

Appendix E: LANL Reports

***Thermal Ionization Mass Spectrometry Uranium Results for
September 2008 RFETS Waters***

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Prepared by: Deborah Norman, Mike Murrell, and David Janecky

Experimental Approach

Six water samples were received at LANL and processed for uranium TIMS measurements. The samples represented collections at three locations sampled December 6, 2007 and May 15, 2008. Aliquots of the samples were spiked with a ^{233}U spike, equilibrated by fuming with perchloric acid, and then chemically processed using ion-exchange columns to isolate and purify a uranium fraction. The processed samples were loaded onto triple filaments for analysis by thermal ionization mass spectrometry using a VG Sector 54 mass spectrometer. A chemistry process blank was also run that contained negligible uranium.

Results

The sample results are tabulated in Table 1. Sample locations are shown in Figure 1. A plot of $^{236}\text{U}/^{238}\text{U}$ vs. $^{235}\text{U}/^{238}\text{U}$ is shown in Figure 2. Table 2 shows calculated fractions of end-member depleted, enriched and natural uranium for this set of analyses.

Table 1. New Thermal Ionization Mass Spectrometry Uranium Results

ID	Sample ID	U (ng/g)	(+/-) (%)	238/235	(+/-) (%)	234/238 (e-6)	(+/-) (%)	236/238 (e-6)	(+/-)
8-3	RFETS GS 13 07	47.3	0.52	160.3	0.40	58.71	1.0	13.1	1.0
8-4	RFETS GS 13 08	21.5	0.25	155.2	0.18	60.60	0.30	11.9	0.4
8-5	RFETS SW093 07	9.93	0.29	143.6	0.22	66.52	0.33	4.33	0.9
8-6	RFETS SW093 08	7.11	0.25	142.9	0.20	67.30	0.50	3.34	2.9
8-7	RFETS SPP DISC 07	60.7	0.27	118.3	0.23	83.97	0.30	43.9	0.4
8-8	RFETS SPP DISC 08	58.7	0.31	117.8	0.33	84.34	0.28	44.2	0.4

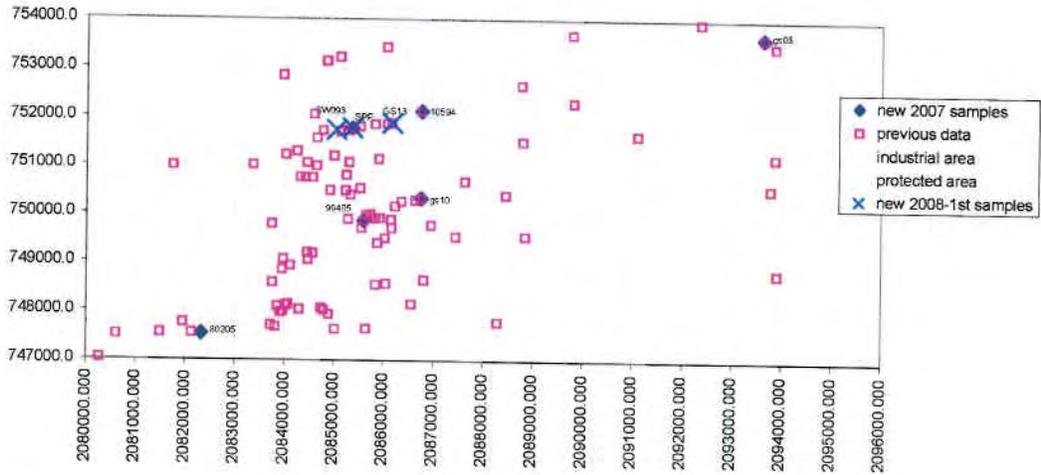


Figure 1. Sampling locations for 2008 RFETS waters.

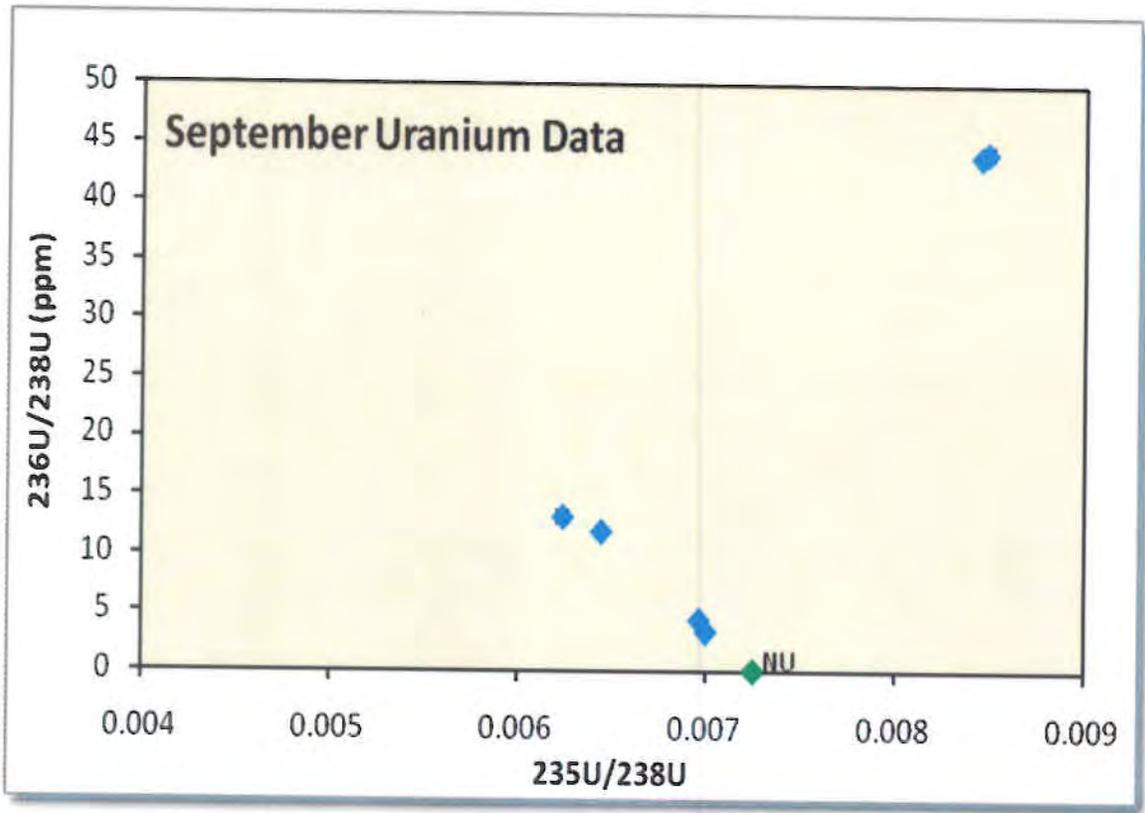


Figure 2. Plot of uranium isotopics for September analyses. None of the samples were solely natural uranium (NU). Samples to the left of the NU reference point indicate the presence of depleted uranium. Samples to the right of the NU reference point indicate the presence of the enriched uranium.

Table 3. Calculated isotopic end-member contributions

Sample Locations	Sample Date	Easting	Northing	normalized to % end-member fractions		
				depleted	enriched	natural
GS13	12/6/2007	2086153.28	751870.11	28.7%	0.05%	71.3%
GS13	5/15/2008	2086153.28	751870.11	25.1%	0.05%	74.8%
SW093	12/6/2007	2085030.39	751730.14	9.1%	0.02%	90.9%
SW093	5/15/2008	2085030.39	751730.14	7.3%	0.01%	92.7%
SPP Discharge Gallery	12/6/2007	2085350.07	751764.39	58.0%	0.42%	41.6%
SPP Discharge Gallery	5/15/2008	2085350.07	751764.39	58.2%	0.42%	41.4%

Discussion

GS13 was previously sampled in the spring of 2002. Isotopic ratios among the four uranium isotopes measured have remained very similar, indicating just under 30% contribution of a depleted uranium end-member and less than 0.1% enriched uranium end-member. The December 2007 sample contained approximately 3 times the concentration of uranium compared to May of 2002, while the May of 2008 sample contained approximately 1.3 times. The large variation in uranium concentrations vs. relatively constant uranium isotopic signatures indicates dilution is a controlling factor for this location.

SW093 had not been previously sampled for uranium isotopic analysis. This sample site is up-drainage from GS13 and the SPP Discharge Gallery. In comparison to the GS13 sample analyses, uranium total concentrations are lower by more than a factor of two. Calculated isotopic contributions indicate less than 10% depleted uranium end-member and 0.2% or less enriched uranium end-member. Concentrations of uranium were decreased in the May 2008 sample, relative to the December 2007 sample, at SW093, consistent with the trend at GS13 but not to the same magnitude.

SPP Discharge Gallery samples have now been sampled for uranium isotopics four times between June of 2002 and May of 2008. This location is between surface water sampling sites SW093 and GS13. There was a shift in isotopic compositions between June 2002 and September of 2007, with the calculated contribution of depleted uranium end-member increasing from 32.6% to 56.7%. Samples from December of 2007 and May of 2008 were slightly higher in depleted uranium end-member contributions than the September of 2007 sample. Calculated contribution of enriched uranium end-member increased from 0.2% in the 2002 sample to 0.4% in 2007 and 2008 samples. Along with the shift in isotopic compositions, the concentration in samples from this site increased from 40 ng/g in the 2002 sample to 60 ng/g in 2007 and 2008 samples.

Thermal Ionization Mass Spectrometry Uranium Results for November 2008 RFETS Waters

Prepared by: Deborah Norman, Mike Murrell, and David Janecky

Experimental Approach

Fourteen water samples were received at LANL and processed for uranium TIMS measurements. The samples represented collections sampled June 6, 2008, August 25-28, 2008, September 2, 2008 and September 16, 2008. Aliquots of the samples were spiked with a ^{233}U spike, equilibrated with concentrated nitric acid only (due to the presence of organic material in the samples), and then chemically processed using ion-exchange columns to isolate and purify a uranium fraction. The processed samples were loaded onto triple filaments for analysis by thermal ionization mass spectrometry using a VG Sector 54 mass spectrometer. A chemistry process blank was also run that contained negligible uranium.

Results

The sample results are tabulated in Table 1. Sample locations are shown in Figure 1. A plot of $^{236}\text{U}/^{238}\text{U}$ vs. $^{235}\text{U}/^{238}\text{U}$ is shown in Figure 2. Table 2 shows calculated fractions of end-member depleted, enriched, and natural uranium for this set of analyses.

Table 1. New Thermal Ionization Mass Spectrometry Uranium Results

ID	Sample ID	U (ug/kg)	(+/-) (%)	238/235	(+/-) (%)	234/238 (e-6)	(+/-) (%)	236/238 (e-6)	(+/-)
11-1	C2 Pond	4.84	0.46	161.7	0.43	57.3	0.48	10.08	0.7
11-2	GS 10	15.2	0.32	151.7	0.30	61.0	0.43	17.85	0.5
11-3	A3 Pond	5.94	0.35	156.6	0.33	60.2	0.40	11.70	0.5
11-4	A4 Pond	0.64	0.20	152.9	0.14	62.4	0.64	10.99	1.4
11-5	B5 Pond	0.79	0.27	149.0	0.24	65.1	0.71	10.74	1.4
11-6	2707	4.89	0.41	161.3	0.38	57.4	0.46	10.05	0.6
11-7	PLFPONDEFF	2.55	0.62	138.1	0.60	66.6	0.70	BDL	
11-9	SPIN, 6/2008	40.9	0.30	122.4	0.25	83.2	0.33	29.30	0.4
11-10	2673	32.0	0.37	152.9	0.34	60.5	0.40	16.08	0.4
11-11	00193	74.0	0.31	137.9	0.26	77.3	0.34	BDL	
11-12	B206989	97.0	0.36	138.1	0.29	84.6	0.40	BDL	
11-13	15699	33.2	0.41	138.2	0.38	67.8	0.44	0.50	3.5
11-14	POM 2	32.2	0.27	153.1	0.22	60.3	0.35	15.97	0.5
11-15	SPIN, 8/2008	45.5	0.33	122.6	0.30	83.1	0.47	29.29	0.4

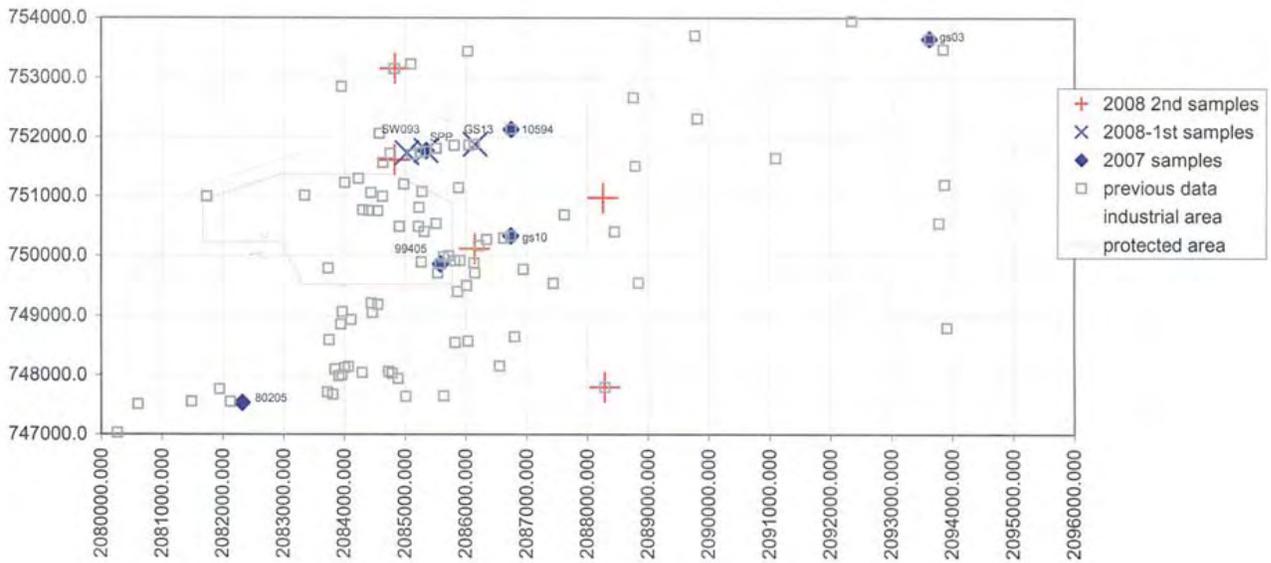


Figure 1. Sampling locations for 2008 RFETS waters.

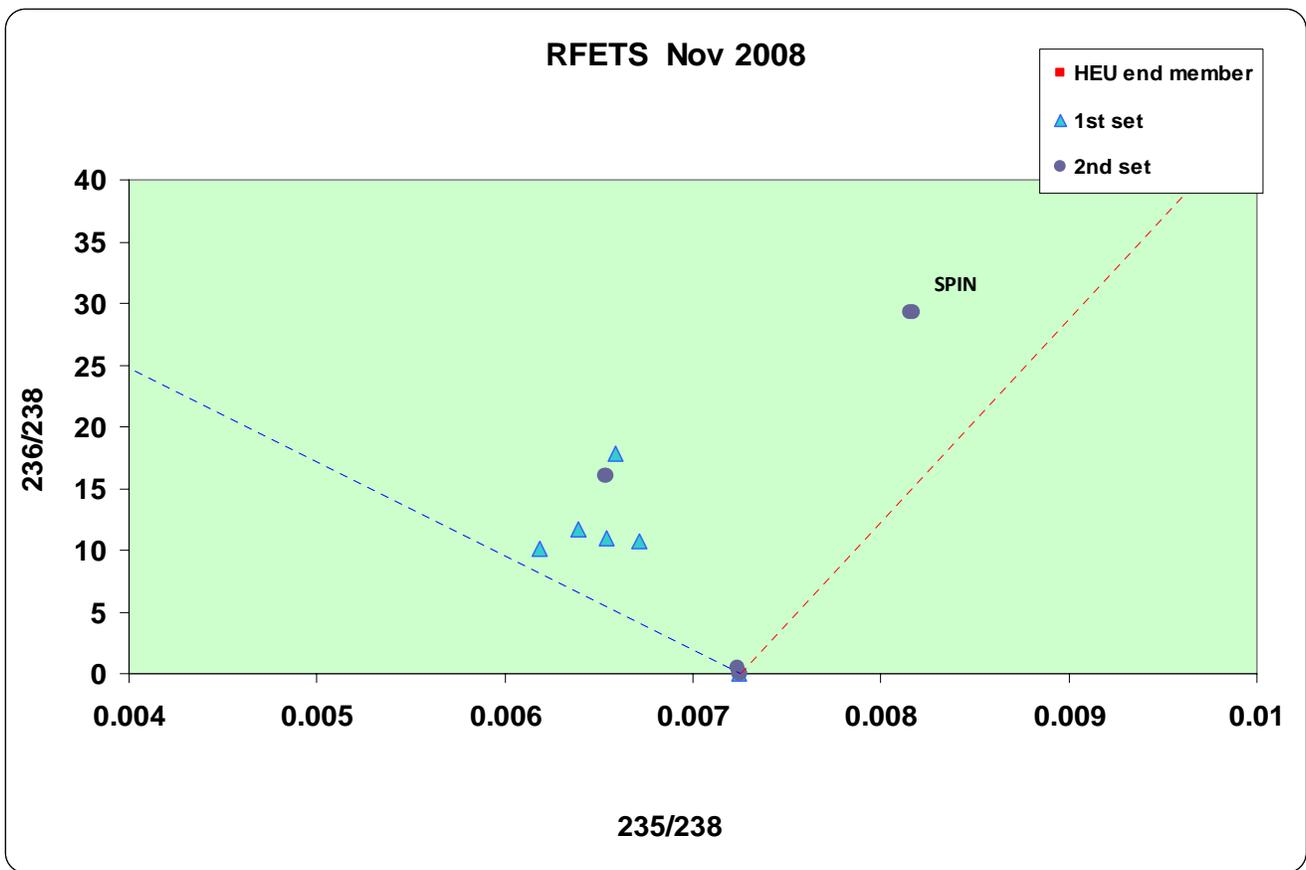


Figure 2. Plot of uranium isotopics for November analyses. Samples to the left of the NU reference point indicate the presence of depleted uranium. Samples to the right of the NU reference point indicate the presence of enriched uranium.

Table 2 Calculated isotopic end-member contributions

**normalized to %
end-member fractions**

Sample	Sample Locations	Sample Date	Easting	Northing	depleted	enriched	natural
11-9	SPIN	6/6/2008	2084827.03	751610.37	37.8%	0.29%	62.0%
11-10	POM2 2667/2673 dup	8/28/2008	2088254.97	750967.59	30.8%	0.09%	69.1%
11-11	Well 00193	8/25/2008	2088287.81	747794.06	0.0%	0.00%	100.0%
11-12	Well B206989	9/2/2008	2084835.33	753145.12	<0.1%	0.00%	99.9%
11-13	Well 15699	8/27/2008	2086150.23	750112.20	0.9%	0.00%	99.1%
11-14	POM2 - Pond B4	8/28/2008	2088254.97	750967.59	30.7%	0.09%	69.2%
11-15	SPIN	8/20/2008	2084827.03	751610.37	37.9%	0.29%	61.9%
11-1	Pond C2	9/16/2008	2089029.74	747596.95	24.4%	0.02%	75.5%
11-2	GS10	8/25/2008	2086741.25	750328.55	33.1%	0.11%	66.8%
11-3	Pond A3	9/16/2008	2088372.01	752508.64	25.3%	0.05%	74.7%
11-4	Pond A4	9/16/2008	2089713.50	753118.66	22.9%	0.05%	77.0%
11-5	Pond B5	9/16/2008	2089567.89	752066.43	21.1%	0.06%	78.8%
11-6	Pond C2 (2707)	9/16/2008	2089029.74	747596.95	24.3%	0.02%	75.7%
11-7	PLF Pond Eff	9/16/2008	2084591.23	752963.33	<0.1%	0.00%	99.9%

Discussion

These two sample sets include both surface water and well samples. Surface water samples included both streams and a selection of ponds.

Ponds A3, A4, B5 and C2 samples contained relatively low concentrations of uranium relative to the suite of samples analyzed from Rocky Flats site. The eastern ponds in a series (A4 and B5) contained the lowest concentrations with 0.6 and 0.8 ppb, respectively. Ponds A3 and C2 samples contained 5.9 and 4.8 ppb concentrations, respectively. Pond B4 samples contained higher concentrations of 32 ppb. Isotopically, these samples were similar, indicating just over 30% contribution of a depleted uranium end member in the Pond B4 samples and a range of 21% to 25% contribution of depleted uranium end-member in the A3, A4, B5 and C2 pond samples. Contributions of enriched uranium are low, with Pond C2 samples indicating the lowest at 0.02%, Pond B4 the highest among these ponds with 0.09% and the others indicating 0.05%-0.06%.

The pond sampled below the most recently active land fill on the site, labeled “plfpondeff” for Present Land Fill Effluent Pond, had a concentration of 2.6 ppb, no detectable uranium 236 isotope, a natural 238/235 ratio, and therefore, a totally natural uranium signature.

Stream sampling site GS10, in the South Walnut Creek drainage, has been sampled and analyzed five times for uranium isotopic compositions. The concentration of 15 ppb, in this latest sample from August 2008, is the highest yet observed from this location. The first sample analyzed from May 2002 was 9.6 ppb, with 13 ppb from August 2005, and 10 ppb from both samples in 2007 from July and October. Contributions of depleted uranium indicated have been relatively consistent from 2005 to present, between 29% and 36% in this set of sample analyses, with the August 2008 sample indicating 33%. Similarly, the indicated contribution of enriched uranium to all those samples is 0.1%. The initial

sample analyzed from May 2002 indicates a lower contribution of 22% and 0.04%, depleted and enriched uranium respectively.

Samples labeled SPIN contained slightly higher concentrations of uranium in August relative to June of 2008, 45 ppb versus 41 ppb. These concentrations are lower than measured from SPP Discharge samples (~60 ppb) in 2007 and 2008, and similar to a sample analysis from 2002. The concentrations are distinctly higher than from the close by surface water sampled previously from SW093 (10 ppb). The isotopic signatures indicate contributions of 38% depleted uranium and 0.3% enriched uranium in the SPIN samples. Again, this is similar to the 2002 sample from the SPP Discharge, but substantially lower than recent SPP Discharge samples which indicate contributions of approximately 60% depleted uranium and 0.4% enriched uranium.

Three wells samples were supplied for this sample set, from down gradient of the Present Landfill (well B206989), up gradient of Pond C2 (well 193), and up gradient of surface sample site GS10 (well 15699). For the sample from well B206989 in the area below the Present Landfill, the isotopics indicate a natural isotopics contribution, but highest concentrations among these sample sets at 97 ppb. Natural uranium and this concentration are consistent with previous sampling (December 2000) of this well and other high concentrations of uranium observed in wells from the northern and western parts of the Rocky Flats site. Well 193 in the Woman Creek drainage, south of the industrial site area, has been sampled and analyzed 5 times for uranium isotopics from June 1999 through the present sampling in August 2008. The latest sample had slightly lower concentrations than previous, with a consistent downward trend from 89.1 ppb from the June 1999 sample to 74 ppb from the August 2008 sample. Undetectable uranium 236 isotope is consistent with calculated contribution of 100% natural uranium and previous analyses. Well 15699 in the upper drainage of South Walnut Creek, directly east of the industrial site area, has not been previously analyzed for uranium isotopics. The uranium concentration in the sample from August 2008 was 33.2 ppb, a moderate value for Rocky Flats. That concentration is similar to samples from Pond B4 and approximately two to three times higher than samples from GS10 surface water, however, uranium isotopic from Well 15699 indicate only a small contribution (0.9%) of depleted uranium in comparison to the 22% to 36% contribution of depleted uranium in both GS10 and Pond B4 samples. None of these well samples indicated contributions from enriched uranium end-member.