Stoller Hanford Office established 1959

HGLP-LDR-078

299-W18-179 (A7661)
Log Data Report

Borehole Information:

Borehole:	399-3-2 (C5575)		Site:	216-Z-12 Crib	
Coordinates (WA St Plane)		GWL[1] (ft):	None	GWL Date:	01/31/06
North (m)	East (m)	Drill Date	TOC Elevation	Total Depth (ft)	Type
135478.354	566363.924	06/80	686.22 ft	42	Cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded Steel	2.4	6 5/8	6	5/16	2.4	42

Borehole Notes:

The logging engineer measured the steel casing diameter and stickup using a steel tape.

The "Well Completion Report" indicates grout outside the 6-in. casing to 15 ft; with adjustment for the 2.4 ft stickup, it would extend to 17.4 ft. A grout plug was placed in the bottom of the borehole casing from 40 to 42 ft.

Log data acquisition is referenced to the top of casing.

Logging Equipment Information:

Logging System:	Gamma 4N		Type:	SGLS (60%) SN: 45TP22010A
Effective Calibration Date:	08/16/05	Calibration Reference:	Not required	
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0	

Logging System:	Gamma 4I		Type:	PNLS SN: U1754
Effective Calibration Date:	N/A	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	01/04/06	01/05/06	01/05/06	
Logging Engineer	Spatz	Spatz	Spatz	
Start Depth (ft)	38.0	14.0	24.0	
Finish Depth (ft)	13.0	3.0	24.0	
Count Time (sec)	200	200	1000	
Live/Real	R	R	R	
Shield (Y/N)	N	N	N	
MSA Interval (ft)	1.0	1.0	NA	
ft/min	NA	NA	NA	
Pre-Verification	DN061CAB	DN081CAB	DN081CAB	
Start File	DN071000	DN081000	DN081012	
Finish File	DN071025	DN081011	DN081012	
Post-Verification	DN071CAA	DN081CAA	DN081CAA	
Depth Return Error (in.)	0	0	0	
Comments	No fine gain adjustment.	No fine gain adjustment.	No fine gain adjustment.	

Passive Neutron Logging System (PNLS) Log Run Information:

Log Run	4	5 Repeat		
Date	01/05/06	01/05/06		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	38.0	23.0		
Finish Depth (ft)	3.0	16.0		
Count Time (sec)	N/A	N/A		
Live/Real	R	R		
Shield (Y/N)	N	N		
MSA Interval (ft)	1.0	1.0		
ft/min	1.0	1.0		
Pre-Verification	DI272CAB	DI272CAB		
Start File	DI272000	DI272036		
Finish File	DI272035	DI272043		
Post-Verification	DI272CAA	DI272CAA		
Depth Return Error (in.)	0	0		
Comments	None	None		

Logging Operation Notes:

Logging was conducted with a centralizer on each sonde and measurements are referenced to top of casing. Repeat data were acquired at a 1000 second counting time at 24 ft to provide additional detail. For purposes of this report, the data acquired at 1000 seconds are reported as main log data rather than as repeat data.

Analysis Notes:

Analyst:	P.D. Henwood	Date:	06/15/07	Reference:	GJO-HGLP 1.6.3, Rev. 0

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

A casing correction for a 5/16 in. thick was applied to the SGLS data.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G4NAug05.xls using an efficiency function and corrections for casing, dead time, and water as determined from annual calibrations. The passive neutron data are used for qualitative purposes and do not require a calibration. Data are reported in counts per second.

Results and Interpretations:

Am-241 is detected at 20 ft at a concentration of 170,000 pCi/g. Gamma rays at approximately 662 and 722 keV were detected that represent Am-241. Cs-137 emits a 661.66 gamma ray that cannot be distinguished from the 662.40 gamma ray emitted from Am-241. The energy peak at 722.01 keV is used to establish the presence of Am-241 rather than Cs-137. In this borehole, the 722.01 keV energy peak was detected at only one depth location (20 ft) where the 662 keV energy peak was also detected and is assigned to Am-241. At all other depth locations where the 662 keV energy peak is detected, it is assumed the contribution is from Cs-137.

Using this approach, Cs-137 is detected from 16 and 21 ft. The maximum concentration of 900 pCi/g is measured at 19 ft.

Pu-239 was detected at 19 and 20 ft and at 23 and 24 ft. The maximum concentration was measured at 19 ft at approximately 875,000 pCi/g. Primary energy peaks associated with Pu-239 were detected at approximately 129, 375, and 414 keV. Interferences from the 375.45 and 376.65 keV energy lines and the 415.76 and 415.88 keV gamma energy lines originating from the decay of Pa-233 and Am-241, respectively, are probable and would result in a slight over estimation of the Pu-239 concentration. The 129 keV energy peak is only detected at 19 and 20 ft. At 23 and 24 ft, the assays for Pa-233 using the 375.45 and 415.76 energy peaks are consistent with that derived from the 312 keV peak. Therefore, it is concluded the Pu-239 only exists above an MDL of approximately 10,000 pCi/g at 19 and 20 ft. The energy peak at 414 keV is dominated by Pa-233 at 23 and 24 ft. Although some Pu-239 probably exists at 23 and 24 ft, it is believed to be below a MDL of 10,000 pCi/g.

Np-237 is detected with the SGLS by measuring a daughter product (protactinium-233) that emits a prominent gamma ray at an energy of 312.17 keV. Pa-233 was detected from 19 to 25 ft. The maximum concentration is approximately 35 pCi/g at a 19 ft depth.

An elevated Th-232 concentration as determined using the 2615 keV (Tl-208) energy peak is indicated between 21 and 26.5 ft. Both U-232 and Th-232 decay to Th-228, the first decay product of U-232 and the third decay product of Th-232. Therefore, the concentration determined for each decay product from Th-228 to Tl-208 will reflect decay from both parents. In spectral gamma log analysis, the 2615 keV Tl-208 gamma ray is used to represent the concentration of the naturally occurring parent Th-232. This gamma ray is energetic relative to gammas emitted by the other daughter products and its yield of approximately 35% results in easy detection. However, because the decay chain of naturally occurring Th-232 is modified by the emergence of the decay products of U-232, the natural component of Th-232 must be determined from its second decay product (Ac-228). Ac-228 can be directly measured using the 911 keV gamma ray. The plot of natural gamma logs shows the disruption of the equilibrium (i.e., separation of the 911 and 2615 keV assays) of the natural Th-232 decay, where between 20 and 26 ft, the Ac-228 indicates Th-232 concentrations below that calculated from the 2615 keV gamma line.

To determine the concentration of U-232, the activity due to natural decay of Th-232, must be subtracted. The Ac-228 concentration is subtracted from the Th-232 concentration calculated based on the 2615 keV Tl-208 energy peak. The result is a maximum concentration of approximately 0.4 pCi/g U-232.

U-233 almost certainly exists where U-232 is detected. In a reactor using thorium target material, U-233 will be generated at roughly three orders of magnitude more than U-232. However, at relatively low concentrations, U-233 does not emit a gamma ray that can be detected with the SGLS and decay products that potentially could be measured have not had sufficient time to build in to detectable levels. It is inferred on the basis of the U-232 concentration that 100 to 1000 pCi/g U-233 may exist in this waste stream.

Passive neutron logging was performed in the borehole. This logging method has been shown to be effective in qualitatively detecting zones of alpha-emitting contaminants from secondary neutron flux generated by the (α,n) reaction and may indicate the presence of α-emitting nuclides, including transuranic radionuclides, even where no gamma emissions are available for detection above the MDL. The passive neutron signal depends on the concentration of α sources, and also the concentrations of lighter elements such as N, O, F, Mg, Al, and Si, which emit neutrons after alpha capture. The passive neutron log indicated a maximum count rate of 100 counts per second (cps) at 19 and 20 ft.

A reaction F-19 (α,n) Na-22 yields a gamma ray at 1274.53 keV and a positron at 511 keV. A 1274.44 keV gamma ray also occurs from the decay of Eu-154. However, there are no corroborating peaks for the Eu-154 and the gamma ray is attributed to the fluorine reaction. The half life of Na-22 is short (i.e., 2.6 years), but will continue to be produced as long as sufficient fluorine and alpha activity exist. The Na-22 was detected from 18 to 20 ft at similar depth intervals as the relatively high Pu-239. The maximum concentration of Na-22 is approximately 1 pCi/g at 19 ft. The 1274 keV energy peak may also be influenced by a prompt gamma ray induced by alpha particles interacting with F-19.

Another unusual energy peak observed in the high neutron flux interval is the 2223.2-keV H capture □-ray. This gamma ray is also an indication of neutron activity.

Spectral gamma data were acquired in this borehole in 1993 and 1998 by Westinghouse Hanford Company and Waste Management Federal Services NW, respectively, using the Radionuclide Logging System (RLS). A comparison plot of the RLS (1993 and 1998) and SGLS (2006) manmade radionuclides show similar concentrations for Pa-233, Pu-239, and Cs-137. Am-241 was observed in the RLS analysis but was not quantified.

The RLS analysis identified a “thorium disequilibrium” condition from 19 to 24 ft. Current analysis suggests this disequilibrium is an indication of U-232.

A comparison of the Cs-137 profiles from 1993 to 2006 suggests no significant change. However, the Cs-137 concentrations should have decreased by 15 to 20 percent due to decay. The apparent lack of decay suggests the 662 keV energy peak may have contributions from other radionuclides, most likely Am-241. It is also postulated that small amounts of fission products may be produced in situ by fissioning of Pu-239 in the intense neutron flux.

Soil samples were acquired and analyzed for Pu-239/240 and Am-241 at the time of drilling the borehole in 1980. Kasper (1982) reports the detection limits for Pu-239/240 and Am-241 using gamma energy analysis were 2,000 and 300 pCi/g, respectively. The detection limits using the SGLS are approximately 10,000 and 50,000 pCi/g. For soil samples below the GEA detection limits, alpha energy analysis was performed. The detection limit for Pu-239/240 and Am-241 alpha energy analysis was approximately 0.1 pCi/g. These sample results plotted with the SGLS/RLS results indicate good agreement at the few depth locations that can be compared.

The SGLS and PNLS repeat data show good repeatability.

References:

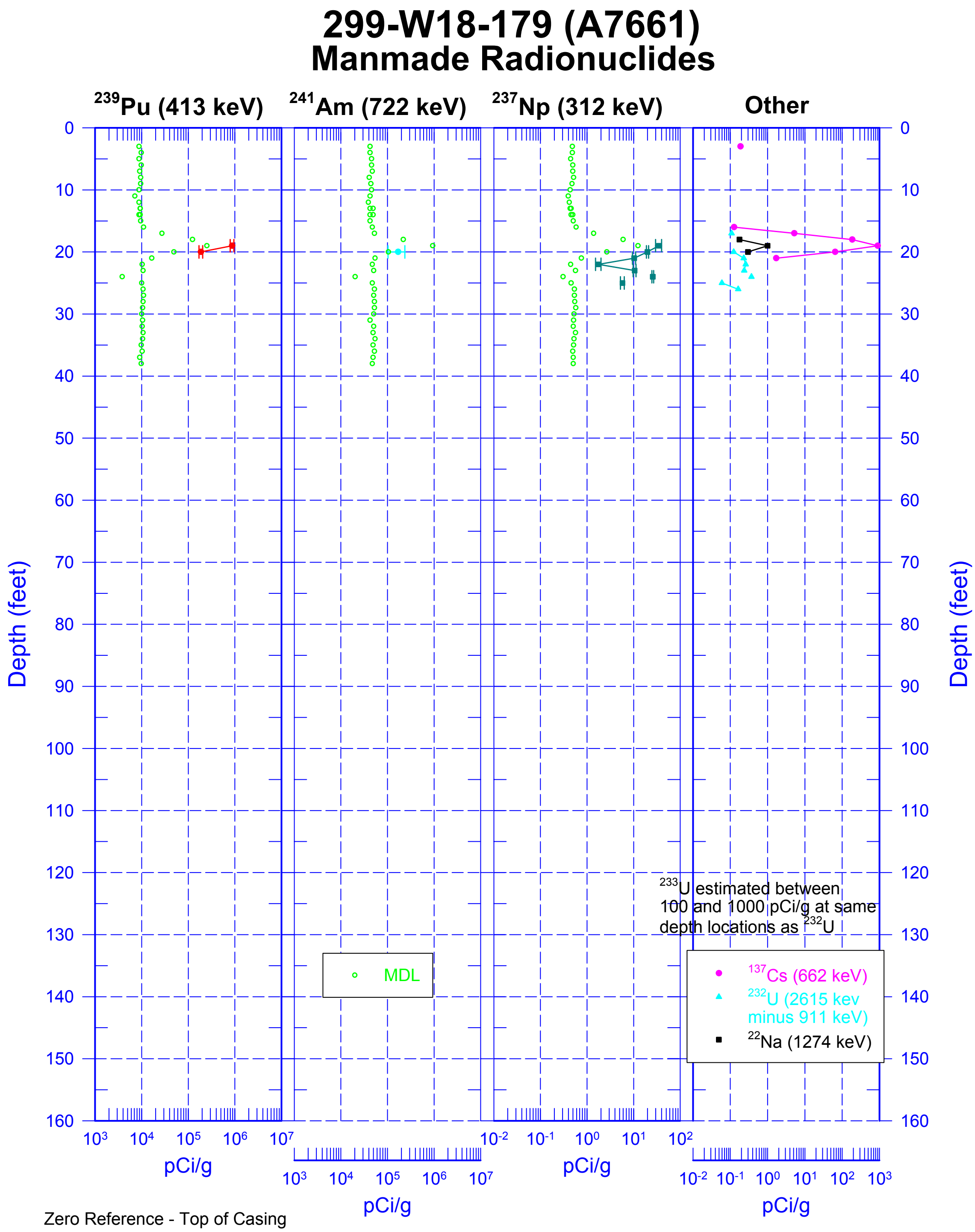
Kasper, R.B. 1982. *216-Z-12 Transuranic Crib Characterization: Operational History and Distribution of Plutonium and Americium*. RHO-ST-44, Rockwell Hanford Operations, Richland, Washington.

List of Plots:

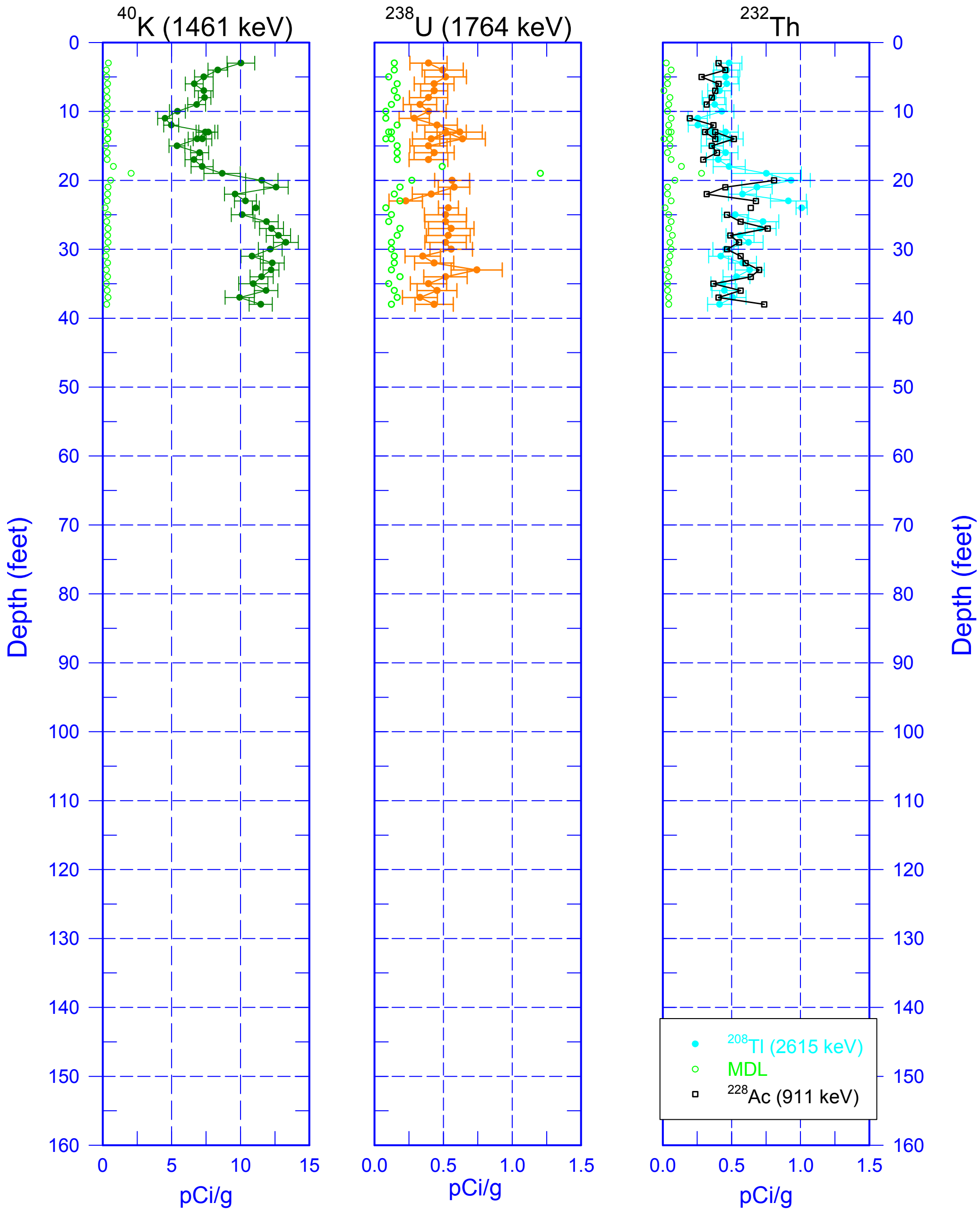
Depth Reference is top of casing

Manmade Radionuclides
Natural Gamma Logs
Combination Plot
Total Gamma, Dead Time, & Passive Neutron
Comparison of RLS/SGLS & Soil Samples (0-40 ft)
Comparison of RLS/SGLS & Soil Samples (0-160 ft)
Repeat of Passive Neutron

[1] GWL – groundwater level

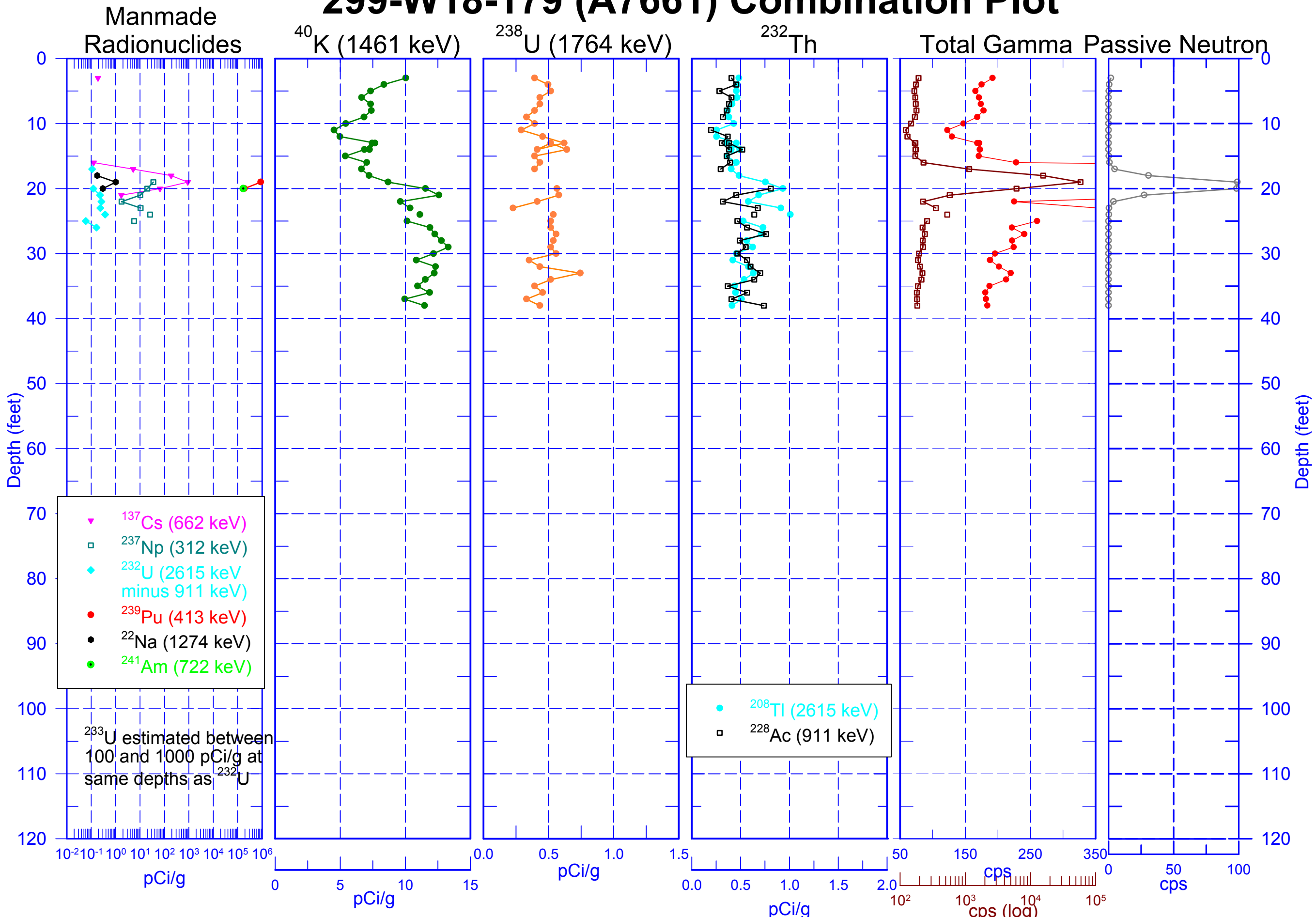

299-W18-179 (A7661)
Manmade Radionuclides
239Pu (413 keV)
241Am (722 keV)
237Np (312 keV)
Other
Depth (feet)
pCi/g
MDL
233U estimated between 100 and 1000 pCi/g at same depth locations as 232U
137Cs (662 keV)
232U (2615 kev minus 911 keV)
22Na (1274 keV)
Zero Reference - Top of Casing

299-W18-179 (A7661)
Natural Gamma Logs



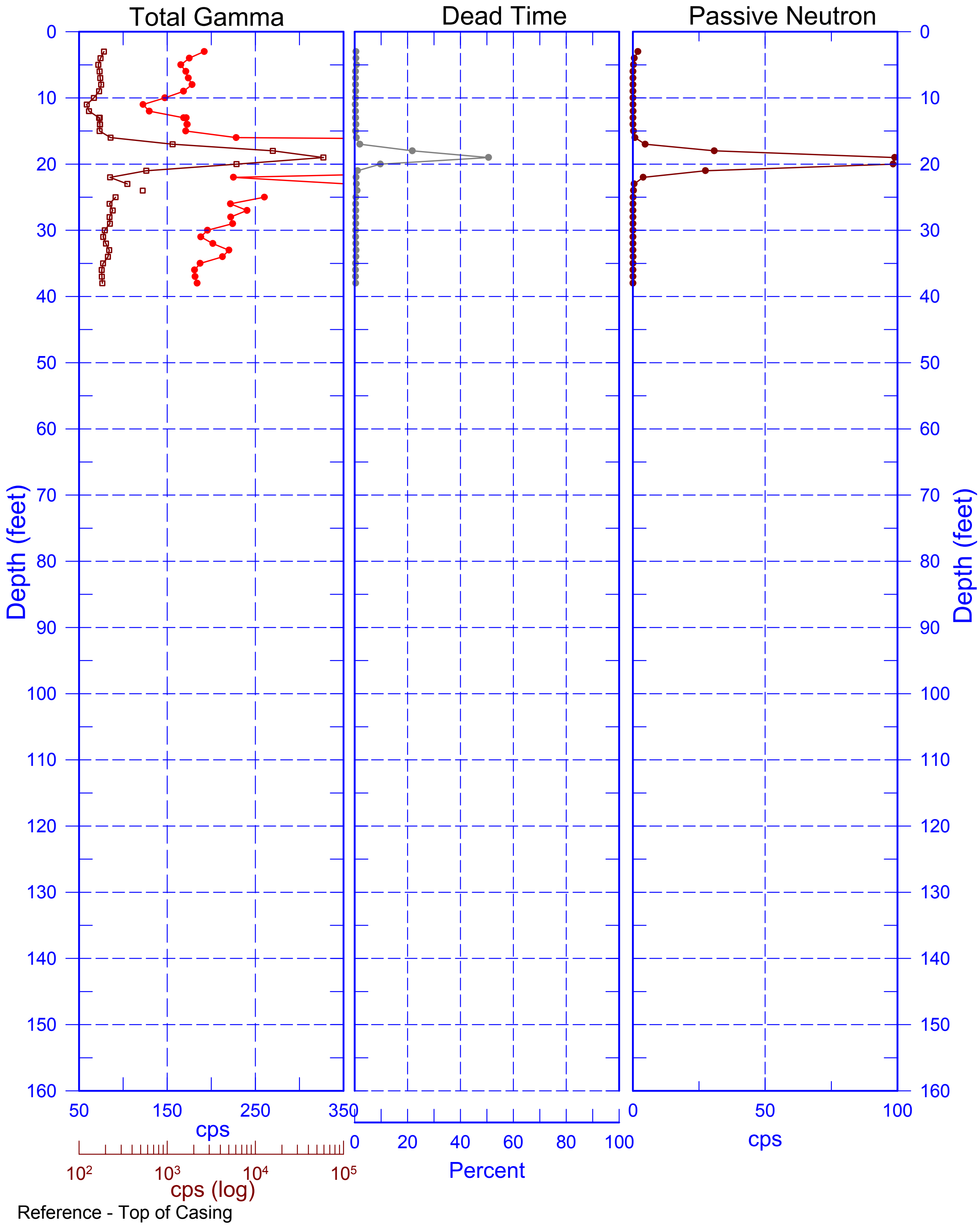
Zero Reference = Top of Casing

299-W18-179 (A7661) Combination Plot

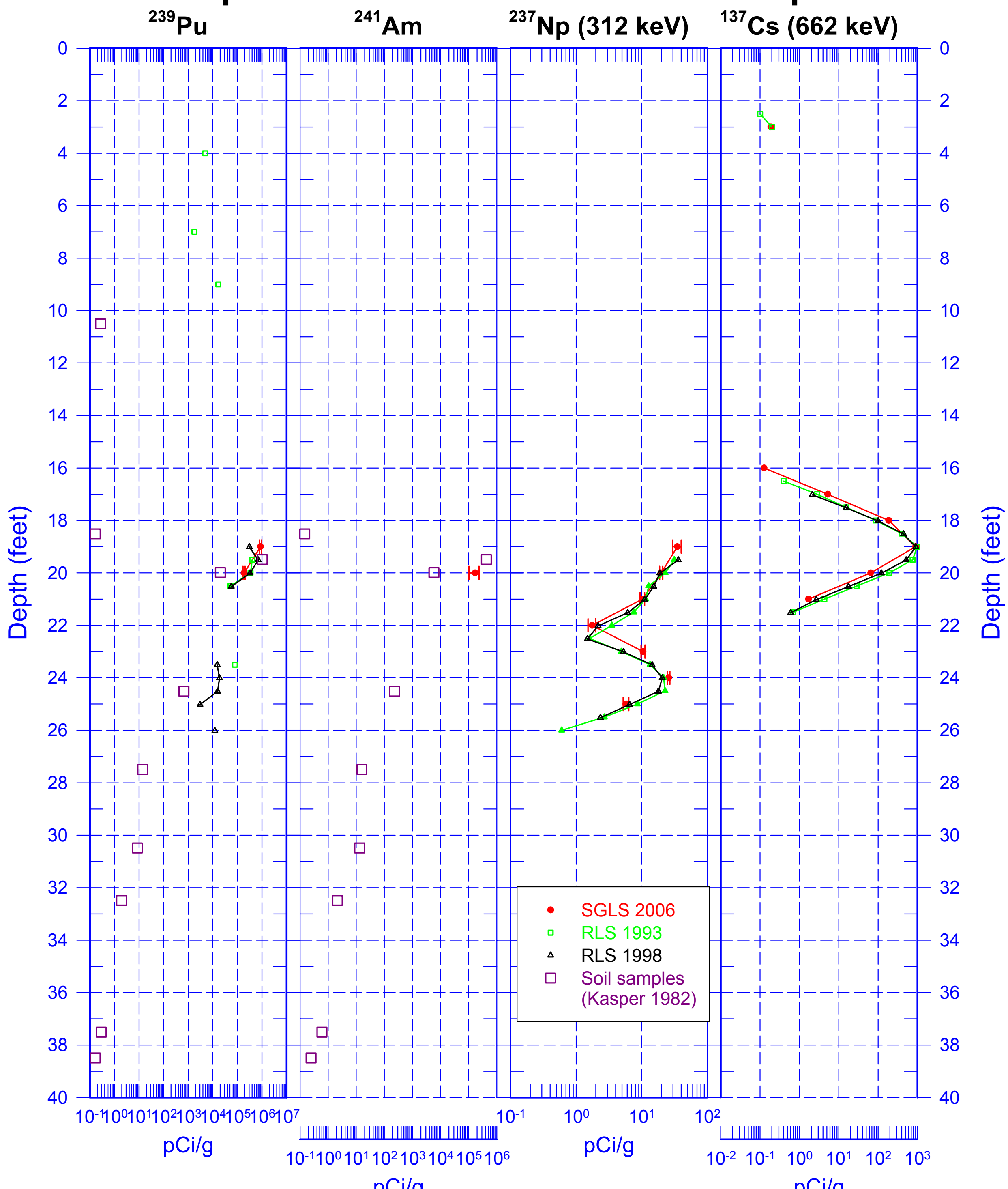


Zero Reference - Top of Casing

299-W18-179 (A7661)
Total Gamma, Dead Time, & Passive Neutron



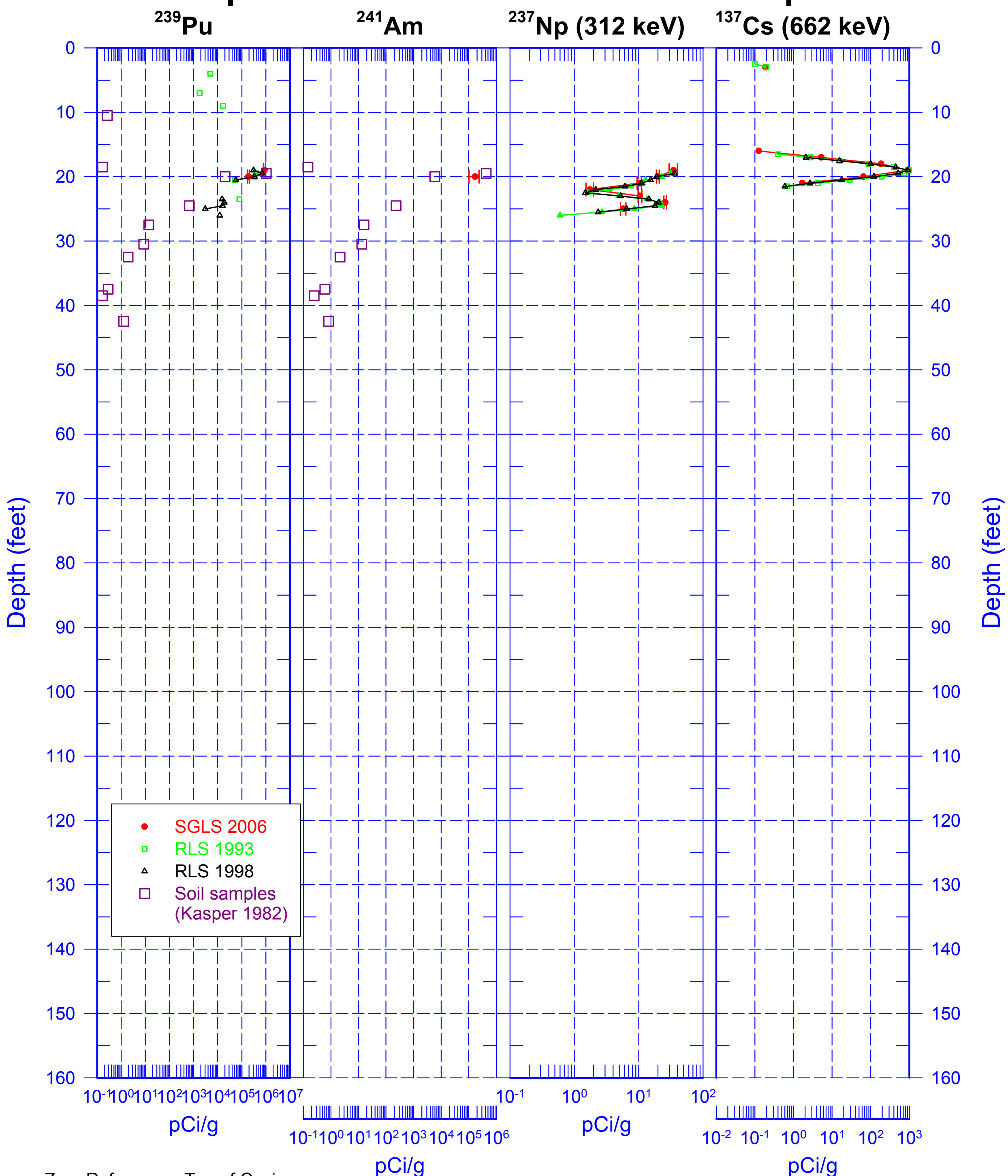
299-W18-179 (A7661)
Comparison of RLS/SGLS & Soil Samples



Zero Reference - Top of Casing

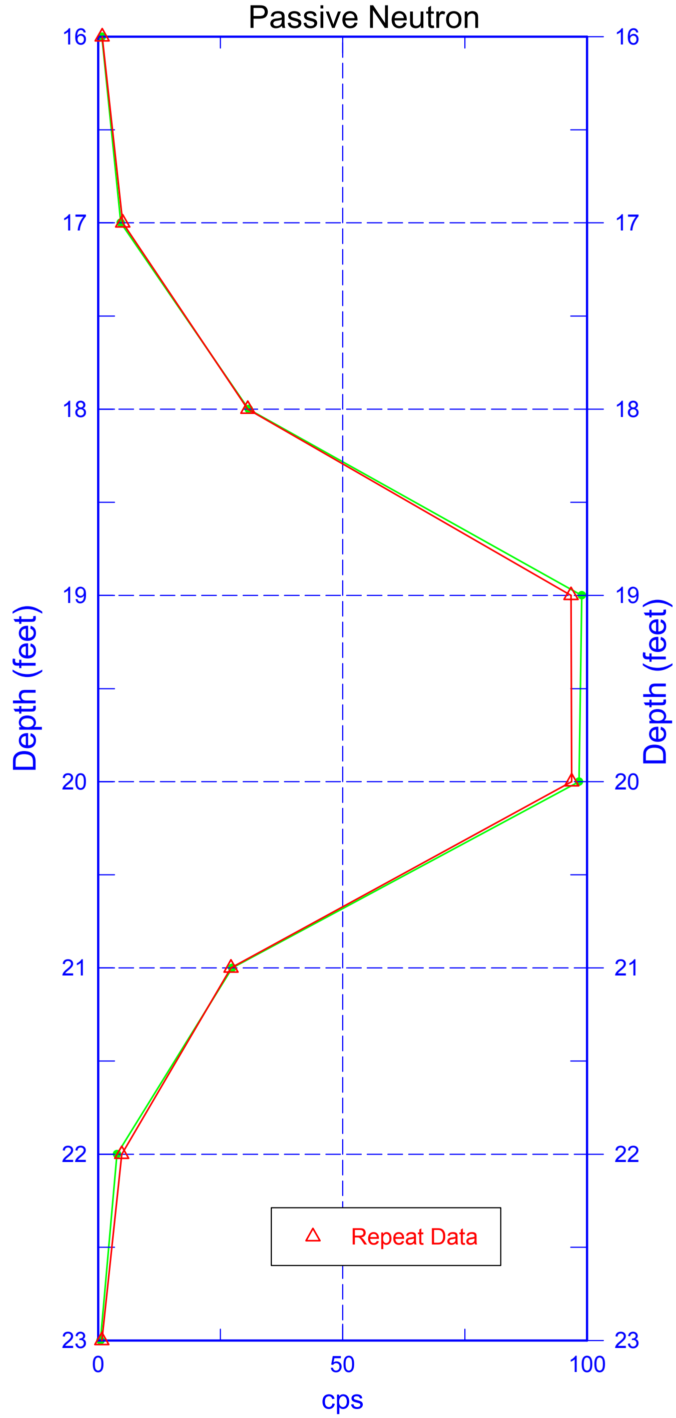
299-W18-179 (A7661)

Comparison of RLS/SGLS & Soil Samples



Zero Reference - Top of Casing

299-W18-179 (A7661)
Repeat of Passive Neutron



Reference - Top of Casing