Stoller Hanford Office

DOE-EM/GJ1228-2006

299-W15-48 (C3427)
Log Data Report

Borehole Information:

Borehole:	299-W15-48 (C3427)		Site:	216-Z-9 Crib	
Coordinates (WA St Plane)		GWL[1] (ft) : None		GWL Date:	05/17/06
North	East	Drill Date	Elevation (TOC)	Total Depth (ft)	Type
Not available	Not available	05/06	Not available	145	Sonic

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	5.0	6	4 15/16	17/32	5.0	145
Threaded Sch. 40 PVC	11.0	4 1/2	4	1/4	11.0	145

Borehole Notes:

Casing information is provided by the driller. The steel casing thickness is approximately 1/8 in. greater at the joints. Additionally, there are three "aces" in the casing string at approximately 13.5 to 14.5 ft, 16.2 to 17.2 ft and at 32.0 to 33 ft. These "aces" are 6 1/4-in. OD by 4 15/16-in. ID by 1 ft long.

All measurements are referenced to the ground surface. The borehole was drilled 32 degrees from vertical starting from the east side of the 216-Z-9 crib and slanting west below the crib.

Spectral Gamma Logging System (SGLS) Equipment Information:

Logging System:	Gamma 4G		Type: SGLS (35 %) SN: 34TP10951A
Effective Calibration Date:	05/17/06	Calibration Reference:	DOE/EM-GJ1162-2006
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Neutron Moisture Logging System (NMLS) Equipment Information:

Logging System:	Gamma 4H		Type: NMLS SN: H310700352
Effective Calibration Date:	03/06/06	Calibration Reference:	DOE/EM-GJ1154-2006
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Passive Neutron Logging System (PNLS) Equipment Information:

Logging System:	Gamma 4I		**Type:**	PNLS SN: U1754
Effective Calibration Date:	Not required	**Calibration Reference:**	Not required	
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	**1**	**2**	**3 Repeat**		
Date	05/17/06	05/18/06	05/18/06		
Logging Engineer	Pearson	Pearson	Pearson		
Start Depth (ft)	0.0	69.0	60.0		
Finish Depth (ft)	70.0	144.0	74.0		
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		
ft/min	N/A[2]	N/A	N/A		
Pre-Verification	DG041CAB	DG051CAB	DG051CAB		
Start File	DG041000	DG051000	DG051076		
Finish File	DG041070	DG051075	DG051104		
Post-Verification	DG041CAA	DG051CAA	DG051CAA		
Depth Return Error (in.)	- 9	N/A	-5		
Comments	No fine-gain adjustment	No fine-gain adjustment	No fine-gain adjustment		

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	**4**	**5 Repeat**	**6**		
Date	05/19/06	05/19/06	05/19/06		
Logging Engineer	Pearson	Pearson	Pearson		
Start Depth (ft)	0.0	55.0	70.25		
Finish Depth (ft)	70.0	70.0	144.0		
Count Time (sec)	15	15	15		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	0.25	0.25	0.25		
ft/min	N/A	N/A	N/A		
Pre-Verification	DH062CAB	DH062CAB	DH062CAB		
Start File	DH062000	DH062281	DH062342		
Finish File	DH062280	DH062341	DH062637		
Post-Verification	DH062CAA	DH062CAA	DH062CAA		
Depth Return Error (in.)	N/A	N/A	+ 2		
Comments	No fine-gain adjustment	No fine-gain adjustment	No fine-gain adjustment		

Passive Neutron Logging System (PNLS) Log Run Information:

Log Run	**7**	**8 Repeat**			
Date	05/19/06	05/19/06			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	0.0	0.0			
Finish Depth (ft)	144.0	144.0			
Count Time (sec)	60	60			
Live/Real	R	R			
Shield (Y/N)	N	N			

Log Run	7	8 Repeat			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	DI362CAB	DI362CAB			
Start File	DI362000	DI362145			
Finish File	DI362144	DI362175			
Post-Verification	DH362CAA	DH362CAA			
Depth Return Error (in.)	N/A	N/A			
Comments	No fine-gain adjustment	No fine-gain adjustment			

Logging Operation Notes:

Logging was conducted without a centralizer on the sondes. Measurements are referenced to the ground surface. Repeat sections were collected in this borehole to evaluate the logging systems' performance. The repeat section for the SGLS was acquired at 400 seconds and 0.5 ft depth intervals, double the counting time and depth interval of the original log.

Depth return errors of 9 and 5 in. were noted for log runs 1 and 3, respectively. This error was introduced when the sheave wheel turned sideways during logging; the position of the logging sonde when this occurred is unknown.

Verification measurements for each sonde were acquired on the drilling platform.

Analysis Notes:

Analyst:	Henwood	Date:	06/26/06	Reference:	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for the logging systems were performed before and after each day's data acquisition.

SGLS pre-run and post-run verification spectra were collected at the beginning and end of each day of logging. The ^{40}K count rate for the logging May 18 fell below the lower control limit but within the HASQARD acceptance limit. The lower count rate is considered to be the result of acquiring measurements on the drilling platform. Typically, these measurements are acquired on the ground surface where counts from naturally occurring radionuclides in the soil are more influential than on the platform. Therefore, the data are accepted. All other verification spectra were within the control limits and acceptance criteria.

Verification spectra using an AmBe neutron source were acquired for the neutron moisture logging system. The upper control limits for counts per second established for this system were slightly exceeded but were well within the HASQARD limits. Because a higher count rate was observed, the data are considered acceptable.

Verification spectra using an AmBe neutron source were acquired for the passive neutron logging system. Currently there are no verification criteria or calibration established for this system as it is used only qualitatively. The counts obtained from the pre- and post-verifications were within 1 percent.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated using the EXCEL worksheet template identified as G4GMar06.xls. A casing correction for 0.531-in.-thick casing was applied to the SGLS data. No correction was applied for the schedule 40 PVC pipe with a thickness of 1/4 in. Although some gamma attenuation will occur from the PVC, it is considered to be of little consequence relative to the steel pipe. The casing joints in the steel casing that are 1/8-in. greater thickness than the remainder of the pipe and the "aces" described under "Borehole Notes" do cause greater attenuation but there is no correction available for this situation.

No corrections for dead time or water were required.

The NMLS data are reported in counts per second. There is no calibration available too convert to percent moisture for the casing configuration encountered in this borehole. The PNLS is to be used qualitatively, only.

Results and Interpretations:

^{233}Pa, ^{241}Am, ^{239}Pu, and ^{241}Pu are the man-made radionuclides detected in this borehole; ^{240}Pu is also inferred to exist. ^{233}Pa, a decay product of ^{237}Np, which is determined from an energy peak at 312 keV, was detected between 50 and 127 ft (42.4 -107.7 ft true depth) with a maximum concentration of approximately 29 pCi/g at 118 ft (100.1 ft).

^{241}Am (662.4 keV) was detected from 51 to 122 ft (43.3 to 103.5 ft) at concentrations ranging from 40,000 to 245,000 pCi/g; the maximum concentration is measured at 121 ft (102.6 ft). Energy peaks attributed to ^{241}Am were detected at approximately 59.54, 208.01, 662.40, and 722.01 keV (see ^{241}Am Plot). The percent yields for these gamma rays are 35.9 E-02, 7.91 E-06, 3.64 E-06, and 1.96 E-06, respectively. Although the 59.54-keV gamma ray exhibits the highest yield, the low-energy gamma ray is severely attenuated by the 17/32-in.-thick steel and 1/4-in. thick PVC casings and the tool housing itself. Therefore, the 59.54-keV energy peak is not expected to be detected throughout the casing and, if it were, an appropriate calibration is not available (the SGLS calibration range is 186 to 2615 keV). The fact that it is consistently detected indicates it most likely originates inside the steel casing as a result of internal contamination from the drilling/sampling process. The internal contamination extends at least from approximately 32 ft to the bottom of the borehole at 144 ft (27.1 to 122.1 ft).

The assays of the ^{241}Am based on gamma rays at 662.4 and 722.01 keV roughly coincide, suggesting the calibration at this energy range is appropriate and the relatively high-energy gamma rays are penetrating the casings. Because the gamma rays from the 622.40-keV energy peak have a slightly higher yield than the 722.01-keV energy peak, the former is used to provide the assay for ^{241}Am.

The ^{241}Am concentrations derived from the 208.01-keV gamma line appear to be slightly overestimated. A 208.00-keV gamma line that results from the decay of ^{237}U may interfere with the 208.01-keV gamma line from ^{241}Am. These nearly coincident peak energies cannot be resolved with the SGLS. ^{237}U (6.75 day half life) is formed by alpha decay of ^{241}Pu (half life of 14.35 years) with a branching ratio of 0.002457 percent. Hence, the presence of ^{237}U indicates that ^{241}Pu is also present and, because it is in equilibrium with its parent, can be used to assay ^{241}Pu. The counts in the 208.01 keV gamma energy peak are subtracted on the basis of the 662.40 keV gamma line from ^{241}Am. The remaining counts are attributed to the 208.00 keV ^{237}U gamma line.

Interference to the 662.40-keV energy peak can be caused by the ^{137}Cs gamma ray at 661.62 keV. However, because the assays for ^{241}Am originating from the 722.01 and 662.40-keV energy peaks coincide, it is likely that gamma rays at this energy can be attributed to ^{241}Am in total.

^{239}Pu was generally detected between 51 and 122 ft (43.3 to 103.5 ft). The dominant interval is between 62 and 87 ft (52.6 to 73.8 ft) with a maximum concentration of approximately 657,000 pCi/g at 72 ft (61.1 ft). Energy peaks associated with ^{239}Pu were detected at approximately 129, 345, 375, and 414 keV. The 375.054-keV energy peak has the highest yield of these energy peaks at 0.0016 percent and was used to determine concentrations.

^{240}Pu and ^{241}Pu are created in the reactor by successive neutron captures on ^{239}Pu. Because separation of these isotopes is very difficult, it is virtually certain they will exist together in the waste stream. If one assumes the waste stream in this crib is dominantly weapons grade plutonium (i.e., ~6% ^{240}Pu), the maximum ^{240}Pu activity in this borehole would be estimated near 40,000 pCi/g. Because of the absence of a relatively high yielding gamma ray from ^{240}Pu, no direct measurement with the SGLS can be made.

After subtracting the influence from the 208.01 keV ^{241}Am gamma line, ^{241}Pu concentrations (on the basis of the 208.00 keV ^{237}U gamma line) are estimated to range between 2 and 10 pCi/g, which is consistent with the proportion for weapons grade plutonium. This concentration is not determined directly so that uncertainty is greater than for other radionuclides.

Note: This borehole is known to be internally contaminated, probably on the inside of the steel casing. The activity of this contamination cannot be quantified but it should be presumed that all the identified radionuclides could exist to some degree inside the casing. The effect of this internal contamination is to cause a slight overestimation of concentrations. On the basis of the 59.54 keV gamma line, the internal contamination exists from 32 ft (27.1 ft) to the bottom of the borehole.

Passive neutron logging was performed in the borehole to detect neutrons that may be generated by interactions of alpha particles with lighter elements such as F, Al, Na, Mg, Si, Cl, and O or from spontaneous fission, predominantly from ^{240}Pu. Where a transuranic is in the form of a compound with one of these elements, the interaction is most likely because the distance the alpha particle must travel is short. No calibration is available for this logging system and the data provided are to be used qualitatively. The passive neutron detector indicates elevated count rates between 47 and 123 ft (39.9 to 104.3 ft). The highest count rates (4 cps) are detected where the highest ^{239}Pu concentrations are measured at approximately 63 (53.4) ft and 70 (59.4) ft; at these depths ^{241}Am and ^{233}Pa are also detected. This count rate is considerably lower (4 cps vs 2600 cps) than observed in other Plutonium Finishing Plant cribs such as 216-Z-1A and 216-Z-12. This suggests the compounds in this crib are in the form of nitrates or oxides rather than as fluorides as postulated for the other cribs. Fluorine has a cross section for capturing alpha particles that is 100 times greater than for the other light elements.

Neutron moisture logging is provided in counts per second, as there is no calibration for this borehole configuration. Some variation in count rate is exhibited.

The ^{40}K and ^{232}Th logs show an increase in concentrations at approximately 51 ft (43.3 ft), perhaps suggesting a lithology change. Apparent ^{232}Th concentrations are elevated by approximately 0.8 pCi/g in the interval between 121 and 130 ft (102.6 to 110.3 ft), and this increase corresponds with fine-grained sediment of the Cold Creek Interval formerly known as the Early Palouse Soil. The relatively low ^{40}K and ^{232}Th values in the interval between 132 and 139 ft (111.9 - 117.9 ft), as well as the relatively high ^{238}U values, are characteristic of the carbonate palesols of the Cold Creek Interval. Enhanced radon was observed in this borehole.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural and man-made radionuclides. The passive neutron data and neutron moisture also show good repeatability.

List of Plots:

Separate plots are provided that are related to logging depth in the 32^{o} slant borehole and for those depth-corrected to "true vertical depth." This designation is located on the bottom of each plot. The depth is plotted at 1"= 20 ft.

32^{o} slant plots:

Am-241 Energy Peak Comparison
Man-Made Radionuclides
Natural Gamma Logs
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Total Gamma, Passive Neutron, & Moisture
Repeat Section for Man-Made Radionuclides

Repeat Section for Passive Neutron & Moisture
Repeat Section for Natural Gamma Logs

<u>True vertical depth plots:</u>

Man-Made Radionuclides
Natural Gamma Logs
Combination Plot (0-125 ft)
Total Gamma, Passive Neutron, & Moisture

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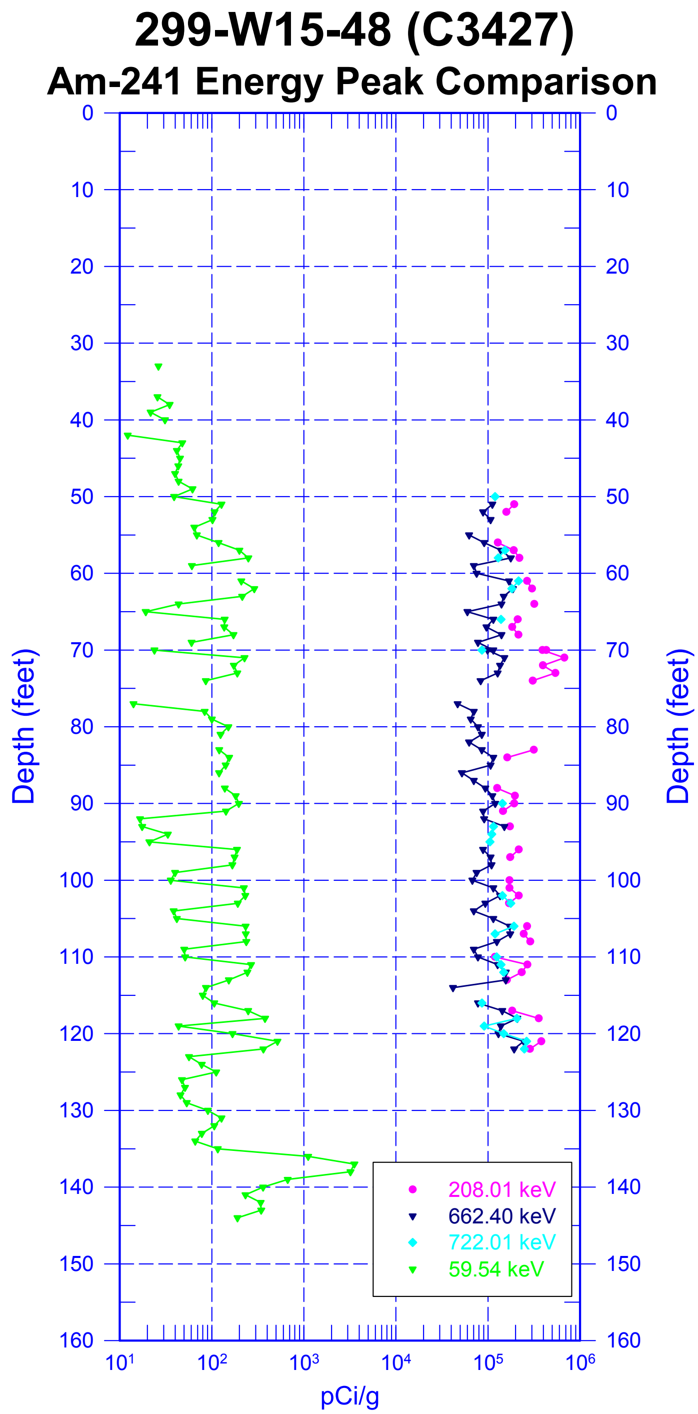
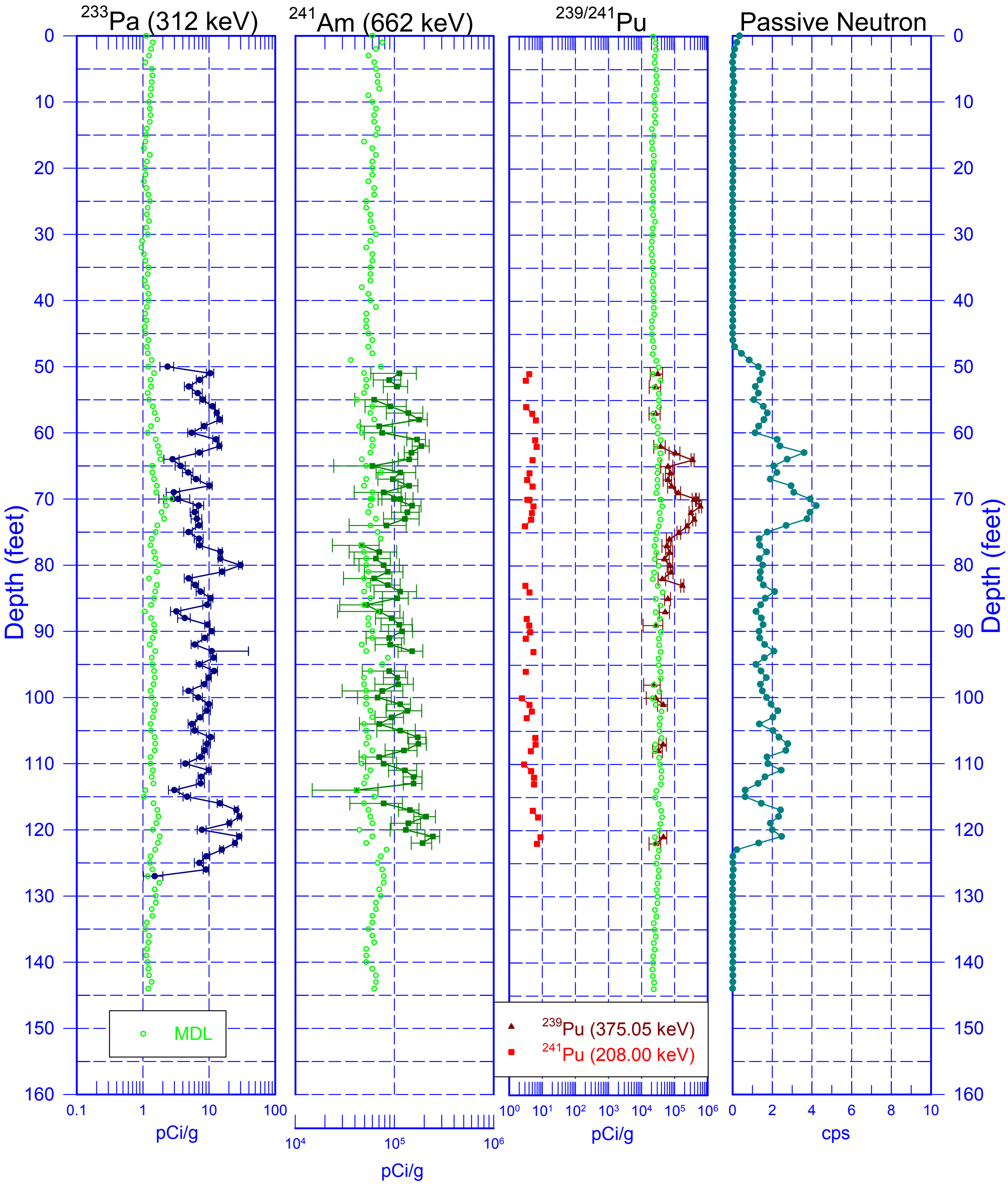
[1] GWL – groundwater level
[2] N/A – not applicable



Zero Reference = Ground Surface (32° slant)

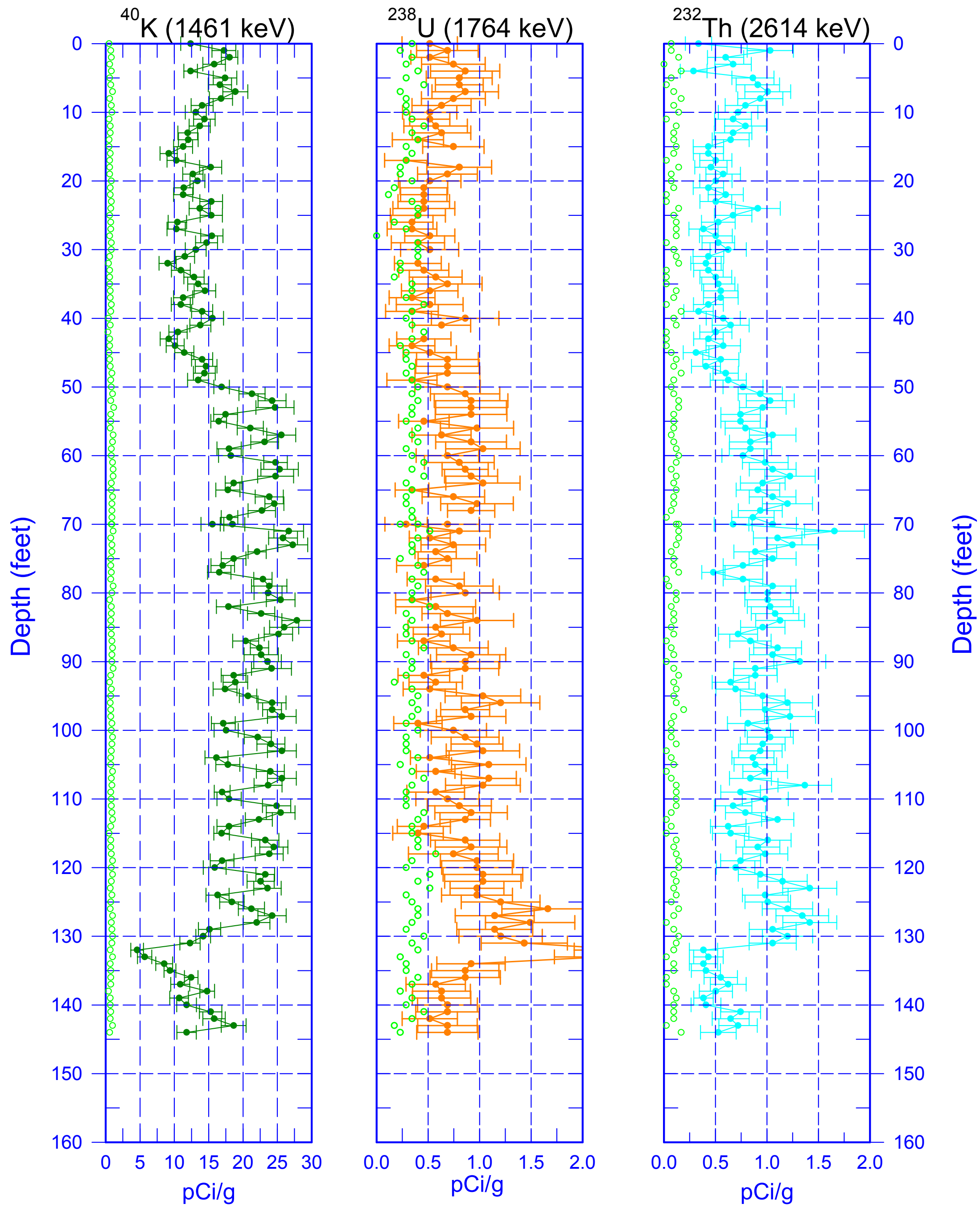
299-W15-48 (C3427)

Man-Made Radionuclides

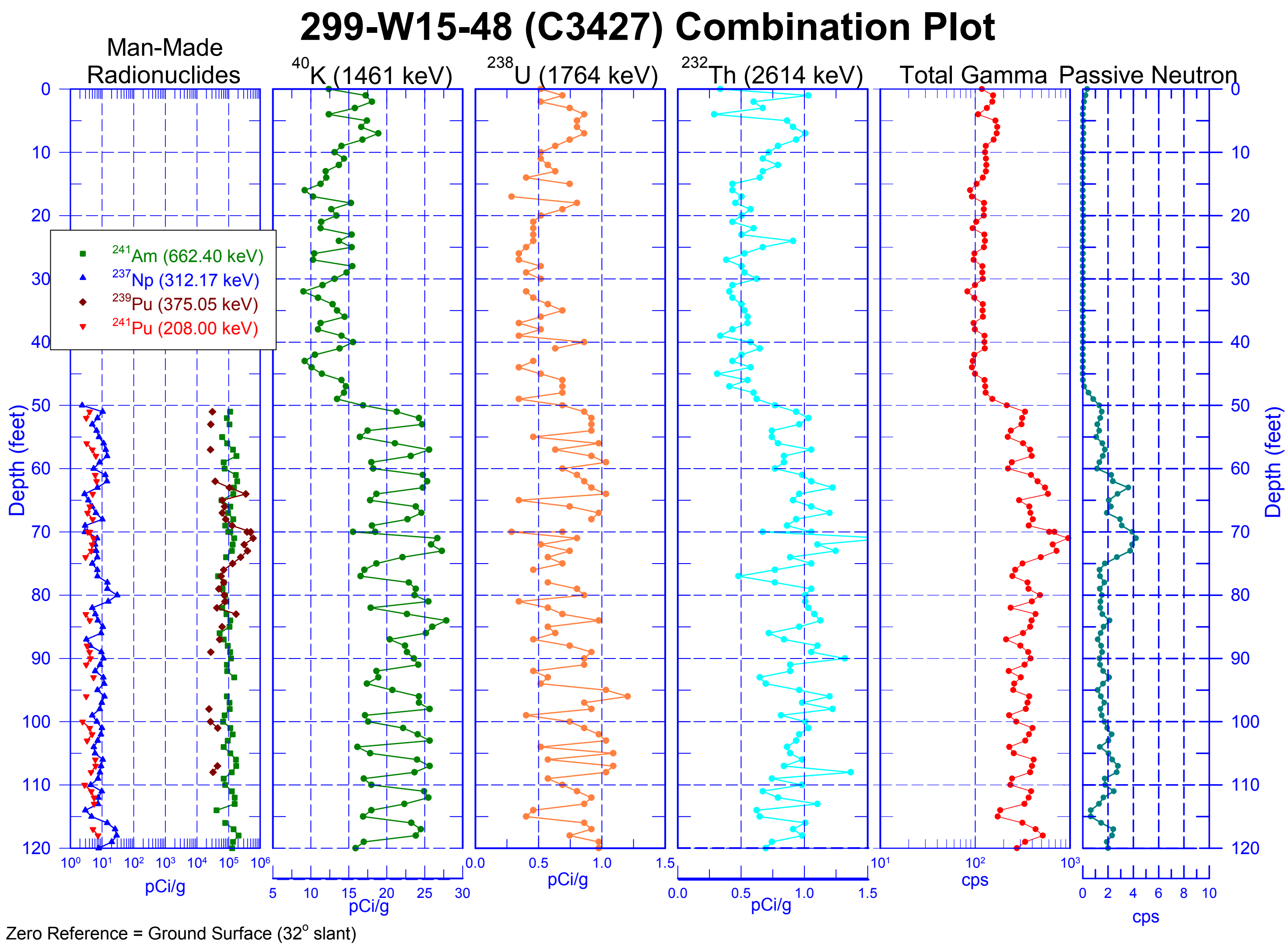


Zero Reference = Ground Surface (32° slant)

299-W15-48 (C3427)
Natural Gamma Logs

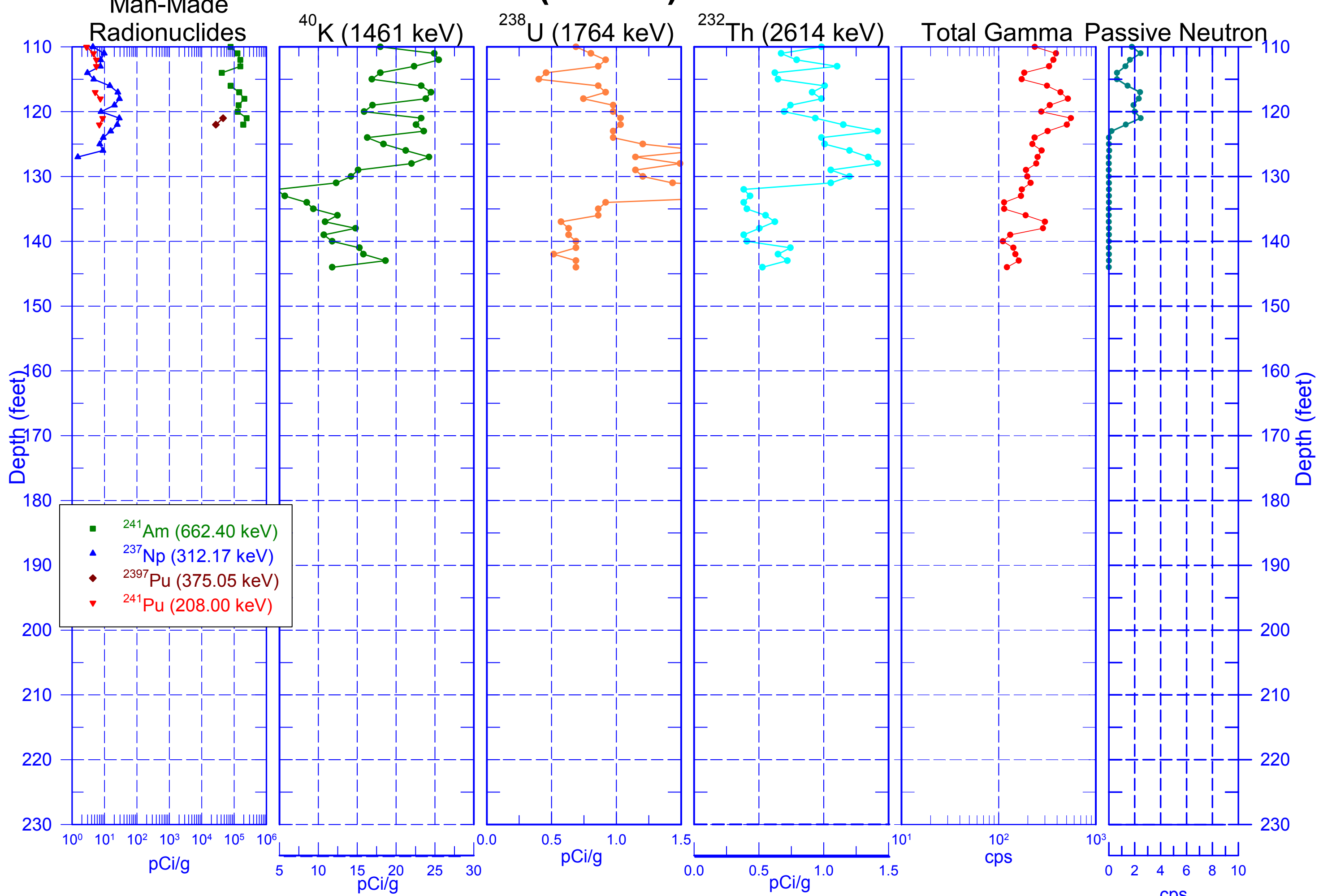


Zero Reference = Ground Surface (32^o slant)



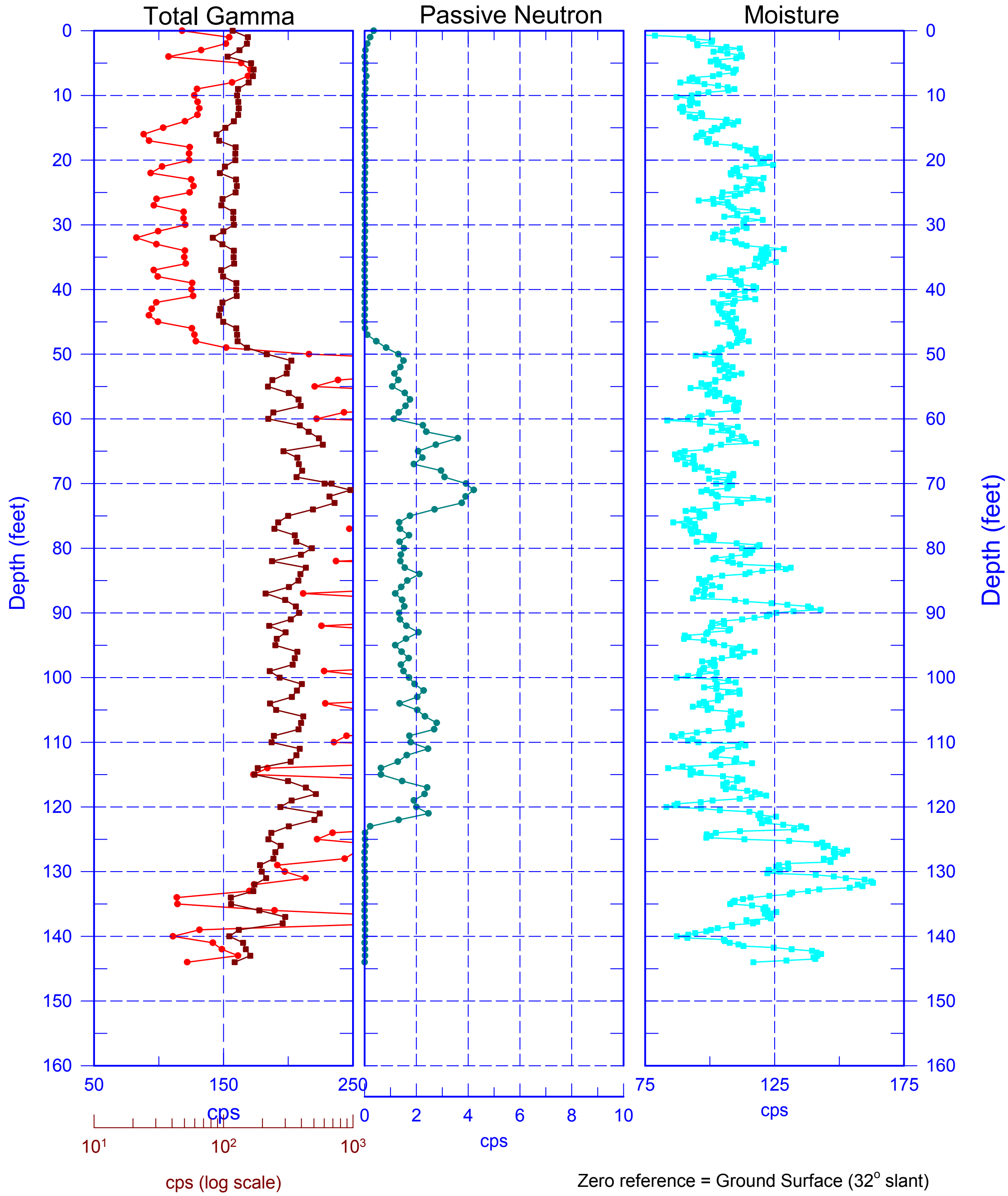
299-W15-48 (C3427) Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Passive Neutron
Depth (feet)
241Am (662.40 keV)
237Np (312.17 keV)
239Pu (375.05 keV)
241Pu (208.00 keV)
pCi/g
cps
Zero Reference = Ground Surface (32° slant)

299-W15-48 (C3427) Combination Plot



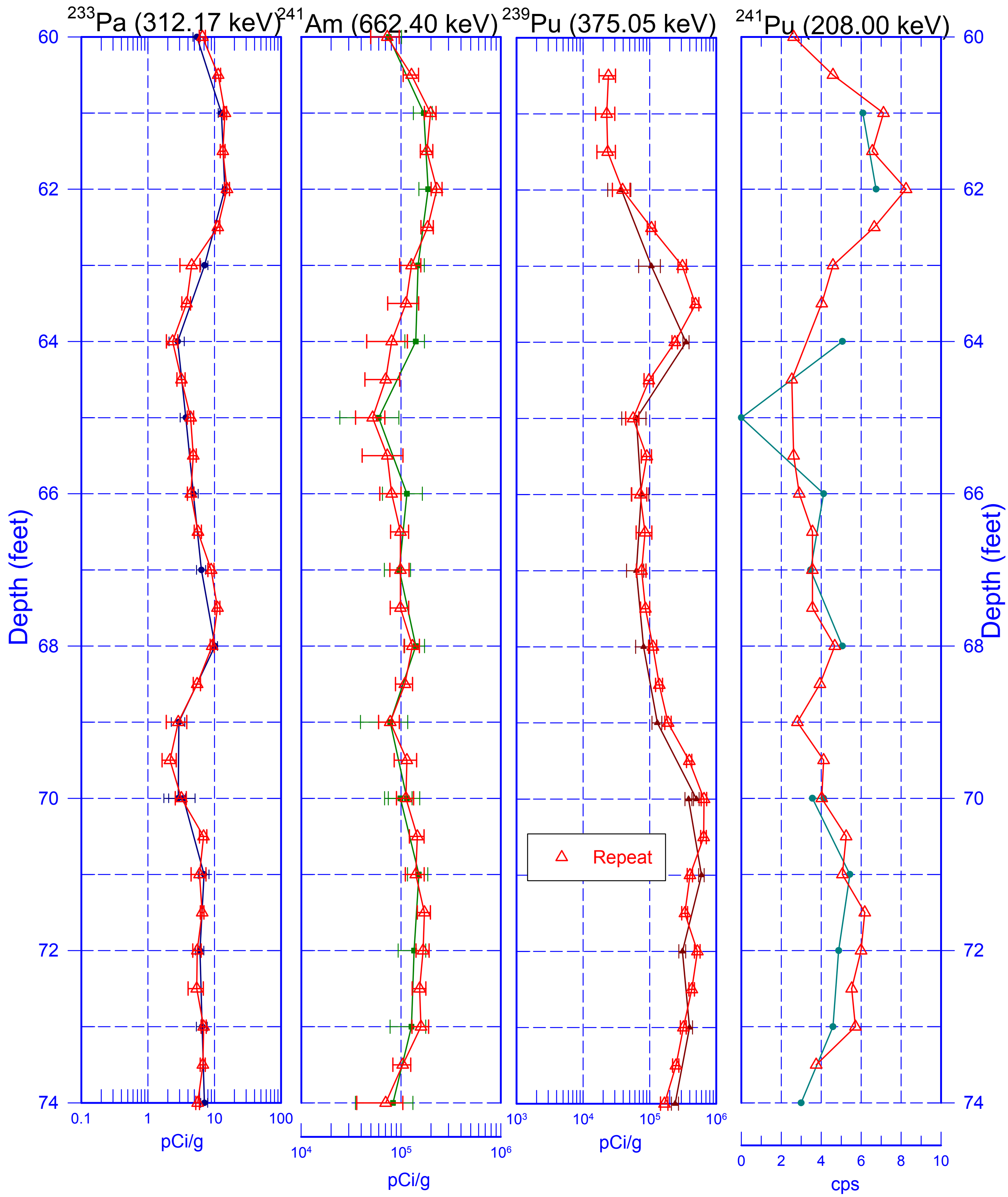
Zero Reference = Ground Surface (32° slant)

299-W15-48 (C3427)
Total Gamma, Passive Neutron, & Moisture



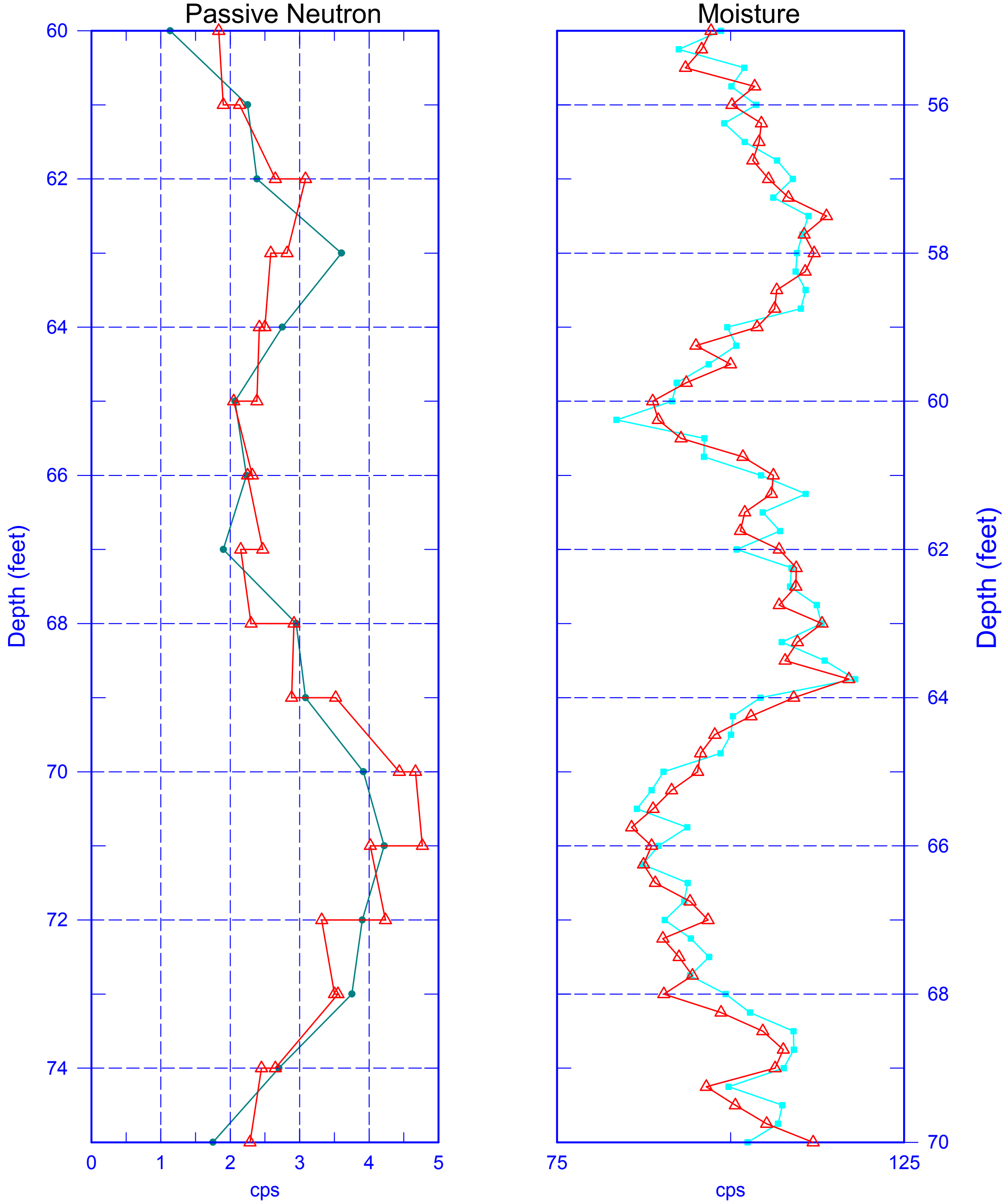
299-W15-48 (C3427)

Repeat Section for Man-Made Radionuclides



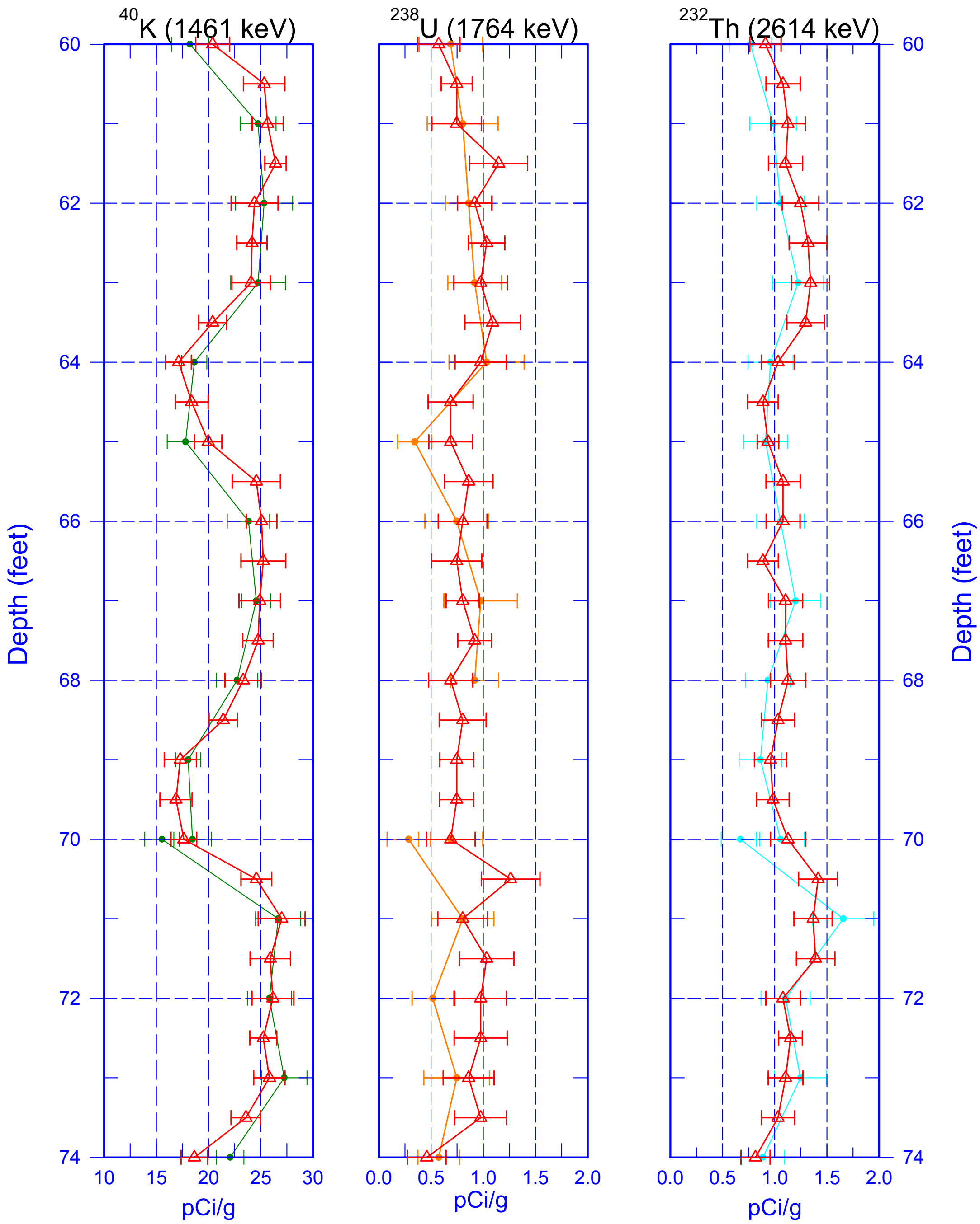
Zero Reference = Ground Surface (32° slant)

299-W15-48 (C3427)
Repeat Section for Passive Neutron & Moisture



Zero reference = Ground Surface (32° slant)

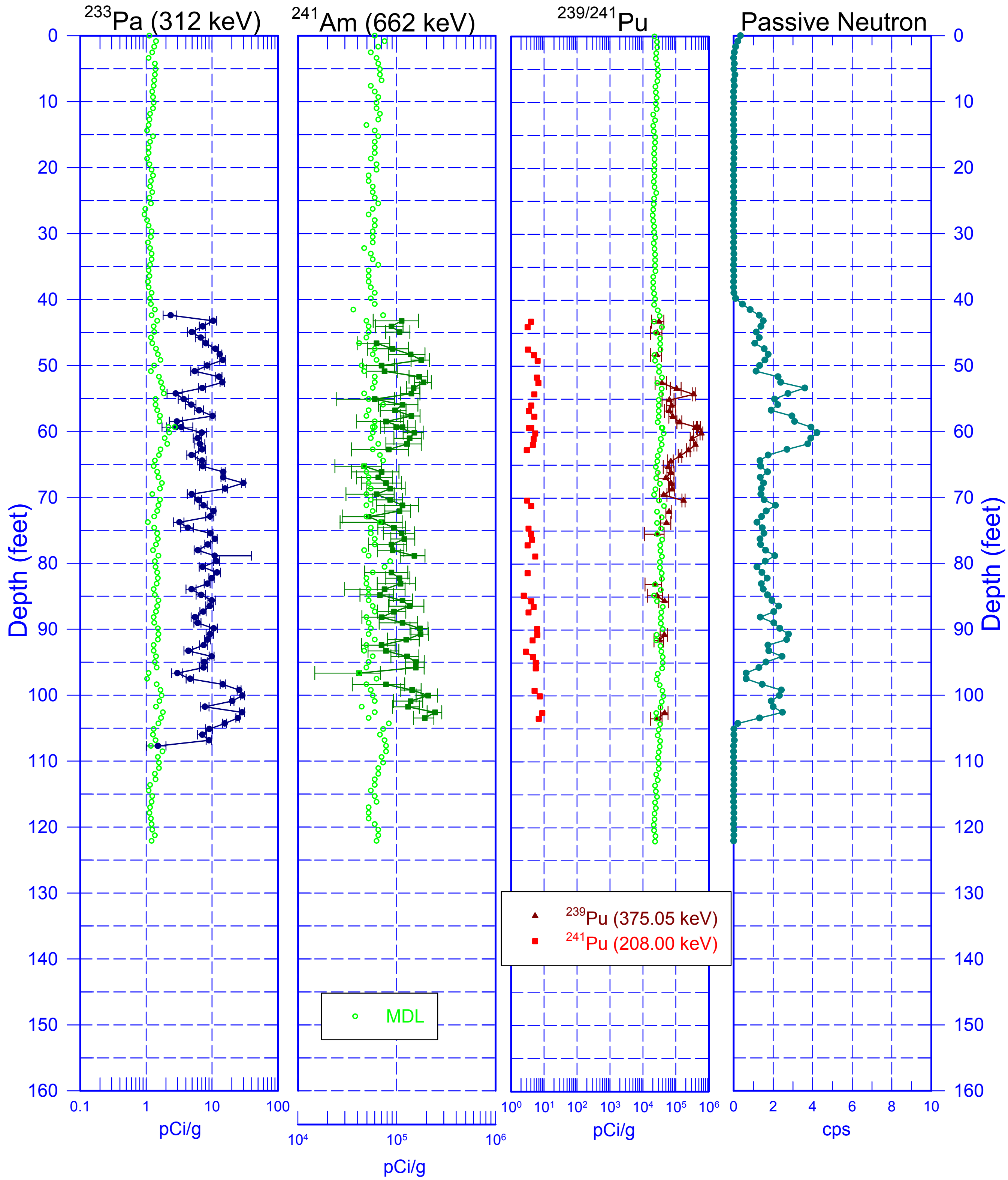
299-W15-48 (C3427)
Repeat Section for Natural Gamma Logs



Zero Reference = Ground Surface (32° slant)

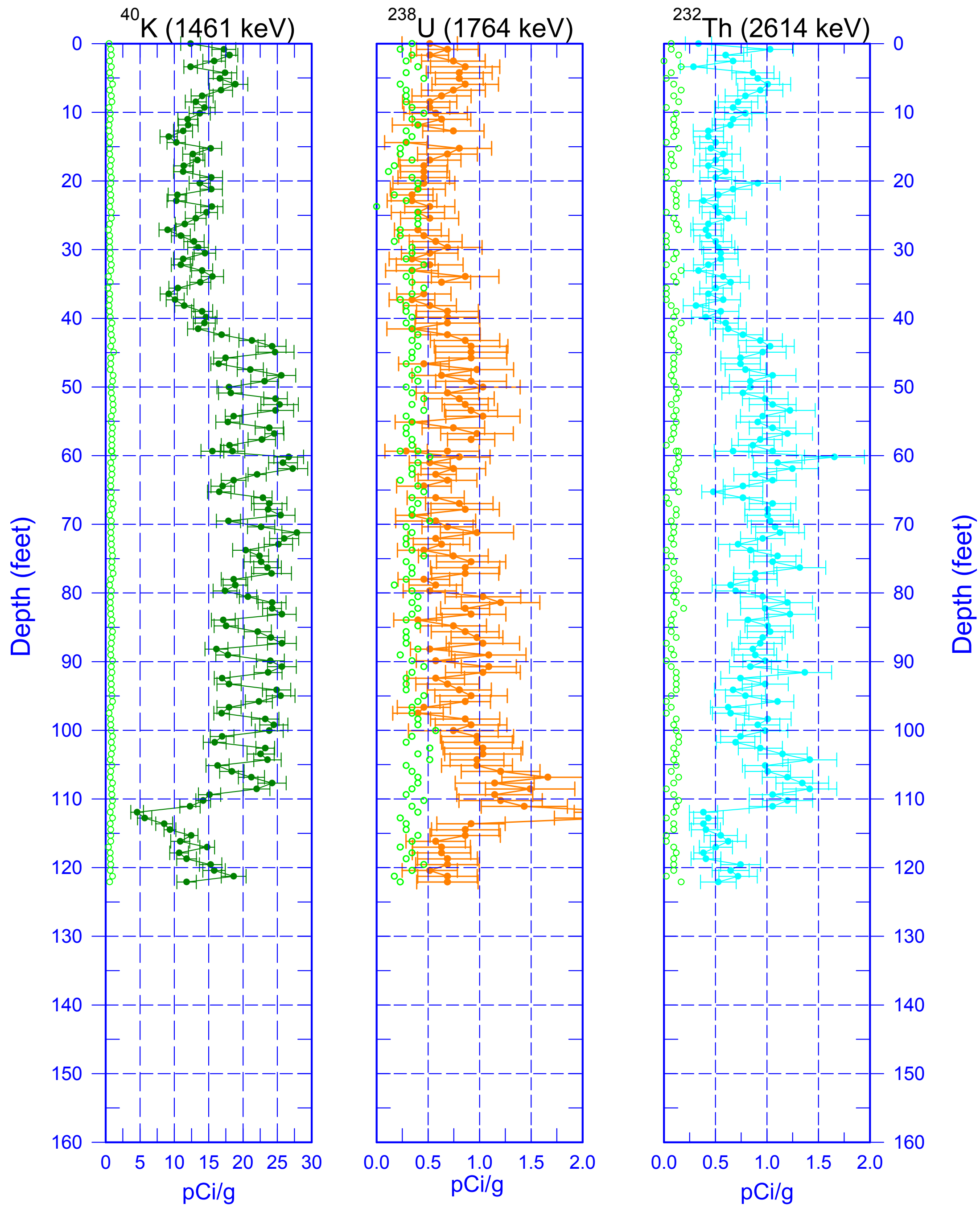
299-W15-48 (C3427)

Man-Made Radionuclides



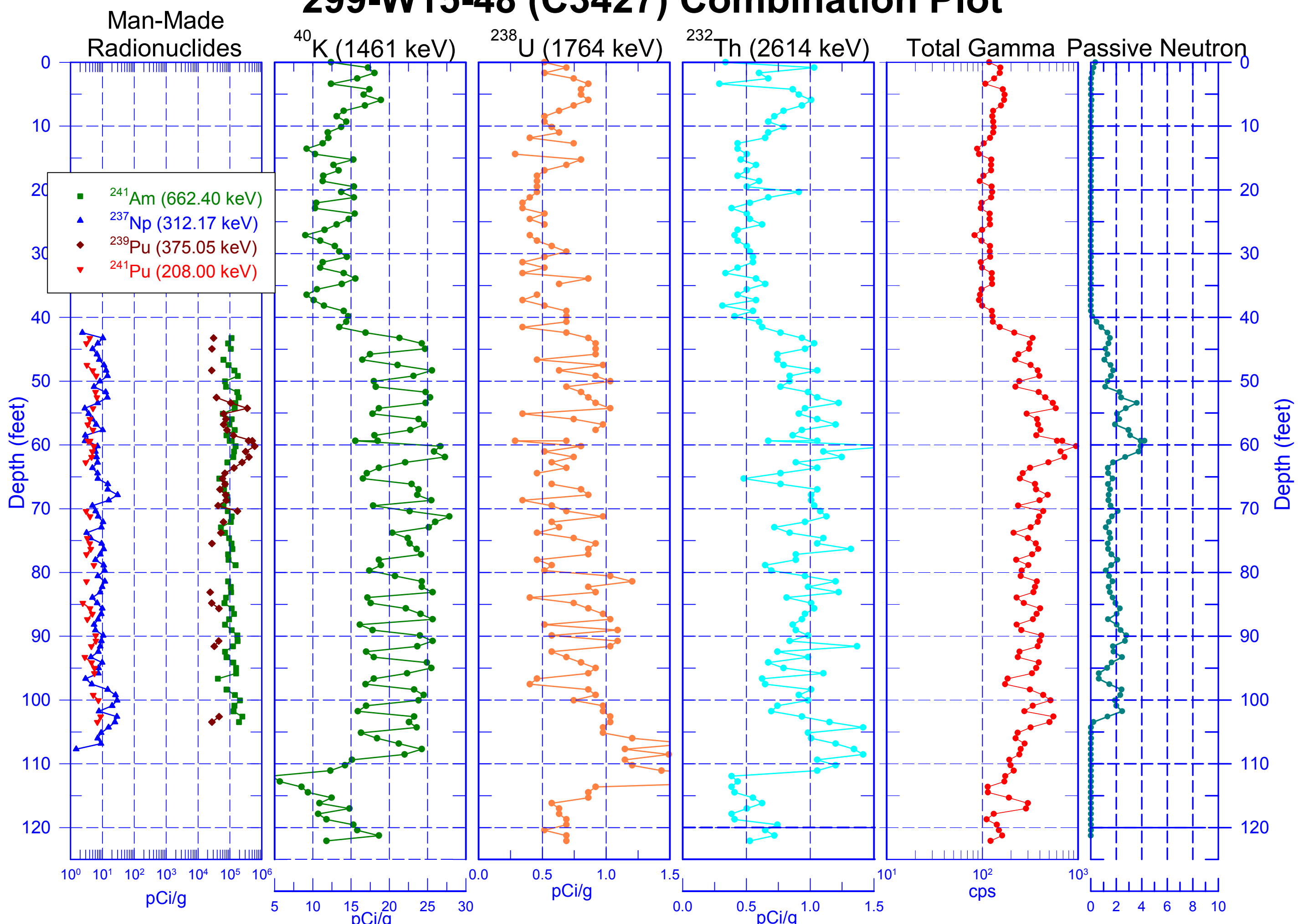
Zero Reference = Ground Surface (true vertical depth)

299-W15-48 (C3427)
Natural Gamma Logs



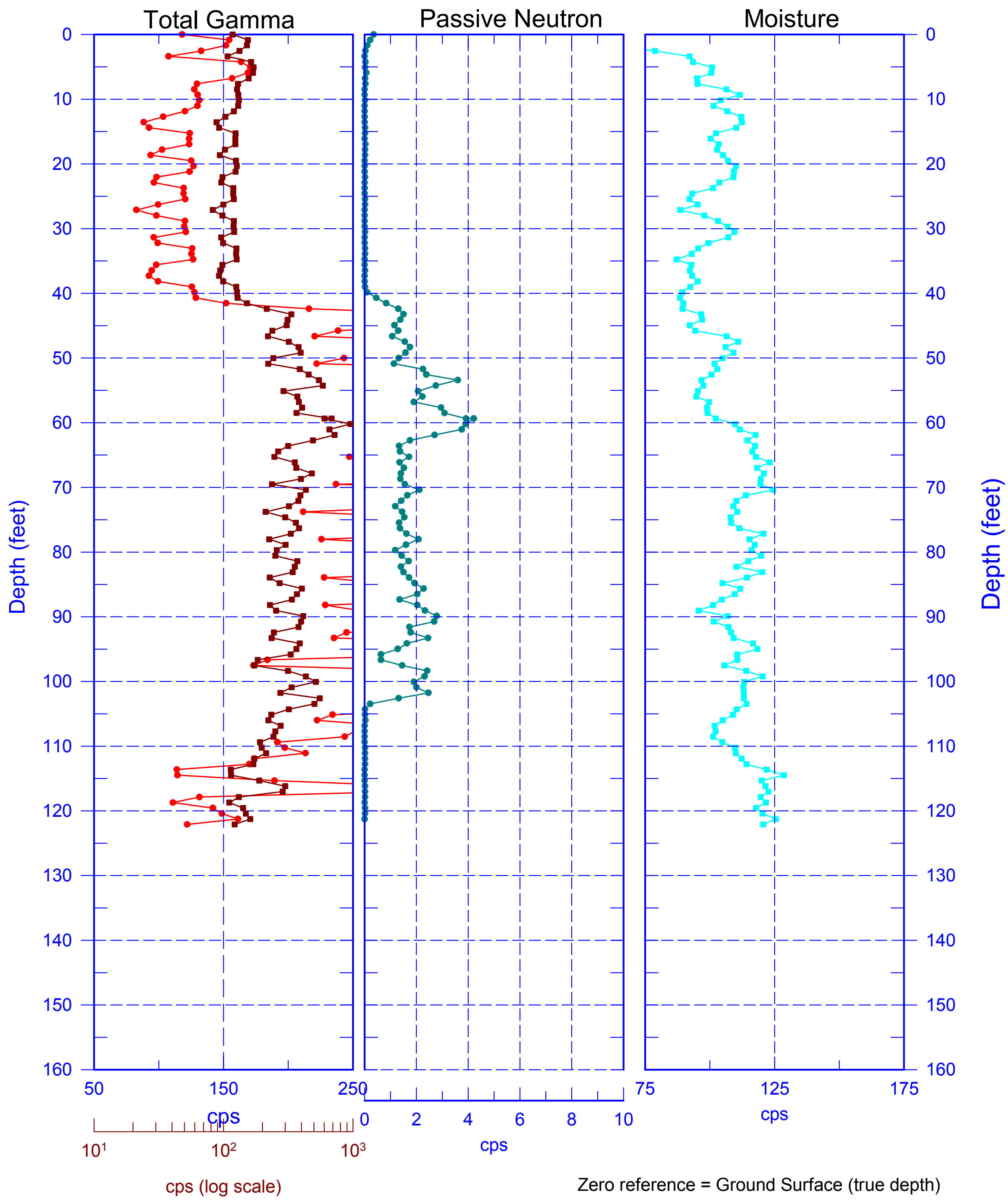
Zero Reference = Ground Surface (true vertical depth)

299-W15-48 (C3427) Combination Plot



Zero Reference = Ground Surface (true depth)

299-W15-48 (C3427)
Total Gamma, Passive Neutron, & Moisture



Zero reference = Ground Surface (true depth)