

299-W14-02 (A7328)
Log Data Report

Borehole Information:

Borehole: 299-W14-02 (A7328)		Site: 216-T-28 Crib			
Coordinates (WA State Plane)		GWL (ft)¹: Dry		GWL Date: 08/12/04	
North	East	Drill Date	TOC² Elevation	Total Depth (ft)	Type
136340.409	566932.32	05/55	675.16 ft	223	Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	3.6	6 5/8	6	5/16	3.6	158
Welded Steel	0.0	8	unknown	unknown	0	223

Borehole Notes:

The logging engineer used a steel tape to measure the 6-in. casing. The 8-in. casing was not visible at the ground surface. The presence of the 8-in. casing is determined from Ledgerwood (1993). All logging measurements are referenced to top of the 6-in. casing. Before the borehole was logged a swab was acquired of the interior of the borehole. No contamination was detected on the swab.

Ledgerwood (1993) indicated the 6-in. casing was set inside the 8-in. casing on a packer to 158 ft. The 8-in. casing was perforated from 0-150 ft and the annulus between the 6-in. and 8-in. casing was grouted. Apparently 10 gallons of sand were emplaced from approximately 150 to 158 ft. The 8-in. casing was also perforated from 181 to 222 ft. Ledgerwood indicated the groundwater level was at 195 and 200 ft in January 1956 and November 1988, respectively.

Logging Equipment Information:

Logging System: Gamma 4E	Type: SGLS (70%) 34TP40587A
Calibration Date: 05/04	Calibration Reference: DOE-EM/GJ692-2004
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 1C	Type: HRLS planar 39A314
Calibration Date: 05/04	Calibration Reference: DOE-EM/GJ713-2004
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4	5
Date	08/10/04	08/10/04	08/10/04	08/11/04	08/12/04
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz

Log Run	1	2	3	4	5
Start Depth (ft)	150.0	107.0	9.0	185.0	225.0
Finish Depth (ft)	107.0	9.0	4.0	149.0	186.0
Count Time (sec)	100	20	100	100	100
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 ³	N/A	N/A	N/A	N/A
Pre-Verification	DE201CAB	De201CAB	DE201CAB	DE231CAB	DE241CAB
Start File	DE211000	DE211045	DE211144	DE231000	DE241000
Finish File	DE211044	DE211143	DE211149	DE231036	DE241039
Post-Verification	DE211CAA	DE211CAA	DE211CAA	DE231CAA	DE241CAA
Depth Return Error (in.)	N/A	N/A	-1	0	N/A
Comments	No fine-gain adjustment.	No fine-gain adjustment. High rate interval.	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.

Log Run	6 Repeat				
Date	08/12/04				
Logging Engineer	Spatz				
Start Depth (ft)	185.0				
Finish Depth (ft)	162.0				
Count Time (sec)	100				
Live/Real	R				
Shield (Y/N)	N				
MSA Interval (ft)	1.0				
ft/min	N/A				
Pre-Verification	DE241CAB				
Start File	DE241040				
Finish File	DE241063				
Post-Verification	DE241CAA				
Depth Return Error (in.)	-1				
Comments	No fine-gain adjustment.				

High Rate Logging System (HRLS) Log Run Information:

Log Run	7	8	9	10	11
Date	08/18/04	08/18/04	08/18/04	08/18/04	08/18/04
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	110.0	96.0	88.0	83.0	9.0
Finish Depth (ft)	96.0	88.0	83.0	8.0	8.0
Count Time (sec)	300	100	300	100	300
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	AC107CAB	AC107CAB	AC107CAB	AC107CAB	AC107CAB
Start File	AC107000	AC107015	AC107024	AC107030	AC107106
Finish File	AC107014	AC107023	AC107029	AC107105	AC107107
Post-Verification	AC107CAA	AC107CAA	AC107CAA	AC107CAA	AC107CAA
Depth Return Error (in.)	N/A	N/A	N/A	N/A	N/A

Log Run	7	8	9	10	11
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	Fine-gain adjustment after files 041 and 083.	No fine-gain adjustment.

Log Run	12 Repeat	13	14 Repeat		
Date	08/18/04	08/18/04	08/18/04		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	48.0	30.0	24.0		
Finish Depth (ft)	38.0	14.0	18.0		
Count Time (sec)	100	100	100		
Live/Real	R	R	R		
Shield (Y/N)	N	Internal	Internal		
MSA Interval (ft)	1.0	1.0	1.0		
ft/min	N/A	N/A	N/A		
Pre-Verification	AC107CAB	AC107CAB	AC107CAB		
Start File	AC107108	AC107119	AC107136		
Finish File	AC107118	AC107135	AC107142		
Post-Verification	AC107CAA	AC107CAA	AC107CAA		
Depth Return Error (in.)	N/A	N/A	0		
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.		

Logging Operation Notes:

Logging was performed with a centralizer installed on the sondes except for log runs 1, 2, and 3. Pre- and post-survey verification measurements for the SGLS employed the Amersham KUT (⁴⁰K, ²³⁸U, and ²³²Th) verifier with serial number 118. A high rate interval from 9 to 107 ft was logged with the SGLS at a 20-sec count time.

High rate logging was performed from 8 to 110 ft. An internal tungsten shield was used from 14 to 30 ft (log runs 13 and 14) in the depth interval of highest gamma activity. The pre- and post-verification measurements were acquired in the Cs-137 verifier, SN 1013.

Analysis Notes:

Analyst:	Henwood	Date:	09/01/04	Reference:	GJO-HGLP 1.6.3, Rev. 0
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SGLS and HRLS 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.

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 for SGLS and HRLS spectra were calculated in EXCEL (source files: G4EJul04.xls and G1CMay04.xls, respectively). A combined casing thickness of 0.6345 in. (0.3125-in. + 0.322-in. for the 6- and 8-in. casings, respectively) was applied to the data from 0 to 158 ft. Below 158 ft a 0.322-in.-thick casing correction was applied. Dead time corrections are applied to the SGLS data where dead time exceeds 4.7 percent. Where SGLS dead time exceeds 40 percent, HRLS data are substituted. Where dead time for the HRLS exceeds 40 percent, data are acquired with an internal shield on the HRLS. No 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 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.

A comparison plot of the Westinghouse Hanford Company Radionuclide Logging System (RLS) data acquired in 1992 with the current SGLS and HRLS data is included. Historical gross gamma logging plots have been copied from Fecht et al. (1977) and digitized. These logs are plotted with the current SGLS and HRLS logs.

Results and Interpretations:

^{137}Cs , ^{60}Co , and ^{154}Eu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected from the ground surface to 174 ft and at a few sporadic locations below 174 ft to total depth. A maximum concentration of approximately 4.7×10^6 pCi/g was measured at 23 ft.

^{60}Co was detected from 108 to 115 ft, 144 to 155 ft, sporadically from 163 to 196 ft, and from 199 to 223 ft. The maximum concentration was approximately 0.4 pCi/g at 211 ft. It is likely ^{60}Co exists in the high gamma activity zone between 10 and 110 ft. The MDL for ^{60}Co is significantly increased in the high activity zone such that it may not be detected.

^{154}Eu was detected from 97 to 123 ft and from 83 to 88 ft. The maximum concentration was measured at approximately 90 pCi/g at 97 ft. It is likely ^{154}Eu exists in the high gamma activity zone between 10 and 110 ft. The MDL for ^{154}Eu is significantly increased in the high activity zone such that it may not be detected. Brodeur (1993) reported ^{137}Cs , ^{154}Eu , and ^{60}Co exist from 17 to 140 ft in depth in borehole 299-W14-04, which is located approximately 45 ft northwest of borehole 299-W14-02. This observation may provide further evidence these contaminants exist in the high rate zone in borehole 299-W14-02.

A comparison plot of RLS data acquired in 1992 with the current SGLS and HRLS data is included. The RLS data were decayed to the date of the SGLS log data. Differences in calibration methodology or casing corrections appear to have resulted in a slight offset in calculated concentrations. However, the profiles of the sets of log data are similar, suggesting stability of contaminants since 1992. One exception may be between 145 and 155 ft where slight increases are observed in the ^{60}Co concentrations and perhaps in the ^{137}Cs concentrations as well.

Plots of historical gross gamma logs acquired in this borehole in 1959, 1963, 1970, and 1976 are included (Fecht et al. 1977). The earliest log data acquired in 06/19/59 indicates contamination existed in the vadose zone to a depth of approximately 120 ft. However, WIDS reports the dates of service for this crib were from February 1960 to December 1966. This inconsistency suggests either a lateral influx of contamination from another source occurred prior to 1960 or the service dates are inaccurate. If the service dates are inaccurate, the contaminant inventory estimated for this waste site may be in error. The 1963 log shows increased activity that extends to approximately 130 ft. Between 1963 and 1970 a significant influx of activity is observed below 120 ft throughout the vadose zone to the total depth of the borehole; groundwater level is reported in Ledgerwood (1993) at approximately 195 ft in 1956. WIDS reports: "Ritter (1966) states that a breakthrough of radioactive strontium and cesium to the groundwater beneath the crib occurred in 1965." By 1976, much of the contamination below 120 ft apparently consisted of short-lived radionuclides and significant decay had occurred. The 1976 profile is similar to the current

profile, suggesting the remaining gamma-emitting contaminants consist of ^{137}Cs , ^{154}Eu , and ^{60}Co . The 1976 log that shows relatively high activity between 200 ft and total depth has decayed at a rate consistent with ^{60}Co contamination, which is the contaminant the current SGLS logs indicate at this depth.

The ^{40}K and ^{232}Th logs show some variations in concentrations, suggesting lithology changes that may be correlated with adjacent boreholes. Log data acquired 08/12/04 (log run 5) show enhanced radon in the borehole between 186 and 225 ft in depth.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural and man-made radionuclides.

References:

Fecht, K.R., G.V. Last, and K.R. Price, 1977. *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells*, ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Ledgerwood, R.K., 1993. *Summaries of Well Construction Data and Field Observations for Existing 200-West Resource Protection Wells*, WHC-SD-ER-TI-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

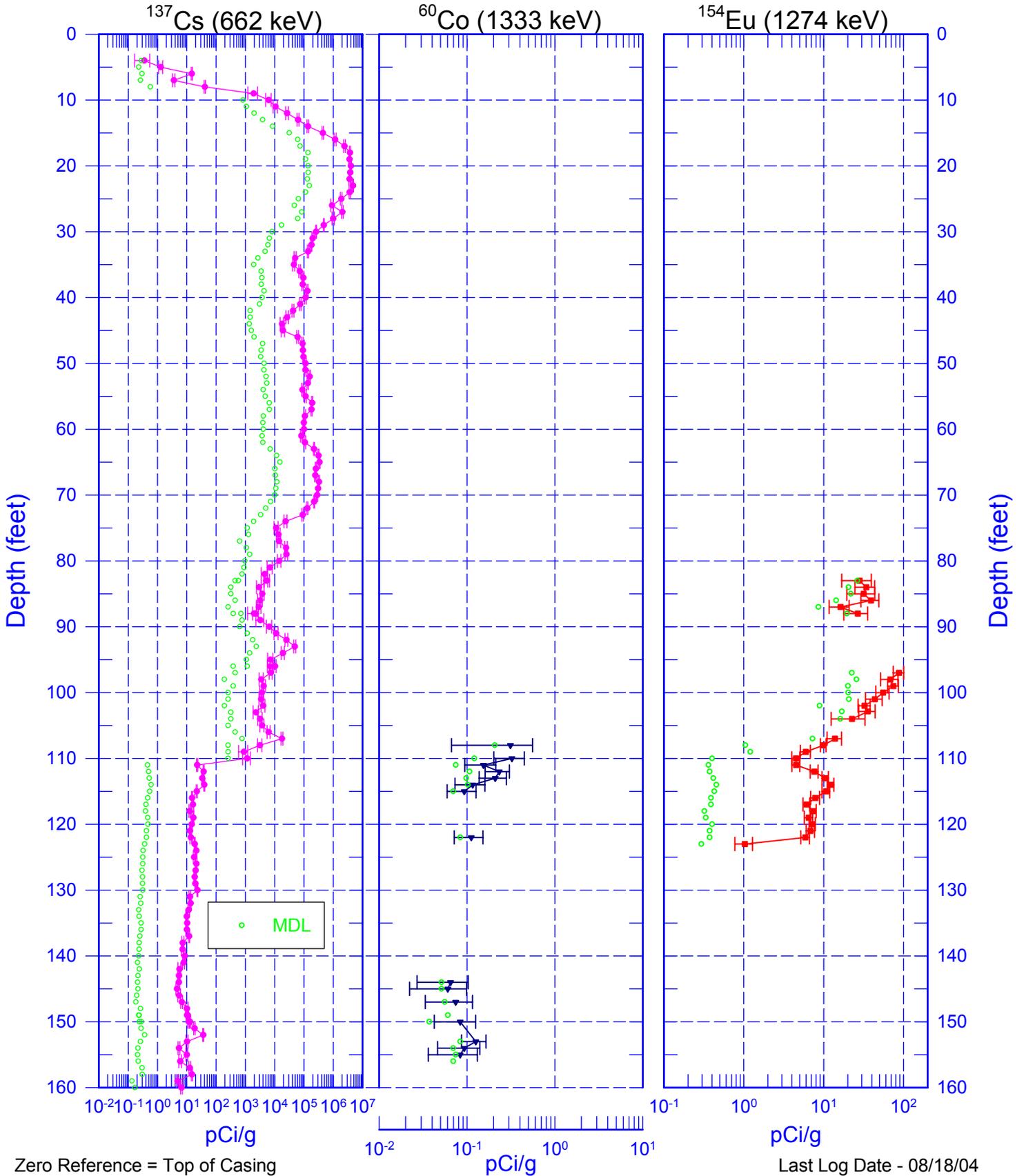
¹ GWL – groundwater level

² TOC – top of casing

³ N/A – not applicable

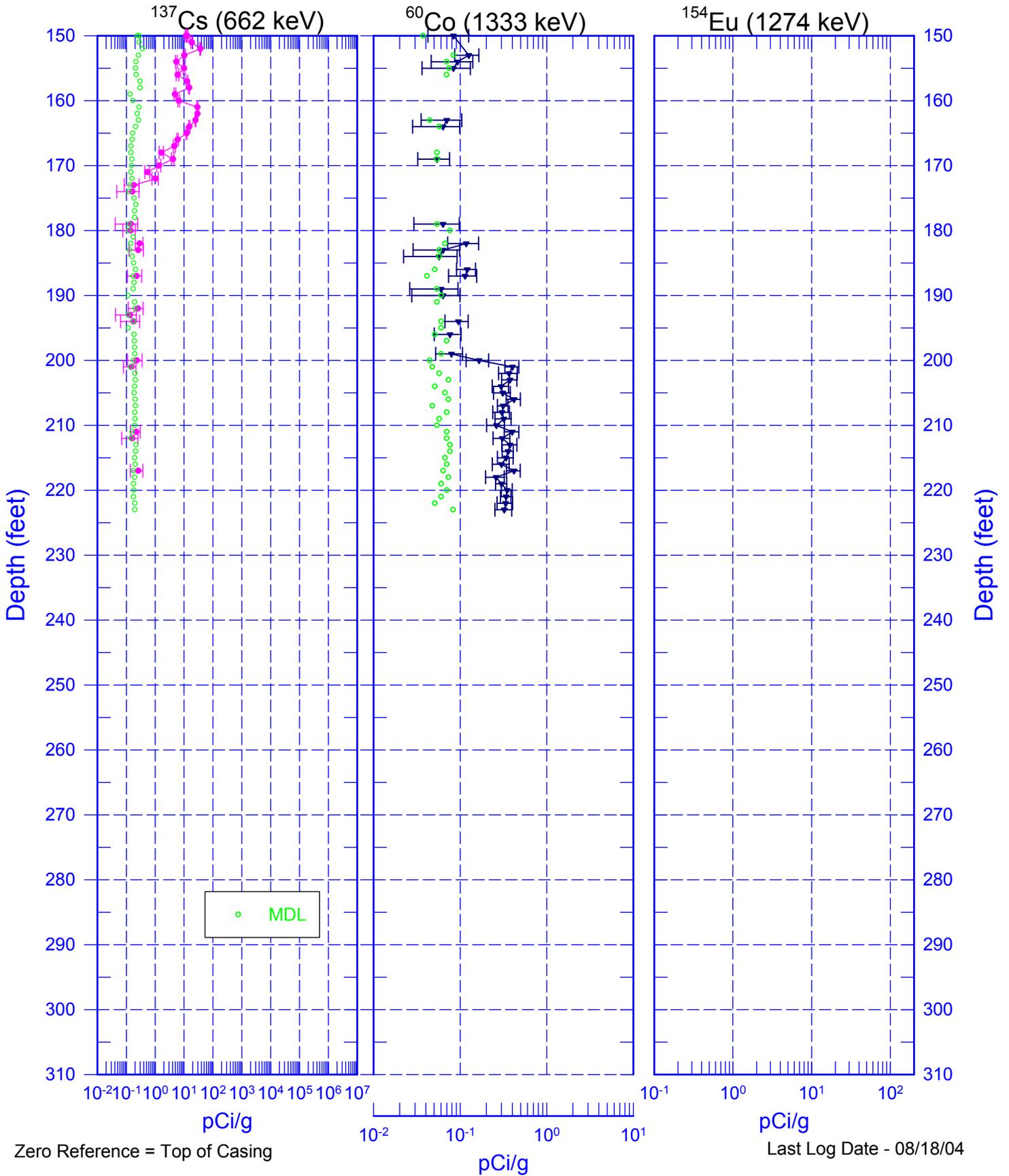
299-W14-02 (A7328)

Man-Made Radionuclides

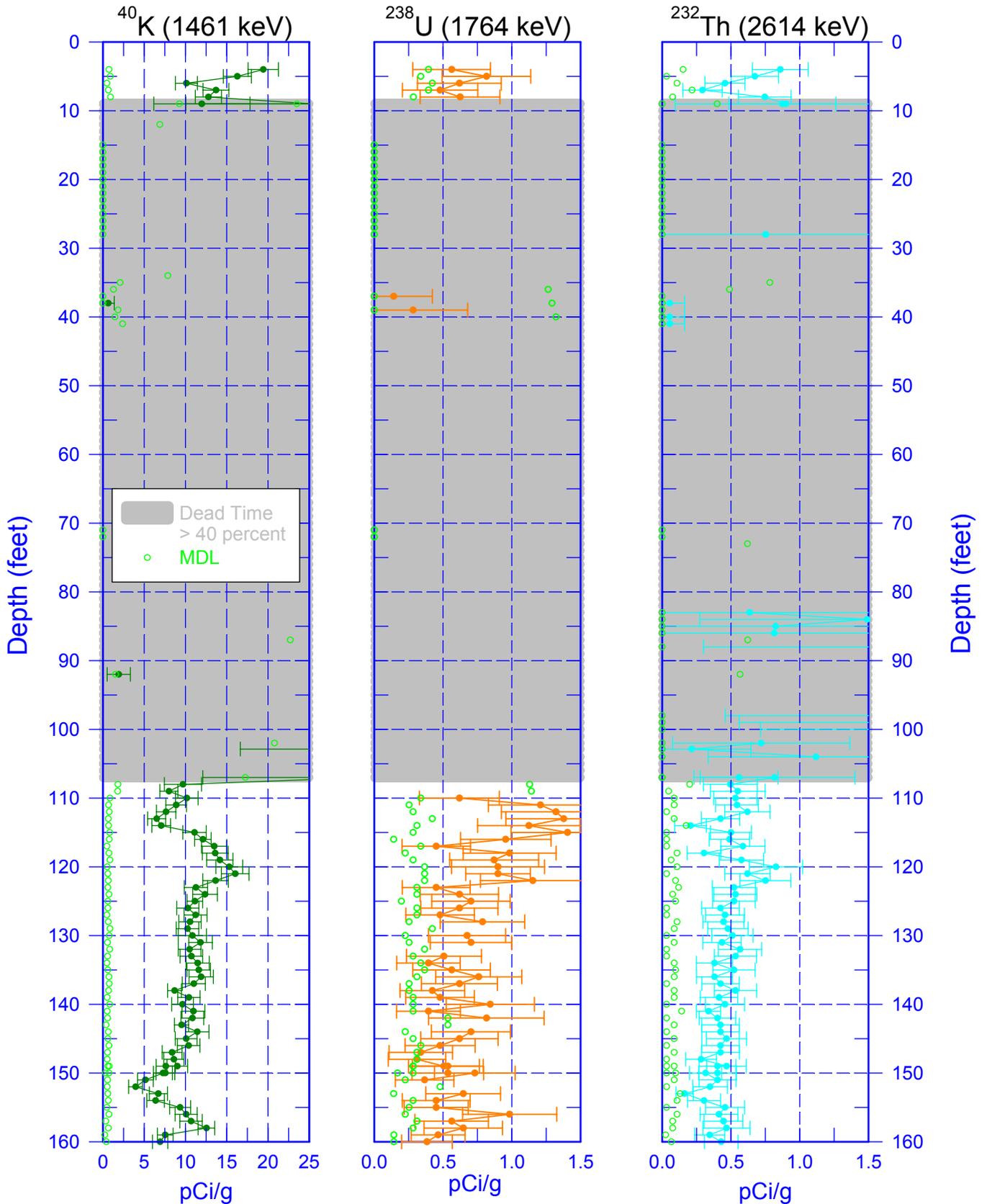


299-W14-02 (A7328)

Man-Made Radionuclides



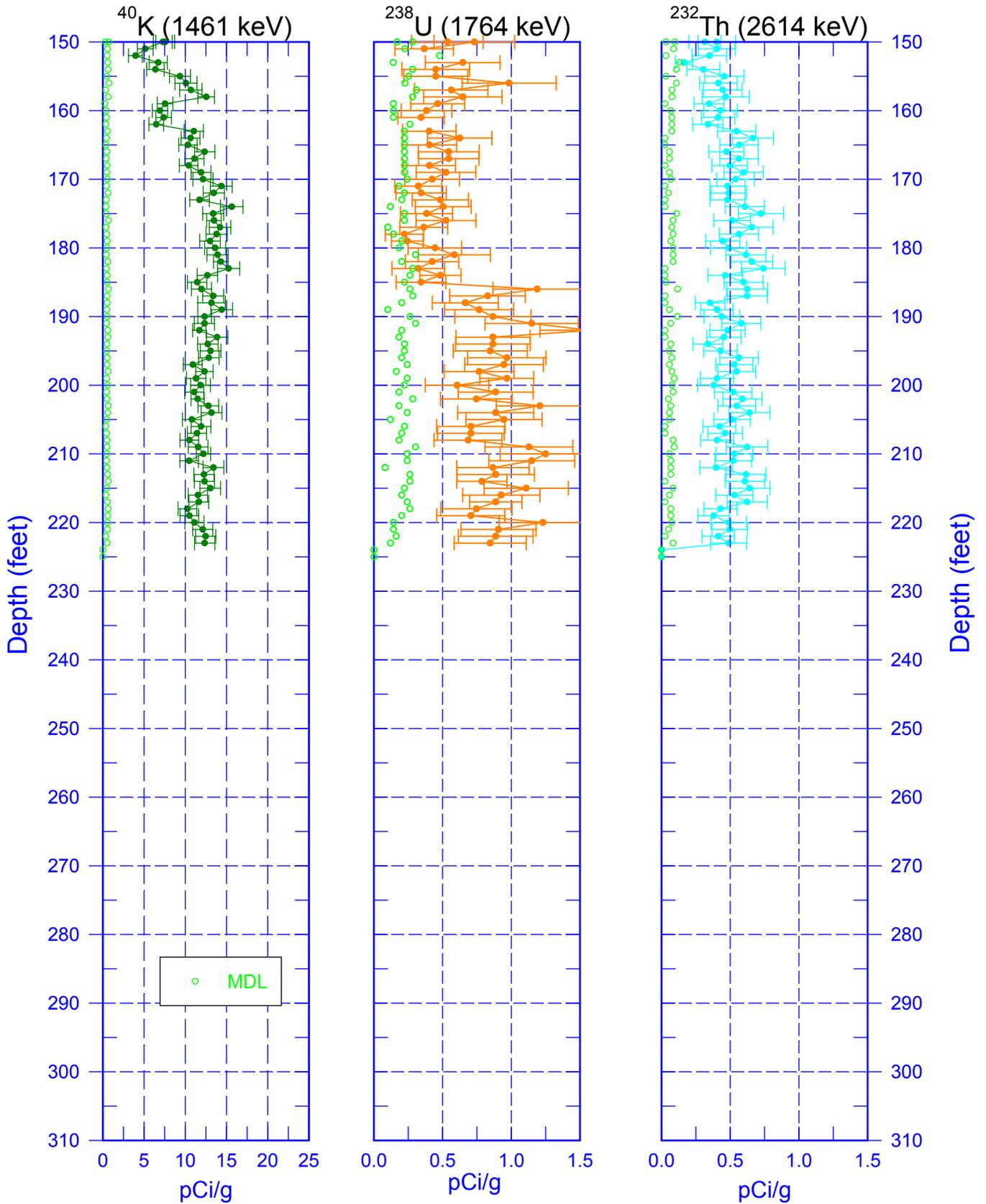
299-W14-02 (A7328) Natural Gamma Logs



Zero Reference = Top of Casing

Last Log Date - 08/18/04

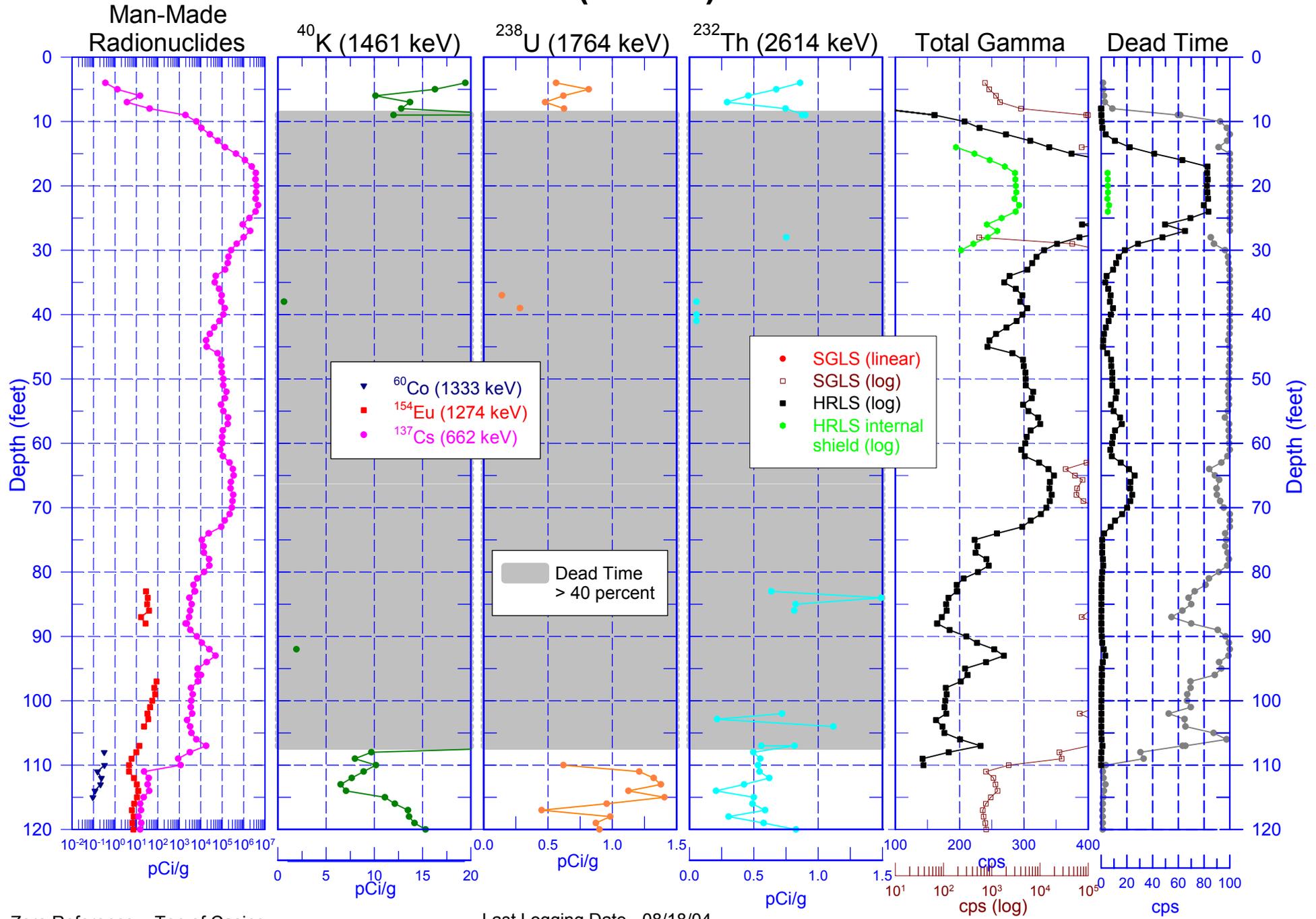
299-W14-02 (A7328) Natural Gamma Logs



Zero Reference = Top of Casing

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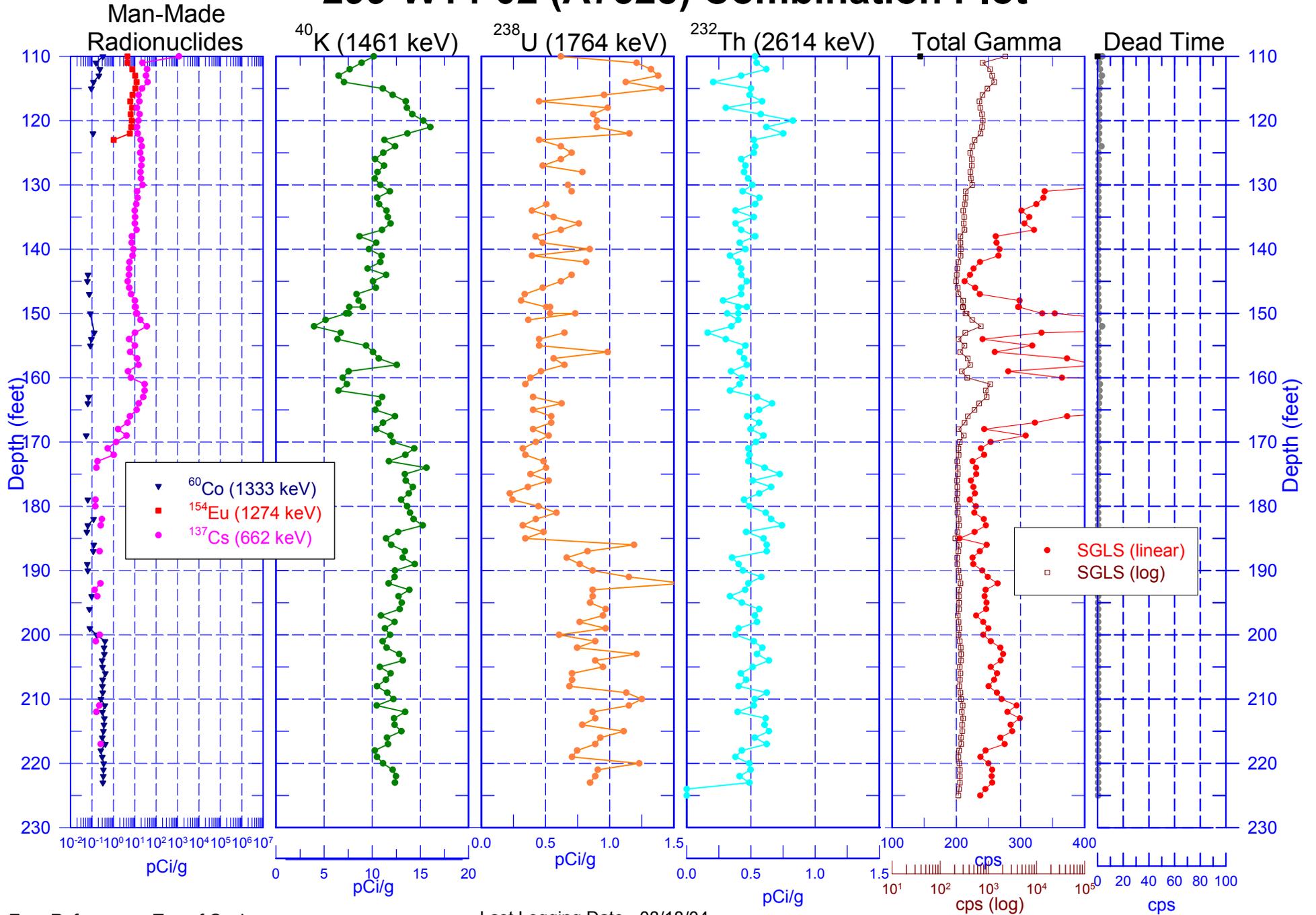
299-W14-02 (A7328) Combination Plot



Zero Reference = Top of Casing

Last Logging Date - 08/18/04

299-W14-02 (A7328) Combination Plot

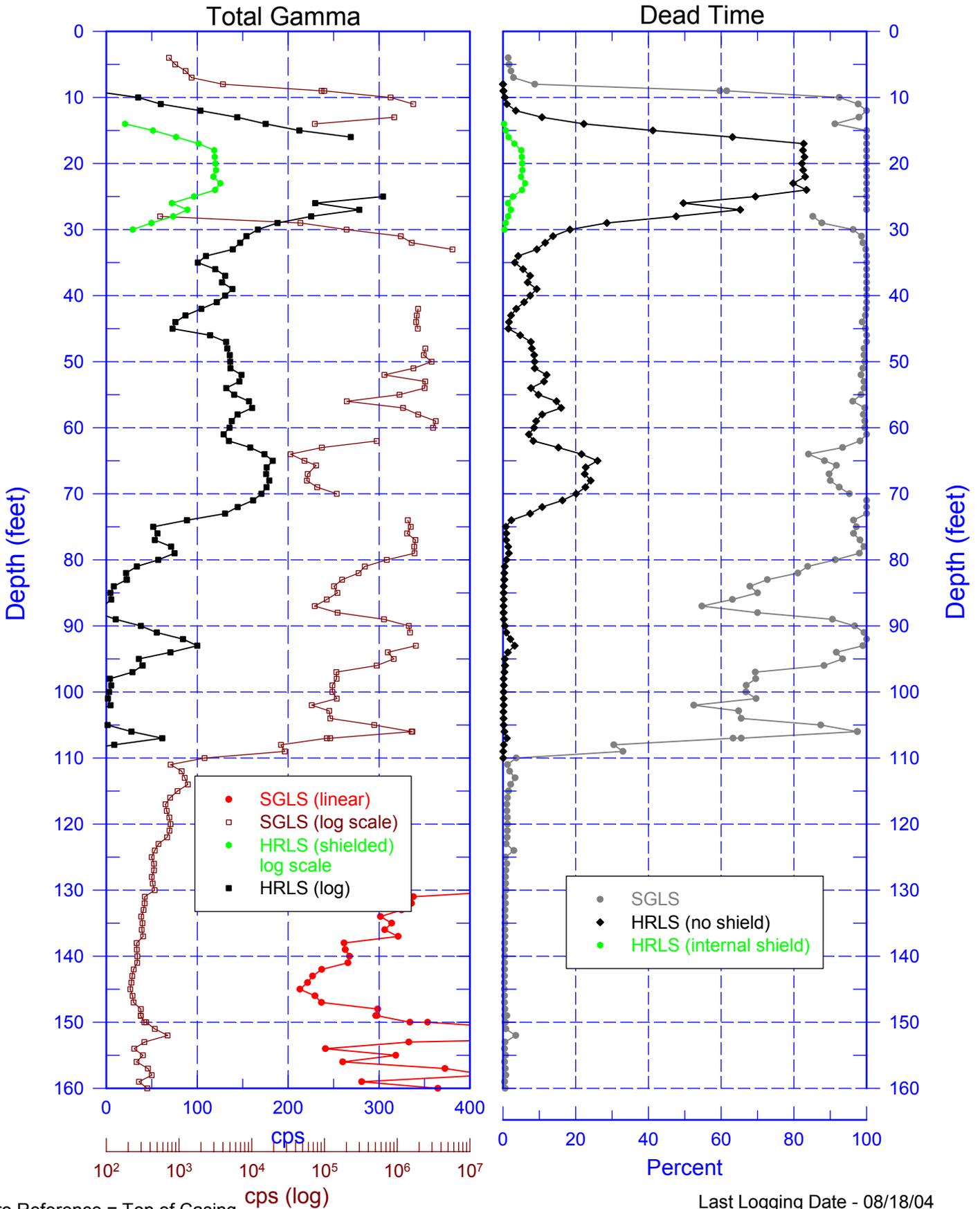


Zero Reference = Top of Casing

Last Logging Date - 08/18/04

299-W14-02 (A7328)

Total Gamma & Dead Time

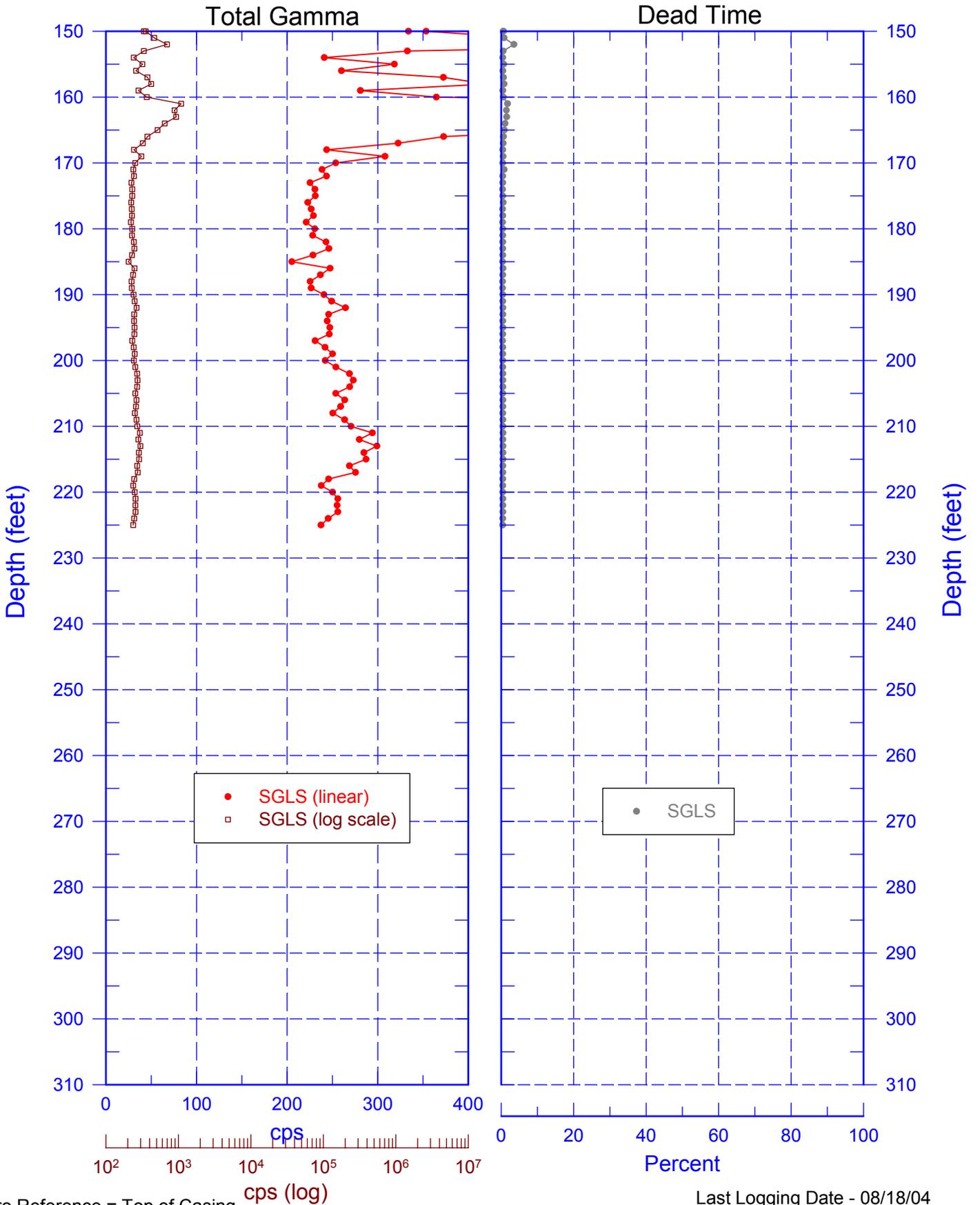


Zero Reference = Top of Casing

Last Logging Date - 08/18/04

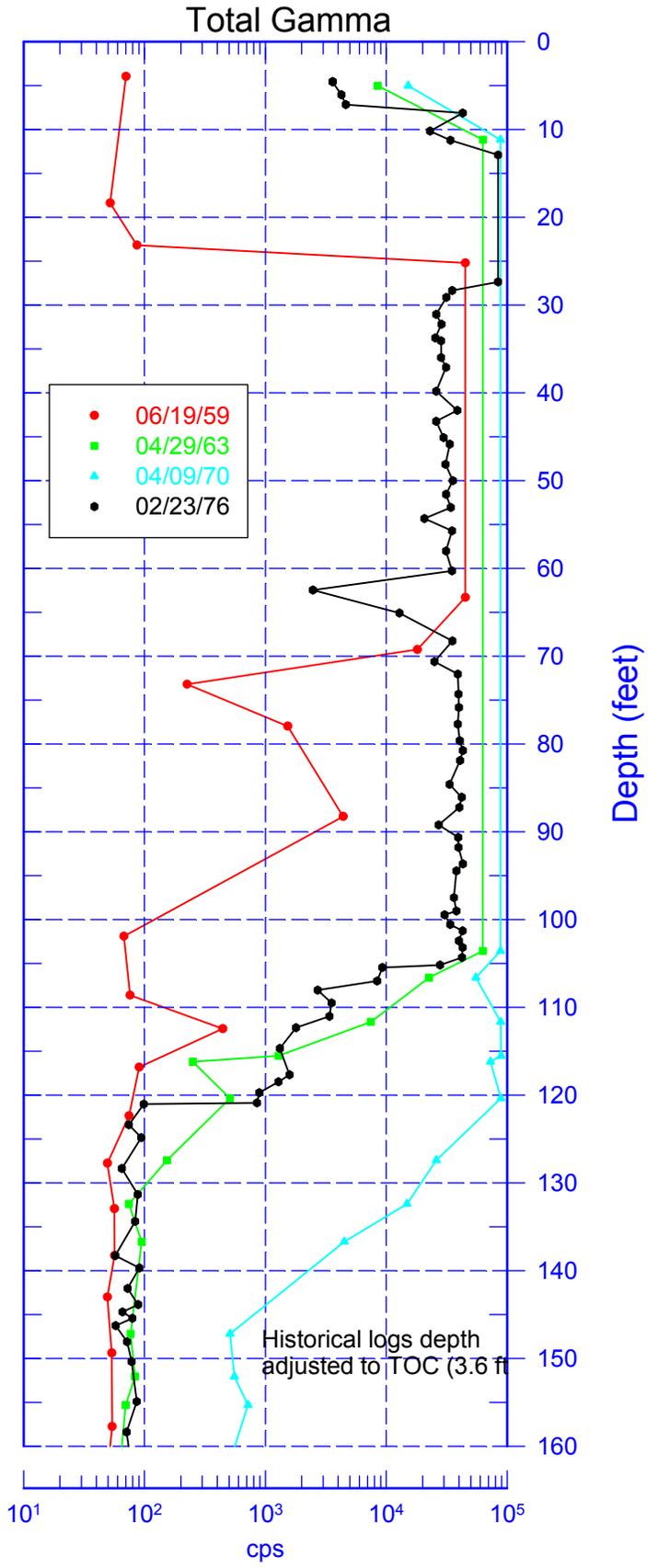
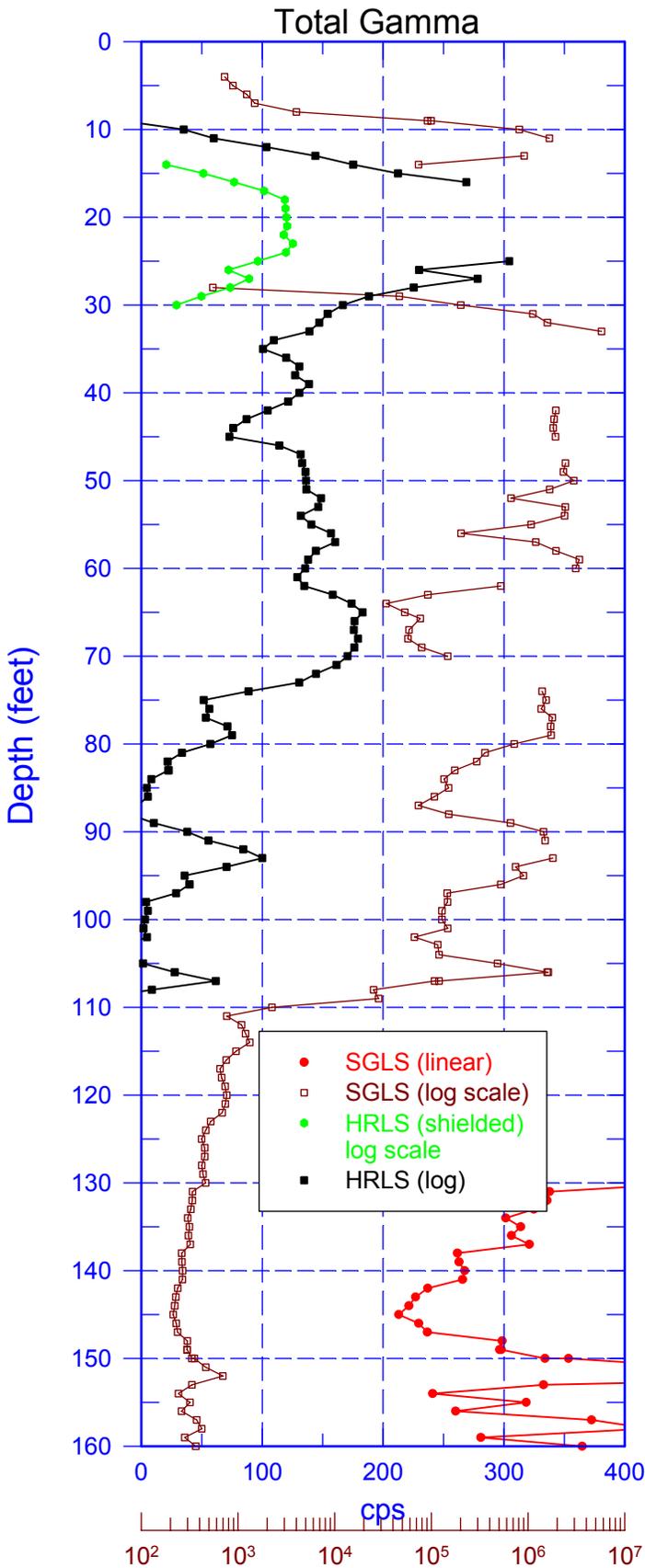
299-W14-02 (A7328)

Total Gamma & Dead Time



299-W14-02 (A7328)

Total Gamma

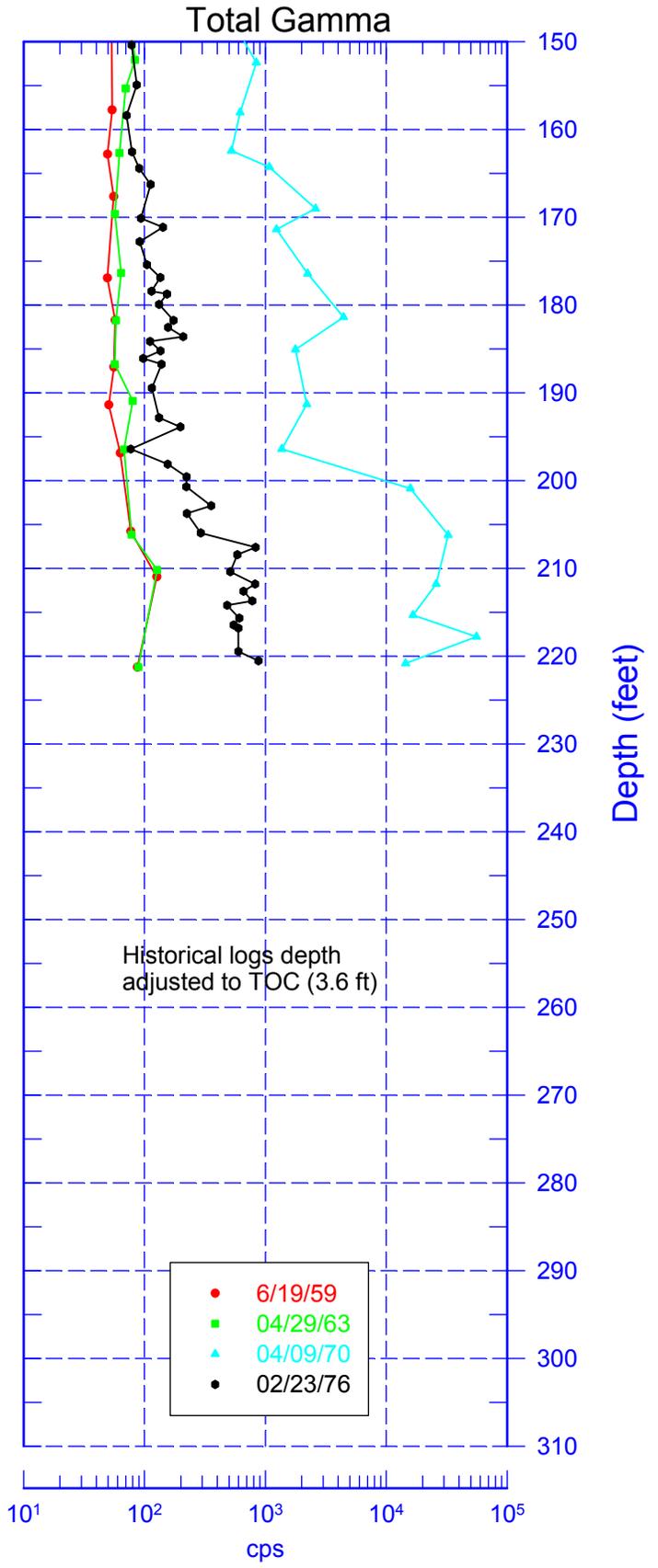
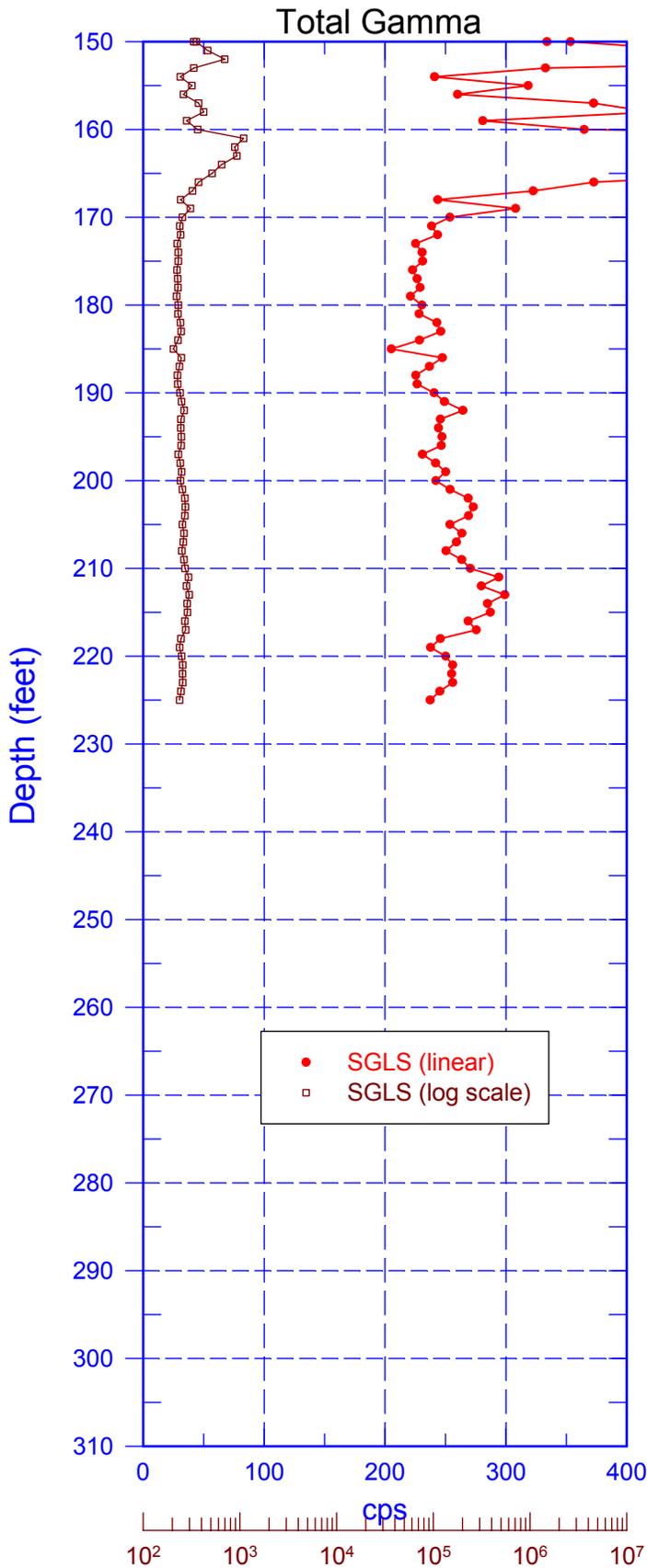


Zero Reference = Top of Casing

Last Logging Date - 08/18/04

299-W14-02 (A7328)

Total Gamma

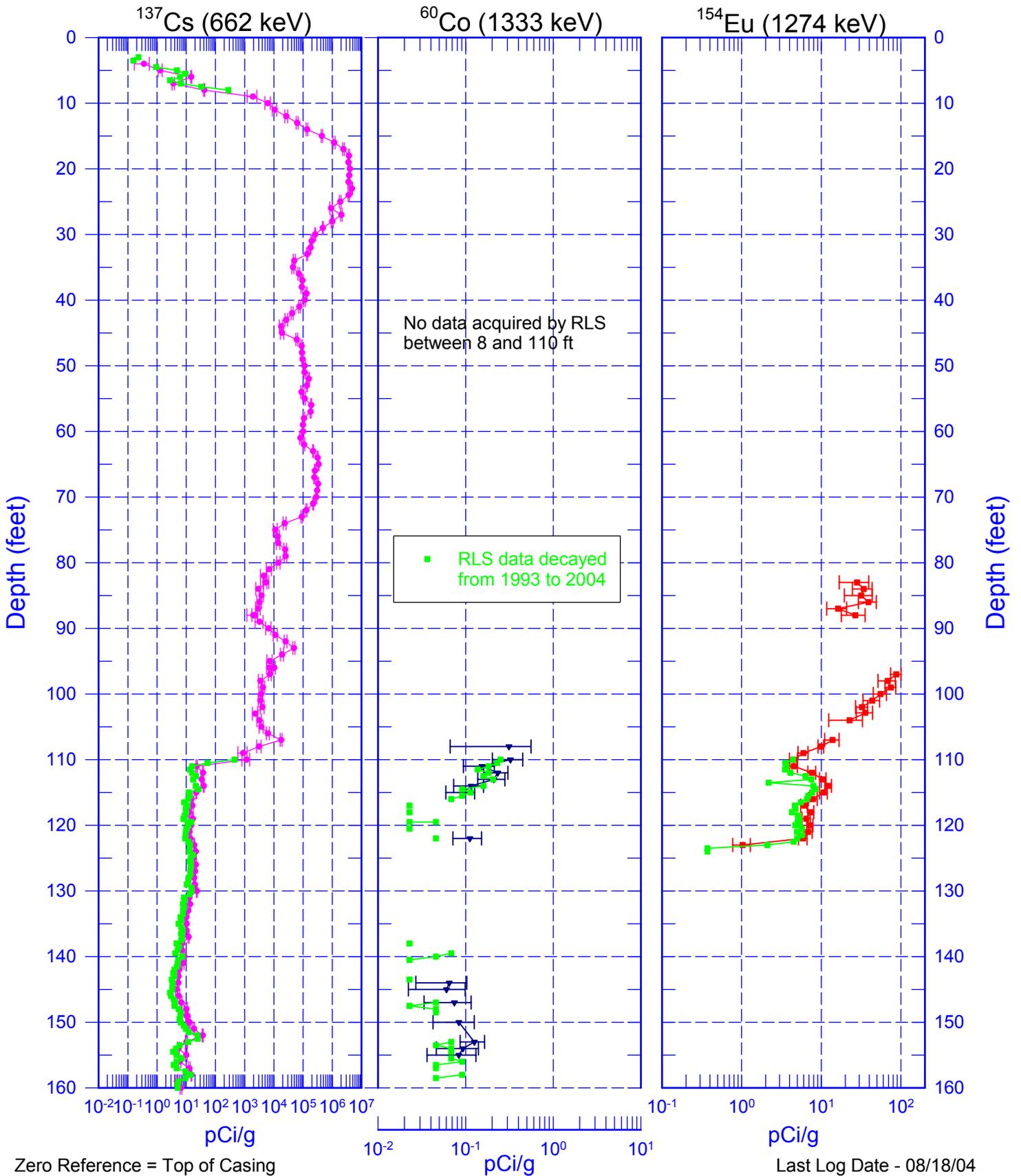


Zero Reference = Top of Casing

Last Logging Date - 08/18/04

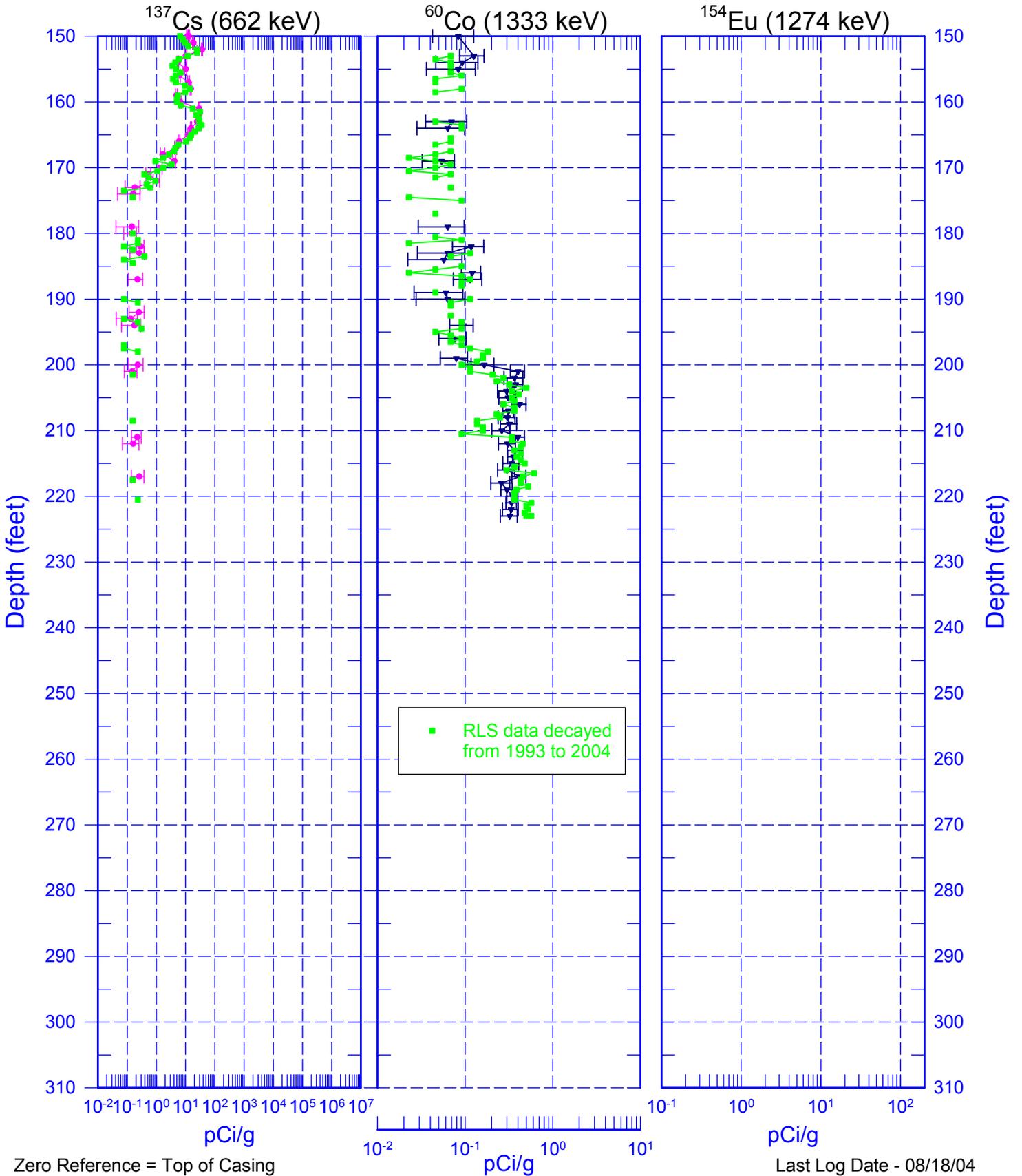
299-W14-02 (A7328)

Man-Made Radionuclide Comparison



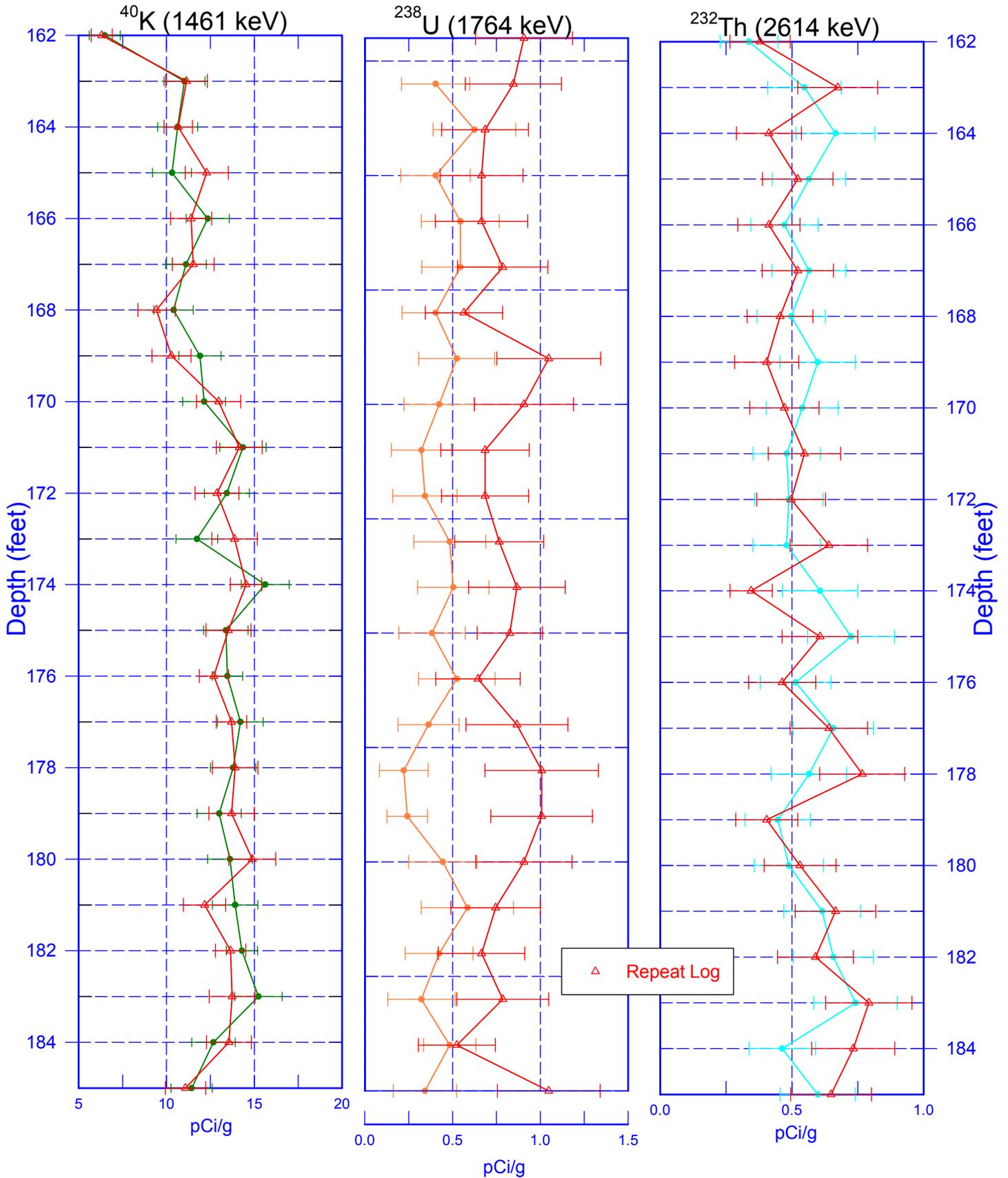
299-W14-02 (A7328)

Man-Made Radionuclide Comparison



299-W14-02 (A7328)

Repeat Section of Natural Gamma Logs

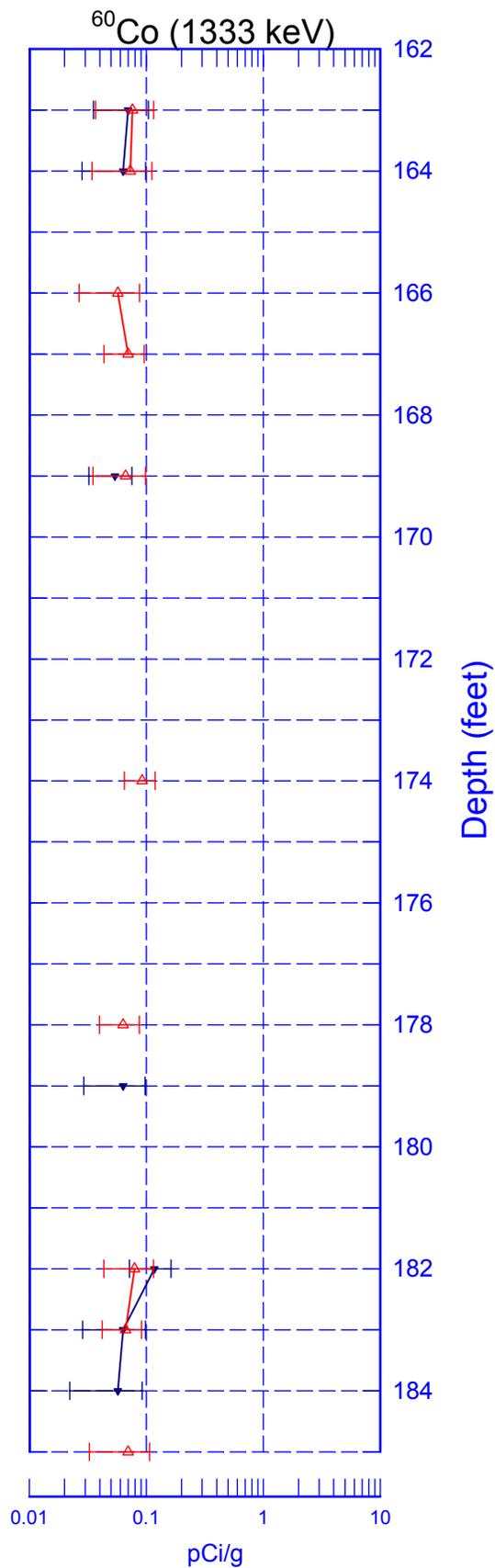
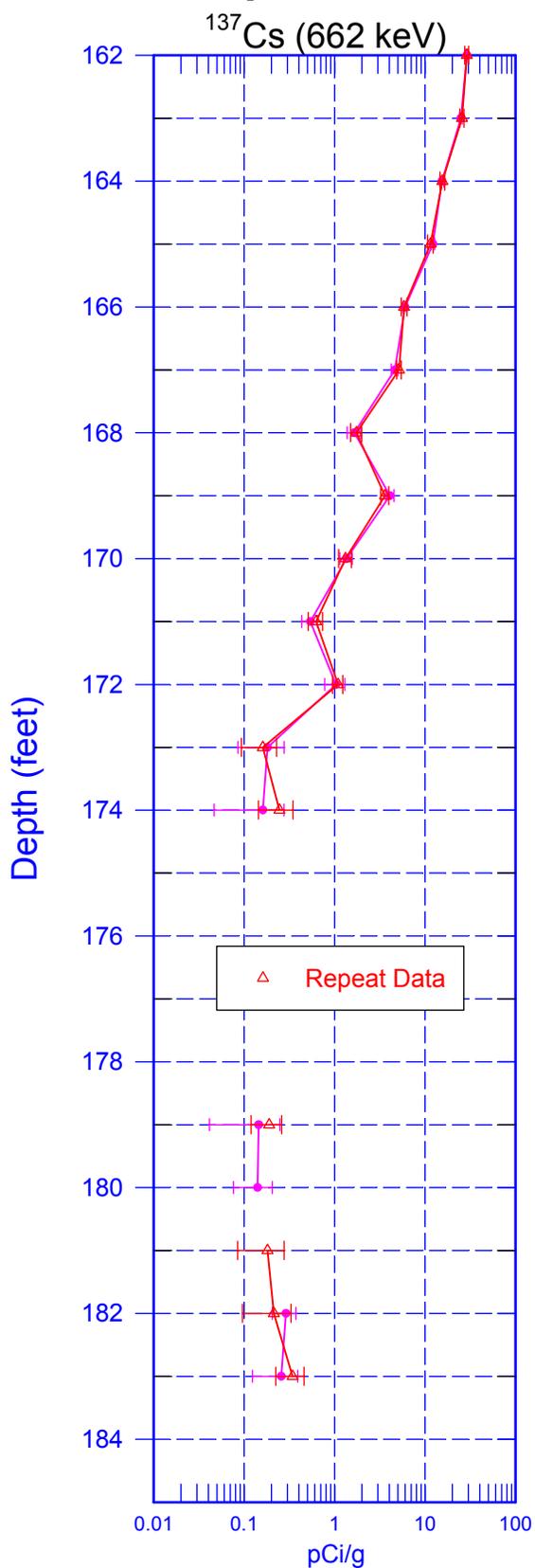


Zero Reference = Top of Casing

Last Log Date - 08/18/04

299-W14-02 (A7328)

Repeat Section of Man-Made Radionuclides



Zero Reference = Top of Casing

Last Log Date - 08/18/04

299-W14-02 (A7328)

Repeat Section of Man-Made Radionuclides

