

C4111 Log Data Report

Borehole Information:

Borehole: C4111		Site: 216-A-10 Crib			
Coordinates (WA State Plane)		GWL (ft)¹: Not reached		GWL Date: 4/09/2003	
North N/A ³	East N/A	Drill Date April 2003	TOC² Elevation N/A	Total Depth (ft) 88	Type Percussion

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0	6 7/16	5 7/16	0.5	0	88
The logging engineer measured the casing stored by the driller using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drillpipe. The driller reported that each section of casing is about 10 ft long with flush outside joints.

Logging Equipment Information:

Logging System: Gamma 2E	Type: 70% HPGe (HO 68B-3572)
Calibration Date: 03/2003	Calibration Reference: GJO-2003-430-TAC
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 1C	Type: High Rate Detector
Calibration Date: 02/07/02	Calibration Reference: GJO-2002-309-TAR
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 2F	Type: Moisture (H380932510)
Calibration Date: 10/2002	Calibration Reference: GJO-2002-387-TAC
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3/Repeat		
Date	4/10/03	4/10/03	4/10/03		
Logging Engineer	Pearson	Pearson	Pearson		
Start Depth (ft)	88.0	43.0	68.0		
Finish Depth (ft)	40.0	0.0	60.0		
Count Time (sec)	50	100	100		

Log Run	1	2	3/Repeat		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	0.5	1.0	1.0		
ft/min	n/a ⁴	n/a	n/a		
Pre-Verification	BE019CAB	BE019CAB	BE019CAB		
Start File	BE019000	BE019097	BE019141		
Finish File	BE019096	BE019140	BE019149		
Post-Verification	BE019CAA	BE019CAA	BE019CAA		
Depth Return Error (in.)	n/a	2.0 high	0.5 high		
Comments	Fine-gain adjusted after file: BE019036	Switched to 100 s count time to improve counting statistics.	None		

High Rate Logging System (HRLS) Log Run Information:

Log Run	1	2/Repeat			
Date	4/13/03	4/13/03			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	53.5	48.0			
Finish Depth (ft)	45.0	45.0			
Count Time (sec)					
Live/Real	n/a	n/a			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.5	0.5			
ft/min	n/a	n/a			
Pre-Verification	AC063CAB	AC063CAB			
Start File	AC063000	AC063018			
Finish File	AC063017	AC063024			
Post-Verification	AC063CAA	AC063CAA			
Depth Return Error (in.)	n/a	0			
Comments	No fine-gain adjustment.	None			

Neutron-Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2/Repeat			
Date	4/9/03	4/9/03			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	88.0	56.0			
Finish Depth (ft)	1.25	46.25			
Count Time (sec)	n/a	n/a			
Live/Real	n/a	n/a			
Shield (Y/N)	N	N			
MSA Interval (ft)	n/a	n/a			
ft/min	1.0	1.0			

Log Run	1	2/Repeat		
Pre-Verification	BF043CAB	BF043CAB		
Start File	BF043000	BF043348		
Finish File	BF043347	BF043387		
Post-Verification	BF043CAA	BF043CAA		
Depth Return Error (in.)	0	0		
Comments	None	None		

Logging Operation Notes:

Zero reference was the ground surface, and the borehole was logged through drill pipe.

SGLS data were collected using Gamma 2E. Pre- and post-survey verification measurements employed the Amersham KUT (⁴⁰K, ²³⁸U, and ²³²Th) verifier with serial number 082. Logging was performed without a centralizer installed on the sonde.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the ¹³⁷Cs verifier with serial number 1013. Logging was performed with a centralizer installed on the sonde.

NMLS logging was performed without a centralizer installed on the sonde.

Analysis Notes:

Analyst:	Sobczyk	Date:	4/16/03	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 and compared to the control limits established on April 10, 2003. The verification spectra were all within the control limits. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra were within 2 percent of the pre-run verification spectra.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of each day and compared to the control limits established on April 11, 2003. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The verification spectra were all within the control limits.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2EMar03.xls and g1capr03.xls). Zero reference was the ground surface. Based on measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to 88 ft. The casing correction factor was calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. Water corrections were not needed or applied to the data.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 45 to 52.5 ft, and data from this region were considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron-moisture calibration is based on a typical 6-in. casing with a thickness of 0.28 in. No casing correction function is available for the neutron log. The effect of the thicker casing may be to underestimate the moisture content.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, 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 and ^{154}Eu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected in the interval from 41 ft through 88 ft at concentrations ranging from the MDL (0.2 pCi/g) to 3,600 pCi/g. The maximum concentration of ^{137}Cs was measured at 46 ft. ^{137}Cs was also detected at log depths of 24 and 32 ft with concentrations near the MDL. ^{154}Eu was detected in the interval from 83 ft through 86 ft at concentrations ranging from 0.7 pCi/g to 1.0 pCi/g.

Recognizable changes in the KUT logs occurred in this borehole. Log spectra between 32 through 44 ft display anomalously low count rates. The low KUT concentrations between 32 and 44 ft probably correspond with the rock fill that is located near the base of the crib. The volume fraction of water is 1 percent or less in this interval as well.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data. ^{137}Cs (662-keV) concentrations are comparable between the repeat and original HRLS log runs. ^{137}Cs and the natural radionuclides at energy levels of 662, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The neutron-moisture and its repeat are within the acceptance criteria.

¹ GWL – groundwater level

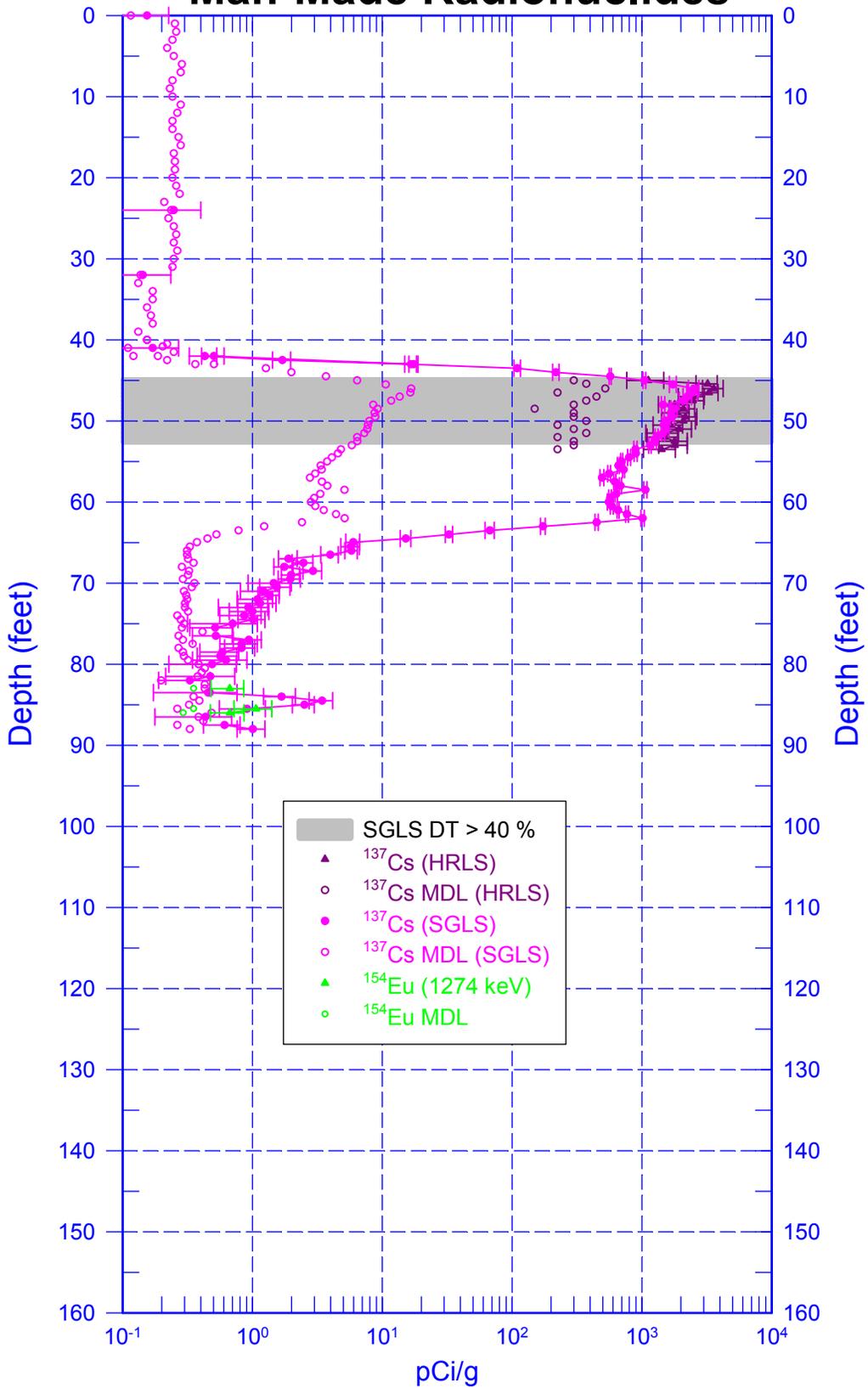
² TOC – top of casing

³ N/A – not available

⁴ n/a – not applicable

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Man-Made Radionuclides

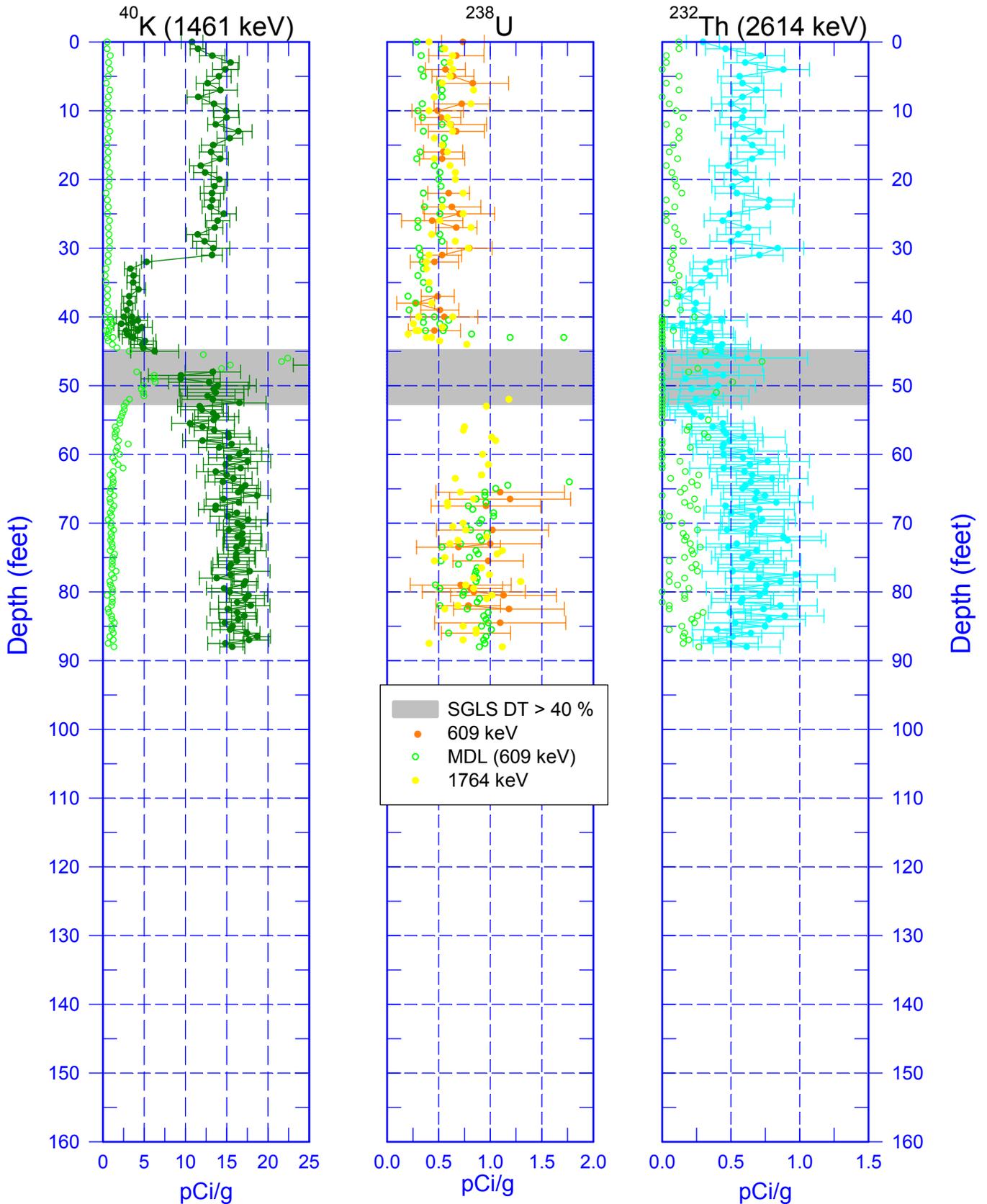


Zero Reference = Ground Surface

Date of Last Logging Run
4/13/2003

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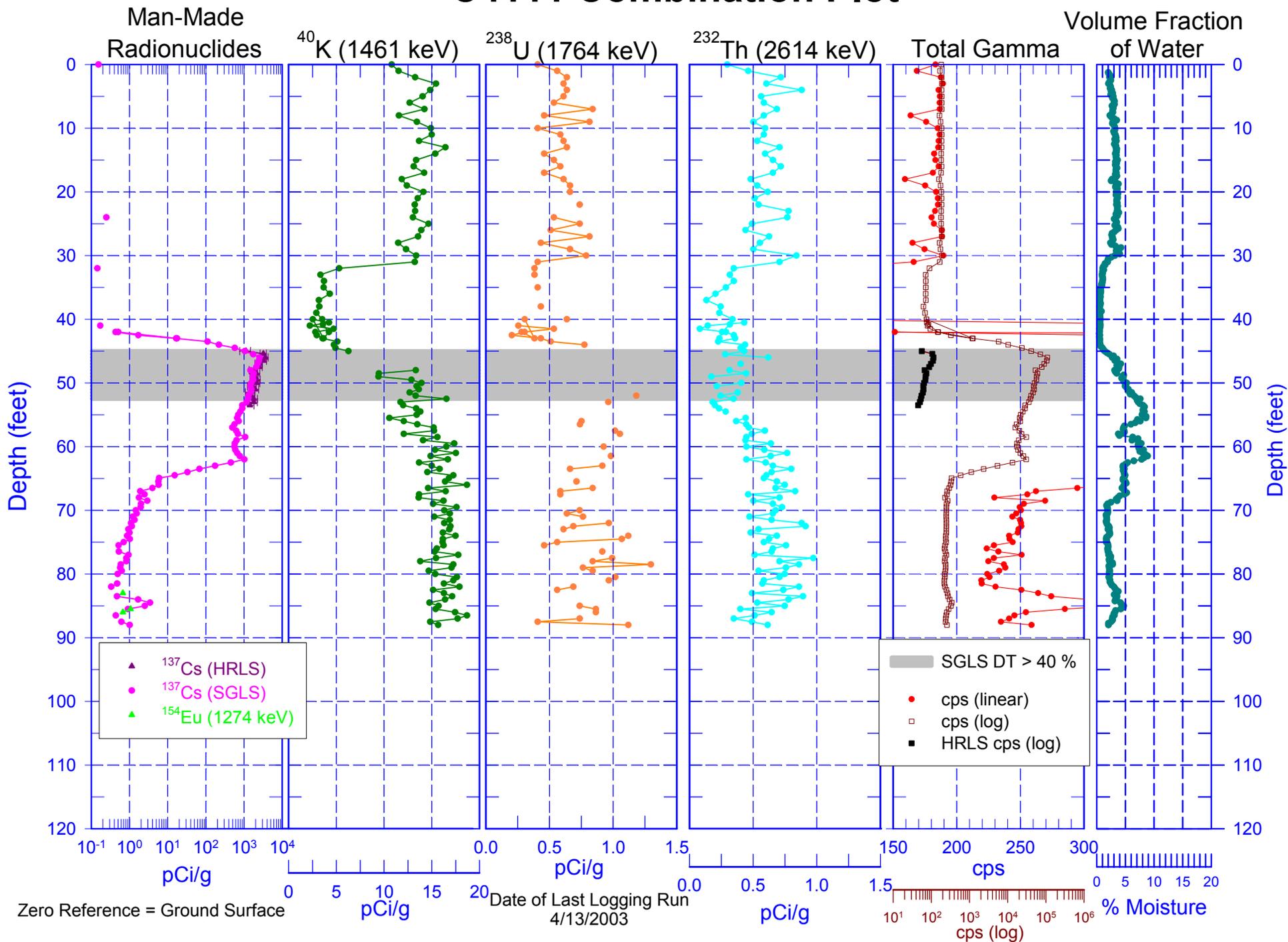
Natural Gamma Logs



Zero Reference = Ground Surface

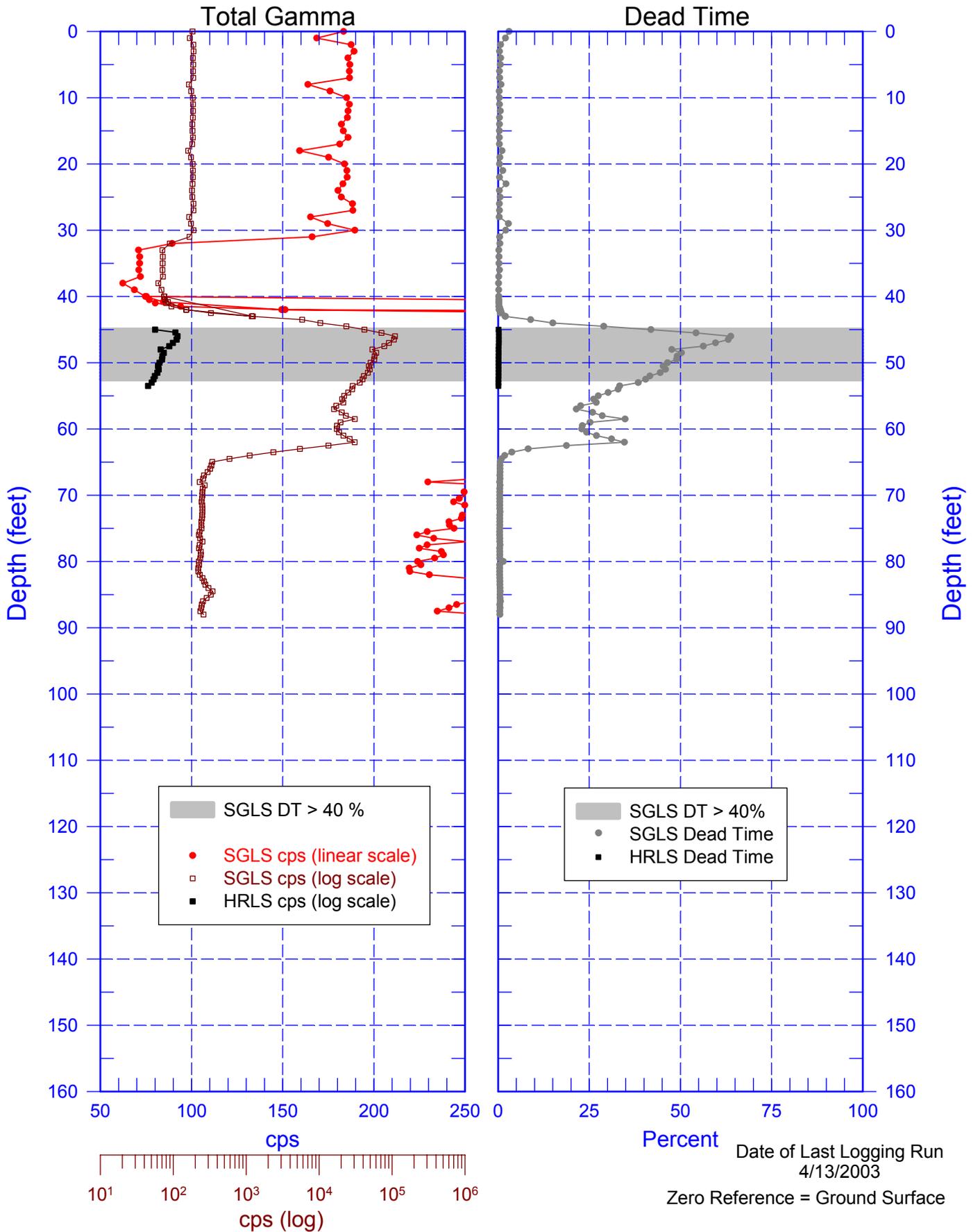
Date of Last Logging Run
4/10/2003

C4111 Combination Plot



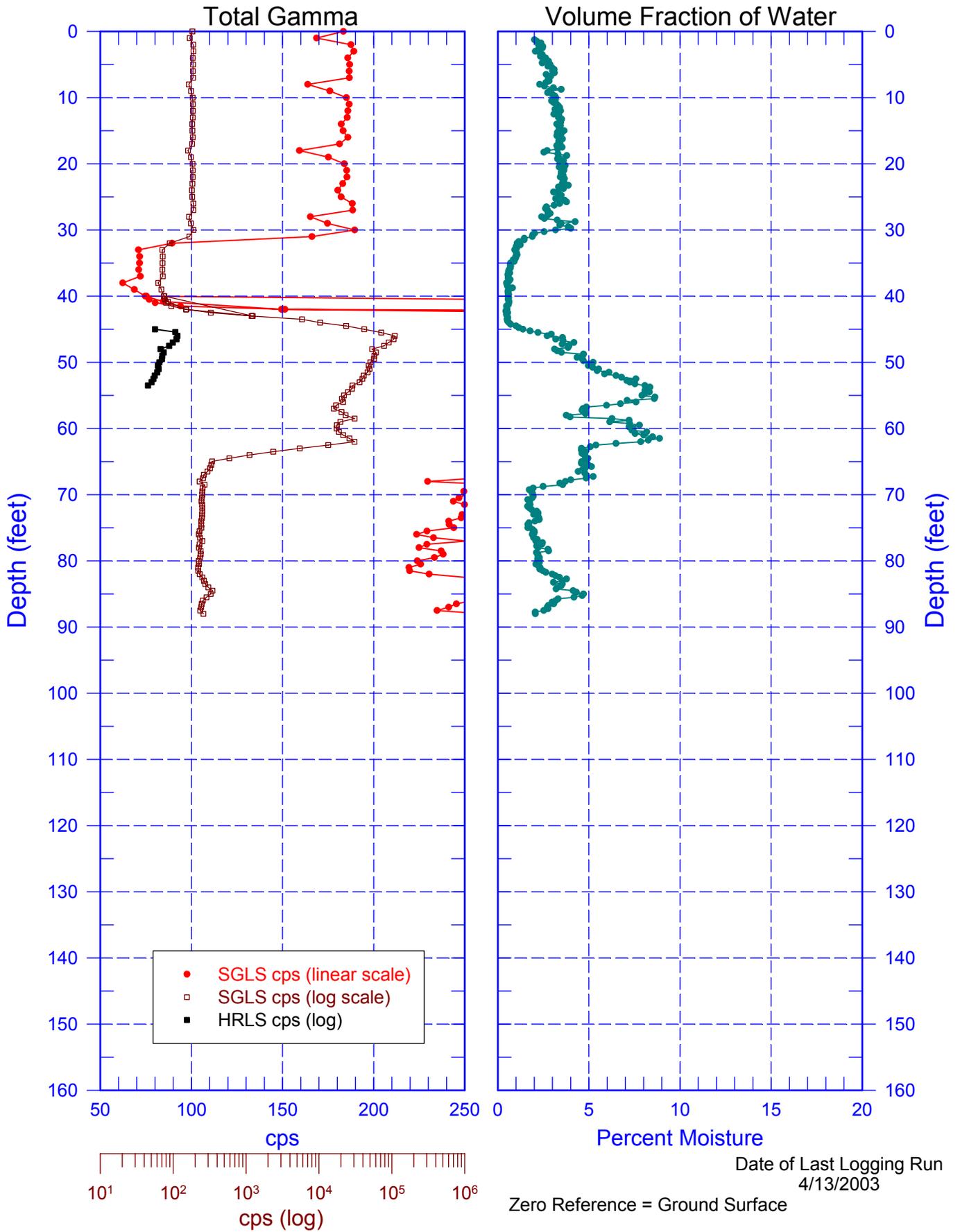
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Total Gamma & Dead Time



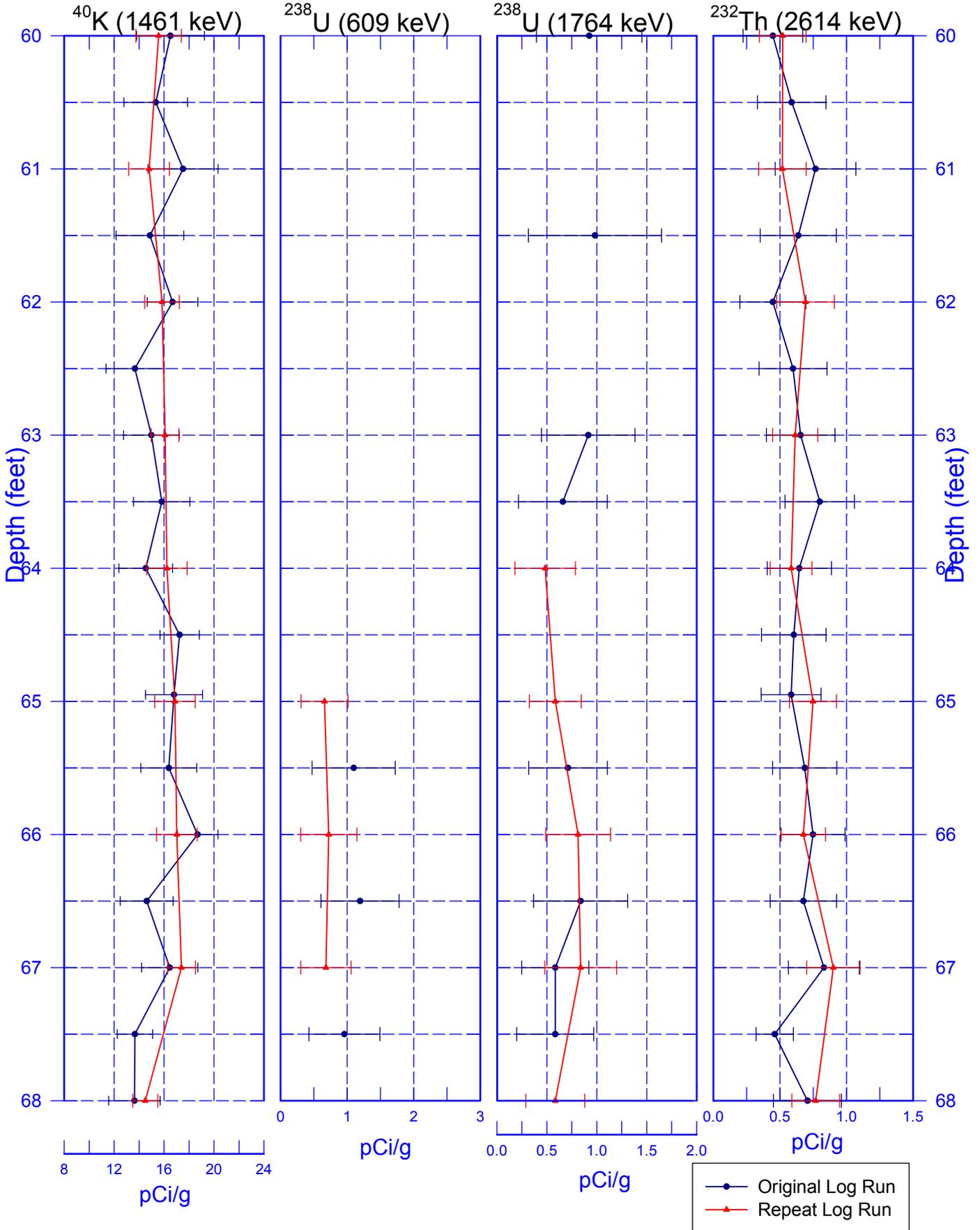
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Total Gamma & Neutron



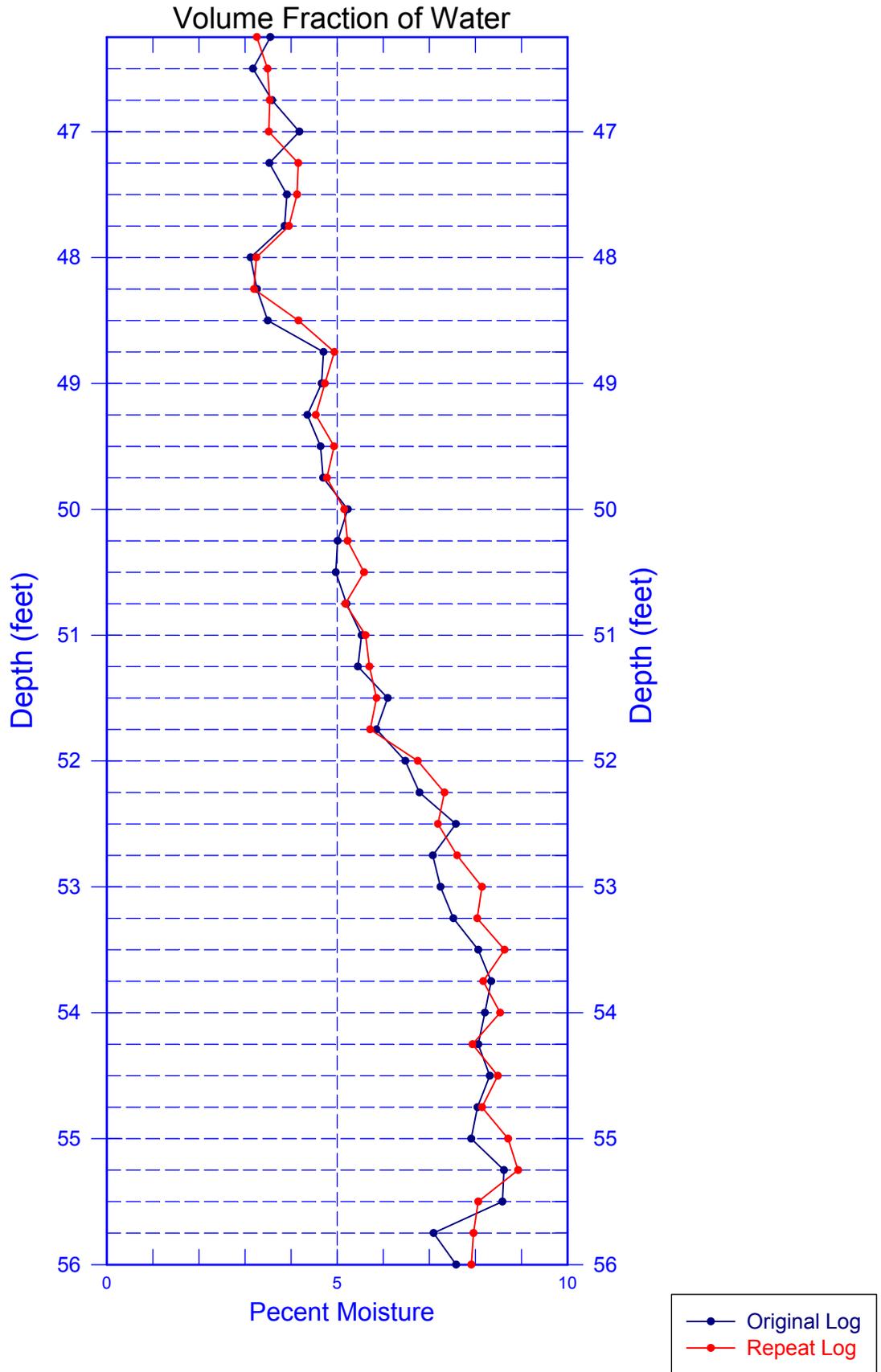
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Rerun of Natural Gamma Logs (68.0 to 60.0 ft)



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Rerun of Neutron-Moisture Log (56.0 to 46.25 ft)



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Rerun of Man-Made Radionuclides

