Data Report:

URANIUM-233 DETECTED IN HANFORD REACH SEDIMENTS

November 04, 2003

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The RadioActivist Campaign (TRAC) conducted this study for Hanford Action of Oregon, supported by a grant from the Citizens' Monitoring and Technical Assessment Fund.

SUMMARY:

Sediment samples were collected from the F-Slough area to explore radiological anomalies. The background anomaly was europium-152 (Eu-152) reported in HANFORD RADIOACTIVITY IN SALMON SPAWNING GROUNDS, dated August 2002.

The sediment samples were gently tumbled to remove and collect "colloidal" contaminants sticking to sediment grain surfaces, thus leaving behind irrelevant analytical "noise" of natural radioactivity within sediment particles. The main purpose of this work was to obtain the first direct measurements of artificial uranium-233 (U-233) in the riverbed of the Hanford Reach.

Five samples of fine sediments were collected from the nearshore riverbed of the Hanford Reach, near F-Slough, on July 20, 2003. Mulberry leaves were collected from trees on shore, near two of the sediment sampling locations. One sediment sample, collected from Hanford Slough served as a "background" for the sediment analyses. Radiological results for the other four sediment samples and the two mulberry leaf samples are reported here.

Three samples (372008, 372010, and 372012) tested positive for U-233 in the range of one picocurie/gram. The U233/Eu152 ratio of these three samples was 0.6.

METHOD:

General sampling locations near F-Slough were selected on the basis of previous work, reported in HANFORD RADIOACTIVITY IN SALMON SPAWNING GROUNDS and in TROUBLE IN THE COLUMBIA RIVERBED. One sampling location (372012) was selected as an exact replicate. Others were selected to test and extend previous results. One sediment sample was to be collected from Hanford Slough, to serve as study background, while also checking Hanford Slough into this analytical schema.

Sediment samples were passed through a 2 mm screen, discarding large fractions irrelevant both to radiochemical processes in the riverbed and to Hanford wastes in the riverbed.

Experience has shown that the Hanford Reach riverbed is "radiologically dynamic." That is, *dis*equilibria of radionuclides in decay chains must be addressed. In consideration of TRAC's single in-house spectrometer, the sediment samples collected on July 17th had to be analyzed sequentially, one after the other. Therefore, the wet sediment samples were refrigerated in sealed bags for three weeks, so that subsequent analyses of the samples, one after another over one week, would not differentiate the samples appreciably.

Each wet sediment sample, of about 1500 g, was then weighed ("wet" weight tabulated, below) and split into one of two quart, square rounded bottles, filled with distilled water. The bottles were rotated horizontally at 6 rpm for 5 hours. The samples were then screened through an 0.475 mm sieve with distilled water flushing. The very fine sediments and the material thus extracted from the sediment surfaces was then evaporated quiescently to a paste and then oven dried <90 C, and weighed. That weight of dried "colloids" is the "dry" weight tabulated in the Results, below.

Each sample was counted for 23 hours in a highly stabilized sodium-iodide, photon detector, with an energy window of 5-3000KeV. Each of these initial spectra were checked to assure conformity for the work-in-progress. Then each sample was recounted for 23 hours, twice, at four day intervals. This allowed quality assurance checks that potential interferences from naturally occurring lead-210 (Pb-210), in the uranium-238 decay chain, were within bounds.

The primary interference is the strong photon peak from Pb-210 (lead-210) in the natural U-238 decay chain. That interference peak is at 46.5 KeV energy. I have to distinguish a weaker 42.4 KeV peak for U-233 analysis. The subtraction of Pb-210 involves counting the strength of Ra-226 (in the U-238 decay chain, but with most photon activity before Pb-210 removed). Then the Ra-226 spectrum (and hence Pb-210)

is subtracted accordingly. The check on this is that the residual U-233 peak does appear at lower energy than the eliminated Pb-210 peak.

Radioactive decay of Pb-210 emits intense (Intensity ~85%) gamma photons at 46.5 KeV energy. The present study seeks to clearly distinguish emissions from U-233 decay (at merely 13% Intensity) at 42.4 KeV energy (from relaxation of daughter, thorium-229, from its born-excited state). This distinction was made by reference to an appropriate "background" reference that included Pb-210 and then by one adjustment for the difference in Pb-210 activity between the sample and the background.

This distinction is crucial because the energy difference between detection of Pb-210 decay and U-233 decay is only 4.1 KeV, to be differentiated in a spectrometer having a photopeak width defined of 9 KeV (Full Width at Half Max = 3 channels).

The acquired spectra were transformed to constant photopeak width and three acquisitions added. The stated background and other reference spectra (including potassium-40, Eu-152, and Cs-137) were then subtracted, yielding final spectra that could be counted for U-233.

The U-233 counts in this report are based on the gamma intensities listed in C.M. Lederer and V.S. Shirley's TABLE OF THE ISOTOPES, 7th ed. (1978), p. 1411, in preference to more recent reports like Brookhaven's NUDAT.

Even with the most careful technique, considerations such as these increase the uncertainty of results. In the results reported here, uncontrollable, deterministic errors likely dominate. That is to say, random uncertainties as evidenced by "counting uncertainty" are far less than the known but uncontrolled, systematic errors. Please note, **the total uncertainty is stated at four times the "±" counting error tabulated in the Results, below**.

RESULTS:

U-233 = uranium-233, a transuranic, fissile product, used to nuclear weapons and other purposes. Halflife: 159,200 years.

Eu-152 = europium-152, a fingerprinting byproduct of U-233 production, resulting from neutron activation of a natural impurity in feed stocks (Eu-151). See HANFORD RADIOACTIVITY IN SALMON SPAWNING GROUNDS, pp. 9-11. Halflife: 13.5 years.

Cs-137 = cesium-137, a product of nuclear fission, either in nuclear reactors like those at Hanford or from fallout from atmospheric testing of nuclear weapons in the 1950s and 60s. Halflife: 30.2 years.

Material tumbled and rinsed off sediment grain surfaces.

Sample Number	Coordinates North 46°	West 119°	Location		
372011	35.470’	23.135’	Hanford Slu, HRM 25.3 west side		
wet/dry = 129					
No results reported: Sample used as background for colloids from sediments.					
372014	39.352’	26.140’	NW F-Slu, HRM 19.6 west side		
wet/dry = 104		U-233	=	–0.13 ±0.04	pCi/g(dry)
		Eu-152	=	0.07	“
		Cs-137	=	0.29 ±0.03	“
372008	38.780’	25.182’	Mid F-Slu, HRM 20.6 west bank		
wet/dry = 55		U-233	=	0.56 ±0.03	pCi/g(dry)
		Eu-152	=	0.91	“
		Cs-137	=	0.18 ±0.02	“
372010	37.967’	24.655’	Off F-Slu, HRM 22.0, west side river		
wet/dry = 85		U-233	=	2.22 ±0.04	pCi/g(dry)
		Eu-152	=	3.68	“
		Cs-137	=	0.95 ±0.03	“
372012	37.077’	24.617’	Downstream of F-Slu, HRM 23.0		
wet/dry = 87		U-233	=	2.29 ±0.04	pCi/g(dry)
		Eu-152	=	3.69	“
		Cs-137	=	1.12 ±0.03	“

Mulberry leaves, collected near two sediment sampling locations, above.

372008m	38.767’	25.190’	NW F-Slu, HRM 19.6, by 372008		
wet/dry = 2.9		U-233	=	0.076 ±0.017	pCi/g(dry)
		Eu-152	=	nd	
		Cs-137	=	nd	
372012m	37.080’	24.627’	Off F-Slu, HRM 22.0, by 372012		
wet/dry = 3.8		U-233	=	nd	
		Eu-152	=	nd	
		Cs-137	=	nd	

“±” one standard deviation counting error. **The uncertainty & minimum detection level for this study is 4 times the listed “±” value.**

nd not detected.

See <www.radioactivist.org/reports.html> for cited TRAC reports.