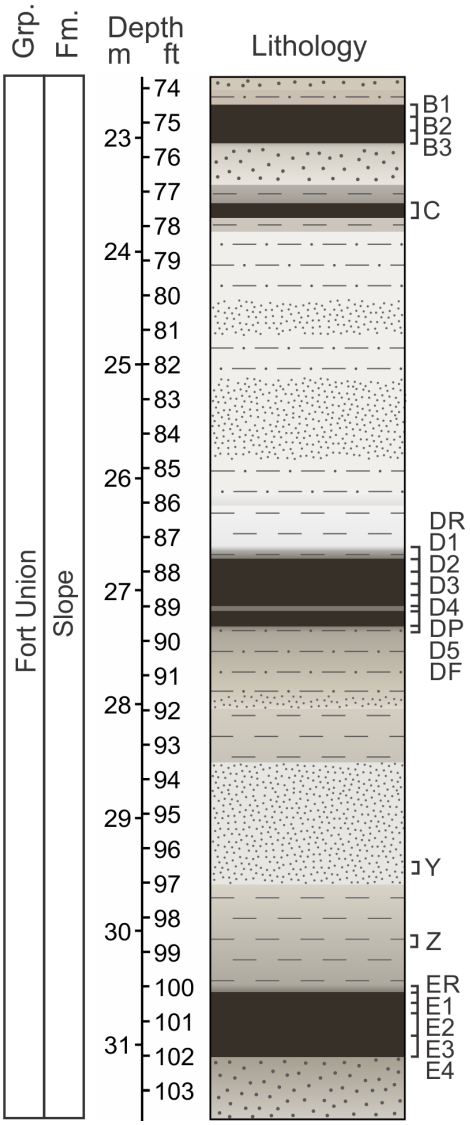
				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A1	6	15	13.60%	439	60	2.0	2.1	8.5	2.1	0.33	2.4	3.1	13.6	7
A2	4	10	15.35%	555	85	2.1	2.8	15.6	3.7	0.37	1.8	3.8	3.0	1
A3	4	10	49.70%	124	62	2.5	1.7	6.1	1.6	0.34	4.6	1.0	15.7	4
V	4	10	93.73%	86	81	2.8	2.1	10.6	2.6	0.35	2.6	0.5	4.6	1
W	4	10	97.91%	94	92	2.7	2.1	11.9	3.0	0.34	3.8	1.2	8.6	2
X	4	10	93.71%	144	135	2.9	2.8	18.6	4.8	0.39	14.4	18.1	25.8	2
B	4	10	54.93%	301	165	4.4	4.1	19.8	5.8	0.76	21.8	33.9	25.4	9
C	4	10	36.37%	729	265	8.2	7.3	30.1	8.7	1.41	40.0	14.2	24.1	10
DR	4	10	79.36%	1049	832	19.2	27.3	143	37.3	3.82	31.9	31.9	21.3	6
D1	4	10	35.26%	2433	858	25.6	30.8	144	35.8	4.57	45.7	22.9	11.9	15
D2	4	10	18.77%	9920	1862	49.9	70.9	349	84.8	9.57	31.0	11.7	10.5	28
D3	4	10	14.78%	8665	1281	34.9	45.7	216	52.1	6.27	18.9	10.1	5.1	14
D4	4	10	10.34%	9038	935	25.6	33.5	159	37.8	4.51	10.1	4.9	5.4	19
D5	4	10	19.17%	2686	515	17.8	20.2	79.6	17.5	2.85	12.1	3.4	7.8	6
DF	6	15	72.92%	596	435	10.3	13.5	70.3	16.6	1.76	15.1	11.0	22.2	5
Y	4	10	95.39%	129	123	2.7	3.2	18.9	4.6	0.42	12.1	34.0	17.9	2
Z	4	10	95.66%	147	141	3.2	3.7	22.5	5.3	0.50	12.6	12.4	17.3	2
E1	4	10	18.35%	2186	401	13.8	14.8	60.6	14.1	2.25	13.0	4.3	4.5	8
E2	4	10	11.04%	1565	173	8.4	7.0	17.7	3.9	1.21	5.6	4.6	3.1	8
E3	4	10	11.27%	934	105	4.9	4.4	9.9	2.1	0.72	3.1	3.5	1.4	3
E4	4	10	9.30%	878	82	3.0	3.2	8.7	1.9	0.47	2.5	3.8	1.2	2
E5	4	10	11.37%	683	78	2.5	2.8	9.1	2.1	0.41	3.5	2.9	3.9	17
E6	6	15	31.53%	221	70	2.7	2.4	7.2	1.7	0.42	6.0	16.8	10.1	19

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-38B

T.131N., R.93W., Sec.36, NE1/4
Surface Elevation 2,576 ft.



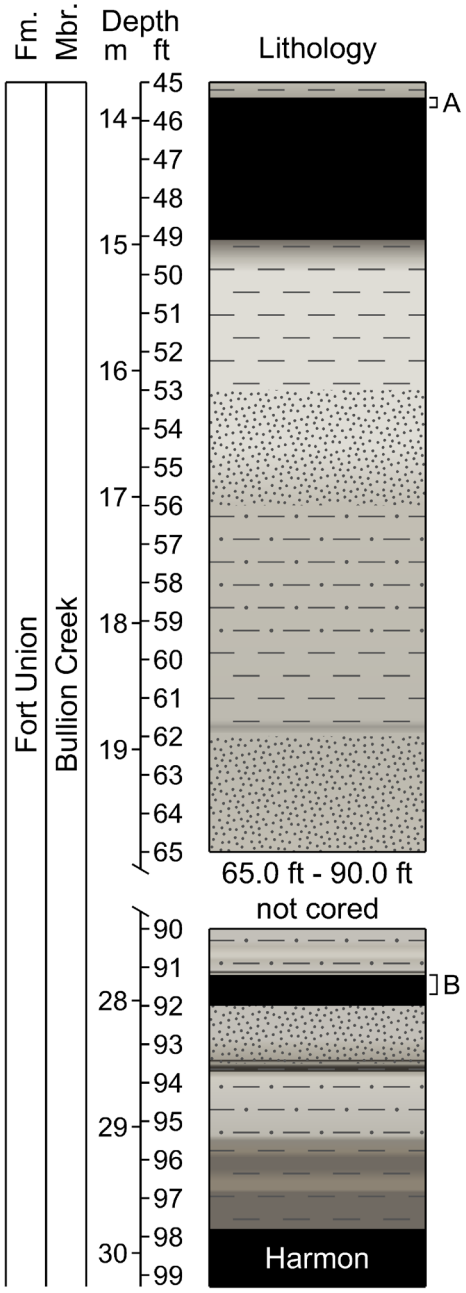
				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
B1	4	10	20.23%	1836	371	11.9	11.2	44.4	13.5	2.17	35.5	9.8	12.4	8
B2	5	13	36.01%	833	300	9.5	8.7	35.6	10.6	1.67	28.5	7.5	16.5	5
B3	4	10	37.45%	452	169	6.8	5.4	18.2	5.3	1.12	21.2	25.8	23.7	7
C	5	13	37.67%	501	189	6.9	6.0	21.7	6.1	1.14	21.0	20.7	27.7	15
DR	4	10	85.58%	802	686	13.3	20.5	117	31.1	2.67	23.2	24.0	25.8	6
D1	4	10	63.17%	1726	1090	26.0	36.6	189	48.2	4.99	41.8	41.3	22.1	9
D2	4	10	27.26%	5316	1449	36.6	50.7	260	65.1	6.90	45.7	18.2	12.1	17
D3	4	10	18.13%	5289	959	27.5	34.5	167	40.4	4.80	30.4	11.4	8.3	16
D4	4	10	19.73%	4785	944	27.4	34.5	163	38.7	4.73	26.9	5.2	8.6	11
DP	2	5	77.65%	491	381	8.4	11.2	65.6	15.8	1.50	13.5	3.8	20.1	5
D5	5	13	51.39%	819	421	12.5	15.1	67.1	15.6	2.08	15.3	5.8	14.1	7
DF	2	5	92.86%	304	283	5.8	7.6	45.3	11.2	1.07	13.5	19.7	22.3	3
Y	4	10	95.23%	123	117	2.3	2.9	18.1	4.3	0.35	9.7	14.0	16.3	2
Z	4	10	92.30%	244	225	4.3	5.5	35.1	8.5	0.70	20.9	20.9	25.2	2
ER	2	5	90.86%	385	350	6.9	9.7	60.1	14.0	1.17	14.1	6.9	25.0	3
E1	4	10	15.45%	4786	739	25.6	28.4	116	26.8	4.29	31.1	5.1	6.6	9
E2	4	10	12.18%	6599	804	24.2	30.0	140	31.8	4.23	15.1	4.5	4.9	17
E3	8	20	13.88%	2720	378	13.0	14.1	55.7	12.0	2.08	6.0	3.8	2.1	6
E4	7	18	14.97%	930	139	6.1	5.5	12.4	2.4	0.88	3.6	3.8	5.1	18

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-39

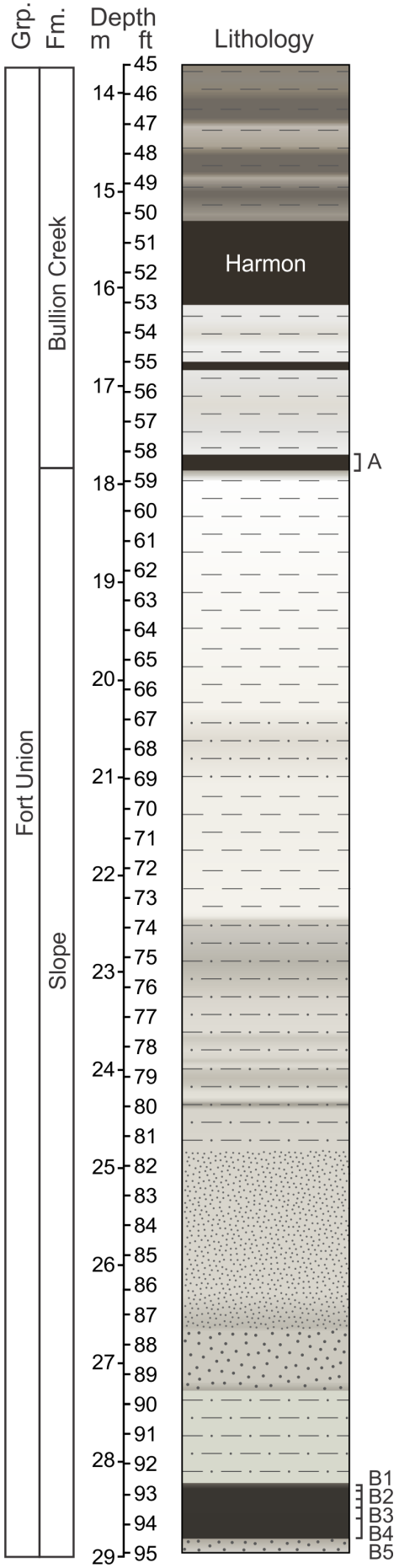
T.131N., R.92W., Sec.22, NE1/4
Surface Elevation 2,564 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	3	8	76.67%	342	262	5.2	6.9	39.9	11.1	1.01	12.9	9.7	19.8	3
B	6	15	34.38%	267	92	3.6	2.9	10.3	2.7	0.54	8.5	13.3	13.3	8

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



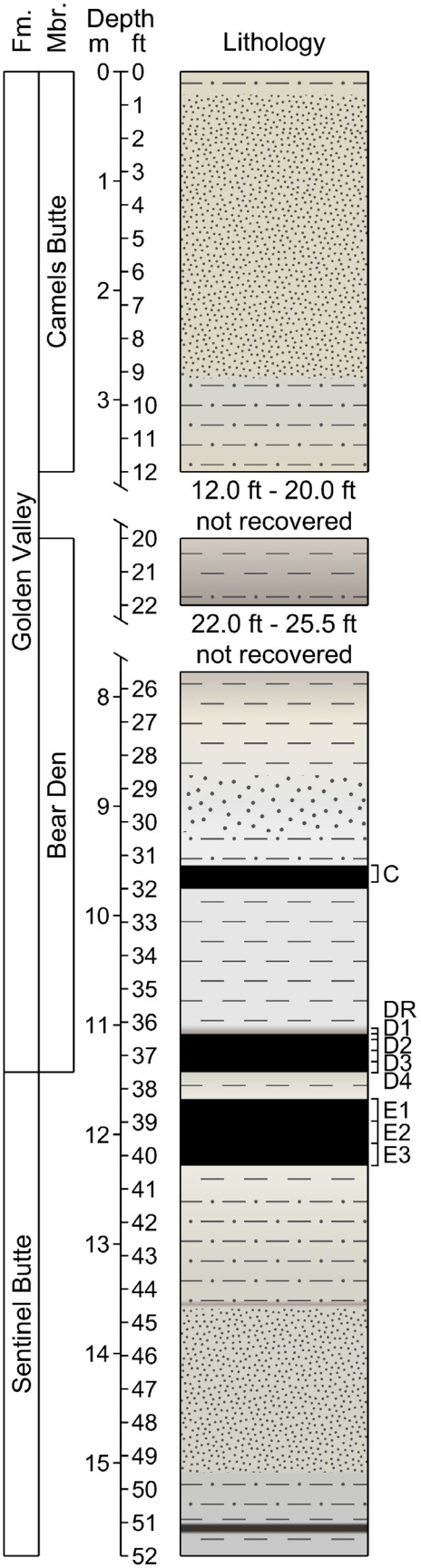
Core NDGS24-40

T.131N., R.91W., Sec.18, NW1/4
Surface Elevation 2,502 ft.

				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	6	15	33.17%	835	277	7.1	9.2	39.6	10.3	1.32	4.9	7.4	6.8	6
B1	2	5	48.81%	709	346	8.6	10.4	50.1	12.5	1.47	10.1	7.4	12.5	5
B2	3	8	58.70%	228	134	4.3	3.8	16.0	4.3	0.66	11.0	7.8	19.8	9
B3	3	8	16.43%	664	109	4.7	3.7	9.6	2.3	0.65	4.6	4.7	4.1	2
B4	4	10	11.55%	866	100	5.0	3.8	7.5	1.7	0.68	2.9	4.4	2.4	2
B5	8	20	13.31%	657	87	4.2	3.1	6.4	1.4	0.57	6.2	5.5	8.2	30

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.



Core NDGS24-42

T.145N., R.97W., Sec.16, NE1/4

Surface Elevation 2,760 ft.

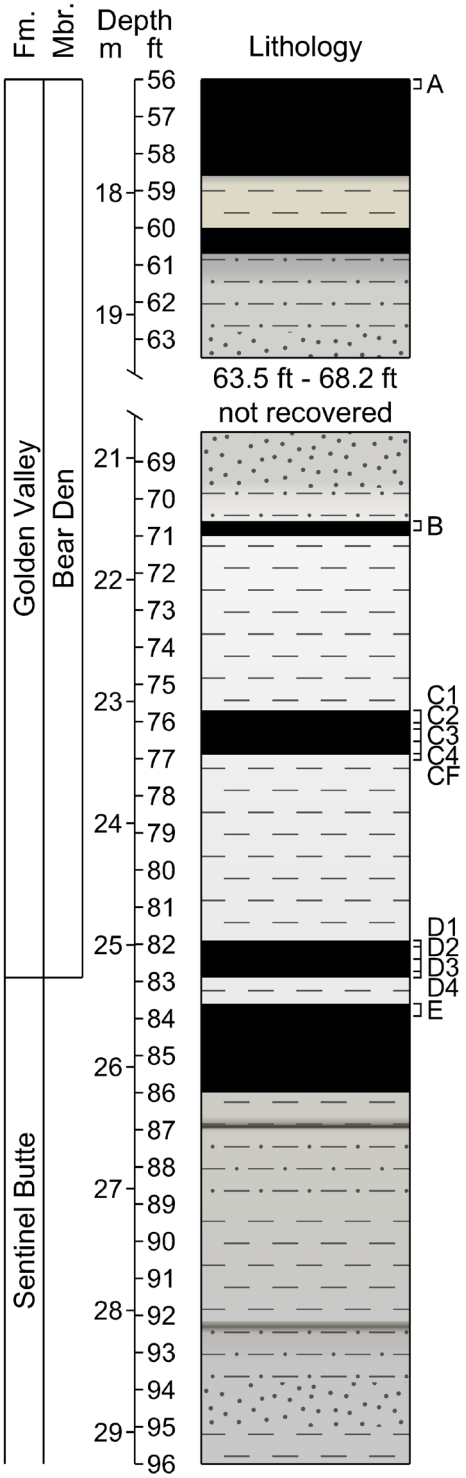
				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
C	6	15	35.59%	3907	1391	47.0	64.3	309	69.6	9.43	28.3	98.6	18.2	17
DR	2	5	90.24%	753	680	13.9	17.6	96.2	26.3	2.48	20.4	33.4	27.2	4
D1	4	10	61.45%	3239	1990	54.5	66.4	268	69.5	9.60	33.5	22.9	20.0	17
D2	4	10	28.74%	4584	1317	42.9	44.6	139	35.4	7.00	23.3	6.2	9.6	7
D3	4	10	39.77%	2130	847	23.0	26.6	97.4	25.2	3.90	17.7	4.4	14.2	5
D4	2	5	76.50%	534	408	8.4	10.6	51.8	13.8	1.48	15.9	12.9	19.4	3
E1	8	20	25.91%	612	159	4.2	4.9	19.7	4.9	0.72	7.5	16.7	5.3	3
E2	8	20	14.46%	760	110	4.8	4.5	10.9	2.4	0.72	5.5	14.8	2.0	1
E3	8	20	12.79%	961	123	5.6	5.0	13.1	2.9	0.83	9.4	20.0	4.6	4

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-42B

T.145N., R.97W., Sec.16, NE1/4
Surface Elevation 2,716 ft.



				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	2	5	20.58%	295	61	3.2	2.6	5.6	1.2	0.46	6.1	59.0	4.0	11
B	2.5	6	60.29%	216	130	4.6	3.9	15.2	3.8	0.67	14.6	20.3	15.1	9
C1	4	10	23.65%	6966	1647	50.9	67.2	346	86.0	9.56	33.8	18.6	20.4	19
C2	2	5	16.59%	6924	1149	41.5	46.6	225	50.2	7.11	31.2	9.7	18.8	16
C3	4	10	24.12%	3306	797	29.3	34.0	144	32.4	5.04	28.2	4.9	15.3	10
C4	4	10	60.90%	1036	631	21.7	24.8	109	25.2	3.69	24.2	39.6	22.7	5
CF	2	5	87.35%	460	402	10.5	13.4	69.3	16.9	1.89	20.8	11.1	26.2	3
D1	2	5	18.63%	2848	531	15.6	16.3	59.0	14.7	2.50	16.2	42.7	13.8	30
D2	4	10	15.02%	1551	233	7.9	7.8	22.6	5.3	1.21	16.1	3.3	10.2	4
D3	4	10	18.03%	3173	572	18.0	17.6	51.3	12.4	2.80	22.0	5.3	10.5	11
D4	2	5	33.30%	2904	967	28.3	28.0	78.9	19.4	4.33	18.1	1.2	6.0	4
E	4	10	17.53%	792	139	4.7	4.7	13.3	3.1	0.73	8.4	3.8	8.7	4

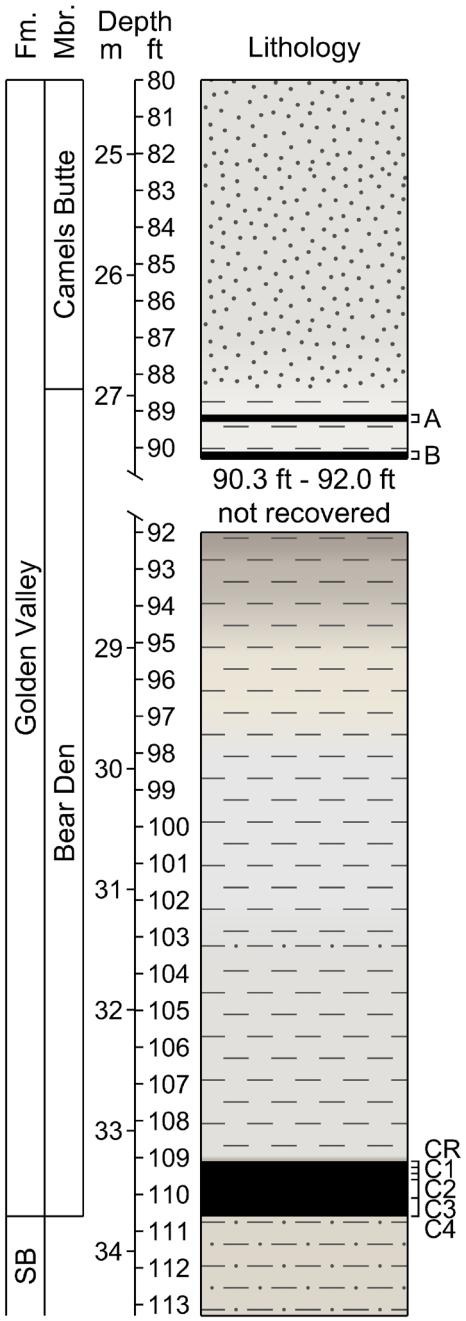
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

Core NDGS24-43

T.146N., R.97W., Sec.36, SW1/4

Surface Elevation 2,702 ft.



				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	2	5	77.62%	210	163	3.6	4.2	23.6	6.1	0.61	14.5	33.3	18.7	10
B	2	5	83.76%	165	138	3.9	3.2	16.1	4.4	0.54	13.4	11.9	44.0	8
CR	2	5	83.89%	832	698	24.6	30.5	118	26.7	4.40	25.6	14.7	25.4	5
C1	2	5	51.61%	2837	1464	64.7	61.2	174	33.1	9.47	32.3	11.8	13.4	13
C2	2	5	14.40%	1660	239	10.2	10.5	33.0	6.4	1.53	10.0	2.1	8.2	57
C3	6	15	24.19%	1135	275	13.4	11.3	24.3	4.6	1.77	19.4	0.9	3.3	8
C4	6	15	51.59%	283	146	5.7	4.5	12.7	3.0	0.74	13.0	2.2	10.3	8

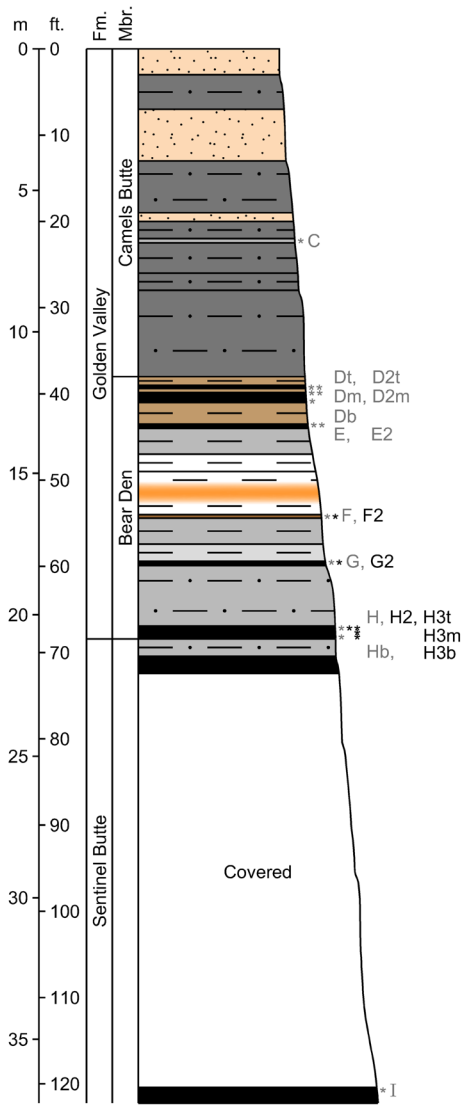
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this core.

REE Section 266

T.145N., R.97W., Sec.16, SE1/4

Elevation at top 2,729 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
C	3	8	93.65%	~176	~165		4.3	24.3			16.1		23.5	4
Dt	3	8	30.45%	1435	437	16.9	20.9	87.7	18.7	3.21	19.3		6.4	6
D2t	3	8	54.50%	701	382	11.1	15.5	84.6	18.4	2.19	20.5		12.6	28
Dm	3	8	28.80%	966	278	10.1	12.1	51.0	11.8	1.86	7.3		4.1	3
D2m	3	8	42.82%	874	374	11.4	15.6	76.6	17.3	2.23	14.6		8.8	5
Db	3	8	32.68%	887	290	9.0	11.4	53.8	12.6	1.74	11.3		4.3	2
E	3	8	51.37%	762	392	9.6	13.0	74.1	17.2	1.91	39.1		16.7	19
E2	3	8	60.41%	~463	~279		10.0	51.0			22.4		13.9	9
F	3	8	81.55%	953	777	24.5	29.7	148	33.6	4.63	61.4	8.0	36.9	8
F2	2	5	70.52%	2097	1479	51.2	59.8	265	63.2	9.25	109	29.6	28.0	9
G	3	8	44.38%	2661	1181	47.6	55.1	227	47.1	8.37	44.2	41.2	29.4	25
G2	2	5	43.60%	4011	1749	72.3	80.0	326	69.9	12.0	77.5	15.7	22.4	14
H	3	8	31.52%	2779	876	32.3	32.8	101	22.4	5.19	22.8	51.1	11.9	8
H2	2	5	29.47%	2470	728	29.2	25.5	61.2	13.9	4.18	17.6	49.2	9.6	5
H3t	4	10	35.54%	1678	596	14.7	18.5	78.8	19.4	2.59	15.6	18.8	5.3	4
H3m	4	10	46.23%	1678	776	20.2	22.9	81.3	20.4	3.28	16.5	1.9	7.9	4
Hb	3	8	32.85%	2398	788	23.6	26.7	94.9	22.1	3.94	24.6	87.5	16.1	7
H3b	4	10	40.69%	5703	2321	64.3	69.6	270	67.0	10.5	44.2	22.6	13.0	12
I	3	8	29.39%	~283	~83		4.2	16.1			5.4		3.8	27

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

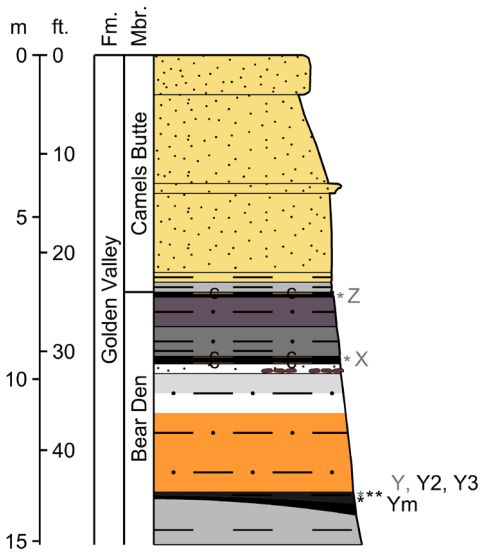
(~) Includes estimated minor lanthanides.

Samples in gray were first reported in Murphy et al., 2023.

REE Section 267

T.137N., R.97W., Sec.36, NW/SE

Elevation at top 2,857 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
Z	3	8	61.31%	~302	~185		6.3	30.1			5.7		12.1	20
X	3	8	38.76%	1320	512	13.3	18.3	97.0	22.8	21.2	15.2		10.8	13
Y	3	8	65.35%	3008	1966	46.3	64.6	360	87.7	76.1	62.2	11.0	35.2	16
Y2	2.5	6.4	48.30%	3672	1774	43.9	56.9	297	76.7	62.6	77.8		27.5	13
Y3	2.5	6.4	40.11%	5355	2148	51.8	64.1	326	86.4	68.1	93.0		26.3	12
Ym	2.5	6.4	37.27%	8515	3174	66.2	83.3	452	137	87.4	89.1		42.0	21

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

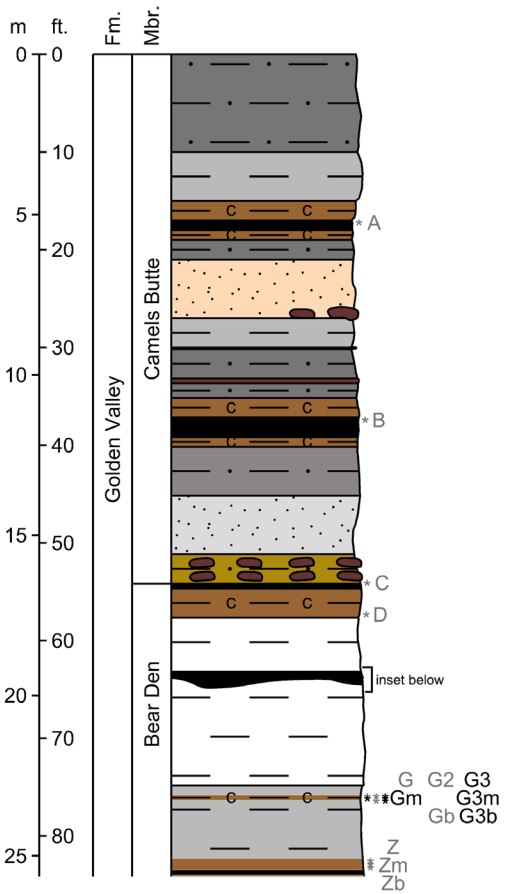
(~) Includes estimated minor lanthanides.

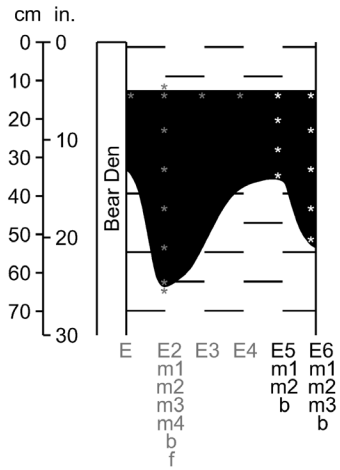
Samples in gray were first reported in Murphy et al., 2023.

REE Section 270

T.140N., R.90W., Sec.5, NE/SE/SE | T.140N., R.90W., Sec.4, NW/SW/SW

Elevation at top 2,366 ft.





					Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	3	8	50.36%	616	310	10.8	12.6	53.9	12.4	1.92	17.3	29.4	15.8	20
B	3	8	17.63%	~433	~76		2.9	9.3			3.2		4.1	4
C	3	8	70.59%	178	125	2.3	2.7	17.2	4.5	0.39	13.6	6.9	24.2	42
D	3	8	90.52%	~75	~68		1.4	7.4			8.7		26.8	4
E2r	3	8	93.57%	389	364	7.6	10.8	66.3	16.5	1.50	18.5	1.8	30.5	4
E	3	8	80.11%	1184	949	23.6	31.7	168	42.5	4.74	54.4	2.2	57.4	28
E2t	2	5	59.41%	2253	1338	44.0	59.3	283	63.1	8.76	39.8	2.0	30.2	13
E3	2	5	65.41%	2288	1497	34.7	51.5	297	74.1	7.30	52.5	2.1	35.6	15
E4	3	8	75.28%	992	747	19.3	24.6	128	32.4	3.75	52.6	2.9	44.2	8
E5t	2	5	66.31%	2043	1355	35.0	45.8	244	61.5	6.83	67.2	2.1	40.8	10
E6t	2	5	67.66%	1695	1147	29.5	41.2	228	56.6	5.90	53.6		36.2	7
E2m1	2	5	26.60%	3057	813	21.2	24.6	128	32.7	3.72	32.3	1.0	13.1	15
E5m1	3	8	70.23%	1342	942	24.9	32.8	157	39.3	4.73	48.0	1.1	38.1	7
E6m1	2	5	62.46%	1323	826	21.8	29.3	148	36.1	4.11	42.3		37.1	6
E2m2	2	5	79.69%	557	444	11.4	16.2	83	18.9	2.19	15.1	1.1	33.4	7
E5m2	2	5	50.93%	1399	713	17.8	22.0	114	28.6	3.21	45.3	2.1	28.8	13
E6m2	2	5	10.83%	~1049	~114		3.6	11.7			17.4		21.9	44
E2m3	2	5	19.01%	~701	~133		5.5	13.3			11.6		14.8	14
E6m3	2	5	40.51%	~276	~112		3.4	10.5			13.7		30.4	8
E2m4	3	8	25.30%	~311	~79		2.8	7.5			7.4		19.8	12
E2b	1	3	70.93%	~211	~150		3.7	20.9			10.2		26.4	3
E5b	2	5	49.34%	678	334	9.3	9.9	50.3	12.7	1.53	30.0	4.8	32.9	26
E6b	2	5	65.95%	~297	~196		5.4	28.1			15.2		32.2	5
F	3	8	90.14%	~96	~87		2.0	12.1			5.5		12.9	3
G	3	8	48.26%	5325	2570	88.9	112.0	505	112	16.6	69.6	54.1	36.6	32
G2	3	8	49.71%	1307	650	22.7	31.4	139	28.2	4.51	56.3	64.8	32.9	32
G3	2	5	59.81%	2345	1403	45.8	56.8	281	65.0	8.32	35.1	26.5	26.9	24
Gm	2	5	44.19%	7137	3154	113	134	620	150	19.9	66.8	53.8	44.7	24
G3m	2	5	49.93%	5771	2882	98.6	119	571	132	17.7	53.8	42.4	38.2	25
G2b	3	8	40.34%	2060	831	29.1	36.5	169	35.4	5.44	63.6	106	32.7	27
G3b	2	5	47.52%	4491	2134	80.1	96.4	413	90.8	14.2	75.5	54.6	40.4	19
Z	2	5	64.35%	630	406	12.5	15.4	65.2	15.2	2.20	26.7		18.9	14
Zm	2	5	33.55%	2105	706	24.6	27.8	98.0	23.3	4.17	28.1		17.1	7
Zb	2	5	39.07%	1430	559	18.8	20.3	74.5	17.9	3.10	28.0		17.0	7

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

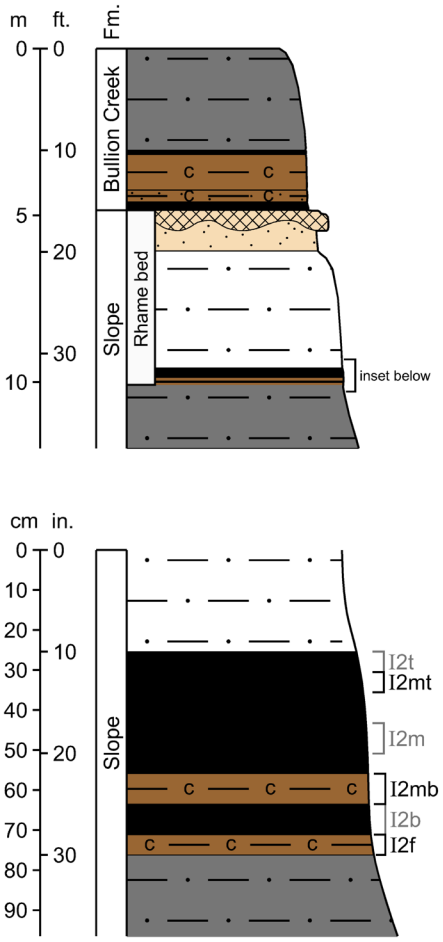
(~) Includes estimated minor lanthanides.

Samples in gray were first reported in Murphy et al., 2023.

REE Section 284 - West

T.137N., R.103W., Sec.31, NW/SE

Elevation at top 2,585 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
I2t	2	5	55.10%	5068	2792	54.1	81.4	483	124	11.1	26.2	32.4	18.3	21
I2mt	2	5	54.20%	3818	2070	43.9	58.1	330	86.9	8.16	24.9	34.0	16.4	13
I2m	3	8	35.62%	1829	651	16.2	20.1	97.8	23.8	2.90	21.4	33.2	24.3	33
I2mb	3	8	83.17%	303	252	5.9	6.4	37.5	9.5	0.95	13.8	7.4	21.4	6
I2b	3	8	52.26%	647	338	9.5	10.9	51.8	12.3	1.62	20.1	20.7	29.9	18
I2f	2	5	82.63%	213	176	3.8	4.4	25.4	6.6	0.64	15.8	9.1	25.5	17

∑REE includes Y and Sc

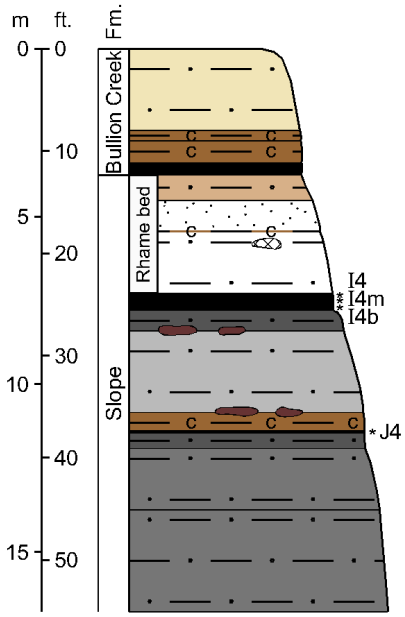
See Appendix B for additional elemental analyses from this outcrop.

Samples in gray were first reported in Moxness et al., 2023.

REE Section 284 - North

T.137N., R.103W., Sec.31, NE/NE/SE

Elevation at top 2,565 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
I4	2.5	6.4	40.06%	3919	1570	32.6	46.0	265	69.1	6.21	17.0	8.1	12.9	12
I4m	2.5	6.4	30.93%	1483	459	11.3	14.2	74.3	18.5	1.96	10.9	7.9	9.0	14
I4b	3	8	54.15%	~300	~163		4.8	26.8			11.2		20.0	7
J4	2.5	6.4	56.29%	~383	~215		5.9	32.4			13.4		19.5	22

∑REE includes Y and Sc

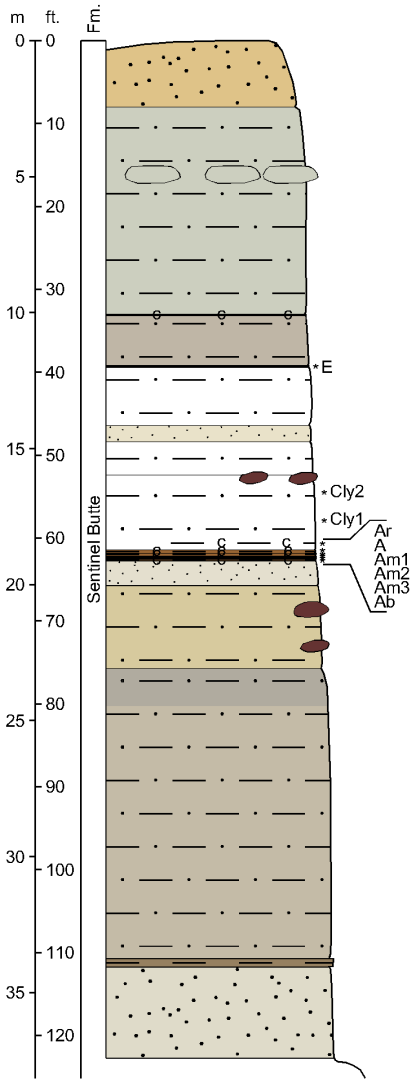
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 307

T.144N., R.100W., Sec.16, SW/SW/SW

Elevation at top 2,547 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
E	2	5	89.19%	~229	~213		5.6	31.7			14.6		23.9	11
cly2	4	10	95.21%	225	214	4.4	5.8	33.3	8.8	0.80	12.7	14.8	19.6	3
cly1	4	10	96.24%	223	215	4.6	5.8	33.0	8.7	0.81	13.5	12.8	20.1	3
Ar	4	10	93.69%	~184	~172		4.3	27.0			12.8		22.8	5
A	2.5	6.4	82.51%	~256	~211		5.8	31.8			14.4		23.4	9
Am1	2.5	6.4	85.98%	~273	~235		5.4	33.1			13.4		25.7	5
Am2	2.5	6.4	37.77%	~560	~211		6.7	22.4			17.1		15.7	8
Am3	2.5	6.4	45.71%	~553	~253		8.8	34.2			22.9		24.3	10
Ab	2	5	79.88%	~216	~173		4.6	26.5			16.0		23.1	22

∑REE includes Y and Sc

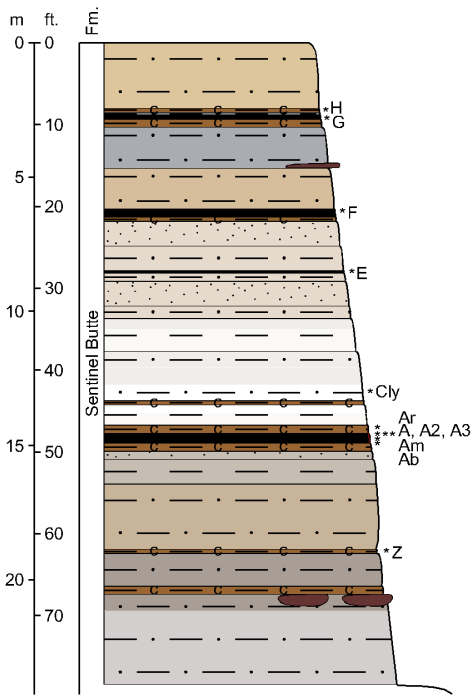
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 308

T.144N., R.100W., Sec.16, NE/NE/SW

Elevation at top 2,520 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
H	2.5	6	61.75%	627	387	12.0	13.5	62.0	15.6	2.07	21.5		15.5	10
G	2.5	6	46.56%	~382	~178		5.4	21.7			16.1		14.1	11
F	2.5	6	70.65%	~342	~242		8.4	40.8			14.8		16.1	3
E	2.5	6	59.36%	698	414	14.0	12.0	49.4	13.2	2.05	19.8		31.8	31
cly	4	10	97.25%	~203	~197		4.1	30.4			13.6	2.1	25.5	3
Ar	2.5	6	89.62%	~189	~169		3.9	25.9			12.6	6.2	23.6	3
A	2.5	6	60.33%	~351	~212		6.5	30.8			14.6	10.4	22.4	4
A2	2.5	6	63.11%	~338	~213		6.1	29.0			14.2	11.4	22.6	3
A3	2.5	6	54.41%	~406	~221		7.1	33.6			14.4	7.5	17.9	9
Am	2.5	6	33.38%	~322	~108		3.6	14.5			10.2	7.6	11.6	18
Ab	2.5	6	36.63%	~347	~173		4.5	18.7			13.3	10.9	15.5	18
Z	4	10	27.73%	~542	~150		4.9	15.5			16.4		18.5	46

∑REE includes Y and Sc

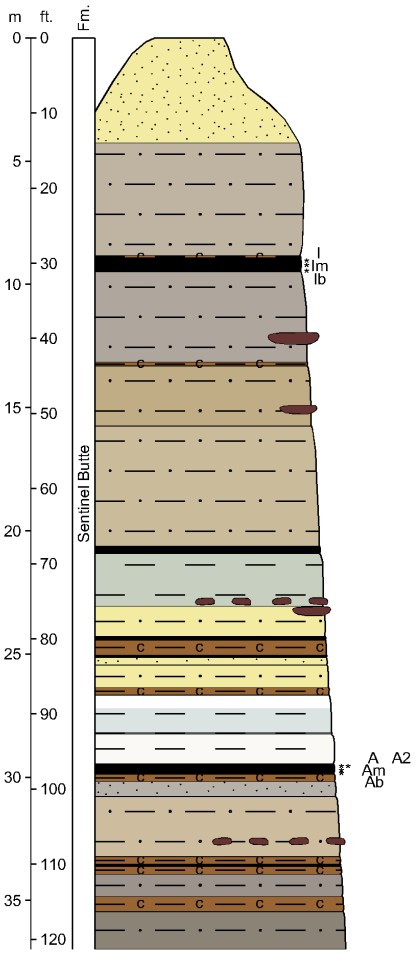
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 309

T.144N., R.100W., Sec.16, SW/SE/NW

Elevation at top 2,570 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
I	2.5	6	59.09%	~110	~65		2.2	9.8			6.8		5.4	4
Im	2.5	6	34.61%	~416	~144		4.4	14.4			14.8		9.9	3
Ib	2.5	6	49.81%	627	312	11.0	13.3	58.6	13.5	1.97	20.5		12.9	13
A	2.5	6	50.81%	~445	~226		8.4	37.1			16.2	10.6	16.1	6
A2	4	10	79.89%	~285	~228		7.3	36.2			16.1	14.6	25.3	4
Am	2.5	6	32.97%	~296	~142		4.5	16.5			9.8	7.8	8.1	9
Ab	2.5	6	48.11%	~365	~120		5.2	22.8			14.6	8.8	12.2	16

∑REE includes Y and Sc

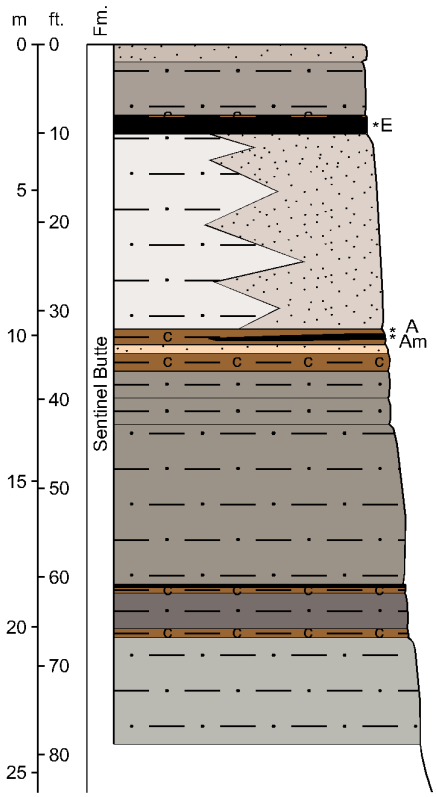
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 310

T.144N., R.100W., Sec.16, NE/SW/SE

Elevation at top 2,483 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
E	2.5	6	36.80%	~562	~207		9.5	38.3			13.2		8.8	6
A	2.5	6	72.53%	~227	~165		4.4	22.0			10.8		17.4	7
Am	2.5	6	28.83%	~423	~122		3.7	12.6			10.6		15.1	15

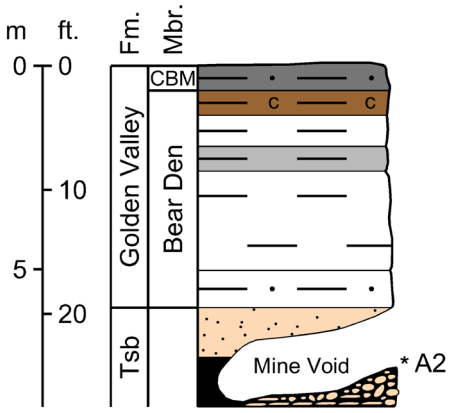
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 316

T.140N., R.90W., Sec.11, NW/NE/NW
Elevation at top 2,355 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A2	2	5	40.23%	2333	938	25.6	32.4	160	38.6	4.57	26.0	7.4	19.2	21

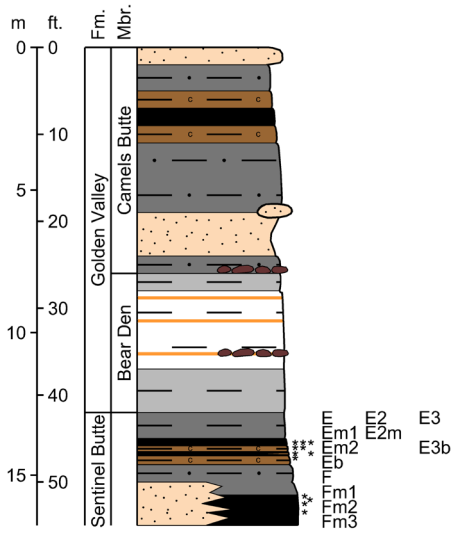
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 317

T.140N., R.90W., Sec.6, NW/SW/SE

Elevation at top 2,402 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
E	2	5	44.33%	1673	742	24.4	24.8	76.8	17.3	3.64	20.4	23.5	10.7	27
Em1	2	5	21.30%	1613	343	10.4	12.2	40.7	9.1	1.67	9.2	34.6	4.7	32
Em2	4	10	11.52%	~1964	~226		6.8	20.9			10.3	46.0	5.4	32
Eb	4	10	40.34%	371	150	4.5	5.0	20.9	5.1	0.74	8.6	19.6	4.4	4
E2	4	10	63.30%	714	452	15.8	16.3	59.4	12.6	2.43	27.0		15.0	24
E2m	2	5	28.22%	2320	655	23.5	28.7	111	23.4	4.02	24.4		14.6	7
E3	4	10	44.89%	715	321	12.9	14.4	52.0	11.5	2.19	18.3		8.8	15
E3b	4	10	38.25%	1202	460	20.4	20.4	65.0	14.7	3.30	17.9		9.4	6
F	2	5	29.18%	1896	553	28.5	34.4	121	22.2	5.14	16.8	14.9	7.5	11
Fm1	2	5	18.09%	1700	308	16.6	18.6	58.7	11.3	2.89	6.8	20.4	3.4	2
Fm2	2	5	24.59%	~611	~150		7.8	22.2			4.4	22.4	7.6	2
Fm3	2	5	15.92%	489	78	3.0	2.7	8.3	1.9	0.46	3.2	36.9	3.5	1

∑REE includes Y and Sc

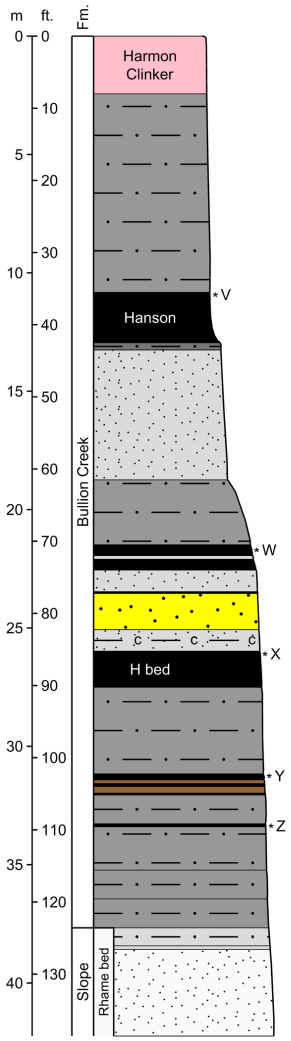
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 319

T.134N., R.102W., Sec.5, NW/NW

Elevation at top 2,830 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
V	2	5	38.83%	~427	~166		5.7	17.8			17.4		8.7	3
W	2	5	40.03%	~187	~75		2.7	10.9			7.0		6.3	2
X	2	5	22.61%	~544	~123		4.4	16.7			10.3		12.3	13
Y	2	5	24.71%	~436	~108		3.2	10.5			9.1		17.9	18
Z	2	5	37.18%	~290	~108		3.3	10.3			14.4		20.8	28

∑REE includes Y and Sc

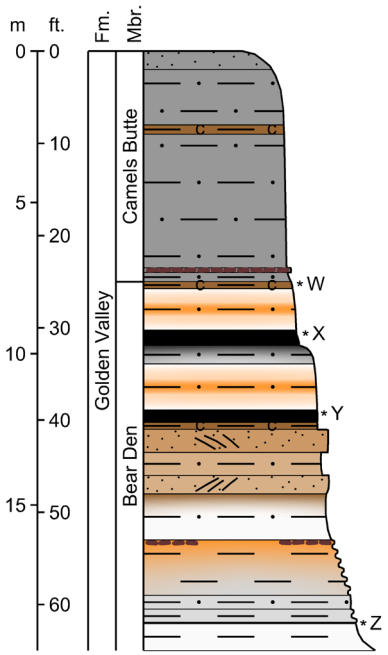
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 320

T.145N., R.99W., Sec.13, SW/SW

Elevation at top 2,730 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
W	2	5	75.91%	~195	~148		3.6	21.7			12.4		23.9	4
X	2	5	66.84%	~165	~111		2.6	13.6			14.7		36.0	4
Y	2	5	41.37%	~594	~246		6.7	39.3			12.3		29.2	17
Z	2	5	79.13%	~163	~129		2.6	15.1			15.7		36.9	9

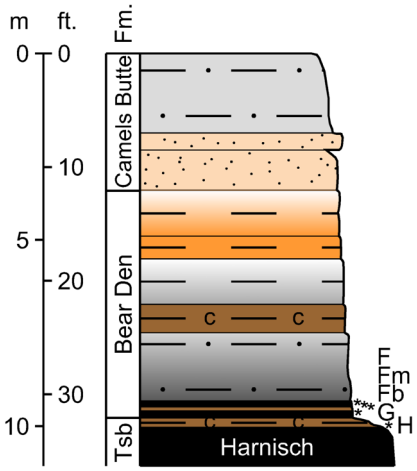
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 321

T.140N., R.90W., Sec.8, NW/SE
Elevation at top 2,359 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
F	2	5	57.82%	3460	2001	71.6	73.2	249	57.8	11.1	53.7	40.6	18.7	26
Fm	2	5	31.17%	4865	1516	58.9	64.1	211	45.5	9.50	36.4	75.2	16.2	9
Fb	2	5	30.41%	3032	922	35.0	40.7	143	31.6	5.87	23.4	58.6	13.7	6
G	2	5	44.24%	1272	563	15.1	18.1	81.1	20.5	2.64	17.5		15.3	4
H	2	5	24.97%	~429	~107		3.6	15.1			9.7		6.1	3

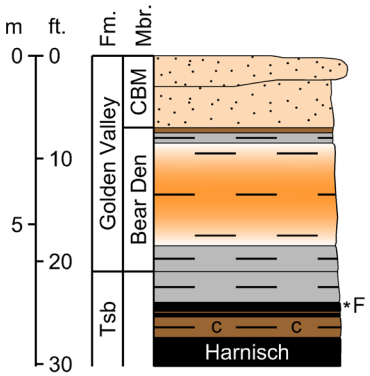
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 322

T.140N., R.90W., Sec.8, NE/SW
Elevation at top 2,366 ft.



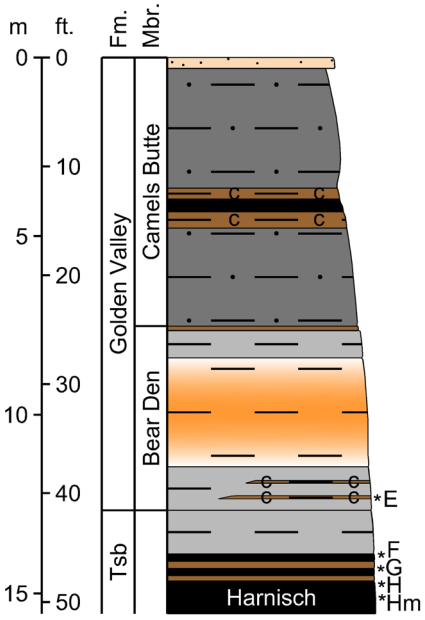
				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
F	2	5	41.03%	1539	631	23.5	21.3	54.9	11.9	3.34	18.6	50.7	8.3	22

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 323

T.140N., R.90W., Sec.8, SE/NW
Elevation at top 2,392 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
E	2	5	47.50%	3546	1685	64.0	74.8	310	69.0	11.1	47.4	68.1	32.0	25
F	2	5	54.45%	1367	744	25.2	25.3	77.8	18.0	3.87	24.8	27.6	16.9	15
G	2	5	42.00%	~389	~163		4.8	21.8			11.2	12.4	9.8	3
H	2	5	36.68%	304	112	3.1	3.8	18.9	4.6	0.57	9.6	5.0	3.5	1
Hm	2	5	22.83%	111	25	0.6	0.7	3.5	0.9	0.10	1.2	2.4	1.7	<1

∑REE includes Y and Sc

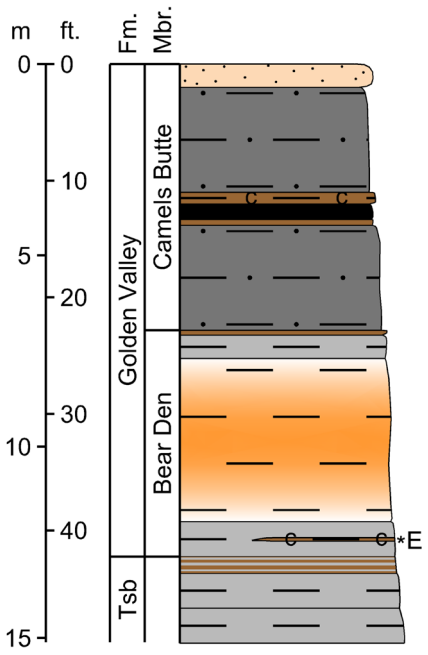
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 324

T.140N., R.90W., Sec.8, SW/NW

Elevation at top 2,392 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
E	2	5	50.13%	6603	3310	107	137	695	160	19.8	59.1	62.3	34.0	27

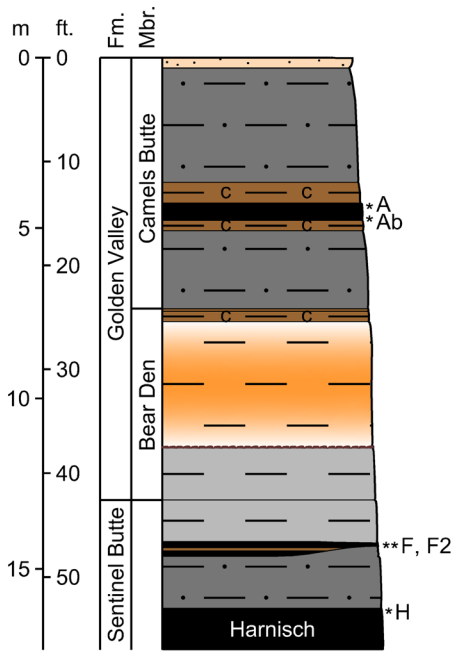
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 325

T.140N., R.90W., Sec.6, SE/SE

Elevation at top 2,405 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	2	5	18.99%	~929	~177		5.9	25.1			3.7	18.5	4.2	4
Ab	2	5	32.82%	1331	437	23.5	27.3	103	17.0	4.20	27.4	14.7	9.1	8
F	2	5	40.40%	5190	2097	76.8	81.3	241	52.3	11.9	23.0	62.5	15.8	23
F2	2	5	33.77%	13157	4443	150	166	695	167	24.1	24.2	134	22.0	30
H	2	5	25.23%	~1110	~280		13.3	47.1			10.9	15.2	6.0	7

∑REE includes Y and Sc

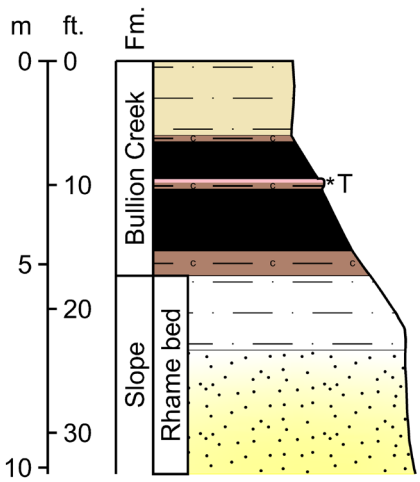
See Appendix B for additional elemental analyses from this outcrop.

(~) Includes estimated minor lanthanides.

REE Section 326

T.136N., R.104W., Sec.15, NW1/4

Elevation at top 2,630 ft.



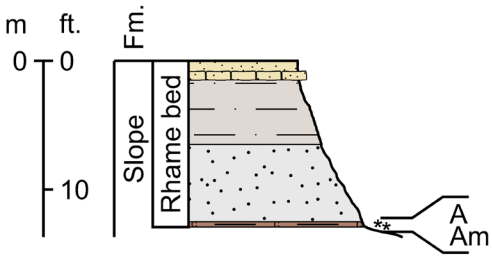
				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
T	5	13	94.37%	87	82	1.4	1.7	12.3	3.4	0.23	5.0	1.5	13.6	2

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 327

T.133N., R.103W., Sec.20, NE/SE
Elevation at top 3,010 ft.



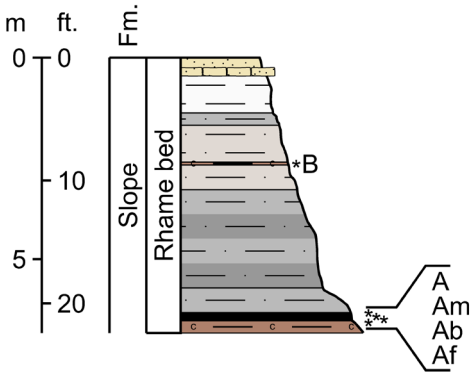
				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	2	5	89.41%	732	654	17.4	21.4	109	27.2	3.15	20.0	10.4	29.9	12
Am	2	5	90.01%	772	695	19.2	22.9	113	28.2	3.45	18.5	9.0	28.4	10

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 328

T.133N., R.103W., Sec.20, NW/SW
Elevation at top 3,020 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
B	2	5	89.13%	375	334	6.5	8.7	52.1	13.7	1.21	27.8	8.0	44.2	41
A	2	5	58.69%	1246	731	23.1	25.3	105	25.2	3.77	19.9	18.1	16.6	15
Am	3	8	48.86%	1440	704	22.7	23.4	89.9	22.0	3.57	17.1	19.4	12.8	11
Ab	3	8	47.60%	1385	659	22.0	23.4	91.7	22.1	3.60	20.6	25.5	15.4	16
Af	3	8	91.47%	190	174	3.5	4.2	24.6	6.4	0.60	14.5	12.7	22.9	14

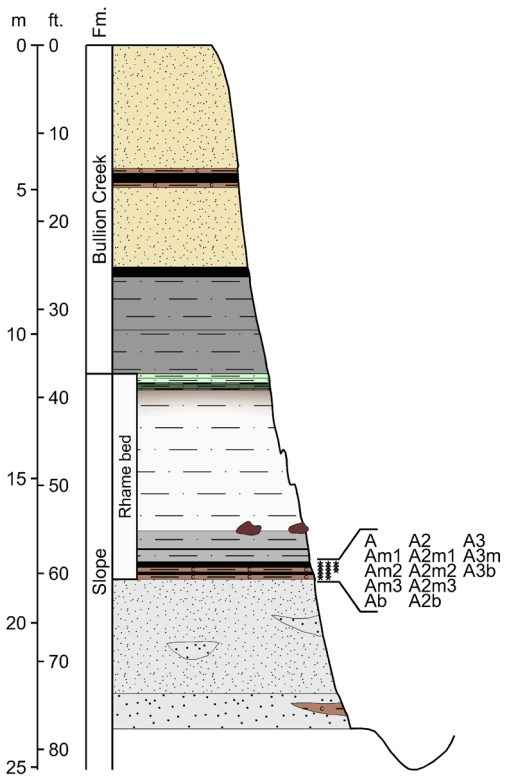
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 329

T.135N., R.102W., Sec.32, E1/2

Elevation at top 2,737 ft.



					Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis									
ID	Thickness		Ash%	∑REE	∑REE	Dy	Gd	Nd	Pr	Tb	Sc	Co	Ga	Ge
A	2	5	46.21%	4507	2083	50.0	65.1	320	81.8	9.23	38.3	110	33.6	47
Am1	2.5	6	37.83%	3527	1334	35.2	43.9	213	51.5	6.30	38.2	81.3	32.9	60
Am2	3.5	9	62.90%	907	570	14.5	16.7	86.1	22.0	2.41	17.7	9.7	21.4	10
Am3	3.5	9	38.37%	4010	1539	44.3	54.7	280	66.5	7.76	30.1	12.1	25.3	41
Ab	3.5	9	85.47%	380	325	7.8	8.5	47.1	12.4	1.29	13.9	5.8	26.0	4
A2	2	5	62.20%	1250	777	20.2	28.1	149	35.9	3.87	28.1	16.7	32.2	27
A2m1	3	8	40.03%	2977	1192	30.5	39.6	223	53.2	5.53	26.0	14.7	25.0	35
A2m2	3	8	41.11%	1820	748	20.7	26.5	139	32.5	3.65	24.6	8.0	15.8	18
A2m3	6	15	81.02%	552	447	11.6	13.5	76.7	19.1	1.96	16.6	4.5	22.7	10
A2b	4	10	72.99%	541	395	9.8	11.7	67.3	16.9	1.68	19.2	6.3	26.0	16
A3	2	5	45.30%	3072	1392	34.3	48.0	269	64.4	6.46	28.6	13.5	31.2	56
A3m	4	10	36.63%	959	351	8.9	10.3	52.3	12.8	1.48	17.2	7.3	15.0	23
A3b	4	10	41.20%	2383	982	26.4	35.4	188	43.1	4.83	28.8	11.0	18.3	24

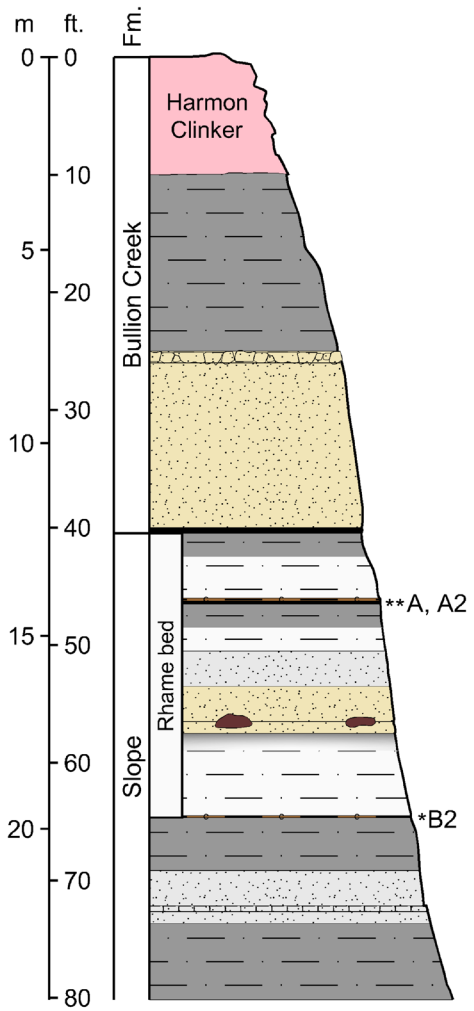
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 330

T.136N., R.106W., Sec.29, NE1/4

Elevation at top 3,247 ft.



				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	3	8	65.80%	1391	915	28.0	35.8	178	41.2	5.22	26.5	24.3	22.0	80
A2	4	10	58.44%	1491	871	27.8	32.8	161	37.7	4.89	26.8	33.3	20.3	76
B2	1	3	82.74%	869	719	20.5	27.2	130	31.1	3.90	19.7	10.9	24.4	13

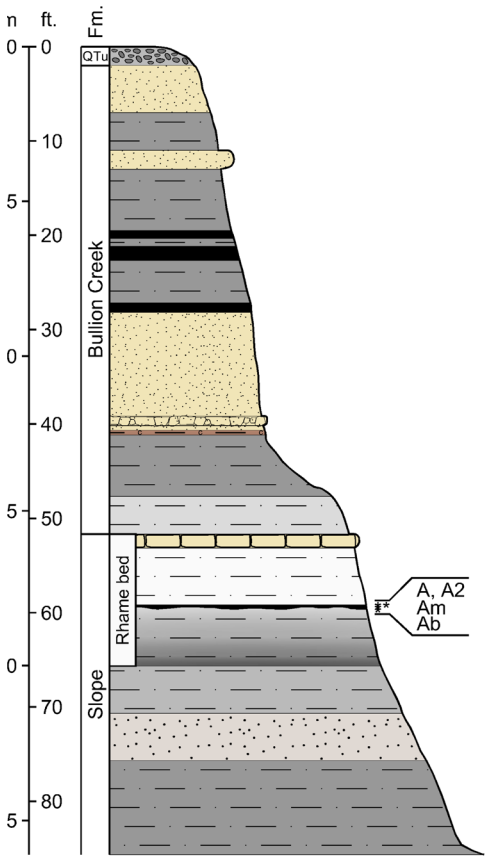
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 331

T.134N., R.102W., Sec.21, W1/2SW

Elevation at top 2,801 ft.



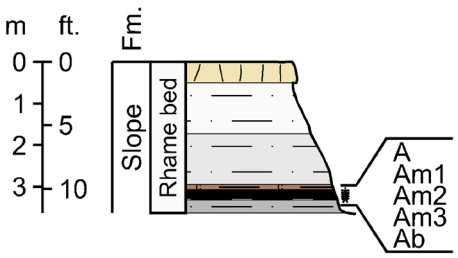
				Concentrations in parts per million (µg/g)										
	in	cm	wt.%	ash basis	dry whole basis									
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	2	5	73.79%	1651	1219	20.3	30.6	194	54.4	4.18	33.1	5.7	24.6	13
Am	2	5	50.20%	3414	1714	28.1	42.1	273	79.7	5.80	42.2	7.6	20.6	18
Ab	2	5	53.39%	1632	871	15.0	21.3	136	37.7	2.94	34.1	7.4	26.6	15
A2	3	8	44.63%	4219	1883	36.4	53.9	346	96.6	7.56	59.4	5.4	28.1	102

∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 332

T.134N., R.102W., Sec.28, NW/NE
Elevation at top 2,758 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	2	5	36.36%	4877	1773	41.7	58.1	303	80.9	8.18	45.0	25.7	17.4	16
Am1	2	5	24.02%	11749	2822	72.2	94.3	456	122	13.4	50.5	37.4	20.5	21
Am2	2	5	24.37%	12241	2983	81.1	102	482	127	14.9	55.3	42.4	36.1	20
Am3	2	5	32.26%	8111	2617	69.8	89.6	448	115	12.8	65.1	48.7	48.7	19
Ab	2	5	87.33%	886	774	20.1	23.2	119	30.8	3.44	21.1	12.8	40.9	17

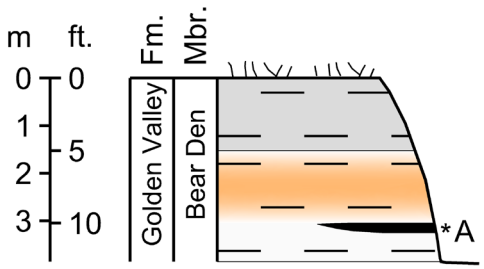
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

REE Section 333

T.143N., R.90W., Sec.2, NW1/4

Elevation at top 2,225 ft.



				Concentrations in parts per million (µg/g)									
	in	cm	wt.%	ash basis	dry whole basis								
ID	**Thickness**		**Ash%**	**∑REE**	**∑REE**	**Dy**	**Gd**	**Nd**	**Pr**	**Tb**	**Sc**	**Co**	**Ga**	**Ge**
A	3	8	41.96%	3014	1254	33.8	44.3	240	57.5	6.31	53.3	26.9	34.0	19

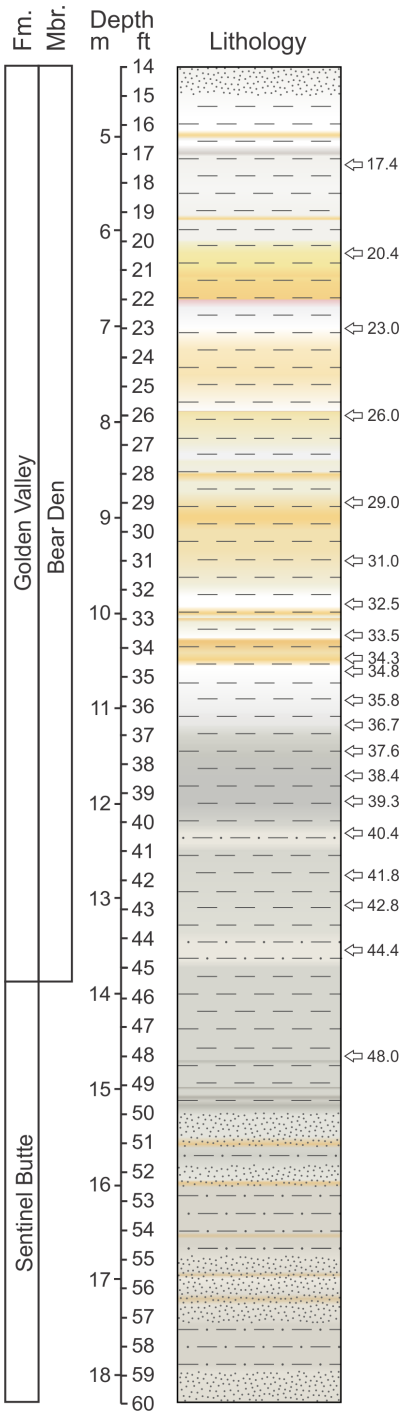
∑REE includes Y and Sc

See Appendix B for additional elemental analyses from this outcrop.

XRD Section 28

T.136N., R.96W., Sec.16, NW1/4

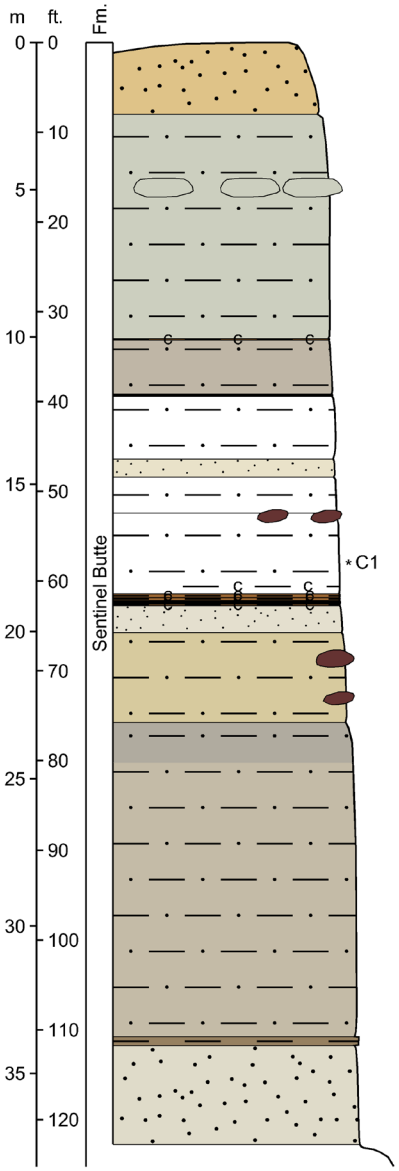
Surface Elevation 2,866 ft.



SAMPLE ID	Smectite	Illite-Smectite	Illite	Kaolinite	Chlorite
17.4	80%			20%	
20.4	2%		1%	97%	
23	1%		6%	93%	
26			15%	85%	
29			17%	83%	
31			33%	67%	
32.5			51%	49%	
33.5	4%		44%	52%	
34.3	1%		38%	61%	
34.8	10%		37%	52%	
35.8	14%		42%	44%	
36.7	48%		27%	26%	
37.6	49%		30%	8%	12%
38.4	32%		36%	21%	11%
39.3	39%		35%	8%	17%
40.4	49%		38%	4%	8%
41.8	68%		21%	3%	7%
42.8	55%		33%	3%	9%
44.4	65%		27%	2%	6%
48	54%		34%	2%	10%

Relative abundances in the < 4 µm size fraction

See Appendix E for other mineralogical analyses



XRD Section 307

T.144N., R.100W., Sec.16, SW/SW/SW

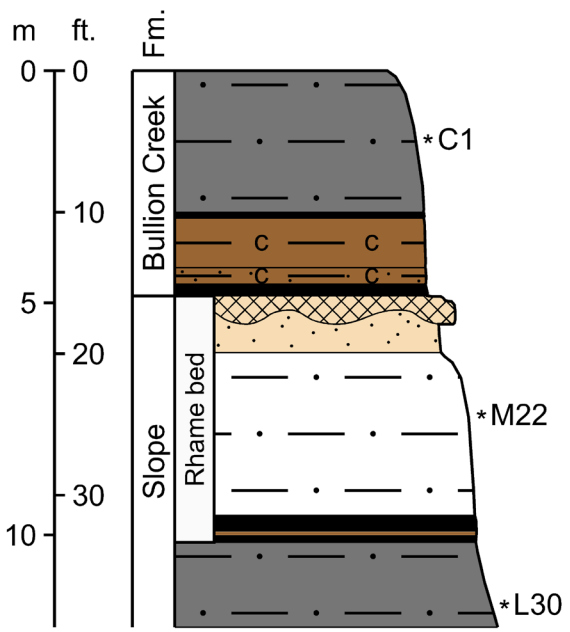
Elevation at top 2,547 ft.

SAMPLE ID	Smectite	Illite-Smectite	Illite	Kaolinite	Chlorite
C1	68%		27%	2%	4%
	Relative abundances in the < 4 µm size fraction				

See Appendix E for other mineralogical analyses

XRD Section 311

T.137N., R.103W., Sec.31, NW/SE
Elevation at top 2,585 ft.



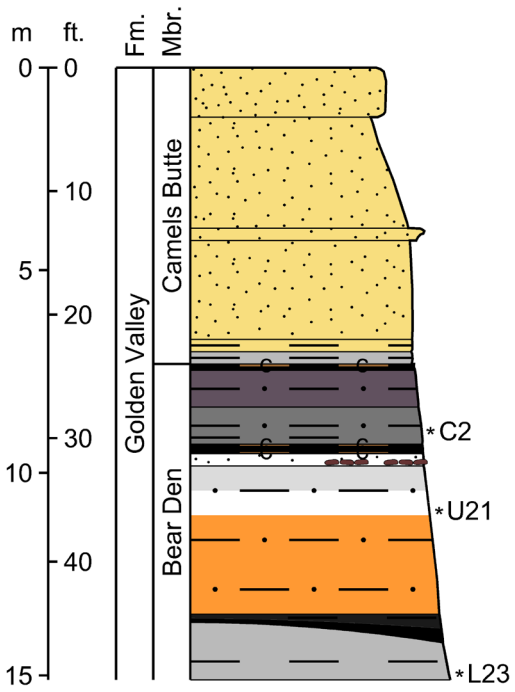
SAMPLE ID	Smectite	Illite-Smectite	Illite	Kaolinite	Chlorite
C1			34%	41%	25%
M22		42%	12%	45%	
L30	76%		12%	7%	5%
	Relative abundances in the < 4 µm size fraction				

See Appendix E for other mineralogical analyses

XRD Section 312

T.137N., R.97W., Sec.36, NW/SE

Elevation at top 2,857 ft.



SAMPLE ID	Smectite	Illite-Smectite	Illite	Kaolinite	Chlorite
C2			53%	22%	25%
U21			15%	85%	
L23	14%		65%	4%	17%

Relative abundances in the < 4 µm size fraction

See Appendix E for other mineralogical analyses

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
2-A	68.84%	43.1	2.1	1.22	0.71	3.0	0.41	21.3	0.17	18.3	4.9	3.5	5.6	0.41	0.17	1.11	10.3	1.08	30.4	178	1.1	1.39	32	4.7	16.5	43	2.3	0.03	43.4	1360	19	10.6	20	8.8	6	143	0.71	5.7	3200	3.7	3.8	89	36	154
2-BR	90.19%	191	7.7	3.31	2.93	10.4	1.22	98.1	0.38	72.6	20.3	12.5	10.9	1.45	0.41	2.69	28.1	1.67	29.8	1370	1.4	2.43	66	14.5	19.6	3	2.7	0.03	20.5	2210	34	4.8	58	10.7	62	92	0.80	17.9	3280	5.7	4.5	156	68	136.0
2-B1	30.30%	772	34.9	15.3	16.9	55.1	5.66	211	1.69	352	85.9	83.5	54.3	7.48	1.96	12.4	97.2	1.50	9.8	141	3.4	0.98	69	3.3	21.6	36	4.4	0.05	40.2	3300	25	6.2	12	5.2	4	450	0.40	4.3	1590	1.9	12.8	326	36	285
2-B2	33.74%	422	22.5	10.6	9.73	33.4	3.82	122	1.28	200	47.9	47.2	41.0	4.66	1.40	8.91	72.6	1.35	13.0	1180	2.8	0.76	32	6.6	17.7	24	3.4	0.03	25.0	7320	61	12.4	41	8.5	7	874	0.63	6.6	2150	9.5	19.2	94	32	149
2-B3	15.55%	833	36.1	15.7	15.9	58.1	6.01	224	1.65	366	90.0	77.7	38.2	7.78	1.97	12.0	112	1.04	20.0	302	2.9	0.14	10	3.1	16.2	24	1.0	0.02	19.6	3360	18	17.1	3	2.2	2	592	0.18	2.4	624	1.5	10.4	26	18	36.2
2-B4	14.10%	731	24.2	11.7	9.40	39.3	4.27	257	1.27	253	68.2	45.1	26.4	5.13	1.46	8.83	94.6	0.43	24.4	352	3.7	0.09	8	3.7	10.6	11	0.7	<0.02	16.7	3580	19	16.0	3	1.5	1	931	0.14	1.4	499	1.6	3.1	19	4	21.8
2-B5	15.03%	400	14.4	7.43	4.76	22.6	2.71	140	0.79	143	38.5	22.4	11.6	2.97	0.92	5.42	71.1	0.27	8.4	435	3.0	0.18	9	3.5	7.4	6	0.9	<0.02	13.3	4320	28	10.5	13	2.3	2	843	0.18	2.1	626	5.5	2.2	21	4	30.6
2-B6	14.71%	599	12.2	7.34	3.02	18.5	2.56	349	0.83	115	39.4	12.9	7.9	2.30	0.93	5.48	83.5	0.43	7.2	917	5.9	0.16	9	4.9	6.5	4	0.5	<0.02	18.2	4120	21	6.0	3	1.2	2	1460	0.11	1.4	535	1.1	1.0	26	14	15.8
2-B7	26.40%	303	10.4	6.36	2.42	13.9	2.22	196	0.69	69.7	21.7	9.9	10.6	1.88	0.80	4.64	87.1	1.23	17.0	159	5.6	1.64	31	22.7	12.1	5	1.0	0.03	27.6	4250	21	11.2	44	4.9	13	605	0.24	3.9	1160	1.2	7.6	99	37	37.7
2-B8	65.53%	114	5.4	3.21	1.61	7.2	1.11	89.7	0.39	36.6	10.2	6.8	15.4	1.01	0.43	2.64	39.4	0.97	10.5	402	4.8	5.96	80	21.8	19.9	3	2.4	0.07	36.3	4240	32	3.7	72	8.1	55	327	0.72	10.4	3420	1.3	4.7	157	188	84.4
2-B9	77.87%	66.9	3.7	2.29	1.23	5.0	0.77	50.3	0.32	27.4	7.4	5.4	14.7	0.69	0.32	2.02	25.5	1.19	22.0	525	3.6	5.21	90	54.5	20.9	2	2.8	0.07	30.6	3970	39	5.7	136	9.7	64	226	0.85	11.7	3980	1.3	5.7	162	294	89.6
2-B10	71.76%	92.5	5.3	3.19	1.67	7.1	1.08	69.4	0.42	37.3	10.1	7.1	15.4	0.98	0.43	2.74	36.0	1.31	26.4	500	3.7	3.73	87	34.2	20.0	3	2.8	0.05	23.5	3970	32	7.7	64	10.0	57	247	0.78	10.4	3540	1.4	6.5	171	317	97.4
2-B11	71.18%	151	8.5	4.89	2.52	12.0	1.70	105	0.60	62.2	17.1	10.2	16.6	1.62	0.62	3.79	58.8	1.10	28.1	514	3.7	3.58	83	24.4	21.1	6	2.5	0.06	24.0	4300	34	6.7	54	9.4	61	254	0.77	10.6	3620	1.4	5.6	153	186	91.8
2-B12	59.61%	140	11.0	6.45	3.08	13.9	2.26	87.2	0.77	67.2	17.6	11.6	15.6	2.04	0.83	4.96	72.3	2.51	166	948	3.1	2.67	69	16.4	26.1	50	2.1	0.04	18.2	3650	41	16.8	41	9.1	48	259	0.60	8.4	2770	2.2	5.2	150	149	83.4
2-BF	85.66%	165	11.4	6.14	3.61	15.4	2.20	102	0.69	79.9	21.2	14.2	15.9	2.18	0.79	4.72	65.3	0.84	49.4	679	2.7	3.47	85	24.8	24.7	8	2.6	0.06	28.9	4110	57	6.4	68	11.0	69	146	0.96	10.3	4350	2.4	3.4	133	148	92.0
2-BF2	94.08%	143	4.8	2.37	2.02	6.9	0.80	50.7	0.31	53.0	13.6	10.3	14.3	0.92	0.32	2.21	17.1	1.80	156	374	0.8	2.34	63	3.5	18.9	3	2.6	0.02	36.6	1520	29	3.5	102	18.1	38	61	1.41	9.4	6660	33.0	6.7	87	16	84.9
2-C1	19.76%	25.5	4.9	3.81	0.98	4.0	1.16	15.1	0.61	13.0	3.3	2.9	8.3	0.71	0.55	3.62	37.6	2.54	13.8	779	6.4	0.67	20	5.1	8.6	5	0.8	0.02	4.2	4760	163	9.2	13	6.4	10	503	0.21	2.6	869	3.0	7.7	39	19	42.6
2-C2	68.28%	49.9	3.6	2.22	1.16	4.6	0.73	25.9	0.33	24.1	6.3	4.8	11.2	0.65	0.31	2.08	20.5	2.19	25.8	696	2.4	3.50	62	13.4	17.2	7	2.1	0.04	25.0	8580	610	5.4	48	10.7	55	256	0.70	7.9	2890	3.9	3.6	116	68	102
2-D1	72.15%	43.6	3.7	2.45	1.09	4.1	0.79	23.5	0.38	20.4	5.4	4.2	15.1	0.63	0.36	2.38	21.5	3.86	30.2	709	2.8	9.05	76	15.3	19.3	3	1.9	0.06	34.6	12800	262	10.7	51	7.7	114	290	0.64	9.9	2870	2.3	8.8	151	113	68.4
2-D2	35.48%	22.5	4.2	3.22	0.82	3.2	0.97	11.8	0.56	11.4	2.8	2.7	13.5	0.59	0.49	3.34	27.0	7.38	62.8	527	4.5	3.71	40	48.4	14.5	12	1.3	0.03	13.9	7010	137	23.8	141	13.2	46	399	0.29	5.1	1160	5.0	13.5	123	65	94.0
3-A1	25.63%	9.4	3.2	2.34	0.60	2.3	0.74	5.1	0.34	5.5	1.3	1.6	6.6	0.46	0.34	2.13	25.3	4.70	85.4	1080	5.7	0.49	12	2.3	7.2	9	0.5	<0.02	3.6	3310	112	13.6	31	2.7	5	352	0.11	2.6	337	5.5	10.3	27	25	20.5
3-A2	12.53%	7.4	3.9	2.80	0.55	2.7	0.90	3.9	0.38	5.2	1.1	1.7	6.3	0.55	0.39	2.40	29.6	2.54	29.1	121	5.1	0.05	5	4.6	8.3	5	0.2	<0.02	0.6	3800	105	24.7	12	0.9	1	429	0.04	1.8	169	4.1	11.3	21	10	8.6
3-B1	18.42%	16.7	2.7	1.73	0.55	2.6	0.58	8.5	0.24	8.8	2.1	2.1	4.7	0.44	0.24	1.48	20.6	5.27	54.2	121	3.0	0.49	8	3.2	7.0	10	0.6	<0.02	2.2	3490	81	13.3	12	3.2	5	384	0.05	1.2	180	3.8	7.6	42	7	42.0
3-B2	19.91%	3.7	0.8	0.58	0.16	0.7	0.19	2.0	0.08	2.0	0.5	0.5	1.1	0.12	0.08	0.51	8.0	0.83	58.9	319	2.6	0.06	3	1.2	2.4	1	<0.2	<0.02	1.2	2360	52	21.5	8	0.3	1	313	<0.02	0.3	44	6.6	1.7	3	7	2.7
3-C1	30.70%	21.9	3.4	2.50	0.67	3.4	0.76	17.4	0.34	11.5	2.6	2.4	7.6	0.49	0.31	2.04	34.5	7.71	305	189	4.3	1.18	43	6.4	9.1	41	2.0	<0.02	6.4	2500	60	12.1	117	6.6	19	225	0.17	1.8	648	25.5	1.5	80	29	108
3-C2	28.33%	15.2	2.9	2.01	0.53	2.5	0.61	9.3	0.28	8.0	1.9	1.9	10.3	0.41	0.26	1.83	19.7	5.41	45.6	418	5.3	2.08	25	10.8	7.4	4	1.3	0.02	9.4	3760	97	15.2	31	5.7	29	424	0.26	3.5	932	0.8	6.3	74	40	47.8
10B-A1	41.91%	20.1	2.1	1.52	0.49	2.0	0.48	10.7	0.24	9.2	2.4	1.9	8.7	0.34	0.22	1.48	14.5	5.95	82.3	411	4.1	3.92	37	4.7	11.3	30	1.7	0.03	13.8	5890	166	12.6	25	10.4	38	196	0.28	4.4	1350	1.8	4.7	104	57	131
10B-A2	10.78%	6.7	2.6	1.92	0.38	1.7	0.60	3.4	0.30	3.9	0.9	1.2	8.5	0.35	0.28	1.85	17.6	5.39	17.6	111	4.8	0.71	13	5.0	8.5	16	0.6	<0.02	2.3	4510	135	10.1	9	5.2	5	275	0.09	1.8	316	5.8	5.0	42	9	55.9
10B-B1	51.09%	27.0	2.5	1.69	0.70	2.6	0.54	14.7	0.26	12.7	3.3	2.6	10.5	0.41	0.24	1.63	16.3	4.19	54.2	695	3.4	4.77	50	10.9	16.5	17	2.1	0.04	22.9	7590	168	12.4	62	10.1	58	344	0.40	6.2	2030	2.3	10.2	101	46	165
10B-B2	19.17%	17.9	3.6	2.44	0.76	3.1	0.80	9.9	0.34	9.4	2.3	2.4	7.1	0.55	0.34	2.12	28.8	1.67	13.3	217	6.3	0.56	14	2.0	6.4	5	0.8	0.02	5.8	4650	92	3.9	14	5.6	5	512	0.29	3.6	1500	1.4	7.3	26	16	36.6
10B-B3	68.37%	39.7	2.7	1.89	0.76	3.1	0.60	22.2	0.30	17.2	4.7	3.2	10.8	0.46	0.28	1.84	19.3	1.31	3.1	517	2.6	6.40	55	0.9	22.8	2	2.0	0.05	30.4	5080	59	2.2	6	15.8	46	288	1.03	7.1	5900	2.7	3.4	114	11	80.8
10B-C1	39.60%	28.0	2.7	1.83	0.73	2.8	0.58	14.3	0.29	12.7	3.4	2.7	11.2	0.45	0.27	1.72	17.2	4.95	16.1	398	3.0	4.61	64	9.4	14.6	5	1.6	0.04	20.3	6310	84	10.8	16	6.3	48	368	0.32	7.2	1910	2.9	10.4	125	372	80.4
10B-C2	18.19%	7.7	2.4	1.92	0.44	1.8	0.58	3.8	0.33	4.5	1.0	1.3	5.4	0.35	0.28	1.90	18.0	3.60	23.3	221	2.6	0.75	20	6.5	6.4	5	0.5	<0.02	5.9	3810	433	13.9	15	1.7	5	372	0.06	2.5	341	5.9	5.7	42	22	20.4
12-Z	91.86%	114	10.7	6.86	2.57	12.4	2.17	70.2	0.93	54.9	12.7	10.5	19.9	1.70	0.88	5.81	75.5	3.66	22.5	938	3.5	9.91	106	24.4	27.4	4	3.4	0.08	44.7	12400	204	4.7	69	13.7	141	166	0.96	12.6	4170	1.9	5.6	205	170	107
12-B	39.12%	25.9	3.3	2.34	0.93	3.0	0.72	13.6	0.36	12.6	3.2	2.8	11.6	0.51	0.34	2.24	21.1	7.70	51.6	2020	5.2	4.70	40	15.3	12.3	25	2.1	0.03	14.2	6710	99	17.0	59	9.8	34	430	0.29	6.0	1420	2.7	14.1	127	89	163
12-C	27.92%	14.9	2.8	2.20	0.50	2.0	0.66	7.9	0.37	7.2	1.8	1.7	12.1	0.40	0.33	2.20	19.0	6.28	32.0	398	5.7	3.44	28	11.4	10.3	16	1.2	0.03	10.3	5670	52	14.2	24	6.6	31	467	0.22	4.9	1050	3.3	10.2	77	92	69.4
16-B1	93.54%	103	11.7	8.19	2.46	11.9	2.65	55.9	1.18	50.8	12.6	9.9	18.9	1.83	1.12	7.23	101	2.46	21.4	746	3.2	10.0	86	13.8	26.2	7	3.1	0.07	41.9	11800	101	5.1	46	13.0	152	73	1.07	12.0	4080	2.4	8.2	145	141	110
16-B2	81.85%	142	20.0	12.8	4.71	21.8	4.27	65.0	1.83	80.6	19.2	18.2	24.8	3.37	1.75	11.1	137	8.11	57.1	666	5.3	8.36	102	42.5	27.1	19	4.9	0.10	37.6	10400	140	20.6	161	12.1	132	176	0.90	14.6	3450	2.0	36.6	206	170	348

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
16-C	72.85%	50.7	5.1	3.62	1.21	5.1	1.13	25.6	0.57	24.0	6.3	4.9	16.5	0.81	0.53	3.52	33.8	7.27	56.2	613	4.2	7.53	67	37.6	22.6	22	3.7	0.06	39.4	12500	159	17.3	90	12.1	126	189	0.68	10.3	2640	2.1	12.0	137	112	280
16-D	38.39%	29.5	3.4	2.61	0.73	3.0	0.79	14.9	0.43	13.4	3.6	2.9	11.0	0.53	0.39	2.68	24.4	4.44	29.7	270	4.4	2.81	37	10.2	11.5	15	3.3	0.03	14.2	5980	87	7.8	37	13.1	42	379	0.36	7.4	1500	2.9	6.4	100	47	361
16B-AR	87.29%	99.9	11.6	7.57	2.45	12.5	2.52	53.1	0.99	50.6	12.4	10.0	15.4	1.93	1.02	6.30	88.8	1.93	22.4	634	3.3	7.86	81	28.2	26.7	4	3.3	0.08	58.5	9810	110	5.9	61	15.0	122	163	1.06	12.6	4370	3.0	6.4	153	108	139
16B-A1	69.71%	162	25.8	17.9	4.33	25.5	5.99	95.4	2.21	83.4	19.9	16.8	17.7	4.09	2.31	13.6	246	2.47	37.4	314	8.0	4.06	55	20.3	35.5	7	4.0	0.09	106	4170	76	12.5	39	17.5	41	207	1.20	12.9	5400	2.4	10.4	153	79	201
16B-A2	54.56%	137	17.5	11.7	3.18	19.0	3.98	84.8	1.40	65.6	16.1	12.9	17.2	2.90	1.49	8.62	171	2.59	26.6	150	12.2	1.52	43	14.6	36.4	8	3.4	0.11	104	2400	84	12.1	27	16.4	13	264	1.09	14.6	5110	2.4	9.5	116	77	178
16B-A3	75.18%	59.5	5.5	3.84	1.10	6.2	1.24	38.5	0.55	25.5	6.7	4.7	12.5	0.90	0.52	3.36	50.0	1.82	7.6	144	8.1	2.47	54	5.2	45.9	5	3.7	0.09	81.3	2580	44	6.0	16	29.6	15	203	1.97	11.1	8490	4.0	4.0	100	34	152
16B-A4	41.23%	29.3	3.2	2.38	0.56	3.2	0.75	18.5	0.36	12.2	3.2	2.3	9.6	0.49	0.33	2.13	28.7	2.70	21.3	89	7.7	1.96	31	9.2	32.7	21	3.7	0.05	41.8	2210	41	5.3	22	12.6	10	262	0.78	6.1	3350	2.6	3.6	59	14	242
16B-AF	84.96%	33.5	1.8	1.28	0.51	2.3	0.40	18.7	0.21	13.3	3.7	2.4	7.0	0.32	0.19	1.28	12.7	1.05	7.4	247	2.6	3.89	41	4.9	21.1	5	3.1	0.04	42.7	1680	27	1.7	19	16.3	22	113	1.08	6.1	4860	3.1	3.9	68	21	131
16B-B	59.05%	52.4	5.8	3.74	1.34	6.3	1.26	28.3	0.50	25.6	6.4	5.0	14.6	0.96	0.48	3.07	51.1	3.54	58.5	500	6.2	4.86	57	40.0	16.4	7	3.2	0.05	29.3	10700	293	11.6	145	9.5	72	141	0.56	7.8	2600	1.5	10.4	134	233	221
16B-C1	33.07%	19.6	2.6	1.84	0.59	2.4	0.57	10.6	0.29	9.5	2.4	2.1	12.1	0.40	0.27	1.80	18.0	7.53	58.2	230	3.5	2.96	31	11.4	10.9	10	2.7	0.03	12.0	5140	94	18.7	41	10.3	42	330	0.28	4.2	1170	2.2	7.5	96	64	207
16B-C2	20.90%	13.6	2.2	1.51	0.46	1.8	0.47	7.0	0.24	6.8	1.7	1.6	7.3	0.33	0.22	1.45	14.2	4.81	41.0	130	2.9	1.66	18	7.2	6.8	2	0.8	0.02	6.9	3410	52	19.5	39	2.9	22	336	0.16	3.1	620	3.5	6.7	50	52	35.1
16B-C3	45.21%	25.4	2.8	1.93	0.69	2.6	0.61	13.5	0.31	11.6	3.1	2.5	11.6	0.44	0.28	1.93	18.1	3.81	24.3	399	4.0	4.15	49	20.5	13.5	5	1.7	0.05	22.6	7050	145	7.8	56	7.7	55	318	0.40	6.5	1880	1.5	8.8	105	138	103
16B-D1	28.32%	13.4	2.6	2.27	0.48	1.8	0.64	7.0	0.43	6.7	1.7	1.6	11.4	0.36	0.35	2.57	19.2	3.68	16.8	231	3.6	1.28	70	5.9	13.9	32	7.0	<0.02	7.5	3520	78	6.2	35	31.4	19	329	0.28	3.7	1370	5.5	4.2	277	51	878
16B-D2	14.99%	3.0	0.2	0.15	0.08	0.3	0.05	1.7	0.02	1.3	0.3	0.3	0.8	0.04	0.02	0.13	1.9	0.17	25.2	178	0.2	0.09	3	0.9	1.4	1	0.2	<0.02	1.2	1850	72	4.9	2	0.9	1	319	0.03	0.5	133	0.9	0.4	8	4	16.9
16B-D3	52.22%	37.6	2.8	1.87	0.78	3.0	0.58	19.0	0.29	16.7	4.5	3.4	11.8	0.47	0.27	1.82	15.8	3.18	23.0	359	2.0	5.57	65	14.3	14.6	3	3.1	0.05	25.3	7000	81	7.8	55	10.9	81	286	0.51	8.5	2120	1.2	9.3	137	35	132
19-A1	34.29%	180	24.4	14.6	6.00	28.7	5.03	89.6	1.95	102	23.9	22.5	30.4	4.28	1.91	11.8	152	4.90	118	789	6.1	1.53	53	64.4	13.6	6	1.8	0.06	5.3	3960	41	45.9	153	6.2	20	823	0.19	8.1	812	4.7	11.9	64	58	87.7
19-A2	44.96%	82.8	9.7	5.88	2.37	11.1	2.01	44.0	0.77	40.6	10.1	8.5	12.4	1.67	0.77	4.84	63.3	3.01	80.1	1340	5.7	2.16	39	29.3	9.2	3	1.3	0.04	10.4	4130	67	22.5	83	5.0	27	835	0.28	7.4	1370	3.5	6.7	87	47	48.5
19-A3	43.02%	34.6	2.8	1.76	0.86	3.3	0.59	19.1	0.25	15.8	4.1	3.1	8.0	0.49	0.24	1.56	20.3	2.11	47.7	914	2.3	4.16	38	8.5	11.0	2	1.3	0.03	12.4	3870	67	6.6	25	5.7	48	433	0.39	5.0	1800	1.3	3.0	77	39	45.9
19-A4	60.62%	55.2	4.1	2.50	1.25	5.0	0.82	29.5	0.36	25.3	6.6	5.1	18.3	0.72	0.35	2.28	26.6	3.58	30.1	828	3.5	8.55	92	13.7	17.3	3	2.7	0.08	24.3	4740	46	8.2	40	10.5	90	395	0.67	16.3	3230	1.8	12.0	128	46	109
19-D1	83.07%	57.0	3.1	2.12	1.07	4.0	0.67	32.7	0.33	24.4	6.8	4.5	14.3	0.56	0.30	2.03	19.6	5.39	44.6	1090	1.9	10.3	84	5.6	21.6	3	3.1	0.07	27.9	6190	74	17.0	17	10.8	119	370	0.79	14.4	3360	1.4	7.1	144	54	117
19-D2	51.17%	37.6	3.0	1.79	0.92	3.5	0.61	20.5	0.24	17.0	4.6	3.5	9.8	0.53	0.24	1.51	21.0	5.54	90.7	951	4.3	5.42	41	6.8	11.0	2	1.5	0.04	10.6	3530	65	18.0	28	6.8	39	561	0.37	6.9	1600	1.2	8.3	66	34	58.1
19-D3	16.11%	4.5	1.4	1.00	0.23	0.9	0.31	2.4	0.17	2.3	0.6	0.7	5.7	0.18	0.15	1.05	8.4	2.12	79.9	234	1.4	0.35	10	7.3	5.1	4	0.3	<0.02	2.7	1740	62	10.3	22	1.6	3	112	0.08	1.6	322	4.0	2.2	24	24	14.8
19-D4	35.58%	23.6	2.9	2.08	0.64	2.6	0.65	12.2	0.35	11.0	2.9	2.4	11.6	0.44	0.31	2.13	17.2	2.67	43.2	546	2.6	2.19	40	6.7	9.3	14	2.3	0.02	12.6	3910	99	5.3	18	7.1	24	171	0.31	5.3	1500	1.9	2.6	78	42	227
19B-U	92.94%	87.6	4.1	2.48	1.45	5.7	0.79	47.5	0.39	41.1	10.3	7.4	22.0	0.78	0.36	2.40	18.1	2.27	3.2	456	1.5	12.4	101	2.5	38.9	3	4.2	0.09	66.6	5080	94	3.8	13	18.5	128	117	1.39	29.8	5090	2.8	8.9	188	28	131
19B-V	97.08%	36.6	2.2	1.45	0.58	2.4	0.44	19.6	0.25	16.6	4.3	3.1	7.6	0.35	0.22	1.62	11.3	1.53	1.5	145	0.4	2.04	38	0.9	19.9	2	3.5	0.02	30.7	1240	19	2.2	6	23.9	17	45	1.71	9.6	5930	2.9	4.1	68	11	111
19B-W	92.51%	22.3	2.2	1.57	0.47	1.9	0.46	15.3	0.27	9.4	2.5	2.0	19.4	0.32	0.24	1.73	12.8	1.18	3.3	506	1.3	6.07	89	1.1	21.6	2	2.9	0.07	24.9	4310	146	0.4	11	12.9	78	66	0.90	10.8	4820	2.5	1.5	163	20	92.0
19B-X	93.92%	61.9	2.3	1.68	0.58	2.4	0.48	44.8	0.30	20.3	6.1	3.0	23.0	0.34	0.25	1.89	12.9	1.66	3.4	610	1.9	11.8	105	3.5	28.6	2	3.7	0.07	36.9	5210	38	0.8	11	14.7	137	140	0.99	12.1	4250	3.2	2.0	195	26	115
19B-Y1	93.20%	194	10.3	4.91	3.76	14.0	1.75	90.9	0.58	88.8	23.2	17.8	17.1	1.97	0.64	4.11	39.2	2.68	22.9	737	2.5	4.30	86	67.6	24.8	5	3.2	0.07	31.4	3750	34	4.8	140	15.5	95	112	1.06	12.0	4470	1.8	7.8	156	207	103
19B-Y2	93.23%	161	11.1	5.76	3.55	13.7	1.97	79.1	0.74	78.0	19.5	15.9	17.8	1.97	0.79	5.14	48.9	2.92	44.6	1840	2.5	4.96	92	111	24.4	5	3.3	0.07	30.4	4820	75	9.6	176	15.4	105	138	1.07	12.4	4370	2.0	4.8	160	121	104
19B-Y3	90.87%	204	13.7	6.47	5.29	20.2	2.32	98.8	0.89	111	25.6	23.3	16.2	2.61	0.88	5.61	57.1	1.56	11.4	680	2.0	5.19	108	17.3	20.2	3	3.4	0.05	32.0	6360	87	8.3	66	14.1	87	147	1.03	12.6	3930	6.0	3.6	143	110	106
19B-Y4	94.05%	171	12.7	6.84	3.71	15.9	2.40	87.2	0.90	80.5	20.2	16.5	18.9	2.25	0.94	6.07	60.5	1.96	8.4	914	3.0	5.84	100	20.4	26.0	5	3.4	0.07	36.9	7660	92	2.4	55	15.7	112	133	1.08	12.7	4620	2.0	3.6	167	511	102
19B-Y5	93.36%	106	9.6	5.96	2.33	11.0	1.98	57.5	0.88	49.6	12.3	9.9	20.9	1.59	0.84	5.54	57.2	2.01	11.3	905	3.3	6.33	100	52.0	25.3	3	3.3	0.07	41.7	10800	214	3.4	173	15.3	115	127	1.05	12.3	4590	2.0	3.4	180	354	98.1
19B-Y6	92.87%	138	12.7	7.43	3.13	15.0	2.54	74.2	1.02	65.6	15.9	13.0	19.8	2.14	0.99	6.52	69.7	2.04	9.9	891	3.6	5.89	102	28.3	27.6	4	3.3	0.08	43.6	11500	232	2.7	81	16.0	102	125	1.14	13.9	4510	2.0	4.9	186	215	96.2
19B-Y7	93.91%	199	14.5	7.60	4.43	18.2	2.58	104	0.96	99.0	23.3	20.0	18.8	2.54	0.98	6.63	67.2	1.90	7.5	876	2.7	5.76	102	17.2	26.2	4	3.4	0.06	34.5	5430	59	2.0	42	16.5	115	127	1.16	13.1	4420	1.9	3.8	166	323	104
19B-Y8	93.17%	156	13.8	8.01	3.52	16.5	2.77	89.2	1.05	75.2	18.3	14.4	21.6	2.36	1.07	6.67	90.0	2.47	16.1	920	3.5	7.48	101	52.7	29.9	4	3.2	0.08	44.7	10900	192	2.9	85	15.7	129	151	1.12	15.2	4440	2.1	5.8	183	180	104
19B-Y9	90.99%	111	12.0	8.25	2.58	12.8	2.67	71.0	1.17	54.0	13.1	10.2	22.0	1.87	1.12	7.07	102	4.77	28.2	880	3.7	10.1	103	26.7	29.1	4	3.2	0.08	44.8	12800	206	6.4	73	11.6	141	175	0.81	13.7	4040	2.0	7.1	202	130	122
19B-Y10	89.21%	113	13.1	9.20	2.68	13.8	3.00	73.2	1.28	55.5	13.5	10.8	20.2	2.04	1.24	7.86	112	4.21	24.8	937	3.7	9.42	103	21.1	24.7	4	3.1	0.08	45.6	12800	219	5.3	58	11.2	130	163	0.83	12.9	4000	2.4	6.8	203	150	120
19B-Y11	92.26%	69.8	7.1	5.00	1.56	7.6	1.59	40.3	0.69	30.8	7.5	6.2	17.2	1.12	0.67	4.30	57.6	3.32	18.1	910	3.4	7.91	101	19.2	25.2	3	3.1	0.08	45.0	14100	209	4.3	63	11.5	108	133	0.83	12.8	4030	1.8	5.8	196	122	100.0

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
19B-A	59.07%	59.6	4.8	2.88	1.29	5.8	0.91	32.4	0.40	29.0	7.1	5.9	12.2	0.77	0.37	2.65	27.4	3.13	56.4	381	2.9	6.05	54	20.4	18.0	8	2.6	0.06	40.3	8520	149	9.7	47	11.5	72	303	0.74	10.3	2760	1.9	6.0	97	75	97.0
19B-D	21.63%	14.4	3.1	2.28	0.54	2.5	0.66	7.6	0.38	8.0	1.8	2.0	12.5	0.42	0.32	2.33	18.9	4.28	31.0	112	3.1	1.40	23	8.1	11.9	41	1.3	<0.02	8.4	4500	64	20.6	24	7.7	17	465	0.17	3.2	611	2.8	14.8	80	44	85.6
19B-Z	96.01%	59.9	4.0	2.30	1.24	5.0	0.73	34.0	0.31	29.3	7.2	5.7	13.2	0.68	0.30	2.12	20.3	1.12	9.7	650	1.5	4.53	74	19.7	18.0	2	2.9	0.04	35.3	9330	157	1.8	53	12.7	91	130	0.91	9.4	3740	1.6	2.4	111	92	86.7
19C-Y	91.45%	120	16.3	11.5	2.69	14.9	3.80	62.3	1.47	50.7	12.1	10.3	21.0	2.42	1.54	9.51	138	4.43	24.9	851	3.3	8.69	105	24.4	28.3	3	3.3	0.09	44.3	12500	187	6.2	69	12.5	113	122	0.88	13.3	4230	2.1	7.0	203	149	113.0
19C-A	35.22%	54.9	12.3	9.52	1.93	10.8	3.08	39.6	1.20	28.1	6.6	6.4	17.0	1.81	1.23	7.06	156	6.33	54.7	564	7.3	2.96	50	27.1	13.2	24	3.1	0.03	13.3	5270	101	16.2	26	7.7	40	424	0.36	4.4	1520	2.5	4.1	150	55	154
19C-Z	78.15%	40.4	10.3	8.08	1.61	7.7	2.41	22.5	1.39	21.6	5.1	5.5	29.4	1.40	1.22	8.62	76.6	0.68	4.4	436	3.6	2.66	47	5.9	9.3	2	1.3	0.04	19.5	8730	3470	0.7	19	4.8	47	71	0.37	5.5	1500	0.9	3.4	118	44	50.2
20-Y	93.53%	290	16.5	7.74	4.97	19.6	2.85	68.6	0.81	101	24.5	22.0	30.7	2.99	0.99	6.19	54.5	1.91	15.5	642	2.7	6.99	102	2.7	33.7	6	2.9	0.08	38.9	4980	38	1.2	12	15.4	133	121	0.98	7.8	4670	2.3	7.7	174	22	102
20-A1	66.89%	599	80.3	47.7	23.0	94.7	16.0	232	6.99	397	89.7	98.7	18.4	14.3	6.56	43.9	416	4.48	53.4	700	8.8	1.99	30	201	14.6	30	2.0	0.02	10.4	3300	68	37.5	355	4.5	19	405	0.25	2.5	917	3.2	4.1	121	539	116
20-A2	25.53%	260	33.0	21.0	7.82	37.8	7.03	117	2.86	151	35.3	32.7	10.2	5.65	2.80	17.4	224	2.83	25.2	268	9.0	0.64	9	31.9	8.7	9	0.5	<0.02	3.4	2540	48	44.4	58	1.3	6	386	0.08	0.9	274	3.8	1.7	28	422	23.0
20-A3	15.06%	153	20.4	11.8	5.66	24.0	4.03	58.6	1.58	99.8	22.6	23.8	13.9	3.67	1.56	10.2	108	4.43	22.8	443	4.0	2.80	39	29.4	11.2	28	2.0	0.04	13.5	3950	65	28.8	72	5.7	36	637	0.38	10.3	2060	2.4	16.0	78	152	101
20-AP	87.91%	74.2	4.2	2.80	1.12	5.0	0.92	47.9	0.38	29.7	8.0	5.0	14.9	0.73	0.39	2.46	32.9	1.87	13.4	810	3.1	8.34	87	45.5	23.4	3	2.9	0.07	37.7	6690	62	5.5	148	13.1	120	172	0.97	11.1	4400	1.8	3.9	147	133	88.7
20-A4	66.94%	123	9.7	6.44	2.36	11.1	2.14	82.7	0.79	49.9	13.3	9.4	15.0	1.63	0.82	5.06	95.2	2.83	23.7	644	8.4	7.49	73	16.5	17.6	4	2.9	0.06	25.9	4940	53	12.9	40	11.8	85	262	0.84	9.2	3760	1.7	7.5	156	101	135
20-D1	23.43%	9.8	2.9	2.56	0.55	1.9	0.74	5.4	0.50	5.1	1.3	1.3	11.5	0.37	0.41	2.83	21.3	1.18	28.7	438	8.4	0.35	17	2.2	7.8	8	1.3	<0.02	3.5	3110	92	13.4	10	2.3	5	437	0.16	1.7	543	1.3	9.8	41	25	138
20-D2	17.96%	14.0	3.5	2.59	0.61	2.5	0.81	6.6	0.44	7.4	1.8	1.9	11.5	0.49	0.39	2.68	18.5	5.67	23.4	411	3.5	1.02	21	13.0	6.8	21	1.2	<0.02	4.2	2510	39	12.0	23	5.6	10	342	0.15	2.6	598	2.9	13.5	60	25	146
20B-A1	25.62%	50.7	3.7	2.36	1.04	4.5	0.75	24.2	0.35	23.7	6.2	4.8	8.9	0.65	0.33	2.22	21.5	0.62	6.9	374	2.1	4.45	41	10.4	13.6	5	2.4	0.04	19.0	4660	51	9.9	36	10.1	64	190	0.80	7.6	3050	2.2	4.1	68	35	93.0
20B-A2	12.65%	40.0	7.2	4.15	1.67	7.4	1.44	13.7	0.55	25.9	5.9	6.3	5.6	1.23	0.55	3.52	41.0	1.64	14.3	176	3.0	0.52	10	20.4	6.2	8	1.1	<0.02	6.8	4250	79	27.0	69	2.0	6	511	0.15	3.0	1050	3.5	6.6	33	34	33.9
20B-A3	39.94%	122	12.5	8.56	2.43	14.0	2.86	65.3	1.04	55.8	14.3	9.6	9.0	2.07	1.09	6.26	118	4.75	18.9	259	7.7	1.16	23	5.4	8.8	11	1.2	<0.02	5.5	2710	50	25.7	10	4.6	11	393	0.14	2.3	547	3.4	2.0	84	98	50.8
20B-B	90.82%	30.9	2.6	1.71	0.66	2.8	0.57	16.2	0.28	13.6	3.7	2.8	7.9	0.44	0.26	1.74	14.4	2.71	31.5	287	1.9	3.23	44	8.5	16.9	14	3.1	0.04	38.5	5410	111	6.9	37	20.3	33	98	1.51	7.3	6200	5.7	7.8	93	50	163
20B-C	90.45%	31.2	2.9	1.82	0.78	3.1	0.62	16.0	0.28	14.3	3.8	3.0	6.2	0.51	0.26	1.74	16.2	2.58	25.5	745	2.0	2.59	35	12.0	14.2	7	3.0	0.04	33.1	3250	74	5.6	44	17.2	20	93	1.31	7.1	5760	4.5	6.5	79	31	174
20B-D1	26.54%	13.8	3.3	2.84	0.68	2.4	0.83	7.4	0.54	7.3	1.8	1.9	8.8	0.46	0.45	3.12	23.7	0.86	10.0	349	5.7	0.42	18	4.8	9.3	10	1.0	<0.02	5.2	3320	105	9.7	24	3.4	8	431	0.20	1.7	1020	3.8	4.6	58	12	62.8
20B-D2	35.89%	16.5	2.6	1.79	0.56	2.3	0.58	8.3	0.27	8.2	2.1	2.0	7.4	0.41	0.26	1.71	14.6	3.74	107	281	2.3	1.75	37	30.2	6.3	3	1.0	0.02	9.0	4210	114	20.7	98	4.5	23	293	0.20	4.6	969	4.8	8.7	95	83	47.0
21-W	90.93%	36.0	1.4	1.07	0.41	1.7	0.27	22.6	0.16	14.2	3.9	2.4	15.7	0.20	0.13	1.21	8.6	1.38	3.0	434	1.7	5.38	88	2.0	25.4	2	3.6	0.06	38.2	3490	137	0.8	8	15.9	73	74	1.16	12.7	4330	2.0	3.7	139	18	107
21-X	88.76%	23.3	1.4	1.07	0.32	1.3	0.27	15.0	0.17	9.6	2.5	1.7	17.9	0.17	0.13	1.21	8.9	1.35	4.2	454	2.0	5.83	101	3.9	24.0	2	3.1	0.08	34.1	3690	506	0.7	9	15.0	80	71	1.10	12.3	4130	2.0	3.4	146	20	93.0
21-Y1	94.21%	159	9.0	4.34	3.29	12.2	1.55	65.3	0.53	76.1	19.7	15.7	17.3	1.72	0.58	3.81	34.8	1.07	2.7	665	2.3	5.21	90	1.8	24.5	4	3.2	0.07	28.4	4830	61	0.7	7	15.6	95	100	1.07	12.3	4310	2.0	5.7	147	31	98.1
21-Y2	93.28%	317	19.0	8.77	6.62	25.7	3.08	146	0.94	156	37.5	30.9	20.3	3.47	1.06	7.15	69.6	1.56	8.7	748	2.7	7.04	103	4.1	29.5	4	3.4	0.07	31.0	5590	55	0.8	12	16.5	117	122	1.27	13.2	4410	2.2	6.2	174	60	96.3
21-Y3	93.70%	325	18.9	8.64	6.68	25.9	3.18	137	0.94	155	39.8	31.2	18.6	3.58	1.11	7.00	72.6	1.68	13.2	717	2.8	5.92	95	2.6	29.1	7	3.4	0.07	31.7	5860	47	0.7	11	17.2	105	121	1.25	14.8	4260	2.1	6.0	169	53	95.5
21-Y4	94.19%	388	23.3	10.8	7.87	31.0	3.96	166	1.23	183	46.4	36.3	19.6	4.40	1.39	8.87	90.9	1.93	11.8	796	2.9	7.67	101	2.8	28.7	7	3.3	0.08	30.4	6870	50	0.9	12	15.3	119	140	1.01	12.4	4490	2.2	5.2	180	110	93.2
21-Y5	91.14%	452	30.1	14.6	9.81	38.7	5.30	197	1.79	222	55.8	44.7	20.7	5.53	1.91	12.5	133	3.38	14.6	816	2.9	8.42	101	29.5	27.3	8	3.2	0.09	31.0	7700	61	3.8	69	14.1	128	167	1.03	12.0	4620	2.1	7.3	192	322	115
21-Y6	90.95%	264	21.4	11.6	6.45	26.5	4.05	124	1.57	137	33.7	28.5	22.6	3.82	1.56	10.5	110	4.72	18.2	773	3.2	7.78	102	87.0	30.0	6	3.1	0.08	35.3	9130	103	6.2	193	14.2	132	168	0.92	12.7	4410	2.0	6.9	190	776	127
21-Y7	91.43%	339	26.7	14.2	7.46	33.0	5.06	164	1.85	163	40.8	32.5	20.1	4.69	1.91	12.4	132	4.88	30.9	814	2.9	8.25	102	175	25.4	7	3.0	0.08	38.0	11300	132	6.6	287	13.6	123	149	0.91	12.3	4390	2.1	6.0	192	854	112
21-Y8	91.87%	248	19.7	11.0	5.34	24.3	3.79	129	1.42	120	29.9	22.7	20.6	3.45	1.42	9.32	110	4.22	38.4	832	2.8	8.46	100	151	28.8	5	3.0	0.08	39.8	12200	158	6.9	328	13.6	134	160	0.91	12.2	4450	1.9	4.8	187	702	102
21-Y9	93.30%	182	15.7	9.12	3.79	18.2	3.13	94.8	1.20	82.9	20.3	15.6	19.0	2.63	1.21	7.81	88.6	2.84	14.0	837	2.7	8.49	103	40.4	26.7	4	3.1	0.08	41.8	13600	181	3.4	119	14.0	126	153	0.97	12.7	4470	2.1	4.2	188	279	95.6
21-Y10	92.64%	105	10.5	6.77	2.28	11.9	2.26	61.6	0.93	48.3	11.9	9.2	18.8	1.69	0.92	5.88	71.1	2.67	17.4	845	2.7	8.17	105	49.5	25.3	3	3.1	0.08	43.9	15000	215	4.0	154	13.8	124	153	0.94	12.5	4470	1.9	4.0	194	306	98.6
21-Y11	93.53%	76.3	6.8	4.54	1.55	7.8	1.48	49.4	0.61	34.2	8.5	6.4	17.5	1.08	0.60	3.94	55.5	2.12	13.8	888	2.6	8.74	98	40.4	25.0	3	3.2	0.08	44.3	15900	238	3.5	120	12.1	123	151	0.89	12.4	4060	1.6	4.7	183	200	88.7
21-AR	92.69%	86.8	6.2	4.13	1.67	7.7	1.31	64.6	0.55	38.9	9.5	7.1	16.4	1.05	0.54	3.21	53.7	2.19	20.2	889	2.4	8.22	91	113	24.0	2	2.8	0.07	45.3	13400	228	5.4	241	13.4	134	170	0.98	11.4	4220	1.7	4.2	156	245	77.7
21-A1	57.41%	95.5	13.6	10.7	2.41	13.4	3.45	95.7	1.27	42.7	10.4	8.4	15.7	2.06	1.35	7.58	220	4.83	81.2	512	5.7	5.38	65	45.7	15.7	9	2.9	0.05	26.7	9950	172	16.8	90	8.5	86	255	0.54	7.4	2410	1.3	6.9	163	149	138
21-A2	18.53%	32.6	5.0	3.92	0.93	4.7	1.25	36.1	0.52	14.5	3.5	2.9	9.1	0.74	0.51	3.03	78.6	4.51	51.9	410	8.4	1.35	14	16.3	6.9	10	0.6	<0.02	5.3	4770	69	23.3	39	3.2	18	345	0.13	1.8	555	2.6	3.7	37	47	32.5
21-A3	15.72%	8.1	2.2	1.87	0.36	1.7	0.56	6.2	0.30	4.3	1.0	1.1	7.7	0.31	0.26	1.74	22.8	3.43	31.3	96	9.1	0.52	13	5.3	4.5	5	0.8	<0.02	2.7	3620	170	15.7	16	3.1	5	390	0.08	2.0	299	2.9	2.6	45	43	34.5

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
21-AP	91.61%	54.6	3.1	1.90	1.01	4.0	0.61	29.3	0.27	24.4	6.4	4.6	14.7	0.55	0.26	1.75	15.8	1.25	6.9	775	2.4	8.46	87	21.8	22.9	2	2.6	0.07	50.6	14200	215	2.7	67	12.5	117	170	0.96	10.3	4430	1.6	3.3	145	125	76.5
21-A4	54.43%	39.1	3.7	2.57	1.00	3.9	0.80	21.2	0.40	18.2	4.8	3.8	15.9	0.61	0.37	2.49	25.9	2.91	21.3	554	9.1	5.53	65	19.2	15.7	3	2.3	0.06	29.2	9970	176	7.3	49	9.0	77	352	0.57	8.7	2610	1.1	7.6	138	93	101
21-Z	94.04%	64.5	4.1	2.51	1.28	5.2	0.77	36.0	0.36	30.4	7.4	5.9	15.4	0.70	0.33	2.45	21.6	1.25	7.0	734	1.7	5.81	80	18.9	20.1	2	3.0	0.06	40.1	11900	629	1.4	53	14.0	107	163	0.98	10.2	3580	2.9	2.5	125	118	78.9
21-C	78.70%	61.3	4.2	2.56	1.33	5.2	0.84	33.4	0.37	28.2	7.5	5.6	15.7	0.76	0.36	2.40	24.0	7.67	47.2	675	2.7	8.20	86	16.7	21.8	3	3.9	0.07	39.7	12200	159	20.6	64	13.3	123	254	0.83	12.6	3450	1.4	13.7	234	105	200
21-D1	43.51%	16.8	2.2	1.62	0.48	1.9	0.51	9.2	0.27	7.8	2.0	1.7	8.3	0.33	0.24	1.63	13.5	5.07	87.5	436	3.4	1.93	22	4.0	6.1	3	1.2	0.02	9.8	4520	120	9.8	18	4.3	26	349	0.24	3.5	935	1.1	3.6	60	74	67.1
21-D2	31.04%	22.3	2.9	1.91	0.72	2.8	0.63	11.1	0.29	11.0	2.8	2.6	9.3	0.48	0.28	1.80	15.8	3.25	65.1	586	2.5	2.60	38	15.4	7.6	2	1.7	0.02	10.7	4660	116	16.3	45	5.1	31	365	0.24	4.9	1020	1.5	5.3	97	98	78.0
21B-A1	27.67%	16.8	1.8	1.11	0.41	1.9	0.37	8.9	0.14	7.8	2.0	1.6	1.5	0.30	0.15	0.90	15.0	0.37	25.9	70	1.7	0.23	4	5.1	2.0	3	0.3	<0.02	1.8	4150	19	21.5	12	0.9	7	582	0.07	0.8	261	2.9	1.1	9	19	9.5
21B-A2	22.72%	16.9	3.3	2.10	0.75	3.2	0.70	6.7	0.27	11.2	2.6	2.8	4.0	0.53	0.28	1.76	24.8	0.98	46.2	107	2.0	0.35	9	11.2	4.6	2	0.9	0.02	3.2	4700	22	24.4	34	1.8	4	633	0.13	2.9	988	3.2	4.6	30	26	28.7
21B-A3	32.04%	55.1	10.4	6.21	2.67	10.7	2.06	17.8	0.87	42.2	9.5	10.7	18.8	1.75	0.84	5.62	51.5	5.19	15.3	316	2.2	1.81	46	14.2	13.0	13	2.1	0.05	20.7	4360	21	31.4	76	8.8	16	320	0.53	12.6	2240	2.4	33.0	94	40	107
21B-U	85.31%	56.9	4.2	2.57	1.22	4.9	0.82	32.4	0.35	26.9	6.6	5.4	15.7	0.69	0.33	2.47	22.4	5.05	72.0	760	2.3	7.49	75	16.3	21.9	9	3.4	0.06	40.7	13200	226	6.4	50	13.2	110	145	0.87	10.4	3490	1.6	8.7	182	102	161
21B-V	92.79%	56.7	4.0	2.51	1.13	4.8	0.78	31.6	0.36	26.6	6.5	5.2	17.3	0.66	0.34	2.46	21.8	1.27	10.0	777	2.1	7.92	80	15.2	22.5	2	2.8	0.06	45.2	17000	1070	1.6	40	13.0	128	160	0.94	10.3	3720	1.7	3.4	138	106	79.3
21B-B	90.37%	39.6	3.3	2.04	1.81	3.6	0.65	19.7	0.29	17.3	4.7	3.6	9.6	0.55	0.28	1.95	19.0	2.50	15.5	6220	2.1	2.23	46	6.7	25.9	6	3.8	0.07	73.4	2690	41	4.1	29	23.9	13	202	1.66	10.7	7090	4.1	9.3	93	34	186
21B-W	97.22%	13.2	1.6	1.15	0.27	1.3	0.33	7.5	0.20	5.7	1.4	1.2	6.3	0.21	0.16	1.30	8.9	1.09	2.4	99	0.6	0.94	25	1.7	13.2	2	3.1	0.03	39.7	961	22	1.3	11	21.2	6	32	1.50	6.0	5230	3.8	3.6	39	7	88.8
21B-X	96.36%	115	4.3	2.21	1.34	5.9	0.73	62.6	0.26	41.1	11.1	6.9	5.7	0.77	0.26	1.88	18.9	0.60	1.5	334	0.7	2.35	37	3.5	10.7	2	1.6	0.02	21.2	2090	48	0.6	49	7.9	24	94	0.57	2.9	2280	9.8	2.4	47	33	42.8
21B-C	54.24%	912	55.8	24.9	20.8	80.2	9.22	396	2.72	432	113	98.9	33.8	11.3	3.08	19.6	194	2.78	11.6	909	14.8	5.67	114	2.1	22.3	13	3.1	0.15	47.1	3930	79	4.3	16	11.2	44	388	0.81	19.6	3400	3.5	32.5	159	87	218
21B-Y	93.27%	108	6.1	3.76	1.63	7.0	1.17	60.9	0.54	43.8	11.2	8.1	17.6	0.97	0.49	3.68	30.1	1.45	3.8	551	2.1	12.7	85	2.1	25.7	4	2.9	0.06	37.8	6180	45	3.8	10	14.5	112	183	1.03	8.9	4360	2.9	3.7	137	24	84.5
21B-Z	96.18%	67.6	4.1	2.44	1.32	5.3	0.76	38.1	0.33	32.4	7.9	6.2	12.6	0.68	0.31	2.38	21.3	1.04	2.9	653	1.5	5.15	64	7.8	17.7	2	3.0	0.04	31.8	7640	104	0.5	23	12.2	86	162	0.88	9.0	3410	1.6	2.2	97	199	81.8
21B-D1	16.69%	7.5	1.8	1.43	0.31	1.3	0.44	3.9	0.25	4.0	1.0	1.0	6.6	0.26	0.22	1.49	12.1	5.57	19.8	67	2.9	0.63	11	2.7	5.6	19	1.0	<0.02	3.1	3190	121	13.3	11	5.7	7	433	0.11	1.5	362	2.2	3.7	43	27	73.8
21B-D2	22.62%	6.5	1.9	1.23	0.39	1.5	0.41	3.1	0.18	3.9	0.9	1.1	5.9	0.29	0.18	1.15	10.4	2.96	44.3	475	1.3	0.49	13	2.5	3.5	2	0.7	<0.02	2.0	2690	67	8.2	14	2.8	5	374	0.07	1.9	306	1.5	2.1	43	13	34.9
21B-D3	19.96%	6.5	2.8	1.97	0.46	2.1	0.64	3.1	0.31	4.2	0.9	1.4	6.3	0.41	0.29	1.87	15.9	2.62	69.0	112	2.7	0.36	12	9.7	3.5	2	0.4	<0.02	2.3	3090	62	20.0	34	1.6	5	370	0.07	1.7	237	2.3	4.7	33	47	18.8
21B-D4	20.07%	4.3	2.5	1.82	0.38	1.6	0.57	2.0	0.30	2.9	0.6	1.0	5.6	0.34	0.27	1.80	13.9	2.54	144	238	2.5	0.19	10	7.3	2.9	6	0.4	<0.02	1.2	2450	51	25.6	27	1.7	3	328	0.03	1.0	111	3.5	4.3	21	8	48.2
23-A	31.19%	21.5	3.9	2.81	0.75	3.2	0.89	11.3	0.41	10.9	2.7	2.6	13.5	0.59	0.40	2.55	26.2	5.69	42.4	705	3.2	3.12	39	14.9	19.9	29	2.8	0.02	12.3	5070	409	188	26	9.0	32	224	0.24	4.9	1140	2.6	23.6	115	69	250
23-B	55.22%	44.0	3.3	2.11	0.96	3.8	0.68	23.4	0.31	19.6	5.2	4.0	11.6	0.57	0.30	2.02	18.6	5.45	32.5	1170	2.6	7.13	48	24.6	18.4	7	2.2	0.04	30.8	7420	291	56.1	54	8.6	84	175	0.51	8.6	1910	1.8	11.0	110	167	83.3
24-A	36.17%	14.7	1.5	1.04	0.40	1.5	0.33	7.9	0.16	6.6	1.7	1.4	6.6	0.25	0.15	1.02	9.5	3.34	58.7	508	1.7	1.77	24	5.4	8.7	12	1.3	0.03	12.5	3910	109	11.3	25	10.7	18	240	0.63	5.4	3590	3.2	3.2	73	28	49.3
25-A1	78.38%	58.9	3.7	2.23	1.11	4.7	0.74	29.4	0.32	26.2	6.9	5.2	12.3	0.67	0.32	2.08	20.0	1.20	17.8	530	2.3	7.93	61	21.3	18.5	7	2.3	0.05	41.4	12300	132	3.5	51	11.5	129	227	0.79	11.4	3340	2.0	14.4	96	129	78.7
25-A2	60.20%	60.0	4.5	2.71	1.26	5.5	0.91	29.2	0.37	27.4	7.1	5.7	10.4	0.81	0.37	2.39	26.3	1.79	17.3	333	3.4	6.23	52	52.7	15.8	11	1.8	0.04	29.7	10600	121	3.0	98	8.1	93	437	0.54	10.3	2080	1.7	79.5	74	254	59.6
25-A3	48.00%	58.0	4.6	2.92	1.33	5.7	0.99	35.4	0.39	26.7	6.7	5.3	8.9	0.82	0.40	2.51	37.4	3.83	29.1	1190	3.4	4.55	43	60.2	13.2	11	1.5	0.03	21.0	8610	196	4.9	89	6.6	64	537	0.42	7.4	1740	1.7	124	91	232	59.0
25-B	34.91%	23.0	3.5	2.43	0.65	3.0	0.77	13.0	0.36	11.2	2.8	2.6	8.0	0.54	0.35	2.28	26.0	6.38	59.7	223	2.9	1.98	28	24.8	8.6	7	1.7	0.02	11.3	7200	347	82.7	61	4.6	30	267	0.20	4.6	861	2.9	71.8	101	70	104
25-C	32.36%	50.3	6.2	3.62	1.61	7.0	1.22	21.4	0.54	29.1	7.1	7.0	11.9	1.10	0.51	3.38	27.4	15.7	108	104	1.1	1.91	23	6.8	12.9	6	1.2	0.03	10.1	3780	81	151	38	4.0	32	224	0.19	5.2	698	4.3	66.4	104	31	48.2
25-D	53.75%	131	14.1	8.31	3.09	15.3	2.90	72.3	1.04	61.2	15.9	13.0	19.8	2.43	1.11	6.83	90.6	6.63	52.0	508	8.8	6.16	48	27.4	24.6	10	2.3	0.05	25.5	10100	204	98.2	164	10.8	77	274	0.50	11.3	1770	2.5	273	141	97	88.5
25-E1	58.35%	99.8	10.1	5.55	3.11	12.0	1.90	44.5	0.79	57.1	13.8	13.5	16.6	1.83	0.79	5.16	42.2	7.90	29.0	1560	3.1	8.72	57	8.9	17.2	6	3.5	0.06	48.5	6520	74	79.0	50	10.3	89	1120	0.55	12.9	2280	2.3	119	205	73	134
25-E2	37.21%	10.5	2.1	1.51	0.37	1.7	0.48	5.4	0.23	5.7	1.3	1.4	5.2	0.31	0.21	1.44	14.9	3.10	202	130	2.1	0.92	13	10.4	5.5	2	0.4	0.02	5.4	4830	282	211	28	1.8	14	153	0.12	1.4	490	2.9	39.8	23	25	12.0
25-E3	12.21%	5.6	2.6	1.92	0.35	1.9	0.61	2.6	0.28	3.7	0.8	1.2	3.6	0.36	0.26	1.75	20.0	0.48	28.3	10	3.1	0.08	2	1.7	3.4	<1	<0.2	<0.02	0.7	4730	207	122	6	0.4	1	245	0.03	0.6	97	3.0	70.8	4	31	3.2
26-Y	93.76%	180	14.3	8.21	4.24	17.1	2.82	93.8	1.03	85.3	21.4	15.8	20.1	2.45	1.08	7.08	86.8	1.23	4.3	9350	2.7	3.81	93	13.7	23.0	4	2.8	0.07	34.4	7280	141	1.3	50	13.5	84	157	0.97	10.1	5180	1.9	3.6	148	134	94.0
26-Z	93.77%	68.4	5.2	3.09	1.64	6.4	0.99	41.1	0.42	33.3	7.9	6.7	20.7	0.86	0.38	2.90	29.7	1.51	5.0	965	3.0	4.99	110	20.7	24.8	3	3.4	0.06	49.7	12800	287	1.8	63	14.8	96	96	1.03	10.6	5130	2.0	2.9	177	201	98.3
26B-A1	46.24%	75.5	6.0	3.42	1.89	7.9	1.19	35.9	0.44	38.4	9.5	8.1	13.3	1.10	0.46	2.87	31.6	4.17	181	217	1.8	2.73	46	30.6	22.1	8	1.9	0.04	39.1	4870	239	45.3	73	7.2	23	143	0.42	8.1	2070	2.0	7.9	119	131	78.1
26B-A2	22.20%	36.3	5.4	3.86	1.08	5.0	1.23	17.0	0.57	18.7	4.5	4.2	15.5	0.81	0.55	3.53	34.8	3.17	54.3	105	3.2	1.82	55	7.1	28.8	35	2.6	0.03	9.8	5040	499	44.8	28	3.5	11	210	0.16	10.8	735	3.1	9.9	304	70	184
26B-Y	93.78%	51.8	7.7	2.13	1.29	4.7	0.67	26.8	0.29	26.0	6.3	5.7	21.4	0.63	0.27	2.10	15.9	1.02	1.7	628	1.7	3.09	94	1.8	23.1	2	3.3	0.05	27.6	2970	55	0.8	9	14.6	68	64	1.06	10.0	4920	2.4	2.9	145	24	90.5

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
26B-Z	93.68%	81.9	7.9	5.15	1.93	8.4	1.74	48.7	0.63	38.8	9.8	7.6	18.7	1.28	0.65	4.00	101	1.40	8.2	1230	3.1	3.76	97	21.1	22.6	3	2.8	0.07	39.7	10200	274	1.8	70	13.3	84	93	0.98	10.6	5070	1.9	3.4	156	232	93.7
28-V	97.74%	19.8	2.2	1.52	0.42	2.0	0.47	11.1	0.23	9.1	2.3	1.9	5.6	0.32	0.21	1.52	19.1	1.59	12.1	298	0.6	0.74	34	3.1	14.0	2	2.9	0.02	25.4	1830	38	6.0	18	24.6	12	32	1.78	4.5	6490	4.6	2.8	53	32	99.4
28-W	93.47%	65.0	5.4	3.11	1.42	6.1	1.07	30.2	0.38	32.2	8.0	6.6	31.0	0.88	0.39	2.62	41.9	2.09	7.8	513	5.2	4.35	74	11.2	21.2	3	2.5	0.06	27.4	3630	280	3.7	38	13.3	84	83	0.98	9.9	4090	2.1	5.6	154	87	92.0
28-X	94.43%	72.7	3.8	2.08	1.33	5.0	0.69	34.6	0.29	34.1	8.9	6.5	16.9	0.68	0.28	1.98	21.4	1.01	3.2	616	2.4	7.60	92	13.5	24.6	3	2.7	0.08	34.5	4880	100	1.0	35	15.7	106	71	1.14	10.9	5190	2.4	2.0	125	60	86.4
28-Y1	94.24%	112	6.6	3.36	2.35	8.8	1.16	49.6	0.45	54.2	13.9	11.0	16.4	1.23	0.47	3.18	26.5	0.95	3.3	668	2.6	6.18	94	14.9	25.1	4	3.0	0.07	31.2	5130	61	0.7	34	15.7	114	79	1.07	12.1	4540	2.3	2.3	132	58	91.6
28-Y2	94.81%	245	15.5	7.42	5.64	20.8	2.65	104	0.88	123	30.9	25.6	18.1	2.95	0.97	6.47	58.9	0.97	2.9	1020	3.0	6.07	102	19.7	26.7	6	3.3	0.06	30.7	5890	48	0.6	40	16.3	116	111	1.08	12.3	4620	2.4	2.7	148	80	99.8
28-Y3	94.07%	360	22.2	10.2	8.13	30.1	3.79	146	1.17	177	44.6	37.4	19.3	4.24	1.33	8.80	79.8	1.11	5.5	821	3.3	5.85	101	17.5	27.4	8	3.2	0.08	29.2	5260	44	0.9	37	15.4	110	94	1.03	11.5	4900	2.7	3.0	157	75	98.9
28-Y4	94.40%	444	30.6	14.1	10.7	40.9	5.17	205	1.79	231	54.3	48.9	20.2	5.66	1.91	12.2	107	1.21	6.6	813	3.8	5.94	103	17.4	27.2	7	3.3	0.08	31.9	5530	48	1.1	35	16.7	122	93	1.28	11.7	4540	2.5	3.3	163	78	95.5
28-Y5	94.18%	430	26.8	12.6	9.54	36.2	4.62	174	1.47	213	52.8	43.3	22.0	5.03	1.63	10.6	126	0.96	6.3	858	3.5	6.10	101	21.7	28.3	8	3.0	0.09	30.6	5960	53	1.0	36	15.8	127	95	1.16	11.8	4650	2.3	3.1	155	101	97.3
28-Y6	94.27%	402	26.4	12.6	9.09	34.9	4.60	170	1.48	200	49.7	40.6	21.6	4.93	1.63	10.7	125	1.07	7.4	887	3.7	6.20	102	22.5	27.9	8	3.0	0.08	31.1	6260	58	1.1	40	15.8	123	99	1.16	12.2	4620	2.3	3.1	168	109	97.9
28-Y7	94.41%	365	26.3	13.1	8.23	33.6	4.68	163	1.57	182	44.4	36.5	21.1	4.78	1.70	11.1	132	1.31	8.2	939	3.2	6.29	98	24.9	27.6	7	3.0	0.08	33.8	8010	86	1.0	44	15.3	121	105	1.13	11.3	4610	2.2	2.7	166	143	96.0
28-Y8	94.54%	332	26.1	13.4	7.63	33.2	4.79	163	1.63	165	39.4	32.2	20.4	4.64	1.74	11.3	141	1.20	8.3	861	2.9	6.26	97	25.4	26.6	7	3.0	0.08	38.2	9910	125	1.0	45	15.2	120	99	1.12	11.3	4590	2.3	2.8	160	160	95.3
28-Y9	94.91%	201	18.4	10.3	4.73	22.6	3.62	112	1.35	99.3	23.7	19.6	18.6	3.18	1.38	9.02	95.8	1.26	7.7	823	3.0	6.39	94	24.3	24.4	6	3.3	0.08	42.2	11200	153	1.2	48	15.1	117	98	1.03	11.5	4470	2.3	3.2	154	172	98.9
28-Y10	95.13%	123	12.2	7.41	2.79	14.2	2.56	76.5	1.03	58.5	14.2	11.1	17.6	2.03	1.00	6.73	74.5	1.18	7.2	808	2.8	6.18	90	22.2	23.0	4	3.0	0.08	43.1	12000	183	1.0	47	14.8	111	87	1.00	11.1	4450	2.1	3.1	147	183	92.4
28-Y11	95.21%	90.1	8.3	5.56	1.83	9.2	1.82	61.4	0.82	40.3	10.1	7.4	16.2	1.32	0.76	5.09	58.8	3.51	45.3	760	2.6	6.01	84	19.4	22.0	4	3.1	0.07	39.3	10100	160	3.6	46	14.3	112	258	0.99	11.2	4150	2.2	10.5	135	184	96.3
28-Y12	95.53%	70.1	5.3	3.68	1.34	6.1	1.17	42.4	0.56	31.2	8.0	5.9	16.5	0.86	0.52	3.48	38.7	2.28	18.8	753	2.5	5.55	86	22.0	21.3	3	3.0	0.07	40.6	11100	202	1.5	67	14.3	107	235	0.96	11.2	4180	2.1	6.4	135	217	93.8
28-Y13	95.56%	57.1	4.8	3.21	1.28	5.4	1.03	32.5	0.51	27.1	6.8	5.6	18.2	0.79	0.46	3.01	33.6	1.26	5.4	840	2.8	6.69	92	31.5	23.2	3	3.1	0.07	48.8	14500	254	1.1	72	14.8	125	118	1.00	11.5	4300	2.1	5.3	151	214	98.3
28-Y14	95.68%	66.4	5.5	3.60	1.50	6.4	1.17	35.7	0.50	32.1	8.0	6.5	17.1	0.96	0.48	3.17	38.6	1.15	5.2	1150	2.7	6.25	89	31.5	22.0	4	3.2	0.07	45.3	13900	238	1.4	76	15.1	117	128	1.01	11.3	4300	2.1	7.3	152	193	99.5
28-Y15	95.95%	61.6	4.8	3.05	1.30	5.4	1.01	33.4	0.46	28.8	7.3	5.9	17.8	0.78	0.44	2.88	33.7	1.09	4.6	823	2.8	7.21	91	37.3	23.1	3	3.1	0.08	49.3	15200	256	1.0	84	14.8	133	110	1.00	11.8	4230	2.1	5.3	146	200	98.4
28-Y16	95.97%	54.6	4.1	2.62	1.14	4.7	0.86	29.8	0.39	25.0	6.4	5.0	16.1	0.68	0.37	2.46	28.1	2.12	16.2	735	2.4	6.08	83	40.0	20.6	3	2.9	0.06	40.9	12400	229	3.1	104	13.8	112	161	0.92	10.5	3970	1.9	3.9	129	219	91.1
28-Y17	95.88%	55.3	4.3	2.49	1.21	4.8	0.84	28.3	0.36	25.6	6.5	5.1	15.6	0.72	0.35	2.36	25.3	1.20	6.5	749	2.5	5.63	83	36.8	20.1	3	2.9	0.06	40.7	13500	268	1.2	92	14.4	108	142	0.97	10.1	4220	2.2	3.5	140	156	91.0
28-A	21.39%	28.6	3.7	2.47	0.86	3.6	0.80	14.1	0.39	14.2	3.5	3.2	8.7	0.59	0.36	2.41	21.9	3.20	21.3	164	3.4	2.20	22	4.5	7.7	11	0.6	<0.02	6.9	4330	133	48.7	17	2.5	25	295	0.12	3.2	617	1.7	7.4	58	36	26.2
29B-A1	91.53%	48.3	2.6	1.65	0.94	3.5	0.53	26.4	0.26	21.2	5.8	4.0	16.6	0.49	0.25	1.66	13.3	1.05	8.6	750	1.9	8.84	87	9.4	23.0	3	2.4	0.06	37.0	13000	170	4.8	27	10.8	120	153	0.75	10.3	3910	1.5	3.8	141	89	84.3
29B-A2	85.90%	162	19.2	7.44	8.62	33.9	2.99	54.3	0.81	162	35.8	39.0	16.8	4.41	0.88	5.38	72.4	4.52	57.8	708	2.1	7.28	88	9.2	23.9	17	2.8	0.08	27.6	9360	110	20.7	33	15.1	112	219	0.77	36.8	3620	2.1	8.9	194	77	123
29B-A3	90.47%	58.5	3.6	2.18	1.27	4.9	0.71	29.6	0.33	27.5	7.2	5.6	17.2	0.68	0.31	2.14	18.4	2.16	20.6	788	2.3	9.73	89	11.6	24.5	5	2.4	0.07	40.0	13600	161	11.9	35	11.9	136	174	0.78	11.8	3950	1.8	6.6	162	105	82.9
29B-B1	90.56%	76.8	5.6	3.38	1.71	6.9	1.13	36.3	0.52	35.1	9.2	7.3	19.8	1.02	0.49	3.33	36.4	1.83	14.8	728	2.3	10.2	89	13.0	23.5	3	2.6	0.07	46.0	14100	172	7.1	41	11.6	132	197	0.78	23.8	3960	1.7	7.6	158	119	89.9
29B-B2	91.09%	59.6	3.9	2.34	1.33	5.1	0.79	30.7	0.36	27.7	7.4	5.6	17.6	0.72	0.34	2.26	21.1	2.44	13.7	729	2.2	10.5	93	12.1	23.4	5	2.7	0.08	41.4	14000	171	6.8	39	11.7	130	224	0.90	11.7	4050	2.5	8.2	161	109	84.2
29B-B3	86.53%	65.4	5.4	3.01	1.97	6.7	1.05	33.4	0.41	32.7	8.3	7.0	15.6	1.00	0.41	2.69	24.5	3.95	33.0	2700	2.1	9.01	80	8.0	22.3	15	2.3	0.06	26.3	9130	90	5.9	37	12.9	114	334	0.77	9.7	3600	5.4	6.0	131	65	86.8
32-A1	61.44%	49.6	4.3	2.85	0.95	4.6	0.93	26.2	0.45	21.6	5.8	4.5	10.8	0.73	0.42	2.78	25.6	7.98	36.4	264	1.9	1.82	29	9.0	16.7	18	3.2	0.07	36.1	1910	59	24.8	30	18.9	15	374	1.47	22.5	4620	6.0	20.6	56	17	119
32-A2	77.35%	25.5	3.4	2.64	0.50	2.7	0.78	12.8	0.50	10.9	3.0	2.3	5.0	0.50	0.43	3.08	22.1	7.73	68.1	74	0.7	0.15	24	6.6	5.2	7	5.6	0.02	8.1	553	20	30.0	31	63.1	2	255	5.49	13.3	15500	21.5	10.4	56	12	213
32-B	91.96%	71.7	5.6	3.57	1.63	6.5	1.09	39.4	0.51	35.0	8.5	6.8	18.5	0.87	0.46	3.38	32.7	2.15	16.5	978	3.3	6.82	109	123	26.9	4	3.2	0.08	39.1	8330	92	5.3	306	15.7	123	151	1.18	11.4	5370	2.3	5.2	183	287	104
33-A	55.59%	30.9	3.3	2.54	0.71	2.7	0.77	18.0	0.44	12.9	3.6	2.5	13.8	0.48	0.39	2.70	23.4	1.75	9.1	487	6.8	4.08	62	2.6	13.6	7	2.6	0.03	22.1	6140	71	3.9	15	11.5	30	235	0.82	9.3	3350	2.8	5.1	89	12	128
38-A1	13.60%	16.3	2.0	1.20	0.47	2.1	0.41	7.6	0.16	8.5	2.1	1.9	2.4	0.33	0.16	1.02	13.0	0.56	8.5	58	2.5	0.13	8	3.1	13.6	7	0.4	<0.02	1.7	4640	61	115	23	1.6	3	161	0.13	1.2	279	8.2	7.3	12	7	11.8
38-A2	15.35%	30.7	2.1	0.97	0.70	2.8	0.34	14.3	0.11	15.6	3.7	3.2	1.8	0.37	0.12	0.84	7.5	0.28	8.4	68	0.3	0.42	9	3.8	3.0	1	0.4	<0.02	2.5	3460	187	6.5	6	1.7	8	156	0.12	1.6	452	2.4	0.6	14	7	12.2
38-A3	49.70%	14.1	2.5	1.94	0.32	1.7	0.57	6.8	0.36	6.1	1.6	1.4	4.6	0.34	0.32	2.21	16.9	1.35	2.6	134	0.5	0.07	28	1.0	15.7	4	4.5	0.03	13.7	2050	164	10.1	6	32.9	1	144	2.79	10.8	7610	6.1	7.7	59	4	164
38-V	93.73%	22.7	2.8	2.19	0.40	2.1	0.58	11.9	0.40	10.6	2.6	2.1	2.6	0.35	0.30	2.69	16.6	2.36	5.3	46	0.2	0.17	20	0.5	4.6	1	5.1	<0.02	7.7	525	35	5.4	21	40.1	3	27	3.37	7.5	8780	13.0	4.4	35	5	168
38-W	97.91%	71.2	4.3	2.67	1.40	5.5	0.81	40.1	0.41	35.1	8.5	6.7	20.9	0.70	0.34	2.84	23.3	1.53	9.7	681	2.4	8.65	114	20.9	25.2	2	4.2	0.07	41.8	8480	92	2.4	69	16.4	117	162	1.20	12.8	4480	2.0	4.2	186	126	130
38-X	93.71%	42.7	2.9	2.05	0.58	2.8	0.55	25.3	0.33	18.6	4.8	3.4	14.4	0.39	0.27	2.31	14.0	1.97	10.6	455	2.0	10.4	75	18.1	25.8	2	4.0	0.08	48.7	6770	49	2.4	62	18.1	154	58	1.51	13.3	4150	6.4	4.4	103	26	116

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
38-B	54.93%	52.2	4.4	2.07	0.95	4.1	0.76	26.2	0.26	19.8	5.8	4.5	21.8	0.76	0.28	1.75	19.8	2.60	26.5	182	1.6	5.16	199	33.9	25.4	9	4.5	0.05	39.2	3540	98	7.8	56	9.6	37	209	0.72	34.5	2580	1.6	13.1	297	58	155
38-C	36.37%	78.0	8.2	3.64	1.63	7.3	1.41	36.8	0.39	30.1	8.7	7.1	40.0	1.41	0.46	2.75	37.4	3.57	46.0	96	3.5	2.83	353	14.2	24.1	10	5.8	0.02	26.4	3670	115	7.5	32	7.1	27	329	0.37	33.6	1270	1.7	14.5	534	139	183
38-DR	79.36%	297	19.2	7.93	6.87	27.3	3.16	135	0.66	143	37.3	31.4	31.9	3.82	0.95	5.31	81.6	2.08	45.9	389	3.9	8.41	168	31.9	21.3	6	4.9	0.06	43.3	5370	72	3.2	65	14.0	89	196	1.15	21.5	3870	2.3	6.8	240	116	160
38-D1	35.26%	262	25.6	13.1	7.53	30.8	4.79	111	1.26	144	35.8	33.2	45.7	4.57	1.65	9.79	127	1.85	26.6	4750	11.1	2.09	225	22.9	11.9	15	3.0	0.02	19.6	3430	118	9.2	38	4.6	19	485	0.29	6.9	939	1.3	5.1	268	153	86.5
38-D2	18.77%	618	49.9	23.3	17.7	70.9	8.86	264	1.93	349	84.8	78.5	31.0	9.57	2.81	15.8	236	1.60	13.6	1100	11.7	0.84	94	11.7	10.5	28	2.1	<0.02	12.4	3230	177	6.9	13	1.7	8	485	0.17	4.2	472	2.2	4.3	67	69	50.9
38-D3	14.78%	396	34.9	19.1	10.9	45.7	6.82	207	1.90	216	52.1	48.1	18.9	6.27	2.46	14.6	200	1.50	14.3	291	16.9	0.19	50	10.1	5.1	14	1.5	<0.02	12.4	3260	133	11.2	17	1.1	2	688	0.12	3.0	273	1.9	5.7	43	31	36.2
38-D4	10.34%	281	25.6	15.2	7.81	33.5	5.23	144	1.63	159	37.8	34.2	10.1	4.51	2.00	12.0	161	1.78	12.2	241	13.6	0.10	24	4.9	5.4	19	0.9	<0.02	4.9	2580	104	2.1	4	0.5	1	595	0.06	2.1	96	5.5	2.1	22	37	21.7
38-D5	19.17%	123	17.8	12.3	4.38	20.2	3.98	56.8	1.58	79.6	17.5	18.2	12.1	2.85	1.70	10.9	132	1.92	10.0	103	18.1	1.30	49	3.4	7.8	6	1.7	0.03	13.6	3260	134	1.8	5	2.8	10	501	0.24	7.6	735	2.6	3.0	37	24	45.3
38-DF	72.92%	125	10.3	7.67	2.95	13.5	2.37	66.0	1.07	70.3	16.6	13.4	15.1	1.76	1.11	7.20	80.4	1.96	8.0	431	5.3	12.8	81	11.0	22.2	5	3.1	0.07	47.2	5580	68	3.3	30	12.6	97	247	1.01	11.4	3970	2.2	6.2	134	36	98.3
38-Y	95.39%	39.0	2.7	1.56	0.83	3.2	0.47	22.2	0.21	18.9	4.6	3.7	12.1	0.42	0.17	1.55	11.6	1.09	7.3	683	1.2	2.80	65	34.0	17.9	2	2.9	0.04	27.6	4630	76	2.5	118	12.0	73	83	0.96	7.2	3340	1.9	2.4	91	85	78.5
38-Z	95.66%	44.6	3.2	1.80	1.02	3.7	0.54	25.1	0.23	22.5	5.3	4.5	12.6	0.50	0.20	1.74	13.5	0.89	4.9	702	1.2	2.49	76	12.4	17.3	2	3.1	0.04	26.1	4780	105	1.0	41	11.9	68	88	0.94	7.9	3670	3.4	2.4	99	82	84.7
38-E1	18.35%	103	13.8	9.07	3.51	14.8	2.94	52.2	1.41	60.6	14.1	13.8	13.0	2.25	1.30	8.78	86.6	1.85	9.5	52	11.0	0.07	75	4.3	4.5	8	1.2	<0.02	3.8	3220	180	6.9	7	2.9	1	583	0.15	3.5	246	1.3	4.0	46	7	44.3
38-E2	11.04%	27.3	8.4	6.30	1.43	7.0	1.96	14.6	1.06	17.7	3.9	4.9	5.6	1.21	0.94	6.28	64.2	0.53	3.3	36	8.1	0.04	27	4.6	3.1	8	1.0	<0.02	1.9	3160	156	6.5	4	2.1	1	570	0.22	3.2	357	3.1	1.8	9	3	31.5
38-E3	11.27%	13.7	4.9	3.76	0.88	4.4	1.17	7.3	0.61	9.9	2.1	2.9	3.1	0.72	0.54	3.54	45.7	0.20	2.4	34	5.6	0.03	13	3.5	1.4	3	0.7	<0.02	2.1	3330	162	6.1	3	1.5	1	611	0.12	2.8	301	3.3	1.0	8	3	22.0
38-E4	9.30%	12.5	3.0	2.35	0.63	3.2	0.74	6.5	0.35	8.7	1.9	2.2	2.5	0.47	0.32	2.01	34.3	0.11	2.4	30	3.0	0.02	9	3.8	1.2	2	0.5	<0.02	1.4	3220	151	10.7	3	0.8	<1	587	0.06	1.7	140	5.1	1.1	4	2	14.1
38-E5	11.37%	14.8	2.5	1.80	0.57	2.8	0.58	8.0	0.24	9.1	2.1	2.1	3.5	0.41	0.24	1.43	27.5	0.25	5.8	33	2.0	0.06	12	2.9	3.9	17	0.8	<0.02	3.0	2700	138	20.6	5	1.4	1	462	0.13	2.2	268	6.7	4.1	13	2	28.0
38-E6	31.53%	12.8	2.7	1.85	0.53	2.4	0.60	6.7	0.26	7.2	1.7	1.9	6.0	0.42	0.26	1.65	22.6	0.74	72.1	52	2.7	0.32	30	16.8	10.1	19	1.0	0.02	10.1	2980	136	28.3	57	3.4	6	416	0.14	3.8	472	4.8	20.8	62	7	41.0
38B-B1	20.23%	125	11.9	4.12	2.57	11.2	1.82	62.1	0.34	44.4	13.5	11.1	35.5	2.17	0.47	2.65	42.5	1.08	14.3	41	5.1	0.20	151	9.8	12.4	8	2.9	0.03	42.2	3160	266	5.0	33	4.2	2	335	0.36	36.0	685	1.5	15.5	232	57	82.2
38B-B2	36.01%	96.8	9.5	3.58	2.00	8.7	1.50	52.9	0.33	35.6	10.6	8.5	28.5	1.67	0.43	2.49	36.8	1.14	8.5	108	3.7	2.03	132	7.5	16.5	5	3.5	0.04	46.6	3650	158	4.1	25	9.6	16	287	0.74	26.8	2350	2.1	11.3	208	32	104
38B-B3	37.45%	46.3	6.8	2.84	1.18	5.4	1.16	24.7	0.28	18.2	5.3	4.6	21.2	1.12	0.35	2.03	27.7	2.06	15.8	115	2.2	3.41	146	25.8	23.7	7	3.7	0.04	27.1	3340	134	7.6	43	7.9	24	249	0.47	18.7	1760	1.9	11.8	225	76	125
38B-C	37.67%	53.6	6.9	3.24	1.28	6.0	1.26	26.5	0.34	21.7	6.1	5.1	21.0	1.14	0.40	2.39	31.6	2.92	34.8	132	2.7	4.67	167	20.7	27.7	15	3.5	0.03	18.9	3640	119	6.5	59	7.7	43	273	0.43	19.2	1390	3.2	11.2	261	77	114
38B-DR	85.58%	256	13.3	5.79	5.04	20.5	2.27	123	0.51	117	31.1	22.9	23.2	2.67	0.69	3.95	58.1	1.72	42.6	437	3.0	10.2	113	24.0	25.8	6	4.4	0.08	49.6	5490	55	2.1	59	15.6	117	137	1.20	29.7	4020	2.5	5.4	171	126	134
38B-D1	63.17%	380	26.0	12.1	8.86	36.6	4.64	172	1.01	189	48.2	40.2	41.8	4.99	1.47	8.34	115	2.03	37.4	292	5.5	7.67	254	41.3	22.1	9	5.4	0.05	35.8	4630	77	3.2	90	11.4	69	254	0.84	21.0	3330	1.5	6.0	384	160	152
38B-D2	27.26%	482	36.6	18.4	12.6	50.7	6.84	213	1.51	260	65.1	55.7	45.7	6.90	2.26	12.7	179	2.03	25.6	112	9.5	1.98	254	18.2	12.1	17	3.9	0.02	17.4	3360	133	9.5	35	4.7	17	413	0.33	10.1	1080	1.7	7.3	360	75	91.2
38B-D3	18.13%	288	27.5	15.8	8.29	34.5	5.54	129	1.45	167	40.4	36.5	30.4	4.80	2.02	11.7	156	2.58	20.7	93	11.8	0.69	133	11.4	8.3	16	2.5	<0.02	15.9	2900	163	9.0	24	2.5	7	466	0.21	6.6	603	2.2	5.5	158	73	59.1
38B-D4	19.73%	277	27.4	16.3	8.01	34.5	5.64	126	1.55	163	38.7	34.9	26.9	4.73	2.11	12.3	165	1.47	9.6	217	16.5	1.47	116	5.2	8.6	11	2.2	0.02	16.4	3270	112	2.7	7	2.8	11	498	0.23	7.4	735	1.7	3.1	119	34	54.7
38B-DP	77.65%	127	8.4	4.84	2.64	11.2	1.68	66.5	0.55	65.6	15.8	12.3	13.5	1.50	0.64	4.12	45.1	1.59	11.4	379	2.7	9.07	69	3.8	20.1	5	2.8	0.05	43.1	4940	73	10.0	17	12.3	83	164	0.82	12.8	3380	4.1	7.7	101	32	95.9
38B-D5	51.39%	115	12.5	8.29	3.40	15.1	2.73	56.1	0.97	67.1	15.6	14.3	15.3	2.08	1.15	7.07	84.2	1.86	9.0	513	7.9	5.33	78	5.8	14.1	7	2.5	0.03	29.4	3520	67	2.8	17	8.2	43	305	0.63	12.4	2770	2.5	9.6	102	173	86.9
38B-DF	92.86%	94.7	5.8	3.07	1.97	7.6	1.04	56.9	0.39	45.3	11.2	8.3	13.5	1.07	0.39	2.66	28.7	0.86	33.5	655	1.8	2.55	75	19.7	22.3	3	2.7	0.03	29.5	2970	70	4.9	59	12.7	63	83	0.95	8.6	4890	2.1	3.3	116	149	81.9
38B-Y	95.23%	36.8	2.3	1.56	0.73	2.9	0.44	20.9	0.23	18.1	4.3	3.4	9.7	0.35	0.18	1.65	13.2	1.02	7.7	702	1.1	2.28	64	14.0	16.3	2	2.7	0.04	25.1	3340	68	1.5	61	11.1	61	71	0.88	7.4	3300	6.4	2.4	82	90	73.1
38B-Z	92.30%	27.0	2.7	2.21	0.38	2.1	0.58	14.4	0.41	11.9	3.0	2.3	3.8	0.34	0.31	2.85	17.6	1.75	2.2	90	0.2	0.51	22	1.2	8.6	2	5.4	<0.02	8.5	820	28	5.1	11	42.3	8	27	3.49	8.5	9310	8.0	4.3	42	10	177
38B-ER	90.86%	117	6.9	4.61	2.27	9.7	1.37	58.9	0.60	60.1	14.0	11.0	14.1	1.17	0.61	4.18	43.6	1.14	8.5	534	2.5	14.7	74	6.9	25.0	3	3.2	0.06	39.3	5530	80	1.2	17	17.0	123	149	1.27	7.7	5040	2.3	3.6	121	33	103
38B-E1	15.45%	189	25.6	16.4	6.91	28.4	5.30	82.5	2.84	116	26.8	28.1	31.1	4.29	2.42	16.8	157	1.59	6.3	82	18.1	0.43	348	5.1	6.6	9	3.2	<0.02	5.6	3320	159	7.9	4	5.2	4	566	0.31	9.1	633	2.1	3.8	403	25	154
38B-E2	12.18%	226	24.2	15.3	7.54	30.0	5.01	105	2.60	140	31.8	31.4	15.1	4.23	2.25	15.3	148	1.08	5.1	65	15.1	0.13	100	4.5	4.9	17	1.5	<0.02	4.5	3040	150	7.2	3	2.6	1	561	0.18	5.9	377	4.3	1.8	31	14	49.0
38B-E3	13.88%	86.3	13.0	9.91	3.17	14.1	3.02	43.9	1.86	55.7	12.0	12.4	6.0	2.08	1.50	10.6	102	0.33	7.5	87	11.5	0.08	29	3.8	2.1	6	0.8	<0.02	2.9	2830	158	24.1	4	0.8	1	551	0.07	2.6	150	7.3	1.3	8	17	21.8
38B-E4	14.97%	15.9	6.1	5.53	1.08	5.5	1.60	7.8	1.15	12.4	2.4	3.6	3.6	0.88	0.86	6.07	64.8	0.38	3.4	77	6.0	0.15	15	3.8	5.1	18	0.7	<0.02	3.3	2380	104	11.7	4	1.7	3	419	0.12	1.8	258	11.0	4.5	8	23	22.1
39-A	76.67%	95.6	5.2	2.95	1.52	6.9	0.98	47.6	0.43	39.9	11.1	7.8	12.9	1.01	0.42	2.79	24.9	2.02	10.8	389	1.9	11.6	56	9.7	19.8	3	3.6	0.09	57.0	7730	90	4.3	23	12.1	99	235	1.22	19.2	3260	2.1	13.3	111	84	126
39-B	34.38%	21.6	3.6	2.53	0.58	2.9	0.80	11.0	0.39	10.3	2.7	2.4	8.5	0.54	0.37	2.44	21.2	8.32	112	176	4.2	3.74	28	13.3	13.3	8	1.2	0.03	17.7	3710	99	27.0	38	5.1	54	270	0.32	6.4	875	5.6	8.8	70	50	44.4

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
40-A	33.17%	86.1	7.1	4.03	1.98	9.2	1.43	58.8	0.52	39.6	10.3	8.1	4.9	1.32	0.54	3.32	39.7	4.45	56.2	199	5.6	1.60	26	7.4	6.8	6	0.7	<0.02	6.4	2350	128	71.5	56	4.1	14	283	0.18	3.1	480	7.7	6.3	73	42	27.1
40-B1	48.81%	110	8.6	5.03	2.44	10.4	1.71	69.8	0.67	50.1	12.5	10.1	10.1	1.47	0.67	4.38	48.3	3.37	12.5	300	6.6	7.61	54	7.4	12.5	5	2.0	0.02	20.0	4960	100	23.3	21	6.2	55	303	0.48	6.7	1810	2.7	9.6	159	14	64.9
40-B2	58.70%	36.7	4.3	3.04	0.75	3.8	0.97	19.2	0.48	16.0	4.3	3.4	11.0	0.66	0.45	3.07	25.9	3.35	37.0	194	3.9	4.36	44	7.8	19.8	9	3.4	0.05	41.4	3080	115	11.5	17	19.2	34	185	1.54	10.1	4410	2.7	12.3	79	60	141
40-B3	16.43%	19.2	4.7	3.50	0.69	3.7	1.09	12.2	0.52	9.6	2.3	2.4	4.6	0.65	0.48	3.17	40.3	1.37	7.3	169	12.9	0.31	12	4.7	4.1	2	2.2	0.02	8.9	2540	200	20.0	9	11.3	3	491	0.44	7.0	427	3.3	5.0	28	99	73.9
40-B4	11.55%	12.8	5.0	3.70	0.71	3.8	1.16	7.6	0.55	7.5	1.7	2.2	2.9	0.68	0.51	3.34	45.9	0.79	4.3	172	13.5	0.11	7	4.4	2.4	2	0.6	<0.02	3.9	2570	235	9.4	7	4.9	1	600	0.12	2.5	270	3.8	4.5	9	13	21.0
40-B5	13.31%	10.4	4.2	3.27	0.71	3.1	0.99	6.0	0.49	6.4	1.4	1.9	6.2	0.57	0.45	3.01	38.3	0.73	3.3	119	8.8	0.08	15	5.5	8.2	30	0.6	<0.02	4.8	2440	198	11.3	5	2.9	1	508	0.16	2.3	470	5.9	7.5	19	8	25.7
42-C	35.59%	431	47.0	22.3	18.6	64.3	8.09	139	2.88	309	69.6	83.2	28.3	9.43	2.99	19.9	135	2.99	20.4	648	6.3	2.91	67	98.6	18.2	17	2.6	0.03	24.5	9820	140	11.5	178	6.4	24	177	1.91	5.6	1730	1.5	16.3	229	242	145
42-DR	90.24%	242	13.9	7.62	3.60	17.6	2.74	130	0.86	96.2	26.3	15.2	20.4	2.48	0.97	5.76	93.9	1.97	16.4	803	3.0	7.78	107	33.4	27.2	4	2.7	0.09	38.6	11300	151	4.6	98	12.0	123	84	0.94	11.8	4380	2.4	6.1	181	106	94.1
42-D1	61.45%	588	54.5	33.4	13.2	66.4	11.8	343	3.87	268	69.5	49.3	33.5	9.60	4.30	24.9	417	3.44	19.2	2450	14.8	0.98	60	22.9	20.0	17	3.7	0.06	20.8	3280	35	10.1	200	19.3	10	136	0.93	16.7	6040	4.1	14.6	92	88	146
42-D2	28.74%	313	42.9	28.6	7.31	44.6	9.90	216	3.31	139	35.4	25.5	23.3	7.00	3.68	20.8	397	1.62	15.4	400	21.7	0.37	20	6.2	9.6	7	1.8	0.02	13.2	6960	275	5.4	13	8.2	4	220	0.93	7.8	2420	1.8	6.5	42	19	71.1
42-D3	39.77%	223	23.0	15.4	4.52	26.6	5.31	159	1.83	97.4	25.2	16.9	17.7	3.90	1.99	11.4	214	2.78	10.4	302	14.8	1.66	46	4.4	14.2	5	2.5	0.05	17.8	8480	237	5.7	10	9.9	34	210	1.32	9.4	2780	1.7	5.7	85	30	96.4
42-D4	76.50%	124	8.4	5.74	2.03	10.6	1.92	83.6	0.75	51.8	13.8	8.6	15.9	1.48	0.78	4.69	74.2	2.15	10.3	702	6.2	5.72	90	12.9	19.4	3	3.1	0.07	26.6	7440	120	4.1	38	13.9	108	148	0.18	12.8	5220	2.5	5.2	137	21	115
42-E1	25.91%	42.0	4.2	2.81	1.13	4.9	0.95	28.3	0.35	19.7	4.9	3.8	7.5	0.72	0.37	2.21	34.8	2.20	43.3	1060	7.8	1.20	31	16.7	5.3	3	0.9	0.02	9.0	6170	171	11.1	26	3.1	12	169	0.06	3.3	683	1.6	1.3	70	109	34.3
42-E2	14.46%	18.4	4.8	3.35	0.87	4.5	1.10	10.4	0.46	10.9	2.4	3.0	5.5	0.72	0.46	2.84	40.2	0.27	18.5	274	8.0	0.10	8	14.8	2.0	1	0.3	<0.02	4.1	6970	213	13.0	24	0.7	1	183	0.10	1.2	214	1.4	1.6	12	59	9.3
42-E3	12.79%	22.0	5.6	3.91	1.01	5.0	1.26	11.3	0.59	13.1	2.9	3.5	9.4	0.83	0.55	3.56	38.4	2.58	13.5	228	5.2	0.66	16	20.0	4.6	4	1.2	<0.02	3.4	6420	212	16.8	40	2.1	7	194	0.06	2.1	342	2.2	7.9	40	93	95.3
42B-A	20.58%	8.3	3.2	2.38	0.51	2.6	0.76	4.2	0.38	5.6	1.2	1.6	6.1	0.46	0.34	2.26	20.8	11.8	138	106	2.0	0.28	16	59.0	4.0	11	0.8	0.02	1.6	3640	156	83.6	156	2.3	3	106	0.62	1.6	187	1.4	16.7	103	27	39.5
42B-B	60.29%	31.1	4.6	3.45	0.86	3.9	1.07	15.9	0.62	15.2	3.8	3.5	14.6	0.67	0.53	3.69	26.9	6.80	84.8	211	2.4	3.76	73	20.3	15.1	9	4.8	0.05	20.8	5150	77	15.0	49	8.1	43	72	0.24	9.0	2400	1.4	32.8	229	72	301
42B-C1	23.65%	543	50.9	24.6	18.6	67.2	8.98	173	3.18	346	86.0	83.4	33.8	9.56	3.36	21.8	174	4.41	26.7	864	4.9	1.27	107	18.6	20.4	19	3.7	0.02	15.6	2880	77	13.6	37	4.4	14	132	0.16	5.2	834	1.4	17.5	377	2510	261
42B-C2	16.59%	319	41.5	23.5	11.8	46.6	8.07	105	3.35	225	50.2	49.4	31.2	7.11	3.27	21.7	202	3.10	21.5	213	5.0	0.55	39	9.7	18.8	16	1.5	<0.02	11.3	2340	73	11.3	19	3.0	6	118	0.23	2.7	528	1.9	7.8	108	736	110
42B-C3	24.12%	219	29.3	16.4	8.06	34.0	5.71	76.2	2.23	144	32.4	33.1	28.2	5.04	2.23	14.6	147	3.55	17.6	1220	4.7	1.73	62	4.9	15.3	10	1.9	0.03	14.3	2830	68	12.8	11	6.1	19	113	0.34	5.4	1360	1.5	6.9	143	113	99.0
42B-C4	60.90%	178	21.7	12.4	5.75	24.8	4.29	67.4	1.63	109	25.2	24.0	24.2	3.69	1.66	11.0	116	4.42	40.4	497	3.1	7.38	125	39.6	22.7	5	3.4	0.07	25.0	4220	55	17.3	124	10.1	85	90	0.76	9.2	3500	1.9	7.1	288	282	151
42B-CF	87.35%	127	10.5	5.78	3.13	13.4	2.01	55.3	0.77	69.3	16.9	13.9	20.8	1.89	0.78	5.06	55.2	2.22	8.8	678	2.5	7.54	108	11.1	26.2	3	3.1	0.09	30.0	4670	43	3.2	24	14.5	122	67	1.10	12.9	5010	2.8	4.6	186	85	112
42B-D1	18.63%	143	15.6	9.66	2.88	16.3	3.35	90.0	1.14	59.0	14.7	10.8	16.2	2.50	1.24	7.28	137	4.72	29.7	190	9.4	1.17	80	42.7	13.8	30	2.6	0.02	5.8	7850	231	8.2	56	6.5	15	166	0.33	3.2	881	1.7	3.5	262	99	162
42B-D2	15.02%	52.8	7.9	5.46	1.43	7.8	1.82	31.6	0.74	22.6	5.3	4.9	16.1	1.21	0.74	4.57	68.0	2.72	7.9	154	15.1	0.27	51	3.3	10.2	4	2.2	0.03	9.9	4190	265	6.6	6	5.1	3	207	0.21	5.7	843	1.2	2.8	116	105	88.5
42B-D3	18.03%	126	18.0	11.8	3.02	17.6	4.05	89.1	1.40	51.3	12.4	10.2	22.0	2.80	1.52	8.84	192	3.40	18.8	126	14.0	0.49	40	5.3	10.5	11	2.0	<0.02	4.8	3030	174	6.6	18	3.9	6	180	0.80	2.6	698	1.6	2.7	95	291	111
42B-D4	33.30%	210	28.3	19.4	4.65	28.0	6.66	155	2.22	78.9	19.4	15.6	18.1	4.33	2.45	14.0	360	1.01	7.4	336	17.6	0.28	13	1.2	6.0	4	1.5	<0.02	10.0	2270	180	2.9	2	7.6	4	160	0.32	6.4	2350	1.5	2.9	28	66	55.6
42B-E	17.53%	28.0	4.7	3.29	0.84	4.7	1.09	19.7	0.42	13.3	3.1	2.8	8.4	0.73	0.43	2.59	44.8	4.05	7.1	384	5.5	0.86	95	3.8	8.7	4	2.5	0.02	9.2	2950	147	10.2	7	8.6	14	145	0.20	5.7	1090	2.9	3.4	238	92	87.1
43-A	77.62%	51.9	3.6	2.29	1.12	4.2	0.72	26.8	0.34	23.6	6.1	4.6	14.5	0.61	0.32	2.18	20.3	14.7	270	2200	2.2	8.08	79	33.3	18.7	10	2.6	0.06	32.6	10600	195	11.5	117	7.4	104	193	2.53	9.6	2880	2.4	5.3	213	95	172
43-B	83.76%	37.5	3.9	3.13	0.71	3.2	0.91	20.0	0.56	16.1	4.4	3.1	13.4	0.54	0.48	3.48	26.4	6.44	37.0	492	3.8	4.22	73	11.9	44.0	8	3.9	0.06	21.4	4900	84	15.6	49	30.4	36	191	0.52	8.6	11900	5.7	11.1	175	37	196
43-CR	83.89%	196	24.6	12.8	6.83	30.5	4.66	88.2	1.32	118	26.7	30.1	25.6	4.40	1.64	10.0	117	1.63	22.7	1500	5.2	7.37	139	14.7	25.4	5	3.6	0.09	47.3	12500	251	4.1	39	11.7	99	217	0.90	17.8	4060	1.9	7.8	227	142	181.0
43-C1	51.61%	250	64.7	50.6	11.5	61.2	15.5	94.3	6.72	174	33.1	48.4	32.3	9.47	7.20	46.0	559	5.55	145	334	9.7	2.85	183	11.8	13.4	13	3.6	0.04	18.0	5460	143	16.9	50	8.1	41	289	0.12	9.9	1950	2.1	10.5	316	77	333
43-C2	14.40%	48.8	10.2	7.97	2.05	10.5	2.42	17.9	1.22	33.0	6.4	8.7	10.0	1.53	1.17	7.87	69.3	3.34	146	59	5.2	0.35	63	2.1	8.2	57	2.6	<0.02	2.6	1860	55	40.4	13	9.6	4	236	0.51	2.7	490	3.1	6.9	115	10	308
43-C3	24.19%	30.6	13.4	12.8	1.93	11.3	3.57	13.7	2.34	24.3	4.6	7.1	19.4	1.77	1.95	13.8	112	0.88	38.2	104	18.5	0.10	48	0.9	3.3	8	2.1	<0.02	6.2	2860	108	22.7	11	6.2	1	445	0.64	4.4	2010	1.6	10.2	41	13	149
43-C4	51.59%	24.2	5.7	5.92	0.78	4.5	1.57	12.8	1.25	12.7	3.0	3.1	13.0	0.74	0.93	6.93	48.9	1.39	11.7	212	10.2	3.56	52	2.2	10.3	8	2.3	0.02	13.2	3350	92	22.0	15	8.2	48	347	1.10	5.3	2720	2.1	7.8	51	16	133
266F2	70.52%	462	51.2	23.3	17.2	59.8	8.56	139	2.82	265	63.2	76.7	109	9.25	2.86	20.0	169	3.36	6.3		2.6		160	29.6	28.0	9			38.2	2860		7.2		21.7						12100		55.2	440		260
266G2	43.60%	470	72.3	40.4	21.1	80.0	13.7	146	5.94	326	69.9	88.6	77.5	12.0	5.36	38.9	281	9.29	161		7.0		122	15.7	22.4	14			9.6	5720		32.8		6.3					1050		38.2	210		449
266H2	29.47%	124	29.2	20.5	4.25	25.5	6.84	81.1	2.54	61.2	13.9	13.8	17.6	4.18	2.52	15.8	305	4.21	67.1		13.7		15	49.2	9.6	5			8.4	3610		8.0		3.6					971		9.0	27		116
266H3t	35.54%	191	14.7	8.55	3.87	18.5	2.97	123	1.07	78.8	19.4	14.9	15.6	2.59	1.12	6.89	93.5	4.18	97.4	211	8.5	0.69	71	18.8	5.3	4	2.3	0.02	6.5	3020	43	22.0	139	5.4	11	199	1.15	9.3	690	3.4	7.1	71	80	91.9

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
266H3m	46.23%	223	20.2	13.1	4.06	22.9	4.49	139	1.51	81.3	20.4	14.7	16.5	3.28	1.65	9.58	200	1.31	11.3	541	15.6	0.38	20	1.9	7.9	4	2.1	0.03	14.8	2620	168	6.1	10	10.9	5	160	0.98	10.9	4150	2.5	3.6	42	77	79.1
266H3b	40.69%	656	64.3	39.7	13.3	69.6	13.8	372	4.62	270	67.0	49.9	44.2	10.5	5.08	29.7	611	4.35	39.3	1640	16.9	0.80	66	22.6	13.0	12	3.6	0.04	12.6	4080	42	8.2	186	11.0	10	146	0.66	12.5	2830	2.1	15.1	95	98	173
267Ym	37.27%	1240	66.2	32.7	19.5	83.3	12.1	629	3.82	452	137	87.4	89.1	12.0	4.25	26.5	279								42.0	21							142								66.5		71	
267Y2	48.30%	661	43.9	21.1	14.1	56.9	7.78	252	2.38	297	76.7	62.6	77.8	8.16	2.73	16.8	173								27.5	13							108								30.8		75	
267Y3	40.11%	778	51.8	25.7	15.4	64.1	9.39	372	2.96	326	86.4	68.1	93.0	9.38	3.35	20.4	222								26.3	12							183								40.1		139	
270E5t	66.31%	512	35.0	14.3	12.0	45.8	5.67	159	1.43	244	61.5	60.0	67.2	6.83	1.75	10.4	118	4.31	10.4	979	4.3	5.13	106	2.1	40.8	10	3.4	0.18	144	4060	62	9.6	24	15.2	53	467	1.60	43.2	4680	2.2	32.0	230	31	157
270E5m1	70.23%	346	24.9	11.0	7.66	32.8	4.24	124	1.20	157	39.3	36.1	48.0	4.73	1.39	8.50	95.5	3.81	17.0	1070	2.9	2.08	68	1.1	38.1	7	4.1	0.14	92.6	2920	50	15.8	17	22.3	18	319	0.94	19.2	6850	3.3	10.1	169	14	187
270E5m2	50.93%	256	17.8	9.02	4.98	22.0	3.25	96.6	1.04	114	28.6	24.1	45.3	3.21	1.16	7.20	78.3	6.13	12.3	657	3.4	2.48	54	2.1	28.8	13	4.9	0.09	76.3	3140	61	12.0	13	12.8	15	392	0.83	13.8	3700	1.8	9.1	253	13	305
270E5b	49.34%	101	9.3	5.48	2.17	9.9	1.87	46.3	0.71	50.3	12.7	10.3	30.0	1.53	0.74	4.81	47.3	10.4	11.3	577	2.2	3.61	67	4.8	32.9	26	6.1	0.08	67.3	3010	51	18.1	14	11.5	18	330	0.55	10.9	3420	1.7	14.6	328	34	443
270E6	67.66%	408	29.5	11.8	10.6	41.2	4.63	132	1.14	228	56.6	53.0	53.6	5.90	1.42	8.51	101								36.2	7							22								26.8		33	153
270E6m1	62.46%	276	21.8	9.99	6.73	29.3	3.78	112	1.09	148	36.1	31.8	42.3	4.11	1.27	7.73	94.3								37.1	6							10								10.6		14	192
270E6m2	10.83%	20.7		3.29		3.6		9.0		11.7			17.4				31.1								21.9	44							11								6.4		2	114
270E6m3	40.51%	20.6		3.14		3.4		10.9		10.5			13.7				33.8								30.4	8							19								10.2		36	239
270E6b	65.95%	57.8		3.02		5.4		29.1		28.1			15.2				32.7								32.2	5							13								5.0		43	184
270G3	59.81%	453	45.8	22.6	15.2	56.8	8.08	144	2.98	281	65.0	69.4	35.1	8.32	2.99	20.4	172	15.1	179	324	4.2	3.87	68	26.5	26.9	24	3.9	0.06	20.2	3060	44	40.6	210	7.7	49	392	0.42	8.3	1660	3.6	32.4	176	123	327
270Gm	44.19%	969	113	56.1	34.4	134	20.1	309	7.47	620	150	152	66.8	19.9	7.42	50.6	444	14.1	81.0	569	8.2	2.46	73	53.8	44.7	24	3.7	0.07	17.4	2690	56	41.0	504	6.5	31	605	0.34	6.3	1230	5.5	35.2	174	180	231
270G3m	49.93%	917	98.6	48.5	31.4	119	17.4	294	6.34	571	132	140	53.8	17.7	6.39	43.4	385	15.0	615	659	6.6	2.38	40	42.4	38.2	25	2.4	0.03	16.1	2460	51	52.2	357	4.9	31	615	0.32	4.8	1130	4.7	31.9	159	145	149
270G3b	47.52%	615	80.1	40.3	24.5	96.4	14.4	210	5.36	413	90.8	106	75.5	14.2	5.31	36.1	307	9.89	213	336	7.9	2.72	149	54.6	40.4	19	7.5	0.15	18.4	2760	56	22.5	514	10.3	34	675	0.40	9.4	1500	4.7	17.0	207	169	464
270Z	64.35%	113	12.5	6.65	3.73	15.4	2.37	51.9	0.85	65.2	15.2	14.9	26.7	2.20	0.85	5.57	68.5								18.9	14							98								8.4		53	
270Zm	33.55%	193	24.6	13.7	5.87	27.8	4.87	98.6	1.72	98.0	23.3	21.9	28.1	4.17	1.71	11.0	148								17.1	7							319								6.5		66	
270Zb	39.07%	152	18.8	10.8	4.37	20.3	3.78	74.2	1.39	74.5	17.9	16.4	28.0	3.10	1.37	8.79	123								17.0	7							318								7.8		79	
284I2mt	54.20%	775	43.9	22.0	13.3	58.1	8.07	384	2.34	330	86.9	63.7	24.9	8.16	2.78	16.6	230	2.07	19.3		16.0		57	34.0	16.4	13		0.04	55.6	2060		7.2	74	10.6				12.5	2350	1.9	13.0	143	50	138
284I2mb	83.17%	80.2	5.9	3.98	1.42	6.4	1.26	42.2	0.61	37.5	9.5	7.0	13.8	0.95	0.56	3.97	36.5	1.74	3.3	577	4.2	8.04	42	7.4	21.4	6	4.0	0.05	32.6	3960	23	7.2	24	18.5	91	82	1.60	12.6	4470	3.3	5.2	69	29	133
284I2f	82.63%	54.9	3.8	2.61	1.00	4.4	0.81	29.9	0.43	25.4	6.6	4.9	15.8	0.64	0.38	2.74	22.0	3.54	37.0	1810	2.7	11.8	85	9.1	25.5	17	5.3	0.08	42.6	5580	32	13.9	24	15.1	126	266	1.14	17.1	3440	2.4	7.3	173	60	218
284I4	40.06%	588	32.6	15.9	10.9	46.0	5.85	283	1.72	265	69.1	53.5	17.0	6.21	2.03	12.2	161	2.21	23.6		6.0		45	8.1	12.9	12		0.04	28.9	1510		4.3	34	6.7				7.0	1390	1.1	13.0	89	24	126
284I4b	54.15%	52.1		2.34		4.8		24.3		26.8			11.2				19.8								20.0	7							42								8.1		21	
284I4m	30.93%	156	11.3	6.62	3.23	14.2	2.27	69.2	0.85	74.3	18.5	15.1	10.9	1.96	0.89	5.64	67.7	7.05	56.8		3.3		20	7.9	9.0	14		0.02	23.8	1440		8.3	27	10.2				9.3	1160	2.0	5.8	52	14	135
284J4	56.29%	71.0		3.30		5.9		33.3		32.4			13.4				28.7								19.5	22							17								4.8		152	
307E	89.19%	71.3		3.14		5.6		36.0		31.7			14.6				24.3								23.9	11							27								5.2		53	
307cly2	95.21%	71.8	4.4	2.55	1.28	5.8	0.87	36.5	0.36	33.3	8.8	6.4	12.7	0.80	0.37	2.44	25.9	1.36	5.1	683	2.5	9.74	64	14.8	19.6	3	3.0	0.07	52.7	12900	113	0.6	34	14.1	150	49	1.04	12.1	3050	2.2	2.5	93	99	98.2
307cly1	96.24%	72.9	4.6	2.76	1.27	5.8	0.93	36.4	0.41	33.0	8.7	6.5	13.5	0.81	0.40	2.76	24.3	1.34	5.2	675	2.5	9.38	63	12.8	20.1	3	2.7	0.08	47.9	13900	133	0.9	41	14.6	157	45	1.10	11.9	3040	2.2	2.3	88	116	84.3
307Ar	93.69%	59.7		2.19		4.3		29.8		27.0			12.8				16.0								22.8	5							18								3.8		67	
307A	82.51%	68.3		3.29		5.8		34.7		31.8			14.4				25.9								23.4	9							25								11.0		37	
307Am1	85.98%	77.7		3.81		5.4		41.5		33.1			13.4				32.0								25.7	5							20								7.8		29	
307Am2	37.77%	47.1		5.91		6.7		26.0		22.4			17.1				54.5								15.7	8							68								22.3		31	
307Am3	45.71%	65.3		6.02		8.8		28.6		34.2			22.9				48.2								24.3	10							70								27.1		34	
307Ab	79.88%	56.0		2.45		4.6		27.0		26.5			16.0				18.9								23.1	22							19								11.4		35	
308H	61.75%	122	12.0	6.53	3.36	13.5	2.26	50.2	0.87	62.0	15.6	14.0	21.5	2.07	0.87	5.73	54.8								15.5	10							67								11.6		118	

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
308G	46.56%	51.2		3.85		5.4		22.1		21.7			16.1				32.5								14.1	11							90								8.2		52	
308F	70.65%	76.8		3.81		8.4		32.1		40.8			14.8				30.2								16.1	3							38								7.8		44	
308E	59.36%	117	14.0	9.82	2.26	12.0	3.11	63.2	1.44	49.4	13.2	10.0	19.8	2.05	1.37	8.91	86.8								31.8	31							152								45.1		148	
308cly	97.25%	71.5		2.31		4.1		36.4		30.4			13.6				17.6	1.20	2.2		2.4		58	2.1	25.5	3		0.06	35.7	7470		2.4	6	16.9				9.3	4170	2.8	2.8	91	18	110
308Ar	89.62%	59.7		2.02		3.9		30.2		25.9			12.6				15.8	1.67	15.4		2.1		65	6.2	23.6	3		0.08	56.9	7730		6.7	13	12.5				11.7	3300	2.1	3.6	91	57	102
308A	60.33%	65.7		3.83		6.5		30.5		30.8			14.6				30.9	3.02	32.7		3.3		74	10.4	22.4	4		0.11	75.0	4810		15.2	44	9.2				17.9	2930	1.6	9.6	96	57	140
308A2	63.11%	63.8		4.41		6.1		30.9		29.0			14.2				35.5	2.87	36.0		4.1		74	11.4	22.6	3		0.11	50.3	5620		18.5	38	11.1				18.0	3360	2.1	16.3	81	62	167
308A3	54.41%	68.8		3.77		7.1		32.3		33.6			14.4				30.3	6.98	149		3.2		55	7.5	17.9	9		0.07	50.7	3310		13.7	38	9.2				13.4	2840	1.7	10.3	92	55	140
308Am	33.38%	30.0		2.07		3.6		14.8		14.5			10.2				17.1	9.59	96.1		1.7		31	7.6	11.6	18		0.04	16.7	2070		37.2	35	7.1				7.4	982	3.4	11.5	70	36	86.4
308Ab	36.63%	35.1		2.49		4.5		14.7		18.7			13.3				19.5	7.59	63.7		1.6		41	10.9	15.5	18		0.03	15.1	2860		17.4	61	19.6				8.6	1040	3.8	13.7	59	33	328
308Z	27.73%	30.1		4.48		4.9		15.0		15.5			16.4				40.9								18.5	46							76								12.3		55	
309I	59.09%	16.8		1.38		2.2		8.4		9.8			6.8				10.4								5.4	4							9								21.1		15	
309Im	34.61%	29.1		3.78		4.4		14.6		14.4			14.8				42.4								9.9	3							65								22.2		41	
309Ib	49.81%	87.9	11.0	5.57	3.64	13.3	2.00	29.0	0.69	58.6	13.5	14.4	20.5	1.97	0.73	4.68	44.6								12.9	13							53								29.1		39	
309A	50.81%	67.3		3.98		8.4		29.9		37.1			16.2				29.2	8.55	111		2.6		77	10.6	16.1	6		0.07	36.8	4500		24.9	39	8.8				16.5	2190	1.6	15.5	160	82	240
309A2	79.89%	73.5		3.28		7.3		35.5		36.2			16.1				25.0	5.21	39.0		3.0		73	14.6	25.3	4		0.10	48.8	7760		15.8	31	11.6				15.5	3120	1.8	9.3	157	106	142
309Ab	48.11%	38.5		2.89		5.2		15.0		22.8			14.6				21.6	4.51	51.0		1.7		41	8.8	12.2	16		0.04	16.5	3130		7.3	47	15.1				8.7	1450	2.8	9.9	68	35	275
309Am	32.97%	31.2		2.81		4.5		14.5		16.5			9.8				22.0	5.23	86.6		1.8		33	7.8	8.1	9		0.04	20.8	2730		21.4	37	7.8				7.2	1630	2.6	12.6	56	33	85.8
310E	36.80%	52.6		4.50		9.5		16.7		38.3			13.2				35.7								8.8	6							28								18.1		23	
310A	72.53%	48.3		3.35		4.4		24.8		22.0			10.8				29.5								17.4	7							30								12.3		66	
310Am	28.83%	24.9		3.62		3.7		13.2		12.6			10.6				35.1								15.1	15							10								12.7		66	
316A2	40.23%	321	25.6	13.5	8.33	32.4	4.81	135	1.69	160	38.6	34.0	26.0	4.57	1.69	11.3	120	5.47	42.9		5.5		71	7.4	19.2	21		0.08	23.3	1310		13.7	45	6.1				10.6	2090	2.0	12.4	163	30	236
317E	44.33%	153	24.4	17.8	4.39	24.8	5.80	93.6	2.27	76.8	17.3	15.9	20.4	3.64	2.24	13.5	266	5.95	138	418	4.4	2.28	56	23.5	10.7	27	2.9	0.04	8.6	3120	99	23.1	151	8.4	39	432	0.28	8.8	1210	3.4	5.5	97	72	189
317E2	63.30%	87.0	15.8	11.2	3.55	16.3	3.63	43.1	1.55	59.4	12.6	13.7	27.0	2.43	1.44	9.43	144								15.0	24							71								14.4		51	
317E3	44.89%	72.6	12.9	6.99	3.51	14.4	2.52	24.8	0.82	52.0	11.5	12.7	18.3	2.19	0.84	5.39	79.5								8.8	15							192								6.4		39	
317Em1	21.30%	81.0	10.4	6.90	2.22	12.2	2.33	56.8	0.96	40.7	9.1	8.0	9.2	1.67	0.86	5.54	95.6	3.75	99.7		5.5		11	34.6	4.7	32		<0.02	4.2	2880		27.0	219	1.6				1.1	275	7.3	2.2	22	86	14.8
317E2m	28.22%	170	23.5	13.7	6.48	28.7	4.76	71.6	1.90	111	23.4	24.9	24.4	4.02	1.72	11.6	133								14.6	7							217								16.0		73	
317Em2	11.52%	50.4		4.57		6.8		39.5		20.9			10.3				64.6	1.46	27.7		8.6		6	46.0	5.4	32		<0.02	3.6	2940		21.0	309	0.6				1.0	128	5.0	2.9	17	108	6.8
317Eb	40.34%	40.2	4.5	2.65	1.28	5.0	0.90	22.4	0.36	20.9	5.1	4.6	8.6	0.74	0.34	2.26	30.0	2.55	62.3	2910	5.7	1.06	22	19.6	4.4	4	0.8	0.02	6.1	2270	95	10.0	107	3.0	18	818	0.11	5.1	526	2.7	3.7	41	55	34.0
317E3b	38.25%	105	20.4	11.3	4.30	20.4	4.06	33.8	1.30	65.0	14.7	15.5	17.9	3.30	1.34	8.46	133								9.4	6							310								8.6		51	
317F	29.18%	118	28.5	13.0	8.58	34.4	4.94	27.2	1.55	121	22.2	34.7	16.8	5.14	1.59	10.6	105	8.69	181	804	3.3	0.46	26	14.9	7.5	11	0.9	0.05	2.2	1430	76	34.2	150	5.3	10	223	0.10	6.1	348	3.7	36.9	41	33	49.4
317Fm1	18.09%	63.8	16.6	8.07	4.09	18.6	3.02	16.4	0.95	58.7	11.3	15.5	6.8	2.89	0.98	6.32	73.6	1.37	41.5		2.5		6	20.4	3.4	2		<0.02	2.2	1680		5.8	180	1.2				1.3	327	1.8	11.5	12	35	13.8
317Fm2	24.59%	27.6		4.40		7.8		8.5		22.2			4.4				46.2	1.08	13.0		2.1		6	22.4	7.6	2		0.02	11.6	2100		4.1	169	2.1				4.0	1790	0.9	4.8	29	38	35.6
317Fm3	15.92%	14.4	3.0	1.89	0.49	2.7	0.65	6.5	0.21	8.3	1.9	1.8	3.2	0.46	0.23	1.36	30.8	0.51	4.3	284	2.3	0.04	8	36.9	3.5	1	0.8	0.02	4.8	2350	107	1.9	266	4.1	1	714	0.30	2.8	1410	1.0	1.7	23	56	29.5
319V	38.83%	34.3		4.60		5.7		17.1		17.8			17.4				43.5								8.7	3															18.3			
319W	40.03%	19.5		1.62		2.7		8.1		10.9			7.0				13.6								6.3	2															4.8			
319X	22.61%	31.7		2.97		4.4		13.4		16.7			10.3				24.5								12.3	13															15.0			
319Y	24.71%	22.0		3.07		3.2		12.2		10.5			9.1				32.1								17.9	18															25.2			

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
319Z	37.18%	20.4		3.50		3.3		10.0		10.3			14.4				29.4								20.8	28															16.1			
320W	75.91%	50.3		1.80		3.6		25.7		21.7			12.4				15.2								23.9	4															3.6			
320X	66.84%	33.5		1.61		2.6		18.0		13.6			14.7				14.0								36.0	4															4.9			
320Y	41.37%	88.6		2.69		6.7		42.1		39.3			12.3				24.1								29.2	17															6.3			
320Z	79.13%	36.5		2.56		2.6		20.0		15.1			15.7				21.8								36.9	9															7.4			
321F	57.82%	459	71.6	46.2	14.7	73.2	15.5	249	5.77	249	57.8	53.4	53.7	11.1	6.09	36.7	598	4.83	120		4.4		137	40.6	18.7	26			13.2	2710		40.8		10.8					2030		29.7	131		257
321Fm	31.17%	334	58.9	37.1	13.2	64.1	12.6	163	4.84	211	45.5	48.3	36.4	9.50	4.89	30.0	443	2.90	83.7		7.9		54	75.2	16.2	9			4.3	1530		30.6		2.4					427		28.5	78		94.8
321Fb	30.41%	235	35.0	20.7	8.52	40.7	7.16	106	2.72	143	31.6	31.7	23.4	5.87	2.74	17.0	211	2.90	54.3		8.1		77	58.6	13.7	6			6.8	1690		19.8		5.5					891		15.0	86		76.2
321G	44.24%	199	15.1	8.23	4.12	18.1	2.87	74.9	1.04	81.1	20.5	16.8	17.5	2.64	1.12	7.05	92.6								15.3	4															6.2			
321H	24.97%	28.0		1.75		3.6		14.4		15.1			9.7				20.1								6.1	3															11.9			
322F	41.03%	92.4	23.5	18.6	3.56	21.3	5.86	61.9	2.45	54.9	11.9	12.2	18.6	3.34	2.45	14.4	284	5.08	88.5		5.4		37	50.7	8.3	22			12.4	5240		15.4		8.8					1060		4.9	113		140
323E	47.50%	481	64.0	35.1	18.4	74.8	12.1	170	5.13	310	69.0	80.3	47.4	11.1	4.95	33.3	268	14.6	43.4		5.1		100	68.1	32.0	25			26.5	3810		30.3		11.9					2210		17.5	215		262
323F	54.45%	142	25.2	17.0	4.81	25.3	5.79	88.7	1.94	77.8	18.0	17.6	24.8	3.87	2.15	12.2	277	9.46	50.2		6.9		70	27.6	16.9	15			17.2	5420		15.5		11.3					1980		8.6	182		158
323G	42.00%	45.2		2.53		4.8		25.1		21.8			11.2				32.3	3.93	26.1		6.4		41	12.4	9.8	3			12.9	3420		10.1		5.6					1560		4.9	87		48.3
323H	36.68%	33.4	3.1	1.52	1.04	3.8	0.55	14.1	0.18	18.9	4.6	4.4	9.6	0.57	0.20	1.24	14.3	5.57	253	126	3.3	0.24	33	5.0	3.5	1	0.8	0.06	4.6	2080	93	20.4	21	4.6	8	860	0.11	10.6	379	1.3	18.9	44	30	32.1
323Hm	22.83%	7.8	0.6	0.33	0.19	0.7	0.11	4.4	0.04	3.5	0.9	0.7	1.2	0.10	0.04	0.26	4.4	0.34	17.7	640	0.4	0.14	3	2.4	1.7	<1	0.3	<0.02	3.4	3580	131	3.2	4	1.1	2	1020	0.07	1.2	251	0.4	0.8	9	15	9.2
324E	50.13%	1100	107	52.0	38.9	137	18.4	349	7.53	695	160	179	59.1	19.8	7.34	51.1	329	14.7	107		5.2		86	62.3	34.0	27			19.0	8070		55.9		9.6					1290		30.7	227		303
325A	18.99%	51.7		3.36		5.9		23.9		25.1			3.7				37.5	0.91	7.7		3.2		7	18.5	4.2	4			4.5	5650		11.6		1.5					341		3.2	14		15.0
325Ab	32.82%	70.4	23.5	11.2	7.32	27.3	4.12	15.9	1.38	103	17.0	30.8	27.4	4.20	1.48	9.48	82.5	4.99	23.9		3.1		41	14.7	9.1	8			8.3	4070		39.3		5.6					678		77.6	60		212
325F	40.40%	427	76.8	53.1	13.7	81.3	17.7	274	6.83	241	52.3	50.1	23.0	11.9	6.94	41.0	720	6.83	58.4	478	7.5	2.71	51	62.5	15.8	23	2.6	0.04	15.3	6510	195	29.3	324	8.1	39	384	0.47	6.2	1300	2.9	11.2	97	255	96.0
325F2	33.77%	1260	150	85.7	34.9	166	29.5	622	11.1	695	167	146	24.2	24.1	11.3	70.2	946	6.12	38.3	1520	8.4	1.90	28	134	22.0	30	2.4	0.03	16.8	8260	223	30.6	650	5.5	27	899	0.43	3.5	758	3.1	5.7	68	601	74.8
325H	25.23%	63.5		6.91		13.3		21.3		47.1			10.9				66.5	4.43	21.6		7.2		13	15.2	6.0	7			7.4	2880		7.9		4.9					566		9.5	34		51.7
326T	94.37%	30.0	1.4	0.92	0.44	1.7	0.28	15.7	0.16	12.3	3.4	2.3	5.0	0.23	0.14	1.09	7.2	0.79	6.5	467	0.6	2.76	23	1.5	13.6	2	2.4	0.02	29.5	2690	44	5.1	6	9.9	55	105	0.74	6.2	3190	1.4	1.9	38	21	74.9
327A	89.41%	222	17.4	9.46	5.63	21.4	3.27	101	1.14	109	27.2	23.3	20.0	3.15	1.22	7.82	81.4	2.90	16.1	470	4.4	11.4	108	10.4	29.9	12	4.4	0.09	33.6	6920	59	5.7	42	18.3	95	129	1.33	14.1	4460	2.8	10.1	169	92	200
327Am	90.01%	235	19.2	10.6	5.82	22.9	3.62	105	1.29	113	28.2	24.2	18.5	3.45	1.35	8.73	93.9	2.25	9.9	332	4.5	9.79	90	9.0	28.4	10	4.1	0.08	30.9	6210	52	4.9	39	19.2	71	117	1.46	12.7	4800	2.9	10.2	157	76	173
328B	89.13%	113	6.5	3.59	2.52	8.7	1.21	57.4	0.50	52.1	13.7	11.0	27.8	1.21	0.48	3.24	31.3	7.45	64.5	3280	2.3	12.8	204	8.0	44.2	41	8.2	0.09	34.8	7290	62	19.2	40	24.5	125	148	1.32	30.9	4570	3.6	21.6	332	46	495
328A	58.69%	215	23.1	15.2	5.13	25.3	4.87	117	2.20	105	25.2	21.7	19.9	3.77	2.03	13.9	132	4.10	81.8	905	10.1	3.69	74	18.1	16.6	15	2.8	0.05	12.2	3110	42	10.6	124	11.2	45	518	0.59	7.6	1880	3.8	8.1	108	61	163
328Am	48.86%	196	22.7	15.8	4.50	23.4	4.97	116	2.29	89.9	22.0	17.9	17.1	3.57	2.12	14.4	151	3.50	96.0	651	14.9	2.33	46	19.4	12.8	11	2.0	0.03	8.0	2530	39	8.5	154	8.1	27	673	0.44	6.6	1390	4.8	5.5	68	58	103
328Ab	47.60%	191	22.0	14.2	4.92	23.4	4.56	98.9	2.04	91.7	22.1	19.6	20.6	3.60	1.89	12.9	126	4.88	65.0	655	12.9	2.30	63	25.5	15.4	16	2.7	0.05	7.6	2600	42	7.2	201	10.9	24	683	0.46	7.6	1440	5.5	5.9	93	58	177
328Af	91.47%	56.3	3.5	2.37	1.03	4.2	0.73	31.5	0.38	24.6	6.4	4.6	14.5	0.60	0.33	2.38	20.4	1.93	8.8	632	2.8	8.60	77	12.7	22.9	14	3.1	0.06	28.0	7670	68	1.4	39	13.4	95	243	1.02	8.0	4160	2.1	2.5	146	96	116
329A	46.21%	766	50.0	24.8	15.0	65.1	9.05	368	2.75	320	81.8	65.7	38.3	9.23	3.14	18.8	245	11.4	93.5	653	8.4	4.62	163	110	33.6	47	8.1	0.10	36.9	2470	57	58.1	201	8.9	35	101	0.36	15.1	2000	2.6	27.7	520	109	527
329Am1	37.83%	455	35.2	18.7	10.4	43.9	6.69	210	2.26	213	51.5	44.7	38.2	6.30	2.46	15.0	181	18.7	162	582	5.4	2.73	96	81.3	32.9	60	4.7	0.07	27.2	1600	48	57.4	154	8.2	26	93	0.63	12.9	1240	3.5	24.4	379	128	278
329Am2	62.90%	186	14.5	8.46	3.77	16.7	2.95	90.3	1.01	86.1	22.0	17.1	17.7	2.41	1.11	6.88	93.3	5.33	39.3	587	3.2	9.35	68	9.7	21.4	10	2.9	0.04	36.7	3670	40	21.3	61	7.5	83	107	0.37	9.6	3010	1.4	10.5	147	67	108
329Am3	38.37%	526	44.3	24.6	13.8	54.7	8.46	178	3.12	280	66.5	64.9	30.1	7.76	3.33	21.2	212	9.53	56.5	810	1.5	4.12	62	12.1	25.3	41	4.0	0.05	16.7	1690	25	25.9	86	5.9	29	273	1.38	5.9	1270	3.3	9.9	201	77	216
329Ab	85.47%	104	7.8	4.97	1.97	8.5	1.61	54.6	0.64	47.1	12.4	9.1	13.9	1.29	0.67	4.26	51.8	2.24	18.2	847	2.5	11.0	66	5.8	26.0	4	3.6	0.05	43.5	4390	43	7.5	36	19.3	66	140	0.86	10.1	5590	3.1	6.4	136	67	143
329A2	62.20%	261	20.2	9.88	7.48	28.1	3.56	101	1.23	149	35.9	35.3	28.1	3.87	1.30	8.34	83.0	6.98	40.5	1930	2.2	9.04	130	16.7	32.2	27	7.0	0.11	32.8	2990	24	24.2	81	9.7	60	183	0.44	18.0	3090	1.8	25.2	235	145	377
329A2m1	40.03%	435	30.5	16.4	10.3	39.6	5.66	142	2.06	223	53.2	49.4	26.0	5.53	2.16	13.8	137	11.1	72.3	359	1.4	4.69	63	14.7	25.0	35	5.0	0.05	18.2	1760	19	43.4	86	7.0	31	272	0.39	6.3	1500	5.3	16.8	181	100	286
329A2m2	41.11%	256	20.7	11.2	6.80	26.5	3.91	81.1	1.45	139	32.5	31.9	24.6	3.65	1.51	9.63	97.6	8.98	95.5	491	1.0	3.77	80	8.0	15.8	18	3.8	0.07	13.3	1480	17	42.6	51	8.6	30	243	0.92	8.5	1460	4.4	13.9	150	52	176

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Cerium	Dysprosium	Erbium	Europium	Gadolinium	Holmium	Lanthanum	Lutetium	Neodymium	Praseodymium	Samarium	Scandium	Terbium	Thulium	Ytterbium	Yttrium	Antimony	Arsenic	Barium	Beryllium	Cesium	Chromium	Cobalt	Gallium	Germanium	Hafnium	Indium	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Niobium	Rubidium	Strontium	Tantalum	Thorium	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
329A2m3	81.02%	144	11.6	7.00	3.30	13.5	2.33	63.6	0.89	76.7	19.1	15.8	16.6	1.96	0.94	6.00	63.7	3.01	30.1	538	1.4	8.41	85	4.5	22.7	10	3.4	0.05	33.1	3680	27	10.7	20	11.7	87	123	1.29	11.6	4580	2.0	7.9	164	45	129
329A2b	72.99%	129	9.8	5.78	2.95	11.7	1.93	56.9	0.77	67.3	16.9	13.7	19.2	1.68	0.79	5.16	51.4	6.36	38.5	501	1.4	7.23	92	6.3	26.0	16	6.3	0.08	30.4	3120	32	20.8	32	20.3	43	160	0.56	13.7	5290	3.3	11.3	215	55	331
329A3	45.30%	514	34.3	17.4	12.7	48.0	6.17	171	2.20	269	64.4	60.2	28.6	6.46	2.32	14.9	140	14.0	50.9	846	1.8	5.12	95	13.5	31.2	56	6.7	0.06	21.9	2060	25	24.5	90	9.7	35	207	0.37	9.2	1920	4.0	11.1	281	106	395
329A3m	36.63%	117	8.9	5.43	2.41	10.3	1.83	48.3	0.67	52.3	12.8	10.6	17.2	1.48	0.72	4.43	56.9	9.29	48.8	261	2.6	4.96	65	7.3	15.0	23	4.3	0.05	27.1	1890	31	39.5	53	7.0	41	65	0.47	8.4	1470	1.6	13.0	150	41	281
329A3b	41.20%	339	26.4	14.0	9.13	35.4	4.87	111	1.77	188	43.1	42.5	28.8	4.83	1.88	12.1	119	9.35	40.6	376	1.5	4.94	95	11.0	18.3	24	4.8	0.08	19.4	1910	25	26.5	78	11.1	36	250		9.9	1730	3.5	13.0	192	62	224
330A	65.80%	301	28.0	14.4	9.22	35.8	5.07	109	1.84	178	41.2	44.4	26.5	5.22	1.89	12.6	101	20.8	313	230	3.6	8.55	108	24.3	22.0	80	10.0	0.07	80.5	5230	33	44.6	106	14.1	88	343	0.80	25.2	2360	2.6	28.5	144	55	969
330A2	58.44%	280	27.8	15.6	8.11	32.8	5.29	105	1.95	161	37.7	38.3	26.8	4.89	2.02	13.2	111	24.6	223	879	3.6	6.20	78	33.3	20.3	76	9.5	0.07	63.4	4250	27	48.9	142	11.6	68	441	0.57	12.8	1620	2.7	23.2	213	54	943
330B2	82.74%	247	20.5	9.63	6.61	27.2	3.55	104	1.03	130	31.1	29.8	19.7	3.90	1.18	7.47	76.5	4.62	42.9	652	3.6	10.5	100	10.9	24.4	13	4.5	0.08	54.9	7420	32	12.4	46	14.9	126	125	1.10	15.7	3760	2.3	28.7	183	80	304
331A	73.79%	484	20.3	9.21	7.21	30.6	3.37	247	0.97	194	54.4	37.5	33.1	4.18	1.10	6.76	84.9	4.57	27.3	2060	5.4	6.71	175	5.7	24.6	13	4.2	0.19	82.3	6250	25	22.3	54	15.0	60	327	1.33	66.9	3730	3.5	33.9	282	30	245
331Am	50.20%	689	28.1	12.3	9.82	42.1	4.66	351	1.25	273	79.7	51.7	42.2	5.80	1.44	8.72	113	6.18	30.1	1170	9.9	2.19	219	7.6	20.6	18	4.6	0.20	104	6640	11	22.3	92	10.7	19	432	1.03	51.7	2720	2.3	55.7	412	27	369
331Ab	53.39%	342	15.0	7.24	4.95	21.3	2.61	171	0.84	136	37.7	25.8	34.1	2.94	0.90	5.74	63.0	9.17	27.2	432	5.9	2.07	152	7.4	26.6	15	7.3	0.09	75.3	6170	11	23.8	78	12.8	17	279	1.08	17.0	3110	2.3	34.2	348	22	614
331A2	44.63%	757	36.4	15.0	13.8	53.9	5.72	295	1.48	346	96.6	72.6	59.4	7.56	1.77	10.7	110	24.1	13.5	787	6.7	2.13	120	5.4	28.1	102	8.2	0.06	85.0	3930	66	43.2	21	9.3	18	495	0.80	11.8	2030	2.4	48.9	635	45	912
332A	36.36%	649	41.7	19.1	14.8	58.1	7.16	304	2.02	303	80.9	63.5	45.0	8.18	2.33	14.4	160	6.24	213	790	8.0	0.44	149	25.7	17.4	16	3.6	0.03	14.2	1680	29	17.6	84	5.7	10	356	0.21	7.7	463	3.3	12.3	248	31	264
332Am1	24.02%	1010	72.2	34.9	22.5	94.3	12.8	482	3.63	456	122	93.7	50.5	13.4	4.27	26.0	324	2.71	38.2	695	16.5	0.47	76	37.4	20.5	21	2.0	<0.02	15.3	1330	25	6.9	141	3.2	6	203	0.32	6.5	579	3.8	9.8	117	36	90.2
332Am2	24.37%	1050	81.1	41.3	24.3	102	14.8	482	4.53	482	127	101	55.3	14.9	5.11	31.7	366	2.72	26.0	781	16.3	0.85	77	42.4	36.1	20	2.4	0.02	12.9	1210	23	5.7	193	4.5	10	187	0.35	6.4	703	4.3	15.6	101	38	97.0
332Am3	32.26%	906	69.8	36.1	22.2	89.6	12.9	404	4.13	448	115	93.8	65.1	12.8	4.53	28.7	304	2.54	16.2	615	10.8	1.22	125	48.7	48.7	19	5.7	0.08	26.0	1380	23	4.7	218	9.2	13	152	0.54	11.3	1390	4.8	20.4	76	38	312
332Ab	87.33%	263	20.1	12.4	5.51	23.2	4.09	125	1.57	119	30.8	23.5	21.1	3.44	1.65	10.7	109	3.32	7.3	371	2.8	11.7	80	12.8	40.9	17	5.0	0.07	29.2	4420	30	10.4	47	26.3	69	91	2.19	13.8	7060	5.6	6.5	159	51	206
333A	41.96%	430	33.8	17.0	11.4	44.3	6.13	172	2.16	240	57.5	49.9	53.3	6.31	2.19	14.5	124	6.06	22.5	1270	1.6	3.05	53	26.9	34.0	19	2.8	0.05	28.6	2570	106	21.6	197	9.1	38	334	0.46	6.1	2180	4.3	37.1	170	58	103

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Aluminum	Calcium	Iron	Potassium	Sodium	Phosphorus	Sulphur	Silicon
19B-U	92.94%	121000	1680	26000	18200	2580	136	178	260000
19B-V	97.08%	47200	751	6040	2570	1130	21	35	362000
19B-W	92.51%	99400	2150	86200	18500	2000	418	757	240000
19B-X	93.92%	121000	1760	35800	21900	2980	289	233	261000
19B-Y1	93.20%	107000	1030	10900	22500	2290	196	396	289000
19B-Y2	93.23%	103000	3100	17500	24600	2520	187	1240	280000
19B-Y3	90.87%	88000	3050	33900	20600	2340	164	1360	267000
19B-Y4	94.05%	105000	1660	20000	28300	3090	199	489	278000
19B-Y5	93.36%	105000	2210	36700	29300	3170	182	815	263000
19B-Y6	92.87%	107000	2240	38000	27100	3230	210	753	255000
19B-Y7	93.91%	108000	1290	14100	25600	2830	174	347	278000
19B-Y8	93.17%	113000	2030	32000	27500	3460	229	719	255000
19B-Y9	90.99%	104000	2730	36600	29400	3880	315	1670	242000
19B-Y10	89.21%	100000	3370	39000	29300	3990	346	1980	247000
19B-Y11	92.26%	104000	2840	35000	30600	3970	339	1250	256000
19B-78.0	96.01%	78500	3130	24100	21400	10300	676	607	298000
19C-Y	91.45%	105000	2230	33700	28300	3390	222	1240	246000
19C-Z	78.15%	35000	12300	281000	10100	3370	684	1100	108000
20-Y	93.53%	119000	1530	12200	22900	2260	379	257	274000
21-W	90.93%	101000	1450	26200	14000	1540	128	606	272000
21-X	88.76%	87400	3290	85100	15100	1510	425	846	237000
21-Y1	94.21%	109000	1310	12900	22000	2180	169	218	285000
21-Y2	93.28%	112000	1970	17000	23600	2540	240	394	271000
21-Y3	93.70%	118000	1740	16000	23900	2700	264	293	265000
21-Y4	94.19%	110000	2000	17600	27400	3090	302	369	271000
21-Y5	91.14%	103000	2800	18900	27200	3420	333	970	260000
21-Y6	90.95%	102000	4020	24000	28200	3860	403	1420	254000
21-Y7	91.43%	103000	3130	30100	28400	4150	661	1260	260000
21-Y8	91.87%	102000	3410	34500	29500	4220	699	1410	253000
21-Y9	93.30%	102000	3570	31700	28800	4390	698	948	258000
21-Y10	92.64%	100000	3910	36200	29100	4620	693	1170	257000
21-Y11	93.53%	99800	3950	37200	30600	4660	717	1020	260000
21-AR	92.69%	95000	3770	36900	28400	5630	663	1170	261000
21-Z	94.04%	80200	6390	50300	23200	8120	720	3050	264000
21B-U	85.31%	79300	13900	55900	22400	3940	567	9280	216000
21B-V	92.79%	87600	15500	47000	26200	6110	702	2290	251000
21B-W	97.22%	34100	1130	4780	970	367	<10	116	366000
21B-X	96.36%	59600	2370	16500	5970	1030	59	170	334000
21B-Y	93.27%	111000	4190	19700	19700	1850	94	364	275000

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Aluminum	Calcium	Iron	Potassium	Sodium	Phosphorus	Sulphur	Silicon
21B-Z	96.18%	77800	3200	23700	19900	7220	88	257	308000
26-Y	93.76%	93800	3350	16900	21300	1400	156	3920	282000
26-Z	93.77%	104000	1790	29700	23500	1910	455	306	263000
26B-Y	93.78%	103000	843	8410	16300	1010	101	77	287000
26B-Z	93.68%	96600	1290	28800	21300	1490	115	415	279000
28-V	97.74%	31000	852	5790	3100	445	15	91	378000
28-W	93.47%	85300	8190	108000	17300	953	3640	280	240000
28-X	94.43%	102000	1530	18600	21400	1050	163	48	292000
28-Y1	94.24%	106000	1440	16100	25400	1220	135	110	285000
28-Y2	94.81%	105000	2160	19000	26100	1280	189	235	286000
28-Y3	94.07%	105000	1720	14100	26000	1190	258	145	281000
28-Y4	94.40%	102000	1600	13000	27000	1250	294	126	277000
28-Y5	94.18%	105000	1890	17300	28200	1480	399	146	279000
28-Y6	94.27%	103000	1950	16300	28000	1560	298	282	279000
28-Y7	94.41%	100000	3810	21800	26800	1470	364	1470	279000
28-Y8	94.54%	98300	2540	23600	27000	1560	586	253	274000
28-Y9	94.91%	96600	3370	26700	28000	1660	623	702	280000
28-Y10	95.13%	94600	3130	29600	27500	1960	704	310	280000
28-Y11	95.21%	87600	6620	31400	25800	3180	739	3270	286000
28-Y12	95.53%	87900	5670	34000	25200	4160	781	2100	287000
28-Y13	95.56%	93500	4460	35200	28500	4110	705	661	279000
28-Y14	95.68%	90600	4640	33800	26900	5000	754	633	283000
28-Y15	95.95%	93600	3920	36300	30100	5070	678	286	279000
28-Y16	95.97%	87100	6450	36600	25900	5630	748	2010	287000
28-Y17	95.88%	87800	5780	35200	25300	6600	820	770	287000
38-A1	13.60%	5590	22500	6360	728	559	55	12000	17500
38-A2	15.35%	10600	17400	9720	2020	396	38	132000	22400
38-A3	49.70%	7990	11900	895	223	331	24	5940	187000
38-V	93.73%	5000	1620	5590	695	175	14	965	378000
38-W	92.30%	11800	941	1780	1930	264	28	271	399000
38-X	97.91%	97800	3500	19400	24300	2380	94	762	270000
38-B	54.93%	77300	9260	23800	6660	904	68	5580	139000
38-C	36.37%	35500	15100	25100	4720	1070	84	11500	80900
38-DR	79.36%	83600	5590	26100	18100	1420	213	2450	230000
38-D1	35.26%	25500	14600	13800	3380	1700	180	13100	54200
38-D2	18.77%	16400	18800	5240	1340	1880	395	14100	23600
38-D3	14.78%	9600	17800	6110	446	1960	423	16400	11500
38-D4	10.34%	6330	16300	2570	301	2030	299	11900	4960
38-D5	19.17%	17100	18000	3530	1730	2040	117	10800	32800

Appendix B - Analytical Results

Concentrations are reported on a whole coal/rock basis (dry) as ug/g or parts per million

SAMPLE ID	Ash (wt%)	Aluminum	Calcium	Iron	Potassium	Sodium	Phosphorus	Sulphur	Silicon
38-DF	72.92%	78600	7310	12800	16000	1970	141	3800	212000
38-Y	93.71%	96700	1660	13900	26600	674	44	251	286000
38-Z	95.39%	75000	1180	10700	18200	2960	46	383	313000
38-E1	18.35%	6050	21900	35800	361	2780	82	17000	10700
38-E2	11.04%	3830	20900	3260	342	3010	23	10900	8480
38-E3	11.27%	3710	22600	2270	354	3140	15	9590	11200
38-E4	9.30%	3310	22000	2460	380	3190	17	10200	3460
38-E5	11.37%	5500	18600	6420	435	3020	17	11900	7900
38-E6	31.53%	16800	16800	66500	1600	3220	34	13100	50900
38B-B1	20.23%	23000	21400	8780	487	706	104	13900	28500
38B-B2	36.01%	47100	15900	5190	3230	745	104	10000	86400
38B-B3	37.45%	50100	13900	15600	4110	709	51	9030	86000
38B-C	37.67%	35100	13900	27300	7310	793	53	10200	86700
38B-DR	85.58%	99300	3560	24100	21700	1140	191	1200	249000
38B-D1	63.17%	70800	9300	18600	11800	1400	254	4200	178000
38B-D2	27.26%	27900	17000	8600	2930	1530	299	11400	53000
38B-D3	18.13%	14300	18400	7720	1250	1620	182	14200	24200
38B-D4	19.73%	16300	18800	2580	2090	1720	186	11500	33900
38B-D5	51.39%	46000	11200	7730	7710	1620	244	6970	156000
38B-Y	95.66%	74500	1330	11900	18200	4010	49	433	314000
38B-Z	95.23%	76300	975	8370	17000	1460	39	493	319000
38B-E1	15.45%	8340	20500	2290	1080	2650	130	8330	22600
38B-E2	12.18%	5870	20100	1290	605	2750	148	8140	14300
38B-E3	13.88%	4820	20500	17100	565	2870	67	17000	6590
38B-E4	14.97%	5990	16200	1860	772	2680	20	8710	27800
307cly2	95.21%	75600	1380	30000	30600	5200	374	599	301000
307cly1	96.24%	74300	1820	31100	31500	6840	497	654	304000
270G3	59.81%	72600	11200	48800	10800	2960	473	8780	140000
270Gm	44.19%	46400	17600	39800	6420	2970	694	13900	78600
270G3m	49.93%	44700	19500	69300	7190	5010	747	16400	82500
270G3b	47.52%	44500	24300	50900	8420	3220	430	19500	79900
317E	44.33%	24700	19800	80400	9110	5960	328	18900	69500
317Eb	40.34%	14600	29800	110000	5900	9010	107	32400	28200
317F	29.18%	9860	18600	102000	2970	5550	132	20800	14900
317Fm3	15.92%	10100	15500	4700	153	584	24	13200	30100
323H	36.68%	9210	21400	139000	4510	11600	120	28800	12000
323Hm	22.83%	5650	35400	35000	1460	3370	78	33600	7730
325F	40.40%	31300	15600	32800	7940	3120	912	14500	73200
325F2	33.77%	23000	12200	19400	3660	2860	736	19400	43600
326T	94.37%	66300	392	7530	14800	2060	49	342	331000

Appendix C

Summary of Drill Holes and Cuttings Logs

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-1	10/9/2024	STATE TRUST	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
145	88	16	NW	47.3827	101.907	2213

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	322	318.3

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☐ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☒ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: Base of Bear Den Member modeled to occur very shallow at ~30’ depth. Although it was deemed possible that glacial sediment extended to that depth, it was elected to drill here as it would represent the easternmost ND State Trust section with the Bear Den Member preserved. Glacial till and outwash were encountered to 25’ and first bedrock encountered at 25’ was not light colored/greasy. With no evidence of lignite above 74’ and unstable sands encountered at depth (a significant washout occurred from 115’-120’), it was elected not to pursue core. The pilot hole was drilled to 320’ to determine the relative depth of the thicker lignites mined just to the east.

Interval (ft)		Drill Cuttings Descriptions - Hole NDGS24-1
0	20	Olive-brown till (limestone pebbles 15-20’)
20	25	Multi-colored gravel, clean, pea-sized
25	30	Gray to tan, silty mudstone, chunky (Tsb)
30	45	Sand (tan)
45	75	Fine, muddy sand, predominantly tan with lesser black grains (chatter at 75')
75	80	Tan & gray cemented sandstone, with one coal flake
80	140	Tan, muddy sand (similar to above the cemented zone) (fewer black grains 120-140’)
140	155	Darker colored (gray to tan), clayey sand
155	160	Gray, sandy mudstone with a few coal fragments
160	170	Gray sand with cemented chunks and chunky silt blocks
170	175	Coal
175	180	Coal and sand
180	190	Gray and tan, sandy mudstone - coming up in hard chunks (chunkier 185-190’)
190	195	Dark gray to black carbonaceous clay with sand
195	205	Gray, muddy claystone with sand (Driller thinks coal @ 200-203')
205	220	Medium-gray, sandy silt (chatter and coal fragments 210-215’)
220	230	Gray mudstone
230	235	Gray mudstone (getting sandier)
235	240	Gray sand
240	245	Gray mudstone with coal fragments
245	255	Gray, muddy sandstone (watery, not much return)
255	260	Gray to brown muddy sandstone
260	265	Coal (~60%) with gray mudstone
265	270	Brown & gray sand with coal fragments (<50%) (mostly clean sand)
270	275	Brown sand (clean)
275	280	(chattering) Gray to brown sand with carbonaceous clay pods and a few coal fragments
280	290	Coal (50%) and gray to brown mudstone (looser 285-290’)
290	300	Tan to gray sand with coal fragments (<10% 290-295’ and ~15% 295-300’)
300	305	Tan to gray sand
305	310	(Chattering) Tan to gray sand with coal fragments (~10%)
310	320	Clean tan to gray sand with coal fragments (increasing ~20%)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-2	10/9/2024	STATE TRUST	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
146	89	36	SE	47.4151	101.9605	2232

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	160	159.4

Core Recovered (ft):	Recovered Core Interval(s) (ft):
44.6	70-71.8, 74.8-85, 94-114.6, 211-213, 217-227

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
20	0

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
1,896	N/A

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☒ Other – claystones may be enriched but no core collected

Notes: Base of Bear Den Member modeled to occur at ~60’. Light gray clay encountered by 75’, with 58-inch-thick interval of lignite and carbonaceous claystone occurring at 95.5’ with significant REE enrichment. Interestingly, light gray/white clay/mud/sandstone continued to 190’. Lignites cored from 205-206’ and 211.8-212.7’ were not enriched, but these positions disagree somewhat with the elog. The pilot hole was drilled to 320’ to determine the relative depth of the thicker lignites mined just to the east.

Interval (ft)		Drill Cuttings Descriptions – Hole NDGS24-2
0	5	Silt, brown, sandy
5	25	Till, brown-gray/brown, pebbles, clay-rich
25	50	Till, gray (medium), pebbles, clay-rich
50	70	Mudstone, medium-dark gray, silty, fissile to blocky, indurated
70	75	Claystone, medium gray, clean, malleable
75	80	Coal, hard; interbedded claystone, light gray
80	95	Mudstone, light gray - gray/white, silty
95	98	Coal, pXRF noted elevated yttrium
98	105	Claystone, light gray/brown, carbonaceous
105	150	Mudstone, white to off-white, silty
150	160	Mudstone, light gray/white, silty
160	185	Mudstone, light gray/green to white, greasy, silty
185	190	Sandstone, light gray/green, silty
190	201	Mudstone, medium gray/green, silty
201	212	Coal with partings; mudstone, gray, silty
217	218	Coal
218	230	Mudstone, gray/brown, silty, carbonaceous
230	240	Mudstone, gray
239	240	Coal
240	250	Claystone, gray/brown, carbonaceous, rootlets
250	271	Claystone, gray
271	272	Coal
272	285	Claystone, gray - gray/brown, some carbonaceous zones
285	319	Coal or coaly zones in claystone, gray to gray/brown, carbonaceous layers
319	320	Coal

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-3	9/3/2024	STATE TRUST	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
146	90	36	NE	47.4225	102.0789	2290

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	160	159.1

Core Recovered (ft):	Recovered Core Interval(s) (ft):
40	78-118

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
6	0

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
112	N/A

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☒ Other – claystones may be enriched but no core collected

Notes: This was the first hole drilled on the project. Based on later experience in identifying subtle color differences from (wet) drill cuttings, the light-colored claystone encountered from 140’-160’ is likely the Bear Den Member. The base was modeled to occur around 110’, and this ≥50-foot discrepancy is the largest model error encountered during the project; possibly a product of local glacial deformation, which would be more likely here in the northeastern part of the project area. Several lignites encountered in the modeled target window thus belong to the Camel’s Butte Member, and their low REE contents confirm earlier work suggesting that younger Eocene lignites are not normally enriched. Because drilling was stopped 50’ below the modeled base of the Bear Den at 160’, the actual base of the Bear Den was not intercepted and the presence of enriched lignites cannot be ruled out, although Hole 4 just to the west did drill through this interval without encountering lignite.

Interval (ft)		Drill Cuttings Descriptions – Hole 3
0	5	Clay, yellow-brown, silty
5	10	Silt, yellow-brown, clayey
10	15	Mudstone, medium brown
15	20	Mudstone, tan
20	25	Mudstone, tan/brown
25	35	Mudstone, gray, fissile-blocky
35	40	Mudstone, gray, fissile-blocky; thin claystone at 40'
40	45	Mudstone, gray, fissile-blocky
45	50	Silt, gray, poor returns
50	60	Mudstone, gray, blocky
60	65	Siltstone, gray, poor returns
65	75	Mudstone, gray, blocky
75	80	Mudstone, gray/brown, blocky
80	82	Coal (2' thick)
82	90	Mudstone, gray, blocky
90	95	Mudstone, gray/brown, blocky
95	100	Mudstone, gray, blocky; coal beds/lenses
100	105	Silt, gray, poor returns
105	110	Mudstone, gray
110	115	Mudstone, gray; coal chips
115	140	Mudstone, gray-medium gray, blocky
140	160	Claystone, white-gray, blocky

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-4	9/3/2024	STATE TRUST	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
146	90	36	NW	47.4261	102.0898	2246

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	160	159.4	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):

Notes: Light gray claystone was encountered at 75', near the modeled position for the Bear Den Member. No core was attempted as a thick interval of coarser-grained sediment with no lignite noted in the cuttings or elog occurred directly below. The light color of this sandy interval suggests the Bear Den Member is present but comprised of a weathered channel facies in this location.

Interval (ft)		Drill Cuttings Descriptions – Hole 4
0	5	Dark brown sandy soil
5	10	Greenish-brown mudstone, clayey (loose)
10	15	Greenish-brown mudstone, more clay (stiffer) (chunks)
15	20	Greenish-brown mudstone, more clay (less stiff than above)
20	25	Brown mudstone
25	30	Brown, medium-coarse sand (fairly clean)
30	35	Brown, muddy sand
35	40	Brown silt
40	45	Right at color change: brown sandy mudstone to gray clayey mudstone
45	50	Brown/gray, clayey mudstone with lignite bits
50	55	Gray, clayey mudstone with lignite bits
55	60	Gray, clayey mudstone with lignite bits and rock bits
60	65	Gray, clayey mudstone with lignite bits & rock bits (loose auger return)
65	70	Gray, clayey mudstone with lignite bits
70	75	Gray clay
75	80	Light gray clay
80	90	Continuing to get lighter, light gray clay with silt
90	100	Light gray silty clay (siltier than above)
100	105	Light gray silty clay, siltier still? Chunks break clean, not bend
105	115	Light gray clay
115	120	Light gray clay with some silt
120	130	Light gray clayey silt
130	140	Light gray sandy-mudstone
140	145	Light gray, muddy, sand
145	150	Light gray, muddy, sand (more coarse)
150	155	Light gray, muddy sand, less coarse and slightly darker in color
155	160	Light gray, sandy mud

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-5	9/4/2024	PRIVATE	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
145	91	25	SW	47.3489	102.2258	2181

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	145	143.6	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Bear Den Member modeled to occur around 75’ depth. Light muds encountered beginning at 100’, but with no lignite visible in cuttings or on the elog past to 145’, it was elected not to core.

Interval (ft)		Drill Cuttings Descriptions – Hole 5
0	10	Olive-brown, micaceous sand
10	20	Olive-brown mudstone with iron
20	25	Yellow mudstone with organic stringer
25	30	Tan mudstone with organic stringer
30	35	Tan-gray mudstone
35	40	Gray, clayey mudstone
40	46	Gray clay
46	50	Gray clay (50%); Coal (50%)
50	55	Blueish or green gray clay with 5% lignite
55	60	Blueish gray mudstone, stiff chunks
60	65	Greenish gray mudstone, stiff, 30% lignite
65	70	Greenish gray mudstone, stiff, 5% lignite
70	75	Greenish gray mudstone, stiff, 30% lignite
75	80	Green/blue silty mudstone with lignite bits
80	85	Green/gray mudstone with lignite chunks
85	100	Green/gray mudstone
100	105	Color starts getting lighter; light gray/green mudstone
105	110	Light gray silty clay (Bear Den)
110	120	Very light gray, sandy mudstone
120	135	Very light gray, silty mudstone
135	140	Very light gray, silty mudstone with sand

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-6	9/4/2024	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
145	91	36	NW	47.3424	102.2264	2125

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	118.1	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Bear Den Member modeled to occur around 20’ depth. Light-colored muds encountered beginning at 20’, but with no significant lignite visible in cuttings or on the elog above 95’, it was elected not to core.

Interval (ft)		Drill Cuttings Descriptions – Hole 6
0	5	Oxidized clayey till
5	15	Oxidized clayey till
15	20	Oxidized clayey till with granite pebbles
20	25	Light-colored silty mud (Bear Den)
25	30	Same with a hint of Fe-oxide
30	35	Same with stronger oxide
35	40	Sandy mud, very strong oxide
40	45	sandy mud, brown-orange, duripan chips?,
45	50	Light gray mudstone
50	75	Medium gray mudstone (Sentinel Butte)
75	80	Medium gray mudstone with a few (sparse) coal flakes
80	85	Poor return, silty mud, medium gray
85	90	Silty mud with coalified wood chips
90	95	Mostly gray mud with some brown carb mud
95	100	Coal (mostly) and minor medium gray mud
100	105	Less coal flakes, more medium gray mud
105	110	Few coal flakes, mostly medium gray mud
110	115	Almost no coal flakes, all medium gray mud
115	120	A few coal flakes again, all medium gray mud

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-7	9/4/2024	PRIVATE	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	90	2	NW	47.2386	102.0510	2235

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	115.2	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Base of Bear Den Member modeled to occur around 40’ depth. Light-colored clays encountered beginning at 15’, but with only minor lignite visible in cuttings, it was elected not to core. A small outcrop just to the south was also sampled during drilling (see measured section 333), containing an interval of kaolinitic clays with a thin REE-enriched lignite. This lignite is about 5” thick but pinches out to the northwest along the outcrop, but likely reappears at the drill site, correlating with the subtle sign of lignite observed in cuttings between 25’ and 30’.

Interval (ft)		Drill Cuttings Descriptions – Hole 7
0	5	Gravelly till
5	10	Transition to bedrock
10	15	Brown, clayey mudstone (Bear Den - carb zone?)
15	20	Very light claystone
20	25	clay light & (oxidized) yellow, some clay brown, some blue-green
25	30	Blue gray mud with a coal flake
30	50	Blue gray mud
50	55	A hint browner - flakes of coal
55	70	Back to medium gray-blue mud
70	75	Lighter blue-gray mud
75	80	Less light blue-gray mud
80	85	Back to medium gray-blue mud with wood chips
85	90	Silty mudstone, medium gray-blue
90	120	Medium-gray blue mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-8	9/4/2024	PRIVATE	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	90	10	SE	47.2155	102.0608	2230

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	118.9	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Base of Bear Den Member modeled to occur around 55’ depth. Light-colored clays encountered beginning at 55’, but with no lignite visible in cuttings or on the elog between 60’ and 90’, it was elected not to core.

Interval (ft)		Drill Cuttings Descriptions – Hole 8
0	5	Brown, loose soil
5	15	Brown till
15	20	Brown mudstone
20	25	Brown, silty mudstone with 30% coal
25	30	Brown, clayey silt, micaceous
30	35	Brown, clayey silt to siltstone, micaceous
35	40	Brown siltstone, micaceous
40	50	Brown, micaceous, muddy sandstone
50	55	Lignite (Alamo bluff)
55	60	Light gray silty, mudstone with lignite 15%
60	65	Light gray/off-white claystone
65	70	Darker gray and brown claystone
70	75	Dark gray claystone
		Sentinel Butte contact
75	80	Green mudstone
80	85	Dark gray/brown mudstone
85	90	Brown/gray claystone, carb
90	100	Gray to dark gray mudstone with organic fragments (rootlets)
100	105	Gray, silty mudstone
105	110	Gray claystone, stiff, fissile
110	120	Greenish-gray silty clay

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-9	9/4/2024	STATE TRUST	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	90	20	NW	47.1912	102.1225	2223

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	140	139	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Base of Bear Den Member modeled to occur around 100’ depth. Light-colored clays encountered beginning at 75’, but with no lignite visible in cuttings or on the elog below 75’, it was elected not to core.

Interval (ft)		Drill Cuttings Descriptions – Hole 9
0	5	Brown/black muddy silt
5	10	Brown micaceous silt, iron staining
10	15	Brown, sandy micaceous silt, iron stain
15	20	Brown, sandy micaceous silt, iron stain, (getting sandier)
20	25	Brown & gray, silty clay (stiff)
25	30	Light green, silty clay
30	40	Blueish gray clay
40	45	(chatter 45-47') Blueish gray, silt - rolls nice
45	50	Blueish gray mudstone with hard flakes (from chatter zone)
50	55	Medium gray, silty mudstone
55	60	Coal
60	65	Medium gray claystone
65	70	Medium gray claystone with coal bits
70	75	Coal
75	80	Light blueish gray, silty mudstone
80	85	Light blueish gray, clayey mudstone getting lighter
85	95	Gray, silty mudstone
95	100	Light gray, silty clay
100	105	Light gray, silty mudstone
105	110	Medium gray, clayey mudstone with lignite bits
110	115	Gray mudstone
115	120	Dark gray mudstone
120	125	Gray, clayey mudstone
125	140	Gray mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-10	9/4/2024	PRIVATE	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	90	30	NE	47.1766	102.1239	2198

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	140	139.1	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☒ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Notes: Base of Bear Den Member modeled to occur around 75’ depth. Unusually thick glacial cover in this location extended to 80’, and the first bedrock encountered was non-micaceous mudstone of the Sentinel Butte Formation, suggesting the Bear Den had been completely removed by glaciation. Moved north off the ridge and re-tried (Hole 10B).

Interval (ft)		Drill Cuttings Descriptions – Hole 10
0	60	Olive brown clayey till with granite/limestone granules/pebbles
60	80	Olive-gray clayey till (still a few pebbles, coal flakes)
80	125	blueish medium gray mudstone (Sentinel Butte)
125	130	blueish medium gray mudstone w/ many coal flakes (pXRF indicated low Yttrium)
130	140	blueish medium gray mudstone w/ a few coalified wood chunks (low Y)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-10B	9/4/2024	PRIVATE	MERCER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	90	30	NE	47.1831	102.1281	2177

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	77.9	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
14.7	47.5-53.9, 67-75.3

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
7		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☒ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
129	

Notes: Base of Bear Den Member modeled to occur around 55’ depth. Light-colored clays were encountered beginning at 20’. Lignites at 51’, 69’, and 72’ were cored but none were REE-enriched, as even the uppermost coal is separated from the base of the Bear Den kaolinite by around 25 feet of gray claystone.

Interval (ft)		Drill Cuttings Descriptions – Hole 10B
0	20	Olive brown clayey till
20	25	White clay
25	35	Medium gray clay
35	40	Medium gray and yellow clay
40	45	Mostly medium gray, some yellow claystone
45	50	Medium gray and yellow-brown (not carby) claystone
50	55	Medium gray claystone with decent amount of coal
55	65	Medium gray clay
65	70	Medium gray clay, a few coal chunks
70	75	Heavy/thick coal
75	80	Medium gray clay

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-12	9/5/2024	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	91	16	SW	47.2052	102.2293	2216

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	160	142.1	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
26.5	135-152.5, 155-164

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
2	1	☐ Yes – enriched lignite(s) identified ☒ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
105	402

Notes: Base of the Bear Den Member modelled to occur around 115'. White claystone encountered at 115'. Lignite(s) at 150' were cored but were not REE-enriched, as they are separated from the base of the Bear Den kaolinite by around 15 feet of gray mudstone. The optimal position for a coal to occur is at the base of the kaolinite (135'), as evidenced by a sample (Z) of clay from this position, which is REE-enriched.

Interval (ft)		Drill Cuttings Descriptions – Hole 12
0	25	Clay, brown, silty, lignite fragments, clinker fragments, till (?)
25	55	Sandstone, brown, very fine grained
55	70	Mudstone, gray, silty
70	90	Mudstone, gray, silty, coal or carbonaceous mudstone stringers
90	95	Coal
95	100	Mudstone, gray
100	115	Sandstone, gray, very fine grained
115	135	Claytstone, white
135	150	Mudstone, gray, silty
150	151	Coal
151	160	Mudstone, gray

Hole No.:		Drill Date:		Surface Owner:		County:
NDGS24-12B		9/5/2024		STATE TRUST		DUNN
Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	91	16	SW	47.1985	102.2288	2153

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	77.5	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☒ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft): N/A	Recovered Core Interval(s) (ft):		
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The base of the Bear Den Member was modeled to occur at 55’ depth, however, glacial outwash extends beyond 80’ depth in this location (the bottom of a broad valley). Thus it is likely the Bear Den was completely removed by glaciation/glacial meltwater. No core was pursued.

Interval (ft)		Drill Cuttings Descriptions – Hole 12B
0	20	Alluvium, gray/brown, sandy - pebbles, lignite fragments, faint bedding
20	35	Clay, gray, silty, pebbles and lignite fragments, Qal
35	40	Sand, gray, very fine - coarse, pebbles, poorly sorted, Qal
40	45	Clay, silty/sandy, Qal
45	80	Sand, gray, very fine to coarse grained, poorly sorted, pebbles, Qal

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-13	9/5/2024	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
143	92	16	SE	47.1988	102.3376	2267

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	100	99.4	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☒ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: The base of the Bear Den Member was modeled to occur at 40’ depth, but no kaolinitic sediment was encountered, so no core was pursued. Local structure or glacial deformation could have pushed the Bear Den up (somewhere above 15’ depth), meaning it was eroded in this location. Brightly-colored kaolinite of the Bear Den Member is visible on aerial imagery within a mile to the southeast, where it outcrops at elevations between 2230 ft and 2250 ft, so it is also possible the thin zone of subtle color change from 25’ to 35’ depth is the Bear Den, and it is present but weakly developed here.

Interval (ft)		Drill Cuttings Descriptions – Hole 13
0	15	Olive brown glacial till; lignite (detrital ?) at 10'
15	20	Clay, blue-gray
20	25	Blue-green clay, some brown clay
25	35	Lighter? medium gray clay, hint of green, not greasy
35	40	Medium gray mud
40	45	Same with rare lignite flakes
45	50	Same with many lignite flakes and brown carb (pXRF suggests low yttrium)
50	55	Medium gray, sandy (flakey)
55	60	Medium gray, sandy (flakey), silty mud
60	65	Medium gray, sandy, silty mud with many lignite flakes and brown carb
65	70	Medium gray, sandy, silty mud with few lignite flakes and brown carb
70	85	Medium gray-brown, sandy, silty mud
85	100	Medium gray mud

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-14	9/5/2024	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
144	93	36	NW	47.2494	102.4188	2373

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	79.2	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☒ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: The base of the Bear Den Member was modeled to occur at 85’ depth, but no kaolinitic sediment was encountered, so no core was pursued. Holes no 14 and 15 occur on a broad topographic high which is more than 3 miles from the nearest outcrop serving as an elevation control point for the model. Hickey (1967) mapped the Golden Valley along this ridge in general agreement with the model, but mapping by Murphy (2004) places the base of the Bear Den higher, at elevations above 2380 ft just to the west. The absence of kaolinitic sediment in this hole supports the mapping of Murphy (2004) and suggests there is a structural high exceeding 90 ft through this area based on surrounding outcrops.

Interval (ft)		Drill Cuttings Descriptions – Hole 14
0	5	Loam, brown
5	15	Mudstone, light gray/buff, silty
15	20	Mudstone, gray
20	21	Claystone, dark brown, carbonaceous, powder
21	35	Claystone, brown
35	40	Mudstone, gray, silty
40	65	Siltstone, gray to steel blue, cemented zones
65	72	Mudstone, gray to dark gray, silty
72	80	Siltstone, gray to light gray, cemented zones (chattering)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-15	9/5/2024	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
144	93	36	SE	47.2417	102.4084	2330

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	100	99.3	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☒ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft): N/A	Recovered Core Interval(s) (ft):		
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The base of the Bear Den Member was modeled to occur at 55’ depth, but no kaolinitic sediment was encountered, so no core was pursued. Like hole no. 14, 0.7 miles to the northwest, it is likely that both the model and Hickey (1967) place the position of the Bear Den too low, and it has been removed by glaciation in this area. A large roadcut constructed just prior to drilling (at the intersection of 13th St and 91st Ave, 1.3 miles to the southwest of this drill location) shows the Bear Den does not occur below an elevation of 2308 ft and confirms the model is at least 30 ft too low locally, and likely significantly more.

Interval (ft)		Drill Cuttings Descriptions – Hole 15
0	20	Yellowish olive brown clay; distinct lack of granules, pebbles; no laminae found
20	25	Blue gray mudstone
25	30	Less blue, more gray mudstone
30	35	Medium gray mudstone
35	40	Medium gray mudstone with many dark brown carb chunks
40	45	Medium gray mudstone with a few medium brown mudstone chunks
45	60	Sand, many dark granules, otherwise, seemingly gray
60	65	Silty, medium gray mud
65	70	Medium gray mud
70	80	Coal
80	100	Still a few coal chips at 85', otherwise, medium gray mud to 100'

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-16	9/6/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	1	NE	46.9762	101.9732	2403

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	78.9	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
34.4	25-59.4

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
4		☒ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
568	

Notes: The base of the Bear Den Member was modeled to occur around 30’ depth. White claystone was encountered by 10’ depth. Enriched carbonaceous claystone recovered at 28’.

Interval (ft)		Drill Cuttings Descriptions – Hole 16
0	10	Thin colluvium; till, brown, silty, pebbles, base goes to white/orange
10	15	Claystone, off-white to white to whitish/orange, iron stained, iron oxide chips
15	25	Claystone, gray to dark gray, clean, fissile
25	25.5	Coal
25.5	30	Claystone, gray
30	35	Siltstone, gray
35	40	Claystone, gray to dark gray, blocky
40	47	Mudstone, dark gray, silty
47	55	Coal
55	80	Claystone, gray to black, FeO chips

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-16B	9/6/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	1	NE	46.9803	101.9723	2419

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	120	119.1

Core Recovered (ft):	Recovered Core Interval(s) (ft):
46.2	57-66.8, 67-76.3, 77-104.1

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
13	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
743	

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 60’ depth. Light-colored claystone was encountered by 45’ depth. Thin REE-enriched lignites recovered at 65’ and 75’.

Interval (ft)		Drill Cuttings Descriptions – Hole 16B
0	5	Olive brown mud, mostly yellow and few large coal flakes
5	30	Olive brown mud, some yellow and few large coal flakes
30	35	Dark gray/brown clay mixed with above
35	40	Blue-green-gray clay mixed with medium yellow brown silty mudstone, minor residual? coal flakes
40	45	Same with slightly more coal flakes
45	50	Light gray clay with yellow brown silty mudstone
50	55	Medium-gray-brown clay and mud with good amounts of carb
55	60	Very light gray, Bear Den!
60	65	Dark/medium gray clay (no coal)
65	70	Gray brown mud
70	75	Medium gray mud with some coal and carb
75	80	Medium gray mud with no coal
80	85	Lighter medium gray mud
85	90	Medium gray mud with significant coal
90	95	Medium gray mud, no coal
95	100	All coal
100	105	Brown/medium gray clay and coal
105	120	Medium gray clay with no coal

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-17	9/6/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	11	NW	46.9626	102.0035	2360

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	113.6	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☒ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: The Bear Den Member is present just below the surface nearby (drill location is within the Hebron Brick Co. east clay pit). Hole drilled along an unmined(?) north-south ridge to determine relative positions of Bear Den kaolinite and Harnisch lignite bed, which was also historically mined in this area. There are no available records as to why this ridge was not mined, but holes no. 17 and 17B suggest earlier miners may have encountered a sandy zone (with neither Bear Den kaolinite or Harnisch lignite) and mined around it. No core recovery attempted.

Interval (ft)		Drill Cuttings Descriptions – Hole 17
0	30	Sandstone, very fine grained, light brown, micaceous
30	45	Siltstone, gray to grayish blue, clayey
45	80	Mudstone, blue/gray, silty
80	85	Sandstone, dark gray, very fine grained, well cemented
85	120	Mudstone, gray to dark gray, silty

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-17B	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	11	NW	46.9614	102.0038	2365

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	160	159.1	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☒ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: The Bear Den Member is present just below the surface nearby (drill location is within the Hebron Brick Co. east clay pit). See notes for hole no. 17. No core recovery attempted.

Interval (ft)		Drill Cuttings Descriptions – Hole 17B
0	5	Brown, soily, sandy, mud
5	20	Brown, sandy mud
20	25	Greenish brown sandy mud
25	30	Greenish brown sandy mud with pebbles
30	35	Gray, clayey silt
35	40	Gray, silty clay
40	50	Gray/brown, silty clay
50	55	Light brown/gray clay with silt
55	70	Brown/gray clay with silt
70	75	Gray clay with silt
75	85	Gray clay
85	90	Gray/brown clay with silt
90	95	Gray/brown clay with silt and sand
95	100	Gray/brown mudstone
100	105	Brown/gray clay with silt
105	110	Brown/gray clay with silt (less silt than above)
110	120	Brown-gray clay
120	130	Gray-brown clay
130	135	Gray-brown clay with lignite grit
135	145	Gray-brown sandy clay with lignite flecks
145	160	Gray brown clay with lignite bits (bits larger than flecks)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-18	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	2	SW	46.9639	102.0038	2363

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	140	139.4	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☒ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft): N/A	Recovered Core Interval(s) (ft):		
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The Bear Den Member is present at the surface (drill location is within the Hebron Brick Co. east clay pit). Hole drilled to determine relative positions of Bear Den kaolinite and Harnisch lignite bed, but the Harnisch was not encountered in this hole (or 17, or 17B). It was historically mined in this immediate area but no underground voids were encountered, but there is also no direct evidence for removal by a paleochannel at 30-35’ where it should approximately occur. No core recovery attempted.

Interval (ft)		Drill Cuttings Descriptions – Hole 18
0	5	Olive brown mud, sandy
5	10	Light yellowish gray mud, silty
10	20	Light gray mud
20	45	Medium gray mud
45	50	Poor return - silty mud
50	55	Back to medium gray mud
55	80	Medium gray mud --- getting siltier
80	85	Medium gray mudstone
85	120	Sand, gray
120	125	Sand with coal chips
125	130	Medium gray clay
130	135	Medium gray silty mud
135	140	Medium gray mud

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-19	9/10/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	4	SW	46.9657	102.0506	2307

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	140	139.3

Core Recovered (ft):	Recovered Core Interval(s) (ft):
29	9-19, 10-12, 19-36

Target Zone Intercepted? (lithology encountered at modeled depth):
☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
☐ No – removed by glaciation (till, outwash, or alluvium)
☐ No – paleotopography/structure (unweathered older strata)
☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
8	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
699	

REE enrichment (≥300 ppm) within/immediately below target zone?:
☒ Yes – enriched lignite(s) identified
☐ Yes – enriched claystone(s) identified; no lignites occur
☐ No – light-colored silt/sandstone present; no lignites/claystones
☐ Other – claystones may be enriched but no core collected

Notes: The Bear Den Member is present at surface (drill location is just east of the Hebron Brick Co. west clay pit). Hole drilled to determine relative positions of Harnisch lignite and the overlying enriched coals identified in the pit (where the Harnisch is not exposed). Push core 9 to 19 ft, moved slightly and cored 10 to 36 foot depth (12 to 19 ft interval was lost). The Harnisch and immediately overlying lignite (which is REE-enriched) were recovered, along with claystone above 11.2 ft which is also likely enriched (based on claystone samples from Hole 19B and 19C), but the lower orange zone coal (measured section 270 of this report and Murphy et al., 2023) was too shallow to identify, if present.

Interval (ft)		Drill Cuttings Descriptions – Hole 19
0	5	Till - clay and pebble-sized rocks
5	10	Medium gray mud
10	15	Black to brown coal, black coal covered in brown mudstone
15	20	Black coal with chunks of opaque amber
20	25	Medium gray mudstone with a few small coal chips, clayey
25	35	Silty mudstone with concretions/consolidated mud/silt
35	40	Silty mudstone, no concretions or consolidated mud/silt - lighter medium gray
40	45	Mudstone with sand-sized coal chips, brown color may come from powdered coal
45	50	Medium gray silty mudstone with sand-sized coal slivers, not as brown
50	65	Medium to slightly darker tannish gray claystone with a few small coal chips
65	70	Medium to slightly darker tannish gray claystone, scarce coal chips
70	75	Medium gray mudstone, hard to tell if tiny black specks are coal
75	80	Medium gray mudstone, a few small clay chips
80	85	Medium gray claystone with a few small coal chips
85	90	Medium gray sandy mudstone, tiny black specks, coal chips?
90	95	Medium brownish gray mudstone
95	100	Darker brownish gray mudstone
100	110	Darker brownish gray mudstone, not sure if tiny coal chips are in place or from above
110	115	Silty, medium brownish gray mudstone with large coal chips
115	120	Slightly darker brownish gray mudstone with many large coal chips
120	125	Slightly bluish gray mudstone, covered in brown, soft coal; abundant small coal chips
125	130	Medium gray, slightly darker, with small coal chips
130	140	Silty mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-19B	9/10/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	5	SE	46.9672	102.0567	2359

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	119.4	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
40	40-80

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
2	16	☐ Yes – enriched lignite(s) identified ☒ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
193	594

Notes: Bear Den kaolinite present from 30’ to 60’ depth (location is just west of Hebron Brick Co. west clay pit). Hole drilled to determine relative positions of Harnisch bed and the overlying enriched coals identified in the pit (where the Harnisch is not exposed). Other than Harnisch rider beds in the overlying ~3 ft, no carbonaceous beds were present in the gray zone or lower orange zone, despite being only ~450 ft west of an upper REE-enriched coal exposed in the pit (measured section 270 of this report and Murphy et al., 2023). In its place is a thick interval of REE-enriched claystone, with REE concentrations peaking around 62’ depth.

Interval (ft)		Drill Cuttings Descriptions – Hole 19B
0	5	Brown silty mud
5	20	Olive brown silty mud
20	25	Brown, carbonaceous mudstone
25	30	Medium gray and yellow mudstone
30	35	(Bear Den) light gray clay (greenish tint)
35	40	(Bear Den) light gray clay (greenish)
40	50	(Bear Den) Whitest clay
50	55	(Bear Den) Yellowish clay, but cleans off white
55	60	(Bear Den - gray zone) Medium-light gray clay
60	65	Medium gray clay with coal flakes
65	75	Coal (Harnisch)
75	80	Medium gray-green clay with many coal flakes
80	85	Medium gray silty mud
85	95	Medium gray silt
95	100	Medium gray silty mud and coal
100	105	Medium gray-brown silty mud and carb flakes
105	110	Medium gray-brown silty mud
110	120	Medium gray mud

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-19C	9/11/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	4	SW	46.9673	102.0546	2302

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	120	119.3

Core Recovered (ft):	Recovered Core Interval(s) (ft):
19	14-33

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
1	2

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
358	479

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: Bear Den Member present at surface (drilling location is within the Hebron Brick Co. west clay pit). Hole drilled to determine relative positions of Harnisch bed and the overlying enriched coals identified just to the southwest and northwest in the pit (measured section 270 of this report and Murphy et al., 2023). The Harnisch lignite (at 19.5') and its moderately REE-enriched rider seams (at 16') were again identified, but the orange zone-gray zone contact where highly enriched lignites occur appears to have been disturbed during clay mining and replaced with fill above 14 ft depth. The lower gray zone is present as evidenced by REE-enriched clays cored from 14-16 ft depth.

Interval (ft)		Drill Cuttings Descriptions – Hole 19C
0	15	Olive brown and yellowish olive brown backfill (driller notes density change at 14')
15	25	Coal (Harnisch)
25	30	Carb & coal
30	35	Medium gray mud
35	40	Medium gray mud with coal chips (minor)
40	50	Gray-green mudstone
50	60	Brownish green mudstone
60	120	Gray-green mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-20	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	6	NE	46.9729	102.0763	2386

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	80	79.2

Core Recovered (ft):	Recovered Core Interval(s) (ft):
27.7	37-55.7, 57-66

Target Zone Intercepted? (lithology encountered at modeled depth):
☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
☐ No – removed by glaciation (till, outwash, or alluvium)
☐ No – paleotopography/structure (unweathered older strata)
☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
7	1
Max ∑REE (ppm) (Lignites):	**Max ∑REE (ppm) (Claystones/other):**
2184	699

REE enrichment (≥300 ppm) within/immediately below target zone?:
☒ Yes – enriched lignite(s) identified
☐ Yes – enriched claystone(s) identified; no lignites occur
☐ No – light-colored silt/sandstone present; no lignites/claystones
☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 40’ depth. Light-colored claystone was encountered by 25’ depth. Thin REE-enriched lignite(s) recovered at 43’. REE-enriched claystone recovered at 40’.

Interval (ft)		Drill Cuttings Descriptions – Hole 20
0	5	Fairly consolidated dark tan sand with mud
5	10	Tan to dark tan clay
10	15	Dark reddish brown clay
		drill chattered on something
15	20	Grayish tan clay, very soft
20	25	Mix of orange-brown clay and hard well lithified gray siltstone, probably what drill chattered on
25	30	Orange/tan clay, gray clay with sand-sized pieces of siltstone
30	35	Sandy, white clay; Bear Den?
35	40	White clay, less sandy
40	45	Bluish gray clay, with significant coal chips
45	50	Bluish gray clay, no coal
50	55	Dark gray clay
55	60	Very dark brownish gray clay with small coal chips
60	65	Very dark brownish gray clay with larger coal chips
65	70	Very dark brownish gray clay with a bit less coal
70	80	Medium gray clay

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-20B	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	6	NE	46.9744	102.0852	2411

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	110	109.8

Core Recovered (ft):	Recovered Core Interval(s) (ft):
40	22-54.5, 89-96.5

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
7	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
445	

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 60’ depth. Light-colored mudstone was encountered by 25’ depth. The base of the Alamo Bluff lignite was REE-enriched at 26’, but a significant interval of channel silts and sands occurs between the Harnisch lignite and the Alamo Bluff, interrupting the typical weathering profile of the Bear Den.

Interval (ft)		Drill Cuttings Descriptions – Hole 20B
0	10	Thin colluvium over Till, gray/brown, fragments of lignite and clinker, silt, sand
10	20	Silt, gray-gray/brown, clayey at top
20	25	Coal
25	35	Mudstone, light gray, silty
35	55	Mudstone, gray-dark to gray, silty, concretionary zone at 45-50'
55	65	Siltstone, gray, poorly cemented
65	85	Sandstone, gray, very fine-grained, poorly cemented
85	95	Coal
95	105	Mudstone, gray/brown - silty
105	110	Claystone, brown, carbonaceous

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-21	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	6	SE	46.9679	102.0855	2405

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	79.6	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
29.2	36-65.2

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
9	13	☒ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
544	1,245

Notes: The base of the Bear Den Member was modeled to occur around 45’ depth. Light-colored mudstone was encountered by 15’ depth. A thin REE-enriched lignite(s) recovered at 46’. REE-enriched claystones recovered at 41’.

Interval (ft)		Drill Cuttings Descriptions – Hole 21
0	5	Oxidized olive brown pebbly clay (till)
5	10	Olive brown mud
10	15	Brown mud with carb and coal flakes (alamo bluff?)?
15	20	Yellow-gray mud
20	25	Yellow-gray silty mud
25	30	Yellow and lighter gray mud
30	40	White clay; Bear Den
40	45	Medium gray clay with abundant coal chips
45	50	Medium gray clay
50	55	Medium gray clay
55	60	ALL COAL (Harnisch)
60	65	Dark gray mudstone with grit
65	70	Gray clayey silt (loose)
70	75	Brown mudstone with pebbles
75	80	Bluish gray silty clay

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-21B	9/9/2024	PRIVATE	MORTON

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
140	90	6	SE	46.9689	102.0764	2388

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	80	79.4

Core Recovered (ft):	Recovered Core Interval(s) (ft):
50	17-67

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
9	6

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
2,407	327

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 35’ depth. Light-colored mudstone was encountered by 25’ depth, but, like hole no. 20B, intervals of channel silts and sands occur between the Harnisch lignite and the Alamo Bluff lignite, interrupting the typical weathering profile of the Bear Den. A thin, highly REE-enriched lignite was recovered at 45’, with REE-enriched claystones just below.

Interval (ft)		Drill Cuttings Descriptions – Hole 21B
0	5	Sandy tan soil
5	10	Tan silt and sand
10	15	Darker tan clay, some oxidization
15	20	Sandy tan clay
20	25	Clay with small coal chips and dark reddish brown carby clay (Camel's Butte?)
25	30	Tan-gray clay with small coal chips
30	35	Medium gray silty clay with sand-sized coal slivers
35	40	Medium gray silty clay
40	45	Medium to dark gray clay with some coal slivers, a few larger chunks-pebble-sized
45	50	Medium to light gray silt/silty clay (Bear Den?)
50	55	Brownish gray to medium gray silty clay
55	60	Medium to dark gray silty clay with a few, small coal chips
60	70	Black coal - Harnisch?
70	75	Medium gray to darker gray mud
75	80	Some medium gray to darker gray mud with a few coal chips

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-23	9/12/2024	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
137	98	8	SW	46.6945	103.0832	2842

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	120	119

Core Recovered (ft):	Recovered Core Interval(s) (ft):
39.5	10-49.5

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☐ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☒ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
2	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
140	

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 75’ in depth, however this area of Stark Co. has poor outcrop control and known structure/paleotopography. The first lignites at 40’ and 44’ were not REE-enriched. The cored interval is notably micaceous and thus agrees with mapping by Hickey (1967) and Murphy et al. (1996) that it is the Camels Butte Member of the Golden Valley Formation, but the position of the Bear Den Member is unknown with no evidence of kaolinitic zones below to 120’. There should be overlap between this hole (bottom-hole elevation of 2722’) and the top of hole no. 24, 1.1 miles to the southeast (surface elevation of 2798’), which is not notably micaceous above 120’, where thick lignites characteristic of the Sentinel Butte Formation begin. It may be that the model is roughly correct and the Bear Den is weakly developed or was eroded after deposition.

Interval (ft)		Drill Cuttings Descriptions – Hole 23
0	5	Yellow-brown mudstone
5	10	Green mudstone
10	15	Green clay with yellow oxidized blebs
15	20	Green-yellow mudstone w/ cemented yellow coarse sand/pebbles and abundant lignite
20	25	Tan mudstone with hard rust orange blebs (crush to clay) and lignite bits
25	30	Green-tan mudstone, very wet and loose
30	35	Tan mudstone with yellow blebs
35	40	Tan mudstone with yellow blebs, very sparse lignite bits (?) may be from above
40	45	Greenish/brown mudstone with abundant lignite fragments (35%)
45	50	Bluish brown mudstone with lignite bits (<10%)
50	55	Bluish gray claystone with sparse lignite bits
55	60	Bluish gray claystone with abundant lignite bits, and large fragments (15%)
60	65	Bluish gray claystone
65	70	Bluish gray claystone with sparse lignite bits (<1%)
70	75	Brown carb with coal (75%)
75	80	Dark gray claystone with little lignite bits
80	85	Gray-blue mudstone
85	90	Bluish gray muddy sandstone
90	95	Bluish gray claystone with lignite bits (<1%)
95	100	Bluish gray mudstone (clean) with lignite bits, more than above
100	110	Medium gray mudstone
110	115	Medium gray clayey mudstone with sparse black coal bits
115	120	Medium gray clayey mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-24	9/12/2024	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
137	98	16	NW	46.6875	103.0623	2798

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	200	198.6

Core Recovered (ft):	Recovered Core Interval(s) (ft):
15.8	44.8-51.2, 120-129.4

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☐ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☒ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
1	
Max ∑REE (ppm) (Lignites):	**Max ∑REE (ppm) (Claystones/other):**
151	

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 20’ depth. No evidence of kaolinitic zones were noted and the first thin carbonaceous zone at 47’ was not REE-enriched according to the pXRF (see discussion in notes for hole no. 23, 1.1 miles to the northwest). Bedrock sands from 10’ to 45’ occur in the modeled position of the Bear Den Member and may represent removal by paleochannels. The cored interval is tentatively assigned to the Sentinel Butte Formation as it is not notably micaceous. Three Sentinel Butte coals, each over 5 ft thick, occur between 120’ and 180’.

Interval (ft)		Drill Cuttings Descriptions – Hole 24
0	5	Brown, sandy alluvium
5	10	Light gray, sandy mudstone
10	15	Light gray sand
15	20	Light gray, silty mudstone
20	30	Light gray sand
30	40	Light gray sand (coarsest I've yet seen on the project) medium-grained?
40	45	Yellow-gray sand, maybe fine-grained
45	50	Medium gray mudstone
50	55	Medium gray and black mudstone
55	60	Mostly brown and black mudstone
60	70	Medium gray mudstone, some carb chunks
70	75	Medium gray mudstone, some carb chunks, some coal
75	80	Green-gray mudstone
80	100	Poor returns, but blue-gray silty mudstone to 100'
100	110	Foam, probably more silt to 110'
110	115	Lithified blue-gray siltstone
115	125	Blue-gray silty mudstone
125	130	Coal
130	135	Green-gray mudstone, coal chips
135	140	Green-gray mudstone, no coal chips
140	145	Green-gray silty mudstone
145	155	Lithified siltstone - green-gray
155	160	Medium gray mud and coal
160	165	Coal
165	175	Medium gray mud with some coal
175	180	Medium gray mud and coal
180	200	Worse returns but a mixture of coal, greenish gray mud, and some light tan mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-25	9/11/2024	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
138	97	36	NE	46.7305	102.8517	2644

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	180	179.2	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
36.4	17-35, 45-53.4, 67-77

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
9		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☒ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
459	

Notes: The base of the Bear Den Member was modeled to occur around 40’ in depth, however this area of Stark Co. has poor outcrop control and known structure/paleotopography. Core recovery from 67-77’ suggest this interval of kaolinitic sand is the Bear Den Member, and the coals recovered belong to the Camels Butte Member. Further coring below the Bear Den was not pursued as no lignites were identified in the cuttings or elog above 150’ depth. Slight REE enrichment seen in lignites above the Bear Den at 48’ and 52’ are associated with elevated U-Mo-As concentrations, a sign lignites have been exposed to descending fluids from weathering of the White River Group.

Interval (ft)		Drill Cuttings Descriptions – Hole 25
0	5	Light to dark brown, sandy mud
5	10	Lighter brown sandy mud
10	15	Pinkish red mud
15	20	Light yellowish-brown mud
20	25	Orange-oxidation on pink to gray mud, some small chunks of sandy gray material
25	30	Medium brown mud with medium-sized coal chips
30	35	Orange-yellow mud with smaller coal chips
35	40	Medium gray mud with a few coal chips, possibly fell from above
40	60	Brown siltstone, mostly liquid, poor return
60	70	Light medium gray, sandy mud
70	80	Light gray sand, mostly liquid, unconsolidated
80	140	Light gray, mostly liquid sand, unconsolidated
140	145	Medium light gray sand, still mostly liquid
145	155	Sandy mud, medium to darker gray
155	160	Dark gray carby mud with small coal chips
160	165	Dark gray mud with significant coal chips
165	170	Silty mud, dark, slightly lighter than above, a few small coal chips
170	175	Less silty, dark gray mud, with a few coal chips
175	180	Dark gray mud, some small coal chips, possibly from above

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-25B	9/11/2025	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
138	97	36	NE	46.7311	102.8615	2677

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	160	158.2	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: The base of the Bear Den Member was modeled to occur around 60’ in depth, and white clay was encountered from 40 to 75’ depth. Camels Butte lignites at 22’ and 28’ were deemed uraniferous based on the gamma log, and seeing no major lignite below the Bear Den, it was elected to just core one hole on this quarter (see hole no. 25). Thin lignites from 81’ to 88’ are likely too deep to have received significant REE accumulations but may contain elevated concentrations.

Interval (ft)		Drill Cuttings Descriptions – Hole 25B
0	10	Yellowish tan clay with sparse coarse sand
10	15	Tan clay with oxidation stains
15	20	Tan, sandy mudstone
20	30	Tan, silty mudstone with lignite fragments
30	35	Tan/gray, clayey silt with fine lignite specks (specks might be from above)
35	40	Gray, clayey silt
40	45	Light gray, sandy clay,
45	55	White, sandy clay, wet & loose
55	60	Greenish white, muddy sand or sandy clay, wet & loose
60	75	Greenish white sandy clay
75	80	Green, muddy sand
80	85	Green-gray, sandy mudstone with coal pieces
85	95	Green-gray, sandy mudstone (very wet, loose)
95	100	Green-gray, sandy mudstone (very wet, loose) with coal
100	105	Green-gray, sandy mudstone (very wet, loose)
105	110	Green-gray, muddy sand (wet, loose)
110	115	Green-gray, muddy sand with lignite - Coal chatter at 114'
115	120	Dark gray mudstone
120	125	Dark gray-green mudstone
125	130	Medium gray mudstone
130	135	Medium gray mudstone with coal specks
135	140	Greenish gray mudstone with coal flakes
140	145	Greenish gray, clayey mudstone with brown organic pockets
145	150	Dark gray-green mudstone
150	155	Dark gray, silty mudstone
155	160	Dark gray mudstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-26	9/12/2025	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
137	97	36	SW	46.6369	102.8697	2879

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	140	139.2	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
15	65-80

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
	2	☐ Yes – enriched lignite(s) identified ☒ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
	599

Notes: The base of the Bear Den Member was modeled to occur around 70’ depth. It contains a lignite which is variable in thickness but highly REE-enriched at an outcrop 0.34 miles to the east (measured section 267 of Murphy et al., 2023), but that lignite is not present at this drill site. More moderately-enriched claystone occurs in its place at 70’ depth.

Interval (ft)		Drill Cuttings Descriptions – Hole 26
0	5	Yellow-brown alluvium
5	10	Yellow mudstone
10	15	Medium gray mudstone
15	20	Medium brown mudstone, carb chunks
20	25	Yellow and medium gray mud
25	35	Yellow, silty mud, iron chips
35	40	Medium gray mud, some yellow iron staining
40	45	Brown gray mud with coal/carb chips
45	50	Medium gray with coal chips
50	55	Brown gray mud with minor coal
55	60	Light gray and iron-orange stained clay, Bear Den!
60	65	Light gray clay, Bear Den!
65	70	Medium gray clay
70	85	Medium gray mud
85	90	Medium brown-gray mud, silty, with organics
90	95	Medium gray, silty mud
95	115	Poor returns - medium gray silt
115	120	Medium gray, silty mud
120	125	Medium gray, silty mud, getting siltier
125	130	Back to medium gray silt
130	135	Sandy, poor returns
135	140	Cemented, medium gray sandstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-26B	9/12/2025	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
137	97	36	SW	46.6349	102.8691	2882

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	100	99.2

Core Recovered (ft):	Recovered Core Interval(s) (ft):
27.6	50-51.3, 58-84.3

Target Zone Intercepted? (lithology encountered at modeled depth):
☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
☐ No – removed by glaciation (till, outwash, or alluvium)
☐ No – paleotopography/structure (unweathered older strata)
☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
2	2

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
238	338

REE enrichment (≥300 ppm) within/immediately below target zone?:
☐ Yes – enriched lignite(s) identified
☒ Yes – enriched claystone(s) identified; no lignites occur
☐ No – light-colored silt/sandstone present; no lignites/claystones
☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 70’ depth. Like hole no. 26, no enriched lignite occurs at the base of the Bear Den in this location either, 0.14 miles to the southwest of hole no. 16 and 0.31 miles to the southwest of measured section 267 (Murphy et al., 2023). Slightly REE-enriched claystone occurs in its place at 78’ depth. The Alamo Bluff lignite equivalent at 50’ occurs above the kaolinite and was not enriched.

Interval (ft)		Drill Cuttings Descriptions – Hole 26B
0	5	Alluvium
5	15	Very yellow, silty mud
15	20	Yellow-gray, silty mud
20	25	Yellow and brown mud
35	30	Brownish gray mud
30	40	Poor return, yellowish brown, silty mud
40	45	Poor return, yellowish brown, silty mud - almost a weird "bright brown" iron?
45	50	Blue-gray mud and brown mud
50	55	Blue-gray mud and brown mud, must be carb around here
55	60	Medium gray mud and brown, silty mud
60	75	Light gray clay, Bear Den!
75	80	Medium gray, silty mud
80	85	Medium gray clay
85	95	Medium gray clay and silt
95	100	Medium gray silt

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-28	9/13/2025	STATE TRUST	HETTINGER

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
136	96	16	NW	46.6006	102.7574	2866

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	100	99.4

Core Recovered (ft):	Recovered Core Interval(s) (ft):
58.2	12.2-60, 70-80.4

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
1	20
Max ∑REE (ppm) (Lignites):	**Max ∑REE (ppm) (Claystones/other):**
109	1,233

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☒ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The base of the Bear Den Member was modeled to occur around 35’ depth. Light-colored mudstone was encountered just below the surface and continued to 35’. The first coal at 75’ was too far below the Bear Den to receive descending REE, which adsorbed to claystones from 35.5’ to 40.5’ at the base of the Bear Den, enriching five continuous feet of claystone over 300 ppm REE.

Interval (ft)		Drill Cuttings Descriptions – Hole 28
0	5	Brown, soily mudstone
5	10	Tan & yellow mudstone with fine sand grains (multi-colored)
10	15	Tan, sandy mudstone. Fine to coarse sand grains
15	20	Gray to light brown, clayey mudstone
20	25	Tan and yellow, clayey mudstone with sparse lignite fragments
25	30	Tan and yellow, clayey mudstone with sand
30	35	Tan, clayey mudstone with orange staining, also with sand
35	40	Medium gray, clayey mudstone with dark orange staining, iron grit
40	45	Tan, clayey mudstone with iron yellow staining
45	50	Medium gray to brown, clayey mudstone with sand
50	60	Brown, silty mudstone with sand
60	65	Brownish gray silty mudstone; lighter with some yellow
65	70	Brownish gray silty mudstone; darker, no yellow
70	75	Medium gray, clay mudstone with fine to coarse sand
75	80	Lignite chips - black
80	85	Medium gray mudstone with abundant coal flecks
85	90	Medium gray to brown, silty mudstone with sand and lignite flecks
90	95	Medium gray to brown, silty, mudstone with lignite flecks
95	100	Medium gray to brown, clayey mudstone with coal flecks

Hole No.:		Drill Date:		Surface Owner:		County:
NDGS24-29		9/12/2025		PRIVATE		STARK
Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
139	97	30	NW	46.8260	102.9704	2618

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	79.6	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft):	Recovered Core Interval(s) (ft):		
N/A			
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The base of the Bear Den Member was modeled to occur at a depth of 45’. No light-colored intervals were encountered to 80’, and the sediment was not notably micaceous, suggesting the model may be too low and the interval drilled was Sentinel Butte Formation. No core recovery was attempted.

Interval (ft)		Drill Cuttings Descriptions – Hole 29
0	20	Mudstone, gray-brown, silty
20	30	Mudstone, gray, silty
30	39	Claystone, dark gray-gray
39	40	Coal
40	80	Mudstone, gray-gray/blue

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-29B	9/12/2025	PRIVATE	STARK

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
139	97	30	NW	46.8261	102.9747	2616

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	60	59.4	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
7.5	11-18.5

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
6		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
626	

Notes: The base of the Bear Den Member was modeled to occur at a depth of 45’. Like hole no. 29, no light-colored intervals were encountered (to 60’), but shallow carbonaceous mudstones were cored, one of which was moderately REE-enriched at 12’ depth. Possible explanations for this enrichment include 1) the Bear Den kaolinite was present just above but eroded away, 2) enrichment is associated with the White River Group as in hole no. 25, or 3) the shallow depth of the enriched suggests this interval was likely subject to long-lived, low intensity Quaternary weathering, which can produce slight REE-enrichment below modern permeable landscapes (Moxness et al., 2021). The latter scenario is deemed the most likely, as the light tan and brownish dry colors of the core are more typical of the Camels Butte Member (which is not always obviously micaceous), than those of the Bear Den Member/Sentinel Butte Formation contact, providing evidence against the first scenario, and the second scenario is usually associated with significant U-Mo-As enrichment, which is absent here. All things considered, it seems more likely that the Bear Den occurs deeper than the modeled position in hole no. 29 and 29B, if present.

Interval (ft)		Drill Cuttings Descriptions – Hole 29B
0	5	Siltstone, gray/green, clayey, poorly cemented
5	10	Mudstone, gray, iron-stained, silty
10	15	Coal to carbonaceous mudstone
15	45	Mudstone, light gray-gray, iron lenses
45	50	Siltstone, gray, clayey
50	55	Mudstone, dark gray, silty
55	60	Coal, hard

Hole No.:		Drill Date:		Surface Owner:		County:
NDGS24-30		9/16/2025		STATE TRUST		ADAMS
Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
132	96	36	SW	46.2062	102.6405	2597

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	140	135.8	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☒ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft):	Recovered Core Interval(s) (ft):		
N/A			
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The top of the Rhame bed was modeled to occur at 45’ depth. No light-colored sediment was encountered, so no coring was attempted. Although it is possible the model projected the Rhame bed 50+ feet too low in this area (meaning the drilled interval was lower in the Slope Formation), it seems more likely, based on the coarse nature of the sediments, that local downcutting by younger channels eroded the Rhame bed in this area.

Interval (ft)		Drill Cuttings Descriptions – Hole 30
0	5	Mudstone, buff, silty
5	30	Siltstone, gray/brown
30	45	Sandstone, brown, iron chips, very fine-grained, poorly cemented
45	75	Sandstone, medium gray, very fine-grained, poorly cemented
75	80	Claystone, gray, coal chips
80	105	Mudstone, gray
105	130	Claystone, dark brown, carbonaceous
130	140	Sandstone, dark gray, very fine-grained, poorly cemented

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-30B	9/16/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
132	96	36	SW	46.2094	102.6346	2583

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	140	138	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft): N/A	Recovered Core Interval(s) (ft):		
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The top of the Rhame bed was modeled to occur at 35’ depth. As with Hole No. 30, no light-colored sediment was encountered, so no coring was attempted. Although it is possible the model projected the Rhame bed 50+ feet too low in this area (meaning the drilled interval was lower in the Slope Formation), it seems more likely, based on the coarse nature of the sediments, that local downcutting by younger channels eroded the Rhame bed in this area. Cuttings of cemented sandstone at 54’ were not consistent with silcrete.

Interval (ft)		Drill Cuttings Descriptions – Hole 30B
0	20	Yellowish gray, muddy silt
20	30	Dark brown, carbonaceous mud
30	35	No return (silt?)
35	40	(Water) medium gray silt
40	60	Medium gray sand; hard zone at 54' "for several feet" (cemented sandstone)
60	65	Brown sand and lignite
70	115	Blue-gray mudstone, sandy, but likely washed in from above, no lignite
120	140	Blue-gray sand, fine-grained, very homogenous cuttings

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-32	9/16/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	96	36	NW	46.1332	102.6320	2701

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Rhame bed	120	119.5

Core Recovered (ft):	Recovered Core Interval(s) (ft):
20	10-30

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
3	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
236	

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☒ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: The top of the Rhame bed was modeled to occur at 40’ depth. A hard zone at 14’, followed by light-colored mudstone and siltstone immediately below, is likely the Rhame bed. A lignite at 13’, above the silcrete, was not REE-enriched, which is consistent with other coals found in the Harmon/Hanson/H lignite zone, which is above. Coaly laminae in siltstone sampled at 29.5’ did contain elevated REE concentrations, but did not contain the organic content typically necessary to enrich >300 ppm. The lower coal seen on the elog at 92’ was not pursued as it would be too far below the weathering profile to receive descending REEs.

Interval (ft)		Drill Cuttings Descriptions – Hole 32
0	5	Clay and silt, brown
5	15	Mudstone, gray, silty, Feo staining from 5-10'
15	20	Concretionary zone, brown
20	25	Mudstone, gray/brown
25	35	Mudstone, light gray/white, silty
35	60	Siltstone, light gray
60	80	Silt, medium gray
80	95	Mudstone, dark gray, thin coal at 90'
95	120	No returns, silt or sandstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-33	9/16/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	96	36	SW	46.1193	102.6352	2707

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Rhame bed	100	99.7

Core Recovered (ft):	Recovered Core Interval(s) (ft):
6	54-60

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☐ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☒ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
1	
Max ∑REE (ppm) (Lignites):	**Max ∑REE (ppm) (Claystones/other):**
119	

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☐ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: Hole no. 33 was drilled one mile SSW of Hole no. 32. Sandstone was encountered to 20’ and the first mudstone encountered below that was not light in color or greasy to the touch. The top of the Rhame bed was modeled to occur at 30’ depth, but Hole no. 32 suggested the model may be 29’ too deep in this area, which would mean the Rhame bed was eroded by the channel sands present in that position. The lignite present at 92’ in Hole no. 32 (78’ below the top of the Rhame bed) is present at 74’ here, further suggesting the Rhame bed would have occurred at the interval replaced by modern alluvium or channel sands. A coal present at 55’, which did not have an equivalent in Hole No. 32, was sampled but did not contain high REE concentrations, as would be expected for a coal 50+ feet below the (presumed) position of the Rhame bed.

Interval (ft)		Drill Cuttings Descriptions – Hole 33
0	5	Brownish yellow gravelly alluvium
5	10	Golden brown sand
10	20	Golden sand
20	30	Gray brown mud
30	35	Green gray mud
35	40	Dark gray clay
40	45	Green gray mud
45	50	Green gray, silty mud
50	55	Coal
55	60	Dark gray mud
60	70	Medium gray mud
70	75	Dark gray mud and coal
75	80	Dark gray coal
85	100	Medium gray sandstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-36	9/17/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
130	96	16	SE	46.0823	102.6850	2772

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	120	119.2	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)
Core Recovered (ft):	Recovered Core Interval(s) (ft):		
N/A			
ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):		REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):		

Notes: The top of the Rhame bed was modeled to occur at 50'. No bright-colored sediment was encountered, so it was elected not to pursue core. Later holes (38, 38B, 40) contained REE-enriched lignites below thick intervals of Rhame bed kaolinite which was relatively gray in both cuttings and wet core but dried very light gray or white. This makes the identification of the Rhame bed from cuttings challenging, as evidenced by this hole, where in retrospect the Rhame bed may be present in the approximate modeled position but it was not discernable in the cuttings.

Interval (ft)		Drill Cuttings Descriptions – Hole 36
0	5	Light brown, sandy mudstone
5	10	Dark brown mudstone with coarse sand
10	15	Brown mudstone with sand and lignite bits
15	20	Brown silt with lignite fragments (20%)
20	25	Tan to gray coarse sand with mud
25	35	Tan to gray muddy sand
35	40	Tan sand, loose and wet
40	45	Gray clay, sporadic coal bits
45	50	Coal
50	55	Gray clay
55	60	Gray to brown clay with coal bits (<5%)
60	65	Brown to gray clayey silt with very fine coal bits
65	70	Brown carbonaceous mudstone with gray clay and coal fragments
70	75	Gray to brown sandy, siltstone, very fine lignite
75	80	Brown to gray carbonaceous mudstone with lignite bits
80	85	Brownish gray silt
85	90	Medium gray clayey silt
90	95	Gray to brown silty clay
95	100	Brown carbonaceous silt with lignite
100	105	Dark brown, sandy silt, carbonaceous
105	110	Medium gray, sandy silt
110	115	Medium gray, silt sand
115	120	Medium gray, silt sand cemented sand nodule

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-38	9/17/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	93	36	NE	46.1330	102.2580	2594

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Rhame bed	140	140.1

Core Recovered (ft):	Recovered Core Interval(s) (ft):
53.7	58.2-111.9

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
18	5

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
1,862	225

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: Rhame bed silcrete encountered at 68’ at the base of a 10-foot-thick lignite (Harmon or equivalent). Thin coals at 79’ and 82’ were not REE-enriched, but thicker coals at 92’ and 103’ contained significant REE content.

Interval (ft)		Drill Cuttings Descriptions – Hole 38
0	5	Yellow-brown sandy alluvium
5	15	Classic golden yellow Tbc fine sand
15	20	Classic golden yellow Tbc fine sand, becomes more grayish yellow at 20'
20	25	Classic golden yellow Tbc fine sand, with less returns
25	30	Classic golden yellow Tbc fine sand, chunk of iron concretion
30	35	Classic golden yellow Tbc fine sand, watery sample
35	40	Gray-yellow sand and medium gray clay
40	45	Gray fine sand, a few chunks of clay
45	50	Back to golden, fine sand
50	60	COAL, Harmon-Hanson equivalent
60	65	SILCRETE and COAL, medium brown, wet, very hard, plant fossils
65	70	KOALINITE, light brown and silt
70	75	Medium brown siltstone
75	80	COAL and medium brown-gray clay
80	85	Medium gray mud and silt (silt is weakly cemented)
85	90	Medium gray mud, silt (moderately consolidated)
90	95	Coal and carb
95	100	Medium gray, silty mudstone; weak cement, rare org. laminae
100	105	Coal and moderately cemented siltstone
105	110	Poor return, brown silt
115	140	Medium gray, fine, sand, bluish, marginally muddier as you go to 140'

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-38B	9/18/2025	STATE TRUST	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	93	36	NE	46.1316	102.2478	2576

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	140	139.3	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
30.2	73.7-103.9

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
17	2	☒ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
1,449	141

Notes: Moved 0.5 miles to the east of hole no. 38 to access the lateral variability of the lignites within/below the Rhame bed and their REE concentrations. The uppermost lignite (B) was thicker and slightly enriched here, in addition to the two enriched lower coals (D and E), which maintained similar thicknesses. Lignite E was more enriched here, possibly a product of three feet of clay overlying it here, as opposed to siltstone in hole no. 38.

Interval (ft)		Drill Cuttings Descriptions – Hole 38B
0	20	Brownish-yellow, fine sandstone (Tbc)
20	25	Brownish-yellow, fine sandstone (Tbc), poor return
25	30	Sand from above and medium gray mudstone
30	35	Sand (as above) with FeO concretions
35	40	Bright yellow/brown/"rusty" fine sand (FeO)
40	45	Brownish-yellow sand and medium gray mudstone
45	55	Medium gray sand
55	65	COAL (Harmon)
65	70	RHAME BED, light brown to tan, moderately indurated, silty mudstone, pseudosilcrete
70	75	Mostly as above, some coal chips, some medium gray-brown, sandy mud
75	80	Mostly gray-brown, muddy sand and coal chips
80	85	Light gray-tan, muddy silt
85	90	Coal and medium gray-tan, muddy silt
90	95	Less coal, medium gray-tan, muddy silt
95	100	Mostly coal, some medium gray-tan, muddy silt
100	105	Brown sand, marble-sized pyrite concs.
105	140	Green gray sand (minor mud)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-39	9/17/2025	PRIVATE	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	92	22	NE	46.1617	102.1650	2564

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	140	139.4	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
29.3	45-65, 90-99.3

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
2		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
262	

Notes: The distinctive interval of brown clays just above the six-foot-thick coal at 97’ depth is similar to the one in hole no. 40 (2.1 miles to the northeast) where the coal is at 50’ depth and a significant interval of bright white clays begins at 59’. This interpretation would put the top of the Rhame bed at this site below 102’ and mean any light gray colors encountered above are from the lower Bullion Creek Fm, which normally is more brightly colored. The Rhame bed stratigraphic enrichment window (likely 115’ to 135’ or so) was thus not cored, but no thick lignites are present in this interval based on the elog and cuttings.

Interval (ft)		Drill Cuttings Descriptions – Hole 39
0	5	Brown, sandy mudstone; colluvium
5	10	Green to brown, sandy mudstone; colluvium
10	15	Greenish gray, silty mudstone
15	20	Yellowish-tan, silty clay
20	25	Yellow-tan, silty clay
25	30	Yellow-tan, silty clay, maybe a bit more coarse
30	35	Medium gray, muddy clay with small fragments
35	40	Dark gray, muddy clay with coal fragments, grittier
40	45	Coal
45	50	Coal, black, clayey
50	60	Medium gray, sandy silt (slightly greenish in color)
60	65	Greenish gray clay
65	80	Medium gray, silty clay (fleck of coal 70-75; more 75-80’)
80	85	Light gray, silty clay
85	90	Light gray, silty clay with fragment of cemented mud
90	95	Light gray, silty with coal fragments
95	100	Gray to brown, carbonaceous muddy silt
100	105	Medium gray to tan, silty clay, carbonaceous
105	110	Light gray mudstone with coal fragments
110	115	Medium gray, clayey silt with coal fragments
115	120	Medium gray mudstone with coal (50%)
120	125	Gray silt with coal fragments
125	135	Medium gray, silty mudstone
135	140	Medium gray, silty mudstone with few coal fragments

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-40	9/18/2024	PRIVATE	ADAMS

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
131	91	18	NW	46.1726	102.1229	2502

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Rhame bed	140	138.7	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
50	45-95

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
6		☒ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites): 346	Max ∑REE (ppm) (Claystones/other):	

Notes: The top of the Rhame bed was modeled to occur at 45’ depth. Silcrete and light-colored mudstone began at 59’. No lignite occurred below until 93’ depth, which likely approaches the lower bound of the enrichment window, as the uppermost part of this coal was modestly REE-enriched.

Interval (ft)		Drill Cuttings Descriptions - Hole 40
0	5	Brown, muddy sand
5	10	Tan, muddy sand
10	15	Tan, sandy mudstone with concretion fragments
15	20	Cemented silt, gray to brown, silcrete (chatter 15-19’)
20	25	Tan, sandy silt
25	30	Tan sand with rock chips (cemented sandstone)
30	40	Tan, silty sand
40	45	Greenish-brown sand
45	50	Greenish-brown sand with carbonaceous mudstone to lignite chunks
50	55	Coal, mixed with carbonaceous mudstone
55	60	Gray mudstone with coal bits
60	65	Gray, clayey silt with fine coal bits (< 1%)
65	75	Light gray, silty clay (Rhame bed)
75	80	Same as above with scattered coal bits and fragments
80	85	Gray to tan, carbonaceous mudstone
85	90	Brown, carbonaceous, silty mudstone with few coal bits
90	95	Brown, carbonaceous, silty mudstone with coal fragments - (5-10%)
95	100	Dark brown, wet and loose, carby mudstone with fine to coarse sand grit
100	105	Gray to tan sandy mudstone with fine black specs
105	110	Gray, muddy sandstone (fine-grained)
110	120	Greenish-gray muddy sandstone
120	130	Greenish-gray muddy sandstone (less mud)
130	140	Greenish-gray muddy sandstone (more mud again)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-42	9/19/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
145	97	16	NE	47.3798	103.0381	2760

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	160	159.2

Core Recovered (ft):	Recovered Core Interval(s) (ft):
40.5	0-12, 20-22, 25.5-52

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
9	

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
1,990	

Target Zone Intercepted? (lithology encountered at modeled depth):
- ☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
- ☐ No – removed by glaciation (till, outwash, or alluvium)
- ☐ No – paleotopography/structure (unweathered older strata)
- ☐ No – removed by paleochannel (unweathered younger sandstone)

REE enrichment (≥300 ppm) within/immediately below target zone?:
- ☒ Yes – enriched lignite(s) identified
- ☐ Yes – enriched claystone(s) identified; no lignites occur
- ☐ No – light-colored silt/sandstone present; no lignites/claystones
- ☐ Other – claystones may be enriched but no core collected

Notes: Drill locations for holes no. 42 and 42B were selected to provide information on the subsurface extent of four REE-enriched lignites sampled at measured section 266 of Murphy et al., 2023, located 0.41 miles to the southeast of this hole and 0.36 miles southwest of hole no 42B. This hole had difficulty recovering the carb zone above the kaolinite (which was slightly enriched at measured section 266). The second lignite (266F equivalent) was not recovered here but in hole no. 42B it was not enriched. The next two lower coals (C and D) were highly enriched in both holes (266G and 266H equivalents), with C thickening to a 16-inch-thick carbonaceous zone of REE-enriched in 42B. Interestingly, an additional thick coal (E) was encountered roughly a foot below D, in both holes, with no REE enrichment, illustrating the abrupt return to normal REE concentrations at the base of the enrichment window.

Interval (ft)		Drill Cuttings Descriptions - Hole 42
0	5	Yellow mud
5	10	Yellow mud with concretion chips
10	15	Light gray and yellow mud with coal and carb
15	20	Same as above, more carb and medium brown mud
20	25	Light gray and brown mud
25	30	COAL
30	35	Light gray CLAY, very soft
35	40	COAL
40	50	Medium gray clay
50	55	Medium gray silt
55	60	Medium gray silt and mud
60	65	Brown-gray clay
65	70	Green-gray, silty mud
70	75	Green-gray, silty mud and brown-gray clay
75	80	Brown-gray mud
80	85	No return - Sand ?
85	90	Medium gray clay; tan ? clay; and COAL
90	95	Green gray mud
95	105	Medium gray mud
105	120	Silty mud - medium gray
120	140	Poor return, foam, (medium gray sand ?)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-42B	9/19/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
145	97	16	NE	47.3802	103.0428	2716

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):
Bear Den	200	198.8

Core Recovered (ft):	Recovered Core Interval(s) (ft):
35.3	56-63.5, 68.2-96

Target Zone Intercepted? (lithology encountered at modeled depth):
☒ Yes – (light-colored kaolinitic clay/silt/sandstone)
☐ No – removed by glaciation (till, outwash, or alluvium)
☐ No – paleotopography/structure (unweathered older strata)
☐ No – removed by paleochannel (unweathered younger sandstone)

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):
12	
Max ∑REE (ppm) (Lignites):	**Max ∑REE (ppm) (Claystones/other):**
1,647	

REE enrichment (≥300 ppm) within/immediately below target zone?:
☒ Yes – enriched lignite(s) identified
☐ Yes – enriched claystone(s) identified; no lignites occur
☐ No – light-colored silt/sandstone present; no lignites/claystones
☐ Other – claystones may be enriched but no core collected

Notes: See discussion in notes for hole no. 42, 0.22 miles to the west.

Interval (ft)		Drill Cuttings Descriptions - Hole 42B
0	5	Orange-tan till
5	10	Yellowish-tan till
10	30	Tan, gravelly, silty, sand till
30	45	Tan, muddy sand
45	50	Tan mudstone with sparse coal chips
50	55	Grayish tan mudstone with coal bits
55	60	Carbonaceous mudstone with coal, brown to black
60	65	Carbonaceous mudstone with coal, brown to black, small coal chips
65	80	Medium gray mudstone (sparse coal chips 75-80')
80	85	Medium gray with coal chips (small to big)
85	90	Medium gray mudstone with carb and coal making mud look darker
90	100	Dark to medium gray silty mudstone
100	110	Medium gray, silty mudstone with coal chips
110	115	Medium gray mudstone with coal chips
115	120	Greenish mudstone with concretion chip (may have come from top gravel)
120	125	Green to gray; silty mudstone to mudstone
125	130	Green, silty mudstone with darker mud clumps (carb?)
130	135	Gray, silty mudstone, not as silty as the green above
135	140	Gray, clayey mudstone with coal chips [chatter at ~138']
140	145	Medium gray, silty mud with carbs based on mud color (dark brown)
145	150	Dark brown, carbonaceous clay
150	155	Deep green mudstone and gray mudstone
155	160	Green clay
160	165	Greenish-gray, silty clay and green clay
165	175	Gray, clayey mudstone with silt
175	180	Gray, clayey mudstone with silt with small coal chips [chatter]
180	185	Gray, silty mudstone with tiny coal bits
185	190	Gray silt
190	195	Gray, silty sand with coal bits
195	200	Gray, silty sand

ole No.:		Drill Date:		Surface Owner:		County:
NDGS24-43		9/20/2025		STATE TRUST		DUNN
Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
146	97	36	SW	47.4186	102.9855	2702

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	160	158.4	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
27.1	79-89.3, 90-104.3, 104.5-107

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
7		☒ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected

Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):
1,464	

Notes: Base of Bear Den Member modeled to occur around 95’ depth. Claystone from 88’ to 109’, although not particularly brightly colored, likely represents the Bear Den kaolinite, with an REE-enriched lignite recovered at 109’.

Interval (ft)		Drill Cuttings Descriptions - Hole 43
0	5	Tan, soily-mudstone
5	10	Tan, sandy mudstone
10	20	Tan sandstone, little silty
20	25	Tan sandstone, very clean
25	30	Tan sandstone, silty
30	40	Tan sandstone, clean
40	45	Tan sandstone, clean
45	55	Tan sandstone
55	80	NO CUTTING RETURN (moved hole to alternate location)
80	85	Gray, clayey siltstone with tiny coal specks
85	90	Gray, silty clay with tiny, black & brown organic specks (mostly foam from soap, not much clay return)
90	95	Carby coal >50% with gray, silty clay
95	100	Gray to tan, clayey silt with coal bits
100	105	Medium gray silt (Driller feels coal 105')
105	110	Medium gray silt, consolidated with sparse, fine sand
110	115	Green silt with coal fragments
115	120	Green silt with coal fragments
120	125	Green, clayey silt and tan, carby mud mix with coal bits
125	140	Gray mudstone
140	150	Dark gray clayey mudstone, hard
150	155	Brownish gray carby mudstone
		(chatter)
155	160	Greenish gray cemented sandstone

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-43B	9/20/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
146	97	36	SW	47.4173	102.9827	2716

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	80	N/A	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Unstable pilot hole; elected to stop drilling and not elog to avoid possible collapse on probe. Unconsolidated brown sand is micaceous and likely belongs to the Camels Butte Member. Based on elevations of Hole 43, the thin, REE-enriched lignite would occur around 120'. Hole 43B was dilled prior to Hole 43.

Interval (ft)		Drill Cuttings Descriptions - Hole 43B
0	5	Brown, soily sand
5	10	Tan, soupy sand with one sharp-edged rock bit
10	15	Brown sand; soupy
15	25	Brown sand; loose
25	35	Brown sand
35	40	Brown sand; little siltier
40	45	Brown sand
45	50	(no cuttings)
50	60	Brown sand; clean; cuttings collected during final 10' of drill pipe
60	65	Gray, silty clay with rust colored, small nodules
65	70	Medium-dark gray, silty clay with carby mix
70	75	Gray clay with brown, carby clay
75	80	Gray clay with tiny coal bits

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-44	9/20/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
147	96	36	NW	47.5131	102.8637	2625

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	140	139.3	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☒ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?: ☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Poorly consolidated sandy material contained some mica (suggesting it could be the Camels Butte Member), but colluvium seems more likely since bright white Bear Den claystones were encountered in Hole 44C at elevations equating to 60’ depth here. The Bear Den Member is likely eroded here and replaced by colluvium at the foot of the Killdeer Mountains.

Interval (ft)		Drill Cuttings Descriptions - Hole 44
0	10	Siltstone, light brown, sandy (very fine grained), poorly cemented, some mica
10	70	Sandstone, light-medium brown, silty, very fine to fine grained
70	80	Claystone, medium-dark gray, some FeO, lenses of clay within the sandstone
80	140	Sandstone, brown, very-fine grained, silty going to siltstone
		Occasional claystone lenses or claystone layers in hole -- poor returns

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-44B	9/20/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
147	96	36	NW	47.5159	102.8640	2616

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	120	N/A	☐ Yes – (light-colored kaolinitic clay/silt/sandstone) ☒ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☐ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Unstable pilot hole; elected to stop drilling and not elog to avoid possible collapse on probe. Based on elevations of Hole 44C, the Bear Den Member should be present by 55’ depth, so it is likely eroded here and replaced by colluvium at the foot of the Killdeer Mountains.

Interval (ft)		Drill Cuttings Descriptions - Hole 44B
0	19	Mudstone, yellow/gray-green, silty, occasional pea-size grains (rock fragments - sub-rounded, gray)
19	19.5	Rock - silicified bentonite?
19.5	30	Mudstone, light green and some brown, silty
30	50	Siltstone, gray/green, poorly cemented
50	120	Mudstone, gray/green, silty, micaceous, occasional pebbles in sandstone in returns - layers or lenses within the sandstone. Jason says drilling like fill (colluvium)

Hole No.:	Drill Date:	Surface Owner:	County:
NDGS24-44C	9/20/2025	STATE TRUST	DUNN

Township (N):	Range (W):	Section:	¼ Section:	Latitude (°N):	Longitude (°W):	Surface Elevation (FASL):
147	96	36	NW	47.5123	102.8594	2607

Target Zone:	Pilot Hole Depth (ft):	E-log Depth (ft):	Target Zone Intercepted? (lithology encountered at modeled depth):
Bear Den	200	197.2	☒ Yes – (light-colored kaolinitic clay/silt/sandstone) ☐ No – removed by glaciation (till, outwash, or alluvium) ☐ No – paleotopography/structure (unweathered older strata) ☐ No – removed by paleochannel (unweathered younger sandstone)

Core Recovered (ft):	Recovered Core Interval(s) (ft):
N/A	

ICP-MS Analyses (#) (Lignites):	ICP-MS Analyses (#) (Claystones/other):	REE enrichment (≥300 ppm) within/immediately below target zone?:
		☐ Yes – enriched lignite(s) identified ☐ Yes – enriched claystone(s) identified; no lignites occur ☐ No – light-colored silt/sandstone present; no lignites/claystones ☒ Other – claystones may be enriched but no core collected
Max ∑REE (ppm) (Lignites):	Max ∑REE (ppm) (Claystones/other):	

Notes: Base of Bear Den Member modeled to occur around 85’ depth. White mudstone encountered at 45’; the Bear Den is very well developed with a nearly 30-foot thickness of bright white claystone. No core was attempted due to a lack of lignite visible in cuttings or elog, but the 70’-80’ interval likely contains clay-hosted REE enrichment based on results from other cores.

Interval (ft)		Drill Cuttings Descriptions - Hole 44C
0	5	Medium brown sand (micaceous) and limey gravel
5	10	Medium brown and olive brown sand, micaceous, limey pebbles
10	35	Olive brown micaceous sand
35	40	Olive brown micaceous sand and green mudstone (a few carby mud chunks)
40	45	Same as above, but less sand and more mud (a few carby mud chunks)
45	50	Lighter green and white mud, borderline claystone
50	55	Same as above, mostly white
55	60	Same as above, mostly white, with rare dark gray piece
60	65	Same, with rare medium gray piece
65	70	Same, but several light brown pieces (a few pink pieces)
70	75	Becoming light/medium gray-green clay (a few pink pieces)
75	80	Medium gray claystone (a few pink pieces)
80	85	Medium gray, clayey mudstone, a remnant (?) pink and white chunk
85	100	Medium to dark gray clay
100	110	Medium gray mud
110	120	Medium gray silty mud
120	145	Medium gray sand
145	155	Coal and white chunks of muddy sandstone (hard) in medium gray sand matrix
155	160	As above with light brown limonite
160	165	medium gray sand with some coal
165	170	Medium gray sand, getting muddy
170	175	Muddy, medium gray sand and brown mud, coal
175	180	Same as above with more brown mud
180	185	Same as above with less brown mud, more coal
185	190	Green gray sandy mudstone, coal, and brown mud
190	195	Green gray silty mudstone and brown mud
195	200	Green-gray-brown mud

Appendix D - Wireline Logs

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-2

COMPANY ND MINERAL RESOURCES
WELL NDGS24-2
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-2
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 146N RANGE: 89W
1/4 Section : SE
Latitude : N/A
Longitude : N/A
DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	10/09/24 11:26
DEPTH DRILLER	320 FT
DEPTH LOGGER	319.7 FT
FIRST READING	319.0 FT
LAST READING	5 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	28.8
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

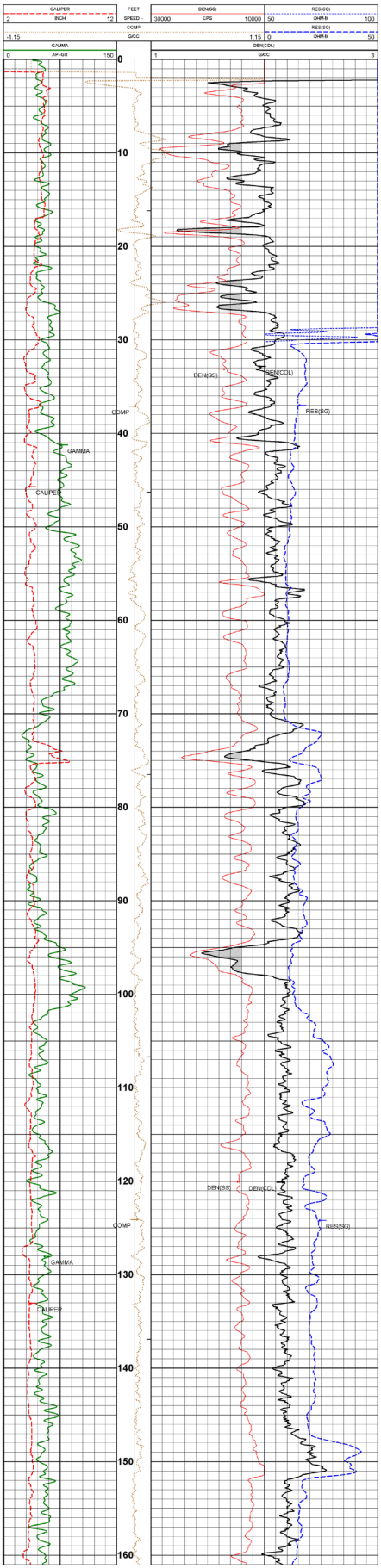
TOOL CALIBRATION NDGS24-2 10/09/24 11:26
TOOL 9239C TM VERSION 9026
SERIAL NUMBER 4588

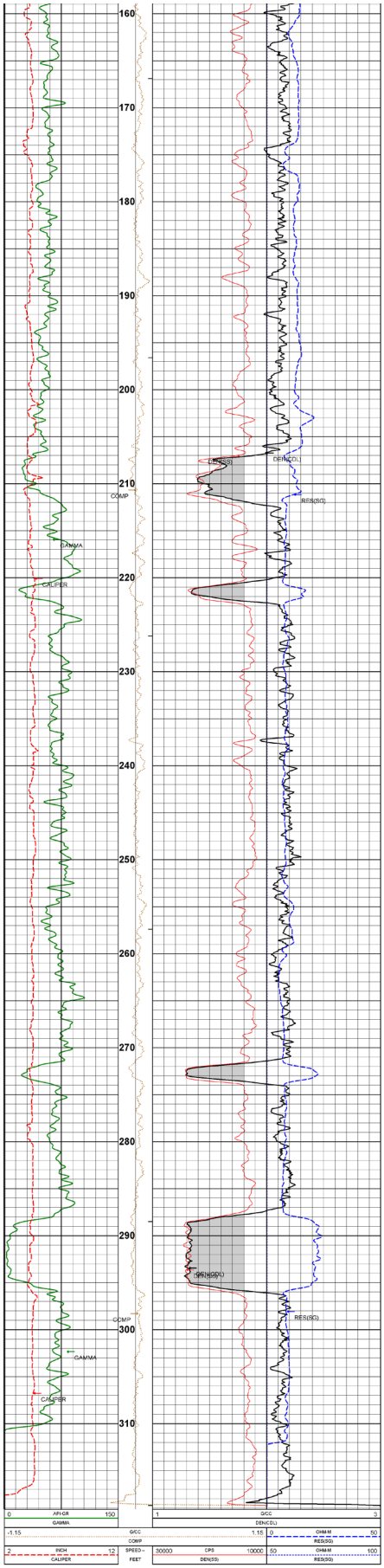
	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Sep21,24	18:05:36	GAMMA	[API-GR]	1.000	340.000	0.000	461
2	Apr13,20	13:10:56	VOLTAGE	[MV]	0.000	1979.000	10073	274901
3	Jul11,24	00:52:41	CALIPER	[INCH]	4.000	6.000	153180	284780
4	Jul11,24	00:45:40	DEN(LS)	[G/CC]	1.726	2.673	5126	810
5	Jul11,24	00:21:54	DEN(SS)	[G/CC]	1.775	2.638	17245	7669
6	Apr13,20	13:09:40	CALIPERL	[INCH]	4.000	6.000	116481	187434
7	Apr13,20	13:11:03	CURRENT	[UA]	0.000	285.524	4964	28719
8	May14,08	11:00:30	F	[CPS]	Default		Default	
9	May14,08	11:00:30	X	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-2 10/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 54
MAGNETIC DECL : 0 ELECT. CUTOFF : 99999 BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 10/09/2024 DISPLAY7_JL65z





CDL DENSITY 1:60 LOG NDGS24-2 10/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 54
MAGNETIC DECL : 0 ELECT. CUTOFF : 99999 BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 10/09/2024 DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-3

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-3
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 146N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-3
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MERCER
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

PERMANENT DATUM	GL	Elevations:	KB	N/A	FT	Other Services:
DRL MEASURED FROM	GL		DF	N/A	FT	NONE
LOG MEASURED FROM	GL		GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT.					

DATE	09/03/24 10:03
DEPTH DRILLER	160 FT
DEPTH LOGGER	159.8 FT
FIRST READING	159.1 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	115.6
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

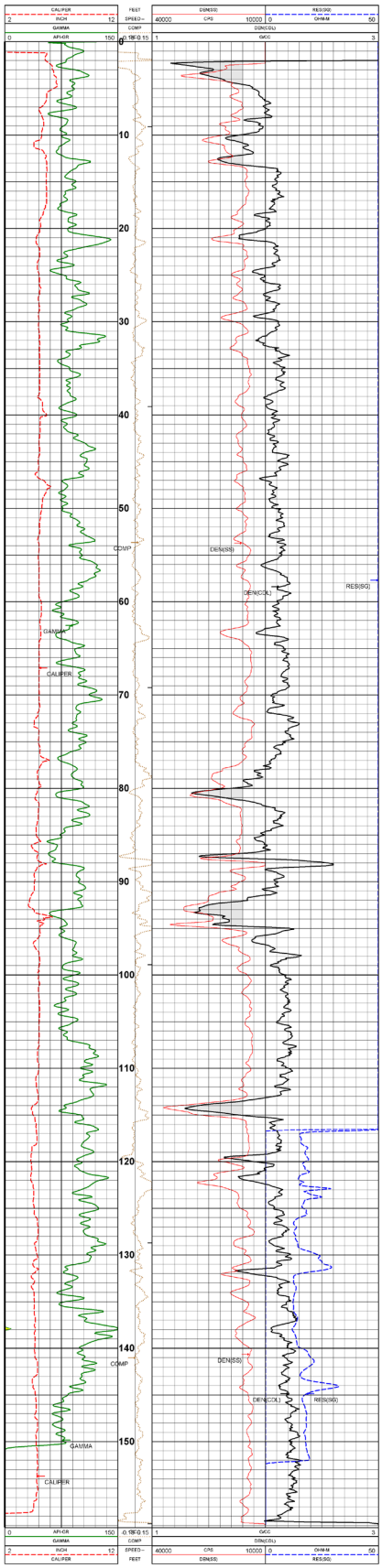
TOOL CALIBRATION NDGS24-3 09/03/24 10:03
TOOL 9239C TIM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4928	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150608	263566
7	Jul30,24	13:12:06	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-3 09/03/24

LOG PARAMETERS

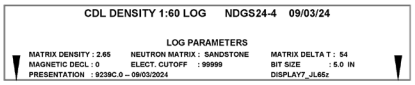
MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z

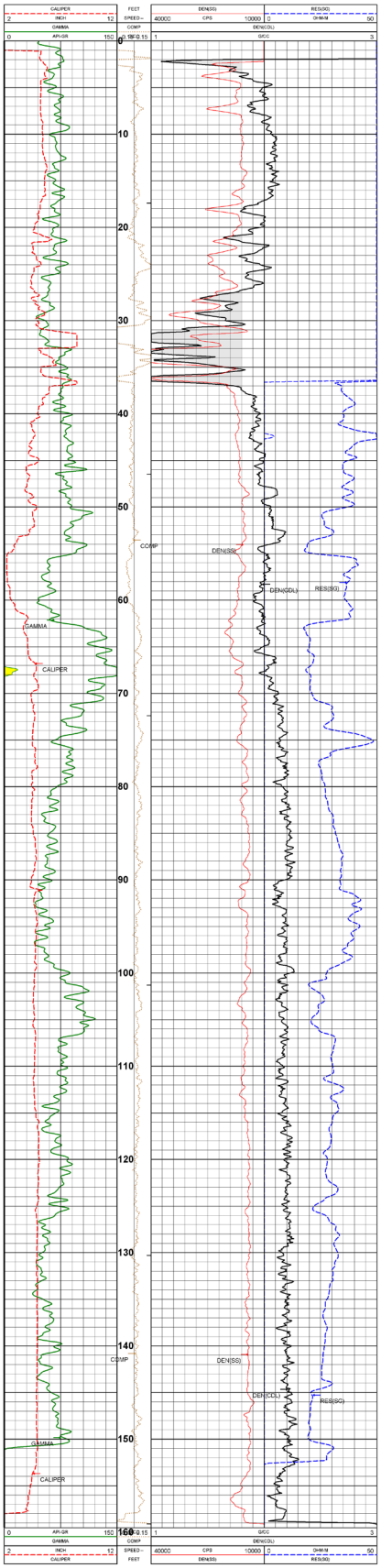


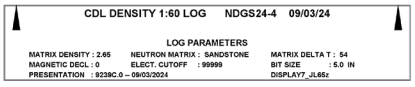
CDL DENSITY 1:60 LOG NDGS24-3 09/03/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z







Century WIRELINE SERVICES

STATE OF NORTH DAKOTA GEOLOGICAL SURVEY NDGS24-4

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-4
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 146N RANGE: 90W
1/4 Section : NW
Latitude : N/A
Longitude : N/A
DISPLAY7_JL65z

						Other Services:
PERMANENT DATUM	GL	Elevations:				NONE
DRL MEASURED FROM	GL	KB	N/A	FT		
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/03/24 12:43	
DEPTH DRILLER	160	FT
DEPTH LOGGER	160.1	FT
FIRST READING	159.4	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	36.2	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-4 09/03/24 12:43
TOOL 9239C TIN VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:59	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul10,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190627	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150600	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-5

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-5
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: DUNN
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-5
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MERCER/DUNN TRACTS
SECTION: 25 TOWNSHIP: 145N RANGE: 91W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/04/24 09:59
DEPTH DRILLER	145 FT
DEPTH LOGGER	144.3 FT
FIRST READING	143.6 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	72
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

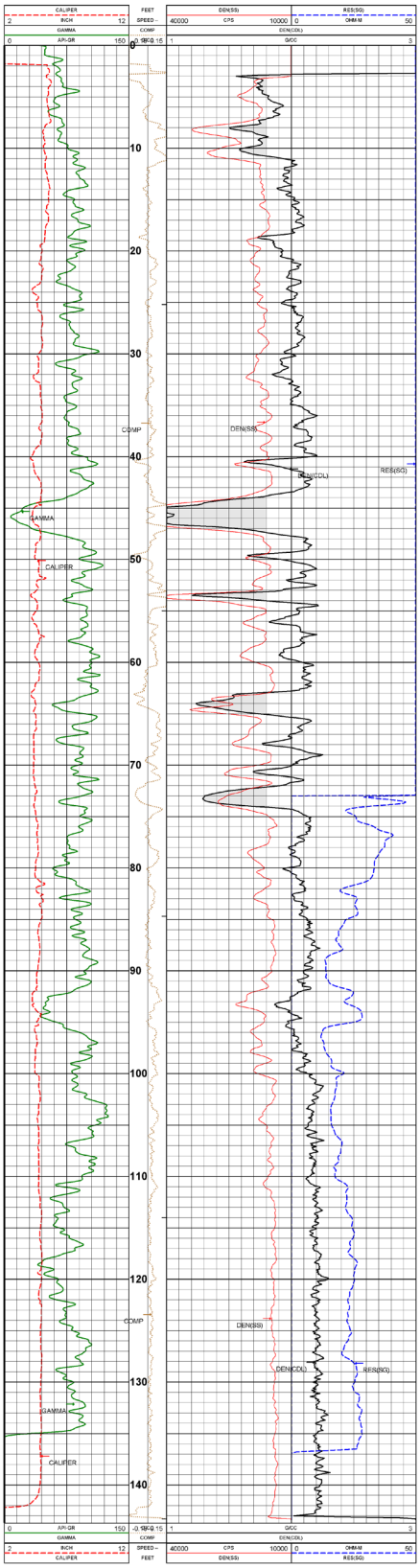
TOOL CALIBRATION NDGS24-5 09/04/24 09:59
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1239

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	369
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190027	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:09	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-5 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-5 09/04/24

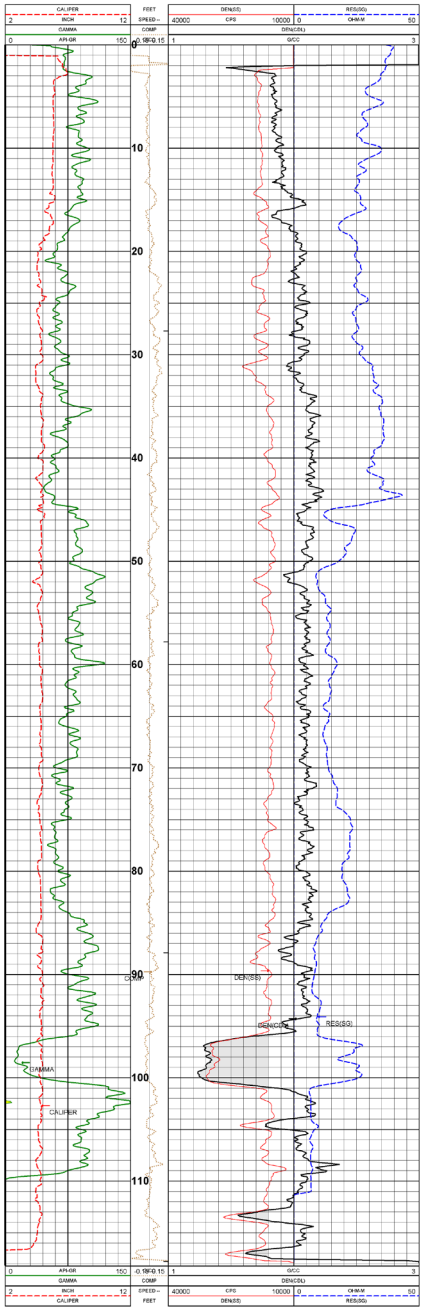
LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-6 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-6 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-6

COMPANY NO MINERAL RESOURCES
WELL NDGS24-6
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-6
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 145N RANGE: 91W
1/4 Section : N/W
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:	KB	N/A	FT	Other Services:
DRL MEASURED FROM	GL		DF	N/A	FT	NONE
LOG MEASURED FROM	GL		GL	N/A	FT	
E.LEV. PERM. DATUM	N/A FT					

DATE	09/04/24 09:25
DEPTH DRILLER	120. FT
DEPTH LOGGER	118.8 FT
FIRST READING	118.1 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	0
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-6 09/04/24 09:25
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1259

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[9V]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:16:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150680	263566
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	8180	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-7

COMPANY ND MINERAL RESOURCES
WELL NDGS24-7
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-7
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MERCER/DUNN TRACTS
SECTION: 2 TOWNSHIP: 143N RANGE: 90W
1/4 Section : N/W
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/04/24 12:43	
DEPTH DRILLER	120	FT
DEPTH LOGGER	115.9	FT
FIRST READING	115.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	9	
RECORDED BY	C.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

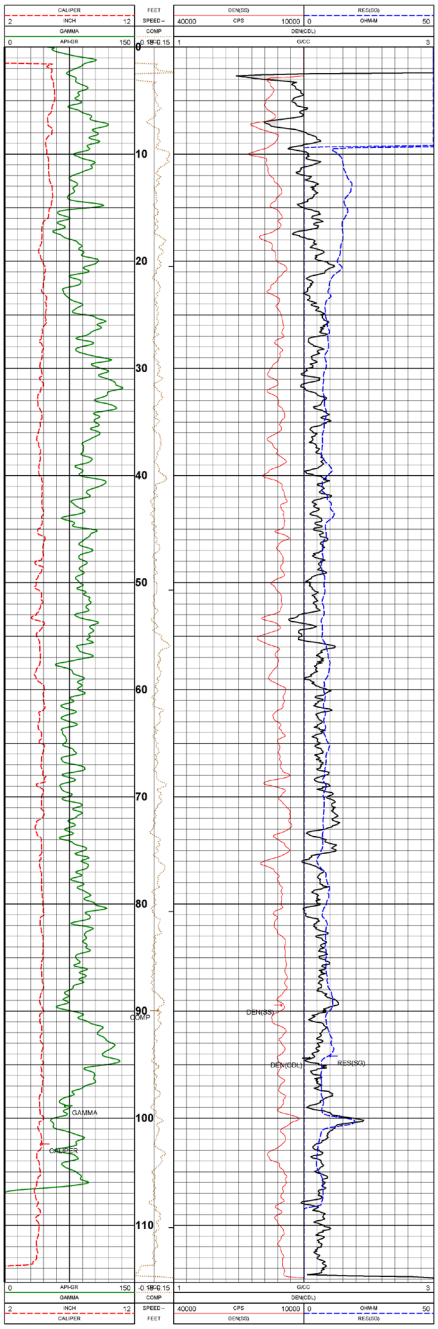
TOOL CALIBRATION NDGS24-7 09/04/24 12:43
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	388
2	Jul30,24	10:11:58	VOLTAGE	[MV]	26.730	234.800	7306	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.776	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	265985
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-7 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024 **DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-7 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024 **DISPLAY7_JL65z**

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-8

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-8
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MERCER/DUNN TRACTS
SECTION: 10 TOWNSHIP: 143N RANGE: 90W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-8
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/04/24 12:05
DEPTH DRILLER	120 FT
DEPTH LOGGER	119.6 FT
FIRST READING	118.9 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	18
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

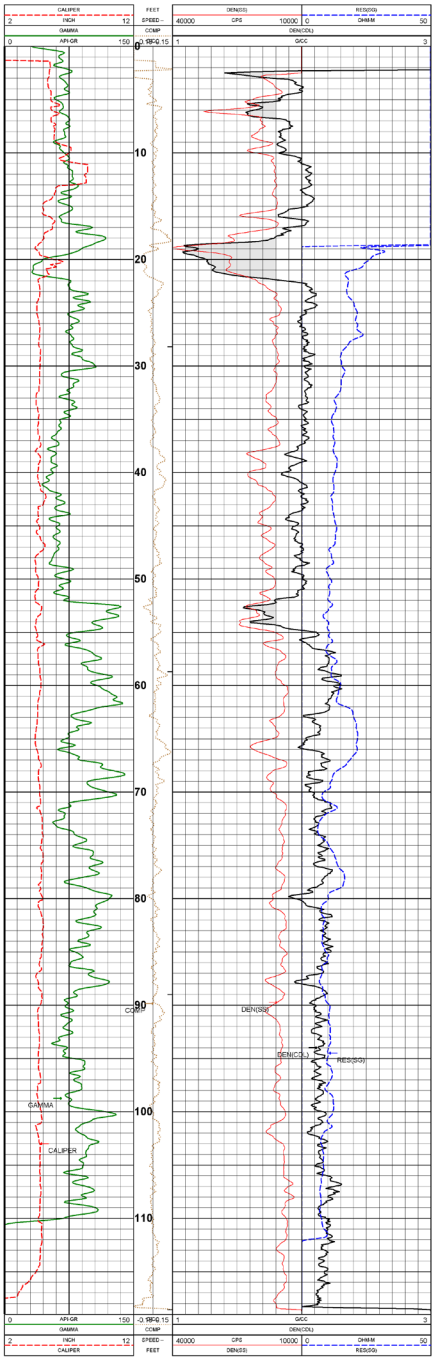
TOOL CALIBRATION NDGS24-8 09/04/24 12:05
TOOL 9239C TIM VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.738	2.673	4926	724
5	Jul18,24	17:16:06	DEN(SS)	[G/CC]	1.775	2.638	20098	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150688	263585
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-8 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	**NEUTRON MATRIX : SANDSTONE**	**MATRIX DELTA T : 54**
MAGNETIC DECL : 0	**ELECT. CUTOFF : 99999**	**BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024		**DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-8 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	**NEUTRON MATRIX : SANDSTONE**	**MATRIX DELTA T : 54**
MAGNETIC DECL : 0	**ELECT. CUTOFF : 99999**	**BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024		**DISPLAY7_JL65z**

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-9

COMPANY ND MINERAL RESOURCES
WELL NDGS24-9
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-9
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 20 TOWNSHIP: 143N RANGE: 90W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/04/24 14:27
DEPTH DRILLER	140 FT
DEPTH LOGGER	139.7 FT
FIRST READING	138 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	63
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

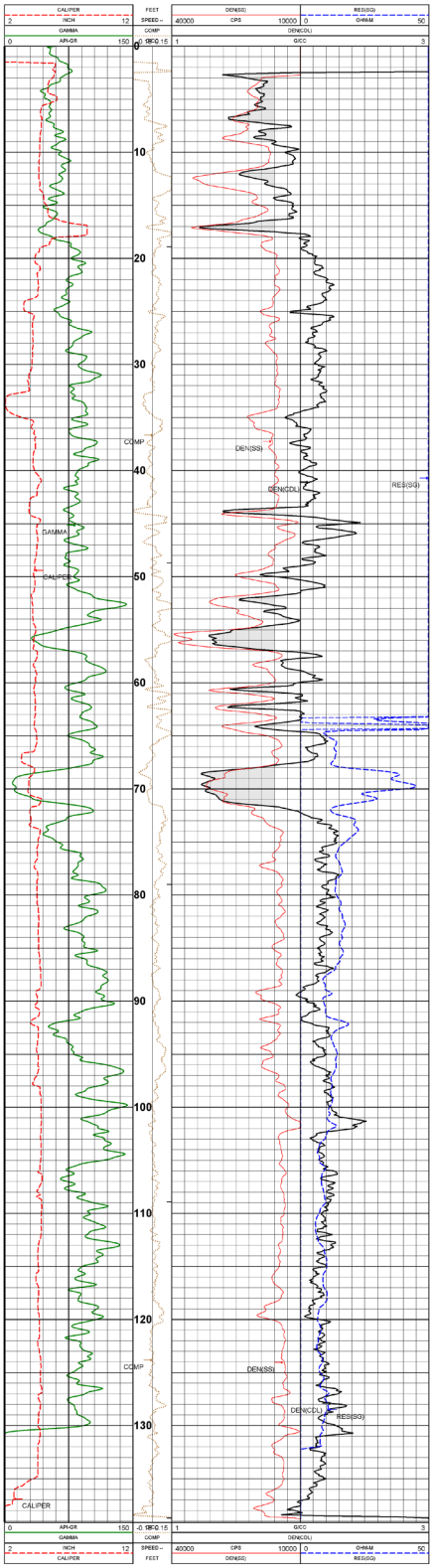
TOOL CALIBRATION NDGS24-9 09/04/24 14:27
TOOL 9239C TM VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	12:11:58	VOLTAGE	[MV]	26.730	234.900	7305	38063
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190627	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150600	263686
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.900	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-9 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-9 09/04/24

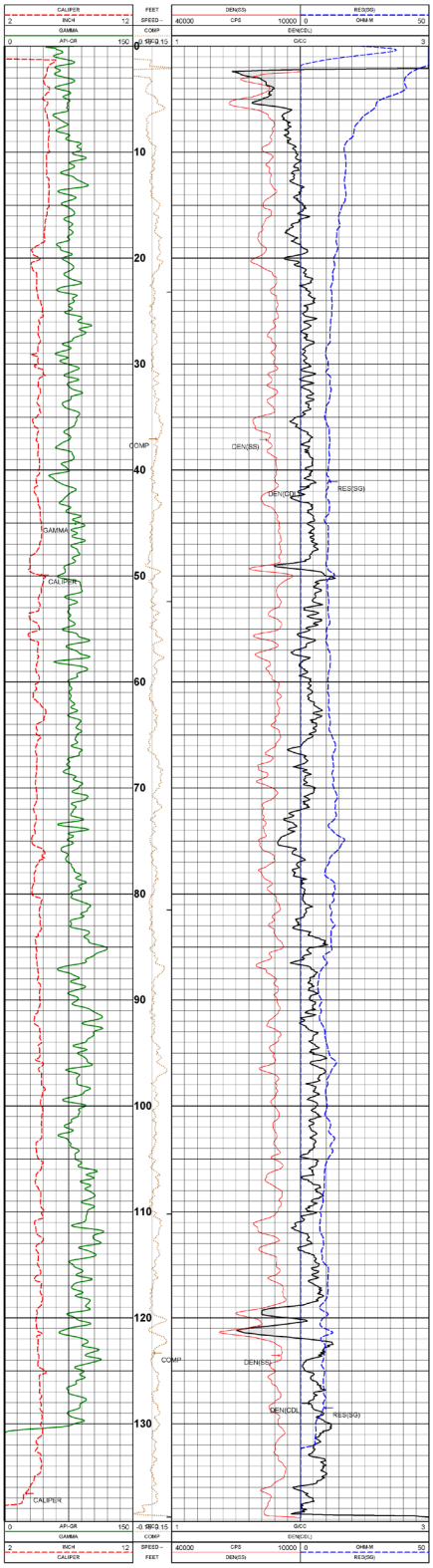
LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-10 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-10 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-10

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-10
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MERCER/DUNN TRACTS
SECTION: 30 TOWNSHIP: 143N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-10
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL		Elevations:				Other Services:
DRL MEASURED FROM	GL		KB	N/A	FT		NONE
LOG MEASURED FROM	GL		DF	N/A	FT		
ELEV. PERM. DATUM	N/A	FT	GL	N/A	FT		

DATE	09/04/24 14:58	
DEPTH DRILLER	140	FT
DEPTH LOGGER	139.8	FT
FIRST READING	139.1	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	0	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-10 09/04/24 14:58
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:58	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.776	2.638	20096	5196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263586
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	6180	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-10B

COMPANY ND MINERAL RESOURCES
WELL NDGS24-10B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MERCER
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-10B
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MERCER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MERCER/DUNN TRACTS
SECTION: 30 TOWNSHIP: 143N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

						Other Services:
PERMANENT DATUM	GL		Elevations:			NONE
DRL MEASURED FROM	GL		KB	N/A	FT	
LOG MEASURED FROM	GL		DF	N/A	FT	
ELEV. PERM. DATUM	N/A	FT	GL	N/A	FT	

DATE	09/04/24 16:11	
DEPTH DRILLER	80	FT
DEPTH LOGGER	78.6	FT
FIRST READING	77.9	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	0	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

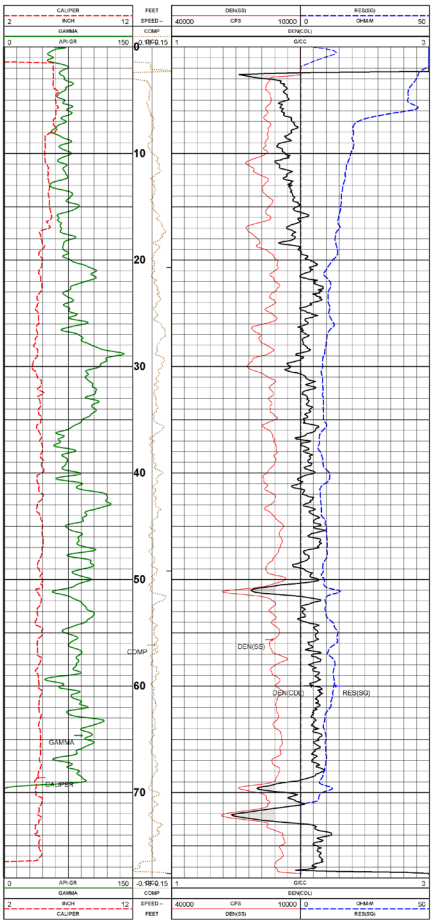
TOOL CALIBRATION NDGS24-10B 09/04/24 16:11
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[5V]	26.730	234.000	7306	38063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	8.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150668	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.000	5198	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-10B 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-10B 09/04/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-12

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-12
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 16 TOWNSHIP: 143N RANGE: 91W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-12
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/05/24 09:16
DEPTH DRILLER	160 FT
DEPTH LOGGER	142.6 FT
FIRST READING	142.1 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	58
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

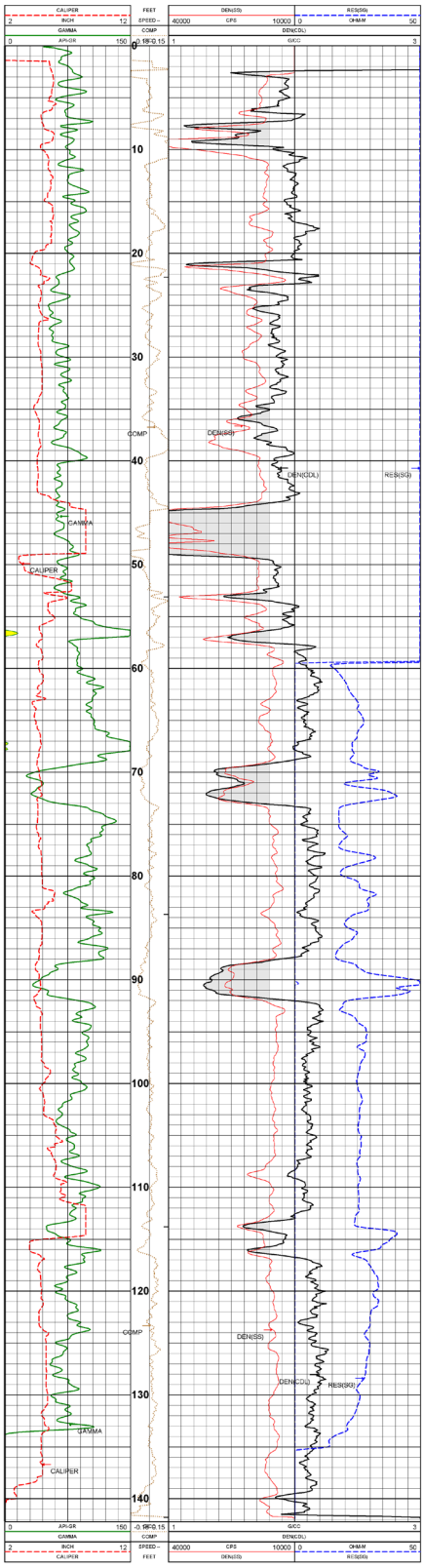
TOOL CALIBRATION NDGS24-12 09/05/24 09:16
TOOL 9239C TIM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7306	35063
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190027	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	9196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:12:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-12 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-12 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-12B

COMPANY NO MINERAL RESOURCES
WELL NDGS24-12B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-12B
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 16 TOWNSHIP: 143N RANGE: 91W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/05/24 10:34
DEPTH DRILLER	80 FT
DEPTH LOGGER	79.2 FT
FIRST READING	77.5 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	0
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

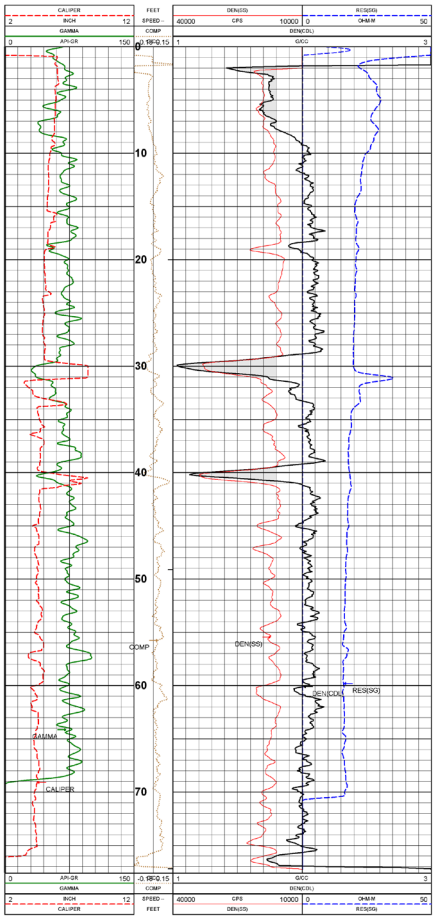
TOOL CALIBRATION NDGS24-12B 09/05/24 10:34
TOOL 9239C TMI VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	369
2	Jul30,24	13:11:55	VOLTAGE	[MV]	26.730	234.800	7306	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305977
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-12B 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024 **DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-12B 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024 **DISPLAY7_JL65z**

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-13

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-13
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 16 TOWNSHIP: 143N RANGE: 92W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-13
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/05/24 14:30
DEPTH DRILLER	100 FT
DEPTH LOGGER	100.1 FT
FIRST READING	99.4 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	0
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

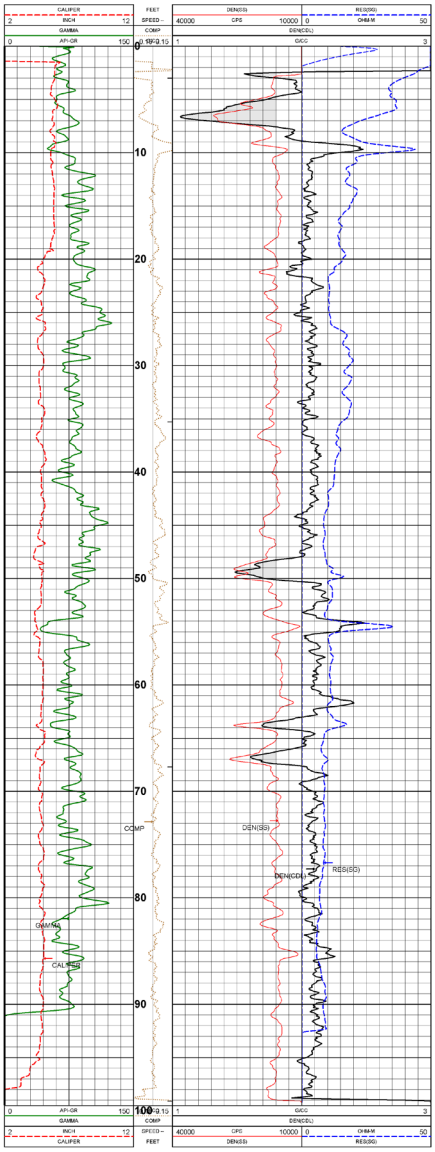
TOOL CALIBRATION NDGS24-13 09/05/24 14:30
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[WV]	26.730	234.600	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.725	2.673	4926	724
5	Jul18,24	17:16:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263566
7	Jul30,24	13:13:00	CURRENT	[UA]	26.730	234.600	8188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-13 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-13 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-14

COMPANY ND MINERAL RESOURCES
WELL NDGS24-14
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY	ND MINERAL RESOURCES
WELL	NDGS24-14
PROGRAM	CRITICAL MINERAL DRILLING
COUNTY	DUNN
STATE	NORTH DAKOTA
COUNTRY	USA
OWNER	STATE
AREA	MERCER/DUNN TRACTS
	SECTION: 36 TOWNSHIP: 144N RANGE: 93W
1/4 Section	NW
Latitude	N/A
Longitude	N/A
	DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/05/24 16:13
DEPTH DRILLER	80 FT
DEPTH LOGGER	79.9 FT
FIRST READING	79.2 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC. STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	73
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

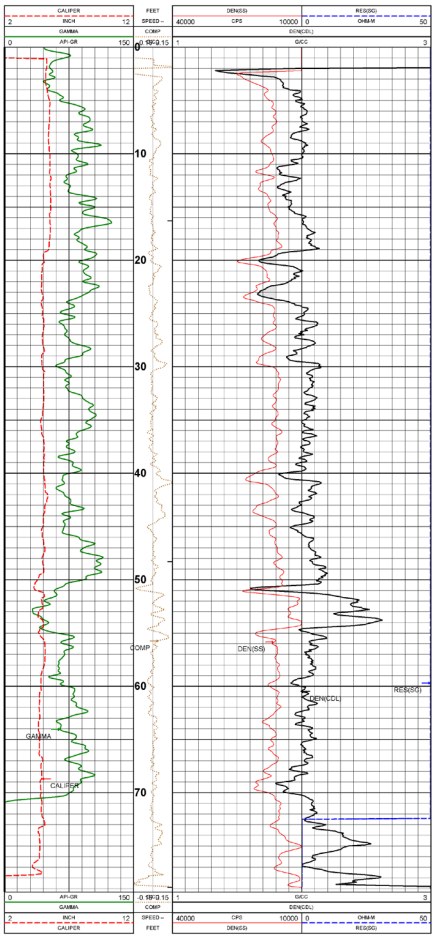
TOOL CALIBRATION NDGS24-14 09/05/24 16:13
TOOL 9239C TH VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.635	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150808	263466
7	Jul30,24	13:13:00	CURRENT	[UA]	26.730	234.800	5188	33510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-14 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-14 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-15

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-15
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: DUNN
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-15

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 144N RANGE: 93W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/05/24 16:46
DEPTH DRILLER	100 FT
DEPTH LOGGER	100.0 FT
FIRST READING	99.3 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	5
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

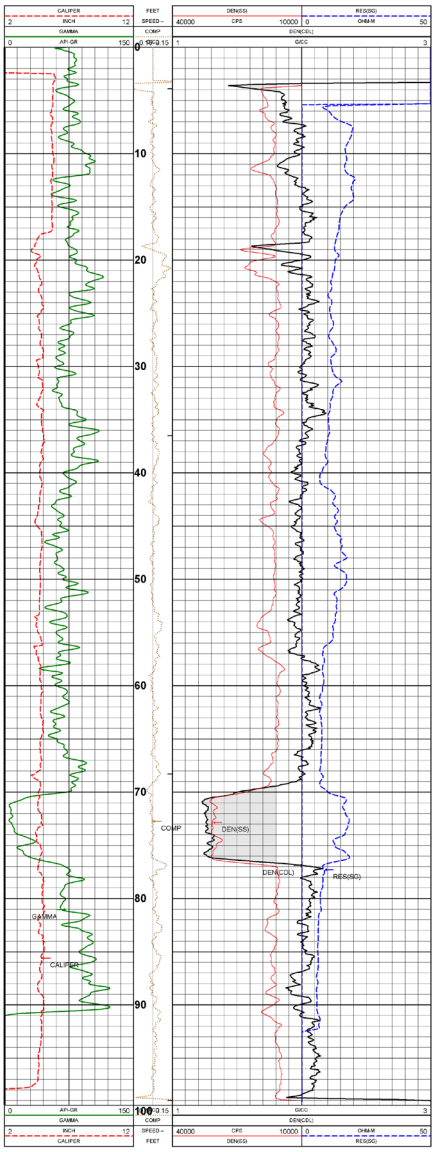
TOOL CALIBRATION NDGS24-15 09/05/24 16:46
TOOL 9239C TN VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:19:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	8.000	150688	283565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23610
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-15 09/05/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-15 09/05/24

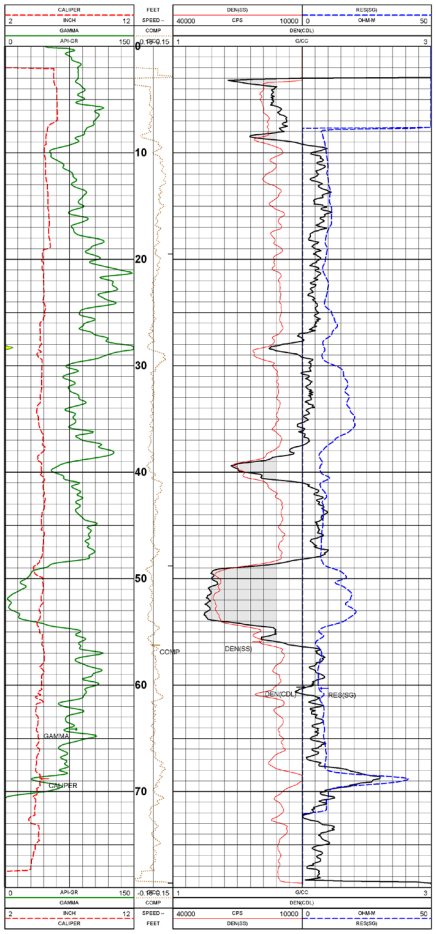
LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-16 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-16 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-16

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-16
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 1 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/06/24 11:42	
DEPTH DRILLER	80	FT
DEPTH LOGGER	79.6	FT
FIRST READING	78.9	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	7.5	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-16 09/06/24 11:42
TOOL 9239C TN VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.890	7306	36063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	8.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:19:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:06	CURRENT	[UA]	26.730	234.890	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-16B

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-16B
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MORTON
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-16B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 1 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/06/24 11:09
DEPTH DRILLER	120 FT
DEPTH LOGGER	119.8 FT
FIRST READING	119.1 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	0
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

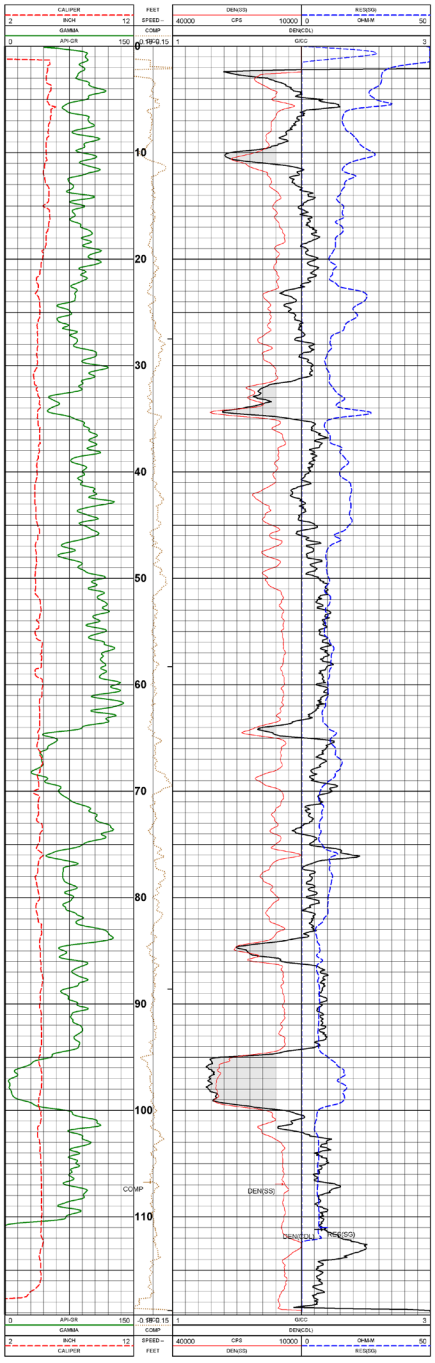
TOOL CALIBRATION NDGS24-16B 09/06/24 11:09
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	220.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[SV]	26.730	234.800	7305	35063
3	Jul19,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5185	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-16B 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-16B 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-17

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-17

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS

SECTION: 11 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-17
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/06/24 16:46	
DEPTH DRILLER	120	FT
DEPTH LOGGER	114.3	FT
FIRST READING	113.6	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	17.0	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

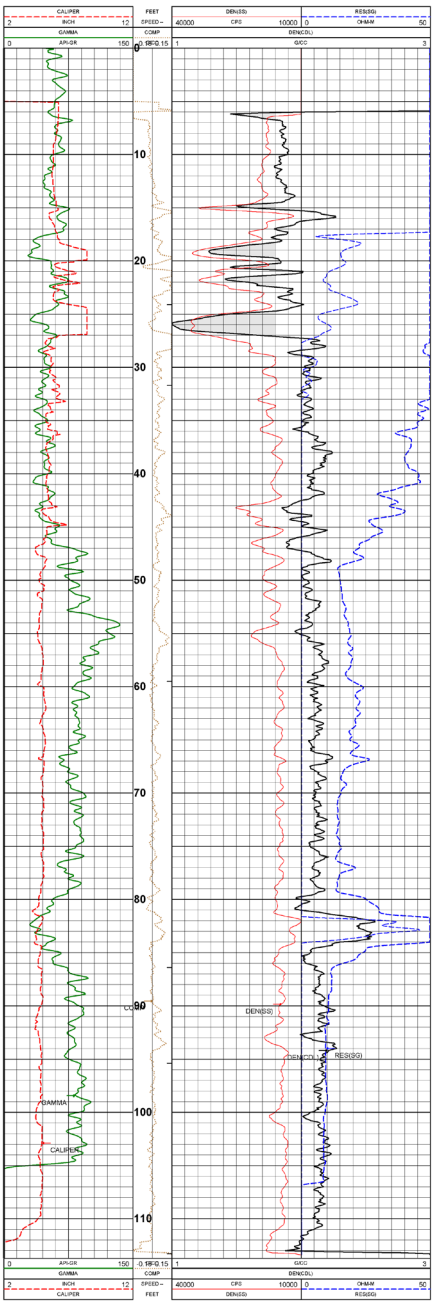
TOOL CALIBRATION NDGS24-17 09/06/24 16:46
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	8188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-17 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-17 09/06/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-17B

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-17B
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MORTON
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-17B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 11 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/09/24 09:22
DEPTH DRILLER	160 FT
DEPTH LOGGER	159.8 FT
FIRST READING	159.1 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	124
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

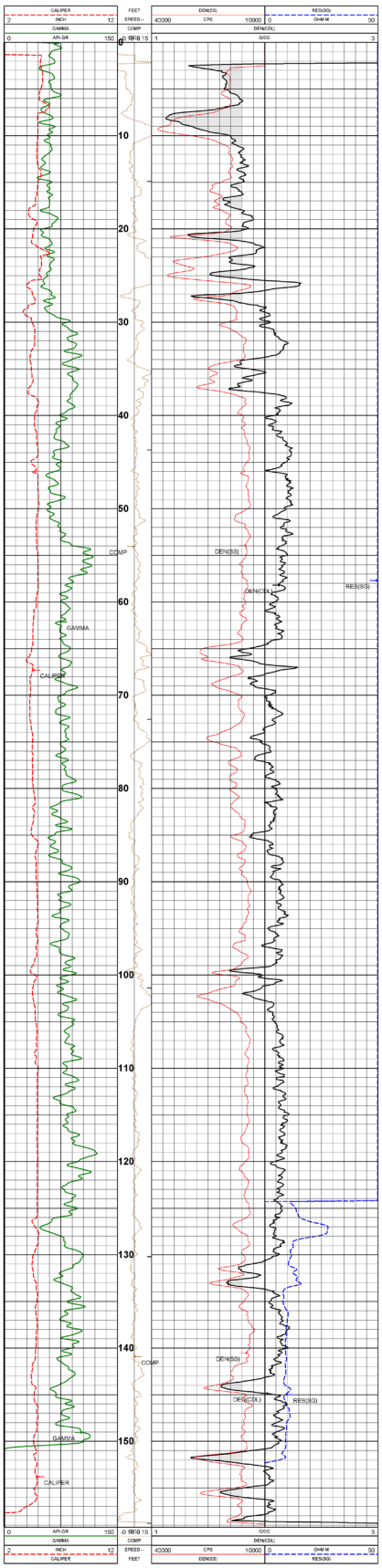
TOOL CALIBRATION NDGS24-17B 09/09/24 09:22
TOOL 9239C TH VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	363505
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-17B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-17B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-18

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-18
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MORTON
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-18

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 2 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/09/24 09:57
DEPTH DRILLER	140 FT
DEPTH LOGGER	140.1 FT
FIRST READING	139.4 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	100.3
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

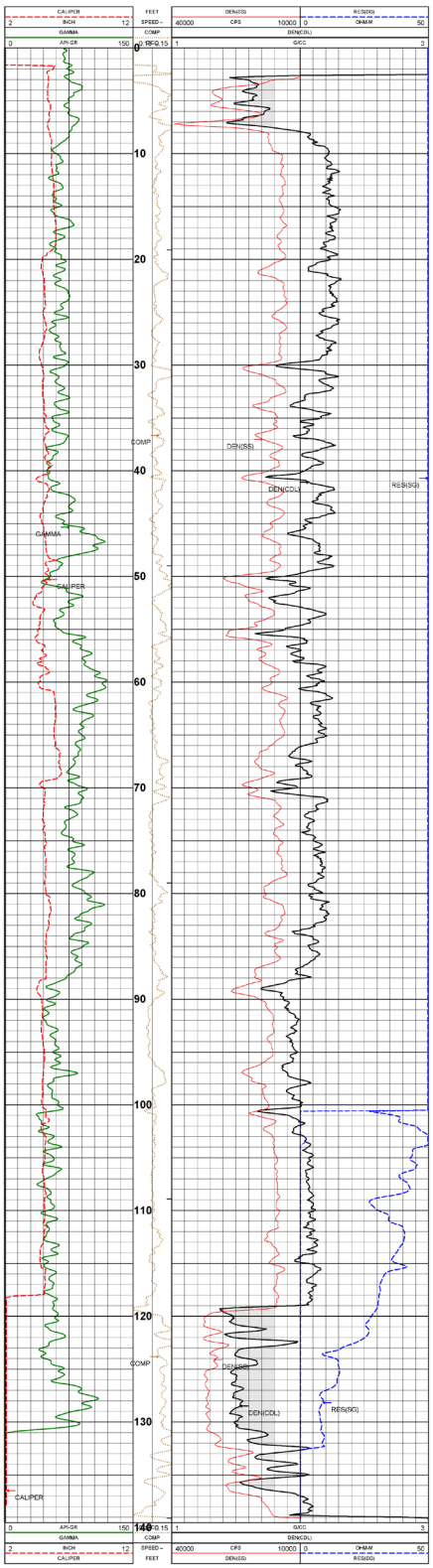
TOOL CALIBRATION NDGS24-18 09/09/24 09:57
TOOL 9239C TSI VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	160680	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-18 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-18 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-19 09/10/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 08/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-19

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-19

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 4 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-19
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

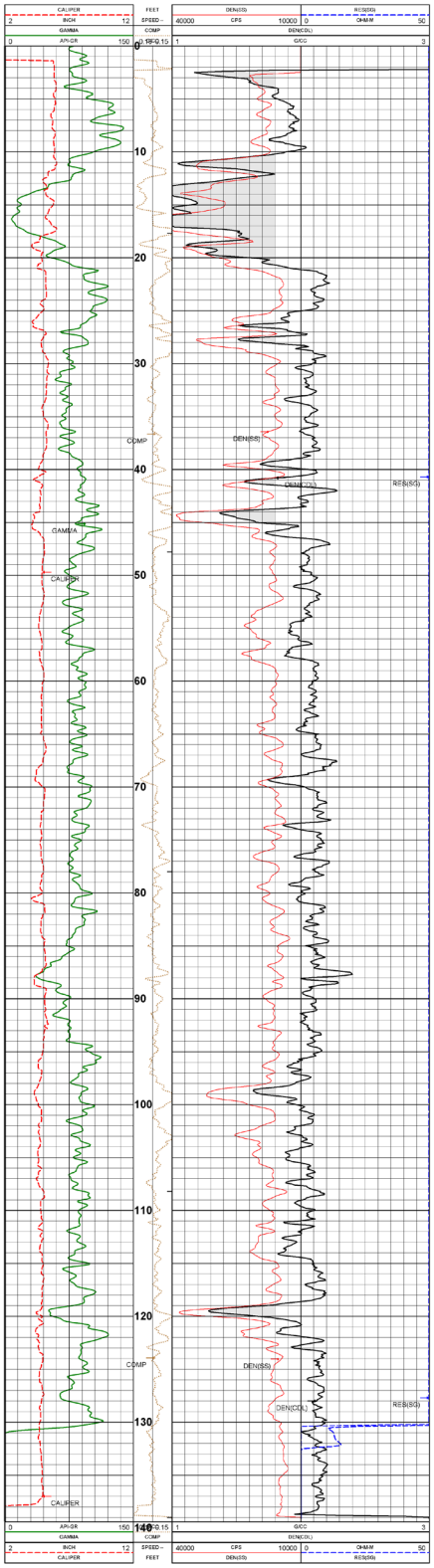
PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/10/24 14:01	
DEPTH DRILLER	140	FT
DEPTH LOGGER	140.0	FT
FIRST READING	139.3	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	130.3	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-19 09/10/24 14:01
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1236

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7306	36063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:09	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-19 09/10/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 08/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-19B

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-19B
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 4 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-19B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL	Elevations:				Other Services:	
DRL MEASURED FROM	GL	KB	N/A	FT		NONE	
LOG MEASURED FROM	GL	DF	N/A	FT			
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT			

DATE	09/10/24 14:38	
DEPTH DRILLER	120	FT
DEPTH LOGGER	120.1	FT
FIRST READING	119.4	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER		FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	95.3	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

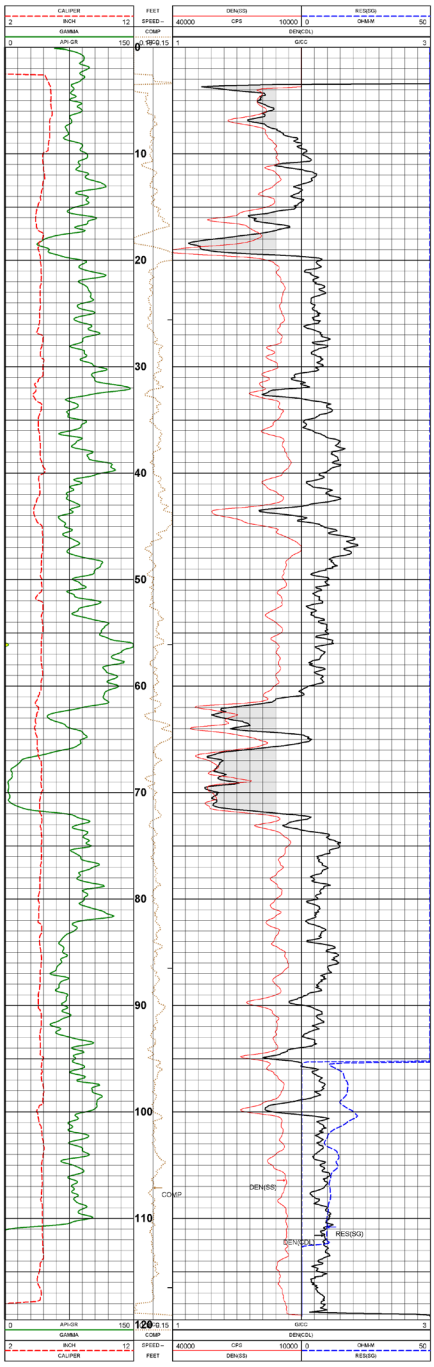
TOOL CALIBRATION NDGS24-19B 09/10/24 14:38
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[SIV]	26.730	234.800	7306	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190027	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:06	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-19B 09/10/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-19B 09/10/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-19C

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-19C
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MORTON
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-19C

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 4 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/11/24 10:09	
DEPTH DRILLER	120	FT
DEPTH LOGGER	120.0	FT
FIRST READING	119.3	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	115	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

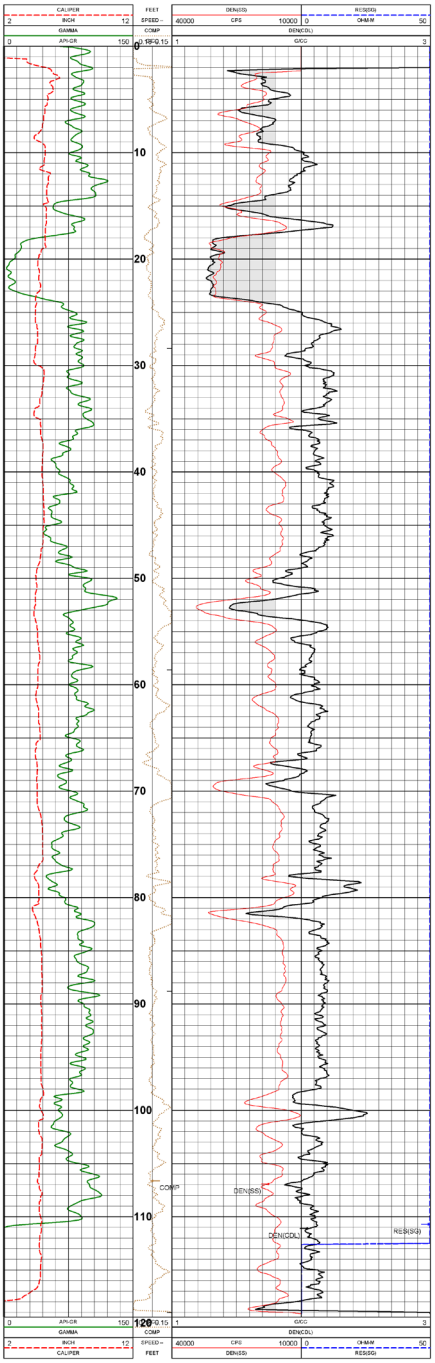
TOOL CALIBRATION NDGS24-19C 09/11/24 10:09
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[9V]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	160688	263665
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-19C 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL. : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-19C 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL. : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-20

COMPANY ND MINERAL RESOURCES
WELL NDGS24-20
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-20

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 6 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/09/24 11:31	
DEPTH DRILLER	80	FT
DEPTH LOGGER	79.9	FT
FIRST READING	79.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	78	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

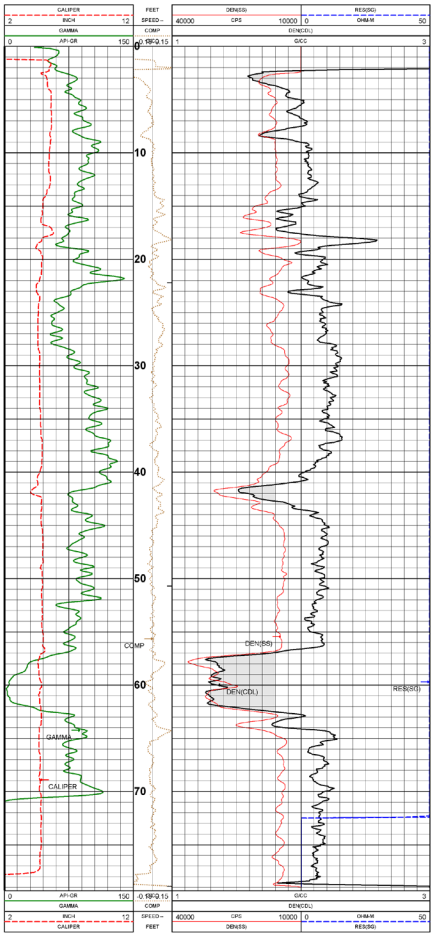
TOOL CALIBRATION NDGS24-20 09/09/24 11:31
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:58	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4928	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

NDGS24-20 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/03/2024 **DISPLAY7_JL65z**



NDGS24-20 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9238C.0 -- 09/03/2024 **DISPLAY7_JL65z**

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-20B

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-20B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 6 TOWNSHIP: 140N RANGE: 90W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

COMPANY ND MINERAL RESOURCES
WELL NDGS24-20B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

DISPLAY7_JL65z

						Other Services:
PERMANENT DATUM	GL	Elevations:				NONE
DRL MEASURED FROM	GL	KB	N/A	FT		
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/09/24 16:18	
DEPTH DRILLER	110	FT
DEPTH LOGGER	110.5	FT
FIRST READING	109.8	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	102	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

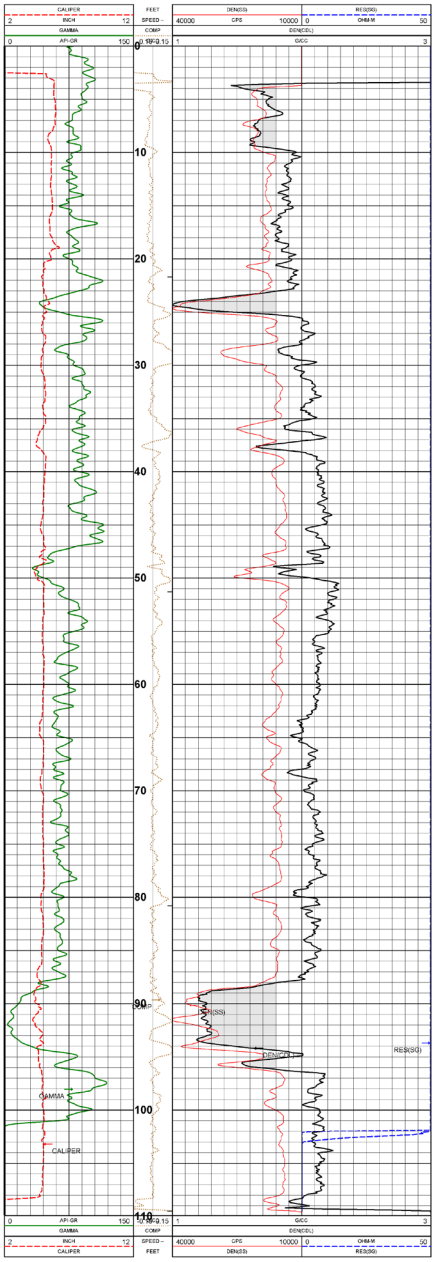
TOOL CALIBRATION NDGS24-20B 09/09/24 16:18
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[MV]	26.730	234.000	7305	35963
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150688	263565
7	Jul30,24	13:13:06	CURRENT	[UA]	26.730	234.000	6188	33510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-20B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-20B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/03/2024		DISPLAY7_JL65z

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-21

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-21

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 6 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-21
PROGRAM CRITICAL MINERAL DRILLING
COUNTY MORTON
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/09/24 12:15	
DEPTH DRILLER	80	FT
DEPTH LOGGER	80.3	FT
FIRST READING	79.6	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	78	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

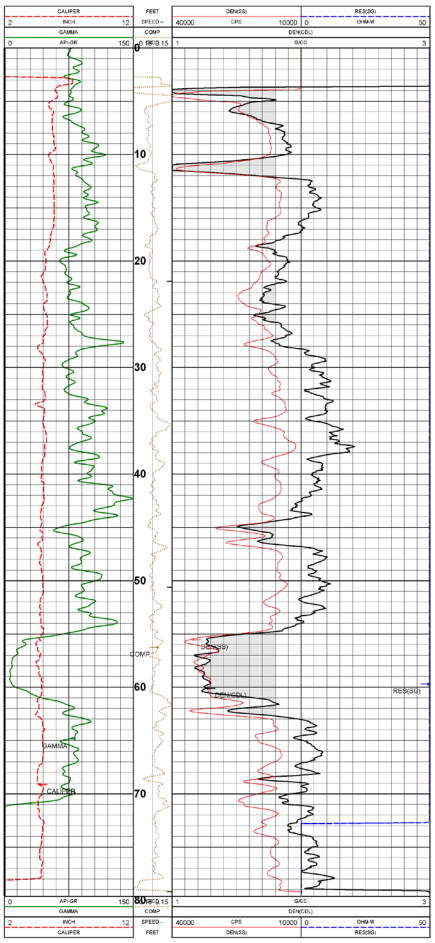
TOOL CALIBRATION NDGS24-21 09/09/24 12:15
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:56	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4928	724
5	Jul18,24	17:10:06	DEN(SS)	[G/CC]	1.775	2.630	20096	5196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263566
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-21 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-21 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-21B

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-21B
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: MORTON
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-21B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : MORTON
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : MORTON TRACTS
SECTION: 6 TOWNSHIP: 140N RANGE: 90W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/09/24 15:43
DEPTH DRILLER	80 FT
DEPTH LOGGER	80.1 FT
FIRST READING	79.4 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	78
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

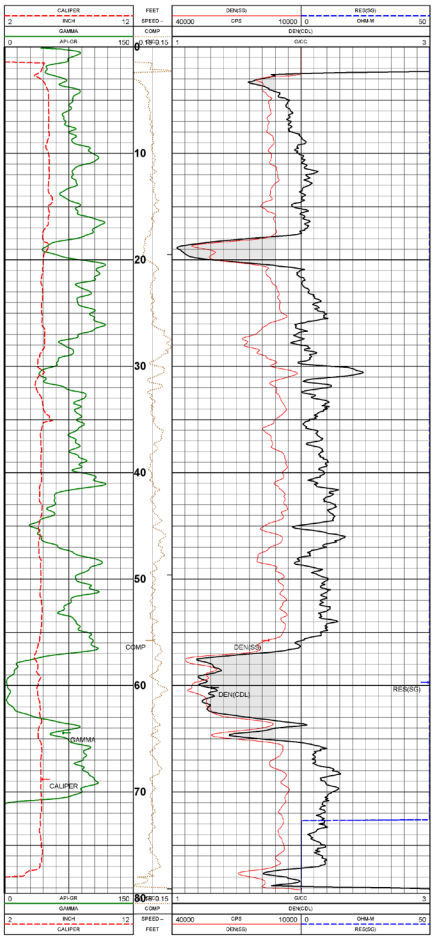
TOOL CALIBRATION NDGS24-21B 09/09/24 15:43
TOOL 9239C TIM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	283565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-21B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-21B 09/09/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/03/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-23

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-23
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: STARK
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-23

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 8 TOWNSHIP: 137N RANGE: 98W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/12/24 16:17	
DEPTH DRILLER	120	FT
DEPTH LOGGER	119.7	FT
FIRST READING	119.0	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	111.7	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

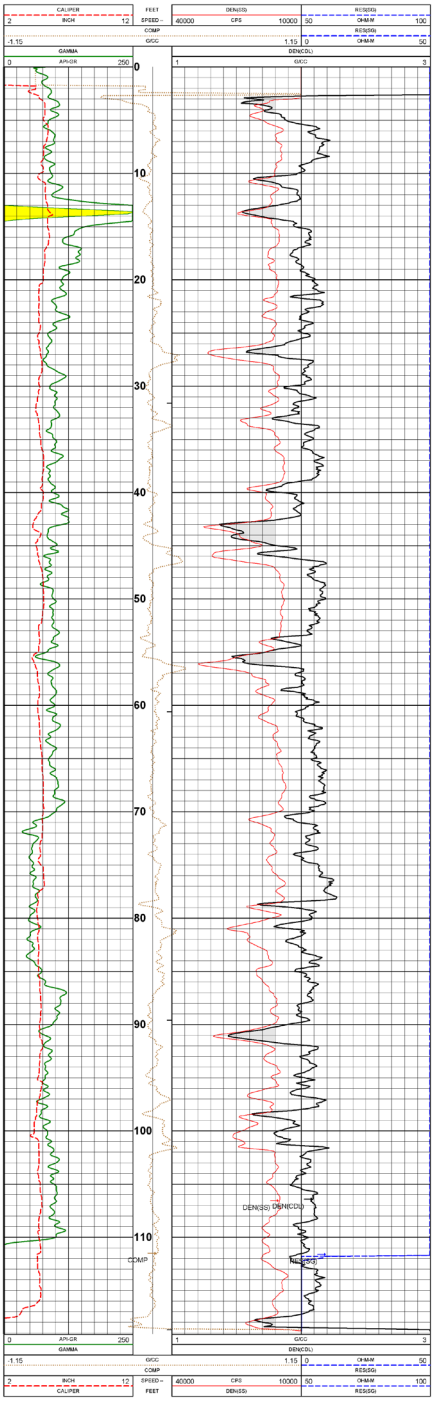
TOOL CALIBRATION NDGS24-23 09/12/24 16:17
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1230

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190627	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	9196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-23 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 54
MAGNETIC DECL : 0 ELECT. CUTOFF : 99999 BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024 DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-23 09/12/24

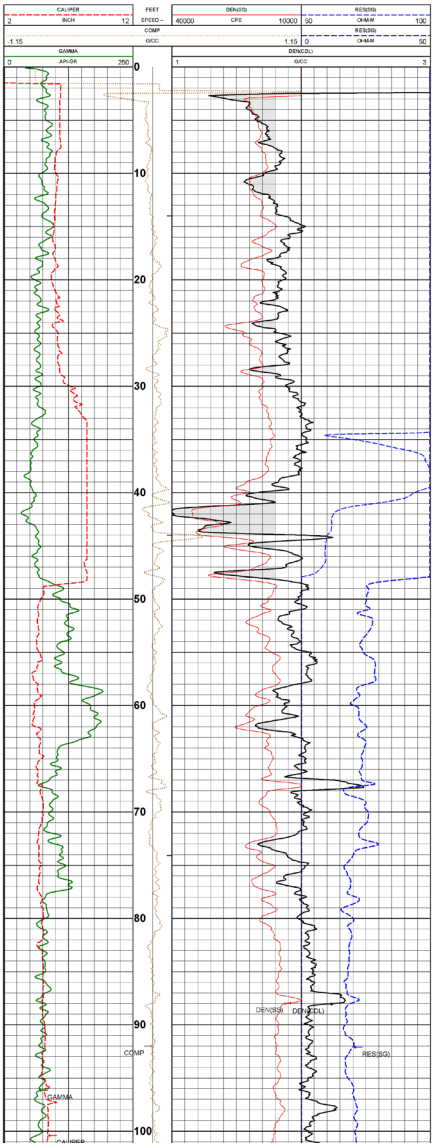
LOG PARAMETERS

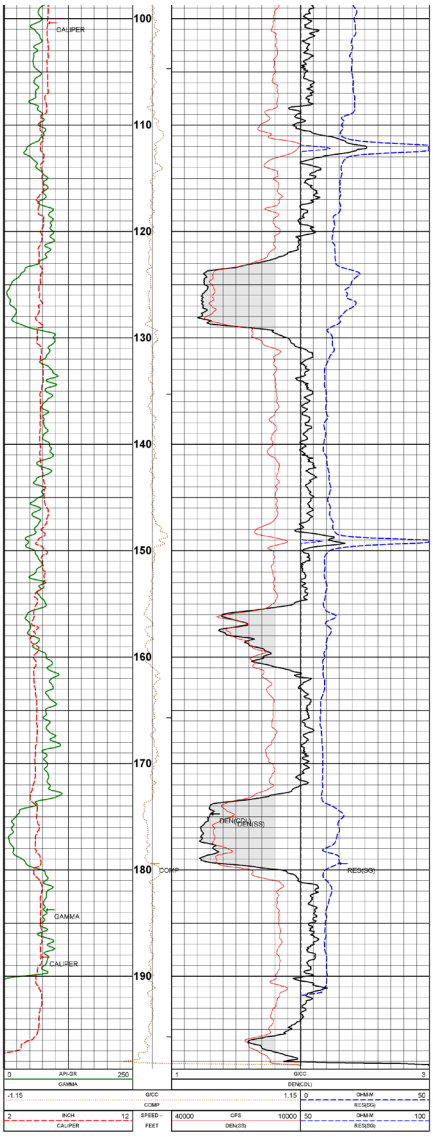
MATRIX DENSITY : 2.65 NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 54
MAGNETIC DECL : 0 ELECT. CUTOFF : 99999 BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024 DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-24 09/13/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z





STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-24

Century WIRELINE SERVICES

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-24
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: STARK
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-24
:
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 16 TOWNSHIP: 137N RANGE: 98W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/13/24 10:17	
DEPTH DRILLER	200	FT
DEPTH LOGGER	199.3	FT
FIRST READING	198.6	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	34.3	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-24 09/13/24 10:17
TOOL 9239C TII VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7306	38063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305977
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263566
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-24 09/13/24

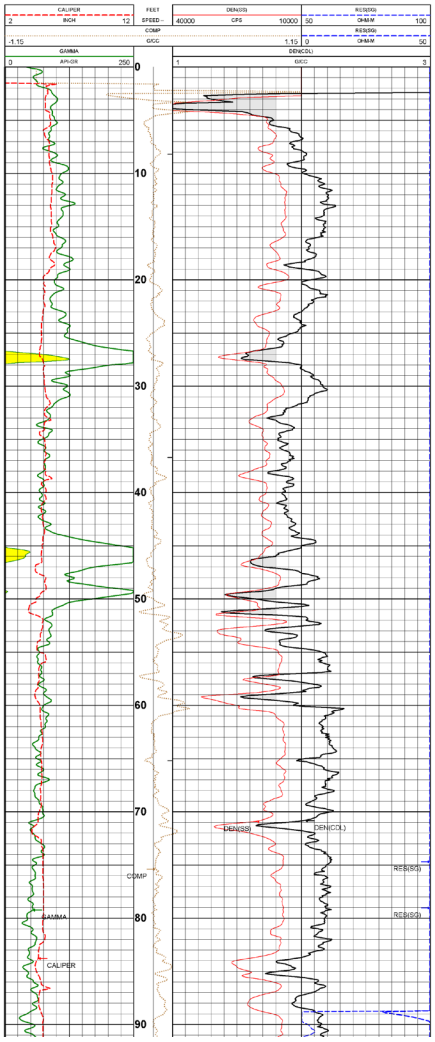
LOG PARAMETERS

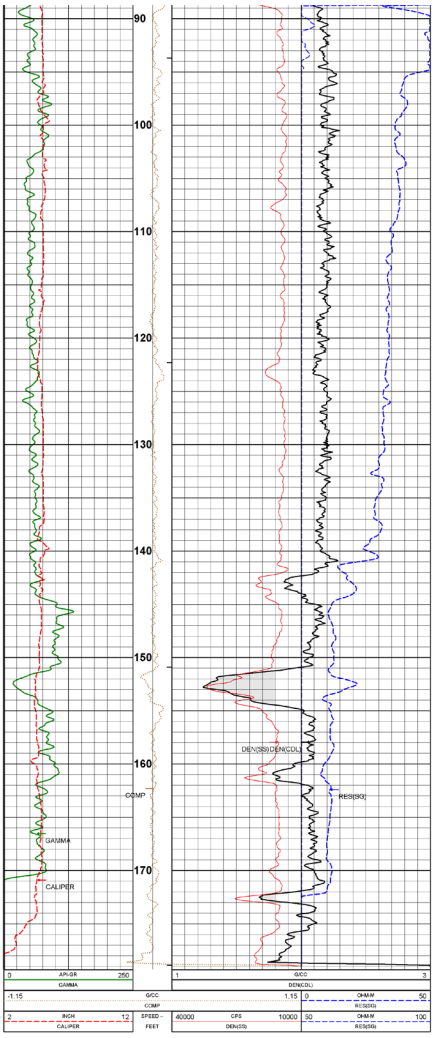
MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-25 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z





CDL DENSITY 1:60 LOG NDGS24-25 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-25

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-25

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 36 TOWNSHIP: 138N RANGE: 97W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/11/24 15:51	
DEPTH DRILLER	180	FT
DEPTH LOGGER	179.9	FT
FIRST READING	179.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	88.7	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-25 09/11/24 15:51
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1235

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35065
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4826	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	283565
7	Jul30,24	13:13:06	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-25B

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-25B
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: STARK
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-25B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 36 TOWNSHIP: 138N RANGE: 97W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/11/24 16:25	
DEPTH DRILLER	160	FT
DEPTH LOGGER	158.9	FT
FIRST READING	158.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	111.5	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

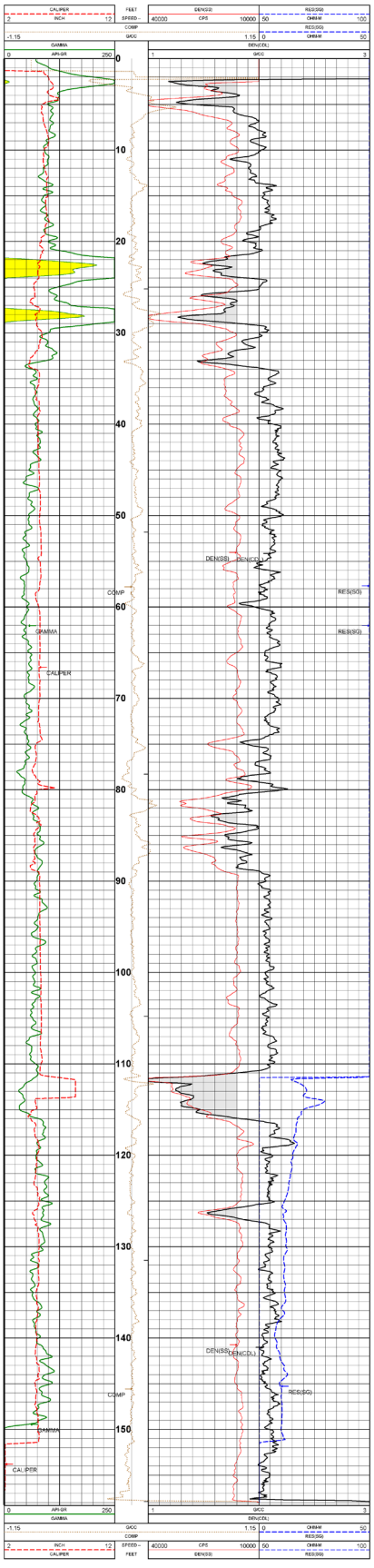
TOOL CALIBRATION NDGS24-25B 09/11/24 16:25
TOOL 9239C TIM VERSION 5026
SERIAL NUMBER 1230

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:55	VOLTAGE	[MV]	26.730	234.800	7305	35963
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	160688	263566
7	Jul30,24	13:13:09	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-25B 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-25B 09/11/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-26 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-26

COMPANY ND MINERAL RESOURCES
WELL NDGS24-26
PROGRAM CRITICAL MINERAL DRILLING
COUNTY STARK
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-26

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 36 TOWNSHIP: 137N RANGE: 97W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

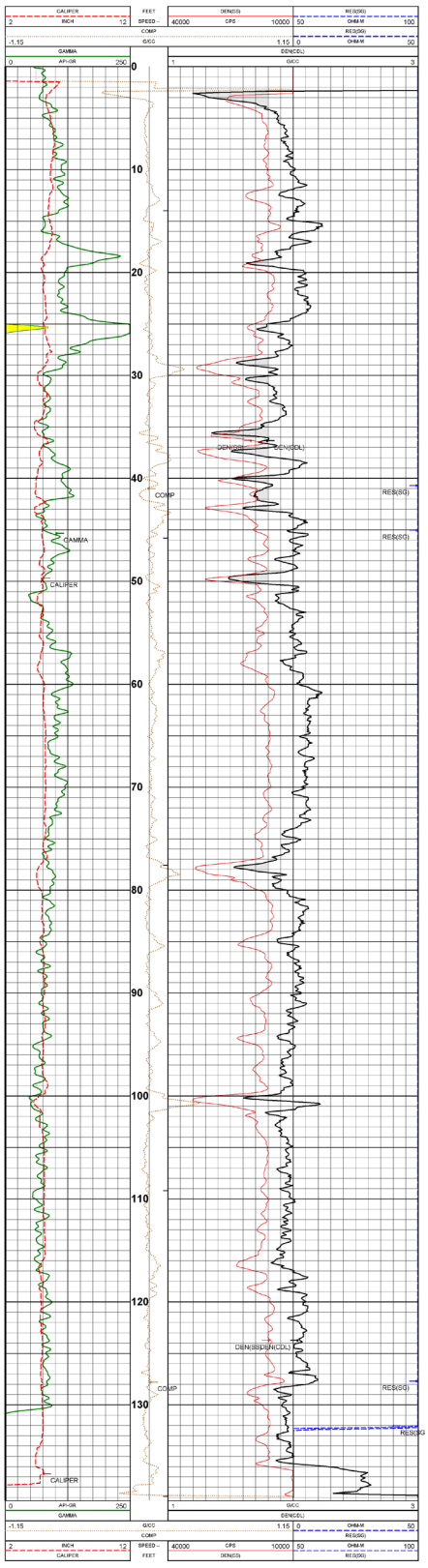
PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/12/24 10:12	
DEPTH DRILLER	140	FT
DEPTH LOGGER	139.9	FT
FIRST READING	139.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	131	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-26 09/12/24 10:12
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	339.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190027	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150858	263565
7	Jul30,24	13:13:00	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-26 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/11/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-26B

COMPANY ND MINERAL RESOURCES
WELL NDGS24-26B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY STARK
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-26B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 36 TOWNSHIP: 137N RANGE: 97W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/12/24 12:54
DEPTH DRILLER	100 FT
DEPTH LOGGER	99.9 FT
FIRST READING	99.2 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	94
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

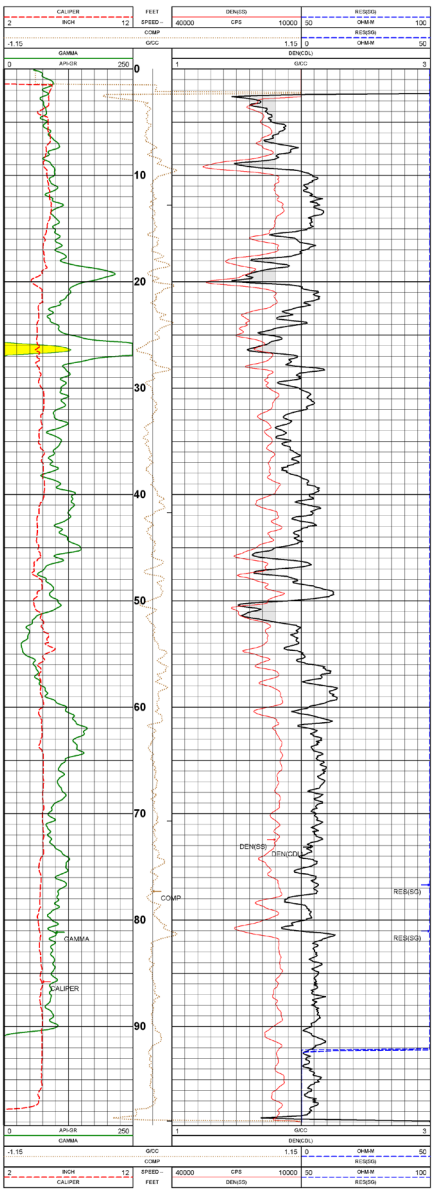
TOOL CALIBRATION NDGS24-26B 09/12/24 12:54
TOOL 9239C TN VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:58	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:59	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:08	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-26B 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/12/2024 **DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-26B 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/12/2024 **DISPLAY7_JL65z**

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-28

COMPANY ND MINERAL RESOURCES
WELL NDGS24-28
PROGRAM CRITICAL MINERAL DRILLING
COUNTY HETTINGER
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-28

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : HETTINGER
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : HETTINGER TRACTS
SECTION: 16 TOWNSHIP: 136N RANGE: 96W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/13/24 13:28	
DEPTH DRILLER	100	FT
DEPTH LOGGER	100.1	FT
FIRST READING	99.4	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	95	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

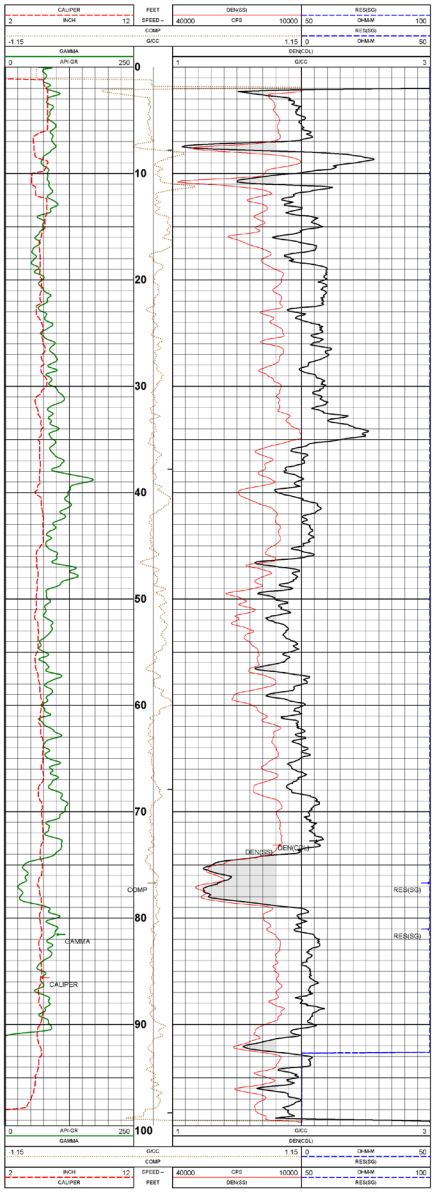
TOOL CALIBRATION NDGS24-28 09/13/24 13:28
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	12:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul16,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.776	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-28 09/13/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-28 09/13/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-29

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-29
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: STARK
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: PRIVATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-29

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : STARK
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : STARK TRACTS
SECTION: 30 TOWNSHIP: 139N RANGE: 97W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/12/24 14:14
DEPTH DRILLER	80 FT
DEPTH LOGGER	80.3 FT
FIRST READING	79.6 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING – DRILLER	NONE FT
CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	70.5
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

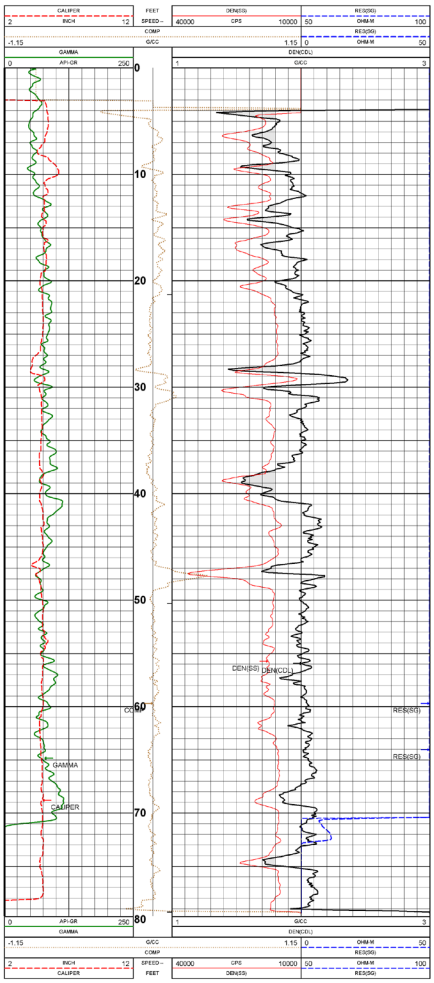
TOOL CALIBRATION NDGS24-29 09/12/24 14:14
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[9V]	26.730	234.990	7305	35963
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.630	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.990	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-29 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/12/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-29 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/12/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-29B

COMPANY ND MINERAL RESOURCES
WELL NDGS24-29B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY STARK
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

COMPANY	ND MINERAL RESOURCES
WELL	NDGS24-29B
PROGRAM	CRITICAL MINERAL DRILLING
COUNTY	STARK
STATE	NORTH DAKOTA
COUNTRY	USA
OWNER	PRIVATE
AREA	STARK TRACTS
	SECTION: 30 TOWNSHIP: 139N RANGE: 97W
1/4 Section	NW
Latitude	N/A
Longitude	N/A
	DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/12/24 14:45	
DEPTH DRILLER	60	FT
DEPTH LOGGER	60.1	FT
FIRST READING	59.4	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	52.5	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

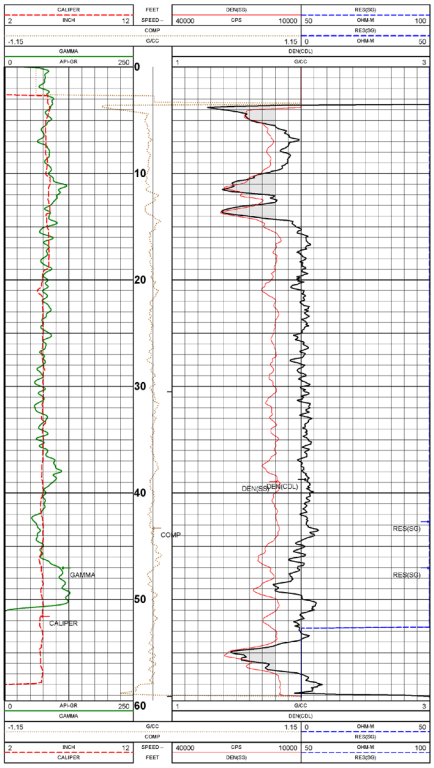
TOOL CALIBRATION NDGS24-29B 09/12/24 14:45
TOOL 9239C TM VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:58	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	734
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20098	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263505
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

NDGS24-29B 09/12/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z



NDGS24-29B 09/12/24

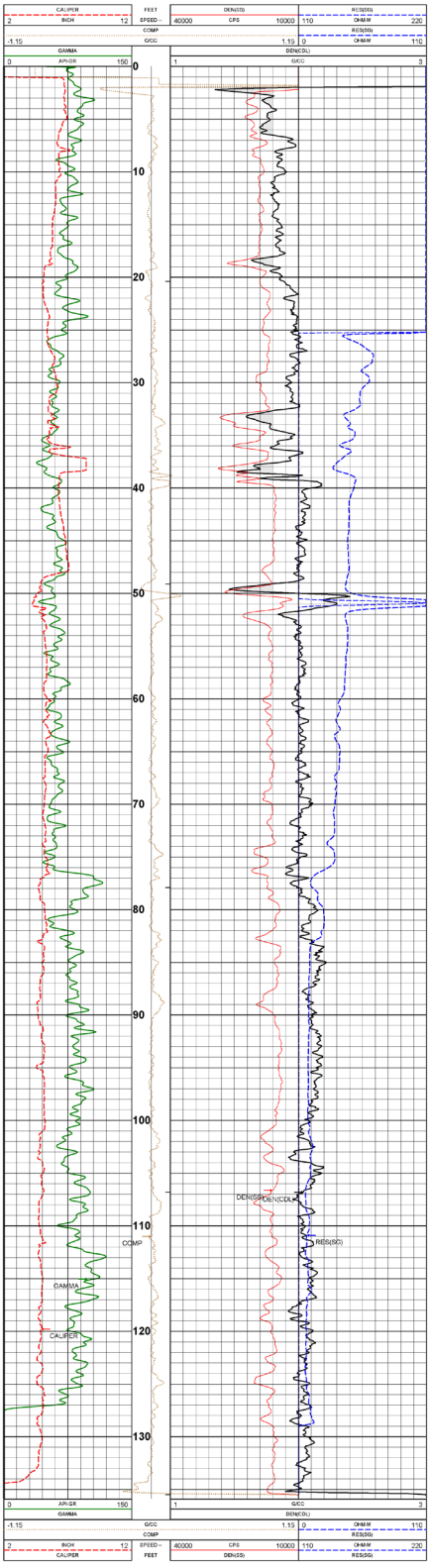
LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/12/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-30 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL. : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-30 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL. : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-30

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-30

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS

SECTION: 36 TOWNSHIP: 132N RANGE: 99W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:	
DRL MEASURED FROM	GL		KB	N/A	FT	NONE	
LOG MEASURED FROM	GL		DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT		GL	N/A	FT		

DATE	09/16/24 14:31	
DEPTH DRILLER	140	FT
DEPTH LOGGER	136.5	FT
FIRST READING	135.8	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	25.2	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-30 09/16/24 14:31
TOOL 9239C TM VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7306	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	8.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5180	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-30B 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-30B

COMPANY ND MINERAL RESOURCES
WELL NDGS24-30B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY ADAMS
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-30B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 36 TOWNSHIP: 132N RANGE: 96W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

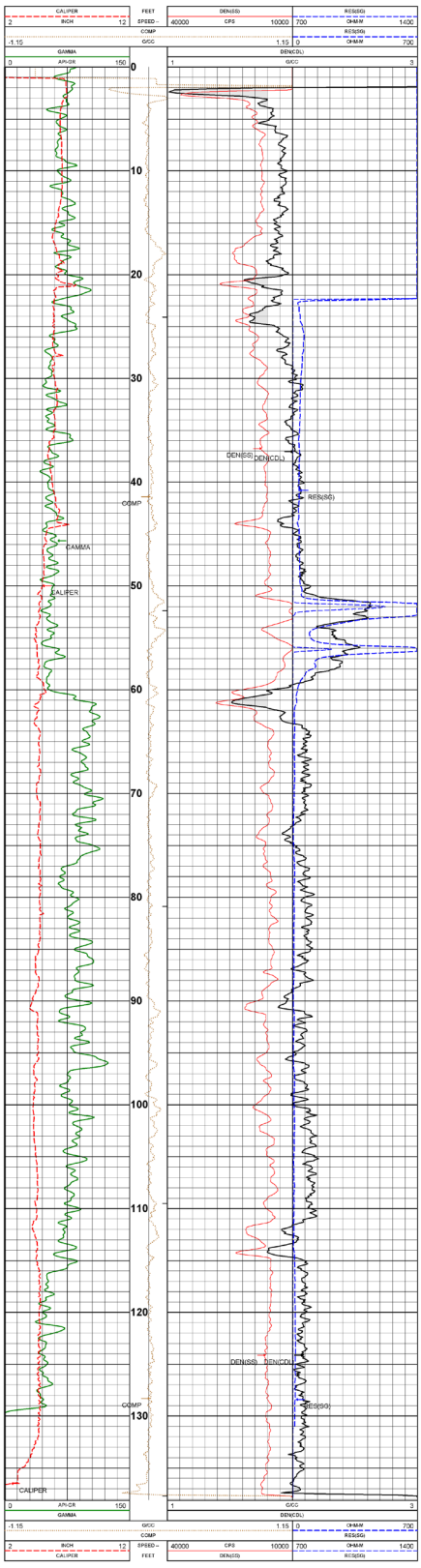
PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/16/24 13:54	
DEPTH DRILLER	140	FT
DEPTH LOGGER	138.7	FT
FIRST READING	138.0	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	22.5	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-30B 09/16/24 13:54
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1239

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190927	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150888	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-30B 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-32

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-32
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: ADAMS
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-32

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 36 TOWNSHIP: 131N RANGE: 96W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/16/24 16:33	
DEPTH DRILLER	120	FT
DEPTH LOGGER	120.2	FT
FIRST READING	119.5	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	40	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

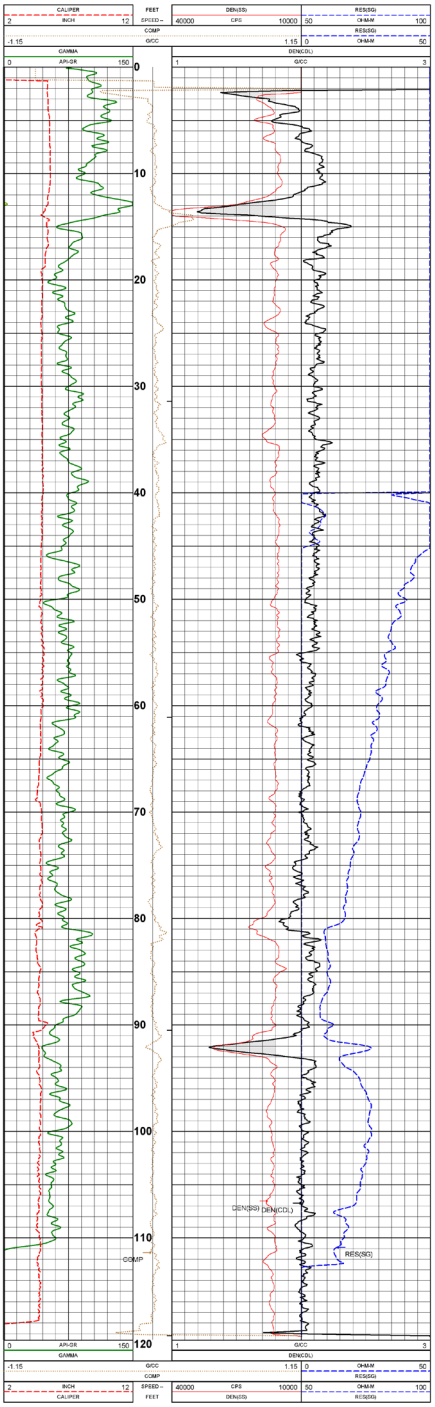
TOOL CALIBRATION NDGS24-32 09/16/24 16:33
TOOL 9239C TRI VERSION 9029
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	16:37:21	CALIPER	[INCH]	4.000	6.000	190027	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8198
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-32 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-32 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-33

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-33
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: ADAMS
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-33

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 36 TOWNSHIP: 131N RANGE: 96W
1/4 Section : SW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

						Other Services:
PERMANENT DATUM	GL	Elevations:				NONE
DRL MEASURED FROM	GL	KB	N/A	FT		
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/16/24 17:06	
DEPTH DRILLER	100	FT
DEPTH LOGGER	100.4	FT
FIRST READING	99.7	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	38	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

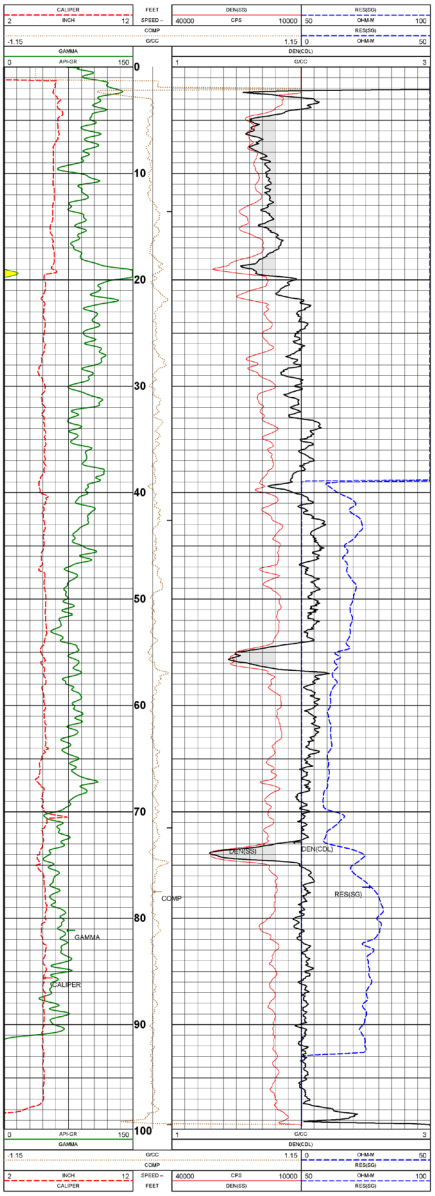
TOOL CALIBRATION NDGS24-33 09/16/24 17:06
TOOL 9239C TN VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:59	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190027	305877
4	Jul18,24	17:17:03	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150680	283565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-33 09/16/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL. : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/16/2024 **DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-33 09/16/24

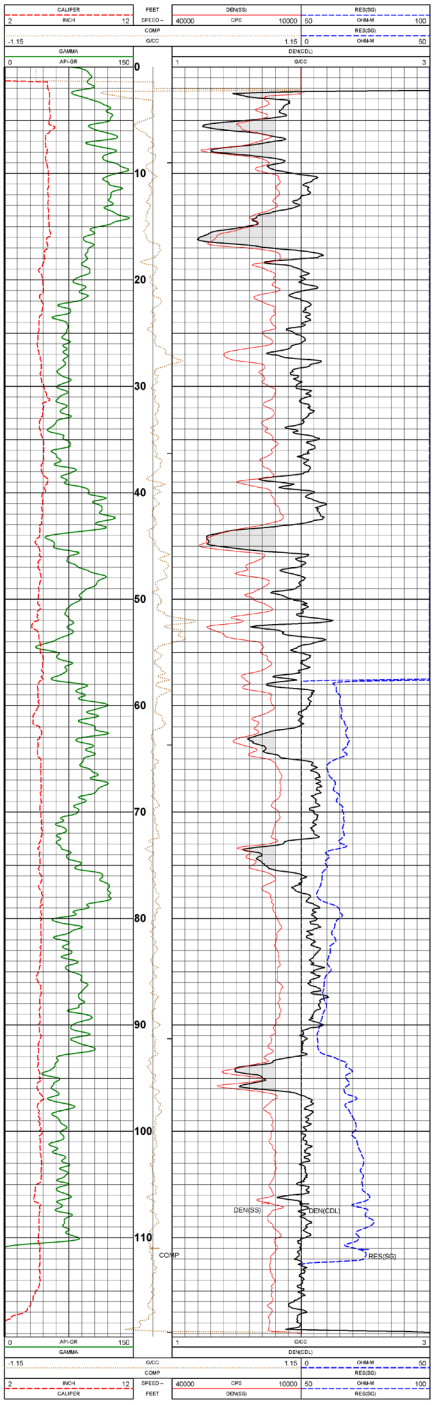
LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL. : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 -- 09/16/2024 **DISPLAY7_JL65z**

CDL DENSITY 1:60 LOG NDGS24-36 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z



STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-36

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-36

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 16 TOWNSHIP: 130N RANGE: 96W
1/4 Section : SE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/17/24 11:23	
DEPTH DRILLER	120	FT
DEPTH LOGGER	119.7	FT
FIRST READING	119.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	58	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-36 09/17/24 11:23
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	160688	263656
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-36 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-38

COMPANY ND MINERAL RESOURCES
WELL NDGS24-38
PROGRAM CRITICAL MINERAL DRILLING
COUNTY ADAMS
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-38

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 36 TOWNSHIP: 131N RANGE: 93W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL		KB	N/A	FT	NONE
LOG MEASURED FROM	GL		DF	N/A	FT	
ELEV. PERM. DATUM	N/A FT		GL	N/A	FT	

DATE	09/17/24 13:31	
DEPTH DRILLER	140	FT
DEPTH LOGGER	140.8	FT
FIRST READING	140.1	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	49.7	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

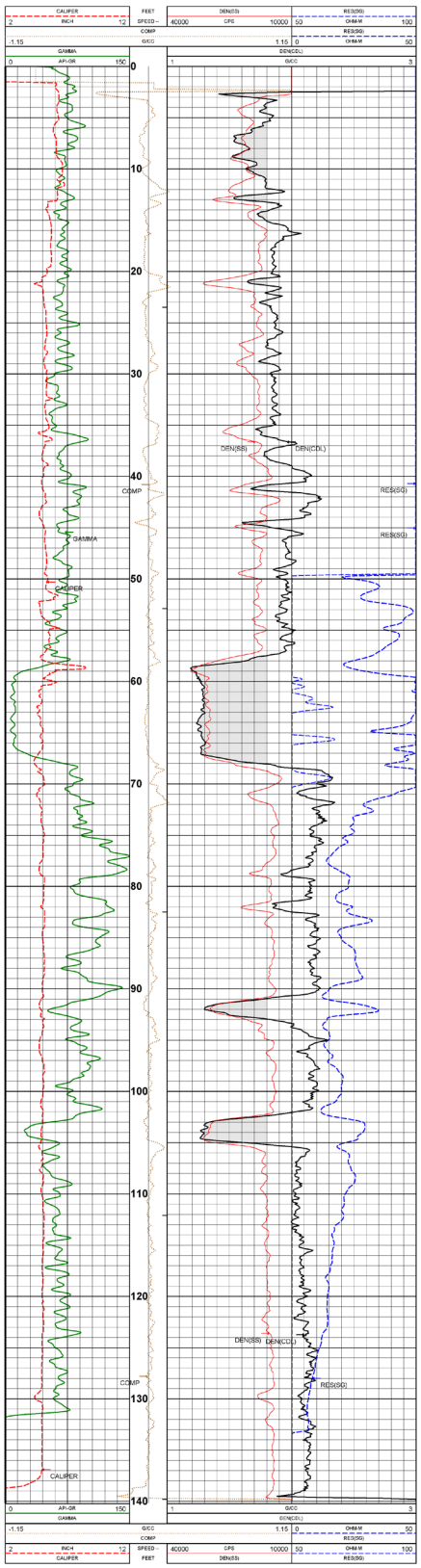
TOOL CALIBRATION NDGS24-38 09/17/24 13:31
TOOL 9239C TIM VERSION 6026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:10:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	363565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-38 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 – 09/16/2024 **DISPLAY7_JL65z**



CDL DENSITY 1:60 LOG NDGS24-38 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65 **NEUTRON MATRIX : SANDSTONE** **MATRIX DELTA T : 54**
MAGNETIC DECL : 0 **ELECT. CUTOFF : 99999** **BIT SIZE : 5.0 IN**
PRESENTATION : 9239C.0 – 09/16/2024 **DISPLAY7_JL65z**

CDL DENSITY 1:60 LOG NDGS24-38B 09/18/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-38B

COMPANY ND MINERAL RESOURCES
WELL NDGS24-38B
PROGRAM CRITICAL MINERAL DRILLING
COUNTY ADAMS
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-38B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : ADAMS TRACTS
SECTION: 36 TOWNSHIP: 131N RANGE: 93W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

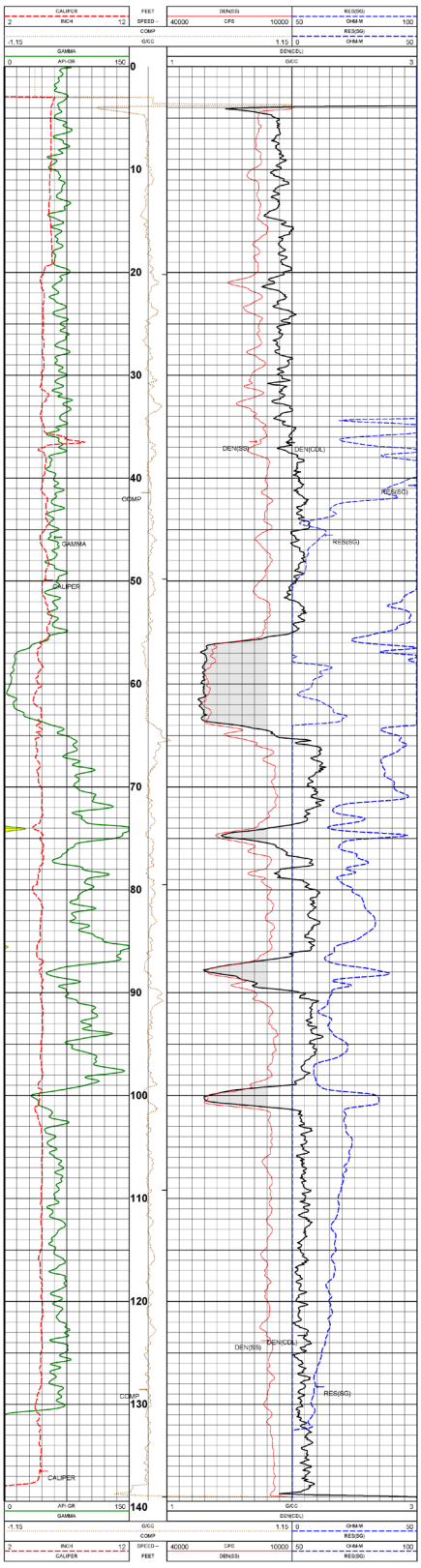
		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/18/24 12:20
DEPTH DRILLER	140 FT
DEPTH LOGGER	140.0 FT
FIRST READING	139.3 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	34
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-38B 09/18/24 12:20
TOOL 9239C TRI VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[MV]	26.730	234.900	7305	35063
3	Jul18,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150680	283565
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.900	5188	23610
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-38B 09/18/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-39 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-39

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-39
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : ADAMS TRACTS
SECTION: 22 TOWNSHIP: 131N RANGE: 92W
1/4 Section : NE
Latitude : N/A
Longitude : N/A
DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-39
PROGRAM CRITICAL MINERAL DRILLING
COUNTY ADAMS
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

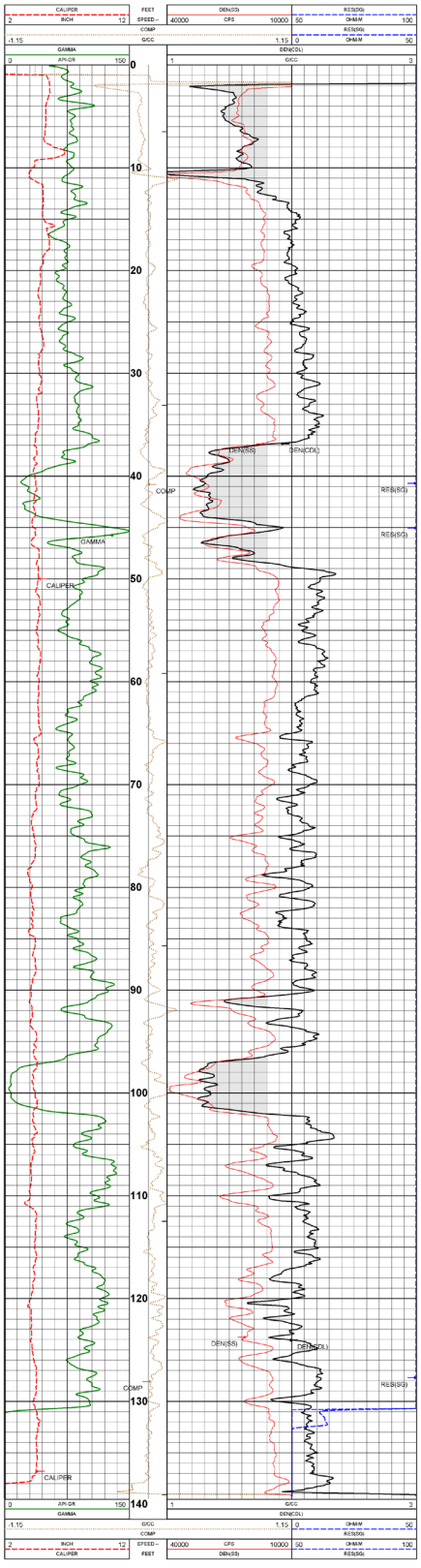
PERMANENT DATUM	GL	Elevations:				Other Services:	
DRL MEASURED FROM	GL	KB	N/A	FT		NONE	
LOG MEASURED FROM	GL	DF	N/A	FT			
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT			

DATE	09/17/24 14:39	
DEPTH DRILLER	140	FT
DEPTH LOGGER	140.1	FT
FIRST READING	139.4	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING -- DRILLER	NONE	FT
CASING -- LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	130.7	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-39 09/17/24 14:39
TOOL 9239C TH VERSION 8026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	330.000	0.000	359
2	Jul30,24	13:11:50	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul19,24	10:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul19,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263565
7	Jul30,24	13:13:06	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-39 09/17/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-40

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-40

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : ADAMS
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : PRIVATE
AREA : ADAMS TRACTS
SECTION: 18 TOWNSHIP: 131N RANGE: 91W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-40
PROGRAM CRITICAL MINERAL DRILLING
COUNTY ADAMS
STATE NORTH DAKOTA
COUNTRY USA
OWNER PRIVATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

DATE	09/18/24 11:27	
DEPTH DRILLER	140	FT
DEPTH LOGGER	139.4	FT
FIRST READING	138.7	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	85.2	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

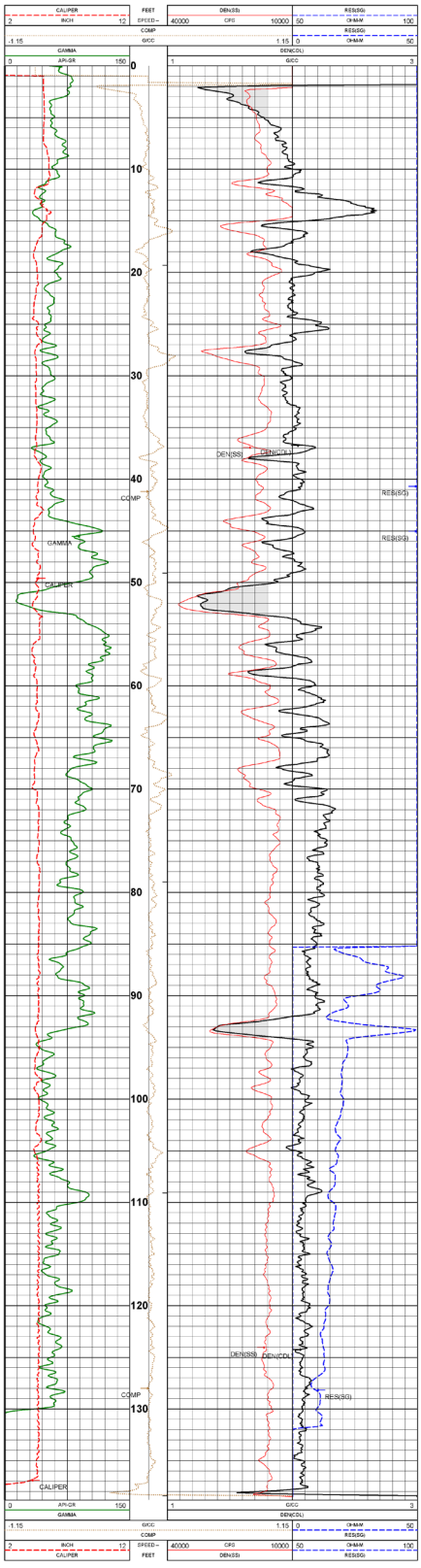
TOOL CALIBRATION NDGS24-40 09/18/24 11:27
TOOL 9239C TIN VERSION 9026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	330.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	306877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul19,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	1926888	263665
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-40 09/18/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z



CDL DENSITY 1:60 LOG NDGS24-40 09/18/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-42

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-42

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 16 TOWNSHIP: 145N RANGE: 97W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY ND MINERAL RESOURCES
WELL NDGS24-42
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

PERMANENT DATUM	GL	Elevations:				Other Services:
DRL MEASURED FROM	GL	KB	N/A	FT		NONE
LOG MEASURED FROM	GL	DF	N/A	FT		
ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

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DEPTH LOGGER	159.9	FT
FIRST READING	159.2	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JOHN	
FLUID LEVEL	148	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

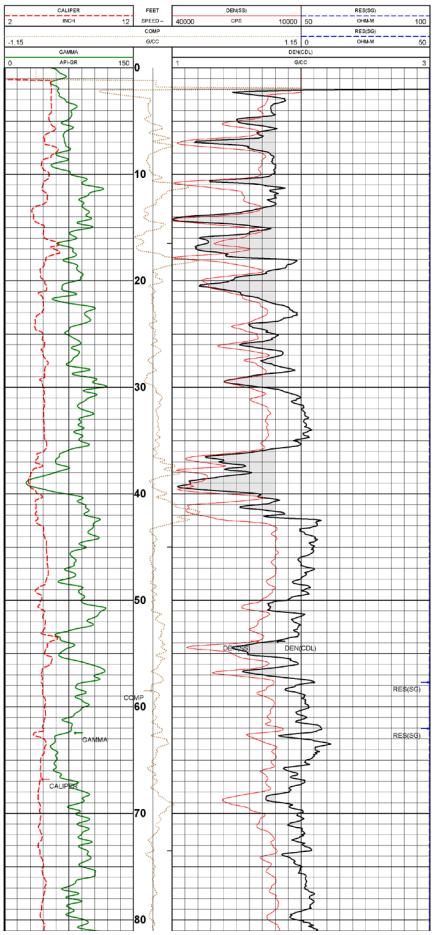
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TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

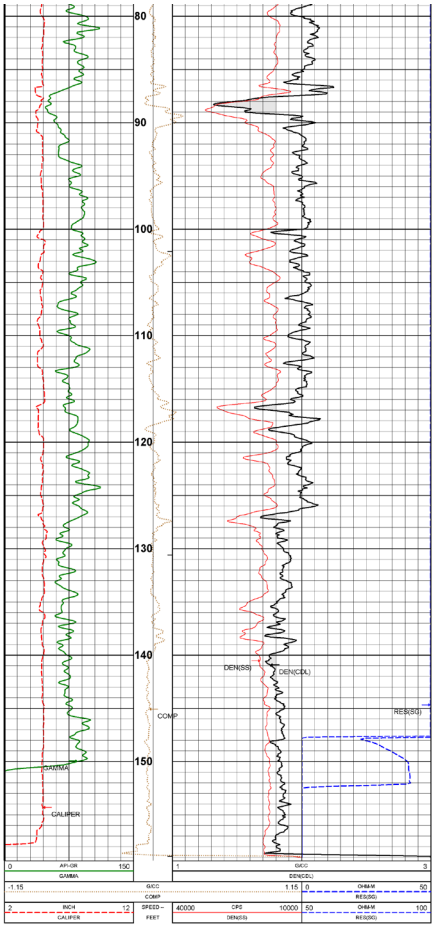
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3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190027	305077
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263566
7	Jul30,24	13:13:08	CURRENT	[UA]	28.730	234.800	6188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-42 09/19/24

LOG PARAMETERS

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MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/16/2024		DISPLAY7_JL65z





CDL DENSITY 1:60 LOG NDGS24-42 09/19/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-42B

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-42B

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 16 TOWNSHIP: 145N RANGE: 97W
1/4 Section : NE
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-42B
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: DUNN
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

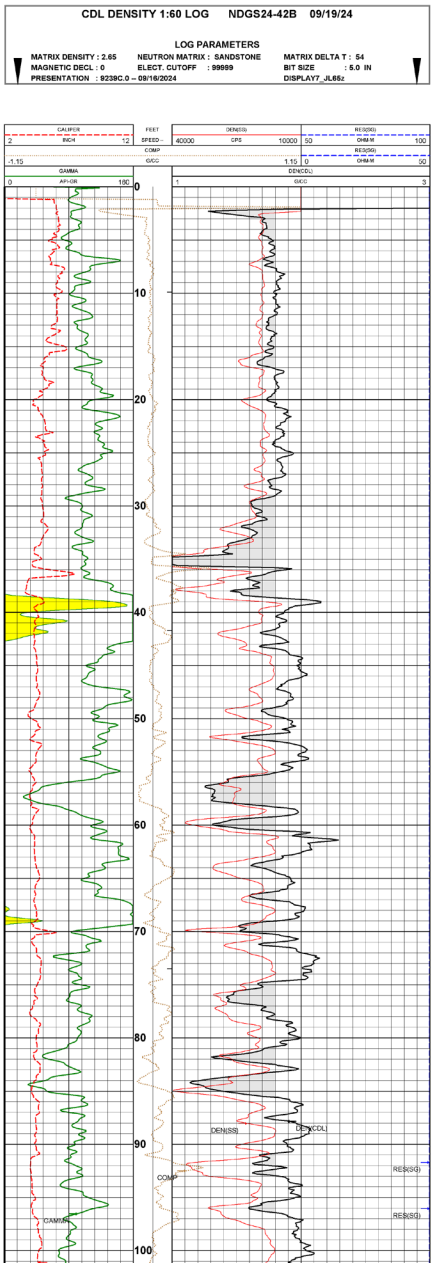
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ELEV. PERM. DATUM	N/A FT	GL	N/A	FT		

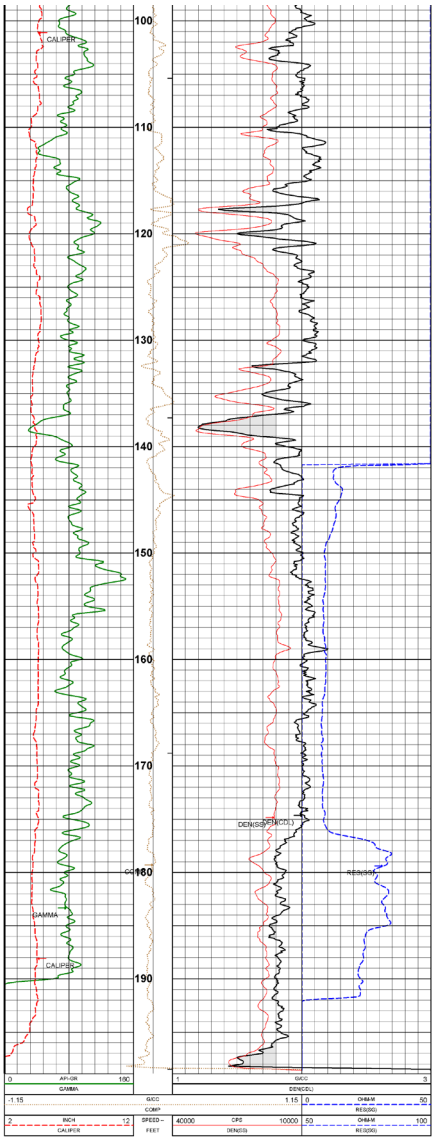
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FIRST READING	198.8	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	142	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

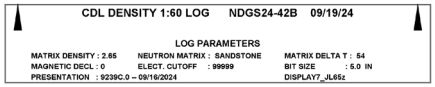
ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-42B 09/19/24 11:40
TOOL 9239C TH VERSION 5026
SERIAL NUMBER 1238

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2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7306	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	150688	263695
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	6188	23510
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	







Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-43

COMPANY NO MINERAL RESOURCES
WELL NDGS24-43
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY	NO MINERAL RESOURCES
WELL	NDGS24-43
PROGRAM	CRITICAL MINERAL DRILLING
COUNTY	DUNN
STATE	NORTH DAKOTA
COUNTRY	USA
OWNER	STATE
AREA	MERCER/DUNN TRACTS
	SECTION: 36 TOWNSHIP: 146N RANGE: 97W
1/4 Section	SW
Latitude	N/A
Longitude	N/A

DISPLAY7_JL65z

						Other Services:
PERMANENT DATUM	GL	Elevations:	KB	N/A	FT	NONE
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LOG MEASURED FROM	GL		GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT					

DATE	09/20/24 12:11
DEPTH DRILLER	160 FT
DEPTH LOGGER	159.1 FT
FIRST READING	158.4 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
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CASING – LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JOHN
FLUID LEVEL	136.2
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

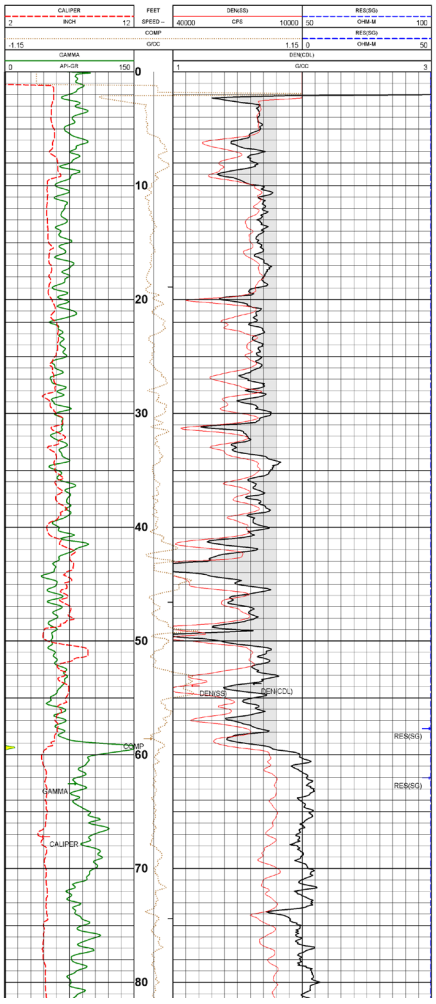
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TOOL 9239C TIM VERSION 5026
SERIAL NUMBER 1238

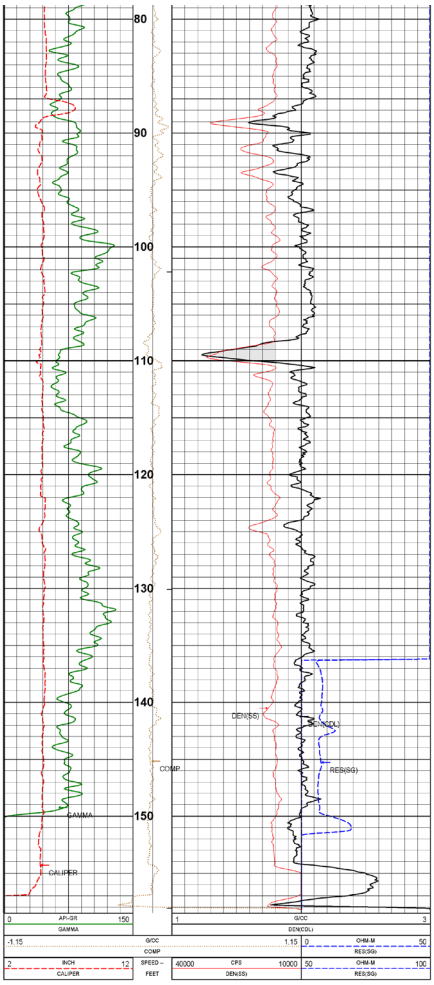
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2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190627	306977
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.728	2.673	4926	724
5	Jul18,24	17:19:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150688	263565
7	Jul30,24	13:13:09	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-43 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/16/2024		DISPLAY7_JL65z





CDL DENSITY 1:60 LOG NDGS24-43 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 – 09/16/2024		DISPLAY7_JL65z

CDL DENSITY 1:60 LOG NDGS24-44 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-44

COMPANY: ND MINERAL RESOURCES
WELL: NDGS24-44
PROGRAM: CRITICAL MINERAL DRILLING
COUNTY: DUNN
STATE: NORTH DAKOTA
COUNTRY: USA
OWNER: STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-44
PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 147N RANGE: 96W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

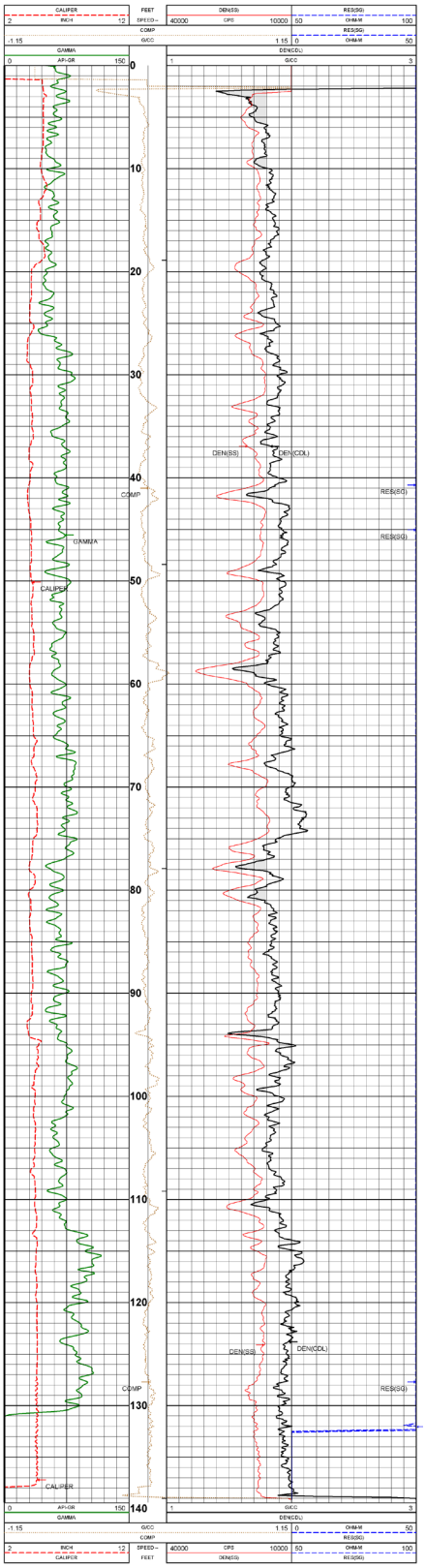
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LOG MEASURED FROM	GL		DF	N/A	FT		
ELEV. PERM. DATUM	N/A	FT	GL	N/A	FT		

DATE	09/20/24 11:04	
DEPTH DRILLER	140	FT
DEPTH LOGGER	140.0	FT
FIRST READING	139.3	FT
LAST READING	0	FT
BIT SIZE	5.0	IN
CASING – DRILLER	NONE	FT
CASING – LOGGER	N/A	FT
CASING O.D.	N/A	IN
CASING TYPE	N/A	
FLUID TYPE	WATER	
FLUID DENSITY	8.4	LB/GAL
FLUID VISCOSITY	N/A	
FLUID PH	N/A	
MUD SOURCE	N/A	
RM @ MEAS TEMP	N/A @ N/A F	
RMF @ MEAS TEMP	N/A @ N/A F	
RMC @ MEAS TEMP	N/A @ N/A F	
CIRC STOPPED	N/A	
RIG NUMBER	JASON	
FLUID LEVEL	129.5	
RECORDED BY	G.A.CREWS	
WITNESSED BY	E.C.MURPHY	
REMARKS 1		
REMARKS 2		
REMARKS 3		

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

TOOL CALIBRATION NDGS24-44 09/20/24 11:04
TOOL 9239C TM VERSION 5026
SERIAL NUMBER 1238

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
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2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35963
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:18:06	DEN(SS)	[G/CC]	1.775	2.638	20096	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	6.000	9.000	150688	263565
7	Jul30,24	13:12:08	CURRENT	[UA]	26.730	234.800	5188	23510
8	Mar31,11	15:12:10	F	[CPS]	Default		Default	



CDL DENSITY 1:60 LOG NDGS24-44 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

Century WIRELINE SERVICES

STATE OF NORTH DAKOTA
GEOLOGICAL SURVEY
NDGS24-44C

COMPANY ND MINERAL RESOURCES
WELL NDGS24-44C
PROGRAM CRITICAL MINERAL DRILLING
COUNTY DUNN
STATE NORTH DAKOTA
COUNTRY USA
OWNER STATE

COMPANY : ND MINERAL RESOURCES
WELL : NDGS24-44C

PROGRAM : CRITICAL MINERAL DRILLING
COUNTY : DUNN
STATE : NORTH DAKOTA
COUNTRY : USA
OWNER : STATE
AREA : MERCER/DUNN TRACTS
SECTION: 36 TOWNSHIP: 147N RANGE: 96W
1/4 Section : NW
Latitude : N/A
Longitude : N/A

DISPLAY7_JL65z

		Elevations:			Other Services:
PERMANENT DATUM	GL	KB	N/A	FT	NONE
DRL MEASURED FROM	GL	DF	N/A	FT	
LOG MEASURED FROM	GL	GL	N/A	FT	
ELEV. PERM. DATUM	N/A FT				

DATE	09/20/24 14:29
DEPTH DRILLER	200 FT
DEPTH LOGGER	197.9 FT
FIRST READING	197.2 FT
LAST READING	0 FT
BIT SIZE	5.0 IN
CASING -- DRILLER	NONE FT
CASING -- LOGGER	N/A FT
CASING O.D.	N/A IN
CASING TYPE	N/A
FLUID TYPE	WATER
FLUID DENSITY	8.4 LB/GAL
FLUID VISCOSITY	N/A
FLUID PH	N/A
MUD SOURCE	N/A
RM @ MEAS TEMP	N/A @ N/A F
RMF @ MEAS TEMP	N/A @ N/A F
RMC @ MEAS TEMP	N/A @ N/A F
CIRC STOPPED	N/A
RIG NUMBER	JASON
FLUID LEVEL	50
RECORDED BY	G.A.CREWS
WITNESSED BY	E.C.MURPHY
REMARKS 1	
REMARKS 2	
REMARKS 3	

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

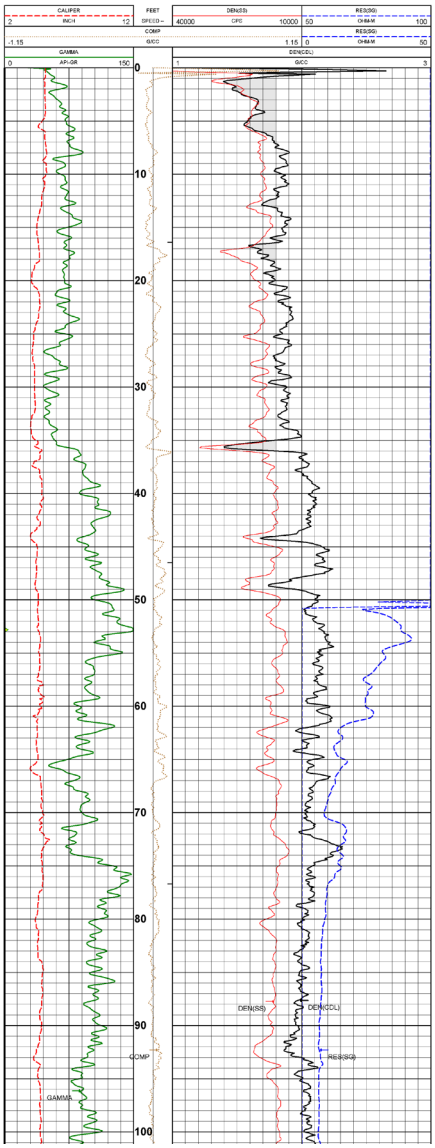
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TOOL 9239C TH VERSION 5026
SERIAL NUMBER 1238

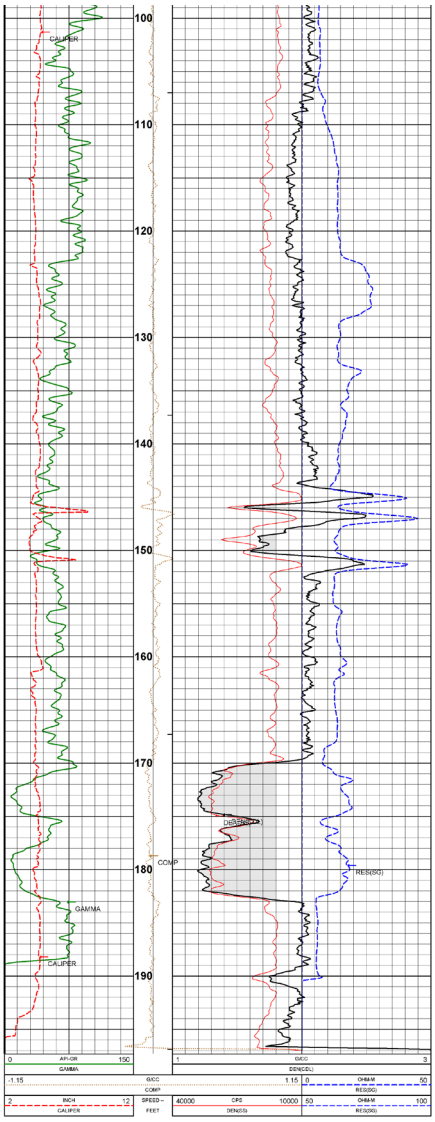
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1	Jul19,24	11:42:56	GAMMA	[API-GR]	1.000	320.000	0.000	359
2	Jul30,24	13:11:58	VOLTAGE	[MV]	26.730	234.800	7305	35063
3	Jul18,24	18:37:21	CALIPER	[INCH]	4.000	6.000	190827	305877
4	Jul18,24	17:17:53	DEN(LS)	[G/CC]	1.720	2.673	4926	724
5	Jul18,24	17:19:06	DEN(SS)	[G/CC]	1.775	2.638	20086	8196
6	Jun12,20	11:09:54	CALIPERL	[INCH]	5.000	9.000	190688	263665
7	Jul30,24	13:13:08	CURRENT	[UA]	26.730	234.800	5188	23610
8	Mar31,11	16:12:10	F	[CPS]	Default		Default	

CDL DENSITY 1:60 LOG NDGS24-44C 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z





CDL DENSITY 1:60 LOG NDGS24-44C 09/20/24

LOG PARAMETERS

MATRIX DENSITY : 2.65	NEUTRON MATRIX : SANDSTONE	MATRIX DELTA T : 54
MAGNETIC DECL : 0	ELECT. CUTOFF : 99999	BIT SIZE : 5.0 IN
PRESENTATION : 9239C.0 -- 09/16/2024		DISPLAY7_JL65z

APPENDIX E

Activation Laboratories Ltd. Geometallurgy

X-ray Diffraction Analysis of Twenty Seven Samples

W.O. # A25-02252
Invoice # A25-02252

Client: North Dakota Department of Mineral Resources

Attn: Levi Moxness

Date Reported: April 2, 2025

Activation Laboratories Ltd.
41 Bittern Street, Ancaster, ON L9G 4V5, Tel: +1.905.648.9611, Fax: +1.905.648.96123

Method

Twenty seven samples were submitted for quantitative X-ray diffraction analysis and clay speciation. For the quantitative XRD analysis, a split of each bulk sample was pulverized. A portion of each pulverized sample was mixed with corundum and packed into a standard holder. Corundum was added as an internal standard. For clay speciation analysis, a portion of each sample was dispersed in distilled water and the < 4 μm size fraction separated by gravity settling of particles in suspension. Oriented slides of the < 4 μm size fraction were prepared by placing a portion of the suspension onto a glass slide. The oriented slides were analyzed air-dry and after treatment with ethylene glycol.

The X-ray diffraction analysis was performed on a Bruker D8 Endeavour diffractometer equipped with Cu X-ray source and operating at the following conditions: 40 kV and 40 mA; range 4-70 deg 2θ for random specimens and 3 – 30 deg 2θ for oriented specimens; step size 0.02 deg 2θ; time per step 0.5 sec; fixed divergence slit, angle 0.3°; sample rotation 15 rpm. The PDF4/Minerals ICDD database was used for mineral identification. The quantities of the crystalline mineral phases were determined using Rietveld method. The Rietveld method is based on the calculation of the full diffraction pattern from crystal structure data. The amounts of the crystalline minerals were recalculated based on a know percent of corundum and the remainder to 100 % was considered poorly crystalline and X-ray amorphous material. The semi-quantitative amounts of the clay minerals in the < 4 μm size fraction were calculated using the relative ratios of their basal-peak areas.

Results

The identified minerals and their abundances in the bulk samples are in Table 1 and the relative abundances of the clay minerals in the < 4 μm size fraction are in Table 2. The diffraction patterns are in Appendix 1 and Apendix 2.

The clay speciation analysis showed presence of illite, kaolinite, chlorite, smectite and mixed-layered illite-smectite. The mixed-layered illite-smectite has about 30 % expandable layers.

Table 1. Mineral abundances in bulk samples (wt %)

Client ID	NDGS-28-17.4	NDGS-28-20.4	NDGS-28-23.0	NDGS-28-26.0	NDGS-28-29.0	NDGS-28-31.0	NDGS-28-32.5
Actlabs ID	A25-02252-1	A25-02252-2	A25-02252-3	A25-02252-4	A25-02252-5	A25-02252-6	A25-02252-7
Quartz	90.6	68.5	43.5	42.8	40.0	43.5	41.4
K feldspar	trace	n.d.	n.d.	n.d.	n.d.	n.d.	0.6
Plagioclase	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Muscovite/Illite	n.d.	1.9	7.4	10.5	12.7	14.1	13.6
Kaolinite	1.0	8.5	14.0	18.9	27.4	22.0	17.1
Chlorite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Smectite*	4	trace	trace	n.d.	n.d.	n.d.	n.d.
Illite-Smectite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Anatase	0.4	0.4	0.5	0.7	0.6	0.4	0.5
Goethite	n.d.	n.d.	n.d.	0.3	0.6	0.4	n.d.
Dolomite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Gypsum	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pyrite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Amorphous	4.0	20.7	34.6	26.8	18.7	19.6	26.8

Client ID	NDGS-28-33.5	NDGS-28-34.3	NDGS-28-34.8	NDGS-28-35.8	NDGS-28-36.7	NDGS-28-37.6	NDGS-28-38.4
Actlabs ID	A25-02252-8	A25-02252-9	A25-02252-10	A25-02252-11	A25-02252-12	A25-02252-13	A25-02252-14
Quartz	41.9	38.8	42.0	44.1	36.3	36.5	37.7
K feldspar	0.5	0.9	1.9	2.8	4.2	4.2	3.9
Plagioclase	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Muscovite/Illite	13.8	12.3	14.2	15.0	16.2	14.8	13.2
Kaolinite	13.1	13.6	14.4	12.9	12.9	9.0	3.5
Chlorite	n.d.	n.d.	n.d.	n.d.	n.d.	2.2	4.7
Smectite*	1	trace	3	4	27	23	13
Illite-Smectite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Anatase	0.4	trace	0.4	0.5	0.4	0.3	trace
Goethite	n.d.	15.7	n.d.	n.d.	n.d.	n.d.	n.d.
Dolomite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Gypsum	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pyrite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Amorphous	29.3	18.7	24.1	20.7	3.0	10.0	24.0

Client ID	NDGS-28-39.3	NDGS-28-40.4	NDGS-28-41.8	NDGS-28-42.8	NDGS-28-44.4	NDGS-28-48.0	NDGS-307-C1
Actlabs ID	A25-02252-15	A25-02252-16	A25-02252-17	A25-02252-18	A25-02252-19	A25-02252-20	A25-02252-21
Quartz	45.1	40.1	31.1	38.8	32.6	30.1	47.4
K feldspar	4.6	4.7	3.6	3.7	3.4	4.0	5.1
Plagioclase	n.d.	n.d.	0.5	3.5	1.7	4.7	3.9
Muscovite/Illite	13.1	14.9	12.8	14.7	15	15	16.3
Kaolinite	3.4	2.4	2.5	1.6	1.9	1.6	0.6
Chlorite	7.3	6.1	6.7	7.1	6.4	7.7	4.7
Smectite*	13	15	38	23	36	22	22
Illite-Smectite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Anatase	0.3	0.3	0.3	0.3	trace	0.3	trace
Goethite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Dolomite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Gypsum	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pyrite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Amorphous	13.2	16.5	4.5	7.3	3.0	14.6	n.d.

Client ID	NDGS-311-C1	NDGS-311-L30	NDGS-311-M22	NDGS-312-C2	NDGS-312-L23	NDGS-312-U21
Actlabs ID	A25-02252-22	A25-02252-23	A25-02252-24	A25-02252-25	A25-02252-26	A25-02252-27
Quartz	35.5	39.3	82.3	37.5	43.3	35.1
K feldspar	3.9	3.9	trace	trace	1.6	3.0
Plagioclase	5.1	n.d.	n.d.	n.d.	n.d.	n.d.
Muscovite/Illite	7.6	9.5	2.3	7.4	14.7	11.6
Kaolinite	5.5	3.6	2	30.4	12.2	1.7
Chlorite	4.6	1.7	n.d.	n.d.	4.6	5.2
Smectite*	trace	42	n.d.	n.d.	n.d.	2
Illite-Smectite	n.d.	n.d.	6	n.d.	n.d.	n.d.
Anatase	n.d.	n.d.	n.d.	0.6	0.4	trace
Goethite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Dolomite	3.0	n.d.	n.d.	n.d.	n.d.	2.4
Gypsum	4.4	n.d.	n.d.	n.d.	n.d.	7.8
Pyrite	3.4	n.d.	n.d.	n.d.	n.d.	n.d.
Amorphous	27.0	n.d.	7.4	24.1	23.2	31.2

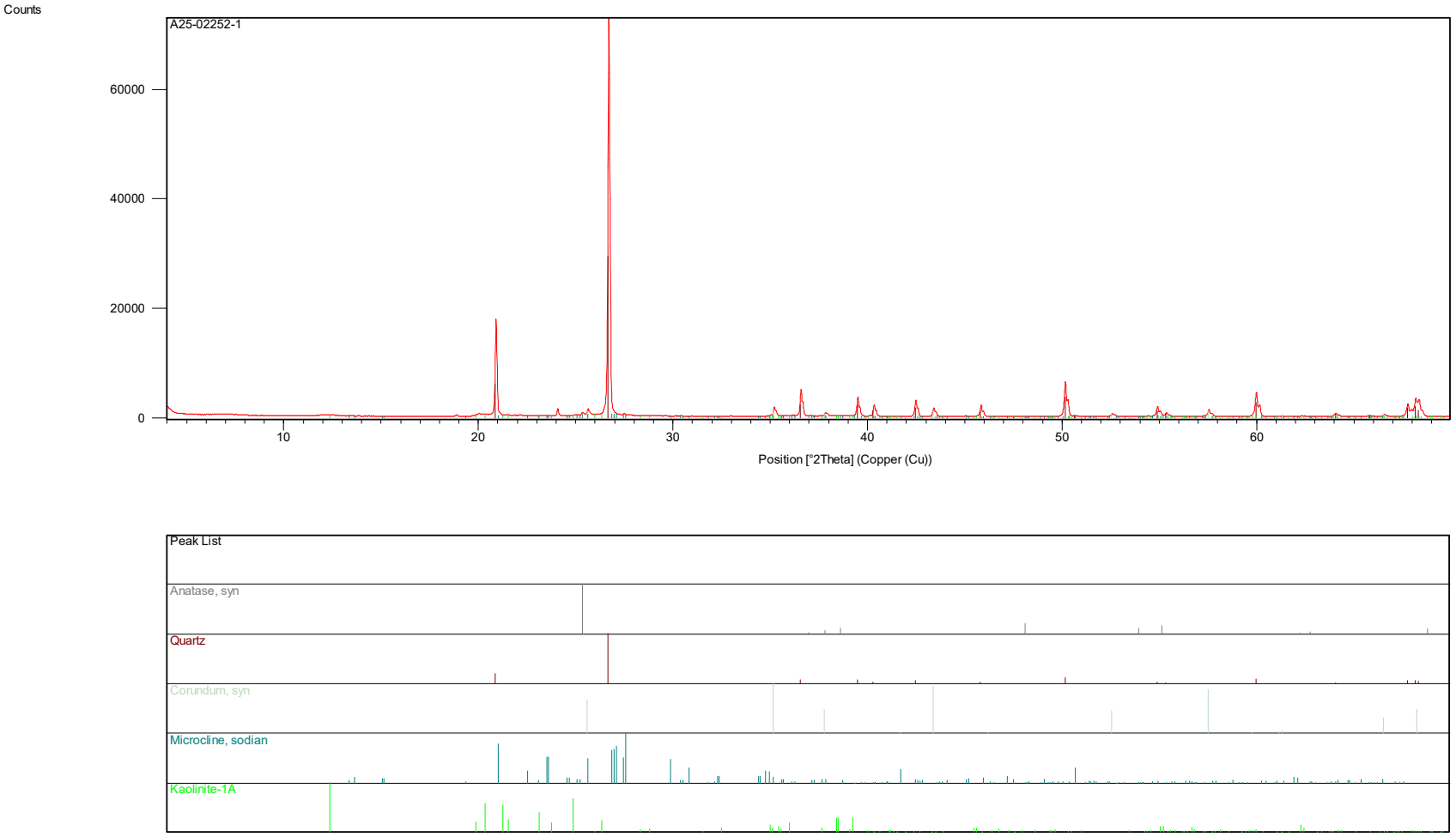
Note: n.d. = not detected; *the amount of smectite is an estimate calculated from the relative proportions of the clay minerals in the < 4 µm size fraction

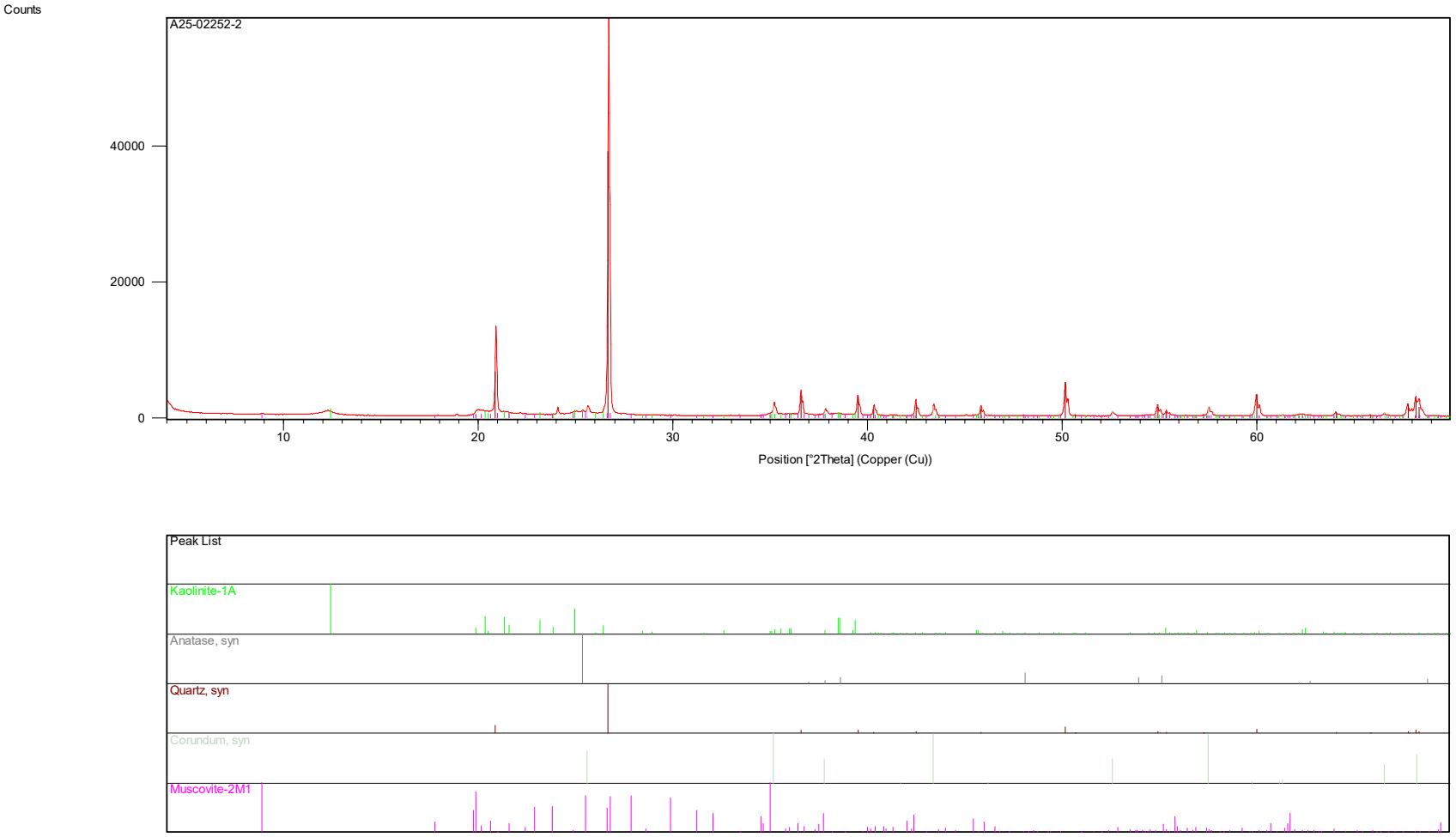
Table 2. Relative abundances of clay minerals in the < 4 μm size fraction

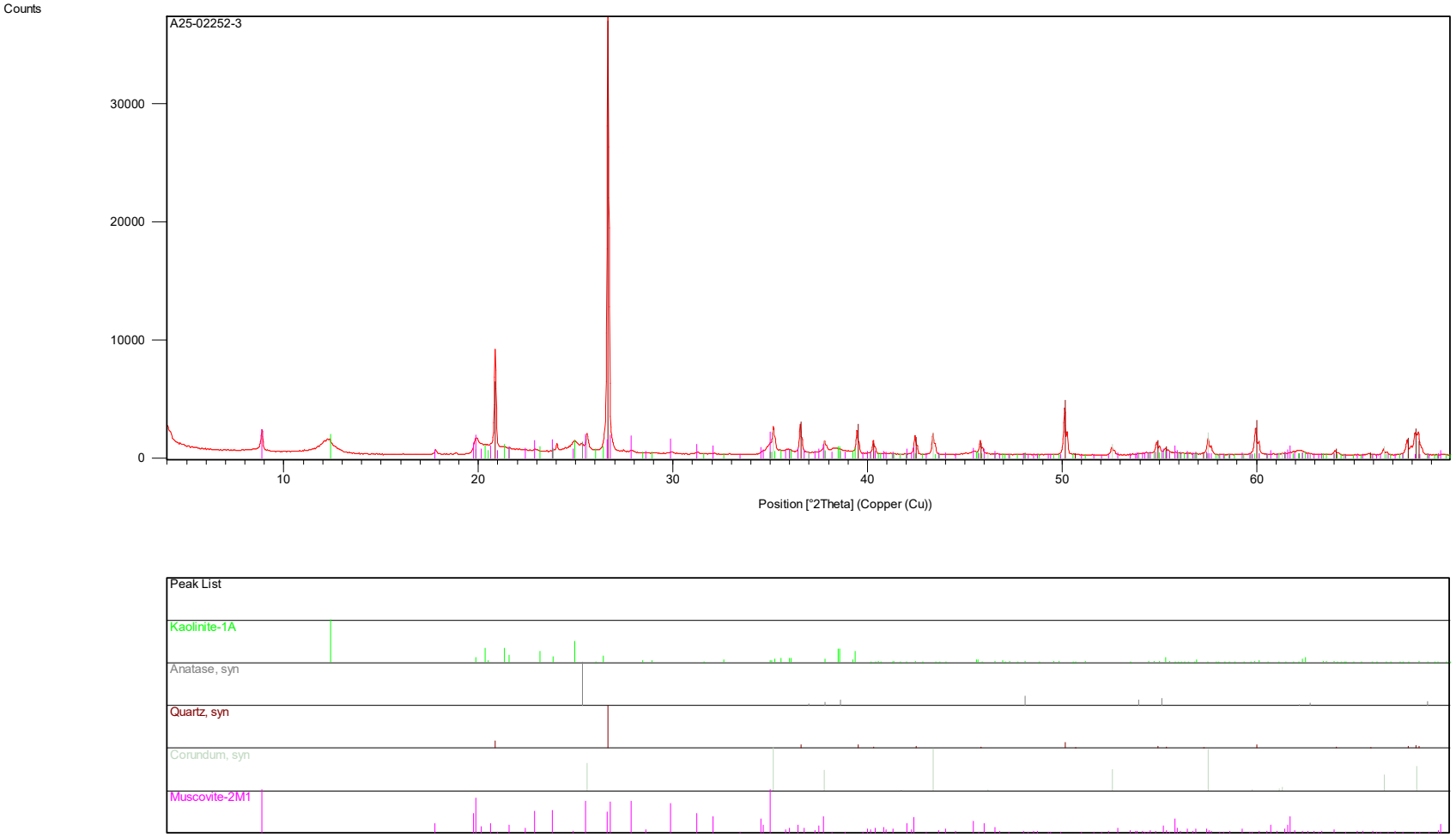
Client ID	Actlabs ID	Smectite	Illite	Illite-Smectite	Kaolinite	Chlorite
NDGS-28-17.4	A25-02252-1	80	n.d.	n.d.	20	n.d.
NDGS-28-20.4	A25-02252-2	2	1	n.d.	97	n.d.
NDGS-28-23.0	A25-02252-3	1	6	n.d.	93	n.d.
NDGS-28-26.0	A25-02252-4	n.d.	15	n.d.	85	n.d.
NDGS-28-29.0	A25-02252-5	n.d.	17	n.d.	83	n.d.
NDGS-28-31.0	A25-02252-6	n.d.	33	n.d.	67	n.d.
NDGS-28-32.5	A25-02252-7	n.d.	51	n.d.	49	n.d.
NDGS-28-33.5	A25-02252-8	4	44	n.d.	52	n.d.
NDGS-28-34.3	A25-02252-9	1	38	n.d.	61	n.d.
NDGS-28-34.8	A25-02252-10	10	37	n.d.	52	n.d.
NDGS-28-35.8	A25-02252-11	14	42	n.d.	44	n.d.
NDGS-28-36.7	A25-02252-12	48	27	n.d.	26	n.d.
NDGS-28-37.6	A25-02252-13	49	30	n.d.	8	12
NDGS-28-38.4	A25-02252-14	32	36	n.d.	21	11
NDGS-28-39.3	A25-02252-15	39	35	n.d.	8	17
NDGS-28-40.4	A25-02252-16	49	38	n.d.	4	8
NDGS-28-41.8	A25-02252-17	68	21	n.d.	3	7
NDGS-28-42.8	A25-02252-18	55	33	n.d.	3	9
NDGS-28-44.4	A25-02252-19	65	27	n.d.	2	6
NDGS-28-48.0	A25-02252-20	54	34	n.d.	2	10
NDGS-307-C1	A25-02252-21	68	27	n.d.	2	4
NDGS-311-C1	A25-02252-22	n.d.	34	n.d.	41	25
NDGS-311-L30	A25-02252-23	76	12	n.d.	7	5
NDGS-311-M22	A25-02252-24	n.d.	12	42	45	n.d.
NDGS-312-C2	A25-02252-25	n.d.	15	n.d.	85	n.d.
NDGS-312-L23	A25-02252-26	n.d.	53	n.d.	22	25
NDGS-312-U21	A25-02252-27	14	65	n.d.	4	17

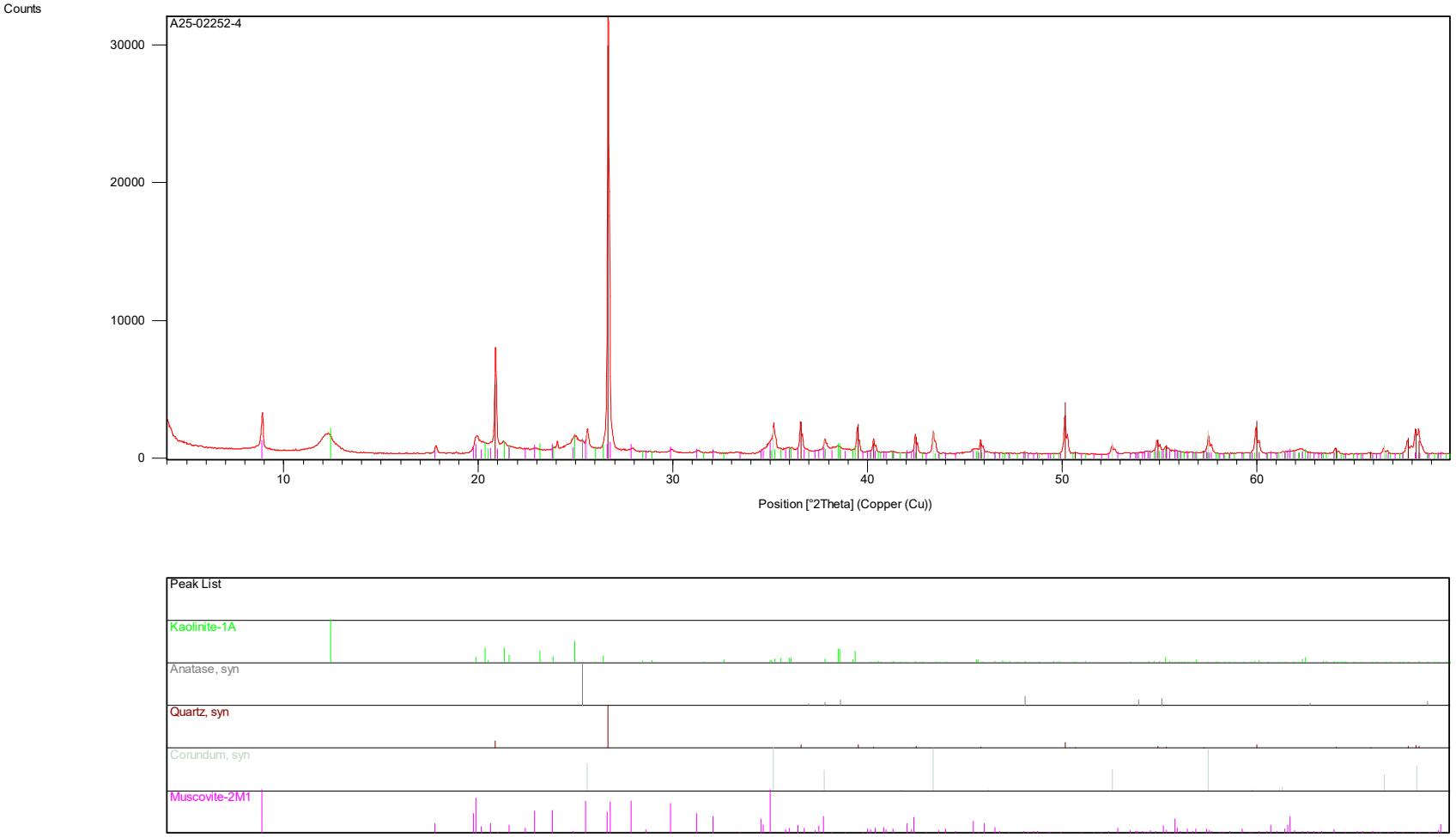
Reported by:
Elitsa Hrischeva, PhD
Activation Laboratories Ltd.

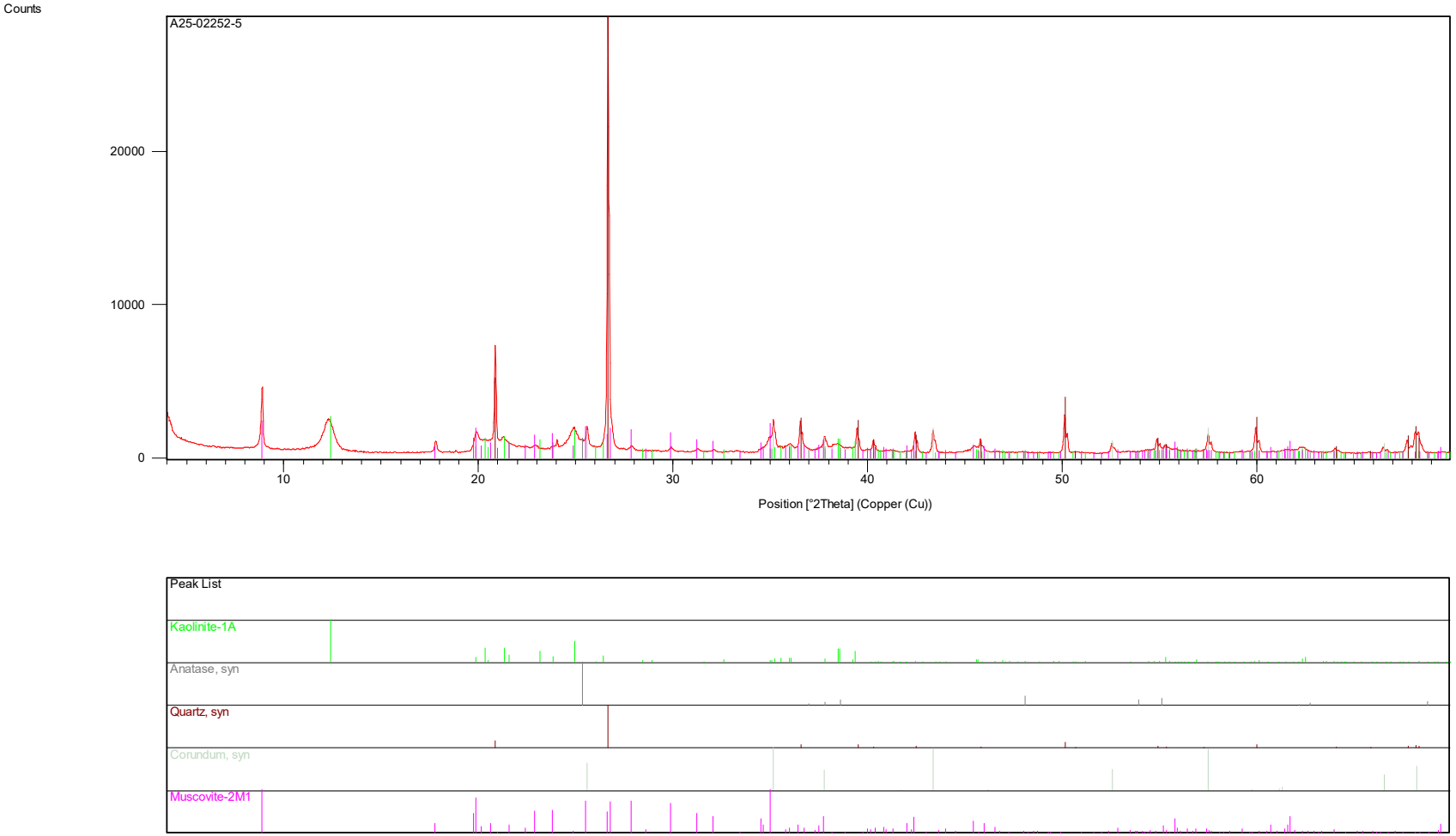
Diffraction patterns of bulk samples

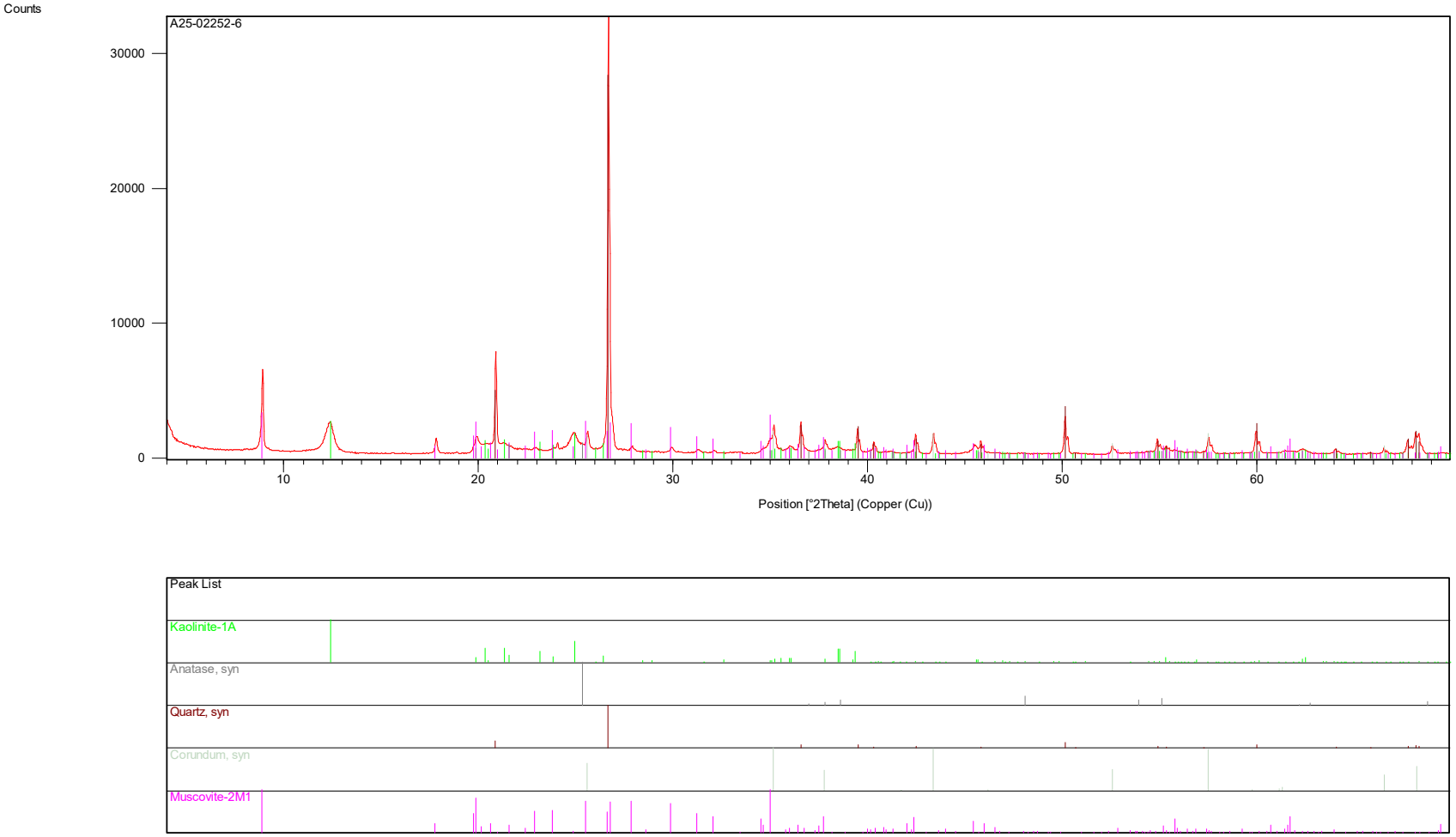

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Position [°2Theta] (Copper (Cu))
Peak List
Anatase, syn
Quartz
Corundum, syn
Microcline, sodian
Kaolinite-1A

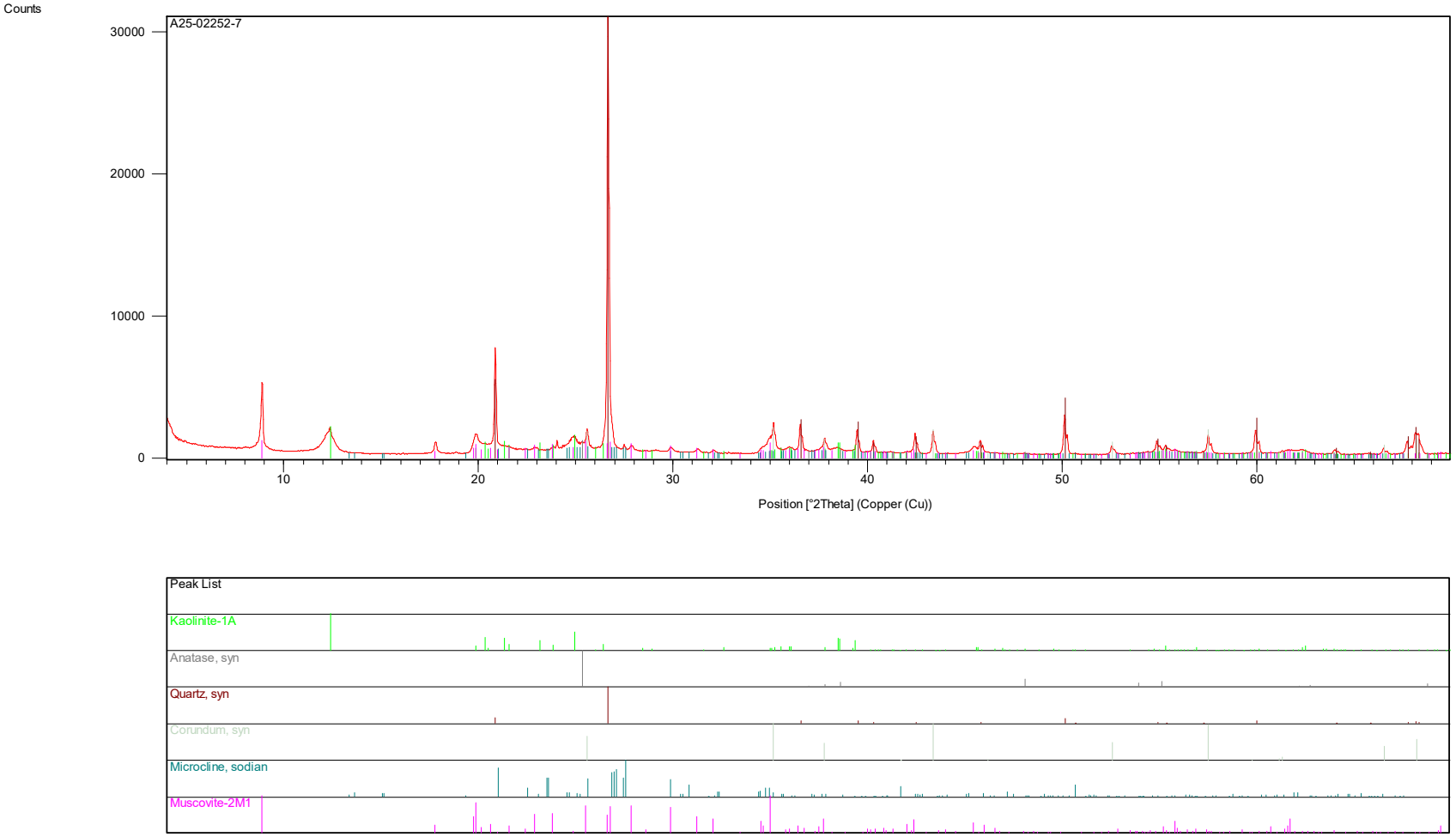

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Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Muscovite-2M1

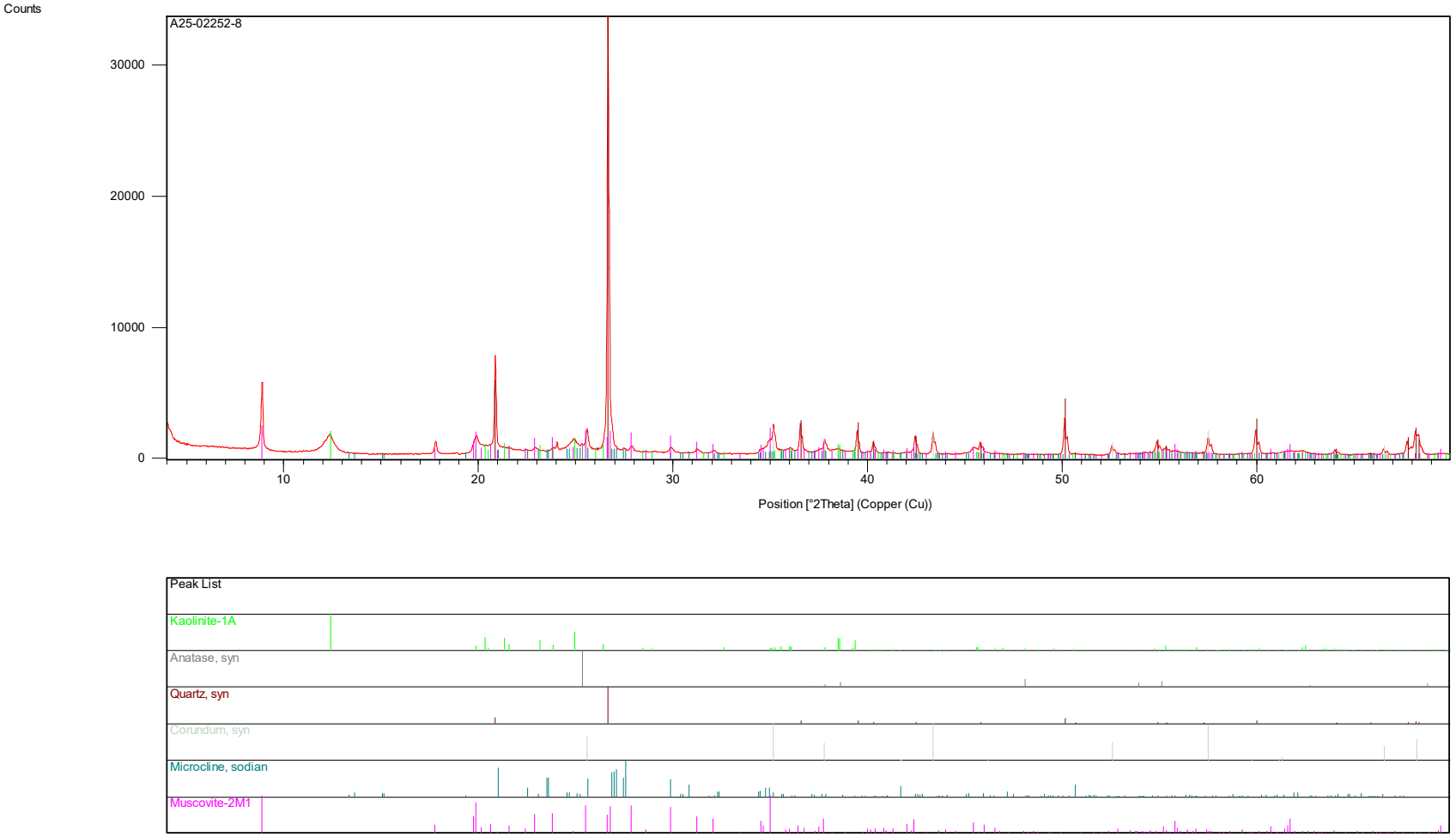

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Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Muscovite-2M1

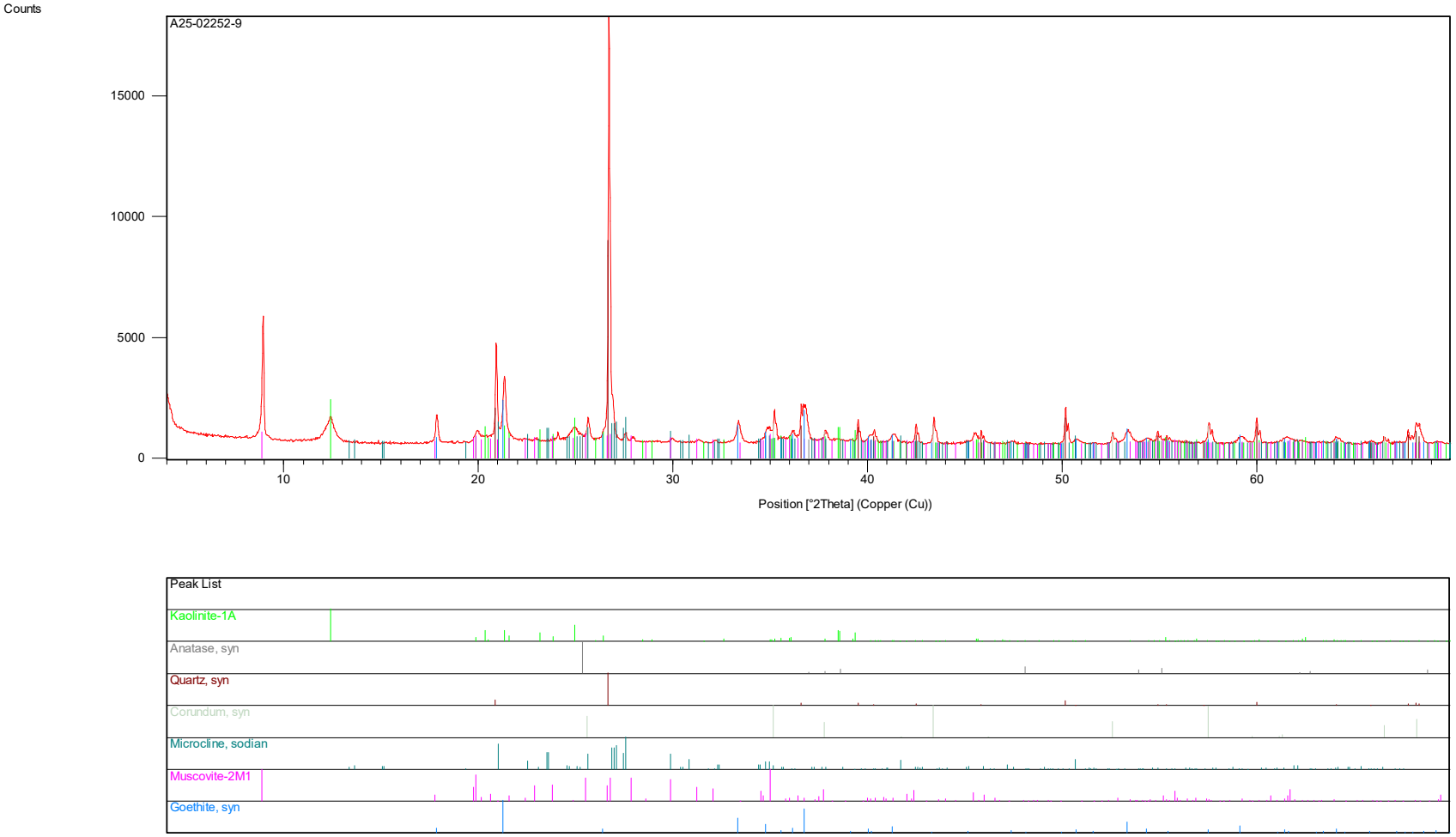

Counts
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40
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60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Muscovite-2M1

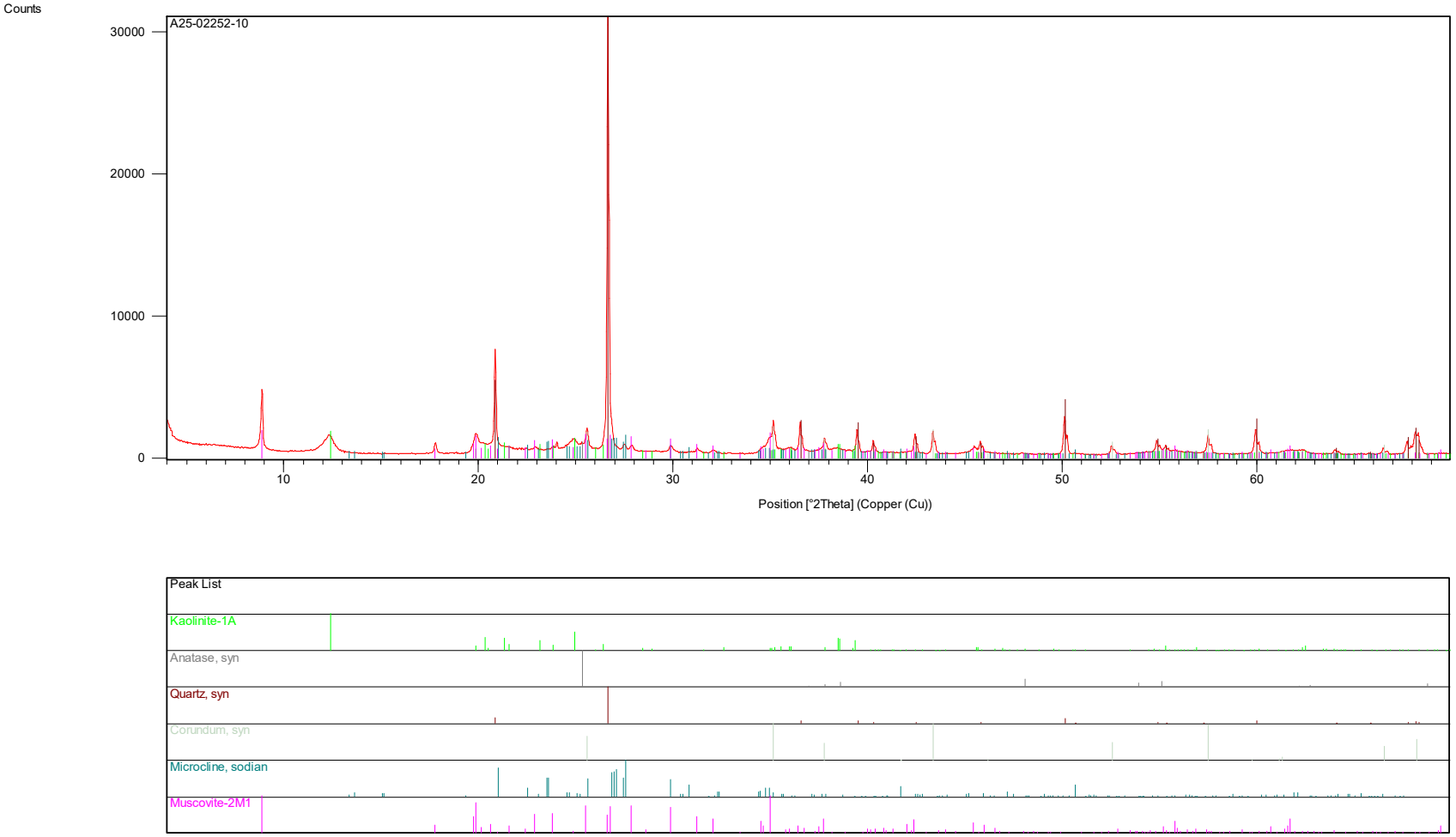

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40
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Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Muscovite-2M1

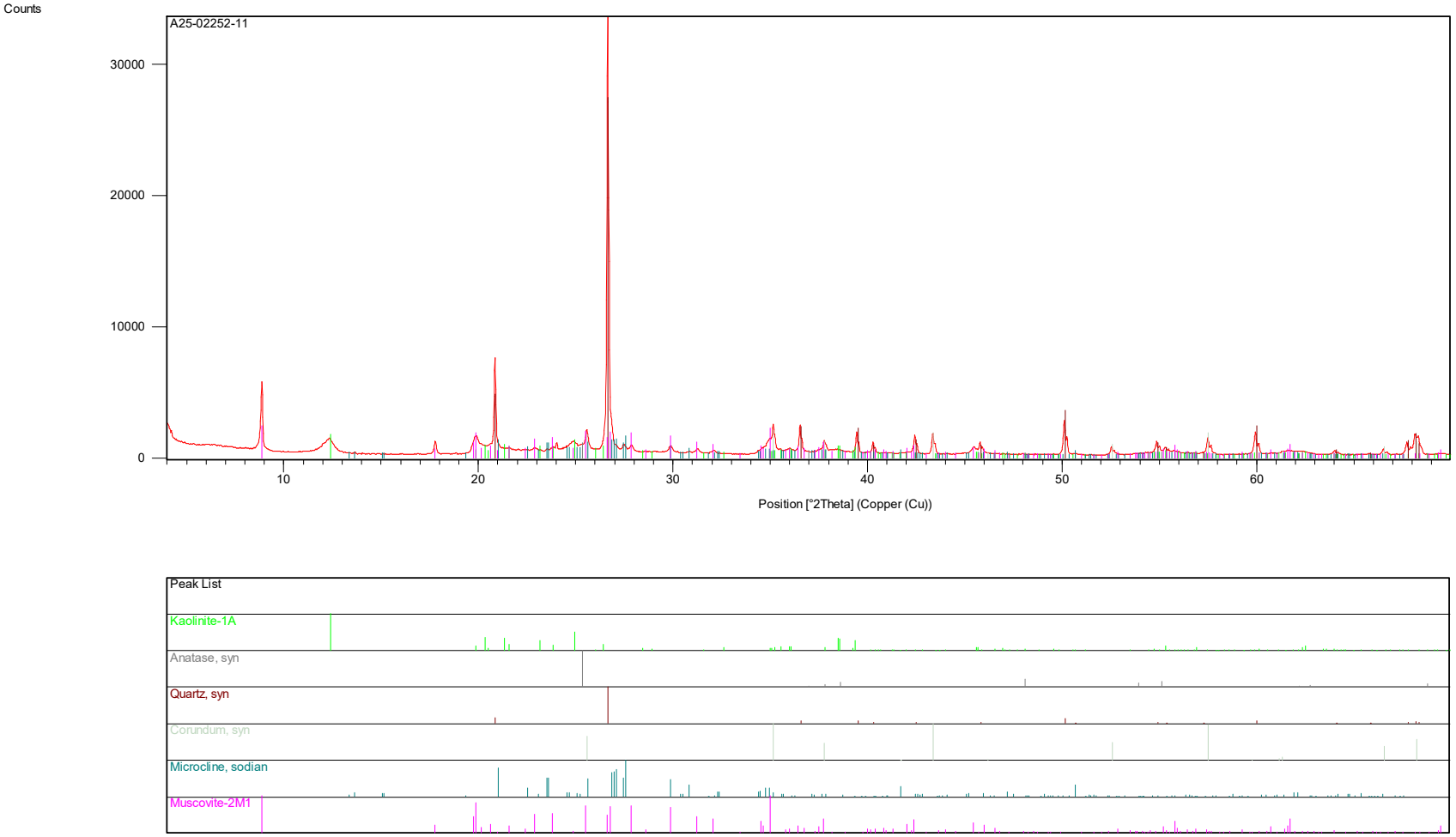

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20
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40
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Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Muscovite-2M1

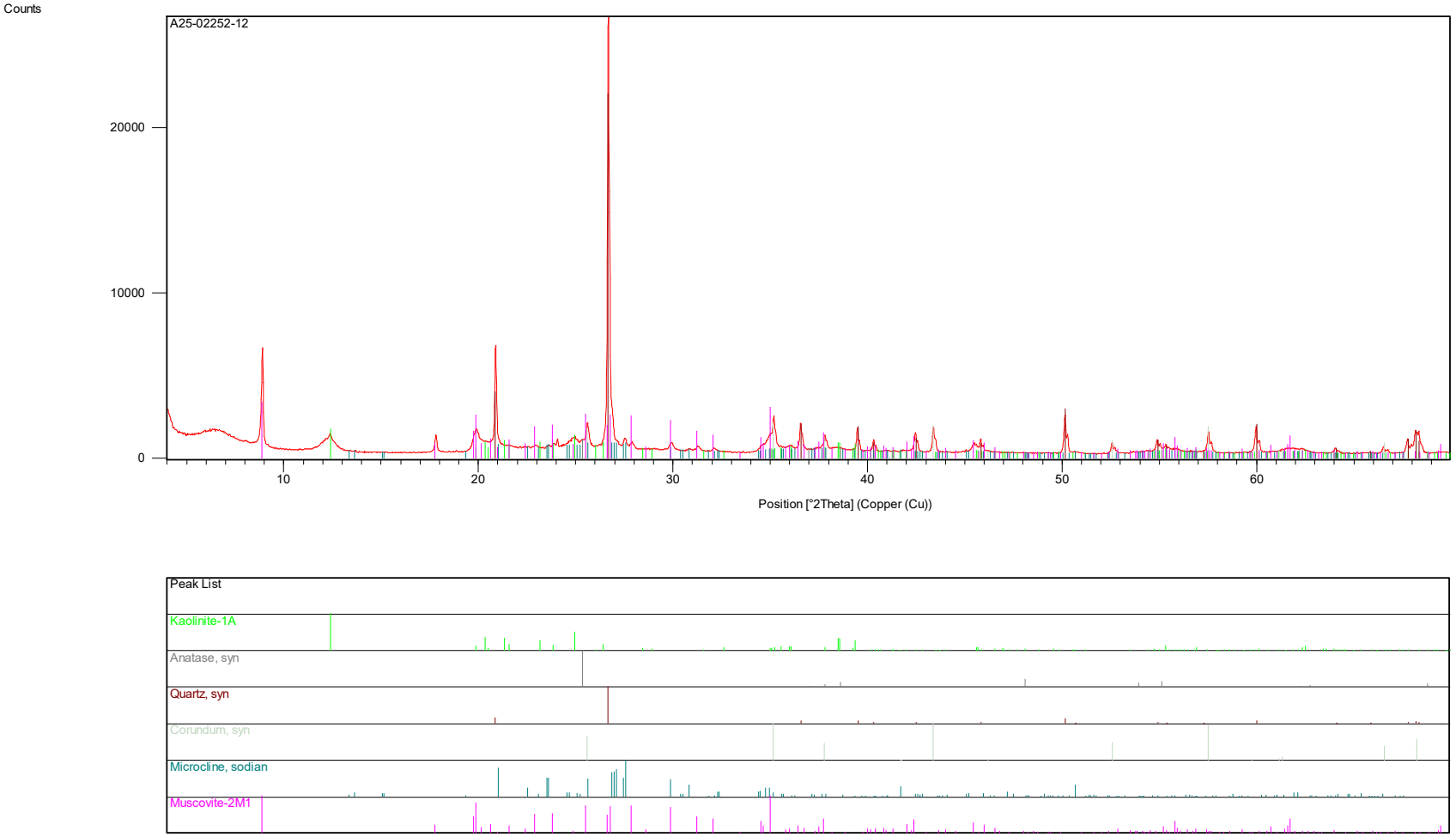

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10000
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20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

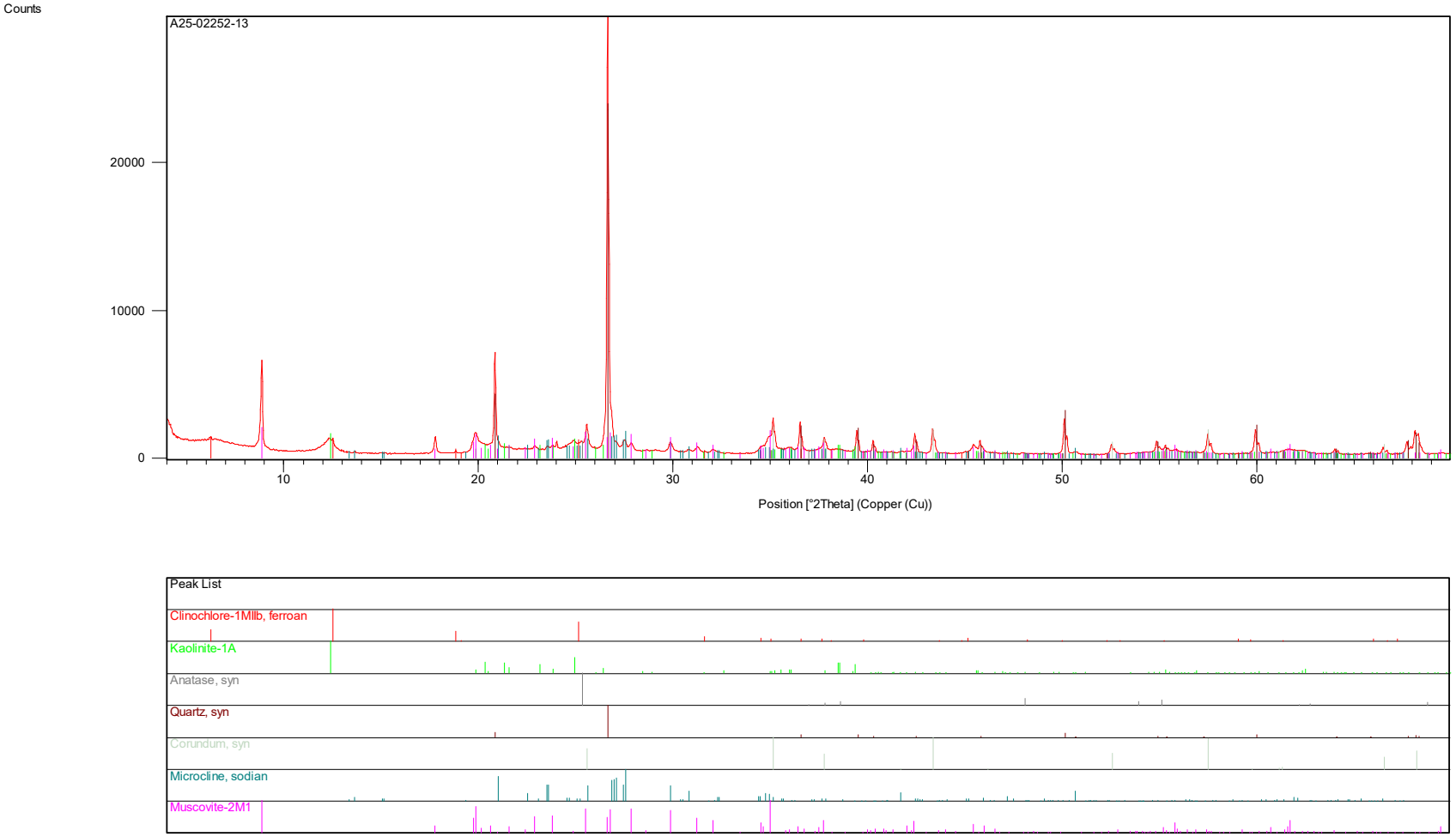

Counts
A25-02252-8
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10000
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20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

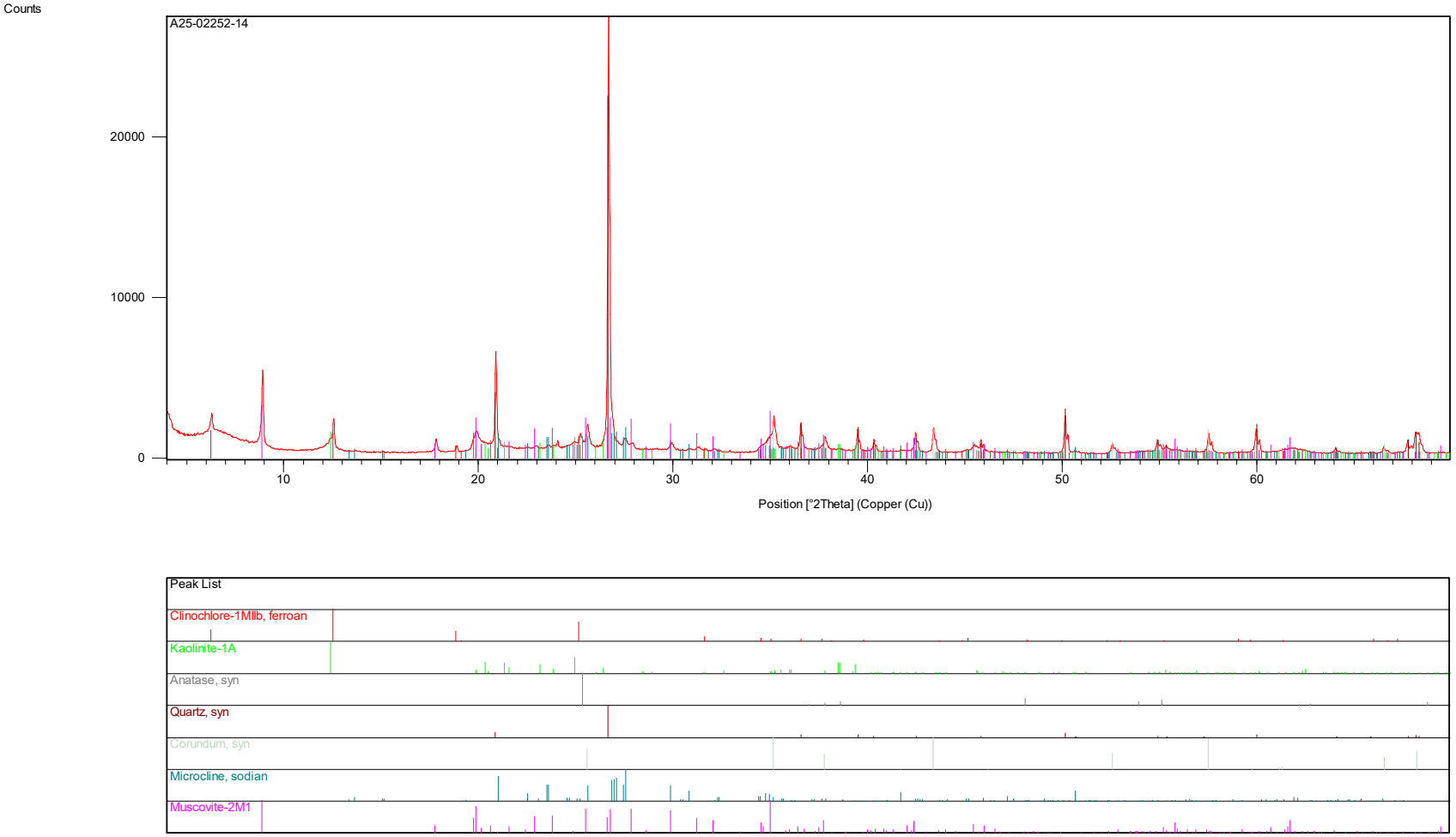

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30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1
Goethite, syn

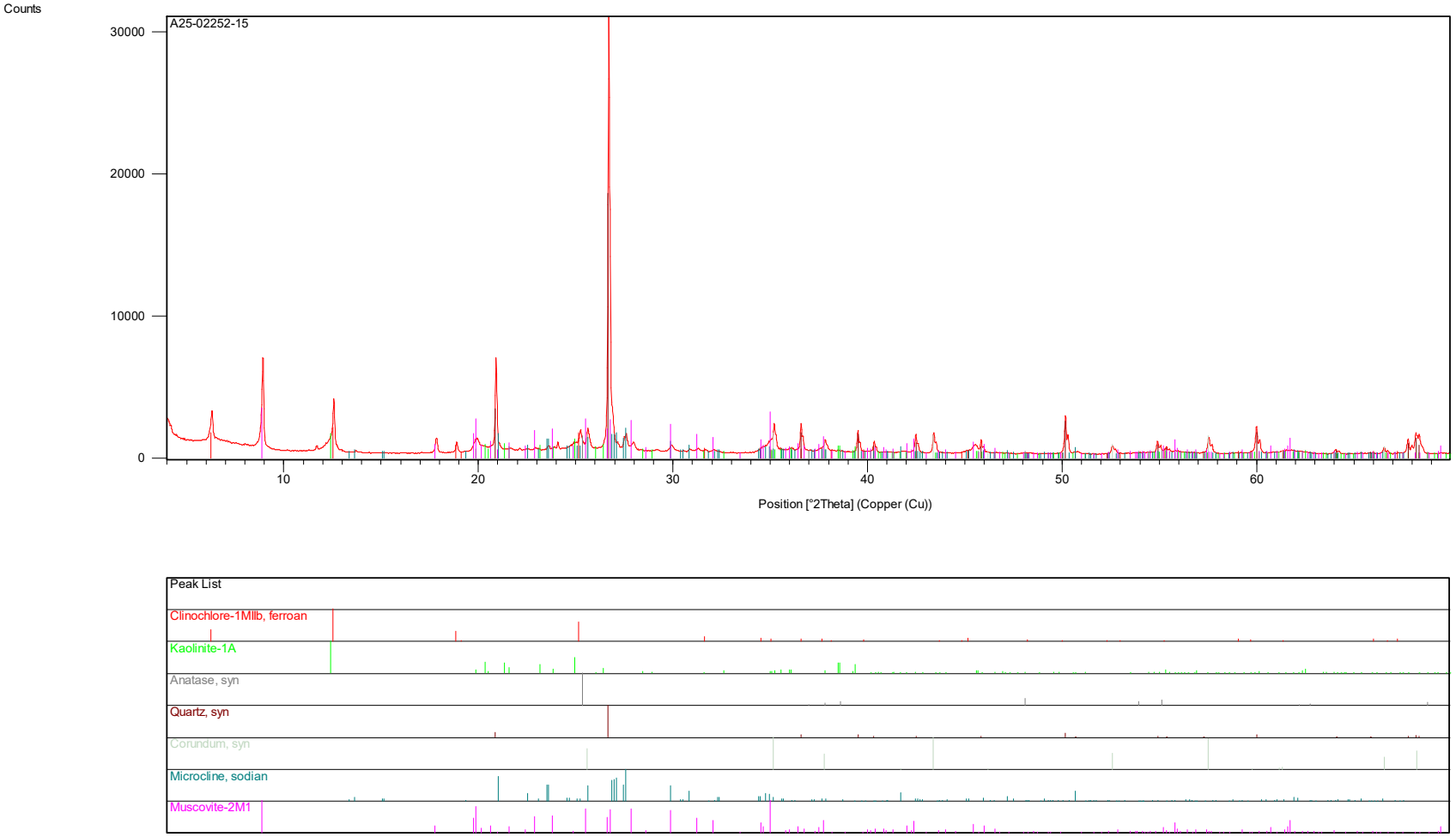

Counts
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20
30
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50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

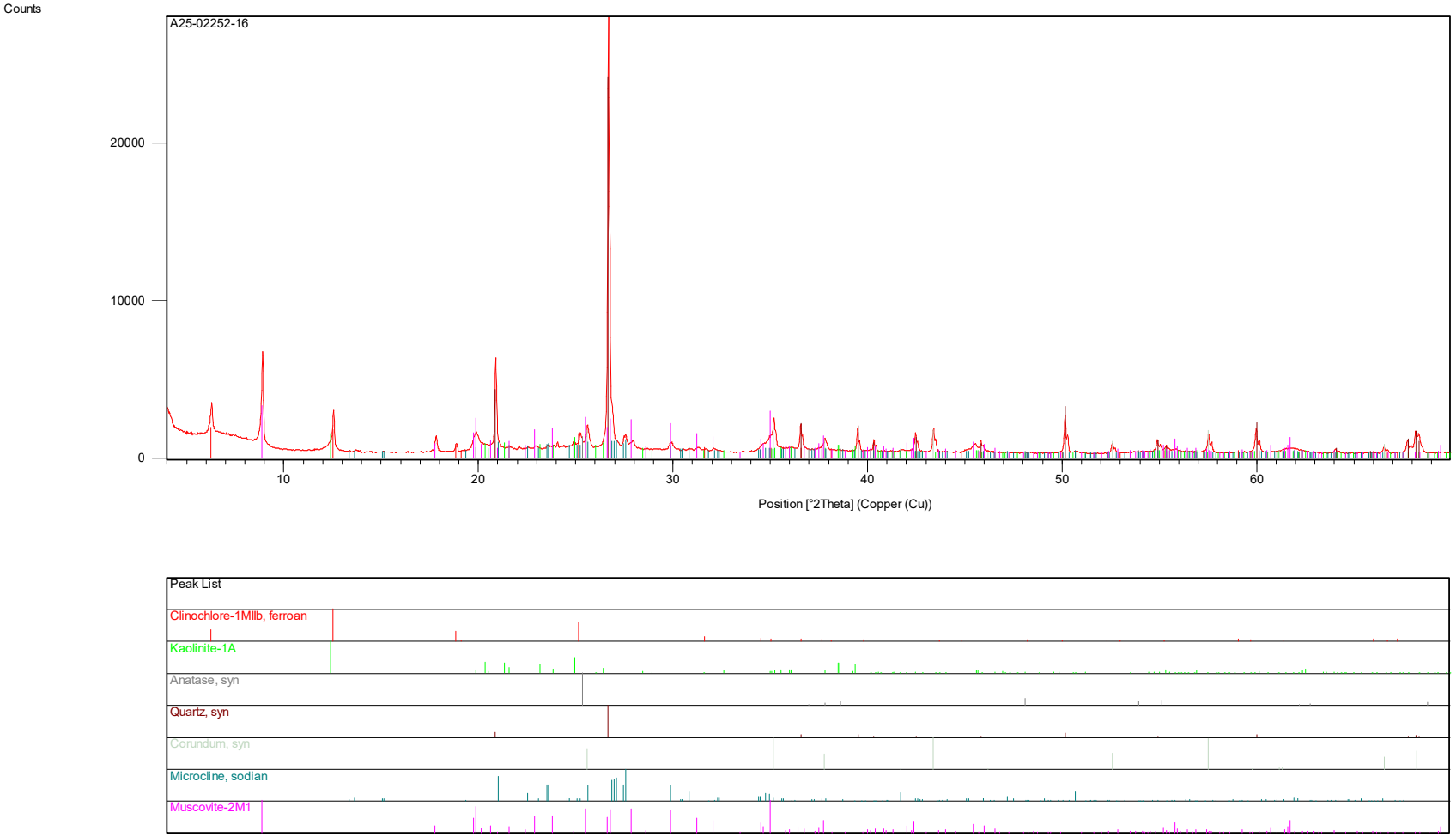

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20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

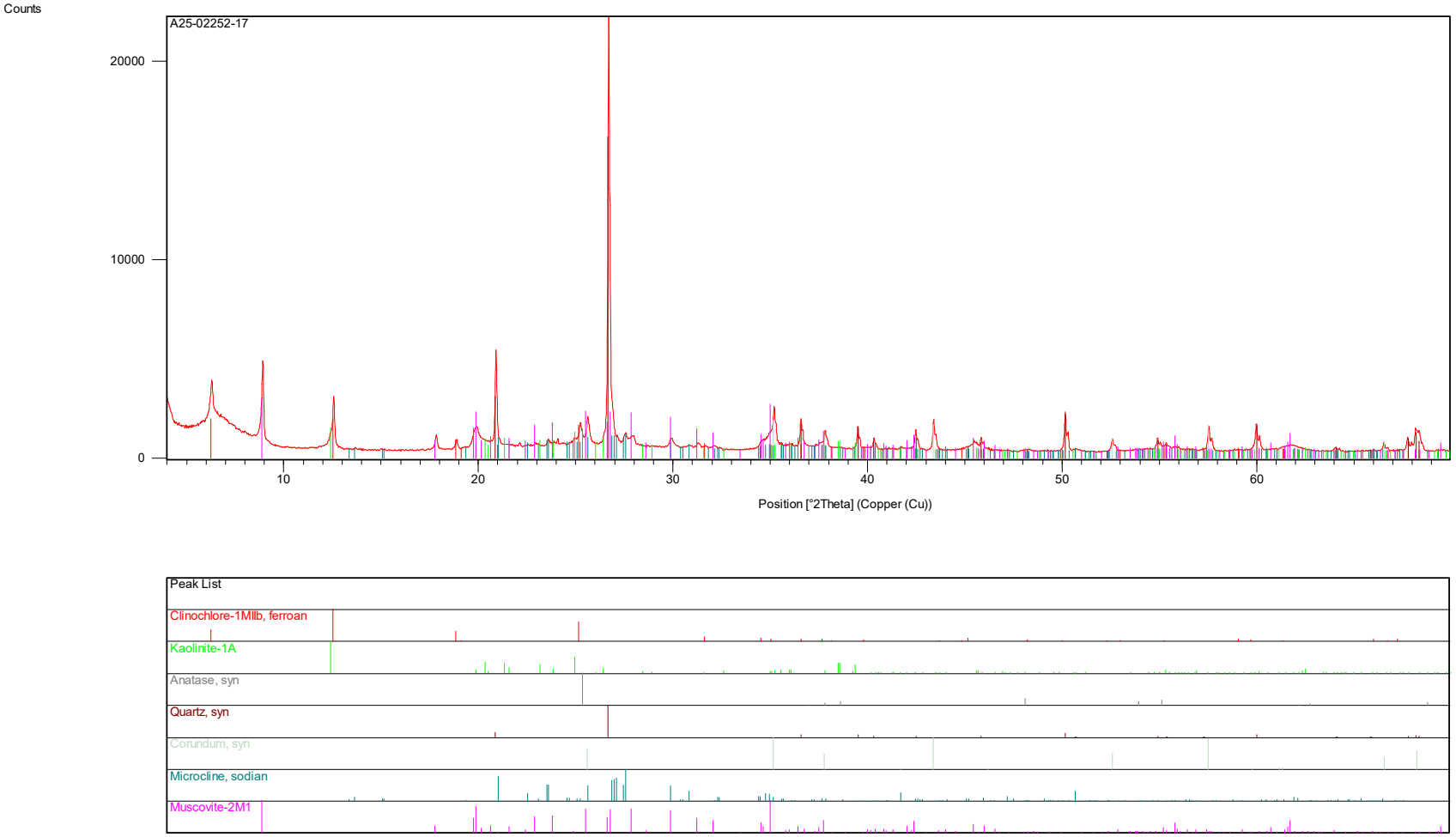

Counts
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10000
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10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

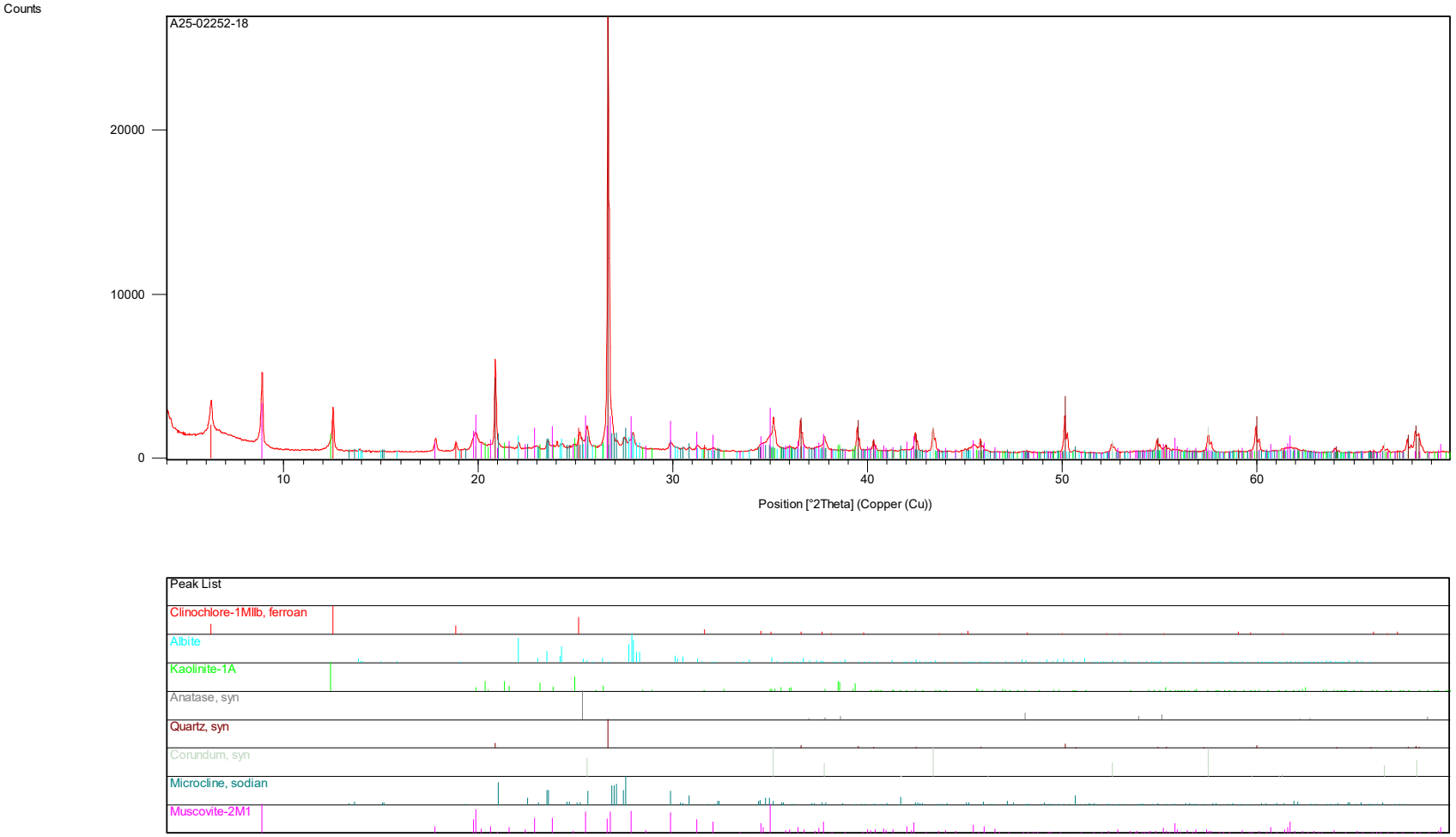

Counts
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10
20
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40
50
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Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

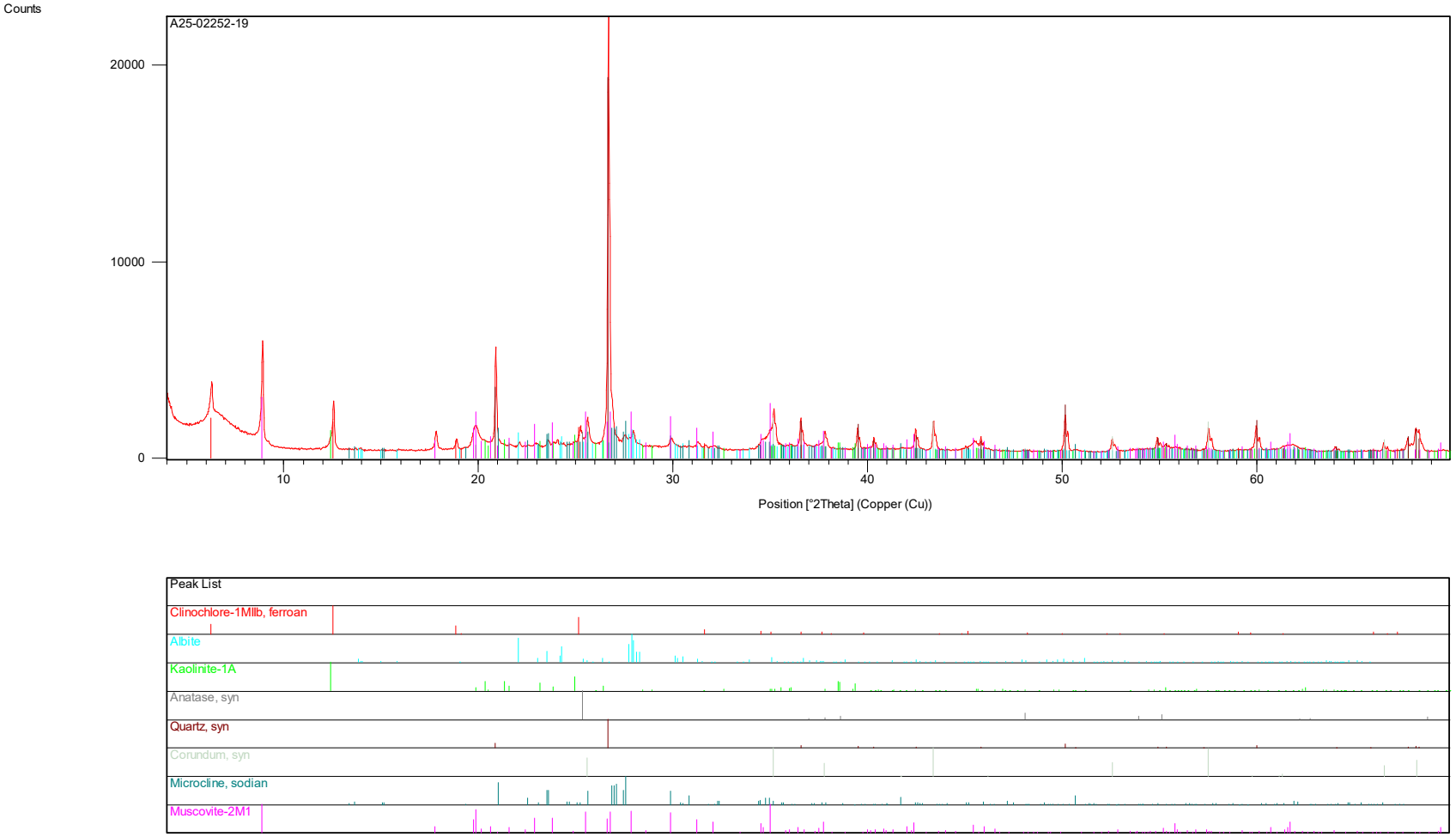

Counts
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50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

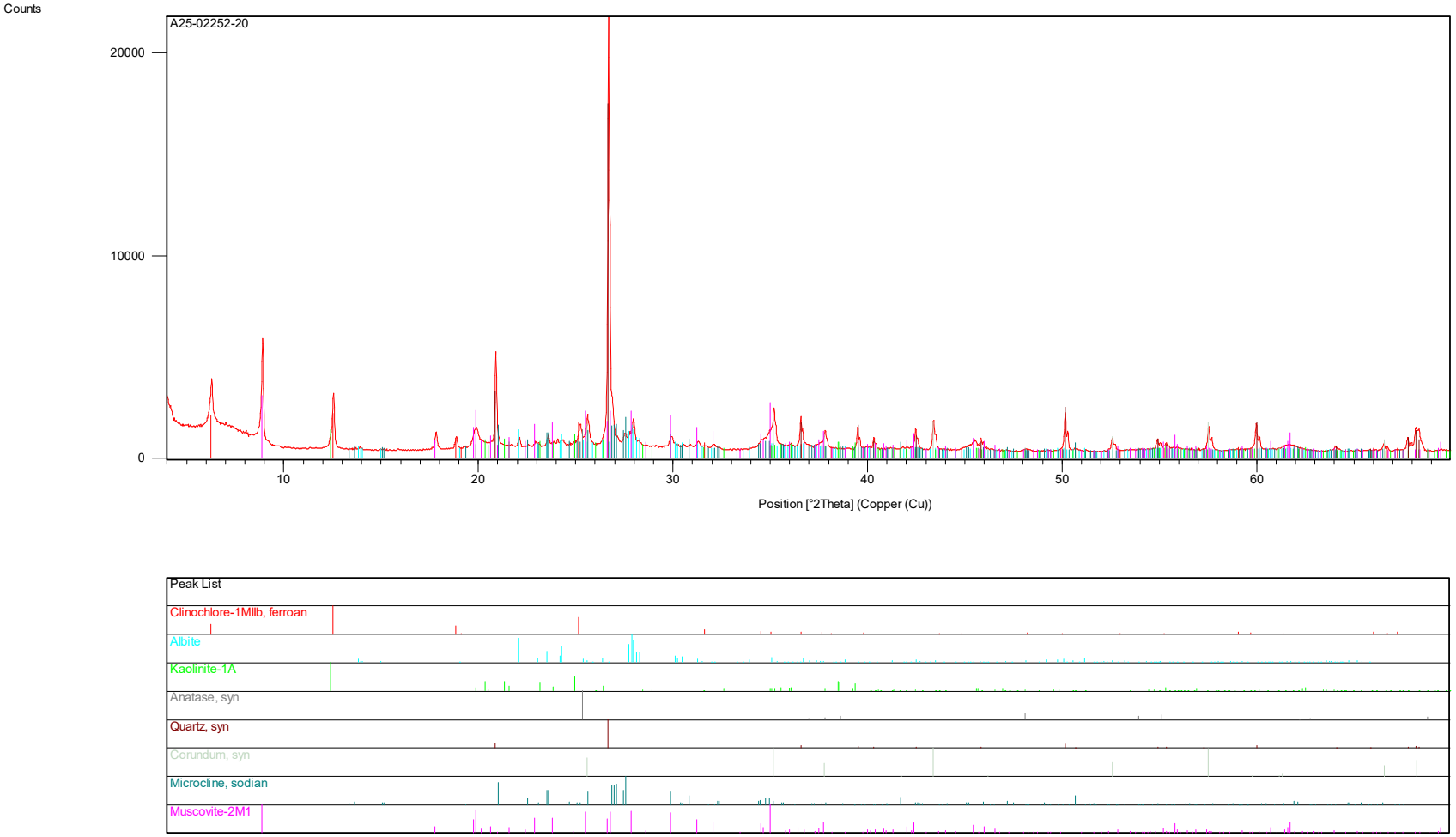

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Position [°2Theta] (Copper (Cu))
Peak List
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Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

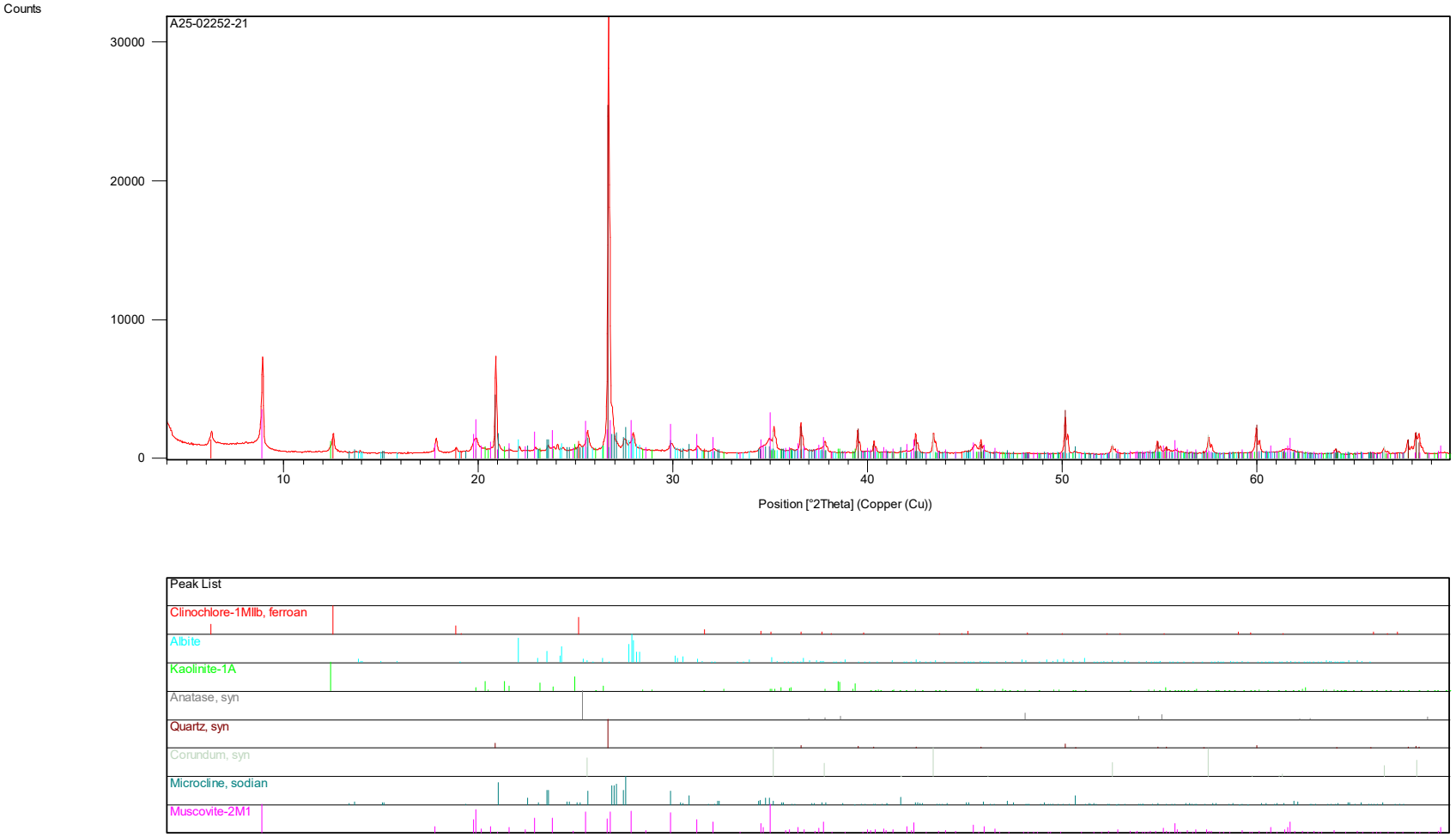

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50
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Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

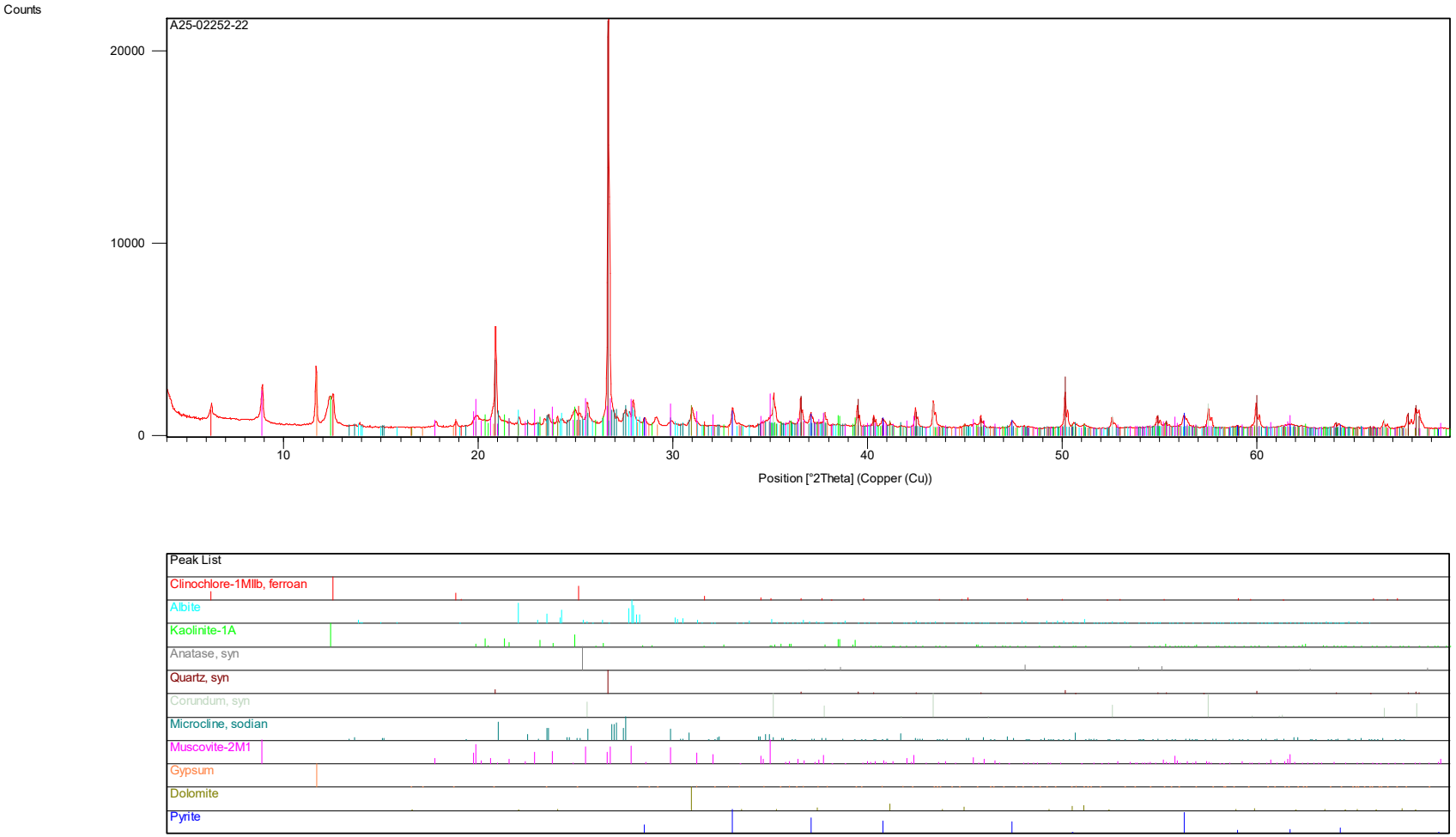

Counts
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10000
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30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

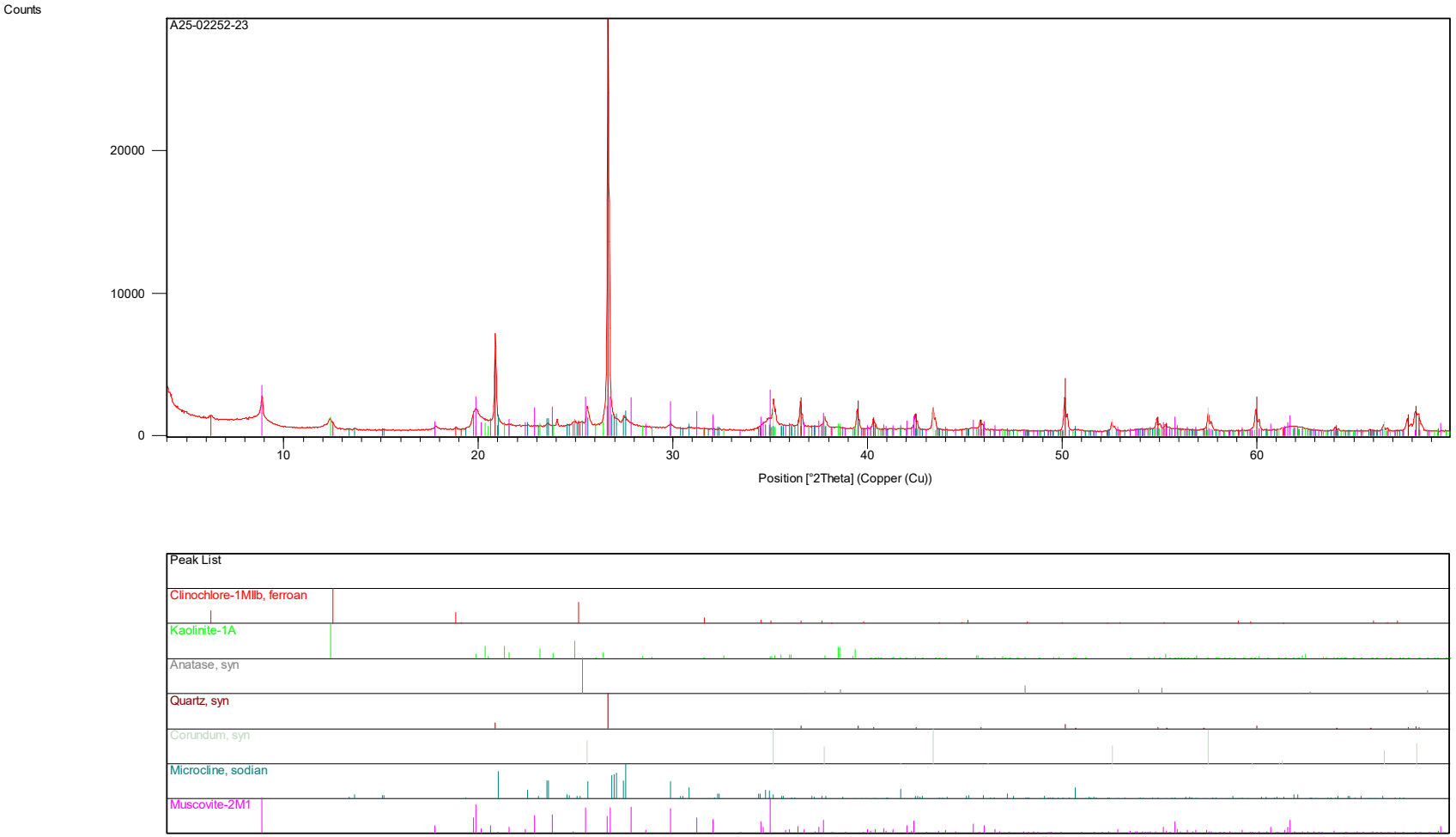

Counts
A25-02252-18
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Albite
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

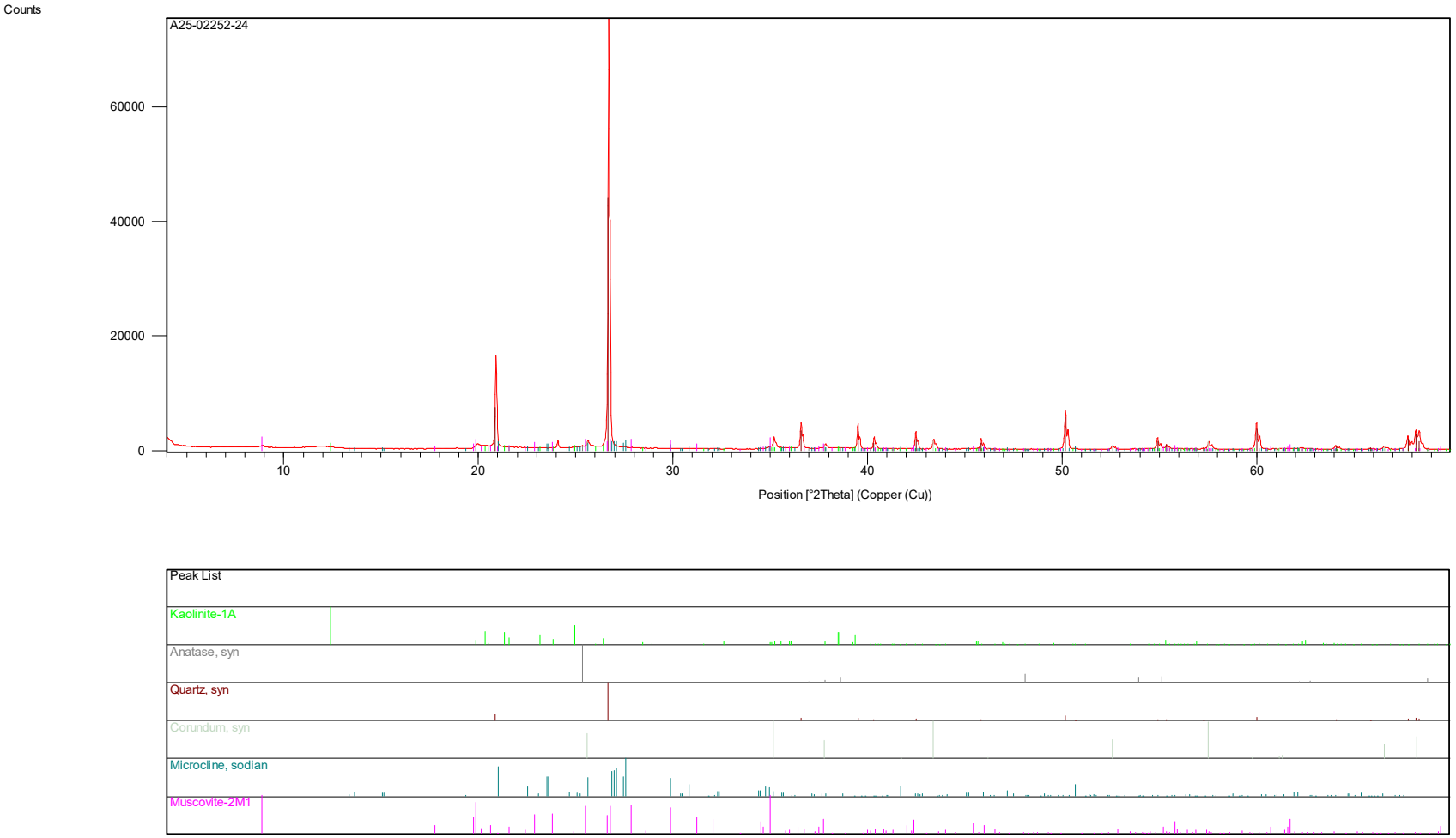

Counts
A25-02252-19
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Albite
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

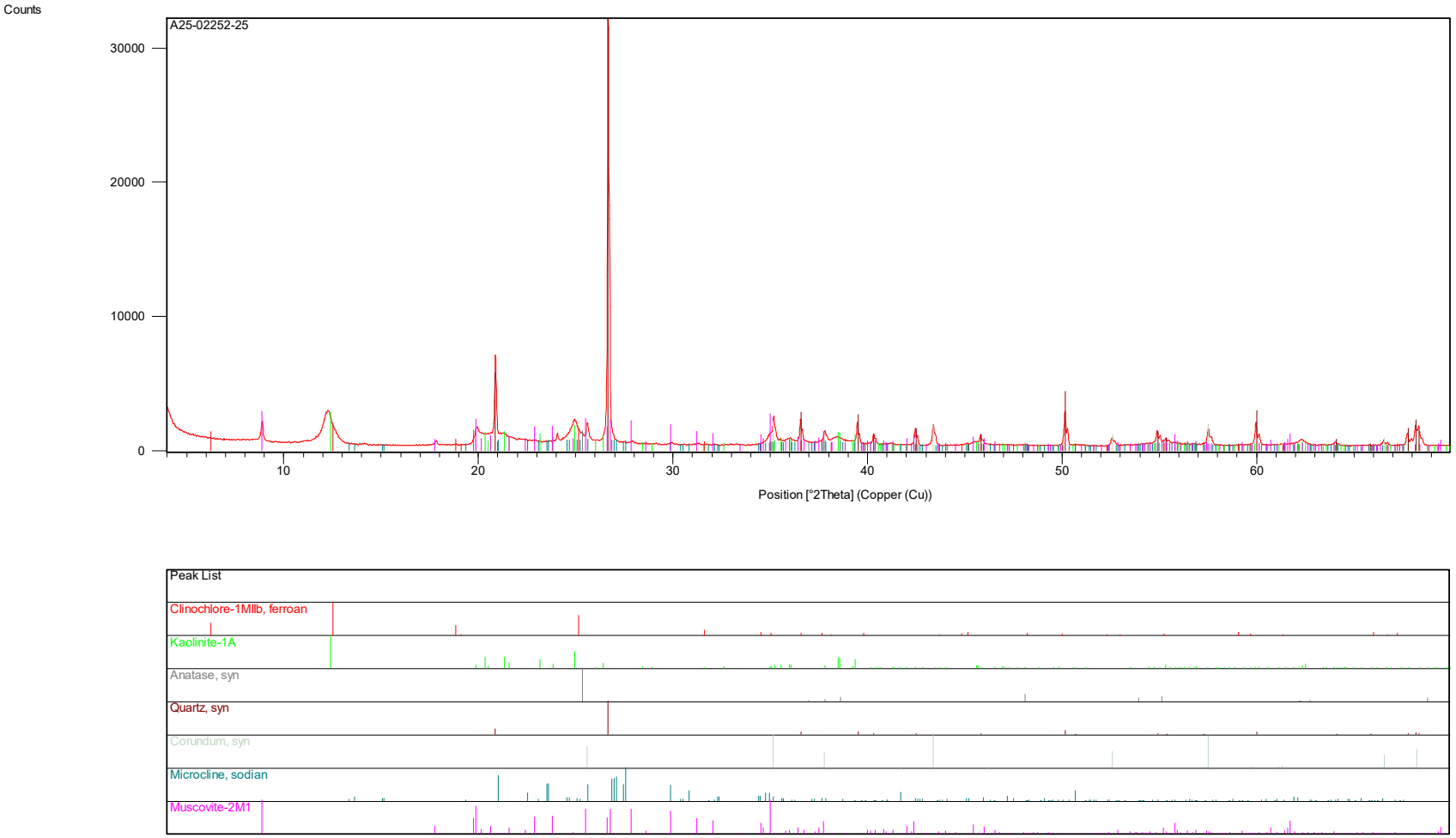

Counts
A25-02252-20
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Albite
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

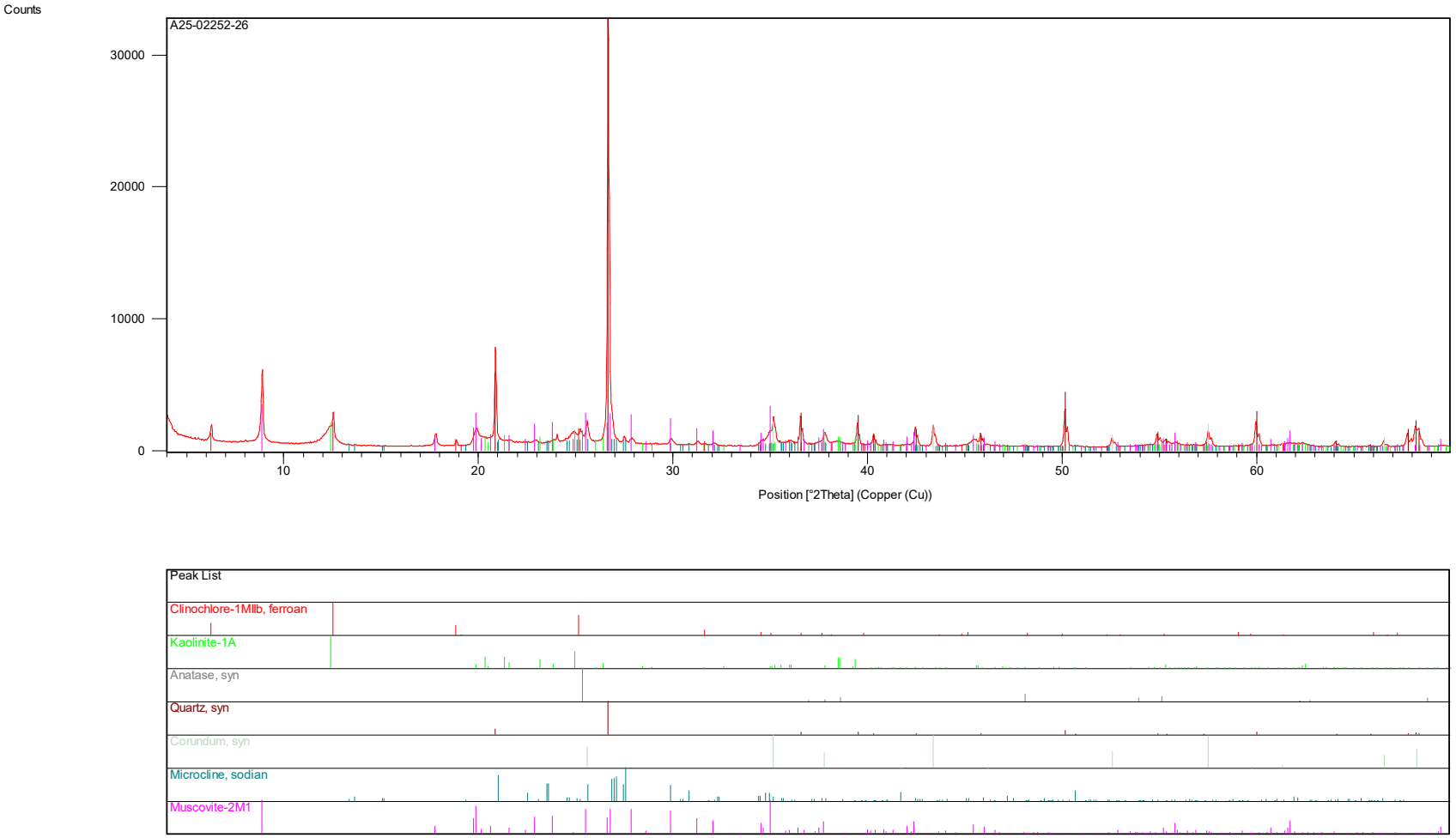

Counts
A25-02252-21
30000
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Albite
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

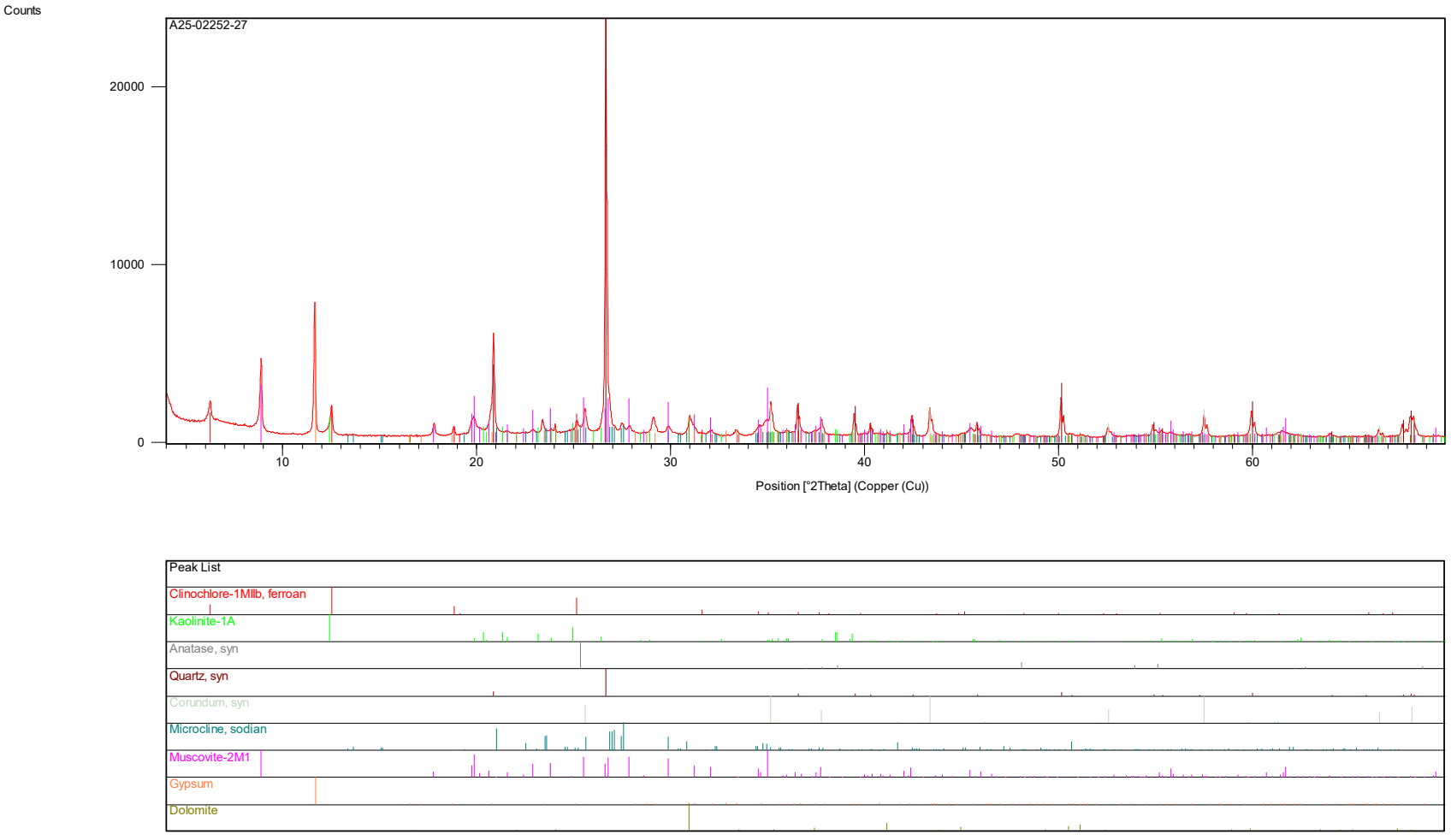

Counts
A25-02252-22
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Albite
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1
Gypsum
Dolomite
Pyrite


Counts
A25-02252-23
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

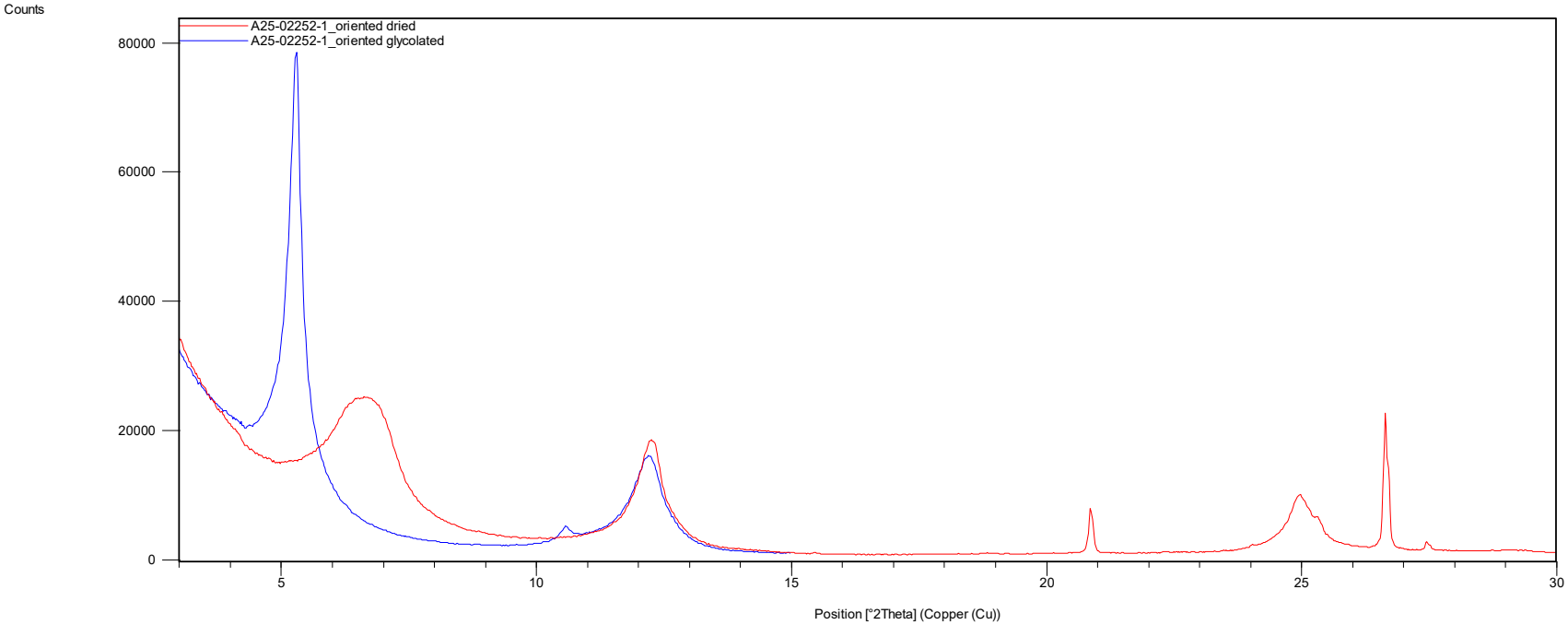

Counts
A25-02252-24
60000
40000
20000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

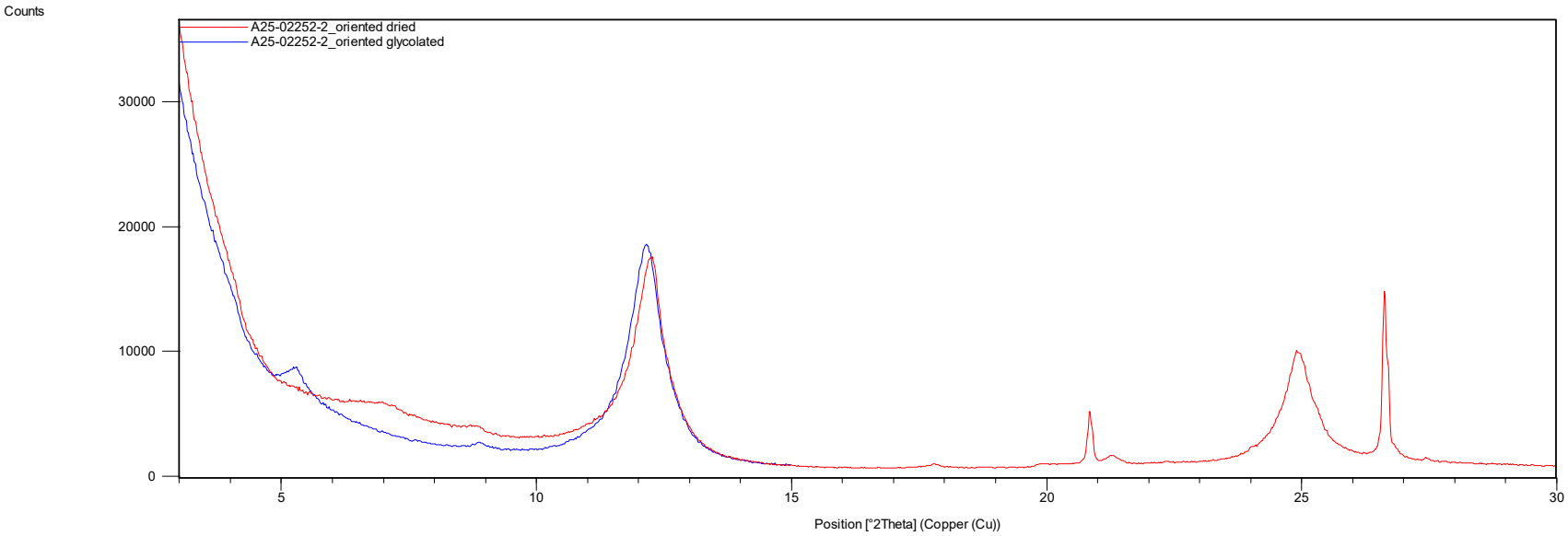

Counts
A25-02252-25
30000
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

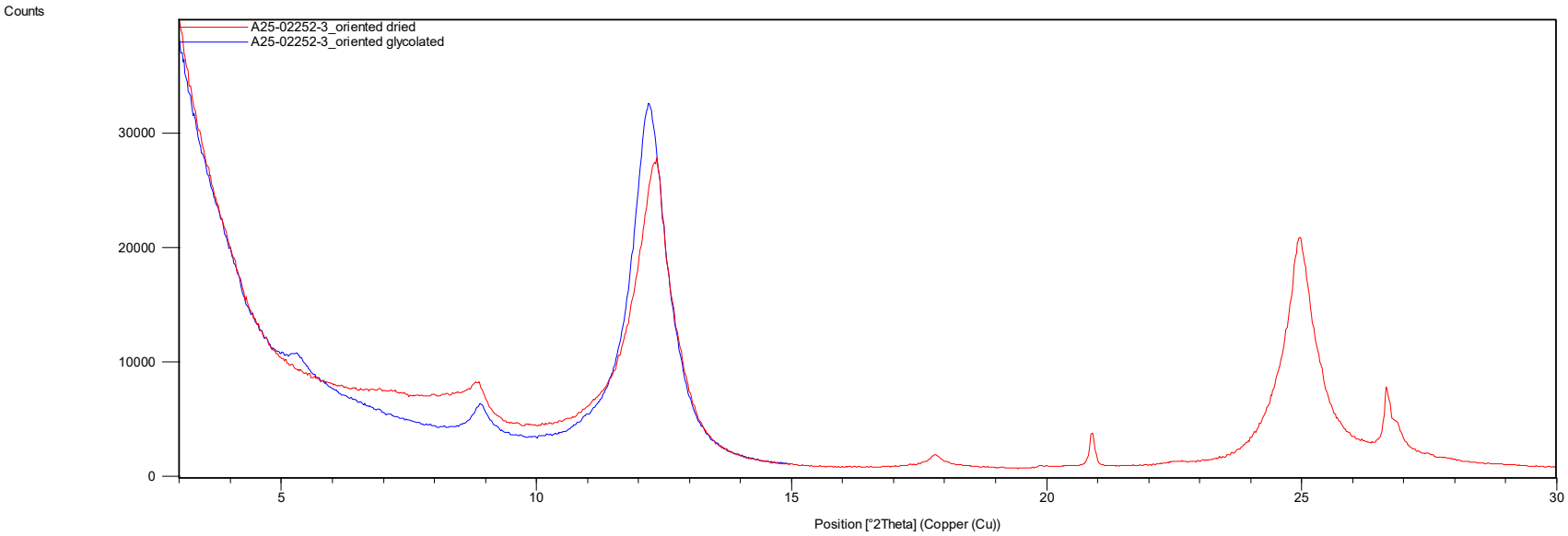

Counts
A25-02252-26
30000
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1

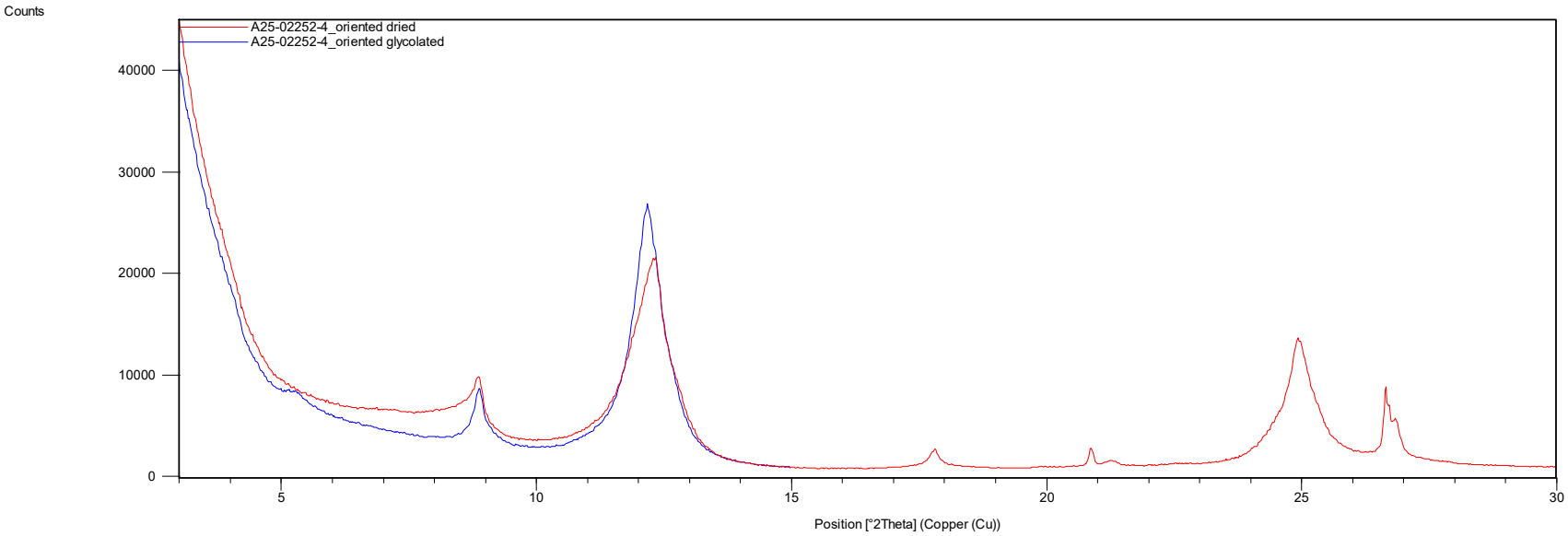

Counts
A25-02252-27
20000
10000
0
10
20
30
40
50
60
Position [°2Theta] (Copper (Cu))
Peak List
Clinochlore-1Mllb, ferroan
Kaolinite-1A
Anatase, syn
Quartz, syn
Corundum, syn
Microcline, sodian
Muscovite-2M1
Gypsum
Dolomite

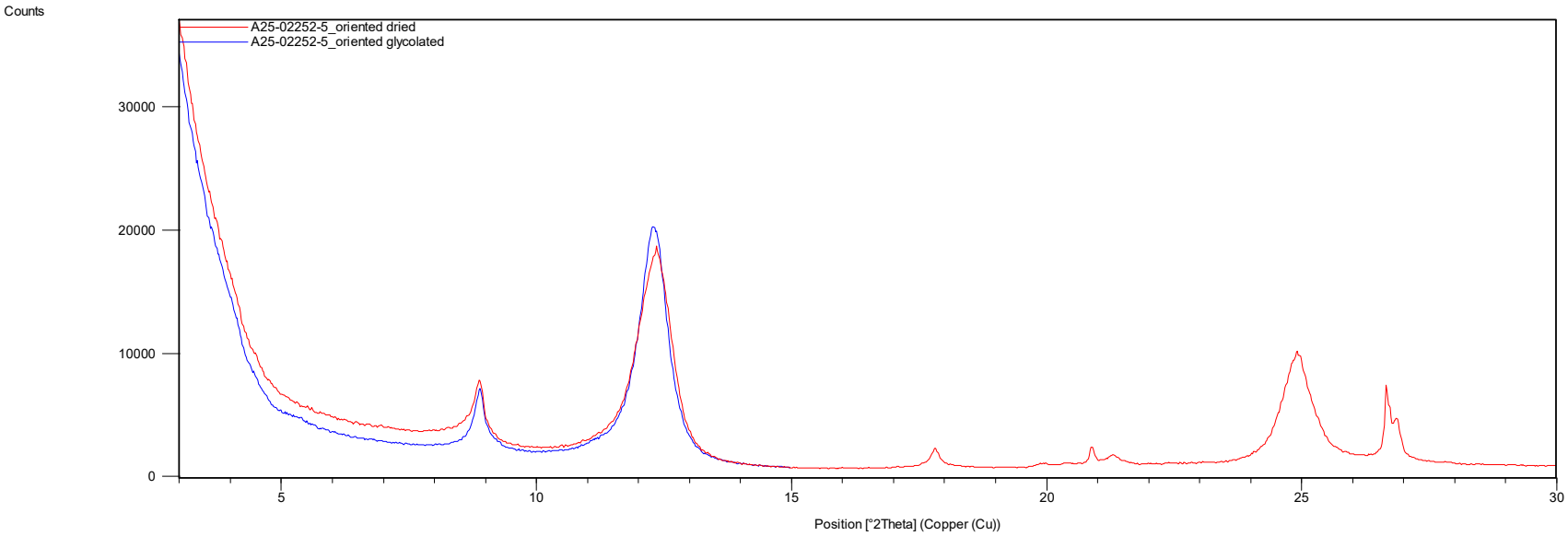
Diffraction patterns of the < 4 μm size fraction

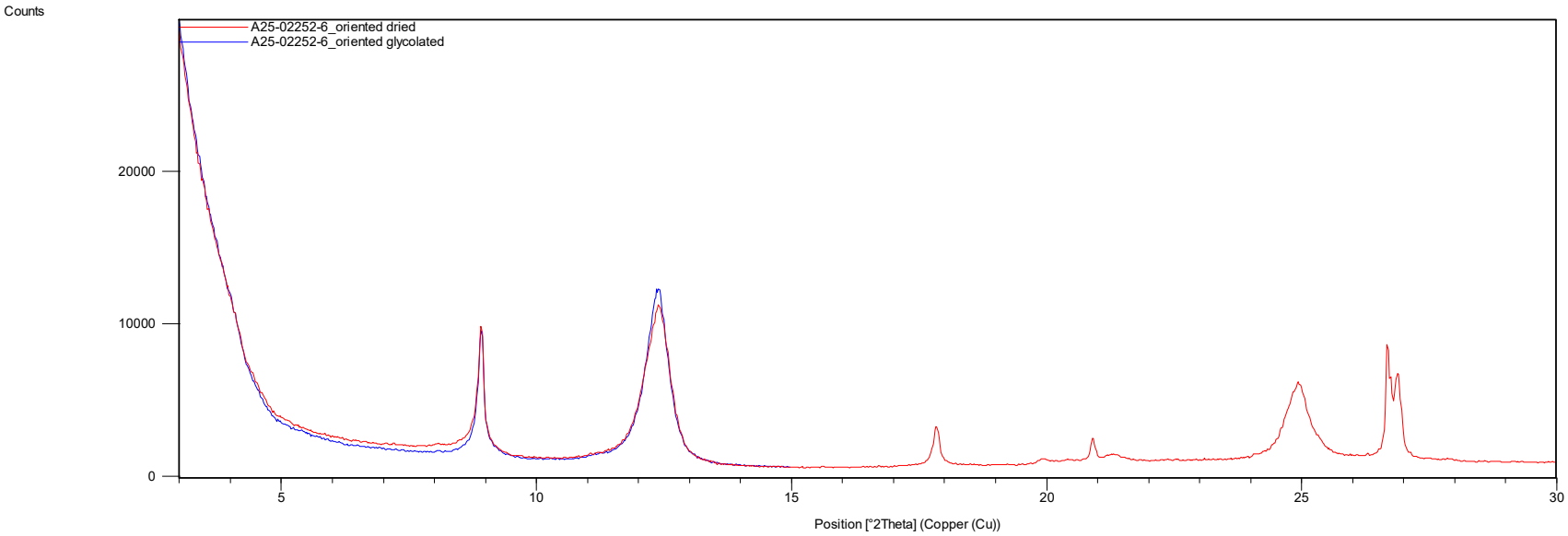

Counts
A25-02252-1_oriented dried
A25-02252-1_oriented glycolated
80000
60000
40000
20000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

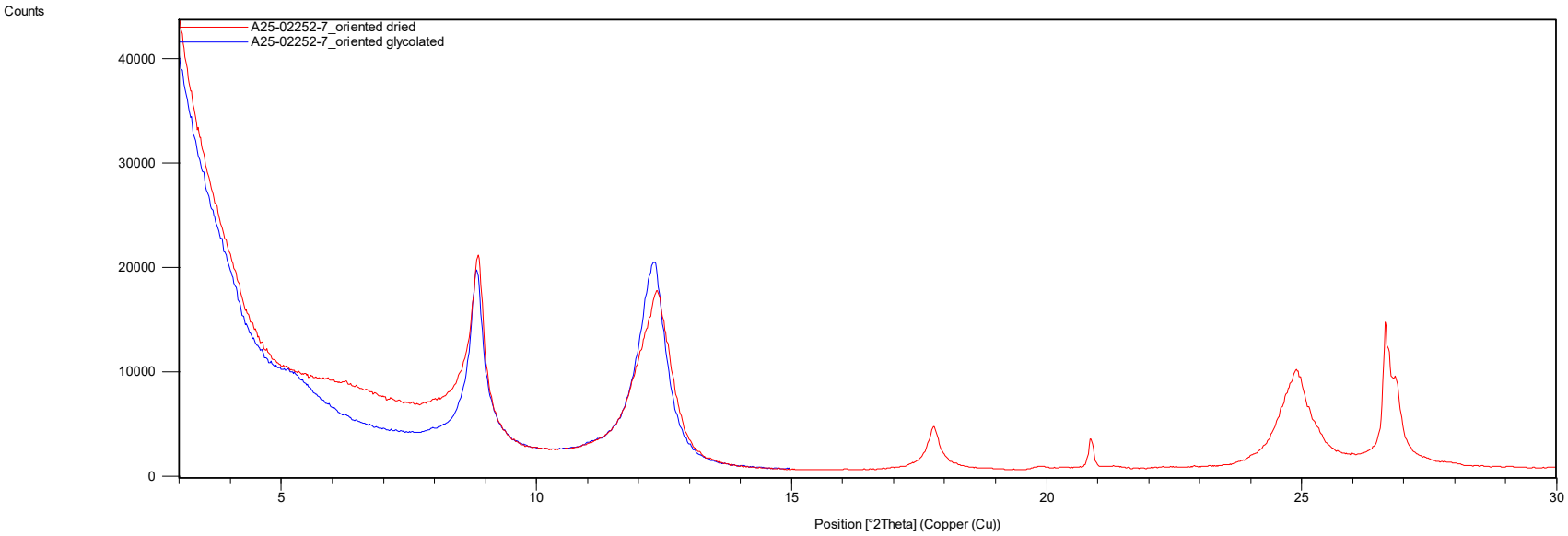

Counts
A25-02252-2_oriented dried
A25-02252-2_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

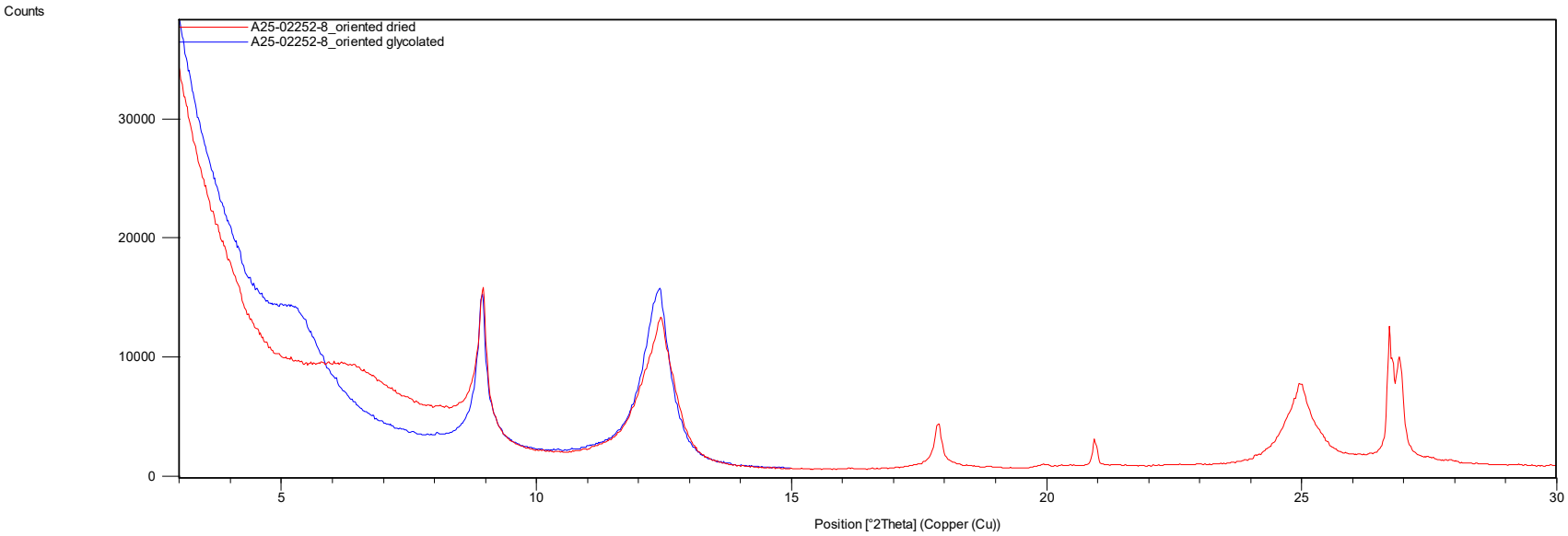

Counts
A25-02252-3_oriented dried
A25-02252-3_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

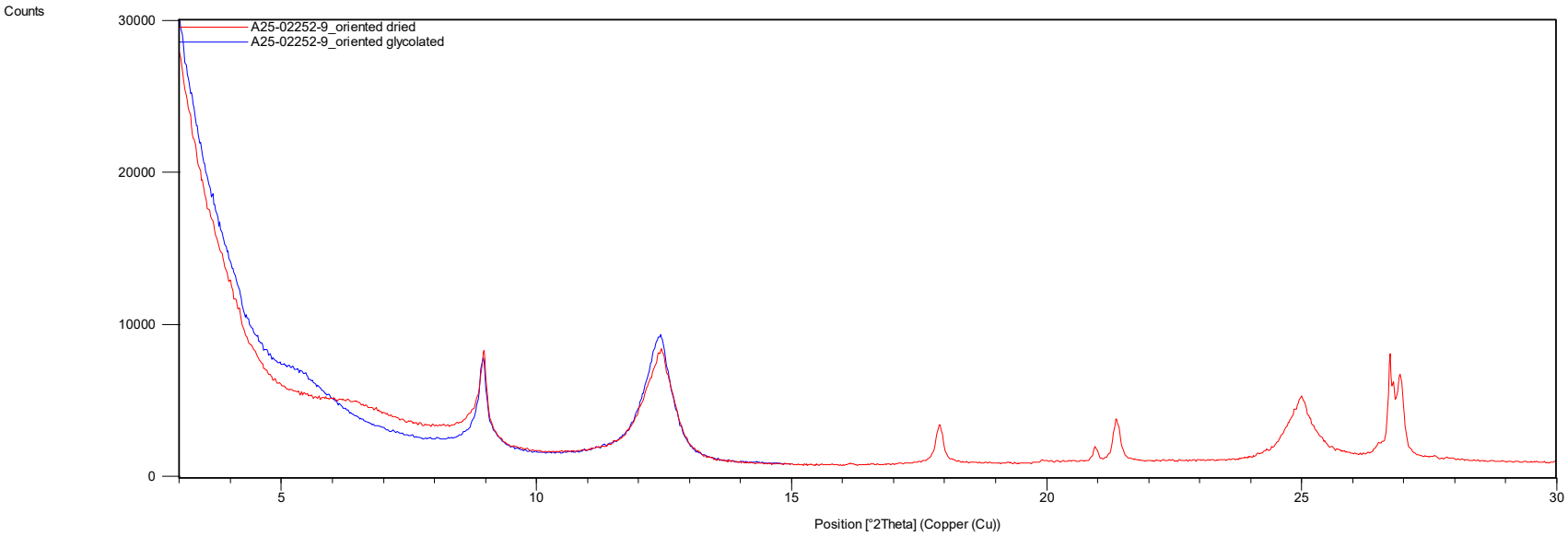

Counts
A25-02252-4_oriented dried
A25-02252-4_oriented glycolated
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

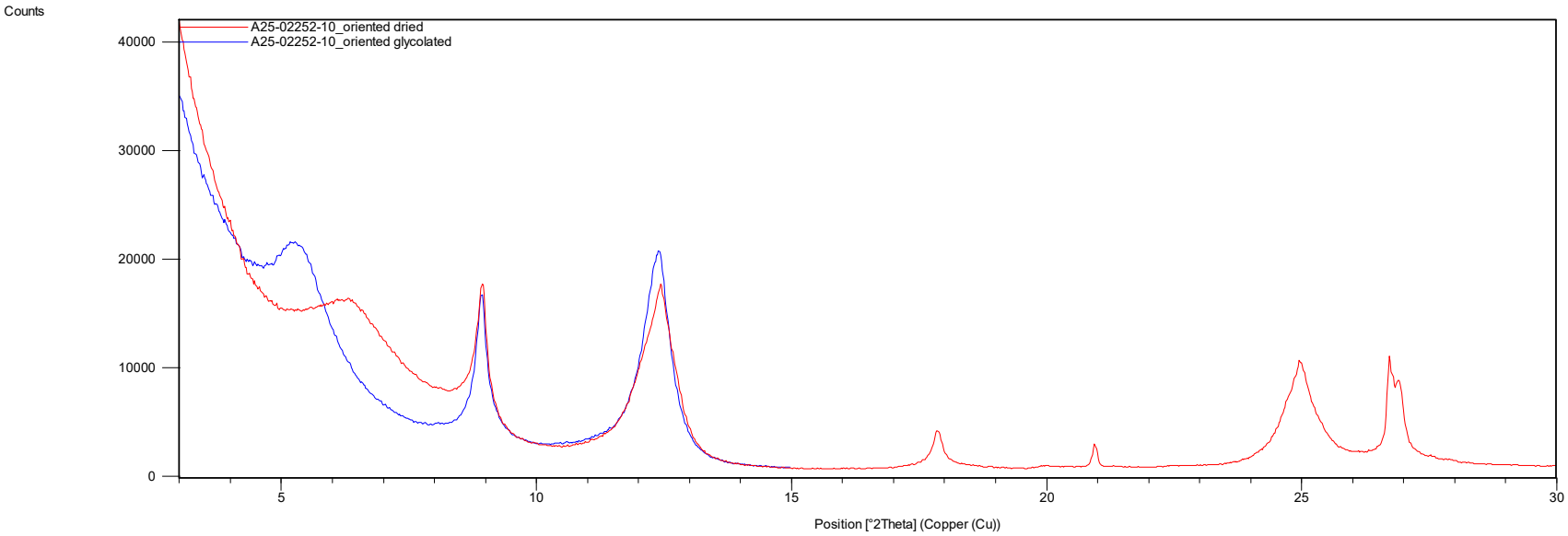

Counts
A25-02252-5_oriented dried
A25-02252-5_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

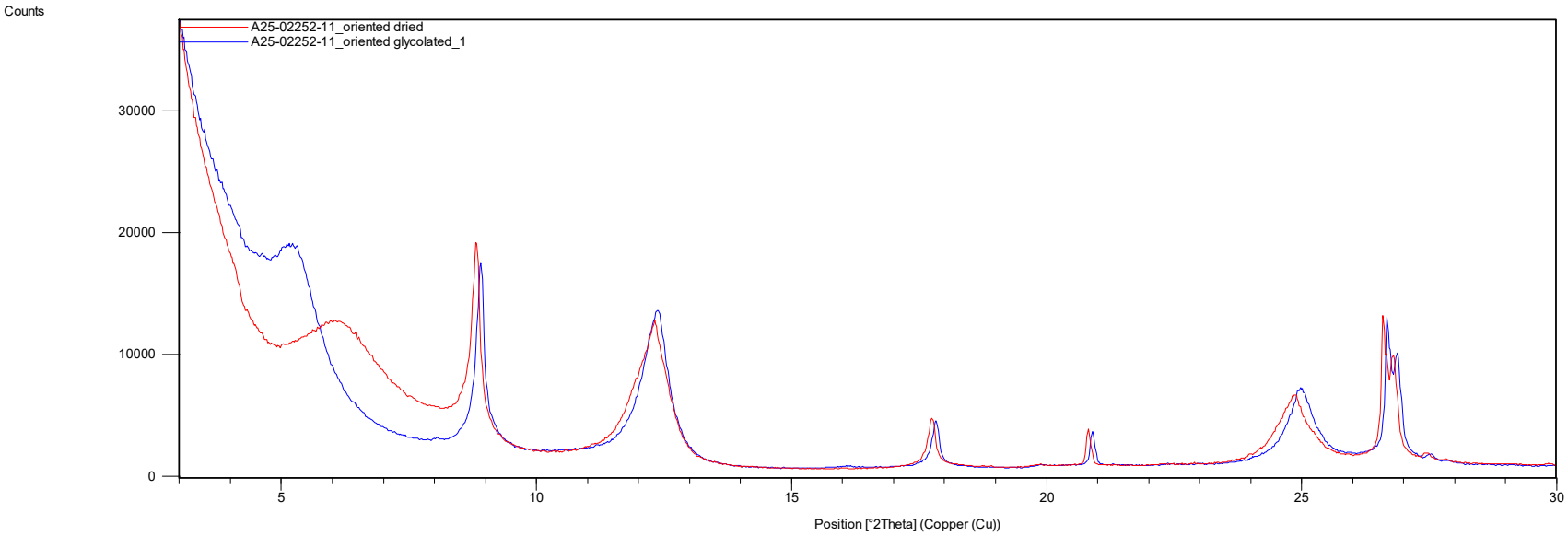

Counts
A25-02252-6_oriented dried
A25-02252-6_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

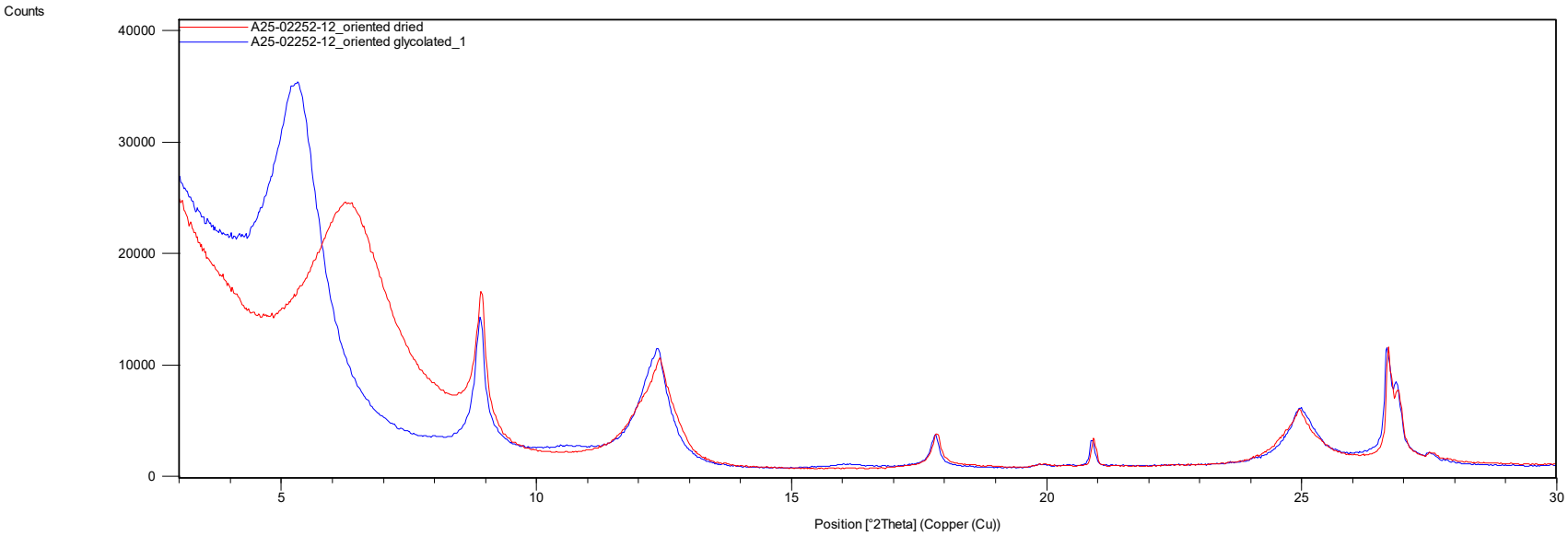

Counts
A25-02252-7_oriented dried
A25-02252-7_oriented glycolated
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

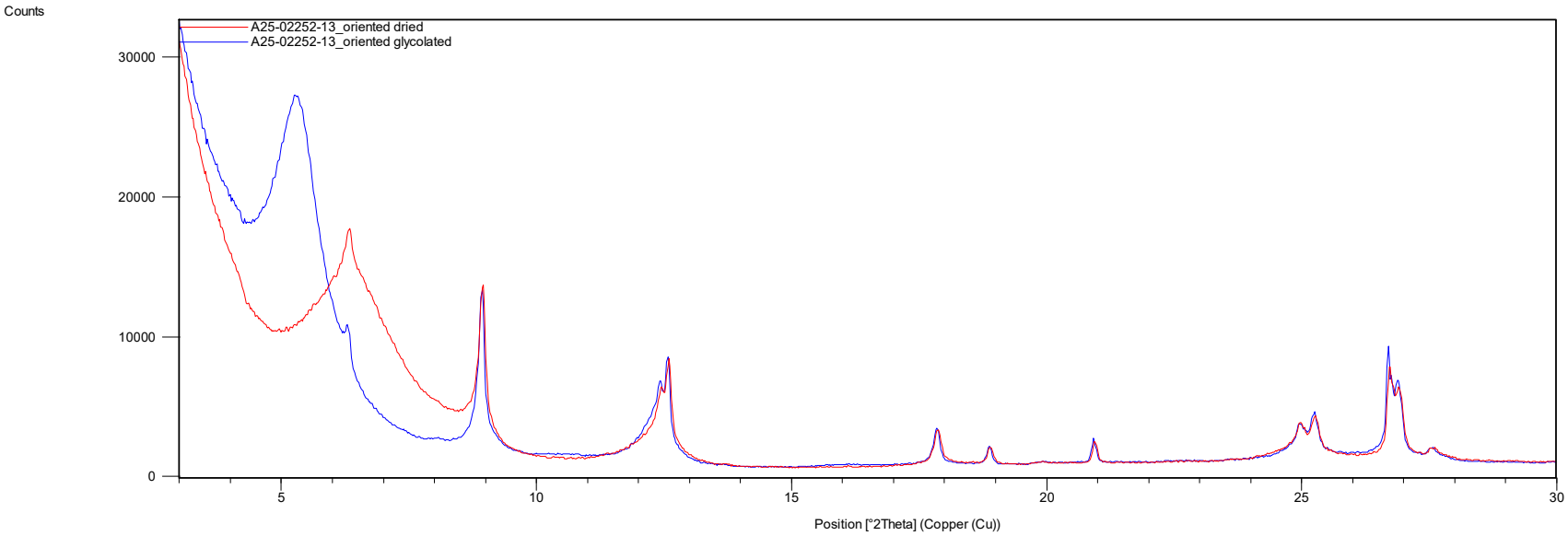

Counts
A25-02252-8_oriented dried
A25-02252-8_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

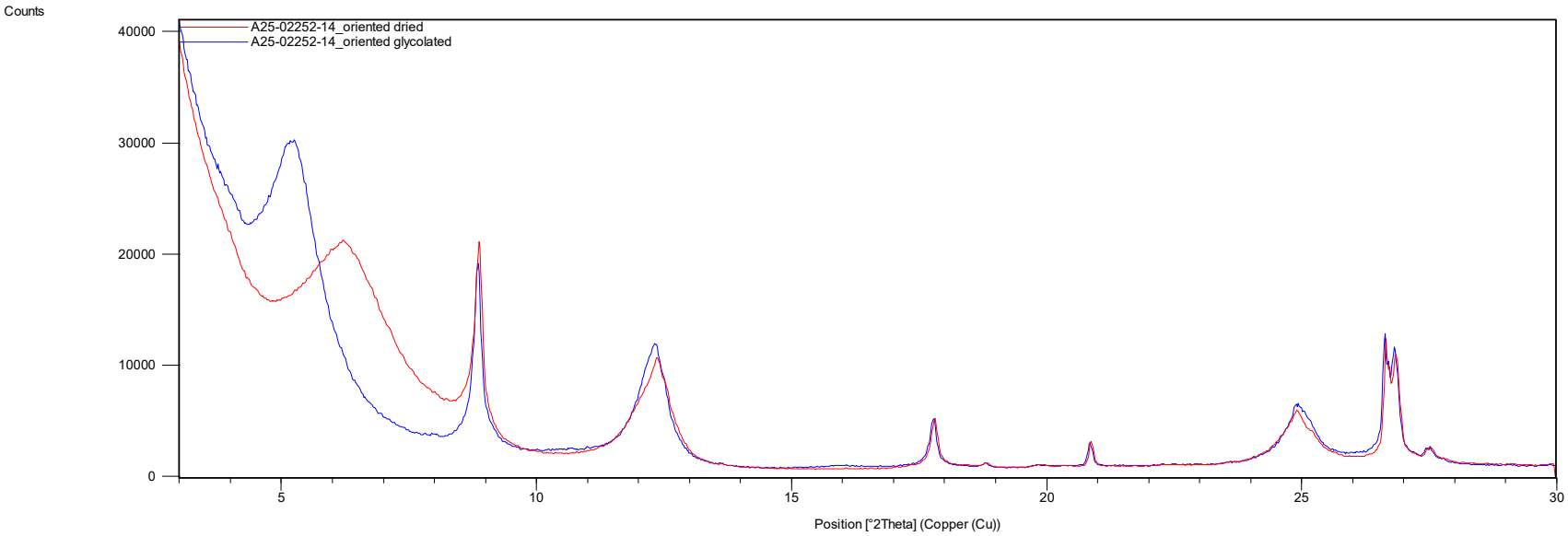

Counts
30000
20000
10000
0
A25-02252-9_oriented dried
A25-02252-9_oriented glycolated
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

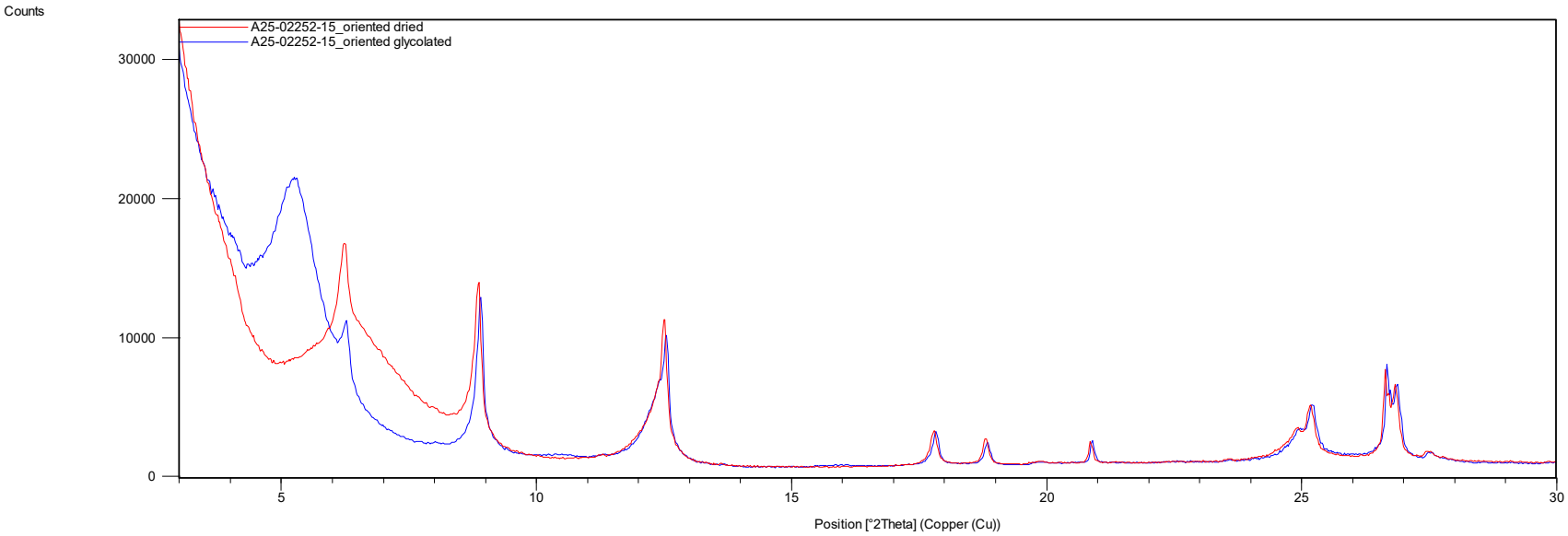

Counts
A25-02252-10_oriented dried
A25-02252-10_oriented glycolated
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

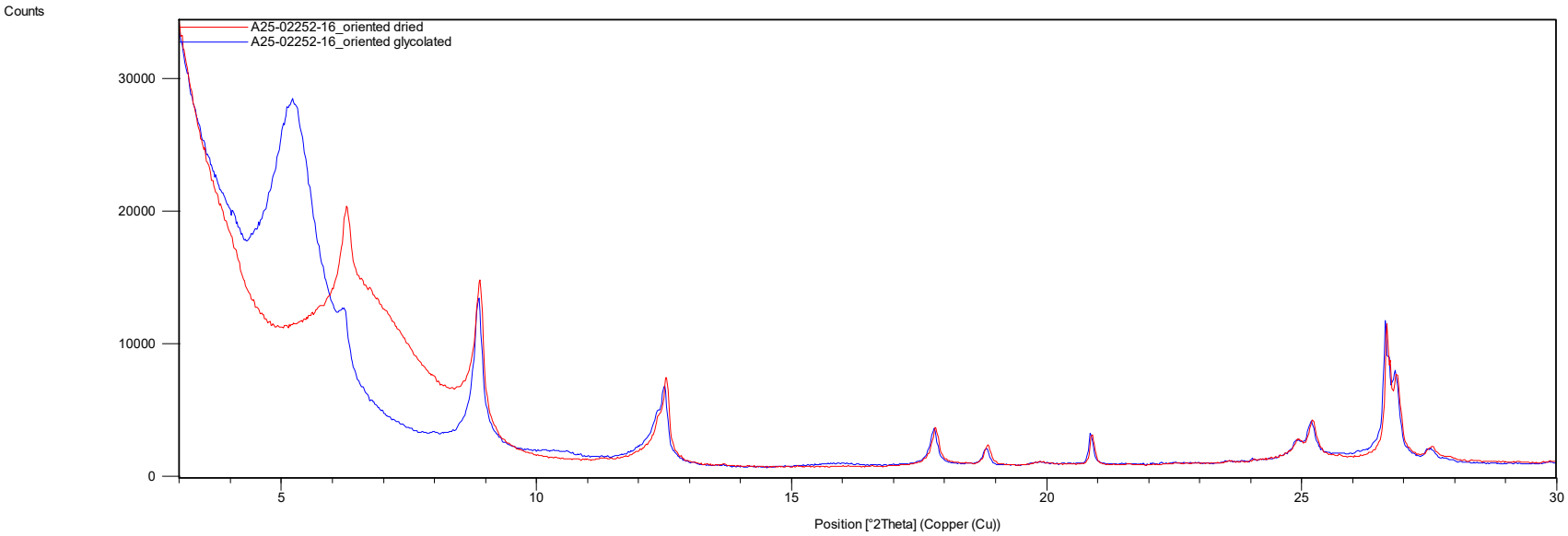

Counts
A25-02252-11_oriented dried
A25-02252-11_oriented glycolated_1
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

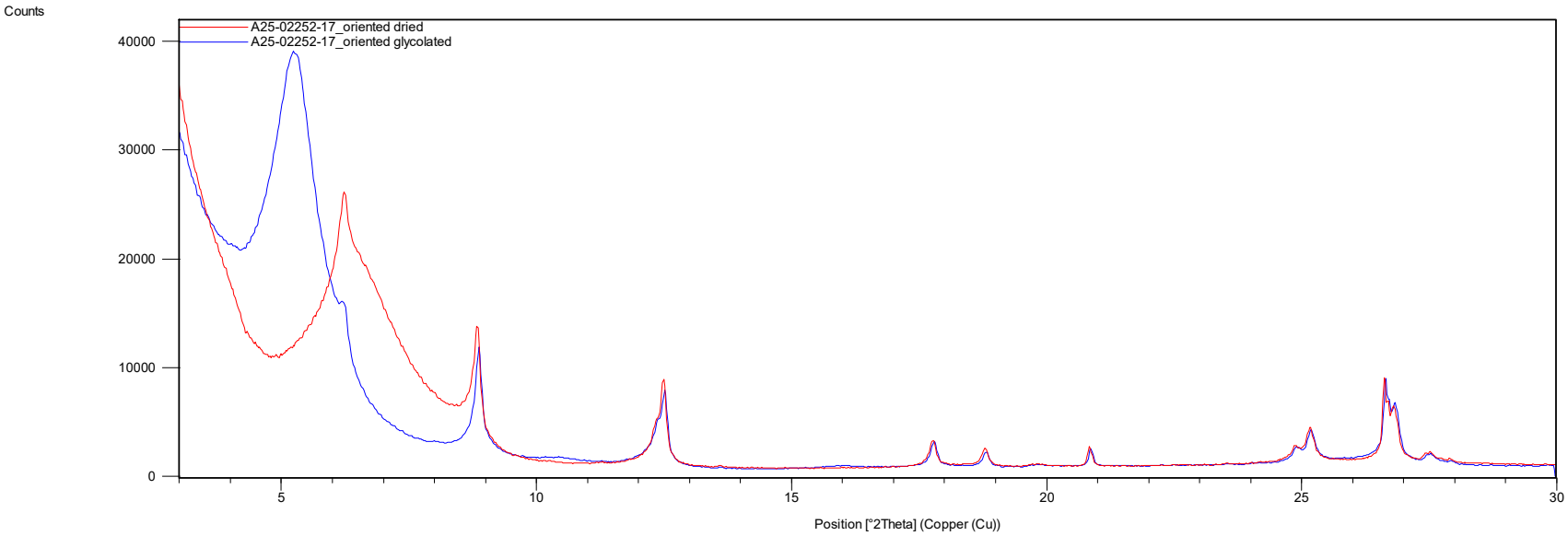

Counts
A25-02252-12_oriented dried
A25-02252-12_oriented glycolated_1
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

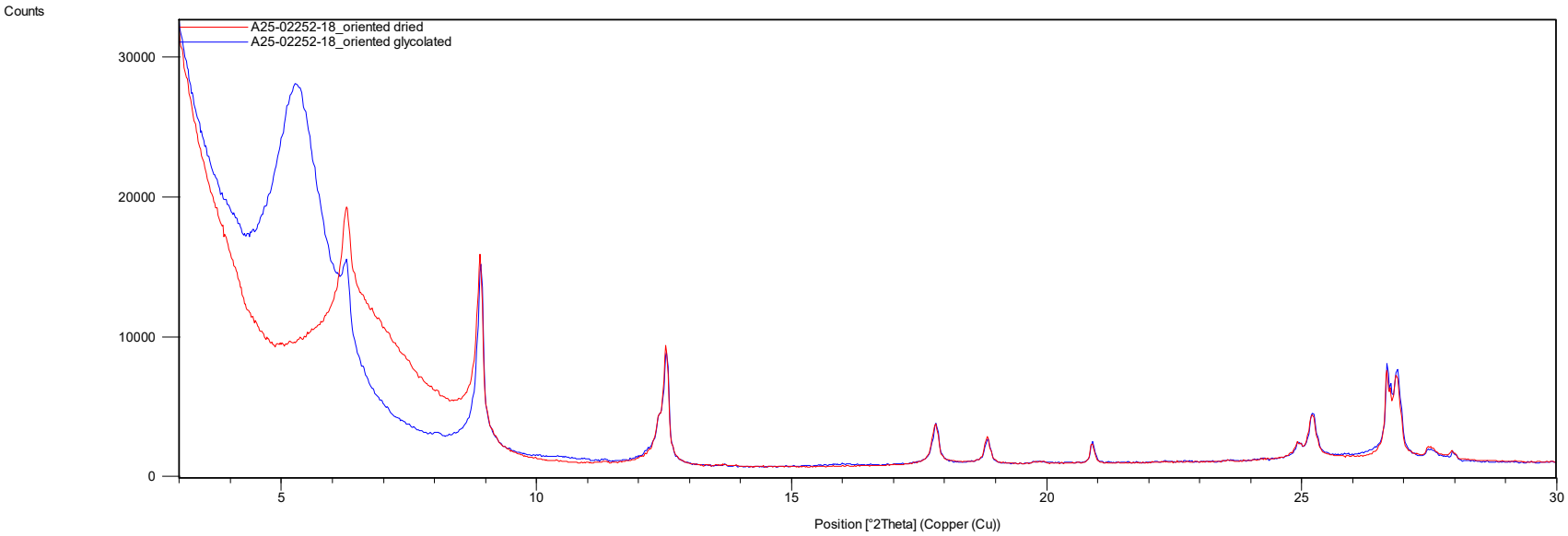

Counts
A25-02252-13_oriented dried
A25-02252-13_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

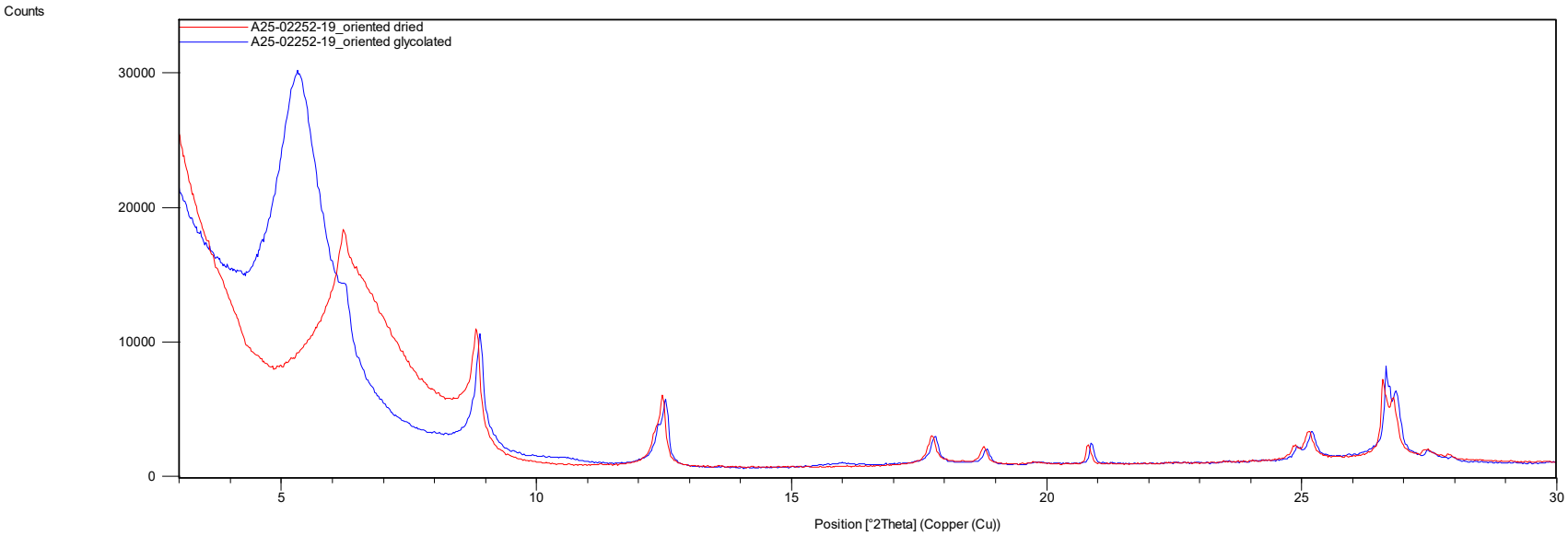

Counts
A25-02252-14_oriented dried
A25-02252-14_oriented glycolated
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

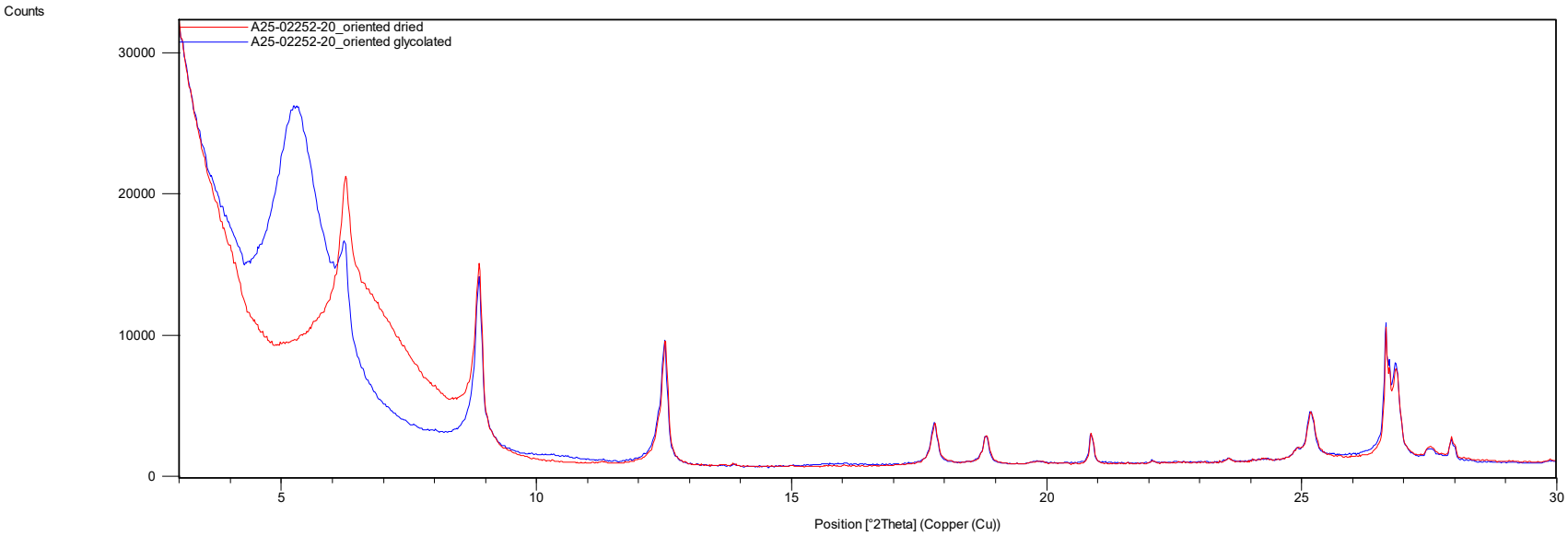

Counts
A25-02252-15_oriented dried
A25-02252-15_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

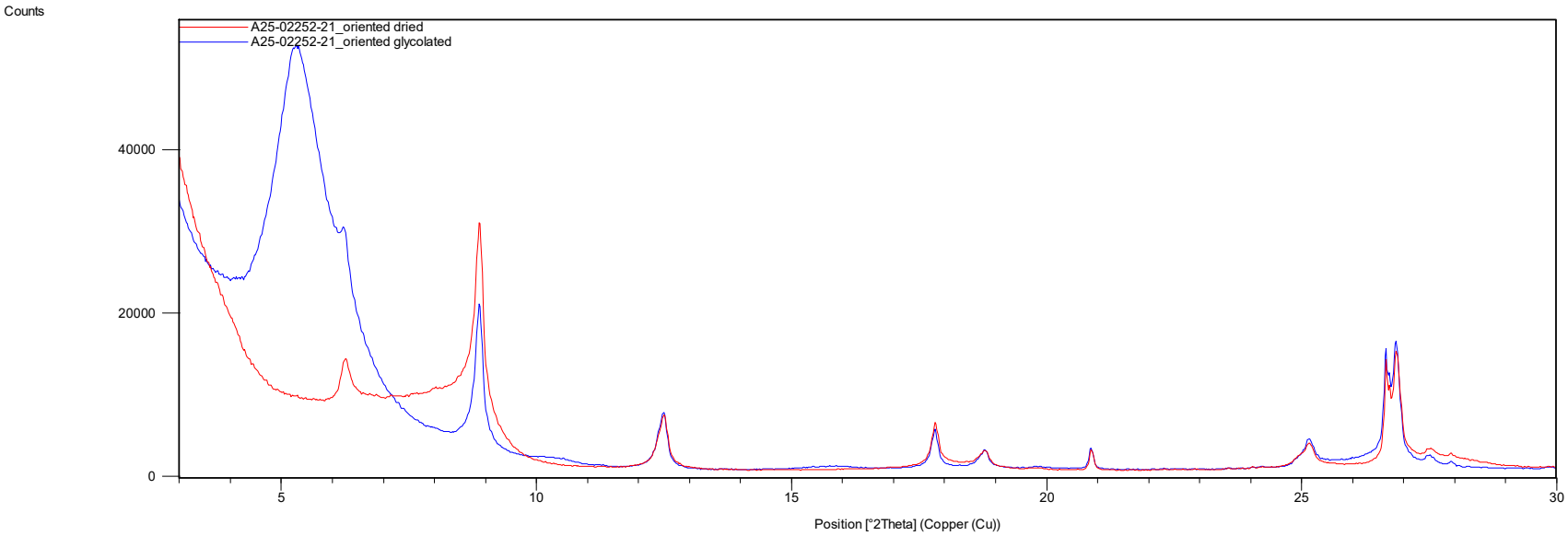

Counts
A25-02252-16_oriented dried
A25-02252-16_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

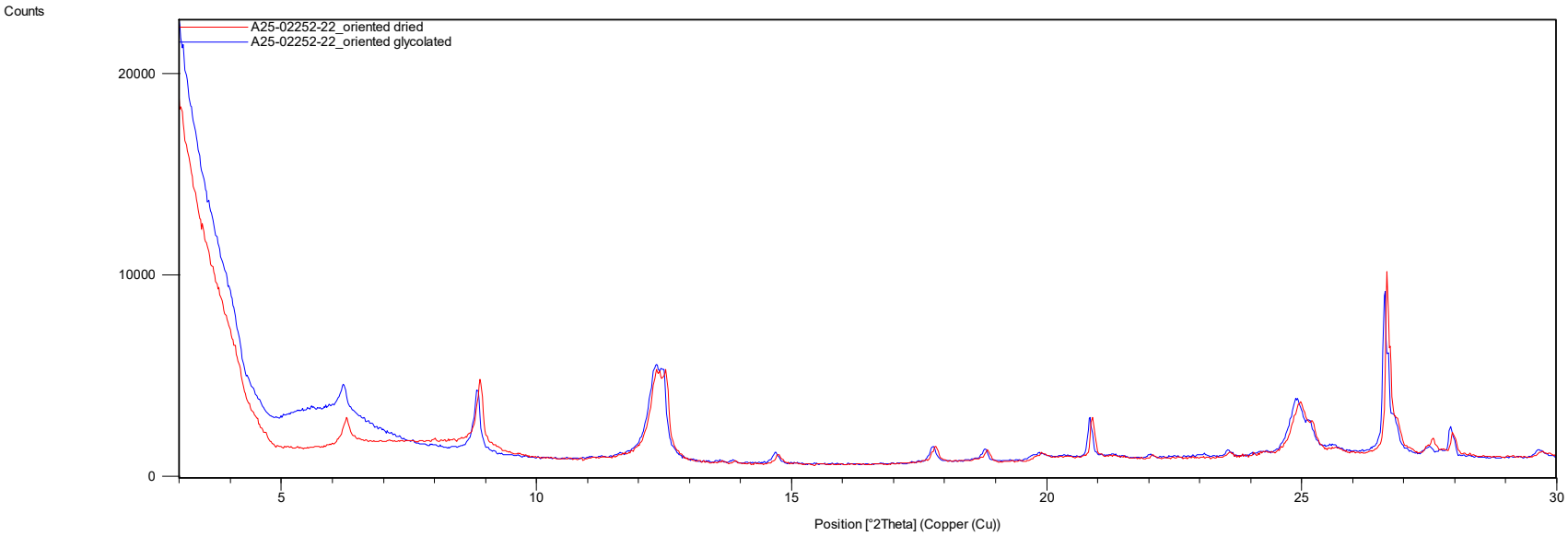

Counts
A25-02252-17_oriented dried
A25-02252-17_oriented glycolated
40000
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

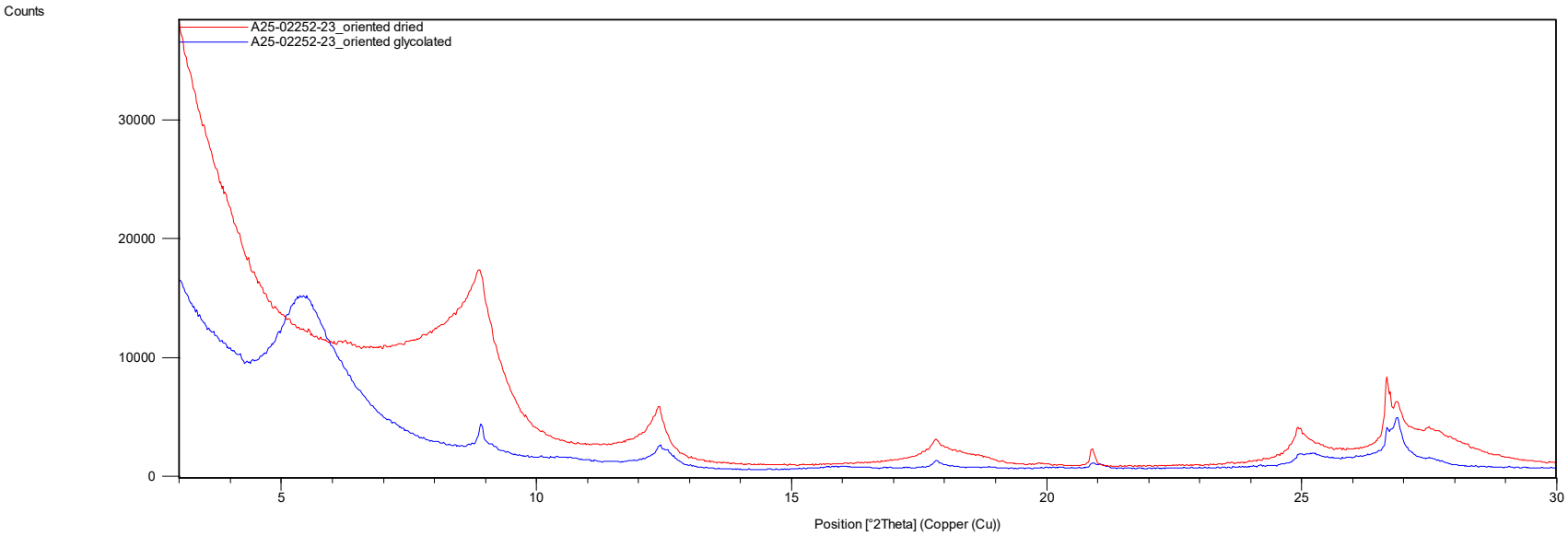

Counts
A25-02252-18_oriented dried
A25-02252-18_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

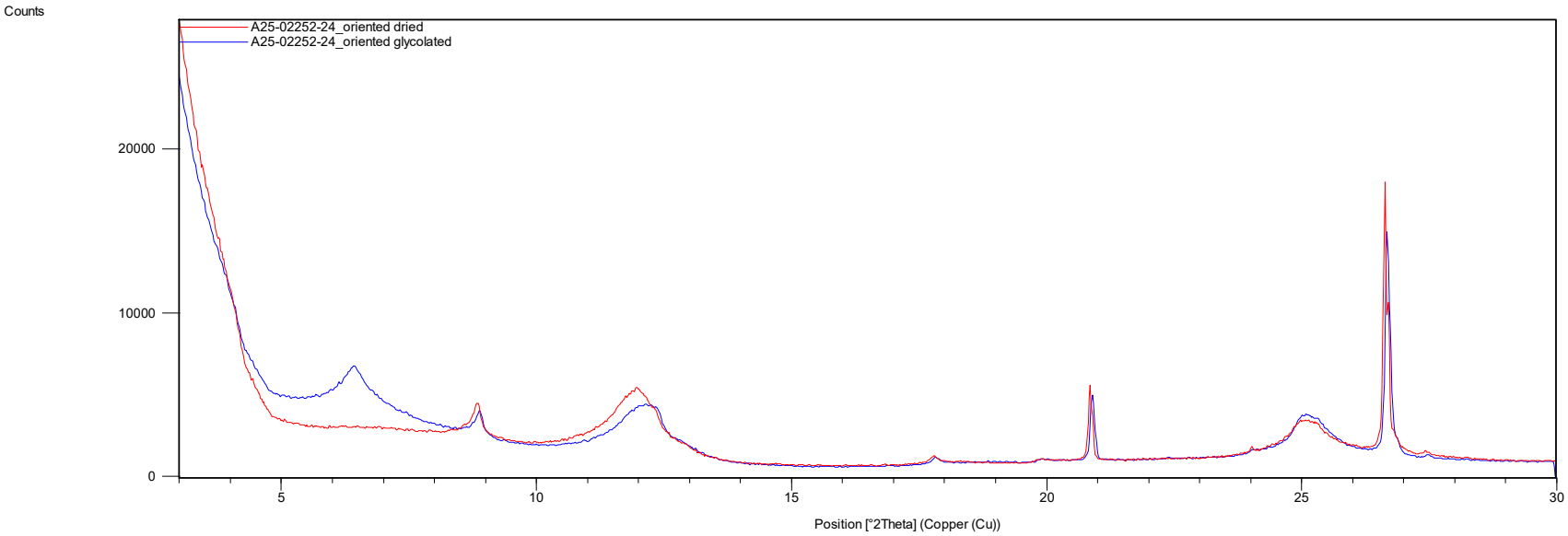

Counts
A25-02252-19_oriented dried
A25-02252-19_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

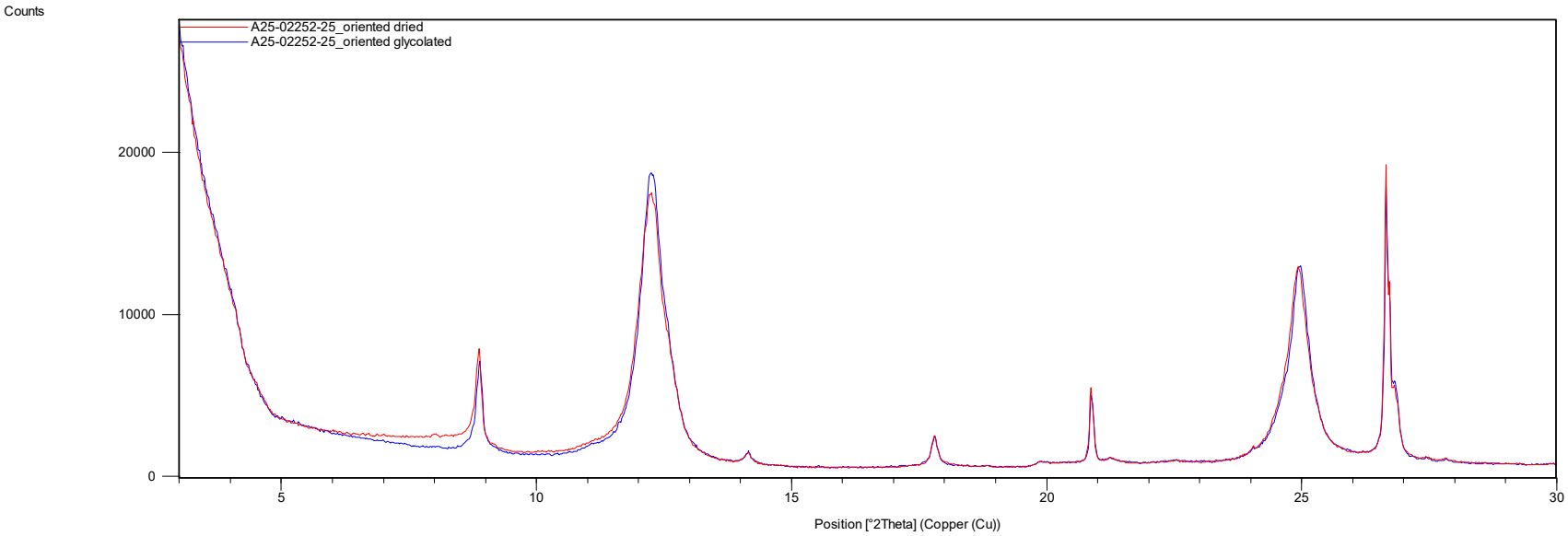

Counts
A25-02252-20_oriented dried
A25-02252-20_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

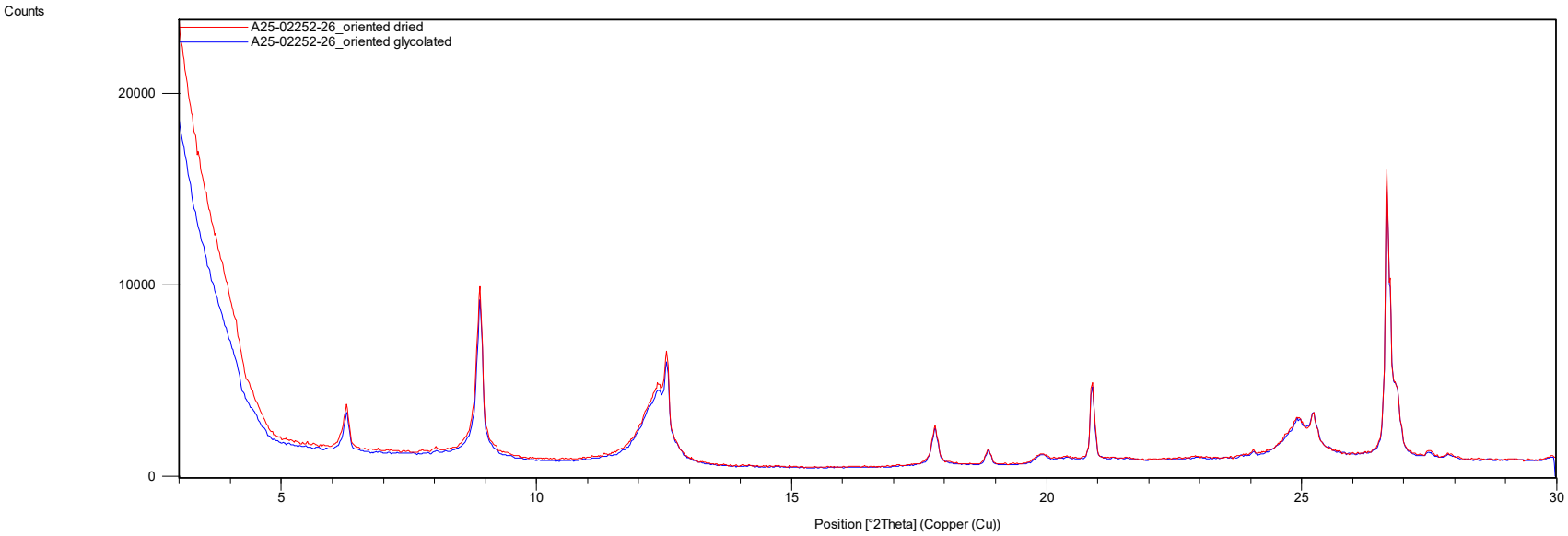

Counts
A25-02252-21_oriented dried
A25-02252-21_oriented glycolated
40000
20000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))

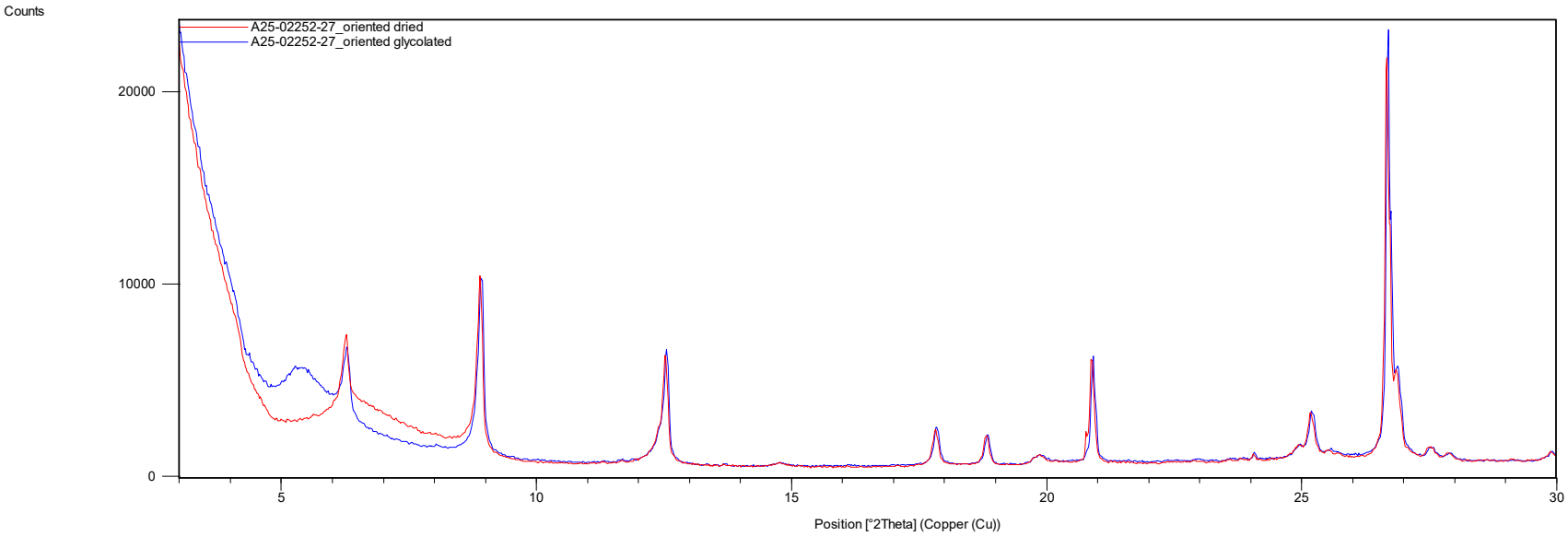

Counts
A25-02252-22_oriented dried
A25-02252-22_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))


Counts
A25-02252-23_oriented dried
A25-02252-23_oriented glycolated
30000
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))


Counts
A25-02252-24_oriented dried
A25-02252-24_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))


Counts
A25-02252-25_oriented dried
A25-02252-25_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))


Counts
A25-02252-26_oriented dried
A25-02252-26_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))


Counts
A25-02252-27_oriented dried
A25-02252-27_oriented glycolated
20000
10000
0
5
10
15
20
25
30
Position [°2Theta] (Copper (Cu))