

On the UNEP and Green Audit measurements
of Uranium in water and soil samples in
Lebanon.

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Background

Two previous papers by Green Audit reported the results of environmental measurements on Uranium isotopes in samples taken from areas of Lebanon where Israeli bombing attacks had occurred (Busby and Williams 2006, 2006a).

Beta counting and CR39 track analysis were used to screen samples for excess alpha and beta radioactivity. Samples which were shown to be more radioactive than the background were sent for laboratory analysis by Inductively Coupled Plasma Mass Spectroscopy (ICPMS) and by gamma and alpha spectrometry. In general, there was evidence of the use of enriched Uranium with isotopic ratios of between 108 and 123 in soil samples, water samples from Khiam in South Lebanon, and material in an ambulance air filter from South Beirut. A crater in Khiam (crater A) had been reported to be radioactive by Dr Khobeissi of the Lebanese National Council for Scientific Research in September 2006. It was this report that prompted Green Audit to ask Dai Williams to visit Lebanon and obtain a sample of soil for analysis. Later, Williams was to return to the craters in Khiam and obtain more samples. This second mission coincided with a mission of the post conflict assessment team of the United Nations Environment Programme (UNEP) to the same area of Lebanon.

By this time the crater had been filled in but it was dug out again to enable the UNEP team to obtain soil samples for analysis at the Swiss Spietz laboratory. UNEP's results were published recently (UNEP 2007).

This short note examines the UNEP results and presents data for water and soil samples examined by Green Audit which were taken from Khiam in November 2006. Whereas the Green Audit results reported enriched Uranium, UNEP reported Uranium with a normal or natural isotopic signature.

UNEP Results

Alerted by newspaper reports of the Green Audit finding of enriched Uranium, UNEP revisited the Khiam site on 20th November and took soil and water samples. The Results given for the UNEP soil samples reported recently (UNEP 2007) are given in Table 1 below with isotopic ratios. Concentrations have been converted to activity on the basis of a conversion factor of

- U238: 12.4 MBq/kg,
- U235: 80MBq/kg
- U234: 230,000MBq/g.

In addition, UNEP took a water sample from the one of the Khiam craters. The result from the UNEP report is given in Table 3.

At the same time, whilst the UNEP team were there, and in discussion with them, Dai Williams obtained soil and water samples. These were brought to England and analysed using ICPMS at the Harwell Laboratory.¹

¹ Scientificals Ltd. Building 551S, Becquerel Avenue Harwell Int'l Business Centre Didcot Oxon.

Table 1 UNEP soil sample results.

| Sample* | U238 mg/kg | U238 Bq/kg ** | U235 mg/kg | U235 Bq/kg** | Isotope ratio |
|---------|---------------|------------------|---------------|-----------------|------------------|
| Soil 1 | 27.2 | 338 | 0.193 | 15 | 141 |
| Soil 2 | 21.0 | 260 | 0.150 | 12 | 140 |
| Soil 3 | 3.5 | 43 | 0.025 | 2 | 140 |
| Soil 4 | 20.8 | 258 | 0.149 | 12 | 139.5 |
| Soil 5 | 14.2 | 176 | 0.101 | 8 | 140.5 |
| Soil 6 | 35.1 | 435 | 0.249 | 20 | 140.9 |
| Soil 7 | 42.5 | 527 | 0.304 | 24 | 139.8 |
| Soil 8 | 52.4 | 650 | 0.372 | 30 | 140.8 |
| Soil 9 | 19.2 | 238 | 0.137 | 11 | 140.1 |

* samples were labelled NUC-2006-030-00001 to 00009 and are labelled here soil 1 – 9.

** derived as described in text above.

Table 2 UNEP soil sample total Uranium activity and U-234 ratio

| Sample | U238 Bq/kg | U235 Bq/kg | U234 Bq/kg | U234/U238 activity |
|--------|---------------|---------------|---------------|-----------------------|
| Soil1 | 338 | 15 | 295 | 0.87 |
| Soil 2 | 260 | 12 | 231 | 0.88 |
| Soil 3 | 43 | 2 | 38 | 0.88 |
| Soil 4 | 258 | 12 | 211 | 0.82 |
| Soil 5 | 176 | 8 | 160 | 0.9 |
| Soil 6 | 435 | 20 | 396 | 0.9 |
| Soil 7 | 527 | 24 | 488 | 0.92 |
| Soil 8 | 650 | 30 | 603 | 0.92 |
| Soil 9 | 238 | 11 | 187 | 0.78 |

Table 3 UNEP water sample from Khiam

| Sample | U238 ng/ml | U235 ng/ml | Isotope Ratio |
|--------------------|------------|----------------|------------------|
| NUC-2006-030-00010 | 5.30 ±0.17 | 0.0377 ±0.0013 | 140.6 |

Table 4 Green Audit (Harwell ICPMS) results for Lebanon water samples taken on 20th/21st November (results are in µg/l). Data as given in Harwell Results Tables (D represents duplicate run on same sample).

| Customer Reference | Laboratory Reference | U-238 | U-235 | U Total | Ratio (238/235) |
|--------------------------------|----------------------|-------|--------|---------|-----------------|
| | Limit Of Detection | 0.04 | 0.003 | | |
| LBW#2 Beirut | EF2725 | 0.4 | <0.003 | 0.4 | NC |
| LBW#2 Beirut | EF2725D | 0.3 | 0.005 | 0.31 | NC |
| LBW#3 Khiam crater B | EF2726 | 6.4 | 0.060 | 6.46 | 109 |
| LBW#3 Khiam | EF2726D | 6.4 | 0.060 | 6.46 | 108 |
| LBW#4 Khiam crater A | EF2727 | 4.0 | 0.040 | 4.0 | 102 |
| LBW#4 Khiam | EF2727D | 4.3 | 0.041 | 4.3 | 107 |
| QC Standard µg.L ⁻¹ | Expected | 5.0 | 0.011 | NM | 455 |
| QC Standard µg.L ⁻¹ | Found | 5.3 | 0.012 | NM | 442 |
| QC Standard µg.L ⁻¹ | Expected | 10 | 0.022 | NM | 455 |
| QC Standard µg.L ⁻¹ | Found | 8.8 | 0.020 | NM | 440 |
| QC Standard µg.L ⁻¹ | Expected | 20 | 0.044 | NM | 455 |
| QC Standard µg.L ⁻¹ | Found | 21 | 0.046 | NM | 457 |

Table 5 Green Audit (Harwell ICPMS) results for Khiam crater soil samples. (D represents duplicate run on same sample). (mg/kg and Bq/kg).

| Sample description | mass U238 | Activity U238 | mass U235 | activity U235 | U238/U235 |
|--|-----------|---------------|-----------|---------------|-----------|
| 16 Sept. Khiam crater soil from house balcony | 13 | 161.2 | 0.12 | 9.6 | 108 |
| 16 Sept Khiam crater soil from house balcony D | 13 | 161.2 | 0.12 | 9.6 | 108 |
| 20 Nov. Khiam soil from inside crater A | 25 | 310 | 0.18 | 14.4 | 141 |
| 20 Nov. Khiam soil from inside crater A D | 34 | 421 | 0.25 | 20 | 137 |
| 20 Nov. Khiam surface soil under tree | 13 | 161 | 0.11 | 8.8 | 125 |
| 20 Nov. Khiam surface soil under tree D | 14 | 174 | 0.085 | 6.8 | 161 |

Discussion

The water samples

On November 20th, during its second mission, Dai Williams took three water samples. One was from the base of the crater in Khiam which had originally been investigated by Dr. Khobeissi. It had been filled in but was re-excavated with a digger to enable the UNEP team also to take samples. The water was seen to be seeping back into the hole once the infill was removed. UNEP took a sample from the same place at the same time; in fact Green Audit's sample was taken by a UNEP technician and handed to Dai Williams. Thus the UNEP analysis (Table 3) and the Harwell analysis LBW#4 are of the same sample. The second GA water sample was taken from a much larger crater 20 metres from the first. It too had been filled in but was not re-excavated. The sample LBW#4 was taken from a pool of water standing on top of the infill. It is known that UNEP took additional samples in the area but only one is reported (Table 3). The third sample LBW#2 was taken from the Haret Hreyk area of Beirut.

Harwell conducted two determinations on each of the Green Audit samples from the two craters. For concentrations of total Uranium the results largely agree with the UNEP Khiam water result; Spietz (UNEP) gives 5300ng/l, while Harwell (Green Audit) gives between 6400ng/l and 4000ng/l.

However, whilst Harwell gives isotopic ratios of 102 to 109, indicating a significant excess of U235 (enriched Uranium), the Spietz result for their single sample was given as 140.6 (a non-significant deficit of U235). This anomaly is extraordinary, given the accuracy of the instruments used by the two laboratories. The discrepancy remains to be explained.

Harwell has made measurements for the UK Ministry of Defence and one of us (CB) has access to the results of all these measurements. Harwell are able to consistently measure isotopic ratios around the natural one of 137.88 in urine solutions containing less than 5ng per litre of total Uranium with an accuracy of ± 5 units in isotopic ratio. Thus it was agreed in the Depleted Uranium Oversight Board (DUOB) that for total urine Uranium levels of greater than 10ng/ litre, isotopic ratios of over 142 and below 136 represent evidence of depleted or enriched Uranium. Harwell have made over 400 measurements which show urine Uranium ratios in individuals within the range 136 to 142 for total Uranium levels with a mean of about 5ng/l. In the water sample measurements, the total amounts of Uranium are more than 5000ng/l. For these reasons the accuracy of the isotope ratio results given in Harwell's analyses of the Lebanon material is beyond question.

We can only conclude that the Spietz analysis of the UNEP water sample does not correspond to the sample they gave to Dai Williams. The only difference apparent is that Spietz filtered the water samples (the filter pore size is not given) while Harwell did not. Therefore if there were enriched Uranium in large particles which did not pass the Spietz filtration this might conceivably explain the discrepancy.

The soil samples

The first trip to Khiam undertaken by Dai Williams in September yielded a soil sample which tested at Harwell for enriched Uranium with an isotopic ratio of 108 (see Table 5). This sample was a piece of earth which had been thrown on to the balcony of an adjacent house and was assumed by Dai Williams to come from the small crater (crater A) near this house. Williams recorded Khobeissi taking a gamma reading of 725 nSv/hr in this crater, compared with a background of 30nSv/hr. A section of this sample was also tested by the radiochemical laboratory of the School of Ocean Sciences, University of Wales which used alpha spectrometry and confirmed that it contained excess total Uranium and an isotopic signature which indicated enriched Uranium (117). David Assinder, who tested the sample, has an international reputation as an expert in measurement of environmental radiation. Thus we have two separate UK labs with two separate techniques confirming high Uranium and enriched Uranium in the same sample.

Dai Williams's second visit to Khiam yielded several new samples of earth of which two have so far been tested. The first of these was from the original crater which, as previous noted, had been filled in but was re-excavated on the day of sample collection. The second was blackened crater soil taken from the undisturbed ground under a tree within 5 metres of the sample taken on the first trip (the house has since been demolished) and 15 metres east of the much larger crater (crater B, also filled in). As described above, both yielded water samples containing enriched Uranium with an isotopic ratio (107) very close to that of the soil samples from the first trip (108). However, analysis of both of the second trip soil samples shows some

curious results. The one from the infill of the first crater gave a natural isotopic signature but with a high total concentration of Uranium. The second, from the crater across the road also gave high levels of total Uranium but levels of 125 and 161 for two separate determinations from the same sample. Harwell were unable to explain this.

It is hard to explain the existence of enriched Uranium in water inside a crater where the soil samples above the water show natural Uranium. It may be relevant that when Dai Williams arrived at the crater in November, it had been filled in with rubble and soil and had to be re-excavated to obtain samples. It was the soil material that had been excavated that tested for natural Uranium, whilst the groundwater that seeped back into the freshly excavated pit tested for enriched Uranium.

Levels of Uranium in the environment

Water

The levels of Uranium in the water samples from Khiam are between 4000 and 6400ng/litre. This can be compared with results from the Atomic Weapons Establishment environmental borehole data for Uranium in water (AWE 1998-2004). These measurements never exceed the limit of sensitivity of the method used which is 240ng/l. Surface water contamination by Uranium measured inside the perimeter of the atomic weapons establishment Burghfield where Uranium is a major component of the process of weapons assembly and where the ground is contaminated as a result of over twenty years of usage can sometimes give levels that are as high as 2000ng/l. We therefore conclude that the groundwater contamination by Uranium in the region of the Khiam craters is significant.

Rock/ soil

Levels of Uranium in soil are given in Eisenbud and Gesell 1997. Table 6.5 gives a mean of 16Bq/kg for limestones, which are the base geology of the area of southern Lebanon, and this is supported by a measurement made by Harwell on a sample from At-Tiri which we sent for analysis which gave 11Bq/kg. In Table 6.6 of Eisenbud and Gesell 1997, adapted from a table given by the US National Council for Radiological Protection, the range of Uranium in all rocks is given as 7-60 and the mean in carbonate rocks as 25. The authors state, 'examples of materials outside this range can be found but are relatively small'. Thus the levels found in the soil samples by both UNEP and Harwell and SOS Bangor of between 160 and 600Bq/kg indicate levels which are between 10 and 20 times too high for normal Uranium levels. UNEP in their conclusions argue that the 'concentrations of Uranium are elevated but have a natural composition and originate from the region'. These high levels were found in all but one soil sample by UNEP and in all but one soil sample by Harwell. Unless the normal levels of Uranium in soil in southern Lebanon are unusually high we must conclude that there has been significant contamination of southern Lebanon by Uranium weapons.

Isotopic Ratios

We are unable to explain the isotopic ratios reported by the Spietz laboratories. Their U234 ratios indicate the presence of depleted Uranium DU in most of their samples (see below). Their U235 measurements also indicate the presence of Depleted Uranium, although less than those indicated by the U234 ratios. The Khiam crater gave a significantly elevated gamma ray exposure measurement when it was first visited by Khobeissi. There was therefore something radioactive inside this crater.

There is more evidence from looking closely at the UNEP results for U234, which they have not referred to. The activity ratio of U234 to U238 in natural samples should be 1.00 since U234 is in secular equilibrium with U238. If the U-238/U-234 ratio is not 1.00, the sample is not natural undisturbed Uranium. Indeed, it is curious that UNEP have not employed the U234/U238 ratios in the measurements they made in Lebanon since they did employ it in Kosovo to determine DU contamination. Applying this method to the Lebanon sample results they give (Table 2 above) enables us to calculate that the concentrations of DU in their samples are between 20 and 30%. It is interesting that for the Lebanon study they changed their method and used U235 ratios and not U234 ratios: the latter give higher DU levels.

In 2001 Busby criticised UNEP's Kosovo reports at a European Parliament conference and in a report to the Royal Society. UNEP's first report denied the presence of DU. Later Busby visited Kosovo with Nippon TV and took samples which were analysed by Assinder at SOS Bangor, as reported by Nippon TV and BBC's *Newsnight*. UNEP then undertook a second mission and found DU. They then argued however that there was no DU at levels which might represent a health hazard. The results tables were not presented to the Press Conference in Geneva and these tables quickly disappeared from the UNEP website and cannot now be located (although Green Audit has a copy which was downloaded from the Website the day after the Geneva Press conference).²

We have long argued that the US may have been deploying large missiles and bombs which contain penetrator warheads containing large amounts of Uranium. Relevant warhead technologies are indicated by unclassified military sources and US patent records (Williams 2002). With the increasing concern about the health effects of Uranium on civilian populations it would seem prudent for the military to develop some way of camouflaging the use of such weapons. With the scientific and technological advances which have occurred since the first use of Depleted Uranium in Gulf War 1 in 1991, it has been increasingly impossible to deny using DU, since this can be easily established by urine and environmental measurements using ICPMS. Therefore a clear alternative is to deploy weapons with penetrators made from natural Uranium. Retrospective examination of areas where such weapons had been used would find only natural Uranium signatures which could be put down to environmental Uranium. UNEP report the presence of natural Uranium in a smear sample they took from the inside of metallic bomb casings which they examined in Lebanon, though they ascribe this to soil contamination. The quantities are significantly high.

A different way of effecting the same result would be to employ some bombs which contained a quantity of enriched Uranium. Some time after a war, the mixture of Uranium isotopes might then approximate to a natural isotopic signature. Such enriched Uranium weapons might be novel experimental weapons. One possibility is that Uranium is being used as the "reactive metal" in the new SFAE's (Solid Fuel Air Explosives) used in the new generation of thermobaric weapons deployed by US forces since February 2002 and witnessed during IDF attacks in Lebanon. Others have suggested a miniature deuterium cold fusion neutron weapon. Measurements made by Durakovic in Afghanistan and by the UK Ministry of Defence on GW2 veterans in 2003 show high levels of Uranium in urine of those involved, but with a natural signature (Busby 2006). The US did not permit the IAEA to enter Iraq with measuring instruments after GW2 for several months and eyewitnesses report the US

² UNEP has recently been able to supply paper copies but has not been able to restore the electronic version to their web sites. We are told that they will continue to look for the data.

military excavating bomb craters and removing soil and other material from impact sites and trucking the material into the desert. Why would they do this? What is certain from our results is that enriched Uranium is present in Lebanon. We have evidence from two water samples, an ambulance air filter and a soil sample from a radioactive crater measured using different techniques by two different laboratories. If both undepleted and enriched Uranium bombs were used in Lebanon, then this could conceivably explain the soil results from UNEP. Nothing can easily explain the UNEP water sample result.

The Final UNEP report

As this paper was being completed the final UNEP report was published on the Post Conflict website. It is a highly designed document with many photographs. However it is unsatisfactory in content and shows clear evidence of bias against conceding that the Lebanon is contaminated with Uranium. UNEP states that there was no use of Depleted Uranium or other Uranium weapons in Lebanon. On p151 of the report UNEP, referring specifically to the Khiam crater, states ‘the analysis of the soil sample showed 26.2 ± 0.7 mg U238/kg with an isotope ratio U235/U238 of 0.00722 ± 0.00001 ’. This isotope ratio represents a U238/U235 ratio of 138.5 and would be considered natural Uranium. The concentration is very high however — about 325Bq/kg. The point is that no such sample was reported in UNEP's Khiam soil sample results published on 15 January and given in Table 2. Table 2 results include measurements from within 70 m of the crater, not measurements solely from within the Khiam crater. Yet it is easy to see that the figure of 26.2 is exactly the mean of the nine measurements presented in Table 2. This extraordinarily improbable coincidence is clear evidence of misdirection, spin and untruth. Let us be clear; UNEP's report is presenting as the measure of soil Uranium content in the Khiam crater the mean value of nine readings of soil Uranium taken from up to 70 metres away. This is a serious matter and should be investigated. UNEP's own soil data provides clear evidence of high levels of uranium directly associated with the crater. We are continuing our analyses of this and other anomalies between the UNEP data and the UNEP reports.

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