

299-W19-72 (A7772)
Log Data Report

Borehole Information:

Borehole: 299-W19-72 (A7772)		Site: 216-U-1 Crib			
Coordinates (WA St Plane)		GWL¹ (ft): None		GWL Date: 08/04/05	
North	East	Drill Date	Elevation (TOC)²	Total Depth (ft)	Type
135001.895	567265.766	02/51	Not available	74	Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	0.7	10 3/4	10 1/4	1/4	0.7	4
Welded steel	0	8 5/8	8	5/16	0	75

Borehole Notes:

Casing diameter and stickup measurements were acquired using a caliper and steel tape. Measurements are rounded to the nearest 1/16 inch. Logging data acquisition is referenced to the top of casing (TOC).

Spectral Gamma Logging System (SGLS) Equipment Information:

Logging System:	Gamma 1E	Type:	SGLS (35%) SN: 34TP40587A
Effective Calibration Date:	03/04/05	Calibration Reference:	DOE/EM-GJ864-2005
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

High Rate Logging System (HRLS) Equipment Information:

Logging System:	Gamma 1C	Type:	HRLS SN: 39-A314
Effective Calibration Date:	04/06/05	Calibration Reference:	DOE/EM-GJ865-2005
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4 Repeat	
Date	08/04/05	08/04/05	08/04/05	08/04/05	
Logging Engineer	Pearson	Pearson	Pearson	Pearson	
Start Depth (ft)	1.0	29.0	37.0	57.0	
Finish Depth (ft)	28.0	40.0	74.0	50.0	
Count Time (sec)	100	30	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A ²	N/A	N/A	N/A	
Pre-Verification	AE089CAB	AE089CAB	AE089CAB	AE089CAB	
Start File	AE089000	AE089028	AE089040	AE089078	
Finish File	AE089027	AE089039	AE089077	AE089085	
Post-Verification	AE089CAA	AE089CAA	AE089CAA	AE089CAA	
Depth Return Error (in.)	N/A	N/A	N/A	N/A	
Comments	No fine-gain adjustment	No fine-gain adjustment	Fine gain adjustment after file -045	No fine-gain adjustment	

High Rate Logging System (HRLS) Log Run Information:

Log Run	5	6	7	8	9
Date	08/05/05	08/05/05	08/05/05	08/05/05	08/05/05
Logging Engineer	Pearson	Pearson	Pearson	Pearson	Pearson
Start Depth (ft)	3.0	10.0	15.0	42.0	37.0
Finish Depth (ft)	6.0	13.0	26.0	34.0	37.0
Count Time (sec)	300	300	300	300	1000
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
ft/min	N/A	N/A	N/A	N/A	N/A
Pre-Verification	AC136CAB	AC136CAB	AC136CAB	AC136CAB	AC136CAB
Start File	AC136000	AC136004	AC136008	AC136020	AC136029
Finish File	AC136003	AC136007	AC136019	AC136028	AC136029
Post-Verification	AC136CAA	AC136CAA	AC136CAA	AC136CAA	AC136CAA
Depth Return Error (in.)	N/A	N/A	N/A	N/A	+ 0.5
Comments	No fine-gain adjustment				

Log Run	10			
Date	08/05/05			
Logging Engineer	Pearson			
Start Depth (ft)	22.0			
Finish Depth (ft)	34.0			
Count Time (sec)	300			
Live/Real	R			
Shield (Y/N)	Y (internal)			
MSA Interval (ft)	1.0			
ft/min	N/A			
Pre-Verification	AC136CAB			
Start File	AC136030			
Finish File	AC136042			
Post-Verification	AC136CAA			
Depth Return Error	+ 0.5			

Log Run	10				
(in.)					
Comments	No fine-gain adjustment				

Logging Operation Notes:

Logging was performed in this borehole on August 8 and 9, 2005, with the SGLS and HRLS. Logging was conducted with a centralizer on each sonde. Measurements are referenced to the top of casing. Data were acquired at 1,000-second counting time at 37 ft with the HRLS. An internal shield was used for the HRLS in the depth interval between 22 and 34 ft at the locations of highest gamma flux. Repeat sections were collected in this borehole to evaluate the logging system's performance.

Analysis Notes:

Analyst:	Henwood	Date:	08/15/05	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 data acquisition. Acceptance criteria were met for all systems.

A casing correction for 5/16-in.-thick casing (8-in. casing) was applied to the spectral log data (SGLS and HRLS) below 4 ft. A combined correction for 0.5625-in. (0.25 + 0.3125 for the 10- and 8-in. casing) thick casing was applied between the ground surface and 4 ft

SGLS and HRLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL worksheet templates identified as G1Emar05.xls and G1Capr05.xls for the HRLS using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied where dead times exceed approximately 11 percent. Where SGLS dead time exceeds 40 percent, HRLS data are substituted. Correction for water was not needed in this borehole.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (¹³⁷Cs, ⁶⁰Co, ¹⁵⁴Eu, and processed uranium [²³⁵U and ²³⁸U]) detected in the borehole, naturally occurring radionuclides (⁴⁰K, ²³⁸U, ²³²Th [KUT]), a combination of man-made, KUT, and dead time, and total gamma plotted with dead time. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. Repeat log sections are also included where appropriate.

Results and Interpretations:

¹³⁷Cs was detected throughout this borehole from the ground surface to total depth (74 ft). A zone of very high ¹³⁷Cs exists between approximately 15 and 41 ft. The maximum concentration is approximately 4 million pCi/g at 26 ft.

⁶⁰Co was detected from 41 to 47 ft. The maximum concentration is approximately 0.9 pCi/g at 41 ft. It is probable ⁶⁰Co also exists in the high rate interval from 15 to 41 ft at higher concentrations.

^{154}Eu was detected from 37 to 44 ft. The maximum concentration is approximately 16 pCi/g at 38 ft. It is probable ^{154}Eu also exists in the high rate interval from 15 to 41 ft at higher concentrations.

The spectra derived from this borehole are unusual because of high concentrations of processed uranium at least 200 times that previously measured by spectral gamma logging at Hanford. Numerous energy peaks (approximately 20 full energy peaks) can be attributed to processed uranium while, generally, experience has indicated only two to three energy peaks where the processed uranium concentrations are much lower. While this may be expected, it is remarkable because the low specific activities of ^{238}U and ^{235}U as evidenced by half lives of 10^9 and 10^8 years, respectively, as well as relatively low yields, would suggest detection of most energy peaks through steel casing would be difficult. Because the spectra indicated energy peaks that are not routinely observed, additional analysis was required.

Processed uranium (i.e., man-made or anthropogenic) is partly determined by the existence of ^{238}U where only the first two daughters in the uranium decay chain have reached equilibrium with its parent and the daughters further down the decay chain have not. These first two daughters include ^{234}Th (half life of 24 days) that decays to $^{234\text{m}}\text{Pa}$ (half life of 1 minute) that branches to decay directly to ^{234}U (99.8 percent) and ^{234}Pa (0.02 percent). ^{234}Pa decays to ^{234}U with a half life of approximately 7 hours. ^{234}U has a half life of 10^5 years and has not had time to sufficiently grow in to the point where gamma rays are detectable with spectral gamma logging. The first daughter, ^{234}Th , emits a 92 keV gamma ray with a relatively low yield and is below the range of 180 to 2600 keV where gamma rays can be reliably quantified by the SGLS through steel casing. Therefore, gamma rays originating from the decay of $^{234\text{m}}\text{Pa}$ and ^{234}Pa are the only ones available to quantify ^{238}U . Of all the gamma rays emitted by these radionuclides, the 1001 keV ($^{234\text{m}}\text{Pa}$) is the most intense (yield 0.84 %) and is used to provide the assay for ^{238}U .

Concentrations of ^{238}U as determined from five $^{234\text{m}}\text{Pa}$ energy peaks are plotted together. There is good agreement in the higher concentration depth interval from 37 to 53 ft. Below that depth the comparison indicates a divergence that may be the result of inside the casing contamination. The correction for casing is greater for the lower energy 766 keV peak than for the 1001 keV peak. If the contamination were inside the casing, the plotted divergence would be the expected result.

Processed uranium also contains ^{235}U in various amounts according to the enrichment used for the reactor fuel at Hanford. This radionuclide can be measured directly from energy peaks at approximately 186, 202, and 205 keV. The highest yield (57.2 %) is from the 186 keV gamma ray that is used to assay ^{235}U .

All of the unusual energy peaks in the spectra for this borehole were attributed to $^{234\text{m}}\text{Pa}$, ^{234}Pa , or ^{235}U except for an energy peak at approximately 312 keV. This peak is normally indicative of ^{233}Pa , which is the daughter of ^{237}Np . The concentration would be approximately 44 pCi/g if it were ^{233}Pa . However, there are no confirming peaks at approximately 300, 340, 398, and 416 keV that are usually present where ^{233}Pa is detected. Several energy peaks attributable to processed uranium could be contributing to the identified 312 energy peak. These include 310.69 keV, yield 0.004 % (U-235), 311.0 keV, yield 0.0001 % ($^{234\text{m}}\text{Pa}$), 310.2 keV, yield 0.0721 % (^{234}Pa), 310.52 keV, yield 0.0001 % (^{234}Pa), and 313.5 keV, yield 0.103 % (^{234}Pa). Even though the yields are very low, it is possible their combined counts may cause an energy peak at 312 keV to be identified. Therefore, the 312 energy peak is attributed to processed uranium and is not reported as ^{233}Pa (^{237}Np).

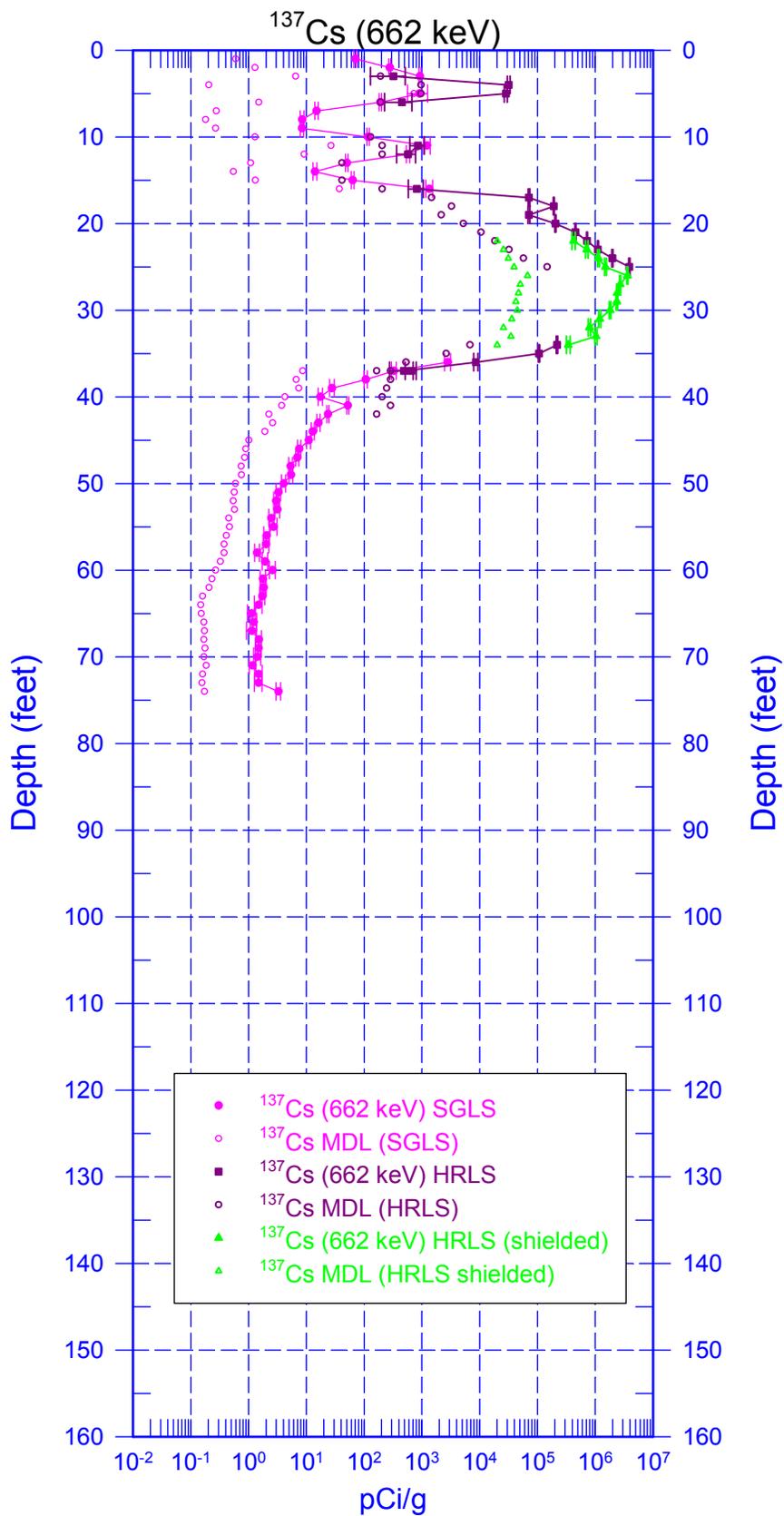
Evidence of processed uranium exists at 9 and 13 ft and from 37 ft to total depth (74 ft). Although no detections of processed uranium exist in the high activity zone between 13 and 37 ft, it is likely present. The MDLs for $^{234\text{m}}\text{Pa}$ and ^{235}U in the high activity zone, as determined from the HRLS, are approximately 1 million and 30 thousand pCi/g, respectively. The maximum concentrations determined from the SGLS occurred at the lower margin of the high activity zone at approximately 40 ft. The measured concentrations were approximately 27,000 and 750 pCi/g, respectively.

The repeat sections for the SGLS indicate good agreement for the naturally occurring and man-made radionuclides.

¹ GWL – groundwater level

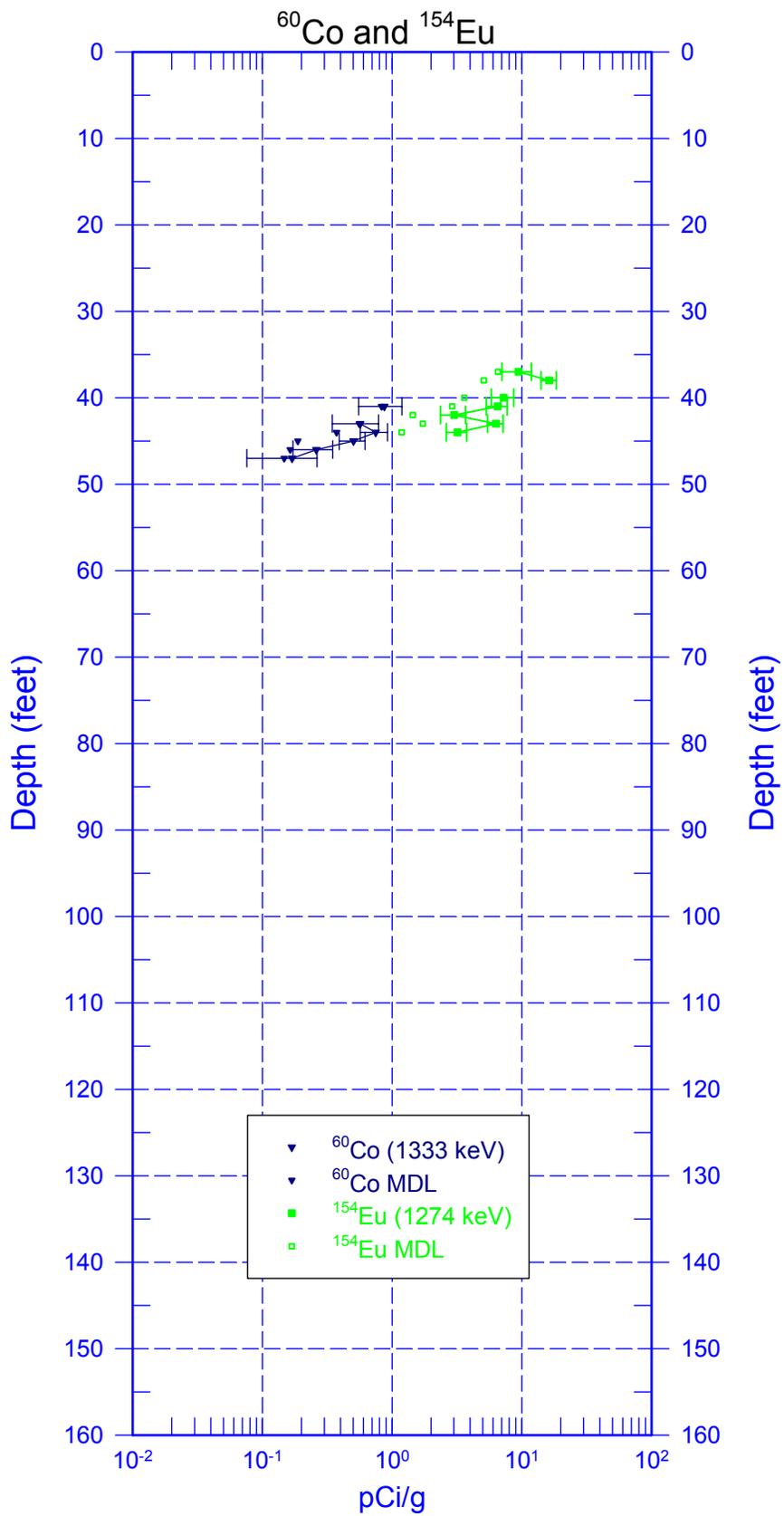
² N/A – not applicable

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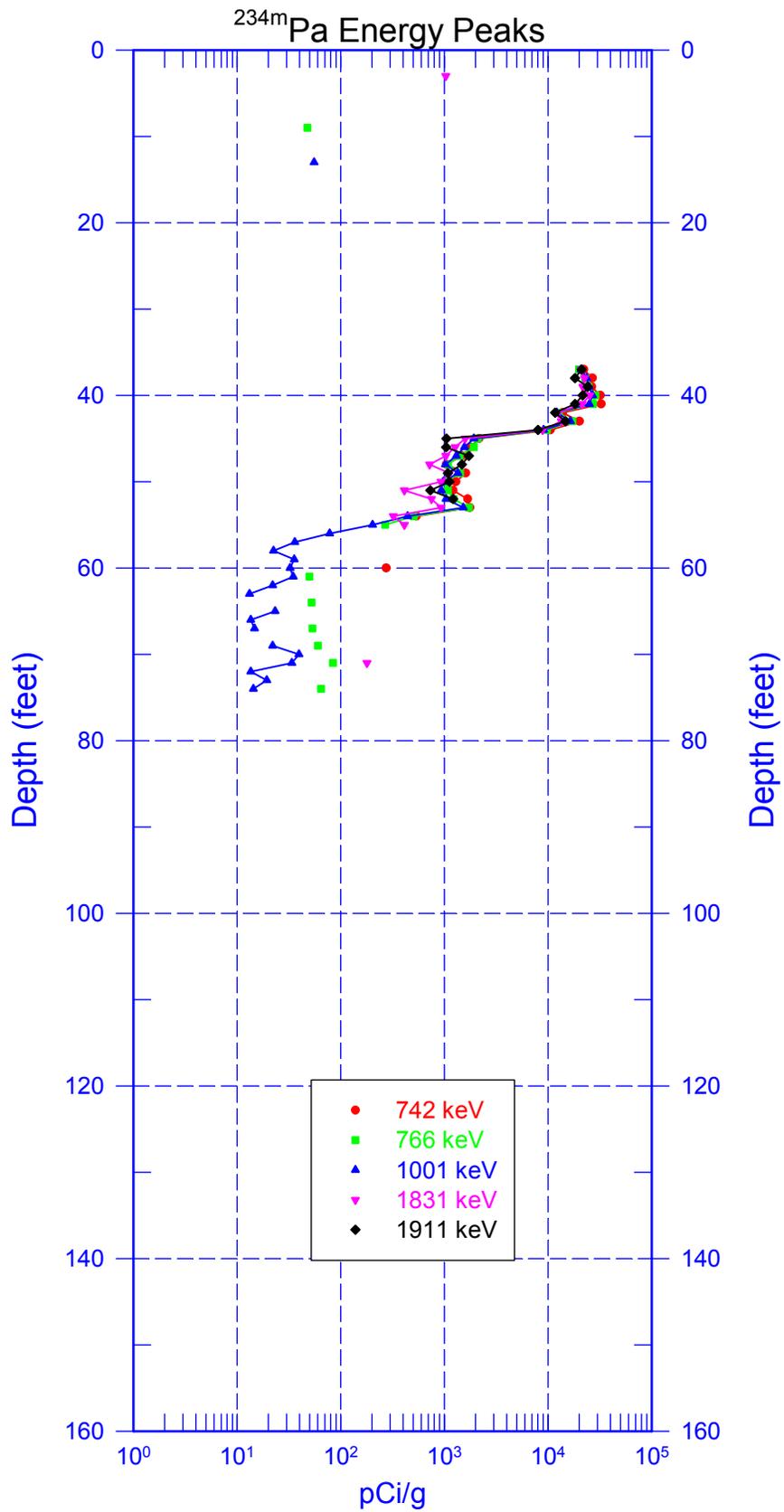
Zero Reference = Top of Casing

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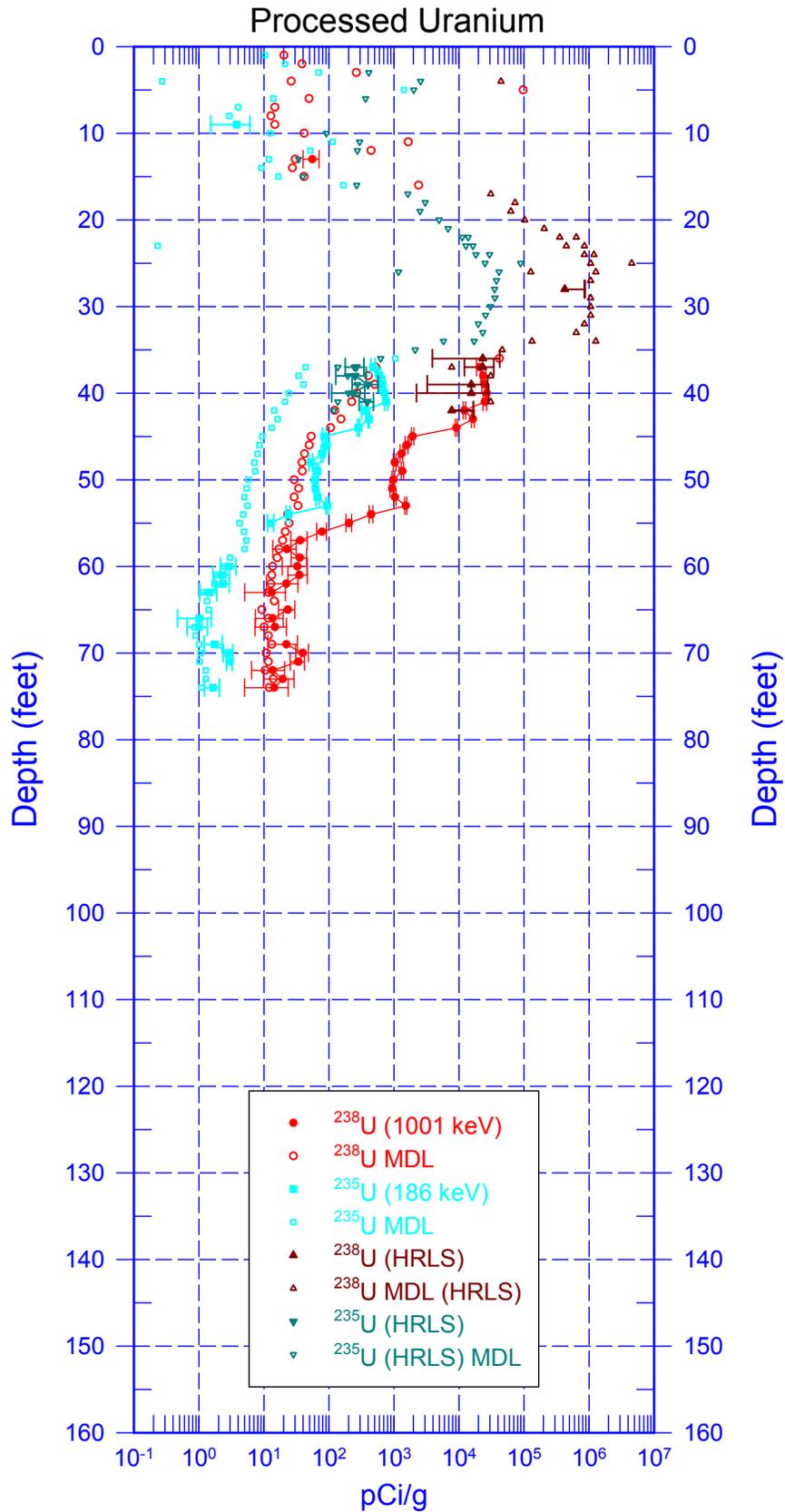
Zero Reference = Top of Casing

299-W19-72 (A7772)



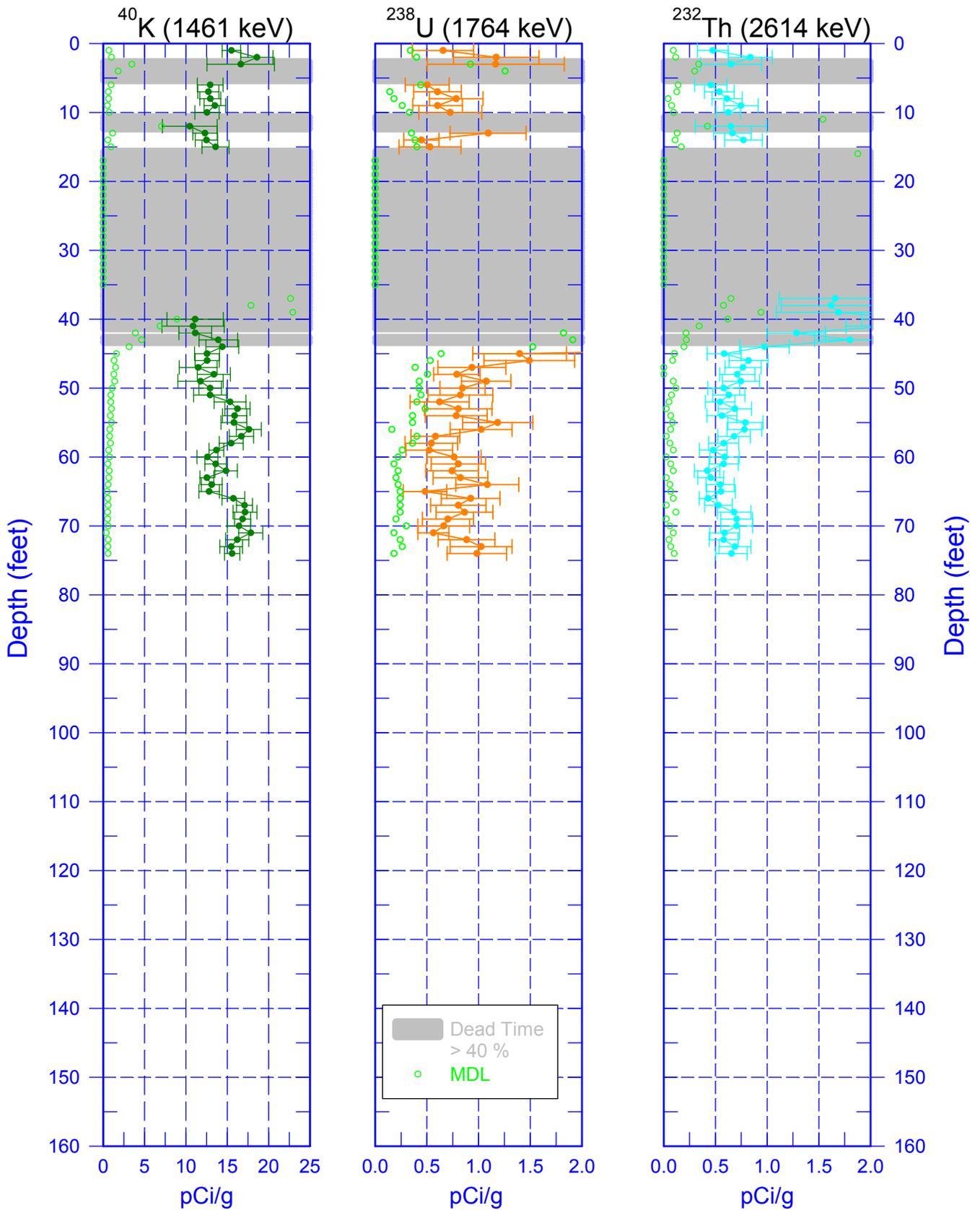
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299-W19-72 (A7772)



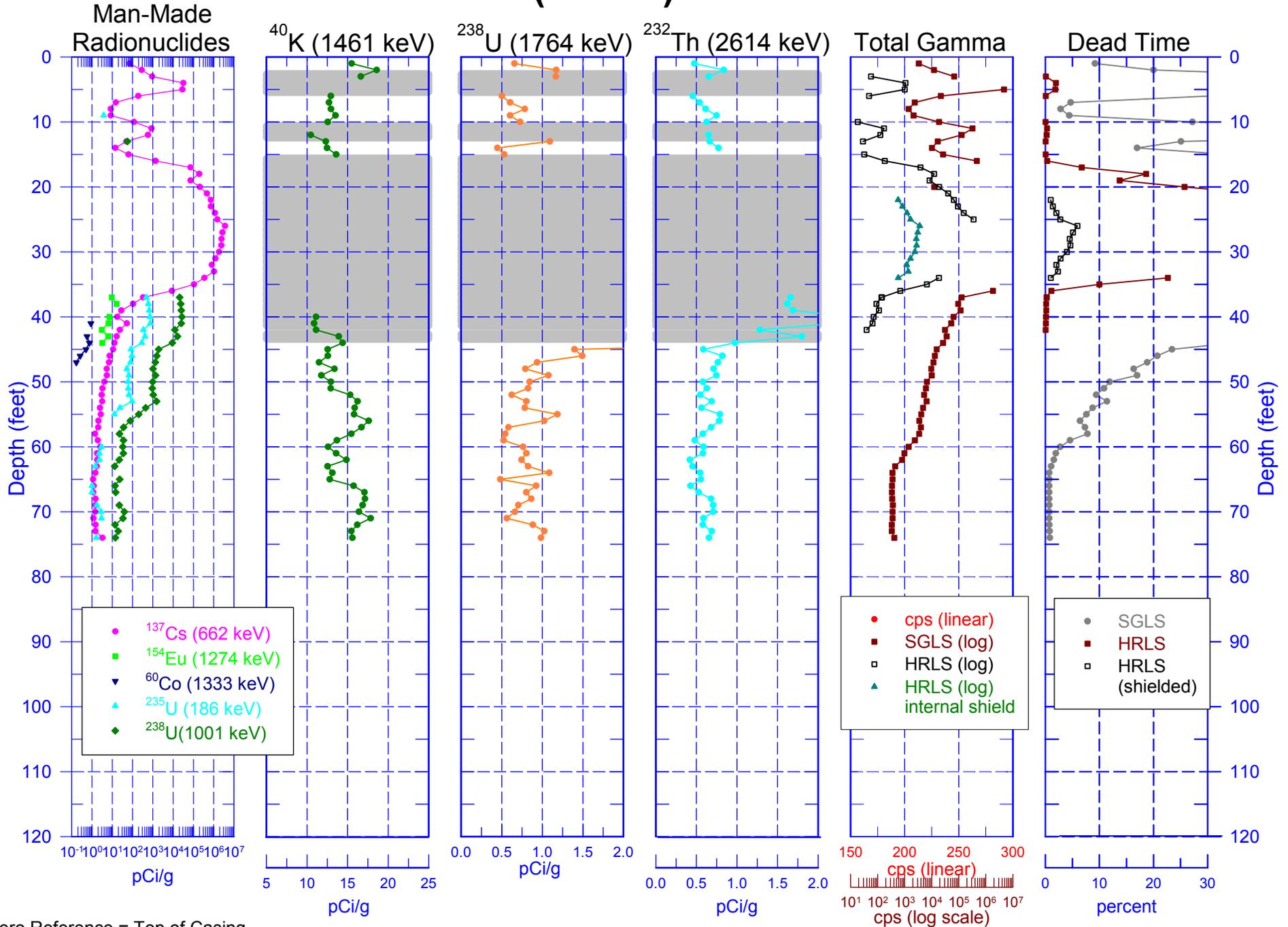
Zero Reference = Top of Casing

299-W19-72 (A7772) Natural Gamma Logs



Zero Reference = Top of Casing

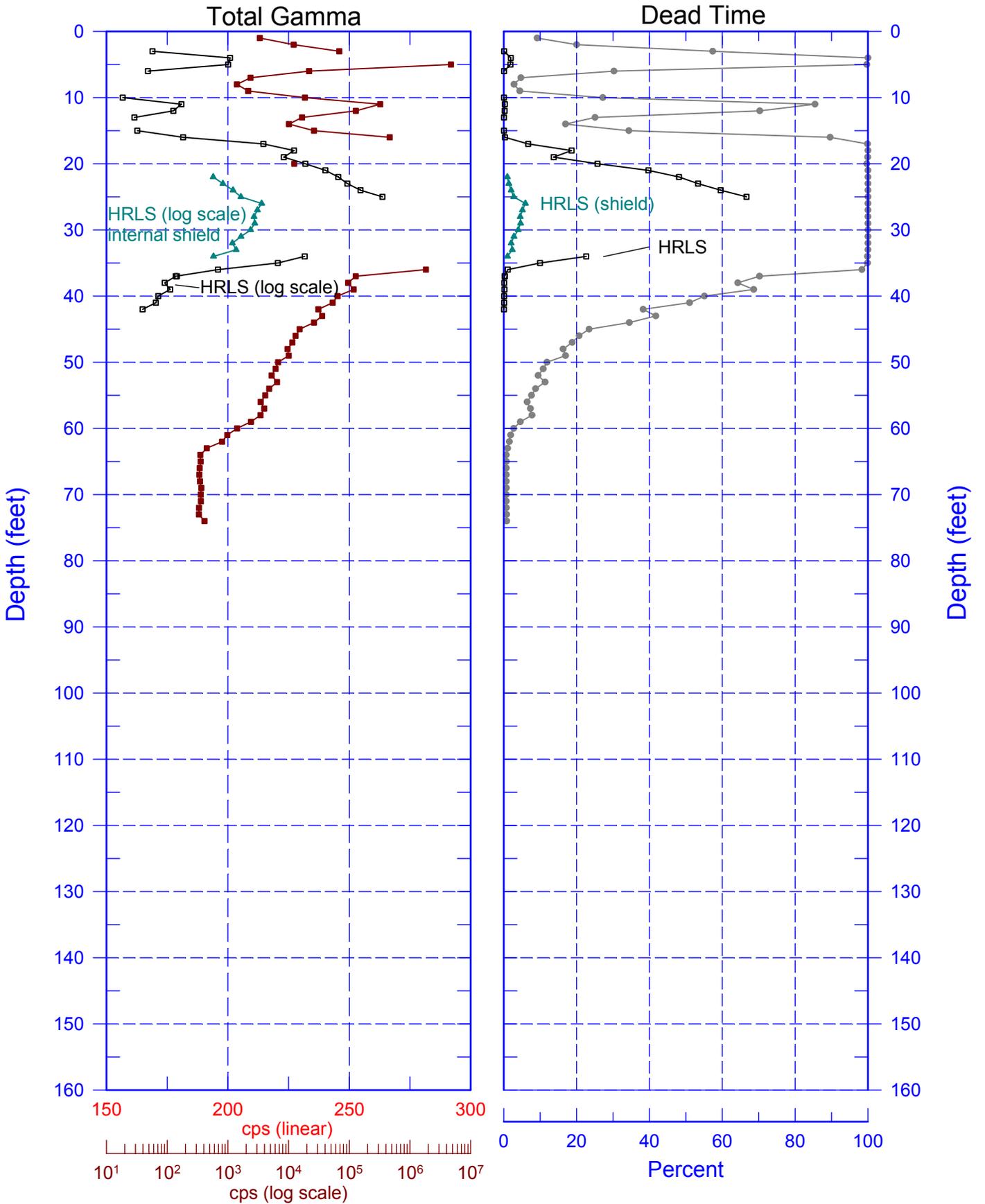
299-W19-72 (A7772) Combination Plot



Zero Reference = Top of Casing

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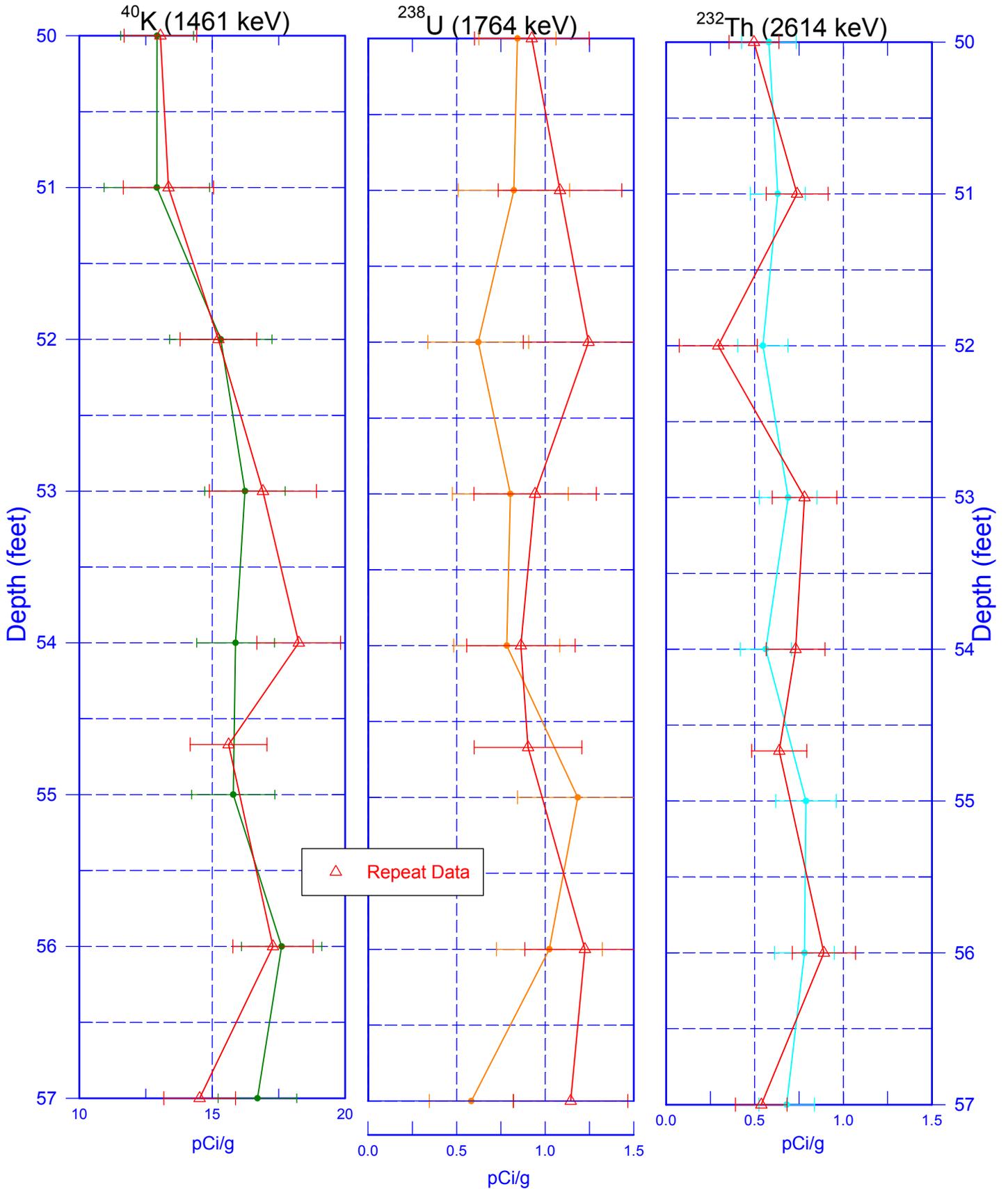
Total Gamma & Dead Time



Reference - Top of Casing

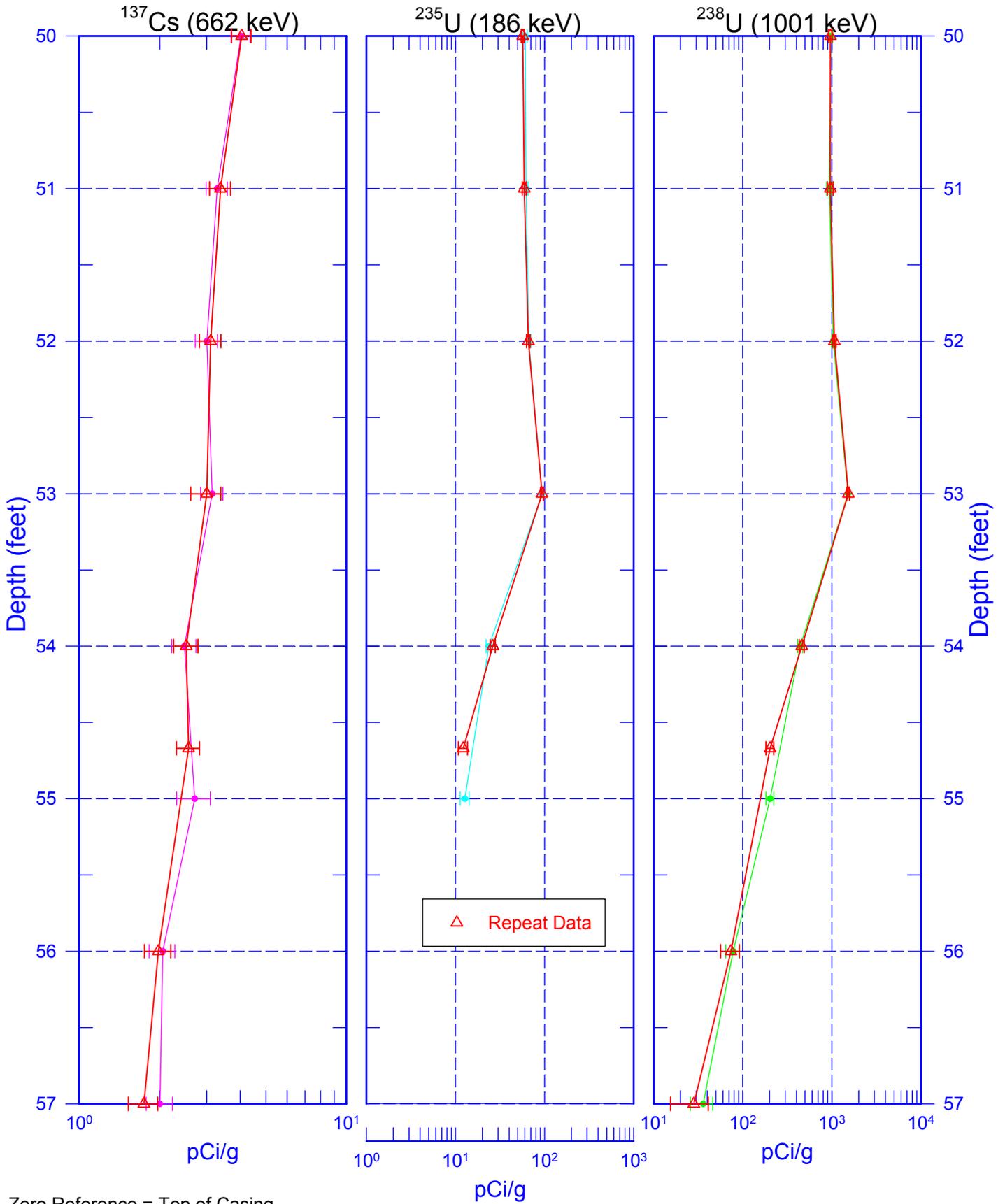
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Repeat Section of Natural Gamma Logs



Zero Reference = Top of Casing

299-W19-72 (A7772) Man-Made Repeat Section



Zero Reference = Top of Casing