

299-W18-67 (A7550)
Log Data Report

Borehole Information:

Borehole: 299-W18-67 (A7550)		Site: 216-Z-3 Crib			
Coordinates (WA St Plane)		GWL¹ (ft): None		GWL Date: 12/11/06	
North (m) 135462.663	East (m) 566571.123	Drill Date 09/49	TOC Elevation 682.38 ft	Total Depth (ft) 47.0	Type Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel	2.6	8 3/4	8	3/8	2.6	47

Borehole Notes:

The logging engineer measured the casing stick-up and diameter using a caliper and steel tape. Logging data acquisition is referenced to the TOC.

Logging Equipment Information:

Logging System: Gamma 1E	Type: SGLS (70%) SN: 34-TP40587A
Effective Calibration Date: 05/02/06	Calibration Reference: DOE-EM/GJ1200-2006
Logging Procedure: HGLP-MAN-002, Rev. 0	

Logging System: Gamma 4H	Type: NMLS SN: H310700352
Effective Calibration Date: 11/22/06	Calibration Reference: HGLP-CC-002
Logging Procedure: HGLP-MAN-002, Rev. 0	

Logging System: Gamma 4H	Type: PMLS SN: H310700352
Effective Calibration Date: Not required	Calibration Reference: HGLP-CC-002
Logging Procedure: HGLP-MAN-002, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2 Repeat	3 Repeat		
Date	12/11/06	12/11/06	12/12/06		
Logging Engineer	Pope	Pope	Pope		
Start Depth (ft)	3.0	31.0	29.0		
Finish Depth (ft)	43.0	28.0	17.5		
Count Time (sec)	200	400	400		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	0.5	0.5		
ft/min	N/A ²	N/A	N/A		
Pre-Verification	AE209CAB	AE209CAB	AE210CAB		
Start File	AE209000	AE209041	AE210000		

Log Run	1	2 Repeat	3 Repeat		
Finish File	AE209040	AE209047	AE210023		
Post-Verification	AE209CAA	AE209CAA	AE210CAA		
Depth Return Error (in.)	N/A	- 0.4	- 0.5		
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.		

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	4	5 Repeat			
Date	12/14/06	12/14/06			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	4.0	20.0			
Finish Depth (ft)	42.5	26.25			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
Sample Interval (ft)	0.25	0.25			
ft/min	1.0	1.0			
Pre-Verification	DH332CAB	DH332CAB			
Start File	DH332000	DH332155			
Finish File	DH332154	DH332180			
Post-Verification	DH332CAA	DH332CAA			
Depth Return Error (in.)	N/A	0			
Comments	None	None			

Passive Neutron Logging System (PNLS) Log Run Information:

Log Run	6	7 Repeat			
Date	12/14/06	12/14/06			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	4.0	12.0			
Finish Depth (ft)	42.0	32.0			
Count Time (sec)	60	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	0.25			
ft/min	N/A	N/A			
Pre-Verification	DH342CAB	DH342CAB			
Start File	DH342000	DH342039			
Finish File	DH342038	DH342119			
Post-Verification	DH342CAA	DH342CAA			
Depth Return Error (in.)	N/A	- 0.5			
Comments	None	None			

Logging Operation Notes:

Logging was conducted with a centralizer on each sonde and measurements are referenced to top of casing. Repeat data for the SGLS were acquired at a 400 second counting times at 0.5 ft depth intervals.

Repeat data with the PNLS were acquired with the same logging parameters (i.e., 0.25 ft intervals at 15 second count time) as the NMLS so that the influence from the neutron flux generated by the alpha emitting radionuclides could be segregated from the flux generated by the neutron source.

Analysis Notes:

Analyst:	Henwood	Date:	01/15/07	Reference:	GJO-HGLP 1.6.3, Rev. 0
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Pre-run and post-run verifications for the logging systems were performed before and after each day's data acquisition. The acceptance criteria were met.

A casing correction for a 3/8-in. thick casing was applied to the SGLS data.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G1EMay06.xls using an efficiency function and corrections for casing and dead time as determined from annual calibrations.

The NMLS and PNLS data were acquired with the same sonde. NMLS data are acquired using a 50 mCi AmBe source while the passive neutron logging system data are acquired without the source. The counts accumulated with the passive neutron system at the same depths are subtracted from the counts acquired with the neutron logging system to determine the counts attributable to moisture. The NMLS count rate data are then converted to volumetric moisture using calibrations for an 8-in. ID casing. The passive neutron counts are considered to be predominantly the result of alpha, neutron (α,n) reactions where alpha emitting radionuclides interact with light elements (e.g., F, N, O, Mg, Al, Si) to produce a neutron flux. Another source of neutrons may be from spontaneous fission of predominantly even numbered isotopes of plutonium (e.g., Pu-240), although this reaction is considered less dominant than the (α,n) reactions.

Results and Interpretations:

AM-241 is detected from 19.5 to 29 ft. The maximum concentration is measured at approximately 230,000 pCi/g at 21.5 ft. Gamma rays at approximately 662, 722, and 208 keV were detected that represent AM-241. Cs-137 emits a 661.66 gamma ray that cannot be distinguished from the 662.40 gamma ray emitted from AM-241. The energy peak at 722.01 keV is used to establish the presence of AM-241 rather than Cs-137. In this borehole the 722.01 keV energy peak is used to determine the AM-241 concentration. When comparing the assays for AM-241 using the 662 and 722 keV energy peaks, there appears to be residual counts in the 662 keV energy peak that may be attributed to Cs-137. On the basis of the 722.01 keV assay, counts from the 662 keV energy peak were subtracted which yields the approximate contribution from Cs-137.

Using this approach, Cs-137 is detected from 19 to 32 ft. The maximum concentration of 10 pCi/g is measured at approximately 30 ft, well below the depth of 21.5 ft where the maximum concentrations of other radionuclides were detected.

The AM-241 concentrations derived from the 208.01 keV gamma line are significantly over estimated. A 208.000 keV gamma line that results from the decay of U-237 (daughter of Pu-241), interferes with the 208.01 keV gamma line caused by the decay of AM-241. For purposes of this report, it is assumed that all of the counts in the 208 keV energy peak that cannot be attributed to AM-241, reflect decay of U-237. Assuming the waste stream is aged (e.g., 40 years or more), U-237 has grown into equilibrium with its parent Pu-241. Equilibrium is a condition where the rate of production of a nuclide by radioactive decay equals the rate of decay of that nuclide. In other words, in equilibrium condition the activity of a daughter product will equal the activity of the parent. After subtracting the influence of AM-241 from the 208 keV energy peak, it is estimated Pu-241 exists between 19.5 and 29 ft at concentrations ranging from 100,000 to 3,300,000 pCi/g; the maximum concentration is at 21.5 ft in depth.

Pu-239 was detected between 18 and 30 ft. The maximum concentration was measured at approximately 1,700,000 pCi/g at 21.5 ft. Primary energy peaks associated with Pu-239 were detected at approximately 345, 375, and 414 keV. Interferences from the 375.45 and 376.65 keV energy lines and the 415.76 and 415.88 keV gamma energy lines originating from the decay of Pa-233 and AM-241, respectively, are probable and would result in a slight over estimation of the Pu-239 concentration. However, assays compared with the 345.01 keV energy peak (which has no obvious interferences) are consistent. Therefore, it is concluded the interferences are minor and the assay using the 413.71 keV energy peak is the most reasonable and is used to determine concentrations of Pu-239. The yields of the 413.71 and 375.05 keV gamma rays are similar (0.0015 and 0.0016 percent, respectively) and an order of magnitude greater than the 345.01 keV yield (0.006 percent). The 375.05 keV gamma line has more potential interferences than the 413.71 keV gamma line.

Weapons grade plutonium is generally defined as approximately 6 % by weight of Pu-240. The table below relates a hypothetical weapons grade Pu mix of the dominant isotopes by weight to activity.

	ISOTOPE (WEAPONS GRADE)		
	Pu-239	Pu-240	Pu-241
Half life (years)	24,110	6,563	14.35
Weight (percent)	93.8	5.8	0.13
Activity (percent)	27.07	6.12	62.50

Even though Pu-239 is more abundant on a weight basis, Pu-241 has a much higher specific activity. The approximate 2:1 (62.5/27.07) activity ratio of Pu-241/Pu-239 is consistent with the ratio measured in this borehole (3,300,000/1,700,000) and the waste likely represents weapons grade Pu.

Although Pu-240 was not detected with the SGLS due to a lack of emission of relatively high yielding gamma rays, it almost certainly exists in this waste stream. Using the assumptions in the table above, the Pu-239/Pu-240 activity ratio is approximately 1:4 that would suggest a Pu-240 concentration of approximately 400,000 pCi/g.

Np-237 is detected with the SGLS by measuring a daughter product (protactinium-233 (Pa-233)) that emits a prominent gamma ray at an energy of 312.17 keV. Pa-233 was detected from 19 to 30 ft. The maximum concentration is approximately 6 pCi/g at a 22 ft depth.

Passive neutron logging was performed in the borehole. This logging method has been shown to be effective in qualitatively detecting zones of alpha-emitting contaminants from secondary neutron flux generated by the (α ,n) reaction and may indicate the presence of α -emitting nuclides, including transuranic radionuclides, even where no gamma emissions are available for detection above the MDL. The passive neutron signal depends on the concentration of α sources, and the concentrations of lighter elements such as N, O, F, Mg, Al, and Si, which emit neutrons after alpha capture. The passive neutron log indicated a maximum count rate of 111 counts per second (cps) at 22 ft.

A reaction F-19 (α ,n) Na-22 yields a gamma ray at 1274.53 keV and a positron at 511 keV. A 1274.44 keV gamma ray also occurs from the decay of Eu-154. However, there are no corroborating peaks for the Eu-154 and the gamma ray is attributed to the fluorine reaction. The half life of Na-22 is short (i.e., 2.6 years), but will continue to be produced as long as sufficient fluorine and neutron activity exist. The Na-22 was detected from 18 to 30 ft at similar depth intervals as the relatively high neutron flux detected by the passive neutron logging system. The maximum concentration of Na-22 is approximately 5 pCi/g at 21.5 ft. The presence of Na-22 strongly suggests that at least some of the alpha emitting radionuclides are present as a fluoride.

Other energy peaks are observed in the high neutron flux intervals that represent capture gamma rays from elements in the formation, steel casing, or the waste stream itself. Gamma rays detected and possible sources include a 2223.2-keV H capture γ -ray, Al-28(n,g) at 1779 keV or Mg-25 (α ,n) at 1779 keV, Mn-56 at 846.75 keV and 1810.72 keV.

Moisture data indicate some variability. Based on relatively high moisture and K-40 increases, a fine-grained sediment interval begins at approximately 29 ft. The transuranic contamination appears to lie above this interval while the apparent Cs-137 exhibits its highest concentration in this interval.

The SGLS repeat logs all show good repeatability.

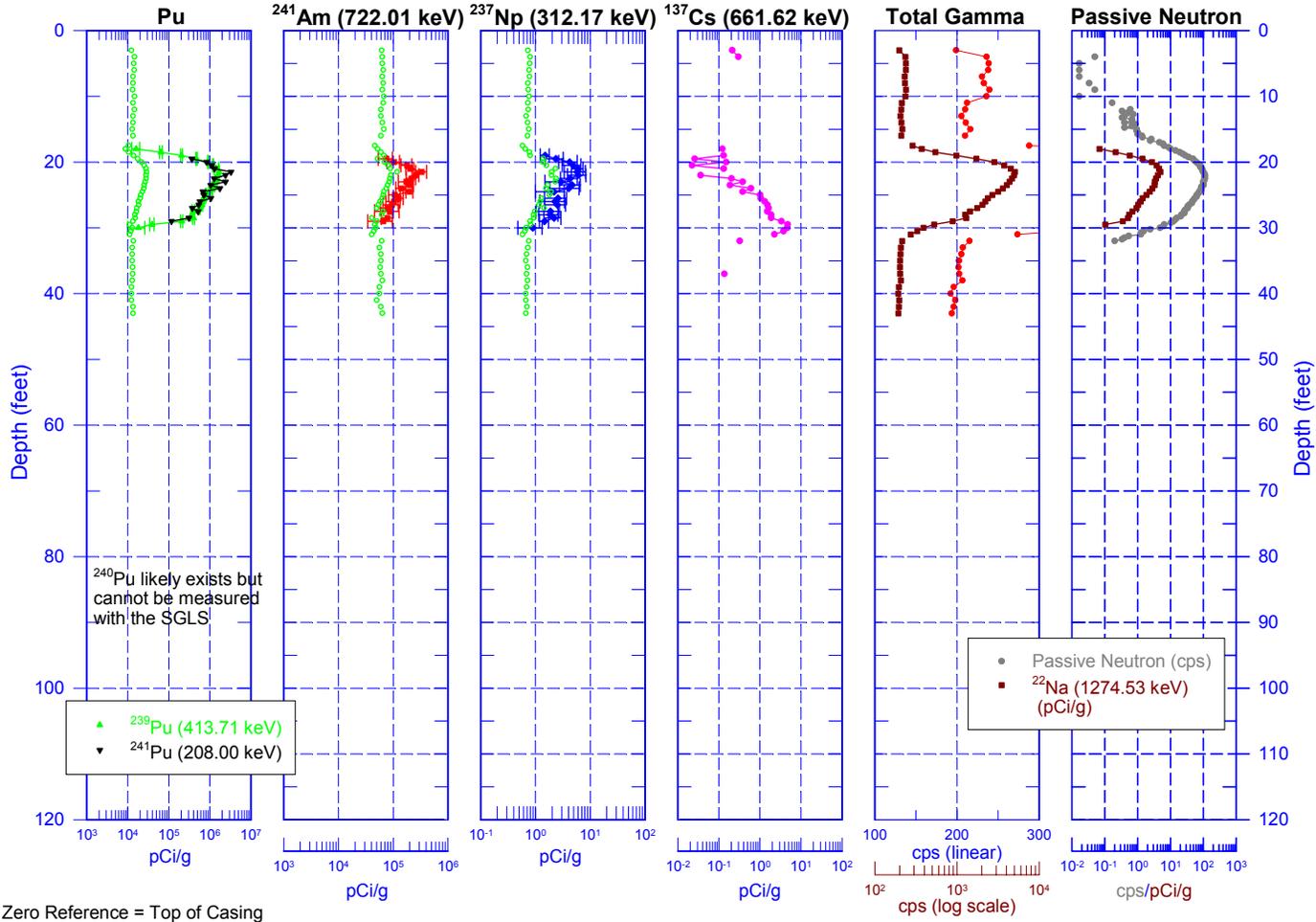
List of Log Plots:

Depth Reference is top of casing
Depth Scale - 20 ft/inch except for repeat logs

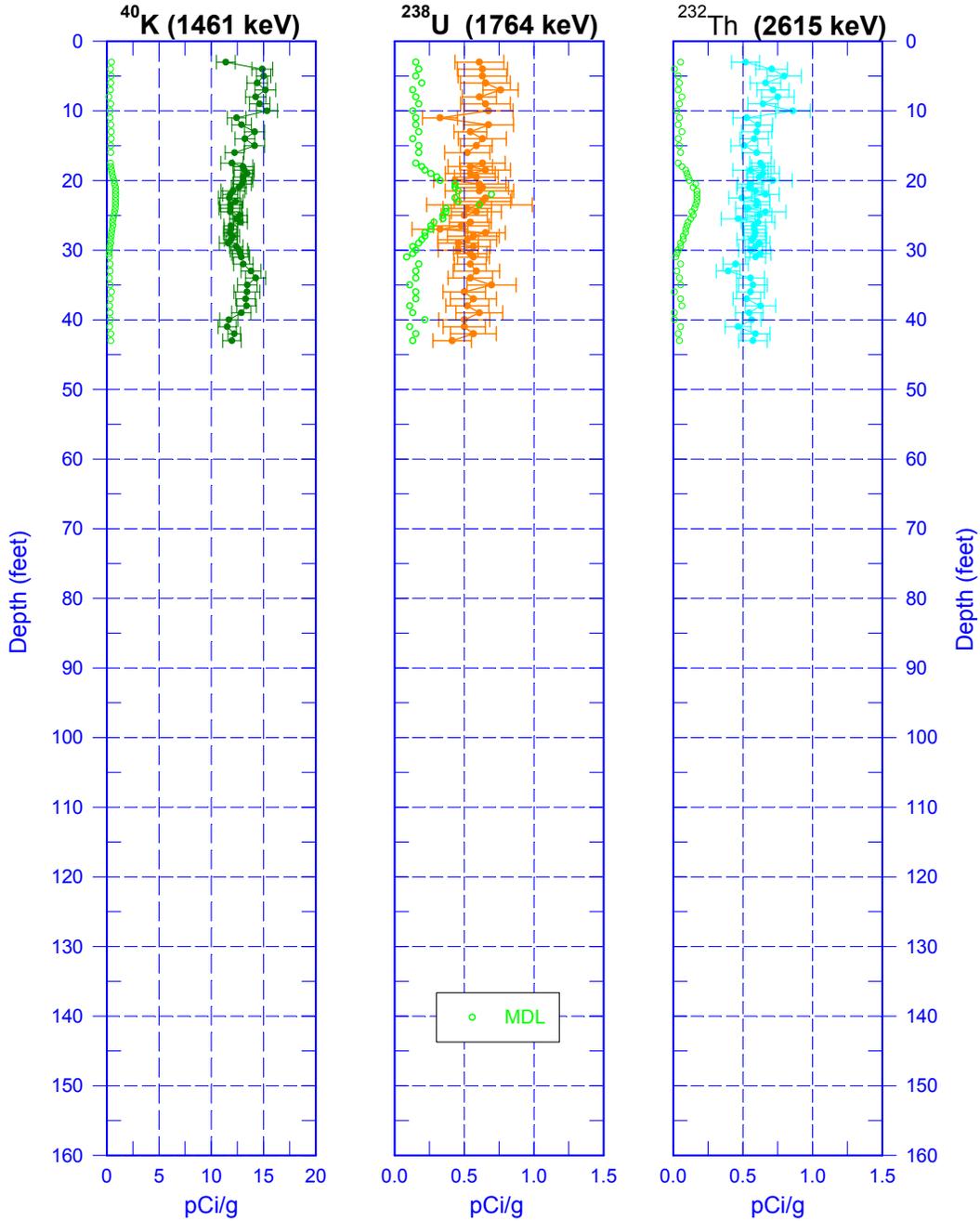
Manmade Radionuclide Plot
Natural Gamma Logs
Combination Plot
Total Gamma, Passive Neutron & Moisture
Total Gamma & Dead Time
Manmade Radionuclide Repeat Data
Repeat Section of Natural Gamma Logs

¹ GWL – groundwater level

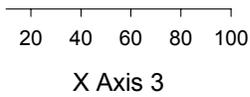
299-W18-67 (A7550) Manmade Radionuclide Plot



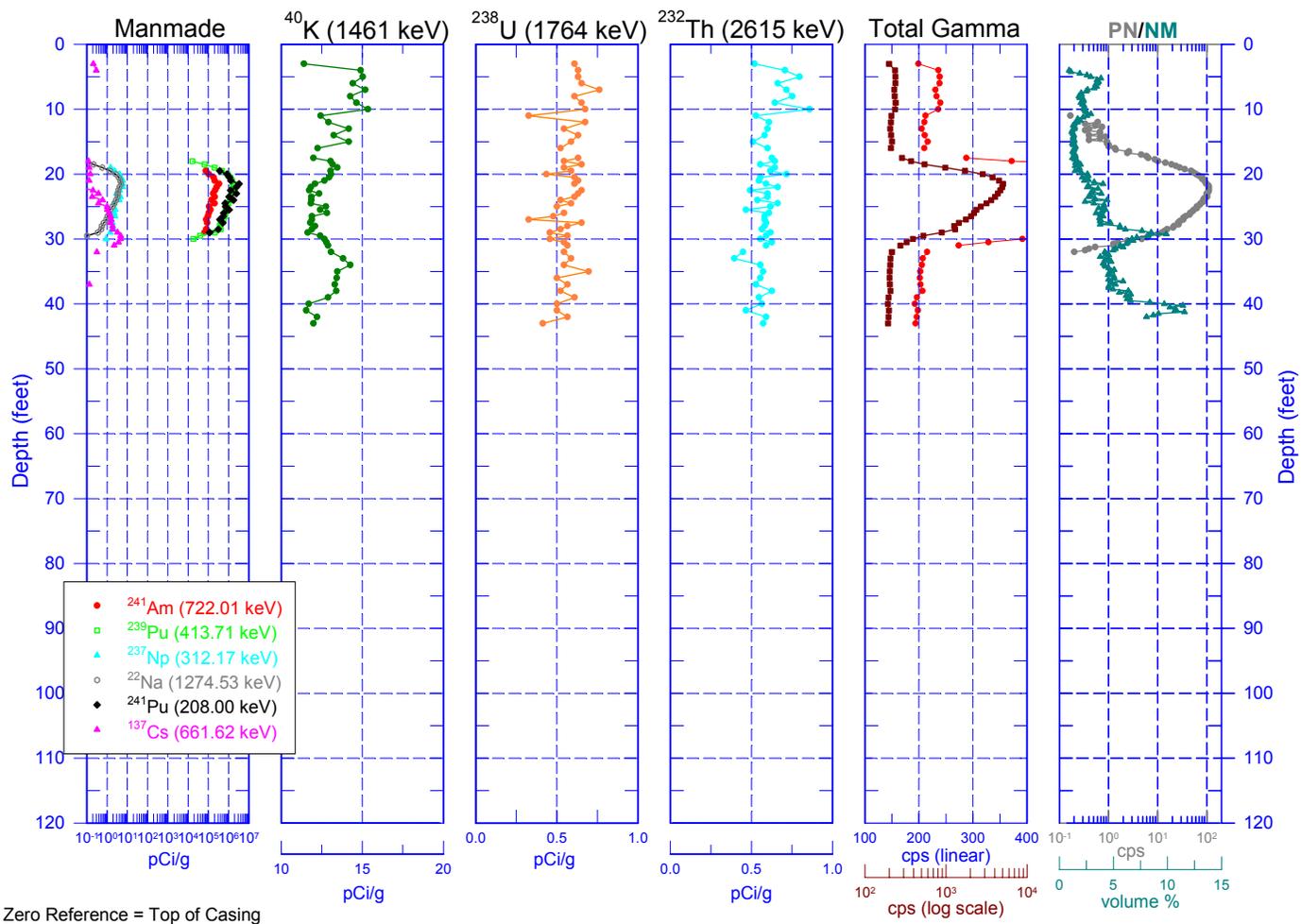
299-W18-67 (A7550) Natural Gamma Logs



Zero Reference = Top of Casing

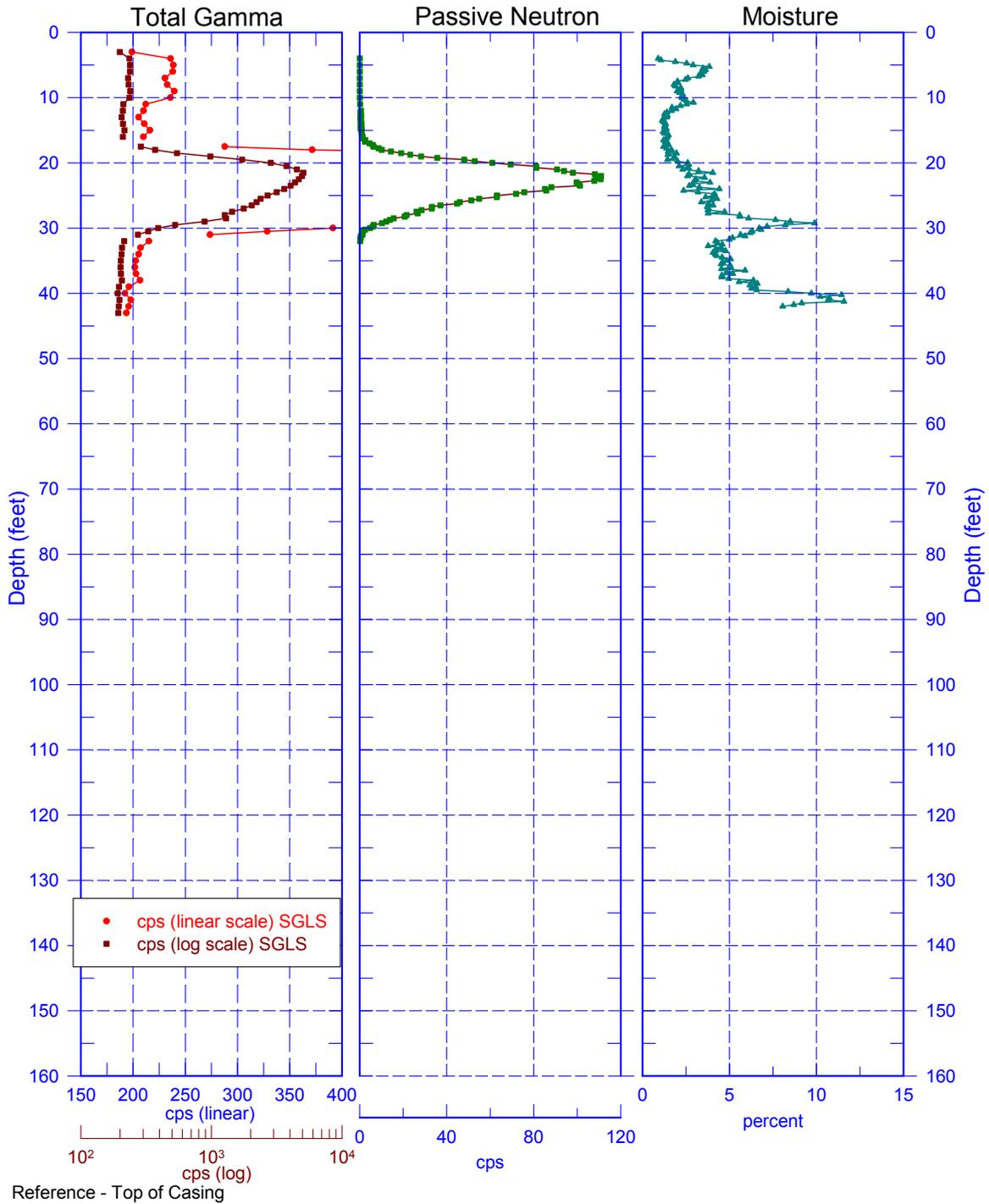


299-W18-67 (A7550) Combination Plot



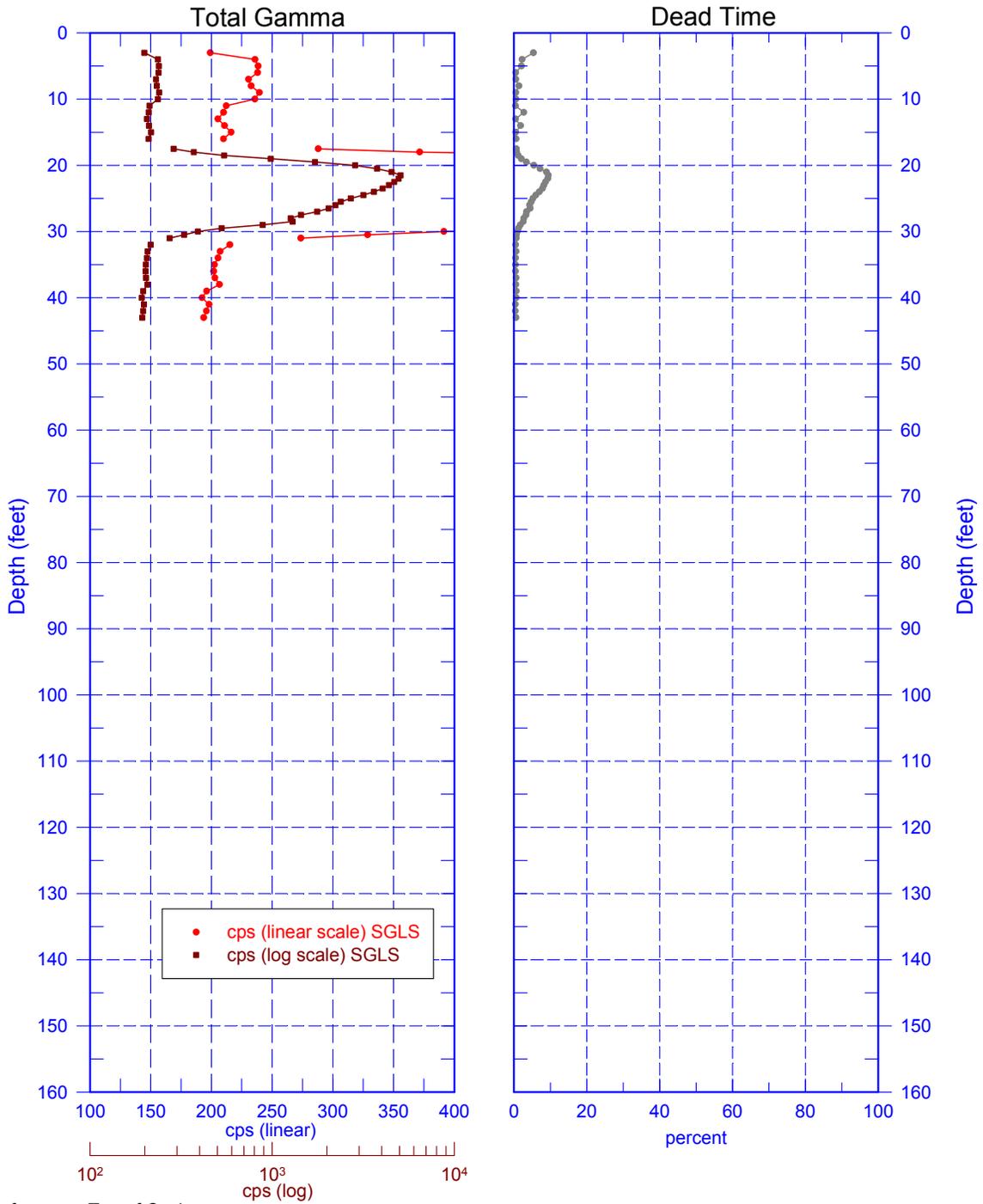
299-W18-67 (A7550)

Total Gamma, Passive Neutron, & Moisture

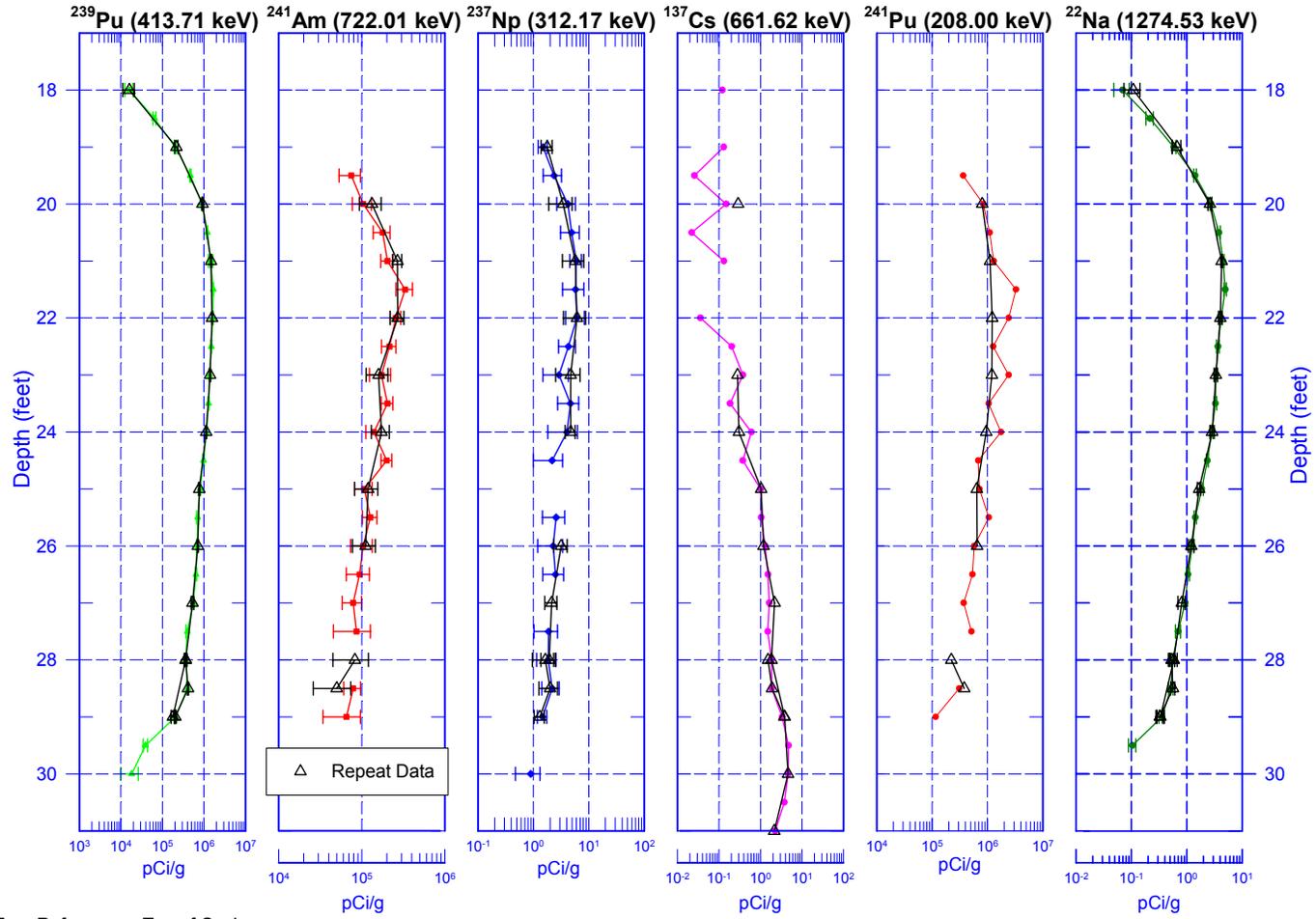


299-W18-67 (A7550)

Total Gamma & Dead Time



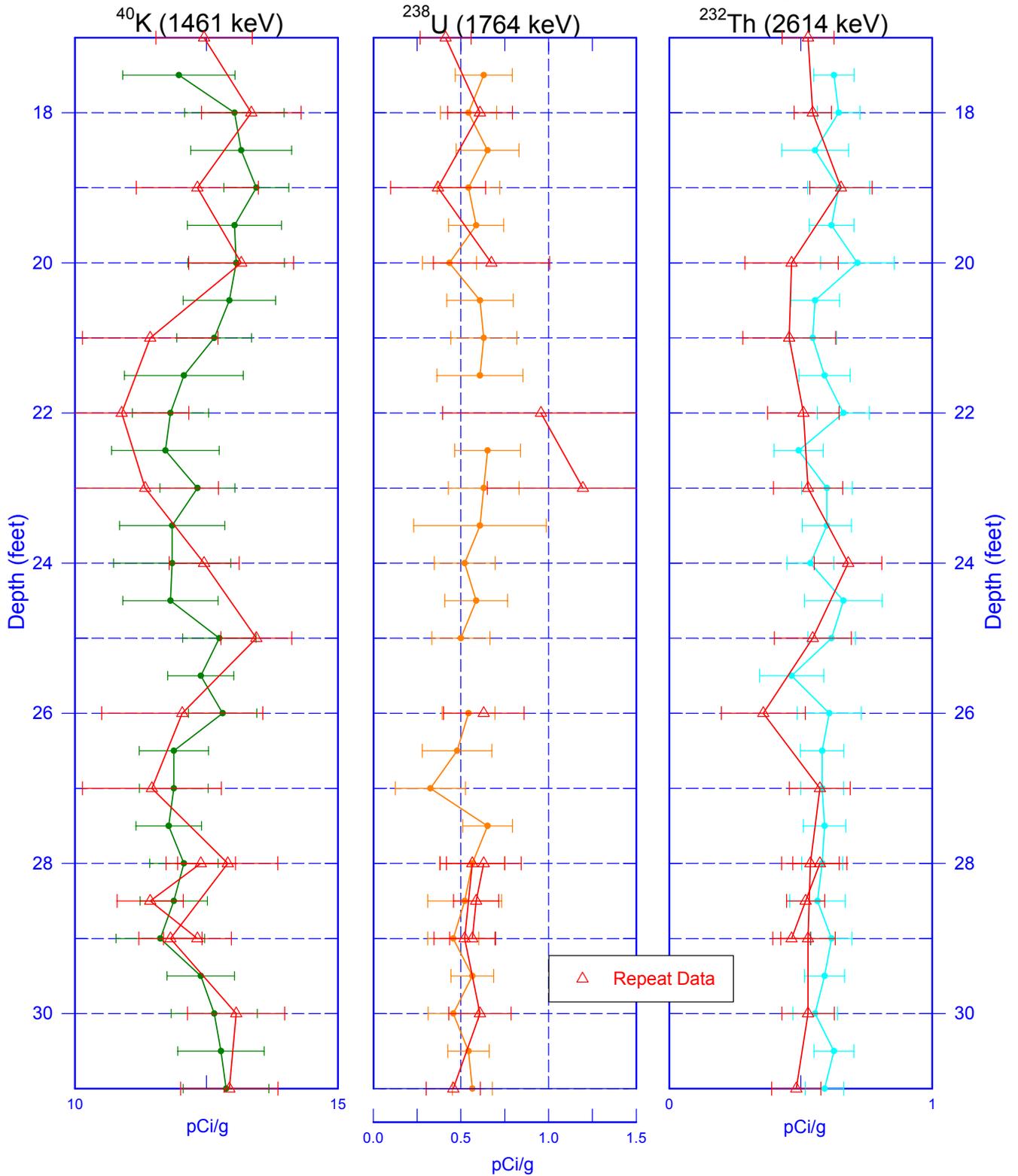
299-W18-67 (A7550) Manmade Radionuclide Repeat Data



Zero Reference = Top of Casing

299-W18-67 (A7550)

Repeat Section of Natural Gamma Logs



Zero Reference = Top of Casing