

## C4107 Log Data Report

### Borehole Information:

<b>Borehole:</b> C4107		<b>Site:</b> 216-A-10 Crib			
<b>Coordinates (WA State Plane)</b>		<b>GWL (ft)<sup>1</sup>:</b> Not reached		<b>GWL Date:</b> 4/15/2003	
<b>North</b> n/a <sup>3</sup>	<b>East</b> n/a	<b>Drill Date</b> April 2003	<b>TOC<sup>2</sup> Elevation</b> n/a	<b>Total Depth (ft)</b> 90	<b>Type</b> Percussion

### Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0.5	6 7/16	5 7/16	1/2	0.5	90
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 drill pipe. The driller reported that each section of casing is about 10 ft long with flush outside joints.

### Logging Equipment Information:

<b>Logging System:</b> Gamma 2E	<b>Type:</b> 70% HPGe
<b>Calibration Date:</b> 03/2003	<b>Calibration Reference:</b> GJO-2003-430-TAC
<b>Logging Procedure:</b> MAC-HGLP 1.6.5, Rev. 0	

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

### Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4/Repeat
Date	4/17/03	4/21/03	4/21/03	4/21/03
Logging Engineer	Pearson	Pearson	Pearson	Pearson
Start Depth (ft)	90.0	64.5	31.0	54.0
Finish Depth (ft)	63.5	30.0	1.0	44.0
Count Time (sec)	100	100	100	100
Live/Real	R	R	R	R
Shield (Y/N)	N	N	N	N
MSA Interval (ft)	0.5	0.5	1.0	0.5
ft/min	N/A <sup>4</sup>	N/A	N/A	N/A
Pre-Verification	BE024CAB	BE027CAB	BE027CAB	BE027CAB

Log Run	1	2	3	4/Repeat	
Start File	BE024000	BE027000	BE027070	BE027101	
Finish File	BE024053	BE027069	BE027100	BE027121	
Post-Verification	BE024CAA	BE027CAA	BE027CAA	BE027CAA	
Depth Return Error (in.)	0	N/A	0	0	
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	Repeat section.	

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

Log Run	1	2/Repeat		
Date	4/21/03	4/21/03		
Logging Engineer	Pearson	Pearson		
Start Depth (ft)	0	60.0		
Finish Depth (ft)	90.0	50.25		
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	BF049CAB	BF049CAB		
Start File	BF049000	BF049361		
Finish File	BF049360	BF049400		
Post-Verification	BF049CAA	BF049CAA		
Depth Return Error (in.)	N/A	0		
Comments	None	Repeat section.		

**Logging Operation Notes:**

During all log runs, zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed without a centralizer installed on the sonde.

SGLS data were collected using Gamma 2E. Pre- and post-survey verification measurements employed the Amersham KUT (<sup>40</sup>K, <sup>238</sup>U, and <sup>232</sup>Th) verifier with serial number 082. On 4/17/2003, two pre-survey verification files (BE024CAB and BE024BAB) were collected due to poor photopeak resolution.

**Analysis Notes:**

<b>Analyst:</b>	Sobczyk	<b>Date:</b>	4/22/03	<b>Reference:</b>	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 each day and compared to the control limits established on 4/10/2003. The verification spectra were all within the control limits except for BE024CAB and BE024BAB. The BE024CAB pre-run verification spectrum was above the upper control limits for the 609-keV, 1461-keV, and 2615-keV full-width at half-maximum values. The pre-run verification spectrum was collected a second time, and the BE024BAB pre-run verification spectrum was slightly above the upper control limits for the 609-keV, 1461-keV, and 2615-keV full-width at half-maximum values. This spectrum demonstrated improved peak resolution prior to the beginning of log run one. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectrum as compared to the pre-run verification spectrum for the day were within 2 percent at the end of the day. Examinations of spectra indicate that the detector functioned normally during all of the logging runs, and the spectra are accepted.

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 within the control limits.

SGLS 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 file: G2EMar03.xls). Zero reference was the ground surface. On the basis of measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to 90 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 56.5 to 57.5 ft. 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 maximum dead time encountered was 43.5 percent at 57 ft. Because of the limited extent and relatively low dead time, HRLS data were not collected.

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 ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), 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  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$  and  $^{154}\text{Eu}$  were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was detected in the interval from 38 ft through total depth (90 ft) at concentrations ranging from 0.2 pCi/g to 1,300 pCi/g. The maximum concentration of  $^{137}\text{Cs}$  was measured at 57.5 ft.  $^{154}\text{Eu}$  was detected in the interval from 84 through 88.5 ft and at 63.5 ft at concentrations ranging from 0.5 pCi/g to 5.6 pCi/g. The maximum concentration of  $^{154}\text{Eu}$  was measured at 86 ft.

Recognizable changes in the KUT logs occurred in this borehole. The low KUT concentrations between 30 and 43 ft probably correspond with the rock fill that is located near the base of the crib. The volume fraction of water is below 2 percent in the interval from 30 through 40 ft.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS and NMLS data. <sup>137</sup>Cs (662 keV) concentrations and the natural radionuclides at energy levels of 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.

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<sup>1</sup> GWL – groundwater level

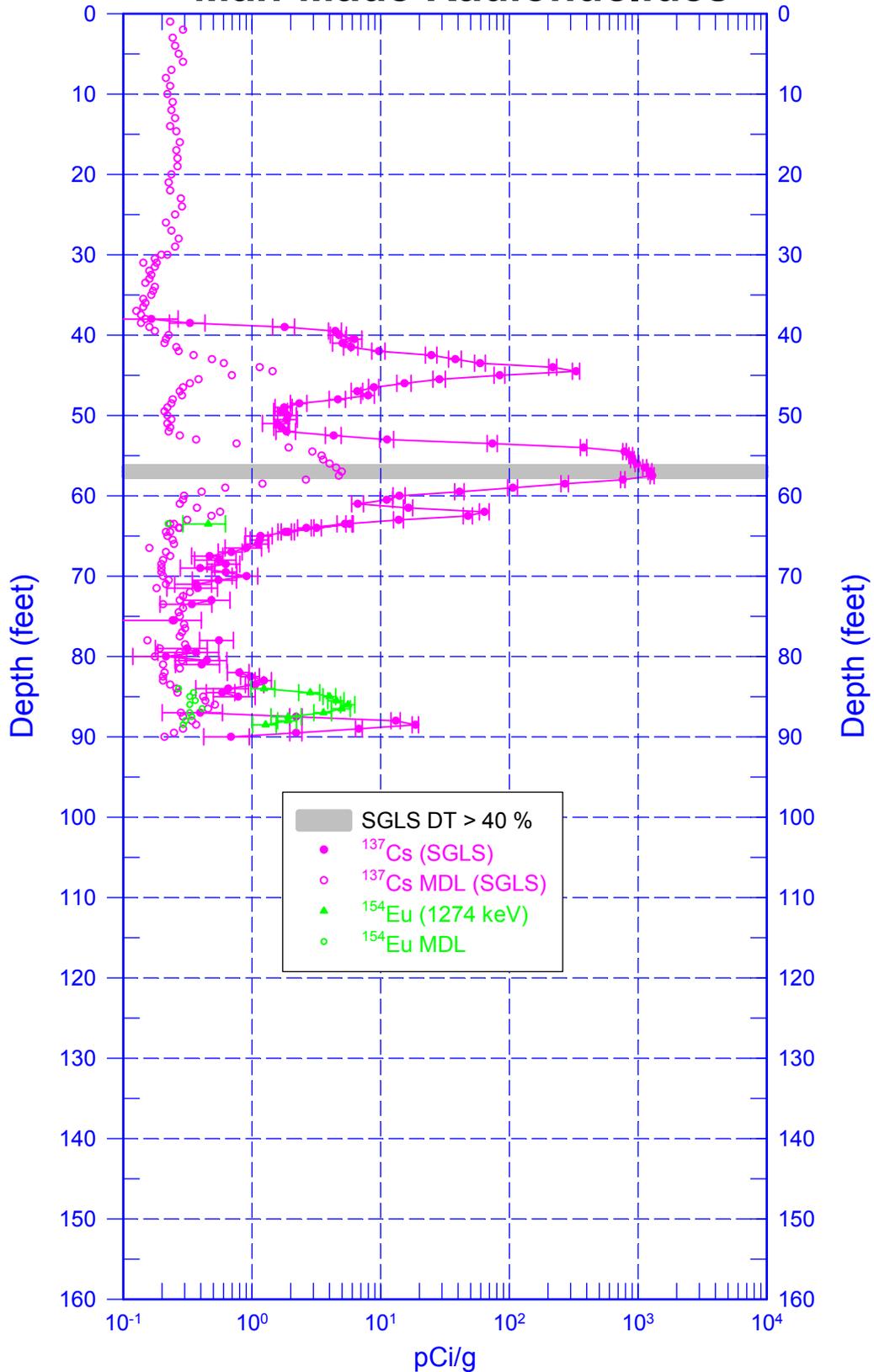
<sup>2</sup> TOC – top of casing

<sup>3</sup> n/a – not available

<sup>4</sup> N/A – not applicable

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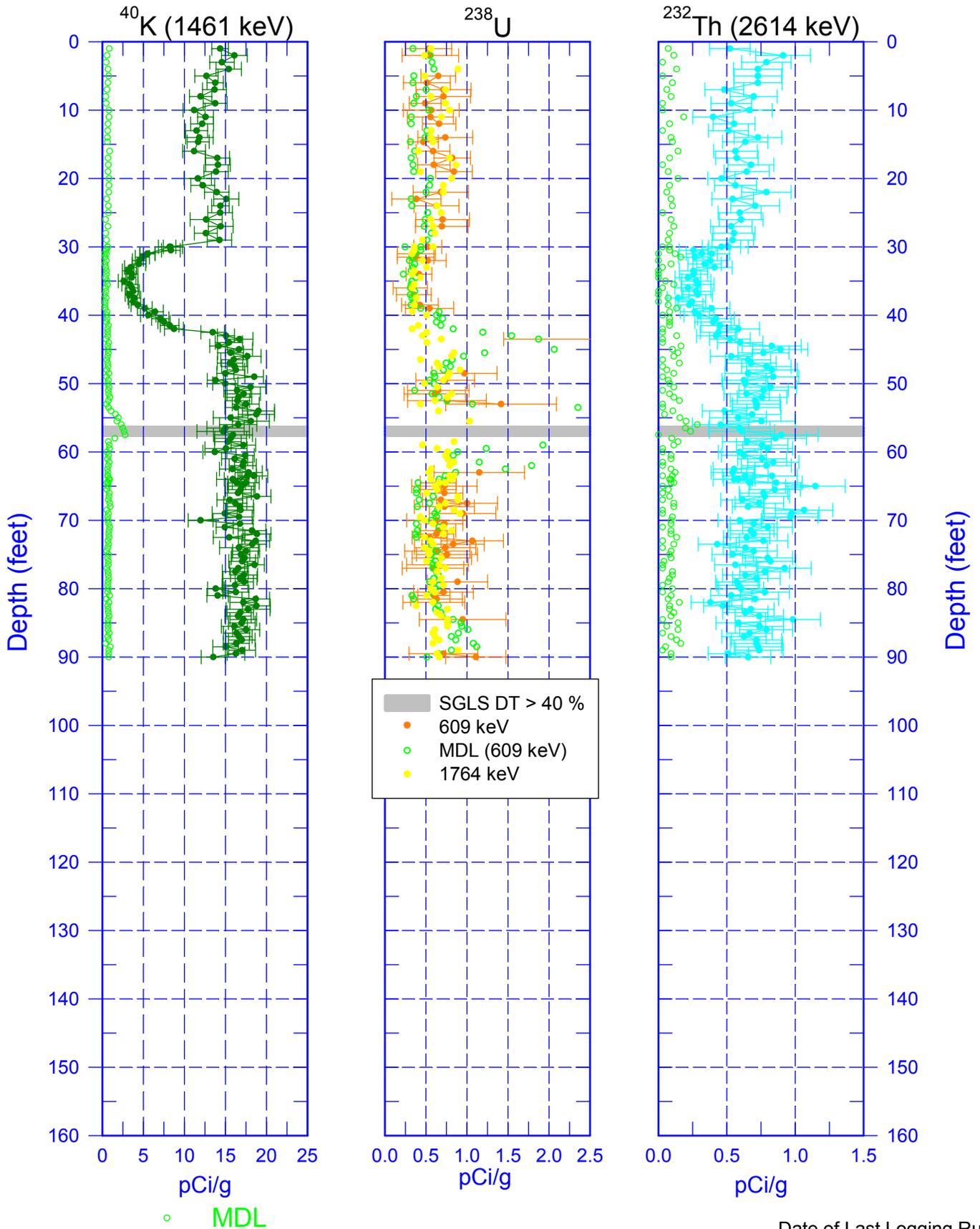
## Man-Made Radionuclides



Zero Reference = Ground Surface

Date of Last Logging Run  
4/21/2003

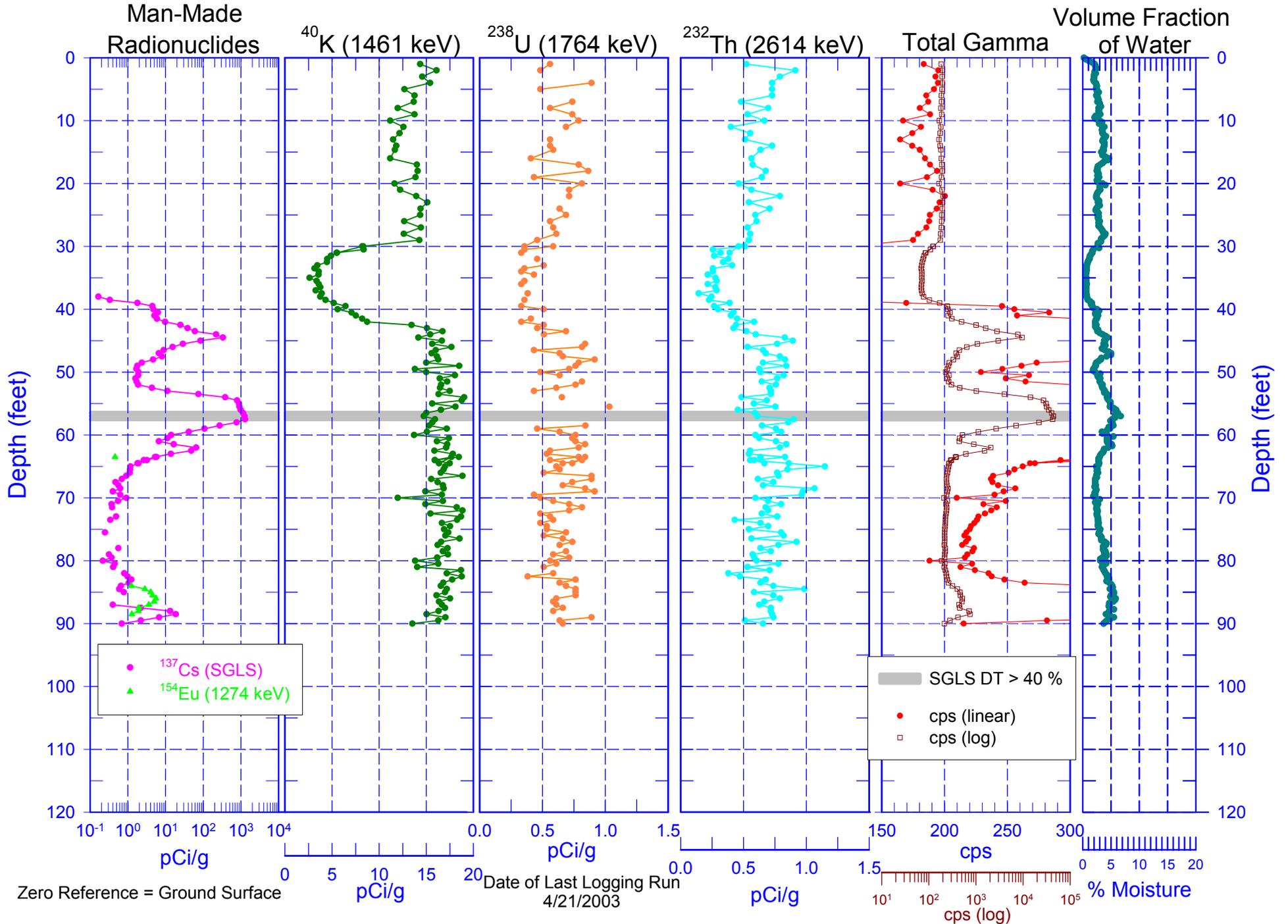
# C4107 Natural Gamma Logs



Zero Reference = Ground Surface

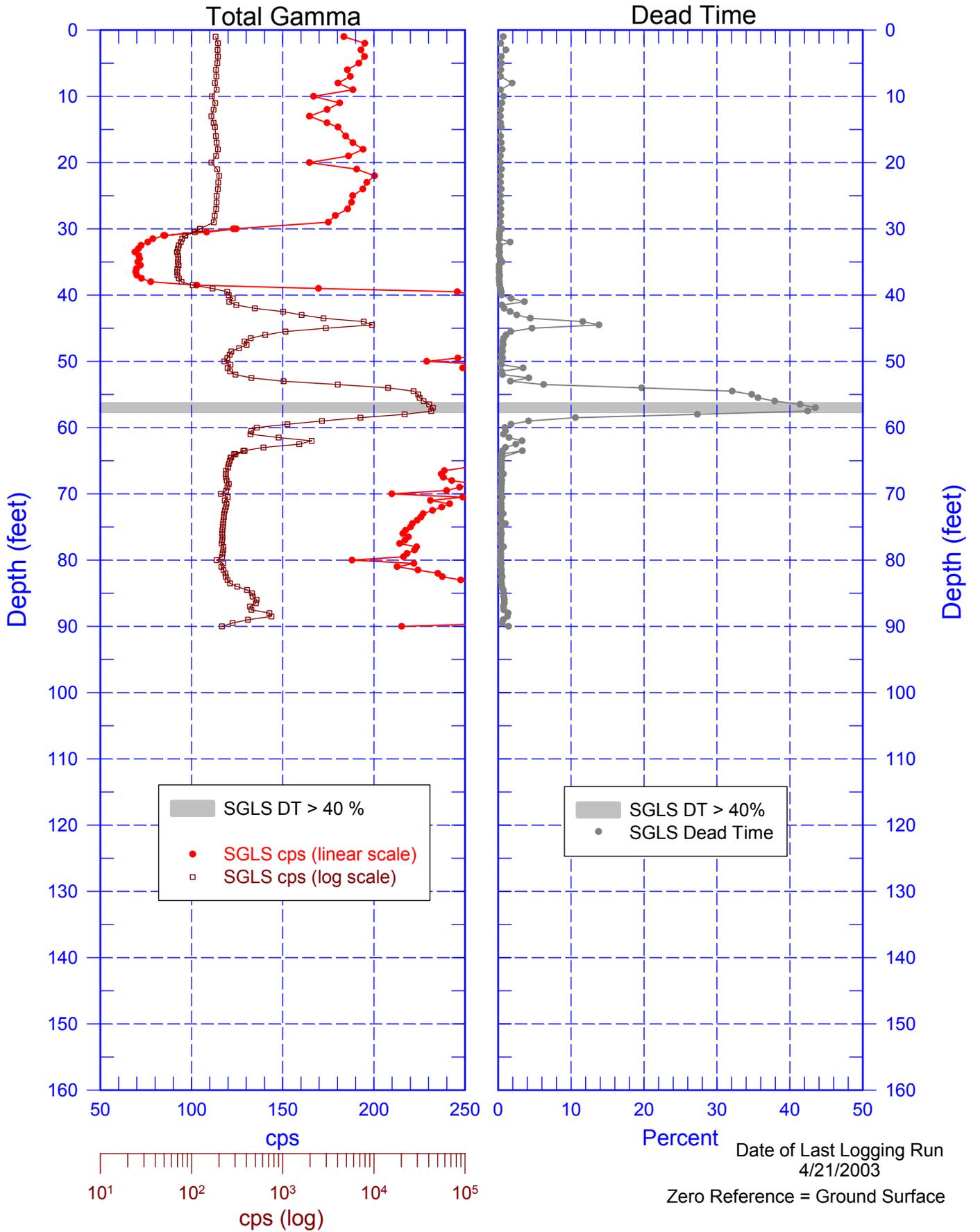
Date of Last Logging Run  
4/21/2003

# C4107 Combination Plot



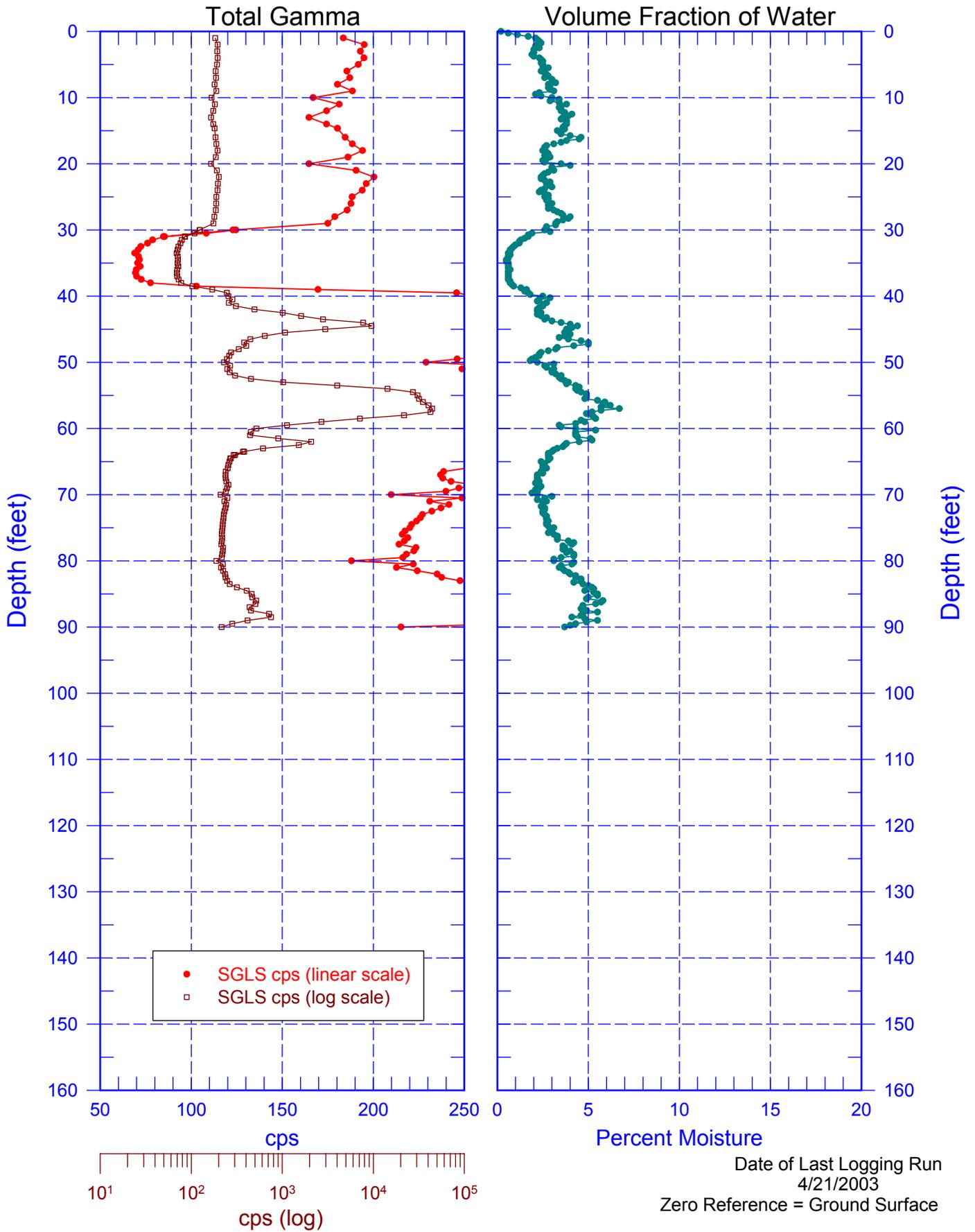
# C4107

## Total Gamma & Dead Time



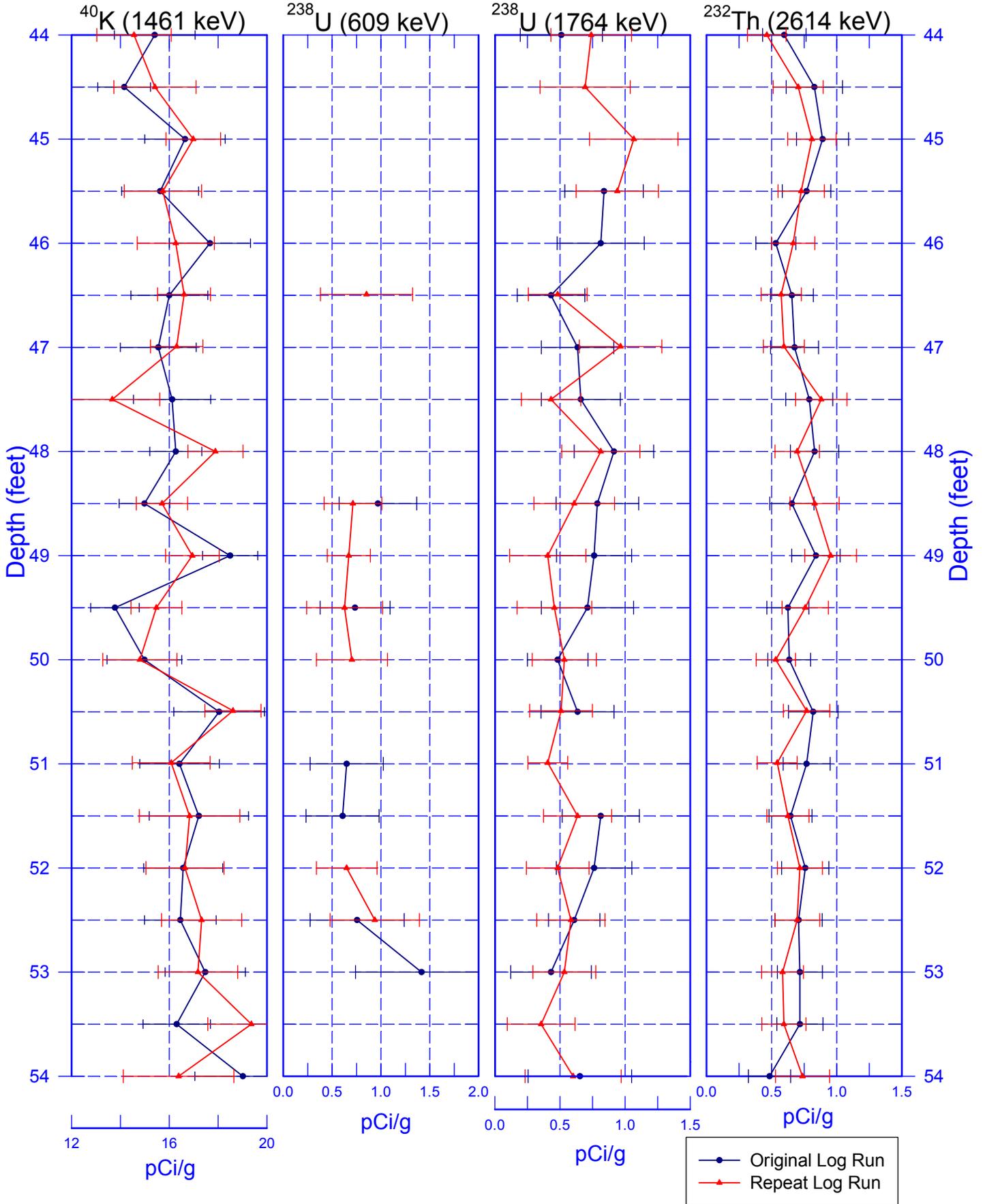
# C4107

## Total Gamma & Neutron



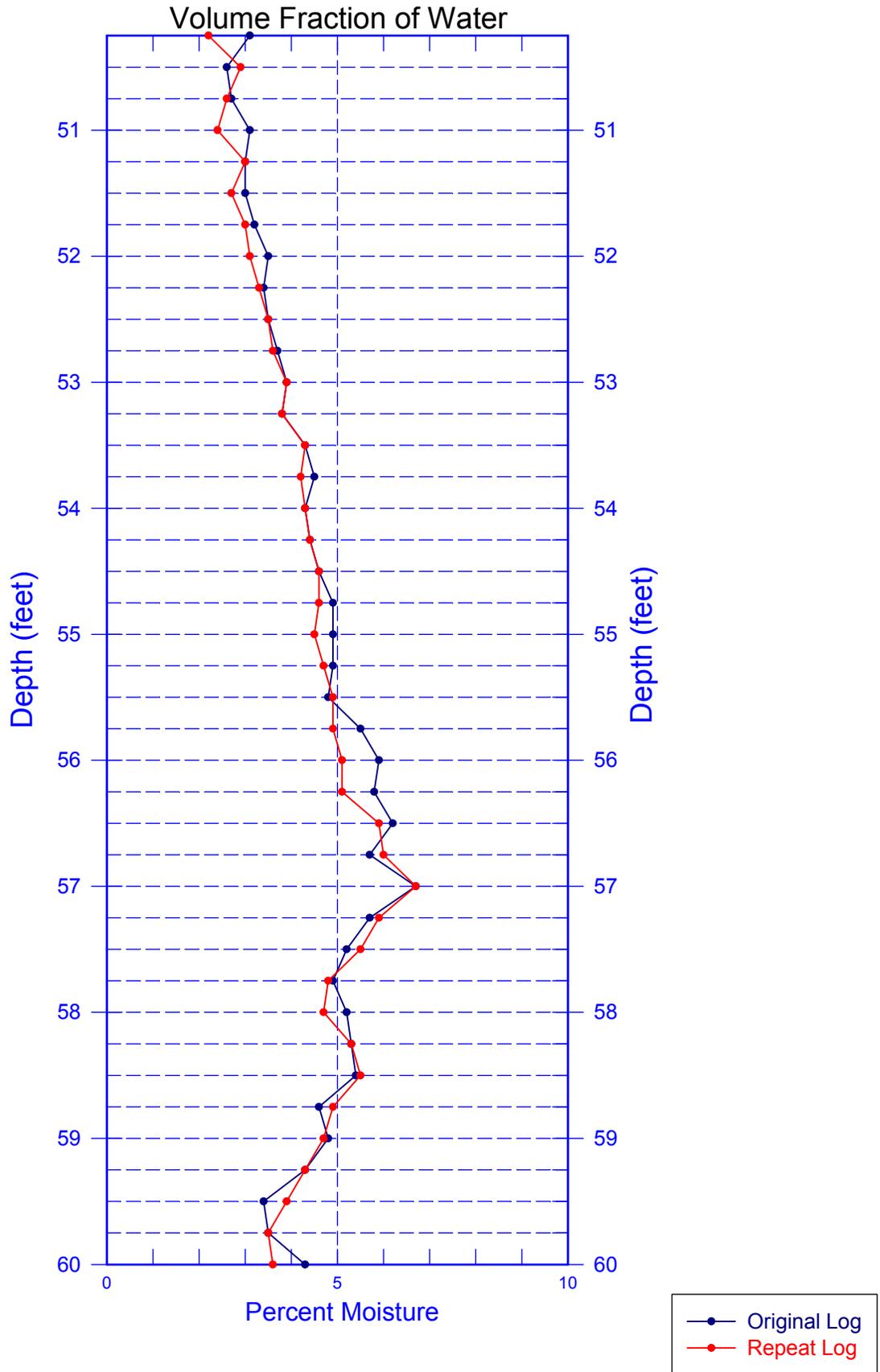
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## Rerun of Natural Gamma Logs (54.0 to 44.0 ft)



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## Rerun of Neutron-Moisture Log (60.0 to 50.25 ft)



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## Rerun of Man-Made Radionuclides

