Did the use of Uranium weapons in Gulf War 2 result in contamination of Europe? Evidence from the measurements of the Atomic Weapons Establishment, Aldermaston, Berkshire, UK.

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Abstract
Uranium weapons have been increasingly employed in battle action since their first use by the US and UK forces in the Persian Gulf War in 1991. Since then they have been used in the Balkans in the late 1990s, then Kosovo in 2000, probably in Afghanistan in 2002 and then also in the 2nd Gulf War (GW2) in March and April 2003. On impact, uranium penetrators burn fiercely to give an aerosol of sub micron diameter oxide particles which are largely insoluble and remain in the environment for many years. There is considerable public and scientific concern that these radioactive particles may remain suspended for long periods, or may become resuspended and are therefore available for inhalation by non combatants at some distance from the point of impact. Little research seems to have been carried out on the distance travelled by the uranium aerosols. The military maintain that the uranium remains near the point of impact, and the Royal Society report (2002) also states that the material does not travel more than some tens of metres. On the other hand, measurements of uranium in local populations in Kosovo some nine months after the use of uranium weapons all tested positive for depleted uranium in urine (Priest 2004) and The United Nations (UNEP) found uranium particles in air filters in Bosnia some years after its use. The question of the dispersion of uranium aerosols from the battlefield is of significant legal interest, since if a radioactive weapon resulted in the general contamination of the public in the country of deployment or elsewhere, the weapon would be classifiable as one of indiscriminate effect.

There is now conceded to be no safe level of exposure to radiation. Further, there are major scientific questions over the risk models used to assess the health effects of uranium particle exposure from weapons use. In addition there is evidence of ill health in many of those exposed to uranium particles from Gulf veterans to the population of Iraq. In this paper we examine the trend in uranium shown by the measurements made on high volume air sampler filter systems deployed by the Atomic Weapons Establishment (AWE) Aldermaston Berkshire UK. AWE have been routinely monitoring uranium in air since the early 1990s but since 2000 have carried out filter determinations from high volume air samplers (HVAS) every two weeks. They were required to set up these monitors in the late 1980s following the discovery of a child leukaemia cluster near the plant. There are monitors onsite but they also deploy them at various other sites some 15km distance from the plant. We have obtained their results using the Freedom of Information Act. Examination of the trends in uranium reported here show that there was a statistically significant increase in uranium in all the filters beginning at the start of GW2 and ending when it ended. Levels in the town of Reading exceeded the Environment Agency Reporting threshold of 1000nBq/m^3 twice during the period. We report the weather conditions at the time and show that over the period there was a consistent flow of air from Iraq northwards and that the UK was in the centre of a anticyclone which drew air in from the south and from the south east. On the basis of the mean increase in uranium in air of about 500nBq/m^3 we use respiration data on standard man to calculate that each person in the area inhaled some 23 million uranium particles of diameter 0.25 microns. We suggest that health data, particularly birth data be examined for possible effects from this exposure. As far as we know, this is the first evidence that uranium aerosols from battle use have been shown to travel so far.
Keywords: uranium, depleted uranium, particles, Gulf War 2, geophysical, dispersion, Aldermaston

Introduction

Depleted Uranium weapons have been employed in battlefields at least since the first Persian Gulf War in 1991. Since then, and since their further use in the Balkans in the late 1990s and possibly Afghanistan in 2002, there have been arguments about the health effects of exposure to the uranium oxide aerosols which are produced when the uranium burns in air upon impact. On the one hand, conventional assessments based on the radiological arguments of the International Commission on Radiological Protection (ICRP) have led to most official agencies and government departments to state that uranium exposure at the levels likely to occur after its use in battle is too low for any significant or measurable health effect. But further, it is argued that populations are not even exposed: contamination of the environment is localised to the positions where the strikes occurred.

On the basis of these two arguments, the many reports of widespread ill health in areas where Depleted Uranium weapons have been used have been discounted by such authorities and thus the military have been absolved thereby of having used a weapon of indiscriminate effect. This is an important ethical, if not legal point since such use is similar to the use of chemical or biological weapons and is banned by the Geneva Convention. Regarding the radiological issue, the European Committee on Radiation Risk (ECRR) an independent radiation risk agency based in Brussels has published a risk model which draws attention to the inadequacy of the ICRP radiation risk models for dealing with the health consequences on internal radionuclides (ECRR2003). The concerns of ECRR have recently been echoed by the French IRSN agency who have agreed that the ECRR questions over the adequacy of the ICRP model for internal exposures to e.g. uranium are valid. (IRSN2005). The errors in the ICRP model, which is based on external irradiation following an acute large dose, are particularly important when considering internal radioactive particles and DNA seeking isotopes. The uranium weapons aerosols are in both these categories since the particles have mean diameters below 1 micrometer and are respirable and when translocated to the tissue from the lungs via the lymphatic circulation can cause high uranium ion concentrations in cells. Uranium as uranyl ion UO2++ has enormous affinity for DNA phosphate. The affinity constant is about 10^{10}, (Nielsen 1992) and uranium stains have been used for DNA imaging in electron microscopy since the 1960s (Zobel et al 1961, Huxley and Zubay 1961). Recently, one of us has pointed out that the uranium may focus external natural background radiation on the DNA and enhance its radiological effect. (Busby 2005, Busby 2005b).

There is considerable evidence that uranium is genotoxic and carcinogenic and is associated with a whole range of harmful health effects. However, this brings us to the second main point made about uranium weapons, that of the particle dispersion and possible exposure of those who are at some distance from the impact point, including non-combatants. The environmental dispersion of uranium particles after any battlefield use is a matter of considerable interest. However, little attempt has been made by any official agencies to determine this dispersion of uranium aerosols; rather it has merely been stated that the material remains near the site of impact and cannot contaminate those who are further than some tens of metres from this point.

Since the 1990s, measurements of uranium in high volume air sampling filters have been routinely made by the Atomic Weapons Establishment at Aldermaston in Berkshire, UK. The requirement to measure uranium and also plutonium followed a public enquiry in the early 1990s into releases of these substances to the local environment and the concerns of local people following the discovery of significant excess childhood leukaemia in the area around the plant (for a discussion and the main papers see Beral et al 1990). AWE made environmental measurements of radioactive contamination both on and offsite at various intervals. By 2000 they were routinely (generally at two week intervals) measuring alpha and beta activity in cloths (passive airshades) and also uranium and plutonium in high volume air samplers. These measurements were made onsite and offsite at various locations shown on the map in Fig 1 and were intended to monitor the releases of uranium from the AWE site. The offsite control locations were some considerable distance from the plant. Thus comparison of levels of radiation at these various sites enables the detection of discharges from the AWE sites.

The annual publication of the results of these measurements was discontinued in 1999 but the monitoring was continued, the results apparently being reported to the UK Environment Agency. It occurred to us to examine these data for any evidence of uranium from the Gulf War 2 which began in March 2003. The question we wish to address is whether uranium aerosols from the bombing of Iraq in March 2003 became sufficiently environmentally dispersed to reach Europe. In 2004 we applied to AWE for access to these data but the data were not released to us. In January 2005, the Freedom of Information Act (FOI) became UK law. A formal application under the FOI to AWE for results from 2000 to 2004 resulted in the release of the data on paper but curiously the period covering Gulf War 2, that is, early 2003 was the only section missing.

Re-application resulted in a long wait, and then eventually we received these data from the Defence Procurement Agency in Bristol, and not from AWE. We report here the trend in uranium in high volume air samples on site and near the AWE Aldermaston as shown by these data.

Method

Sampling at AWE was reported for various control sites, shown on the map in Fig 1 and listed in Table 1. Not all sites were continuously operating over the whole period we are interested in and so we decided to examine the trends in Hannington, Thatcham, Silchester and Reading, four sites for which the monitoring results were most continuous. The distance in kilometers from AWE for each of these sites is given in Table 1.

We reduced the HVAS Uranium in air data to nBq/m^3 and examined the trends by plotting the data obtained every two weeks from the beginning of 2000 to the end of 2003 for each of the four sampling sites and also for the onsite HVAS detectors. We also made statistical tests on the main excursions from the mean levels, particularly the excursion associated with the period at the start of the Gulf War 2.

Table 1 Approximate distance and direction of the offsite high volume air samplers (HVAS) from the AWE site

Sampler	Direction from AWE	Approximate Distance km
Hannington	SW	12
Thatcham	WxN	12
Silchester	E	3
Reading	NE	13

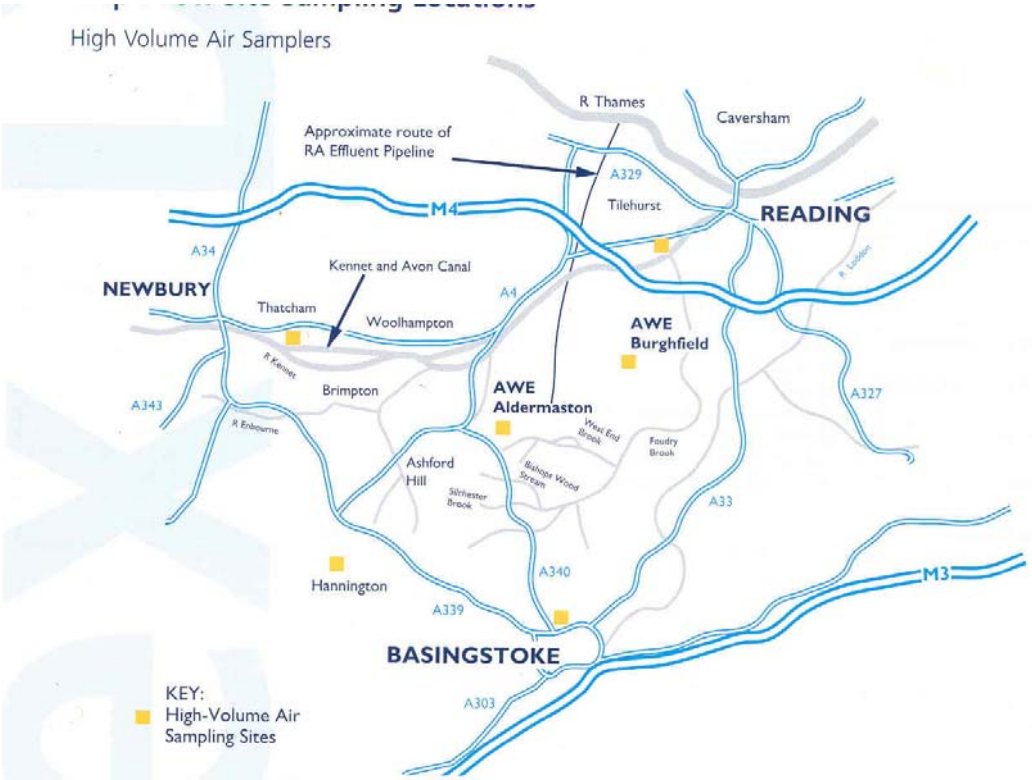


Fig 1 Sampling sites for High Volume Air Samplers in the vicinity of the Atomic Weapons Establishment, Aldermaston in the 1997 report.

Results

The Trend in uranium in air over the whole period is shown in Fig 2 where all the samplers are separately plotted. In Fig 3 we show the period immediately before and after the Gulf War 2 'Shock and Awe' US bombing of Iraq which began on 19th March 2003. The excursion shown in uranium in the air samplers was statistically significantly different from the mean value and in the case of Reading exceeded the 1000ng/m^3 statutory limit above which the Environment Agency has to be informed

In Table 2 is given the offsite and onsite levels over a short window either side of the Shock and Awe bombing. Table 3 gives the timeline for the Gulf War 2 bombing. Table 4 shows some statistical data for the results.

Fig 2 Uranium in air (nBq/m^3) as shown by HVAS data points (*mostly) at two week intervals from 1998 near the Atomic Weapons Establishment, Aldermaston at four offsite and four onsite positions, R001, R002, R007 and R009. The two major excursions are labelled Gulf War 2 and Afghan Tora Bora. (* before 2000 measurements were taken at longer intervals).

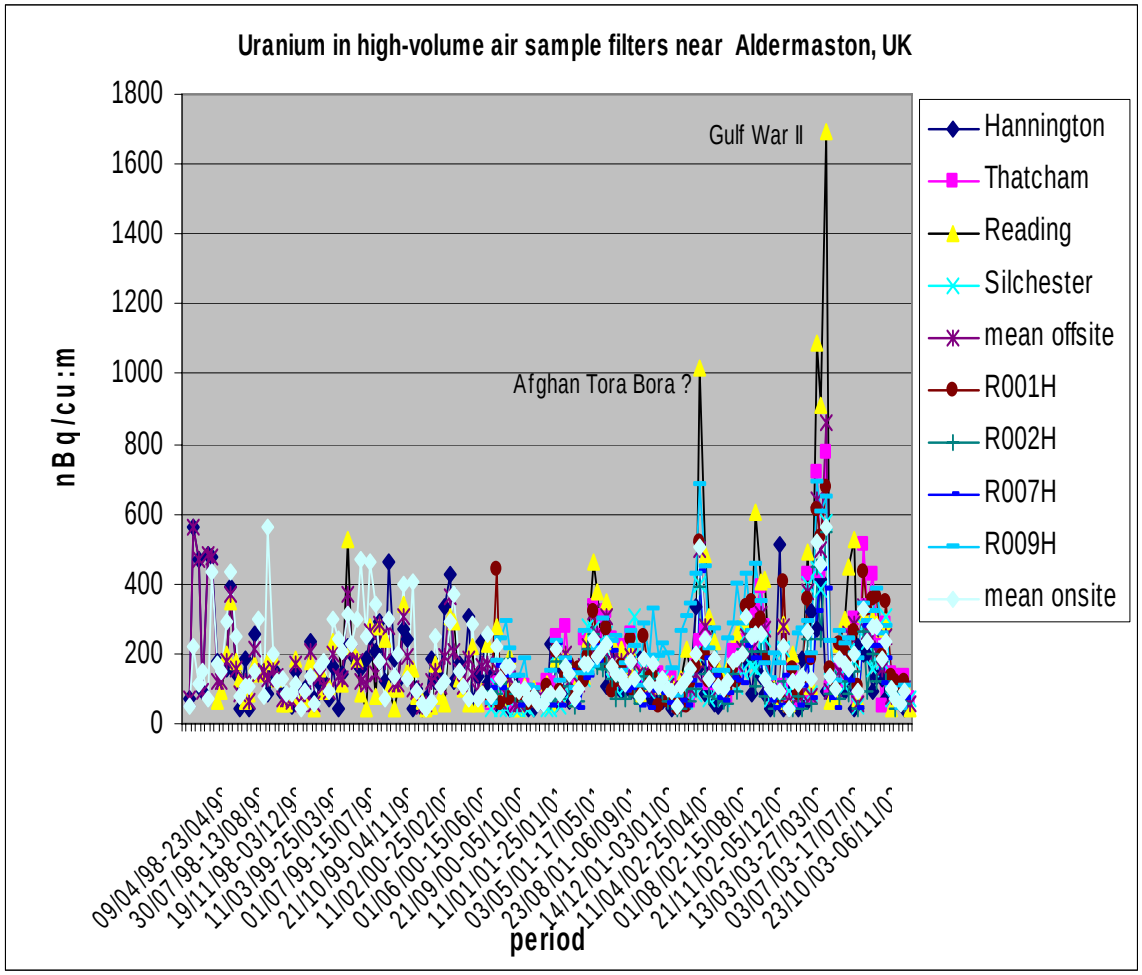


Fig 3 Uranium in air (nBq/m^3) over the period of the US 'Shock and Awe' campaign of bombing as shown by HVAS data points near the Atomic Weapons Establishment, Aldermaston at four offsite and four onsite positions, R001, R002, R007 and R009. Legend colours as for the positions in Fig 2.

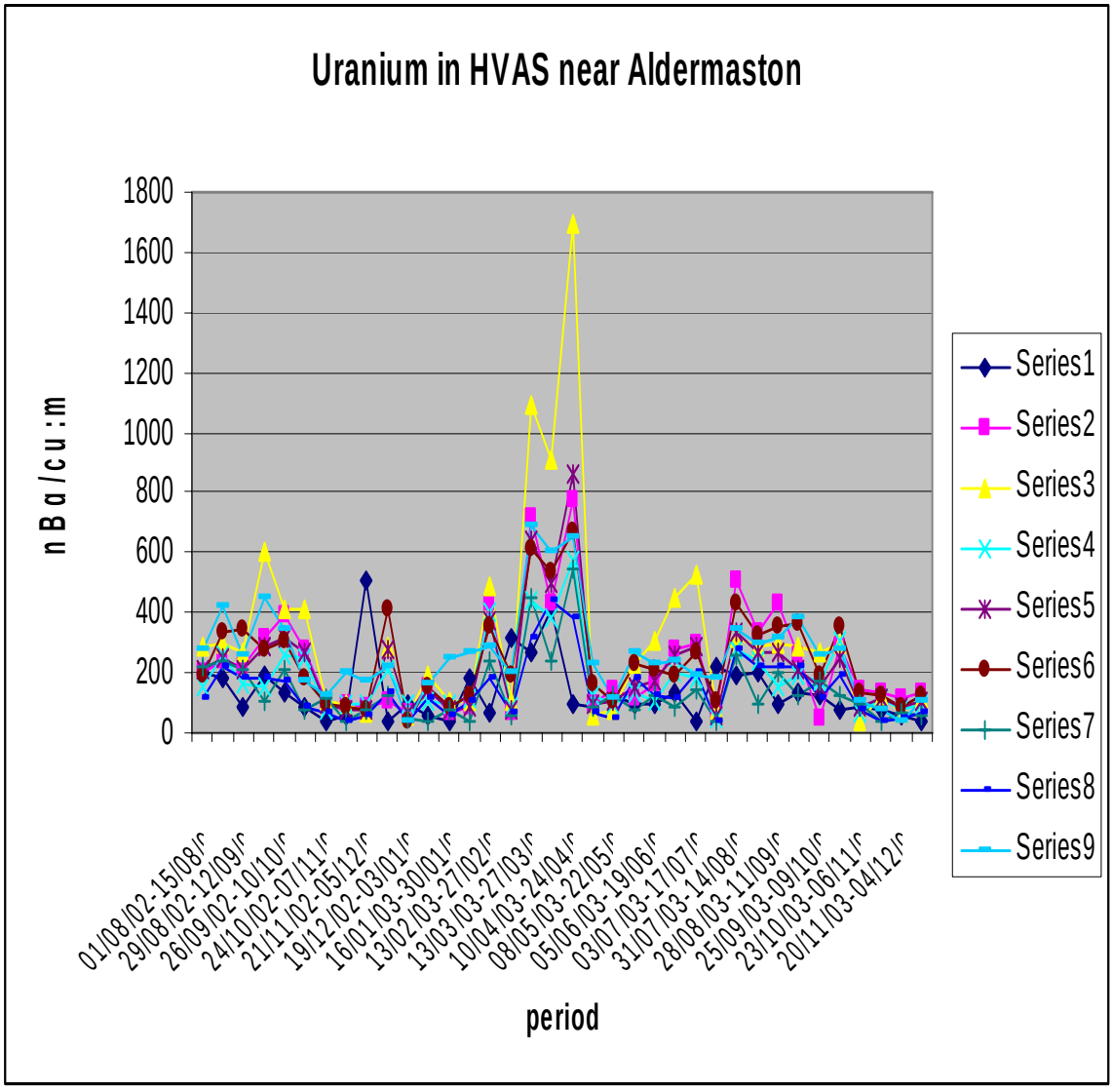


Table 2. Mean uranium in air in offsite and separately onsite high volume air samplers near AWE Aldermaston UK over period of the Gulf War 2, 'Operation Iraqi Freedom'. The first major bombing was on 19th March. War period is right justified in column 1.

Filter collection period	Onsite mean level nBq/m^3	Offsite mean level nBq/m^3
19/12/02-03/01/03	41.5	64.75
02/01/03-16/01/03	118	139.25
16/01/03-30/01/03	117	80.5
30/01/03-13/02/03	134.75	86.5
13/02/03-27/02/03	266.75	375.75
27/02/03-13/03/03	129.25	81
13/03/03-27/03/03	516.75	642.25
27/03/03-10/04/03	456.5	498.5
10/04/03-24/04/03	563.25	863.75
24/04/03-08/05/03	137.5	94.75
08/05/03-22/05/03	98	102.75
22/05/03-05/06/03	188	149.75
05/06/03-19/06/03	171	168
19/06/03-03/07/03	159.25	255
03/07/03-17/07/03	201.5	283
17/07/03-31/07/03	92	57.25
31/07/03-14/08/03	329	331.75

Table 3 Gulf War 2 Timeline

Date	Event
01/03/03	Unofficial missile targeting of Iraqi radar and other military installations occurred throughout early March 2003
19/03/2003	President George W Bush declares war on Iraq at 5.30 am Baghdad time when US launches Operation Iraqi Freedom. Called a 'decapitation attack' the initial air strike attempted to target Saddam Hussein and other leaders in Baghdad
20/03/2003	US launches second round of air strikes against Baghdad. Secretary of State Rumsfeld: *What will follow will be a force and a scope and a scale that has been beyond what we have seen before*
21/03/1003	Heavy aerial attacks on Baghdad and other cities. The campaign, publicized in advance by the Pentagon was termed the 'shock and awe' campaign
14/04/2003	Major fighting declared over

Table 4 Statistical data for the four offsite AWE high volume air sampler results (nBq/m^3). Period 29/06/00 to 04/12/ 03 representing 89 two-week periods of which three, 13/13/13 to 24/04/03 are those designated 'war' and 86 were designated 'not war' for ANOVA and logistical regression. Means and standard deviations shown.

Filter	**Not war**		**War**	
	Mean	**SD**	**mean**	**SD**
Hannington	116.6	78	259	158
Reading	201.3	152	1230	409
Silchester	134.4	78	468	100
Thatcham	168.9	97	641	181
Offsite	**155**	**101**	**650**	**212**
R001	166.4	105	606	69
R002	111.7	62	411	154
R007	117.3	69	382	61
R009	220	106	649	42
Onsite	**154**	**85**	**512**	**82**

One way ANOVA gave $p<0.000$; $F>50$ for significance tests of differences between all offsite sites individually except Hannington for which $p= 0.004$. For all offsite sites combined and also for all onsite sites combined $p< 0.000$ for test of 'war' against 'not war'.

Discussion

The increase in uranium in the filters which occurred in the period 13 March to 24th April 2003 was not a chance phenomenon. Inspection of the trend shown in Figs 2 and 3 and of the statistical data also, show that the mean levels over the two years prior to the excession were around $100ng/m^3$, compared with the $600ng/m^3$ excession levels. Where could the uranium have come from? Was the increase in uranium due to oxide particles from Gulf War 2?

The increases in uranium in the filters occurs in all the filters, and levels are greater offsite than onsite. Thus the event can be assumed to be distinct from any releases from the Atomic Weapons Establishment itself; the increases point to an increase in the whole area of uranium in the air over the period represented by the filters. These increases were in material from the period from 13th March to the 24th April. This is also roughly the period of Gulf War 2, and since it is now universally conceded that a significant amount of uranium weapons were used in the bombing and anti tank warfare, it seems reasonable to connect the uranium increases in the filters with the production of uranium oxide aerosols in Iraq. The first increase was seen in the filter which was removed and measured on 27th March, 9 days after the initiation of the bombing on 19th March. This would firstly require that there was an airflow from Iraq to England in the period 19th to 27th. In addition to this, we should have to agree that the particles could be carried by this airflow, although in a sense, the evidence from the present analysis is implicit in the results; i.e. the increases found clearly demonstrate that the uranium particles are capable of long distance travel.

As we stated in the introduction, there is considerable disagreement about the dispersion of uranium weapons aerosols following their production on the battlefield. On the one hand, the military and official agencies claim that the particles do not travel far from the site of impact, and that contamination is localised to within a few tens of metres of the impact site. The UK Royal Society Report on Depleted Uranium stated that atmospheric transport of DU occurs over relatively short distances (tens of metres) following the impact of armour piercing projectiles. Although increases in Uranium levels were reported in Hungary during the use of DU in Kosovo, the Royal Society argue that the uranium was from increases in the atmospheric dust loading of natural uranium due to bombing, and not DU from the weapons (Royal Society, 2002). The United Nations Environment teams who visited the Balkans (UNEP) also maintain that DU remains near the site of its use, and made many environmental measurements in Kosovo (UNEP2001). However Busby made measurements of DU in Kosovo and was able to show that DU dust existed in rainwater puddles having been rained out some 9 months after the attacks which produced it, and measurements subsequently made by UNEP in Bosnia and Montenegro showed the existence of DU particles in air (see Busby 2003). Priest visited Kosovo and Bosnia for the BBC and made urine measurements of members of the public in the areas where DU was used. Using mass spectrometry, he found significant DU in all those who were tested, including his own BBC cameraman (Priest 2003). Dietz reported in 1991 that he had been able to show in the 1980s that DU from the Knolls Atomic Power Laboratory in Schenectady, NY with diameters of about 4 microns were able to travel some 26 miles from the plant.

The mean aerodynamic diameter of battlefield DU was assumed by the Royal Society to be between 1 and 5 microns. However, measurements made by the US Military in the late 1980s using sophisticated filter systems showed that the main particle diameters were much smaller than this. Table 5 gives the diameters of DU particles found in an analysis by the Pacific Northwest Laboratory in a study in 1984, (Glissmeyer et al 1985). The variation in the reported measurements of DU particle diameters may be due to the difficulty of measuring the diameters of ultrafine particles.

Table 5. Approximate aerodynamic equivalent particle size distribution for DU particles obtained from outdoor test firings (Glissmeyer, Mishima and Bamberger, 1985)

Particle AMAD micrometers (μm)	Mass percent in size range
<0.18	31
0.18-0.56	14
0.56-1.8	15
1.8-5.6	13
5.6-18	11
18-56	7
>56	9

Thus it is clear that just under half the total mass of the uranium oxide consists of particles smaller than the wavelength of visible light, particles whose behaviour may be taken to approximate to that of a gas. Therefore the dispersion of such material may be expected to be similar to the dispersion of radioactive gases from nuclear accidents like

the Chernobyl accident. It is merely a question of examining airflow patterns to see if air from Iraq could have reached the UK and Europe.

The airflow from Iraq to Europe at the time.

The meteorological conditions at the time of the initial bombing were anomalous, and such that there was probably airflow from Iraq to Europe. Indeed in February 2003 and later in April this airflow carried Saharan desert sand all the way to the UK (Burt 2003, Simons 2003)

For Western Europe, over most of the period, including that of the Gulf War, there was a southerly flow of air to England generated from complex Atlantic lows, with a persistent high over the UK and France. Air also entered this High Pressure system from the east and this air has also been drawn in from the south. Figs 4, 5 and 6 show the synoptic conditions from Europe, north Africa and the Atlantic on the 19-22nd March and Fig 7 shows the atmospheric pressure and geopotential situation on the 19th March when the first attacks occurred. It is clear from these that there is a significant potential airflow from Africa to Europe. Examination of the synoptic charts for Iraq, the Mediterranean and Eastern Europe show that from the 19th to the 25th, winds in Baghdad where most of the main bombing occurred were south or southwesterly, sending any material northwards towards weak low pressure troughs laying East West along the southern Mediterranean for most of the period. This line of persistent troughs is clearly seen at the junction of the warm and cold air in Fig 7. These systems fed air into the easterly flow into the England and France anticyclone. Table 6 outlines the daily situation in Iraq and Eastern Europe as shown by the Met Office Polar Stereographic charts.

Table 6 Weather systems in Iraq, the Mediterranean and Europe.

Date	Wind at Baghdad	Speed knots	General synopsis at 1200
19/03/03	W to SW	15-20	High 1032 England; Low 970 N Russia; Low N Africa 1010; weak troughs Cyprus to Turkey/ Greece to Ukraine
20/03/03	SW	15	Low 993 Russia with trough to N Greece and to Denmark; Low 1001 E Turkey; trough to Cyprus
21/03/03	S to SW	10	Low 1000 Ukraine moving E; Trough N Greece to N Turkey
22/03/03	SW	10	High 1035 France; Low 1017 Ukraine; troughs S Italy to Cyprus –Turkey
23/03/03	SW	10	High 1032 France; Low 1002 S Mediterranean moving East; troughs Egypt- Turkey and Greece- Turkey
24/03/03	S or SW	20	High 1027 N Africa; High 1024 France; Fronts Greece-Turkey and N Africa- Cyprus-Turkey
25/03/03	S	25	High 1027 N Africa; High 1024 France; Low 992 Baghdad; trough Greece-N Turkey

Thus at minimum, the atmospheric conditions do not oppose the conclusion that the uranium at Aldermaston was from the Iraq bombing. A computer modeling calculation of the origin of air arriving at Reading on 27th March using the noaa hysplit algorithm (www.arl.noaa.gov) shows the potential source regions of air as being northwest European with North African sources for the 1K and 5K arrival heights. From the lengths of these trajectories Martin Doyle of the University of East Anglia, who we discussed this with concedes that it is possible that material sourced in places like Iraq could arrive in the UK within 7 days, although he points out that trajectories between the Middle East and the UK are uncommon (Doyle 2006). Nevertheless, the weather conditions at the time were anomalous, and since the uranium is clearly there, the empirical evidence is that sufficient air from Iraq arrived in Europe to cause increased levels in the filters. Certainly by 11th April, the noaa hysplit model shows air from Reading as sourcing in Iraq some ten days earlier. This would explain the highest levels in the second HVAS filters of the war period. The backward trajectory noaa calculation is shown in Fig 8.

Fig 4 Synoptic Chart for Atlantic/Europe 19th March 2003. (*Source: Meterological Office, Bracknell; www.wetter-zentrale.de*)

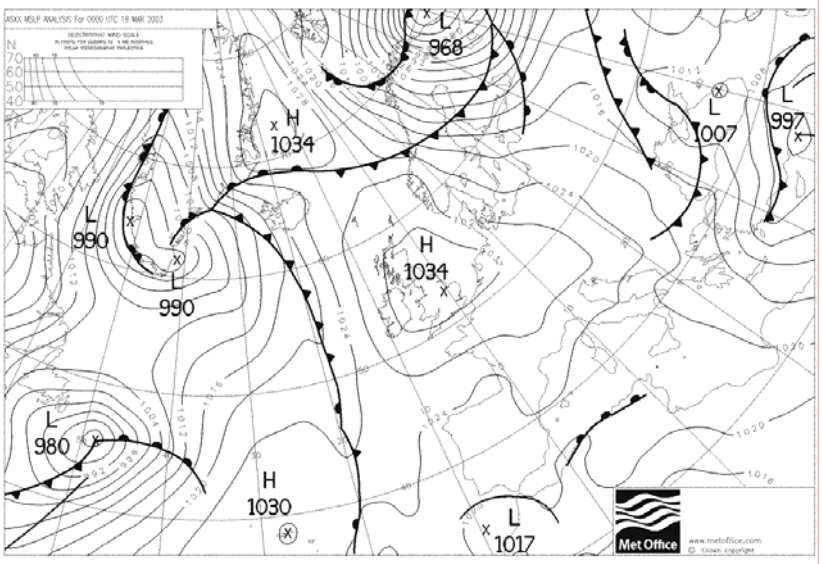


Fig 5 Synoptic Chart for Atlantic/Europe 20th March 2003 (*Source: Meterological Office, Bracknell; www.wetter-zentrale.de*)

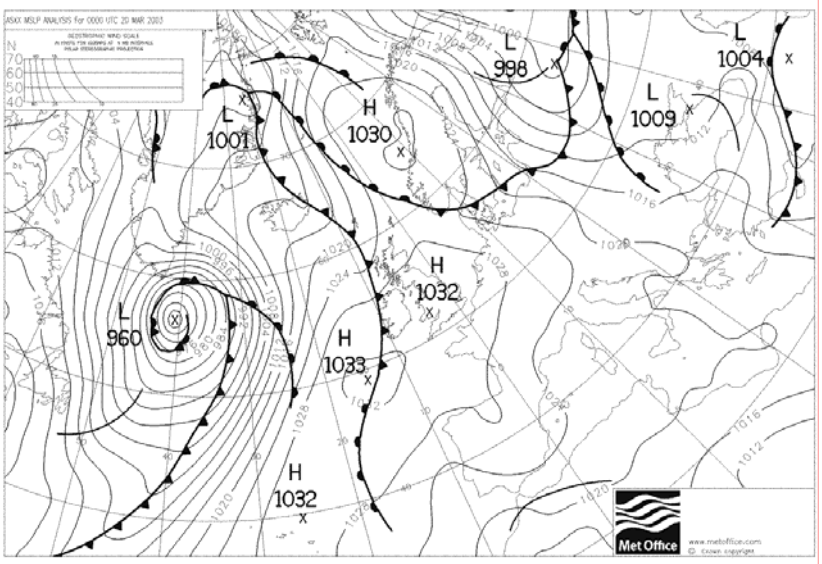


Fig 6 Synoptic Chart for Atlantic/Europe 22nd March 2003 (*Source: Meterological Office, Bracknell; www.wetter-zentrale.de*)

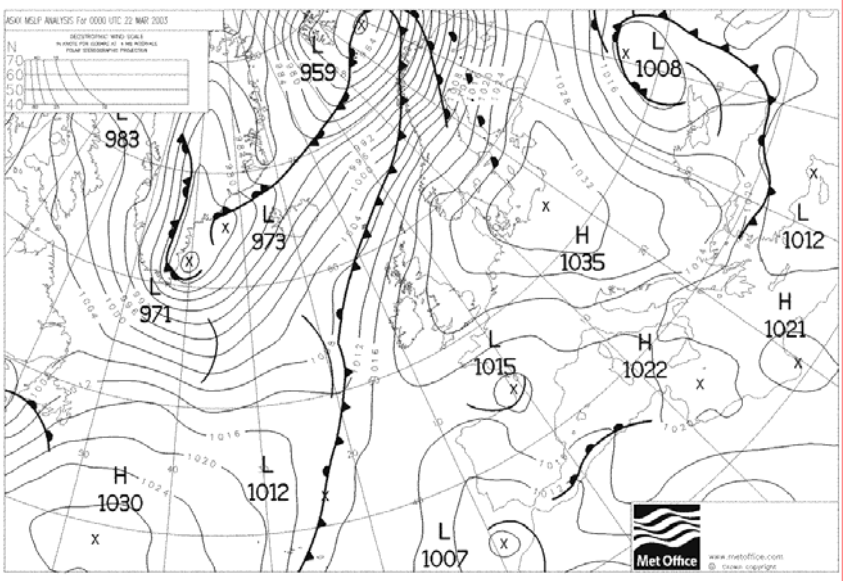


Fig 7 Geopotential and atmospheric pressure chart for Atlantic and Europe showing warm air from Africa penetrating Western Europe (Source *www.wetter-zentrale.de*)

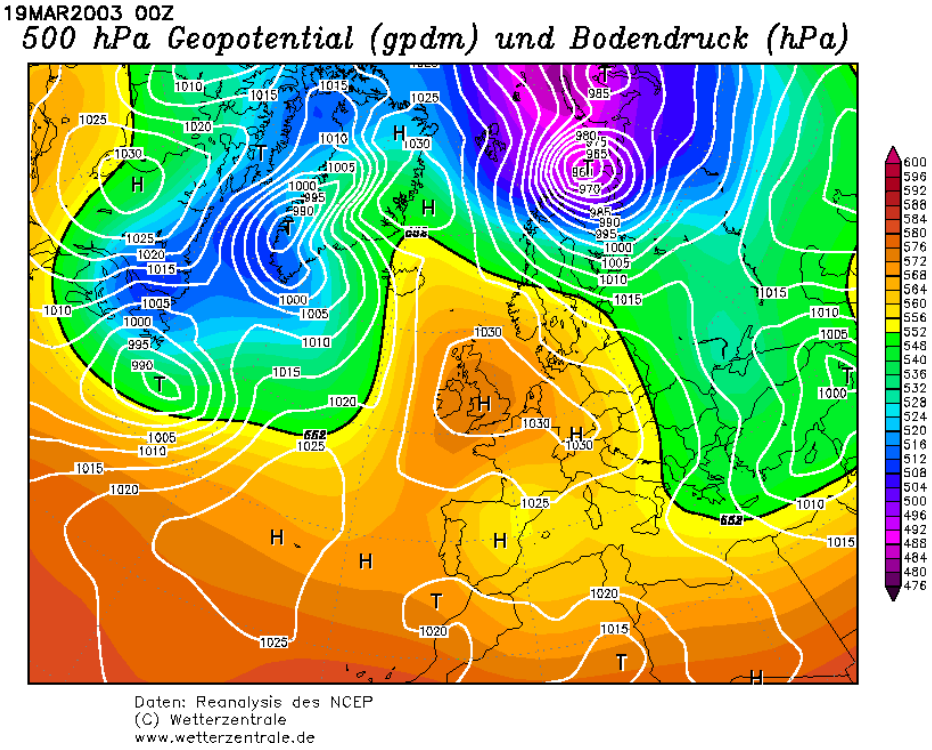
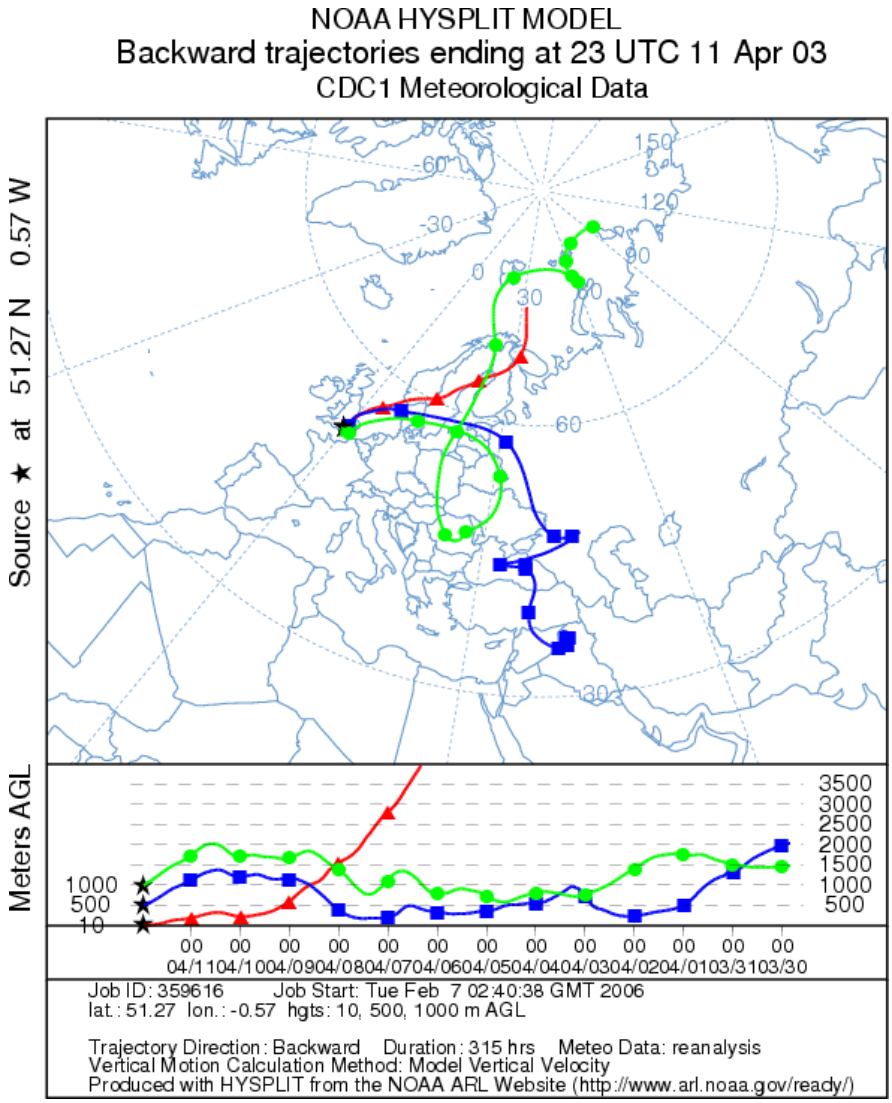


Fig 8 NOAA HYSPLIT calculated backward trajectory for sources of air at various levels (10, 500 and 1000m at Reading) arriving in Reading on 11th April 2003. Each point represents 24 hrs .



Exposure of the public to uranium aerosols from the Gulf War 2.

Over the period of the excession, the mean offsite level of uranium in air over the six weeks was 650nBq/m^3 with peak levels in Reading that exceeded the Environment Agency statutory reporting level of 1000ng/m^3 twice. Since the background level could be considered to be 155nBq/m^3 we can say that there was an excess of uranium in air of some 500nBq/m^3. If this material consisted of uranium oxide particles from the Gulf War bombing the we can first calculate the number of particles of 0.25 μm diameter in a cubic metre of air. The activity of uranium is taken to be 12.5MBq/kg. Thus the mass of 500nBq is about 4 x 10^{-11}g. Taking the density of uranium oxide as 9.8, there are about 48,000 particles of 0.25μm diameter in one cubic metre. Using inhalation volumes from ICRP standard man (23 m^3 per day; ICRP 1974) and assuming a 50% outdoor inhalation

of the uranium per day, in the six weeks of elevated uranium each person would have inhaled about 23 million particles. These particles would have rapidly transferred through the lungs and into the lymphatic system where they would have access to all tissues.

It is not the intention of this paper to spend much time addressing the health effects of uranium particles and other internal exposures. One of us has dealt with this in various places elsewhere (see e.g. Busby 2002, 2003, CERRIE 2004) and there is a considerable literature drawing attention to anomalous mutagenicity associated with exposure to the uranium particles from weapons use (Craft et al. 2004, Kuepker and Kraft 2004) The arguments about the health effects pivot upon the scientific validity of using radiation risk models obtained from studies of external acute high dose irradiation (mainly the Japanese A-Bomb studies) for chronic internal exposures to radioactive substances which produce anisotropic i.e. local doses. In addition, one of us has pointed out elsewhere that uranium will amplify natural background gamma radiation owing to its high atomic number and its ability to convert the gamma radiation into local photoelectrons (Busby 2005, 2005b). Uranium has a very high affinity for DNA (Nielsen et al 1992, Zobel et al 1961, Huxley and Zubay 1961, Constantinescu 1974) and in cells which have internalized a submicron uranium particle, the equilibrium ionic concentration of uranium will be high enough to have saturated the DNA in the cell by binding to phosphate. This focusing of the radiation on the DNA may be the cause of many anomalous mutagenic effects which show themselves in cell cultures (e.g. Miller et al 2002, 2004) in laboratory animals (e.g. Paquet 2005, IRSN 2005) and in the many reports of ill health associated with exposure to uranium (e.g. Craft et al 2005, Zaire et al 1997)

Conclusions

The use of battlefield uranium weapons has been classed by some as weapons of indiscriminate effect; as such they would be implicity illegal under various conventions of war. Those who defend or justify their use do so by arguing that the uranium is localized at the point of impact or nearby and that exposure of large populations does not occur. The history of the disclosures of the data in this case supports the idea that AWE were aware that their filters provided evidence of the long range movement of uranium. They were at first reluctant to release any data; it required a Freedom of Information Act request to force them to release the results of the monitoring. But significantly they did not send initially the block of data relating to the Gulf War period, and a second request was necessary. The long wait between this second request, and the appearance of the data, and the fact that the missing data came from a different organization, the Defence Procurement Agency in Bristol, suggests that there was significant attention being paid to the interpretation of the results, and decisions had to be made about what the data would show and its political implications for the military.

Despite many pieces of evidence that the uranium aerosols are long lived in the environment and are able to travel considerable distances, this is the first evidence as far as we know, that they are able to travel thousands of miles. The distance traveled from Baghdad to Reading following the wind patterns implicit in the pressure systems at the time is about 2500 miles. Although this transport may be hard to believe at first, the regular desert sand events which occur in the UK should teach us that the planet is not such a large place, and that with regard to certain long lived atmospheric pollutants, *no*

man is an island. This was a lesson first shown graphically and alarmingly by the atmospheric nuclear tests of the 1960s and the subsequent Strontium-90 in milk, and more recently by the Chernobyl accident. However, like the atmospheric tests, the use of battlefield uranium weapons, especially the new bunker busting bombs which are alleged to have more than 1 ton of uranium in the warhead, are events which are controlled by man: they are not accidents. The results from the AWE filters should teach us that the consequences are not restricted to the areas where they are used. Indeed, on the basis of the results reported here, there would have been a significant exposure to the public in many countries. Uranium is a powerful genotoxic stressor. Although the air concentrations are small in mass terms, the evidence suggests that the excession in the UK represents evidence of dispersion of a new type of uranium, the ceramic sub micron oxide particle. It seems likely that air concentrations in European countries closer to Iraq would have been exposed to higher levels than those found at near Aldermaston. In view of the many reports of heritable genetic effects in areas where uranium has been used and these particles generated, and in the illnesses reported in Gulf veterans, time series analysis of infant mortality and congenital malformation rates in European databases assuming exposures to the foetus or the pre conception parents in mid March 2003 might be worth carrying out. We have applied to ONS in the UK for monthly data but apparently they are not ready yet.

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