299-E28-23 (A6799)

Log Data Report

Borehole Information:

Borehole:	299-E28-23 (A6799)		Site:	216-B-5 Injection/Reverse Well	
Coordinates (WA State Plane)		GWL[1] (ft):	280 ft	GWL Date:	1980
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
136731	573782	07/79	N/A[3]	330.5	Cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel (welded)	1.33	8.625	8.0	0.3125	0	232
Steel (welded)	1.21	6.625	6.0	0.280	0	278
Steel (threaded)	1.17	4.25	3.75	0.25	0	278
#10 slotted SS screen	none	4.25	3.75	0.25	278	328

Borehole Notes:

The casing depth information provided above is derived from a well construction and completion summary obtained from *Hanford Wells* (Chamness and Merz, 1993) and from *Summaries of Well Construction Data and Field Observations for Existing 200-East Aggregate Area Operable Unit Resource Protection Wells* (Ledgerwood 1992). The approximate casing size information for the 4-in., 6-in., and 8-in. steel casings is confirmed from tape and caliper measurements collected in the field by MACTEC-ERS personnel. For analysis purposes, the measurements for the 4-in. stainless steel screen are assumed to be the same as the 4-in. steel casing.

This borehole was originally drilled in 1979 approximately 6 ft southeast of the 216-B-5 Injection/Reverse Well. During September 1980 and March 1981 the borehole was completed as a groundwater monitoring well. During drilling, a 10-in. casing that is reported to have since been removed, had been placed to 20 ft in depth. An 8-in. casing was placed to about 232 ft and a 6-in. casing was placed inside the 8-in. casing to the bottom of the borehole at about 330.5 ft. A 4-in. casing with a 4-in. slotted screen on the bottom 50 ft was introduced inside the 8-in. and 6-in. casings to a depth of 330.5 ft. The 6-in. casing was cut at 328 ft and pulled to about 278 ft to expose the 50-ft section of screen to the formation water. A grout seal was emplaced between the 6-in. and 8-in. casings and between the 8-in. casing and the formation from 232 ft to the ground surface. A 2-ft cement pad was poured at the surface to complete the seal.

Logging measurements are referenced to the top of the 8-in. casing. The depth to groundwater in the area has been reported at about 295 ft in 1948 (Smith 1980) and at about 280 ft in 1979. Logging was terminated at 287 ft, which is at a depth believed to be just above the current groundwater level.

Logging Equipment Information:

Logging System:	Gamma 1D		Type:	SGLS (35%)
Calibration Date:	07/01	Calibration Reference:	GJO-2001-243-TAR	
		Logging Procedure:	MAC-HGLP 1.6.5	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4	5
Date	11/08/01	11/12/01	11/13/01	11/14/01	11/15/01
Logging Engineer	Musial	Musial	Musial	Musial	Musial
Start Depth	1.3	29.0	98.0	187.0	243.0
Finish Depth	30.0	99.0	188.0	273.0	287.0
Count Time (sec)	200	200	200	200	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[4]	n/a	n/a	n/a	n/a
Pre-Verification	A0034CAB	A0035CAB	A0036CAB	A0037CAB	none
Start File	A0034000	A0035000	A0036000	A0037000	A0038000
Finish File	A0034029	A0035070	A0036089	A0037086	A0038044
Post-Verification	A0034CAA	A0035CAA	A0036CAA	none	A0038CAB

Logging Operation Notes:

Spectral gamma logging was performed in this borehole during November 2001 on five separate days. Logging was terminated at a depth of 287 ft before groundwater was encountered. Waste management issues restrict logging below the groundwater level. A repeat section was collected between 243 and 273 ft to measure logging system performance. Log run 5 was conducted using a 100-s counting time rather than 200 s as a result of operator error. The statistical precision of the measurements was not severely compromised as a result of the shorter counting time because this section of borehole had only one (278-287 ft) or two casings (242-278 ft) that cause gamma attenuation. In addition, the repeat section shows good agreement in spite of the difference in count times.

Analysis Notes:

Analyst:	Henwood	Date:	12/03/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Pre-run and post-run verifications of the logging system are to be performed for each day's log event. However, two post-run verifications are not available. The post-run verification data have been misplaced for log run 3, and for log run 4 were not collected because of a tool warming (loss of liquid nitrogen) problem. The pre-run verification file for log run 5 was inadvertently overwritten by the post-run verification data and is not retrievable. The efficiency (peak counts per second) of the logging system was slightly lower each day in the post-run verification as compared to the pre-run verification where this comparison was available. This change was generally in the range of 6 to 13 percent. The cause of this discrepancy is being investigated. Evaluation of the spectra indicates the detector is functioning normally and the log data are provisionally accepted, subject to further review and analysis. One exception is the data collected near the end of log run 4 when a liquid nitrogen loss occurred. The data collected from about 260-273 ft are considered suspect as broadening of energy peaks in a spectrum is exhibited. This poor resolution is likely caused as the liquid nitrogen dissipates and the detector is not cooled sufficiently to provide optimal performance. This warming of the detector results in a slight under-estimation of the concentrations. The post-run verifications were used for the energy and resolution calibration for log runs 1, 2, and 5 and the pre-run verifications were used for log runs 3 and 4 during data processing.

Casing corrections for 0.322, 0.280, and 0.237-in.-thick casings were applied for the 8-in., 6-in., and 4-in. steel casings, respectively. These values are within the error of the field measurements collected to confirm casing size and represent the published thicknesses for ASTM schedule-40 steel pipe, a common borehole casing at Hanford. For analysis purposes the 4-in. stainless steel slotted casing was also assumed to be schedule-40 casing. Where more than one casing exists at a depth the casing correction is additive (e.g., a 8-in. and 6-in. casing would be the correction for 0.322 + 0.280 = 0.602).

Each spectrum collected during a log run was processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL using an efficiency function and corrections for casing and dead time as appropriate. Where dead time is greater than about 40 percent, pulse pileup and peak spreading effects tend to result in underestimation of peak count rates. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations rather than the ^{214}Bi peak at 609 keV. The higher energy 1764-keV energy peak exhibits slightly better count rates than the 609-keV peak because of less gamma attenuation caused by the multiple casings in this borehole.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclide (^{137}Cs) detected in the borehole, naturally occurring radionuclides (^{40}K, ^{238}U, ^{232}Th [KUT]), a combination of man-made, KUT, and soil sample results of radionuclides (analyzed in 1980), total gamma plotted with dead time, and a repeat section plot. 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, casing corrections, or water corrections. These errors are discussed in the calibration report. Soil sample results are derived from the 216-B-5 Reverse Well Characterization Study (Smith 1980).

Results and Interpretations:

^{137}Cs is detected continuously throughout the borehole at low levels (i.e., less than about 10 pCi/g). Two anomalous zones occur, one at about 228 ft in depth, and another beginning at about 250 ft. The low level concentrations pervasive in the borehole are probably the result of contamination inside either the 4-in. or 6-in. casings. Gamma spikes occur at about 30-ft intervals beginning at about 15 ft in depth and probably extending to at least 262 ft. These spikes may be associated with welds at the casing joints that may have an affinity to adsorb ^{137}Cs. The ^{137}Cs contamination zone beginning at 250 ft probably extends to at least 330 ft as suggested by the soil sample results shown in the combination plot. The profile of the ^{137}Cs contamination between 250 and 280 ft approximates the 1980 ^{137}Cs soil sample results for the same depth interval. Comparison of the decayed concentrations of ^{137}Cs in the soil samples to the current ^{137}Cs concentrations determined by logging indicates an under-correction for casing resulting in calculated concentrations being slightly low in the log data. A ^{137}Cs concentration of about 1,000 pCi/g at a depth of about 280 ft is measured with both methods. Concentrations between 280 and 287 ft determined by logging do not match the soil sample results at the same depth interval because the dead time exceeds 40 %, at which level the calculated concentration data are unreliable and tend to be under-estimated. The high rate logging system (HRLS) should be employed in this interval to obtain accurate ^{137}Cs concentrations.

Soil sample results from 1980 (Smith 1980) show ^{137}Cs, strontium-90 (^{90}Sr), americium-241 (^{241}Am), and plutonium-239/240 ($^{239/240}$Pu) contamination between 250 and 330 ft; possible detection of ^{241}Am and $^{239/240}$Pu, and ^{137}Cs also occurred in single soil samples at 10, 80, 140, and 200 ft in depth. These radionuclides are not generally detectable by the SGLS using normal counting times. Gamma rays emitted by ^{241}Am and ^{239}Pu that would have the best chance of being detected with the SGLS are at the 59.5- and 129.3-keV energy levels, respectively. Although the gamma-ray yield of ^{241}Am is fairly high (i.e., 36 %), the energy is so low that gamma attenuation by the casing is a major factor in detection. The gamma energy of ^{239}Pu at 129.3 keV is also relatively low and the yield is very low (0.0063 %). ^{90}Sr does not emit a gamma ray and can only be inferred from an elevated low-energy gamma-ray continuum given concentrations exceeding about 1,000 pCi/g and no influences from other radionuclides. The ability to infer the existence of ^{90}Sr, even at high concentrations, would be further degraded by the incoherent downscattering of gamma rays in the low energy continuum. Therefore, it is unlikely any of these radionuclides with the exception of ^{137}Cs can be detected in a multiple casing configuration and/or within groundwater using short counting times.

It is recommended that the interval below the water table be logged with the SGLS and HRLS to confirm the existence of ^{137}Cs and attempt to measure the other radionuclides. One or two depth intervals within this zone should be selected for long counting times to determine if ^{241}Am, ^{239}Pu, or ^{90}Sr can be detected or inferred. In order to relog this borehole interval below the groundwater, waste management issues must be resolved.

The KUT log profiles are essentially featureless. The multiple casings and grout have contributed to significant gamma attenuation. The cause of an apparent change in the KUT and total gamma at about 30 ft is unknown and probably cannot entirely, if at all, be attributed to lithology changes. It would appear the 10-in. surface casing that is purported to have been placed to 20 ft and then removed may remain in the borehole to about 30 ft in depth with grout placed between the 8-in. and 10-in. casing as well as between the 8-in. and 6-in. casings. A sequence of finer grained sediment appears to exist between 230 and 270 ft as evidenced by an increased ^{40}K concentration. In particular, the ^{232}Th concentrations between 250 and 260 ft suggest clayey material and this depth interval also coincides with increased concentrations of the man-made radionuclides. An increase in ^{232}Th between 280 and 285 ft is also associated with increases in man-made radionuclide concentrations.

A repeat log section was collected between 243 and 273 ft in depth. The log data show good repeatability for depth and radionuclide concentration except between about 260 and 273 ft. The log data for this depth interval collected in log run 4 should be considered suspect. Depletion of liquid nitrogen that maintains the detector at optimum efficiency was occurring near the end of this log run. The repeat log data (log run 5) should be considered more reliable even though a shorter count time (100 s) was used for this interval than in log run 4 (200 s).

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[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not available
[4] n/a – not applicable

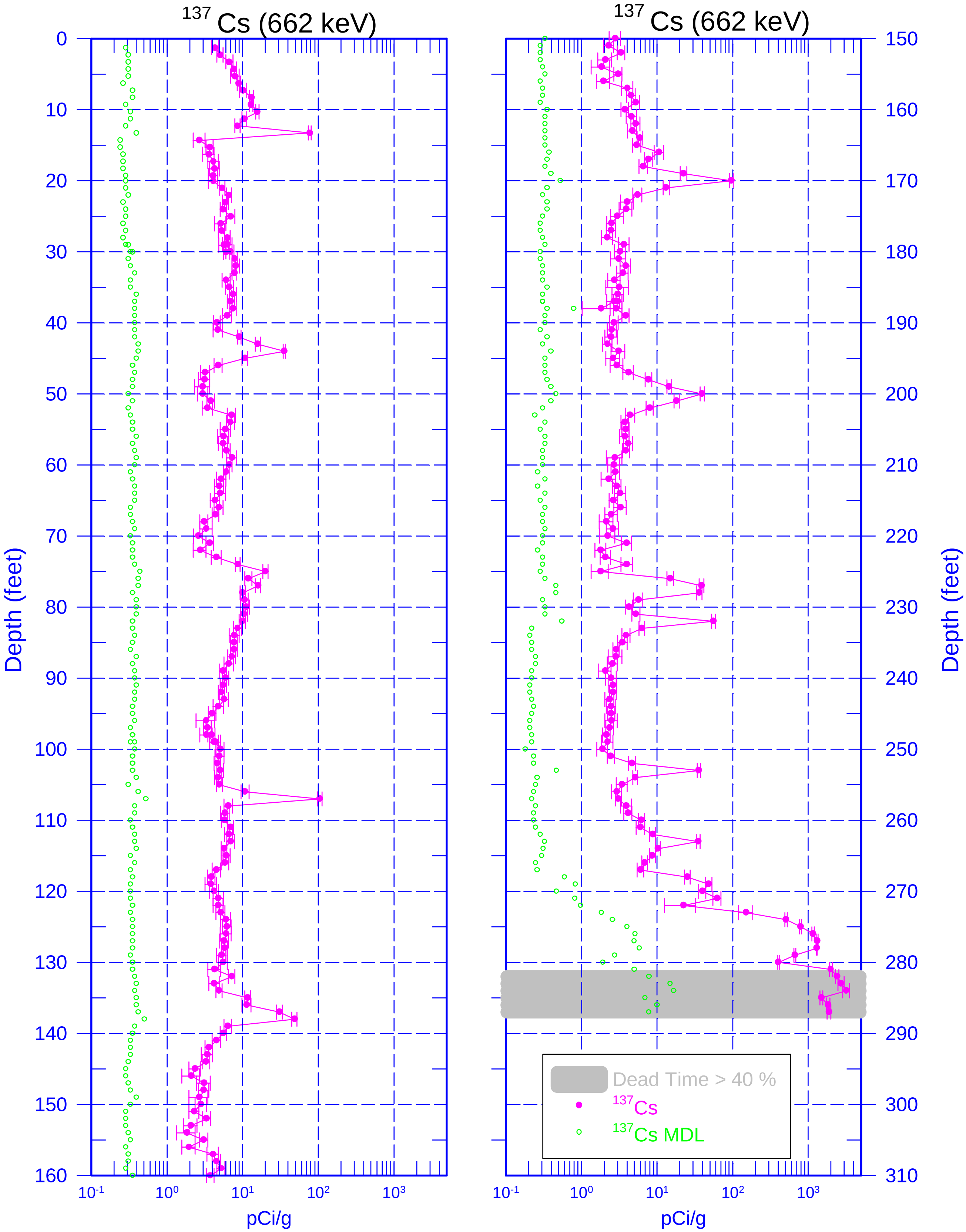
References:

Chamness, M.A., and J.K. Merz, 1993. *Hanford Wells*, PNL-8800, prepared by Pacific Northwest Laboratory for the U.S. Department of Energy.

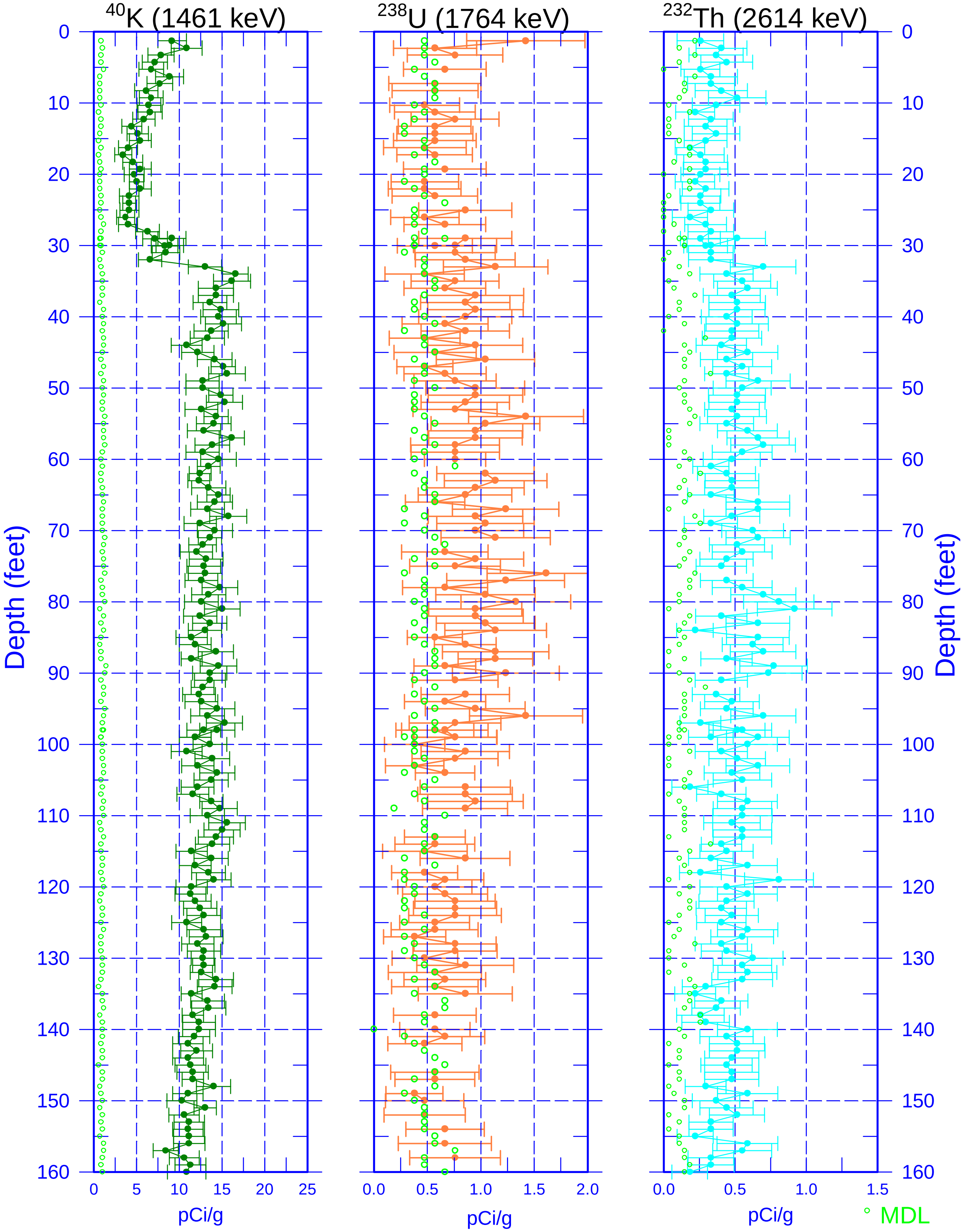
Ledgerwood, R.K., 1992. *Summaries of Well Construction Data and Field Observations for Existing 200-East Aggregate Area Operable Unit Resource Protection Wells*, Draft WHC-SD-ER-T12EAA, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Smith, R.M, 1980. *216-B-5 Reverse Well Characterization Study*, RHO-ST-37, Rockwell Hanford Operations, Richland, Washington.

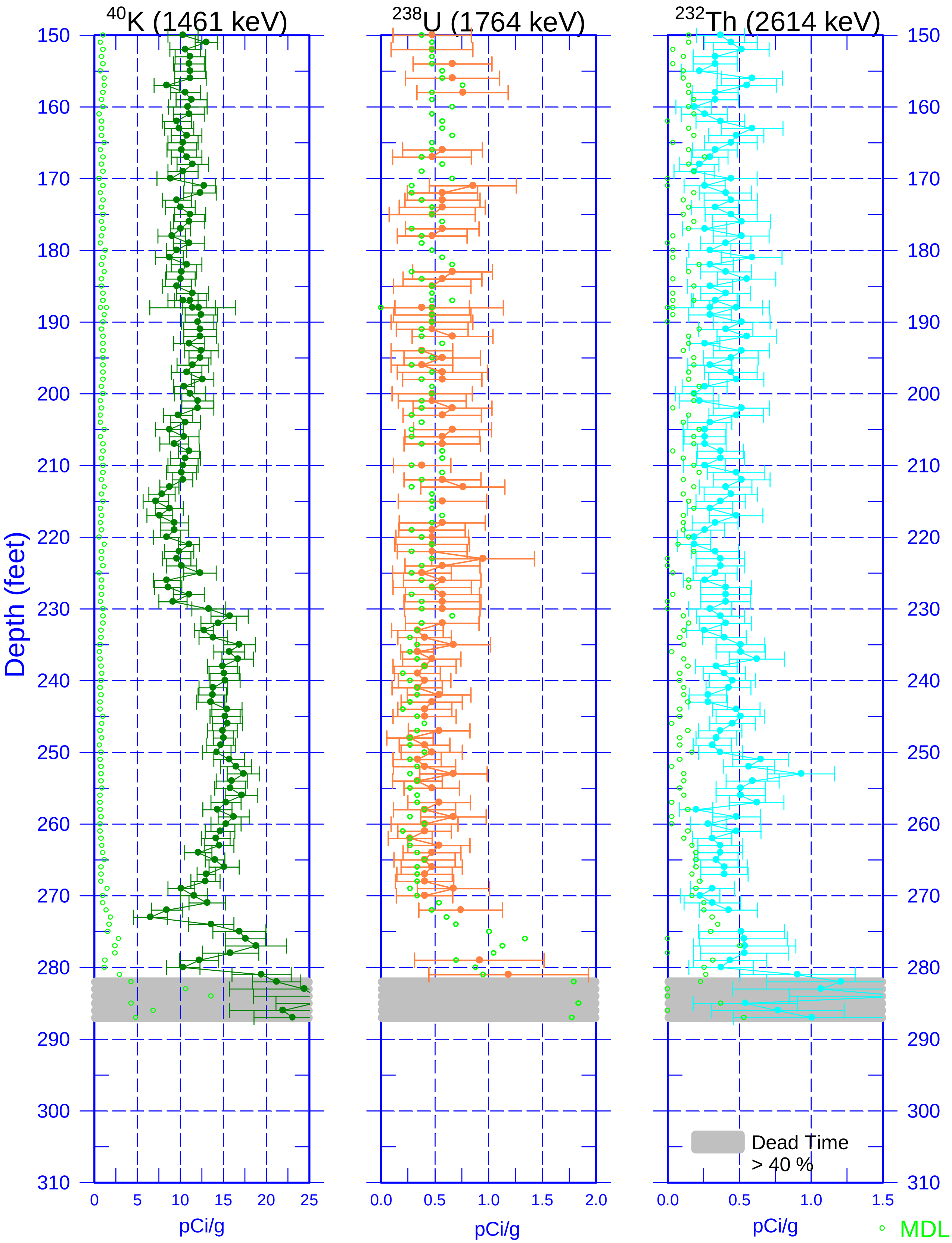
299-E28-23 (A6799)
Man-Made Radionuclide Concentrations



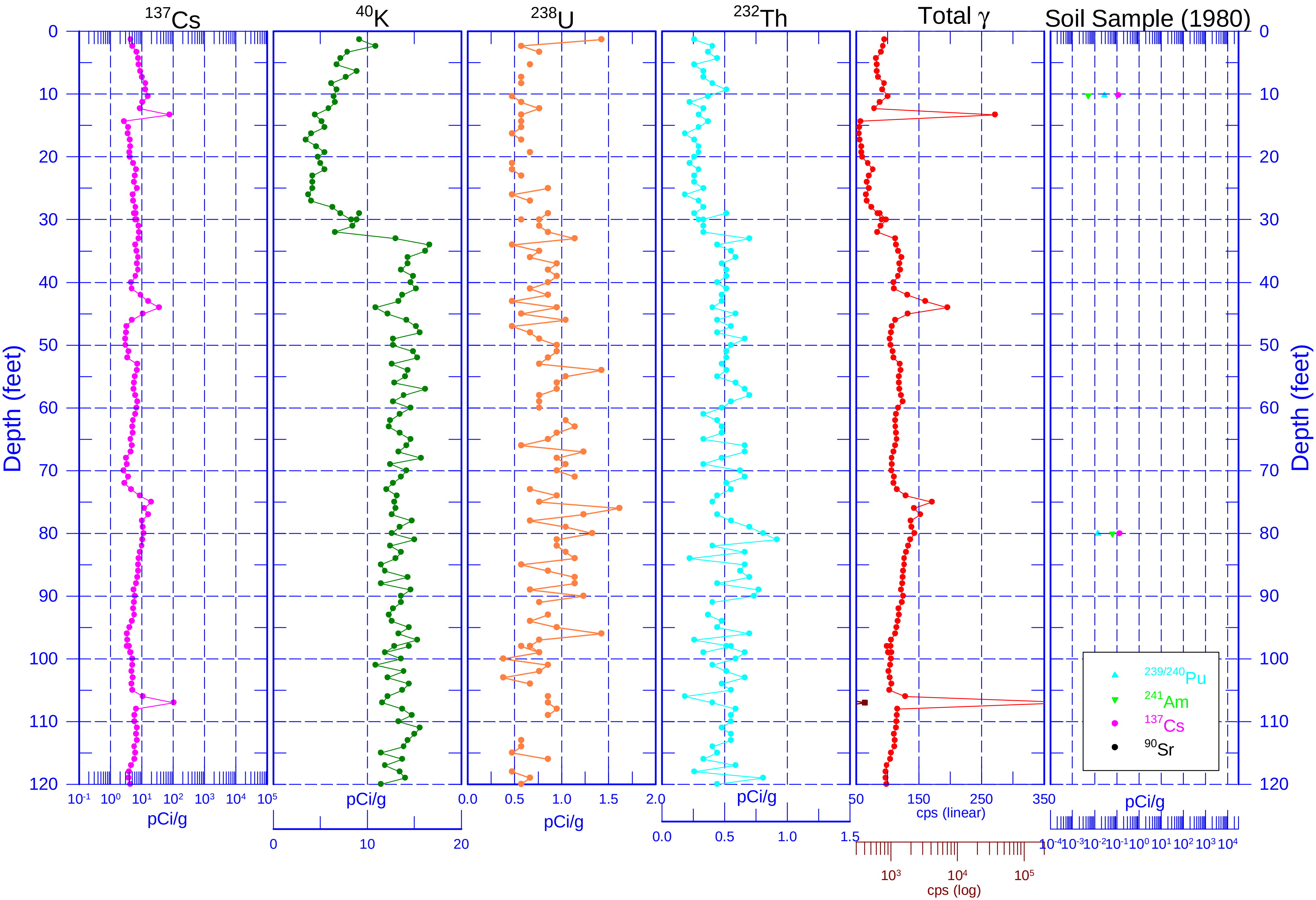
299-E28-23 (A6799)
Natural Gamma Logs



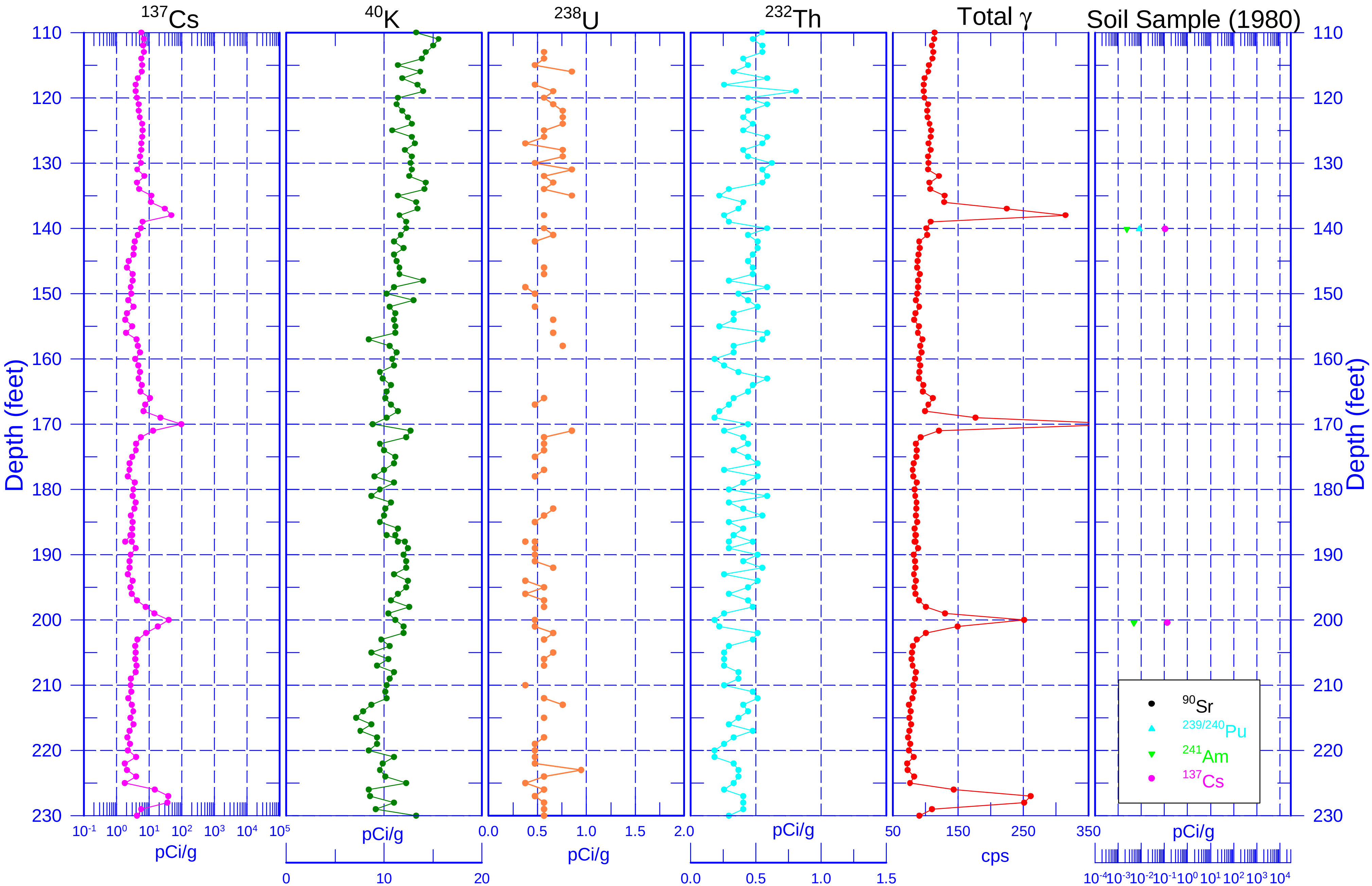
299-E28-23 (continued)
Natural Gamma Logs



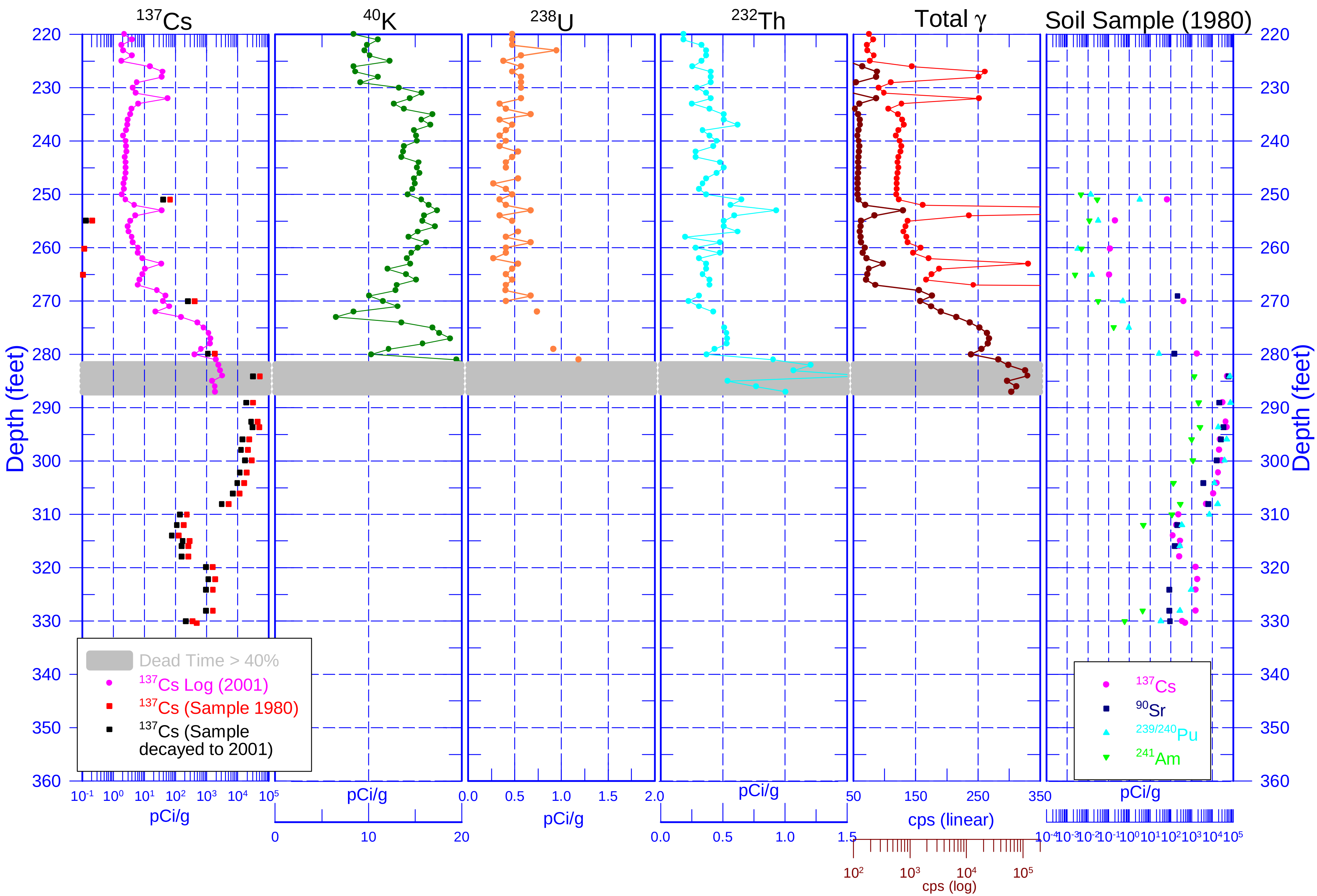
299-E28-23 (A6799) Combination Plot



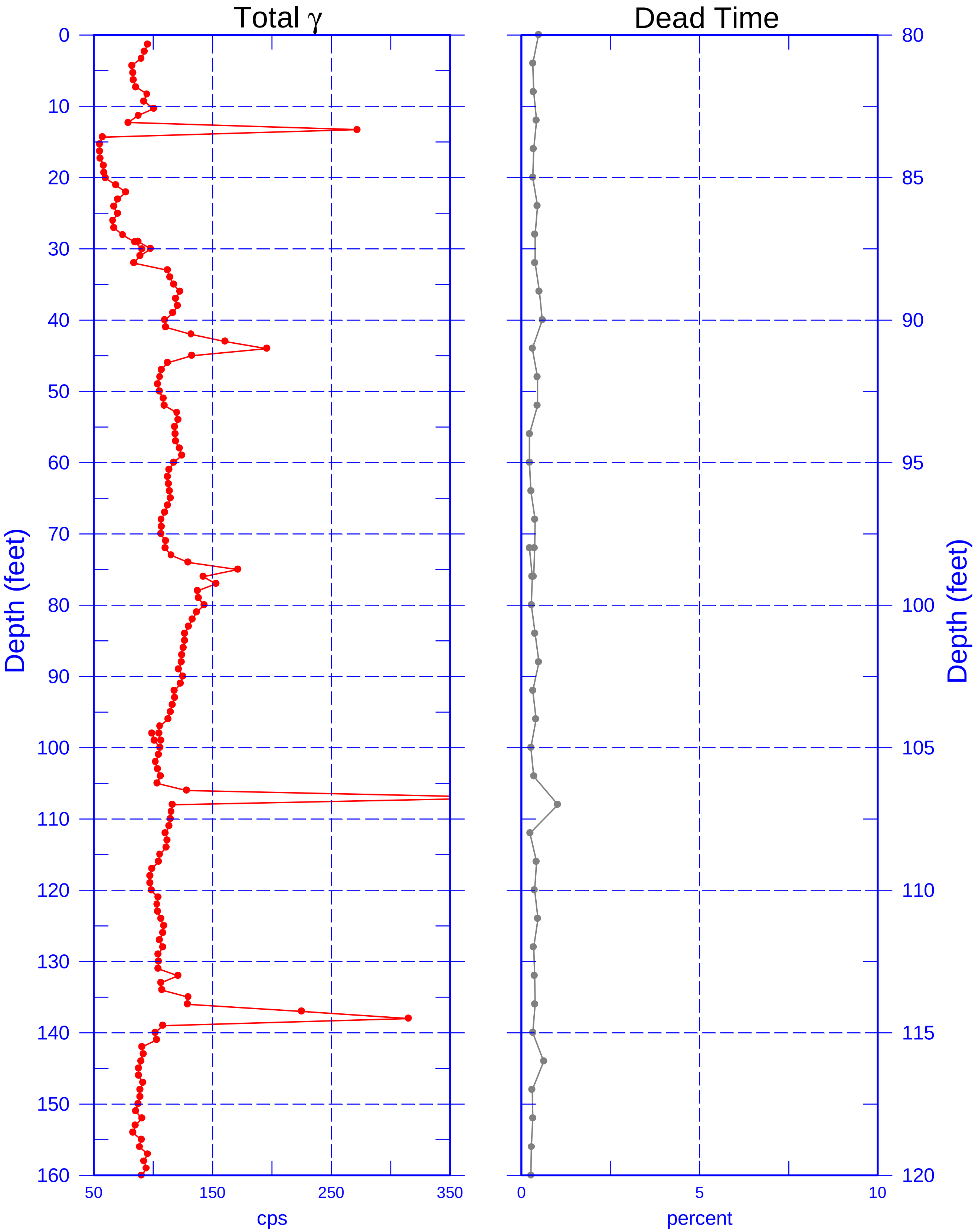
299-E28-23 Combination Plot (continued)



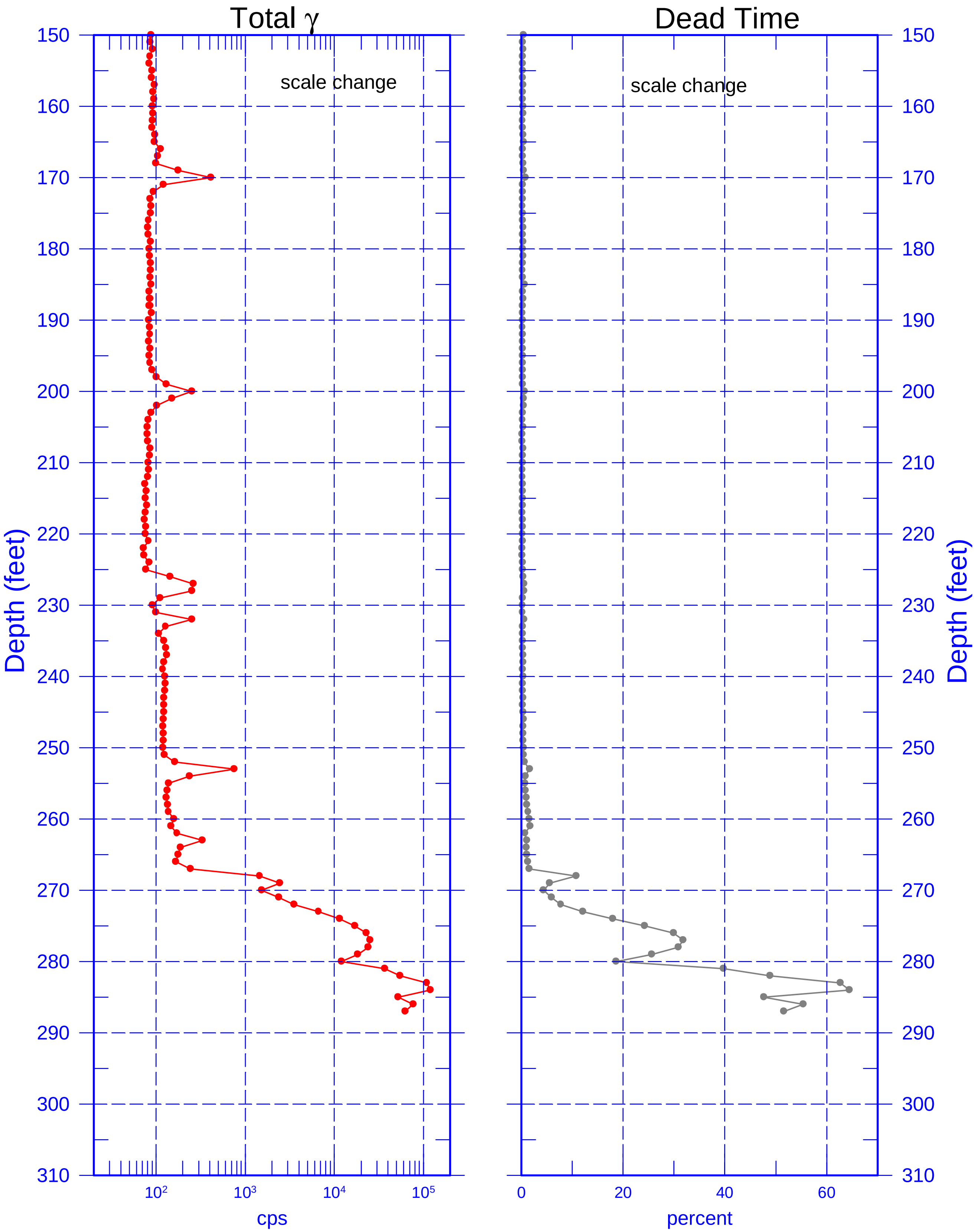
299-E28-23 Combination Plot (continued)



299-E28-23 (A6799)
Total Gamma & Dead Time



299-E28-23 (continued)
Total Gamma & Dead Time



299-E28-23 (A6799)
Repeat Logs