

C4178
Log Data Report

Borehole Information:

Borehole: C4178		Site: 216-Z-7 Crib			
Coordinates (WA State Plane)		GWL (ft)¹: Not Available		GWL Date: Not Available	
North Not Available	East Not Available	Drill Date 07/02/04	TOC² Elevation N/A ³	Total Depth (ft) 50	Type Push

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	1.8	6 5/8	5 1/2	9/16	1.8	50

Borehole Notes:

The logging engineer used a caliper to determine the outside casing diameter. The caliper, casing stickup, and inside casing diameter were measured using a steel tape. All measurements were rounded to the nearest 1/16 in. C. Cearlock (Fluor Hanford) provided the casing depth. All logging measurements are referenced to ground surface.

Logging Equipment Information:

Logging System: Gamma 2A	Type: SGLS (35%) 34TP20893A
Calibration Date: 03/2004	Calibration Reference: DOE-EM/GJ642-2004
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 4L	Type: Passive Neutron U1754
Calibration Date: None	Calibration Reference: None
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2 - Repeat	3 Repeat		
Date	07/14/04	07/14/04	07/14/04		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	52.0	20.0	18.0		
Finish Depth (ft)	0.0	15.0	14.0		
Count Time (sec)	200	200	400		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	0.5		

Log Run	1	2 - Repeat	3 Repeat		
ft/min	N/A	N/A	N/A		
Pre-Verification	BA368CAB	BA368CAB	BA368CAB		
Start File	BA369000	BA369053	BA369059		
Finish File	BA369052	BA369058	BA369067		
Post-Verification	BA369CAA	BA368CAA	BA369CAA		
Depth Return Error (in.)	0	N/A	0		
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.		

Passive Neutron (PN) Log Run Information:

Log Run	1	2 - Repeat			
Date	07/14/04	07/14/04			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	0.0	13.0			
Finish Depth (ft)	51.25	18.0			
Count Time (sec)	N/A	N/A			
Live/Real	N/A	N/A			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
ft/min	1.0	1.0			
Pre-Verification	DL032CAB	DL032CAB			
Start File	DL032000	DL032206			
Finish File	DL032205	DL032226			
Post-Verification	DL032CAA	DL032CAA			
Depth Return Error (in.)	N/A	- 0.25			
Comments	No fine-gain adjustment.	No fine-gain adjustment.			

Logging Operation Notes:

Logging was performed with a centralizer installed on the sondes. Pre- and post-survey verification measurements for the SGLS employed the Amersham KUT (⁴⁰K, ²³⁸U, and ²³²Th) verifier with serial number 082. Maximum log depth exceeded the reported casing depth by approximately 2 ft. A region of interest between 14 and 18 ft was re-logged (log run 3) at enhanced counting time (400 seconds) and spatial interval (0.5 ft) to further investigate energy peaks observed in the original log run (log run 1) that are not typically observed in spectra.

Passive neutron logging was also performed in the borehole to detect neutrons that may be generated by interactions of alpha particles in the soil, or, to a less extent, from spontaneous fission.

Analysis Notes:

Analyst:	Henwood	Date:	07/26/04	Reference:	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the verification spectra were within the acceptance criteria. Examinations of spectra indicate that the detector functioned normally during logging, and the spectra are accepted.

Verification spectra using an AmBe neutron source were acquired for the passive neutron logging system. Currently there are no verification criteria established for this system. The counts obtained from the pre and post verifications were within 1 percent.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source file: G2AMAR04.xls). The casing configuration was assumed as one string of 6-in. casing with a thickness of 9/16 in. to 52 ft (total logging depth). No dead time or water corrections were required.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides (^{40}K , ^{238}U , and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. 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, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it exhibited slightly higher net counts per second.

Results and Interpretations:

^{137}Cs , ^{60}Co , and ^{239}Pu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected between 14 and 19 ft with a maximum concentration of approximately 7 pCi/g at 17 ft. It was also detected at a few sporadic depth intervals throughout the borehole near its MDL of approximately 0.2 pCi/g. Because ^{239}Pu was also detected at the same depth interval (14-19 ft) and ^{239}Pu is often associated with ^{241}Am , consideration was given to the possibility the presumed ^{137}Cs energy peak at 661.66 keV could be attributed, all or in part, to the 662.40-keV energy peak resulting from the decay of ^{241}Am . A confirming gamma energy peak for ^{241}Am at 722.01 keV was not detected. Furthermore, there is no evidence of ^{241}Pu or ^{237}Np , the parent and daughter, respectively, of ^{241}Am . Therefore, the counts measured in the approximate 662-keV energy peak are most likely the result of the decay from ^{137}Cs with little or no ^{241}Am .

^{60}Co was detected near its MDL of 0.1 pCi/g at sporadic locations between 17 ft and total depth of the borehole.

^{239}Pu was detected between 14 and 19 ft with a maximum concentration of approximately 240,000 pCi/g at 16 ft. Energy peaks associated with ^{239}Pu were detected at approximately 129, 204, 333, 345, 375, 383, 393, 414, and 452 keV. The 375.054-keV energy peak has the highest yield of these energy peaks at 0.0016 percent and was utilized to determine concentrations; the 129-keV peak has a slightly higher yield but the low-energy gamma ray is significantly attenuated by the steel casing and tool housing.

Passive neutron logging was performed in the borehole to detect neutrons that may be generated by interactions of alpha particles with oxygen and other less important elements in the soil or from spontaneous fission. Many transuranic radionuclides decay predominantly by alpha particle emission and the passive neutron system may be useful to identify the existence of these radionuclides where no gamma emissions are available for detection. The even number isotopes of plutonium such as ^{240}Pu also decay by spontaneous fission and are thus neutron emitters. There is no calibration for this logging system and the data provided are to be used qualitatively. The passive neutron detector indicates the highest count rate at 15.75 ft, which approximately corresponds with the highest ^{239}Pu concentration.

The ^{40}K and ^{232}Th logs showed an increase in concentrations at approximately 40 ft perhaps suggesting a lithology change.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural and man-made radionuclides. The passive neutron data are less repeatable but show enhanced count rates at similar depth locations.

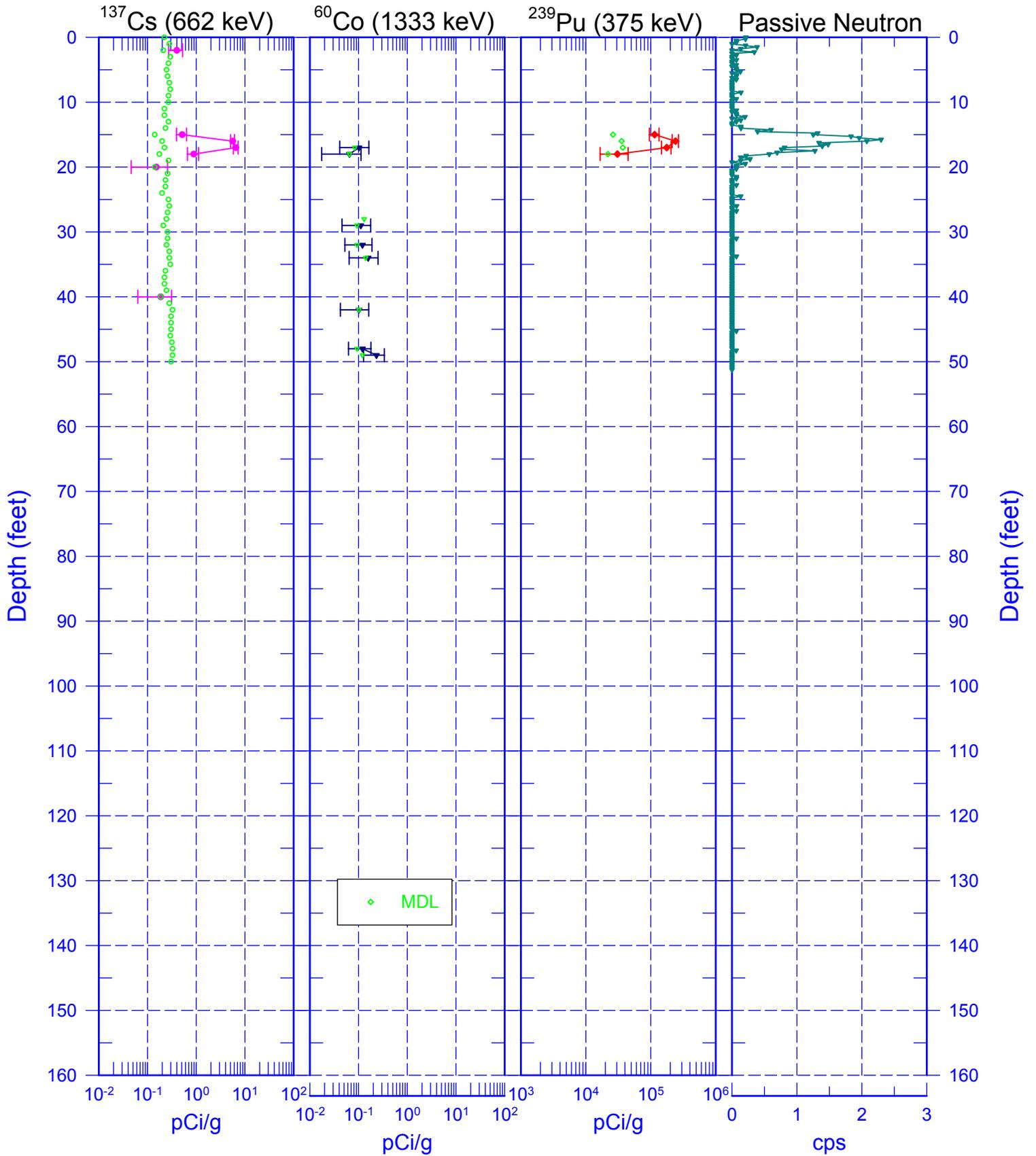
¹ GWL – groundwater level

² TOC – top of casing

³ N/A – not applicable

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Man-Made Radionuclides



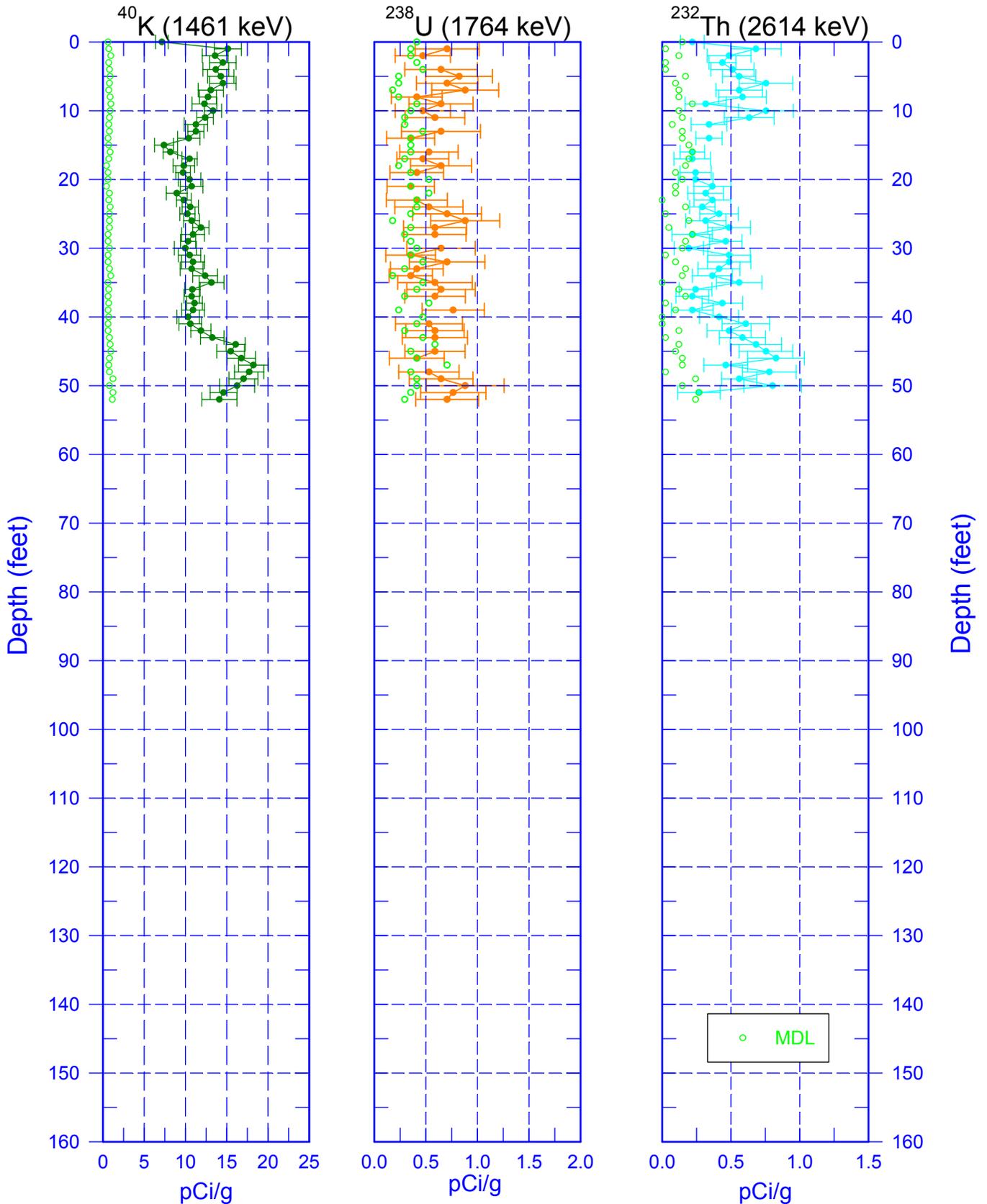
Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 07/14/04

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Natural Gamma Logs

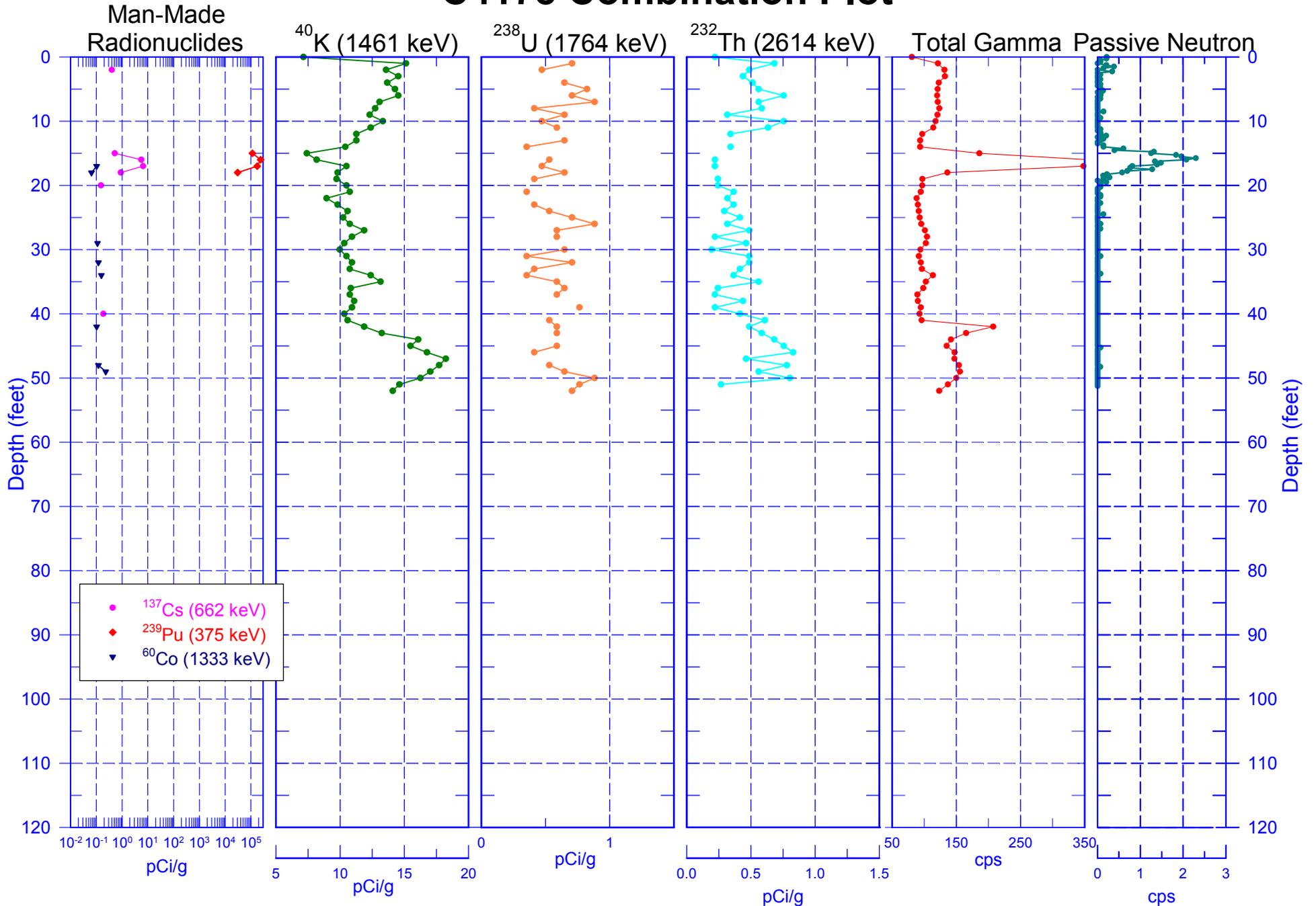


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Log Date - 07/14/04

C4178 Combination Plot

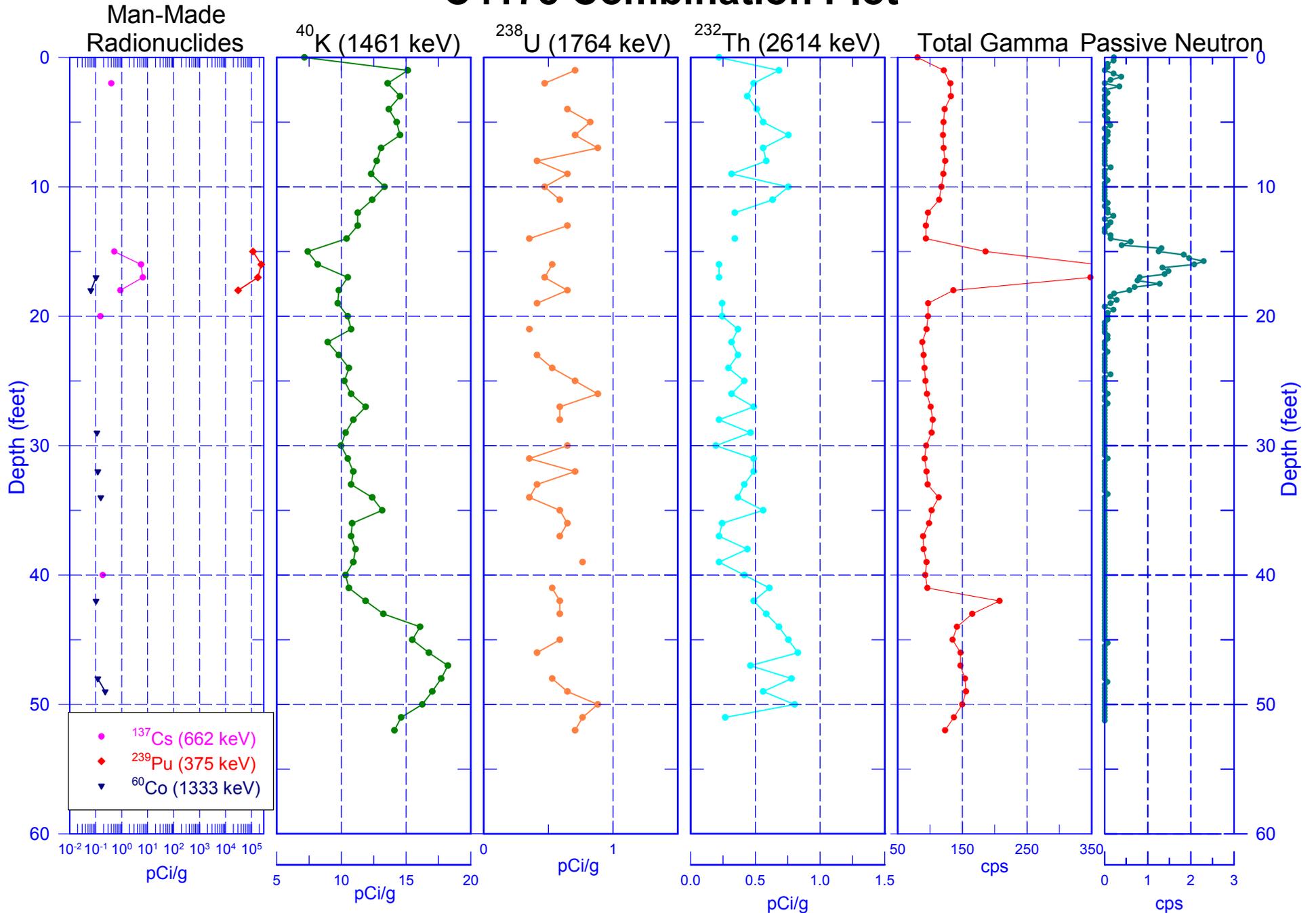


Zero Reference = Ground Surface

Depth scale: 1" = 20 ft

Last Logging Date - 07/14/04

C4178 Combination Plot



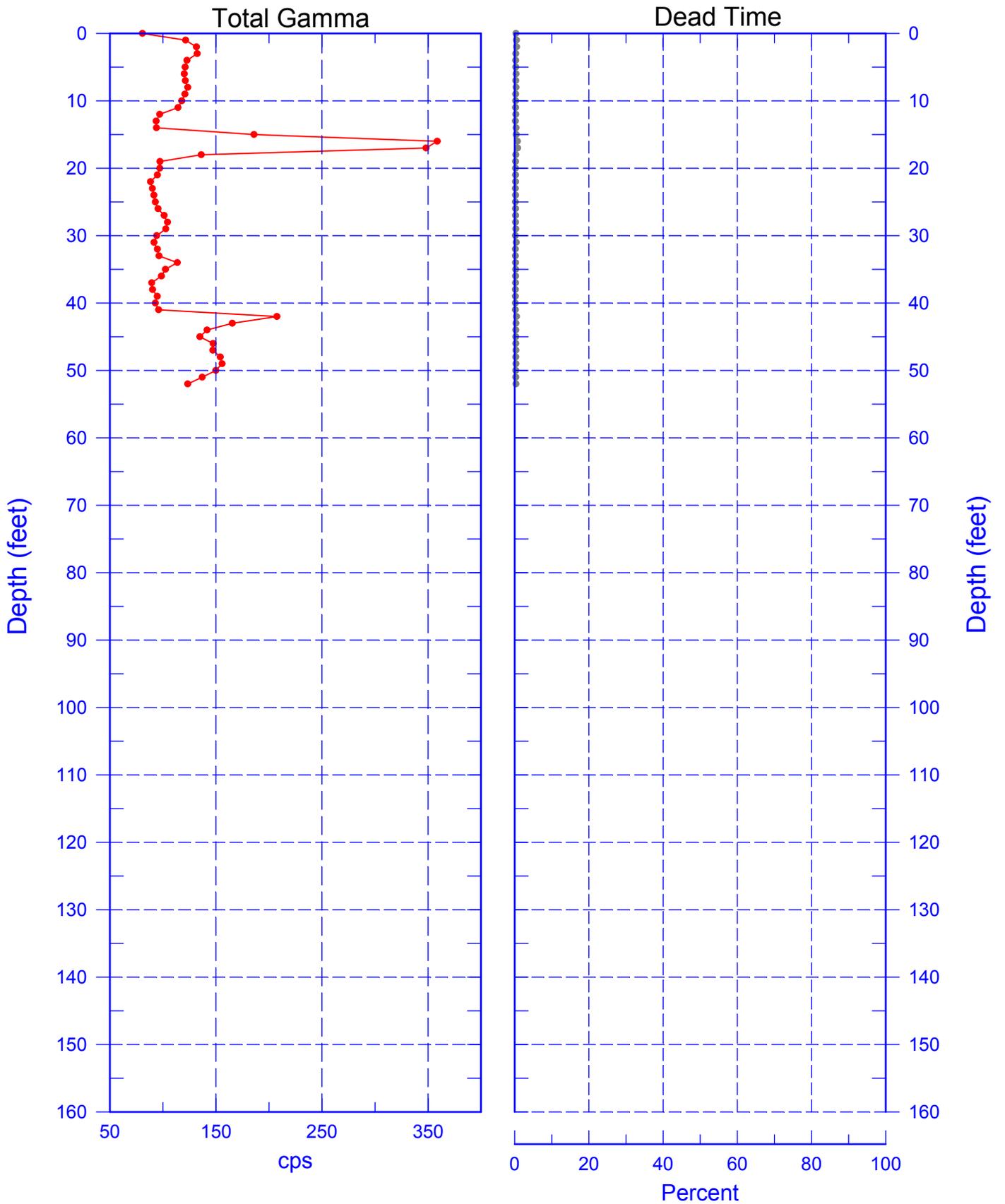
Zero Reference = Ground Surface

Depth scale: 1" = 10 ft

Last Logging Date - 07/14/04

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Total Gamma & Dead Time

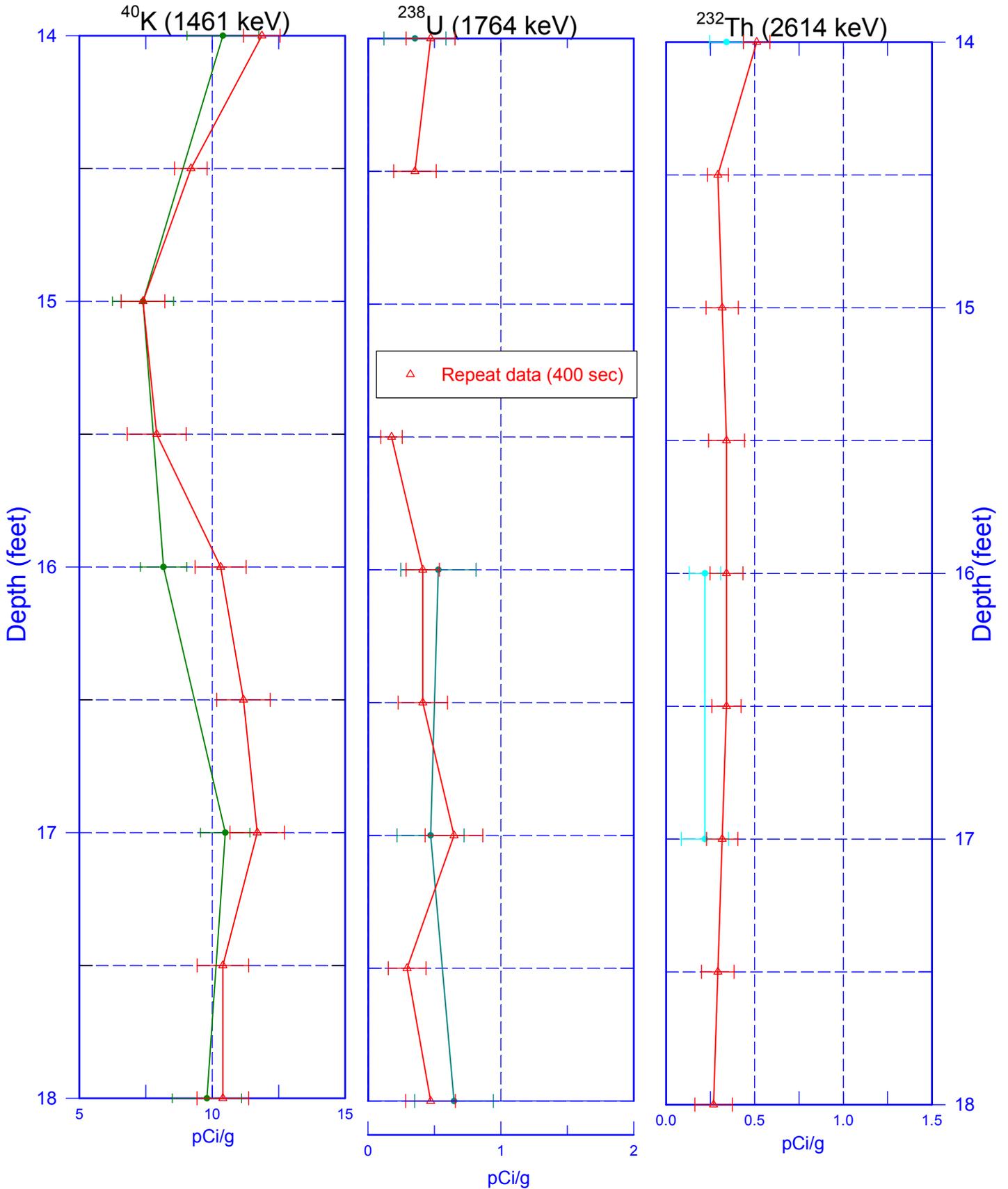


Zero reference = Ground Surface

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Repeat Section of Natural Gamma Logs

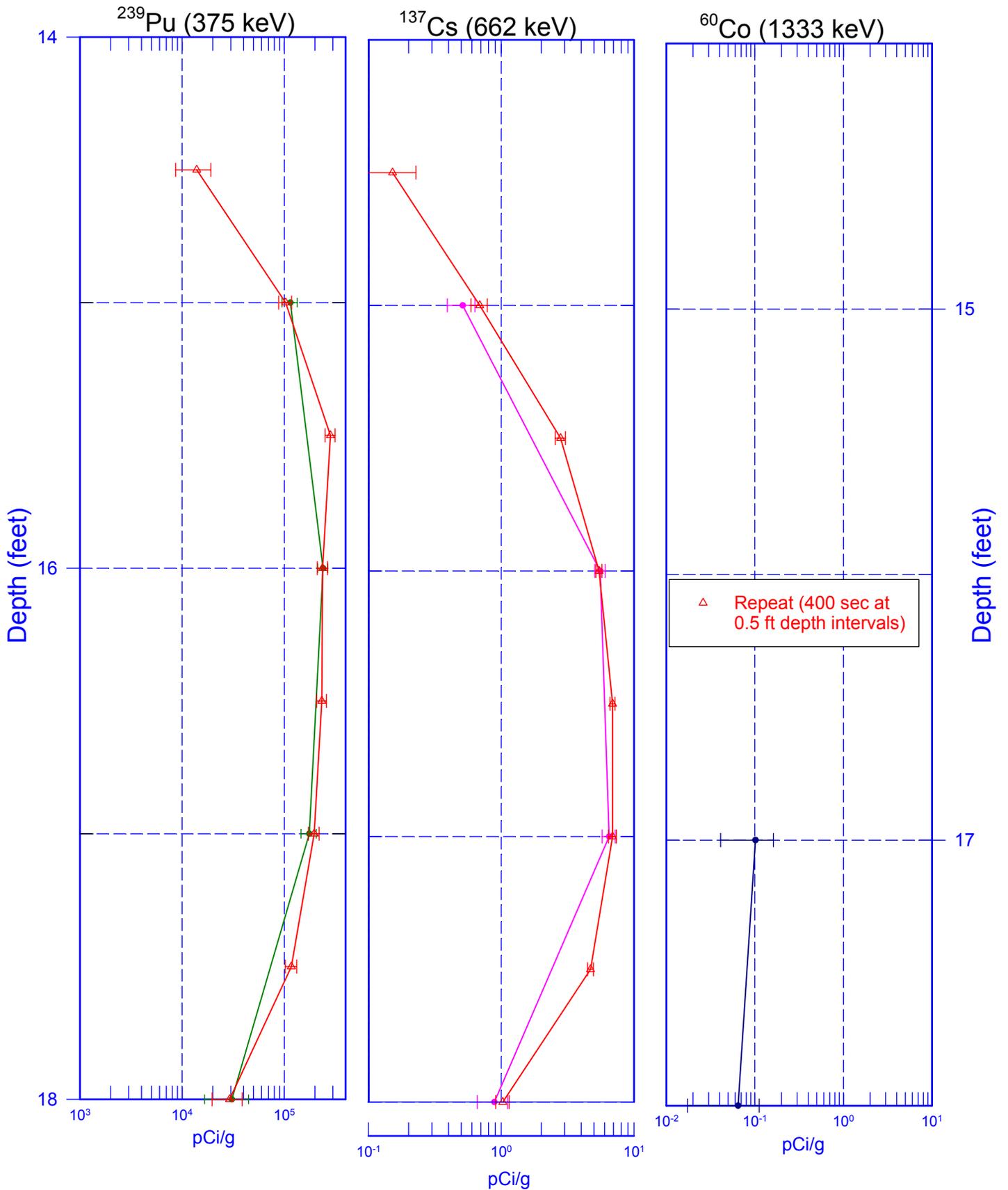


Zero Reference = Ground Surface

Last Log Date - 07/14/04

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Repeat Section of Man-Made Radionuclides



Zero Reference = Ground Surface

Last Log Date - 07/14/04

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Passive Neutron Repeat Section

