



# Uranium Medical Research Centre

# Health Consequences of Radiological Warfare

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Radioactive tank, Iraq - July, 2003



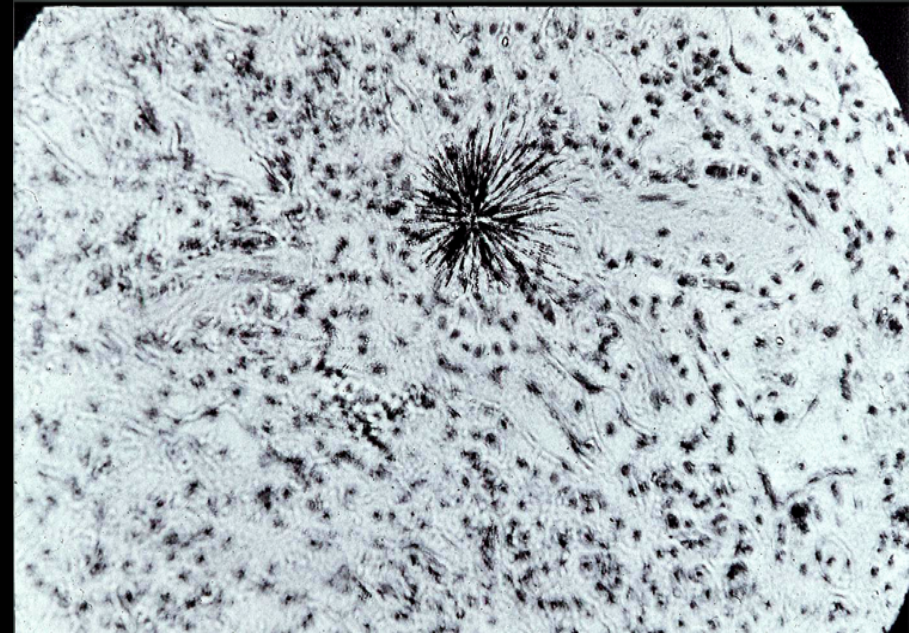
Bunker buster target, Kabul - August, 2002



Contaminated town, Nangarhar - May, 2002



Alpha radiation in lung tissue



# Mission of UMRC

Independent research of the medical and environmental impact of contamination of the biosphere with radioactive weapons.

# Mechanisms of Transport of Battlefield Uranium

1. Aerosol formation as a consequence of pyrophoric properties of uranium anti-armor penetrators.
2. Deposited aerosols and oxide particles carried on clothing.
3. Deposition of uranium-rich dust by ordnance detonation.
4. Resuspension and long-distance transport of contaminated soil particles.





Tank remains and residue of DU oxides, Baghdad Gate - August, 2003



Radioactive tank crew member's vest 1,000 x background



Bomb explosion and dust plume in Afghanistan



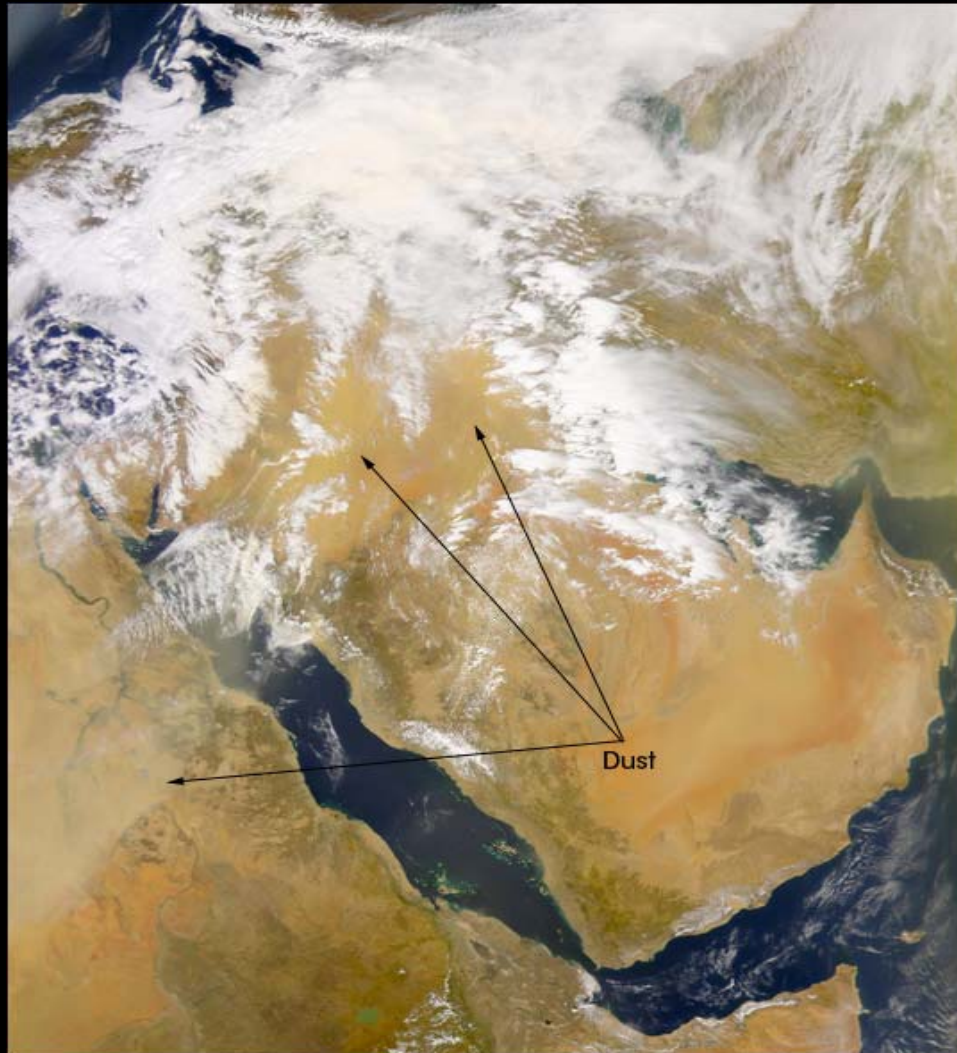


Bomb explosions in Iraq

# Dust Storm



# Dust Storm in the Middle East





# Dust Migration over Iraq



# Total Radioactivity Released by Uranium Weapons

Conflict	Mass (Tonnes)	Activity (Bq)
Chernobyl Reference		$1.9 \times 10^{18}$
Gulf War 1	350	$1.3 \times 10^{13}$
Balkan Conflict	11	$4.1 \times 10^{11}$
Afghanistan	1000 (estimate)	$3.7 \times 10^{13}$
Gulf War 2	1700 (estimate)	$6.3 \times 10^{13}$
<b>Total</b>	<b>3061</b>	<b><math>1.3 \times 10^{14}</math></b>

# UMRC Field Work and Sample Collection Activities

## **Afghanistan:**

1. May-June, 2002: Field Investigation
2. September, 2002: Field Investigation
3. June, 2003: Field Investigation
4. September, 2003: Field Investigation

## **Iraq: Gulf War II**

1. September-October, 2003: Post-conflict Field Trip
  - Radiation survey of shock and awe bombsites
  - Public health investigation of ten cities
  - 100 biological, geological, and ballistic debris samples



# Chronology of Studies

- 1991:** Clinical, Laboratory, and Whole Body Counting Evaluation of Gulf War Veterans
- 1997:** Neutron Activation Analysis of the Urine of Contaminated Gulf War I Veterans
- 1999:** Medical Effects of Internal Contamination with Uranium
- 2001:** On Depleted Uranium Gulf war and Balkan Syndrome
- 2002:** The Quantitative Analysis of Depleted Uranium Isotopes in British, Canadian, and United States Gulf War Veterans
- 2003:** Estimate of the Time-zero Lung Burden of Depleted Uranium in Gulf War Veterans by the 24 Hour Urinary Excretion and Exponential Decay Analysis
- 2003:** Undiagnosed Illnesses and Radioactive Warfare
- 2004:** The Quantitative Analysis of Uranium Isotopes in the Urine of the Civilian Population of Eastern Afghanistan after Operation Enduring Freedom
- 2004:** Spectrometry Analysis of Uranium Concentration and Ratio, Chromosomal Studies, and Clinical Assessment of Contaminated Victims

# Iraq: Gulf War I

# Ratio of Uranium Isotopes

	<u><math>^{238}\text{U}</math></u>	<u><math>^{235}\text{U}</math></u>	<u><math>^{238}\text{U}:^{235}\text{U}</math></u>	<u><math>^{235}\text{U}:^{238}\text{U}</math></u>
<b>Natural Uranium</b>	99.2739	0.7200	137.88	0.00725
<b>Shrapnel (DU)</b>	99.7945	0.2026	492.60	0.00203
<b>Urine</b>	99.3778	0.6542	162.23	0.00616



# The Unique Signature of Artificial Uranium

	$^{238}\text{U} / ^{235}\text{U}$ Ratio
Natural Uranium	137.88
Depleted Uranium	492.60
Non-Depleted Uranium	$137.88 + ^{236}\text{U}$

# Groundbreaking Work Gulf War 1

DU contamination found ten years after exposure

- “Chemical Forensic Detective Work: the Search for Depleted Uranium in Biological and Environmental Samples”
- Geological Association of Canada, No. 266, p 65, May 31, 2001

Proof of depleted uranium incorporation into organs

- Radioisotopic analysis of bone, kidney, liver, and lung from deceased Gulf War Canadian veteran
- Official cause of death – Gulf War Illness

# Captain Terry Riordan



First Canadian veteran whose cause of death was  
Gulf War Illness



# Key Publications

## Gulf War I

### Conclusive proof of inhalational DU contamination

- “Quantitative Analysis of Depleted Uranium Isotopes in British, Canadian and United States Gulf War Veterans”
- Military Medicine 167, 8:620-627, 2002

### Quantity of inhaled DU exceeds safe limits

- “Estimate of the Time-zero Lung Burden of Depleted Uranium in Gulf War Veterans by the 24 Hour Urinary Excretion and Exponential Decay Analysis”
- Military Medicine 168, 8:600-605, 2003

## Isotopic Data for Positive Samples

<u>Patient</u>	<u>U 238</u>	<u>U 235</u>	<u>U238 / U235</u>	<u>Sigma</u>
R.B.	99.3266	0.6584	150.88	3.26
R.G.D.	99.3154	0.6758	146.96	0.68
J.G.	99.7565	0.2339	426.46	3.64
J.H.	---	---	153.02	0.47
K.I.M.	99.4280	0.5663	175.58	14.24
D.N.	99.2963	0.6925	143.47	3.60
A.P.	99.3456	0.6495	152.91	0.23
R.P.	99.4643	0.5200	191.30	0.17
T.R.	99.5564	0.4346	229.07	1.28
S.R.	99.5603	0.4304	231.34	1.59
F.S.	99.4876	0.4945	200.77	2.95
V.S.	99.7113	0.2830	352.42	1.47
R.W.	99.3025	0.6825	145.57	1.38
A.W.	99.4862	0.4966	200.34	0.65
Average	99.4644	0.5245	207.15	4.29
SD	0.1517	0.1508	84.17	
SE	0.0421	0.0418	22.50	

## Isotopic Data for Negative Samples

<u>Patient</u>	<u>U 238</u>	<u>U 235</u>	<u>U238 / U235</u>	<u>Sigma</u>
G.B.	99.2769	0.7156	138.76	0.63
B.B.	99.2742	0.7076	140.25	1.77
L.B.	99.2738	0.7180	138.25	0.35
D.B.	99.2701	0.7233	137.43	0.32
P.C.	99.2570	0.7210	137.67	0.35
C.C.	99.2738	0.7113	139.47	0.39
M.K.	99.2762	0.7152	138.80	0.78
C.P.L.	99.2702	0.7200	137.84	0.49
G.L.	99.6228	0.7189	138.10	0.32
C.O.	99.2811	0.7135	139.14	1.01
P.R.	99.2744	0.7192	138.32	0.44
Average	99.3118	0.7158	138.68	0.84
SD	0.1168	0.0044	0.85	
SE	0.0389	0.0015	0.28	

## Gravimetric Data for Individual Samples

<u>Patient</u>	<u>U pg/g</u>	<u>U pg/24hr</u>
G.B.	5.01	10196.99
P.C.	7.33	12149.63
R.G.D.	13.07	1290.24
W.H.	8.55	960.00
M.K.	4.01	35.94
C.P.L.	0.20	545.44
G.L.	1.49	141.90
K.I.M.	2.77	14111.26
P.R.	15.21	7604.85
S.R.	77.96	268225.11
F.S.	163.02	10780.19
M.D.T.	0.0150	1.60
A.W.	2217.04	11426.01
Average	250.56	40758.21
SD	657.85	79696.79
SE	198.35	24029.49



## DU at Time-zero in Individual Samples

<u>Patient</u>	<u>DU (mg)</u>
G.B.	$7.00 \times 10^{-4}$
P.C.	0.00
R.G.D.	$1.13 \times 10^{-3}$
M.K.	$3.35 \times 10^{-6}$
C.P.L.	$6.15 \times 10^{-6}$
G.L.	$1.60 \times 10^{-6}$
K.I.M.	$4.29 \times 10^{-2}$
P.R.	$1.72 \times 10^{-4}$
S.R.	1.54
F.S.	$4.78 \times 10^{-2}$
A.W.	$5.05 \times 10^{-2}$
Average	$1.53 \times 10^{-2}$
SD	$4.59 \times 10^{-1}$
SE	$1.38 \times 10^{-1}$

## Autopsy Specimens

	<u>U 238</u>	<u>U 235</u>	<u>U238 / U 235</u>
Lung	99.2348	0.6932	143.20
Liver	99.2792	0.7082	140.20
Bone	99.3220	0.6718	147.80

# The Silver Bullet

## 120mm DU Anti-tank Long Rod Penetrator



Penetrator travels at  
1.5+ km/sec



Impact equivalent to  
1.5 kg of TNT



Uranium penetrator passes through 4+ inches of steel



Battlefields of Iraq remain littered with uranium projectiles since 1991.



The background is a dark blue gradient with several lens flare and bokeh effects. A bright yellow and white light source in the top right corner creates a strong diagonal beam of light across the frame. On the left, a red circular lens flare with a bright white center is visible. In the lower right, there are several out-of-focus circular bokeh spots in shades of green and blue.

# Afghanistan: Operation Enduring Freedom







UMRC field team inspects radio station destroyed by heavy weight bombs, Kabul

# Health Impact

## Immediate Symptoms Encountered after Bombing:

- Epistaxis and nasal discharge
- Chest pain and hemorrhagic expectoration
- Burning sensation in throat, nose, lips, or mouth
- Eye irritation
- Feeling of skin hyperthermia, rash, or irritation
- Dry cough
- Gastric and intestinal alterations
- Diarrhea

# Health Impact

## Delayed Symptoms Encountered after Bombing:

- Fatigue
- Intermittent fevers, nocturnal perspiration
- Headaches
- Recurring or continuous joint, nerve, chest, and/or muscle pain
- Short-term and sporadic memory loss
- Mental confusion and disorientation
- Depression and loss of initiative
- Chronic cold, influenza, recurrent viral illnesses
- Asthma, chronic bronchitis
- Dry or productive cough
- Lower-back pain
- Dysuria
- Gastrointestinal problems
- Anorexia



# Health Impact

## Chronic Symptoms Encountered after Bombing:

- Progressive kidney pain, lower back discomfort
- Sexual dysfunction
- Miscarriages and/or birth defects
- Infant and new-borne unexplainably ill, weak, lethargic, rashes
- Failure to thrive in children
- Increasing numbers of family and community health problems
- Changes in immune system



Child lethargic, disinterested, and under-developed  
Lal Mah Village - September, 2002

# Afghanistan Specimens

May-June, 2002:

- Jalalabad, Lal Mah, Makam Khan Farm, Farm Arda

September, 2002:

- Jalalabad, Spin Gar (Tora Bora), Poli Cherki, Kabul, and Khandahar

June and September, 2003:

- Jalalabad, Kabul, and Bibi Mahro

## Trip 1: Uranium Isotopic Ratios in Urine

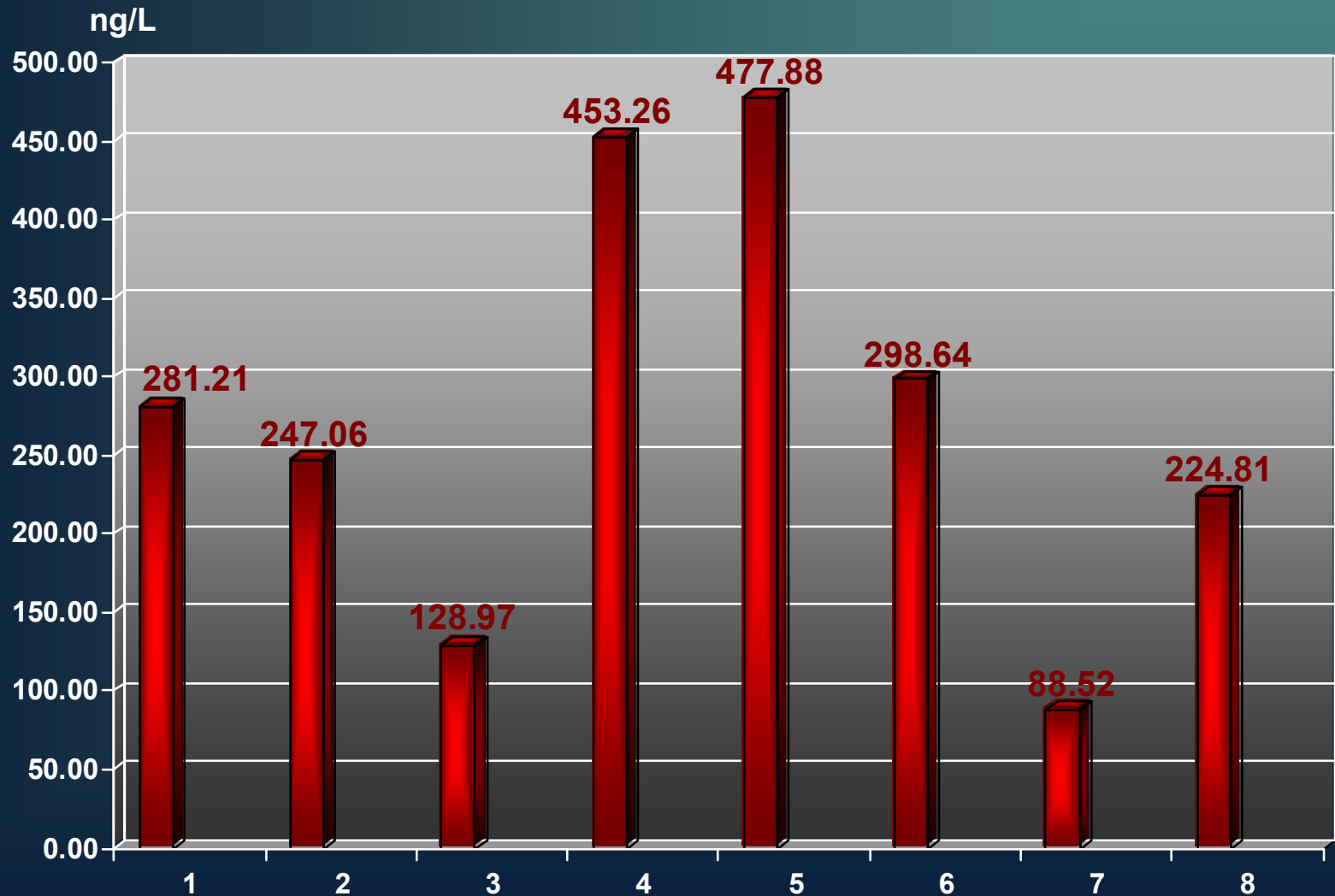
<u>Subject</u>	<u><math>^{238}\text{U} / ^{235}\text{U}</math></u>	<u>Sigma</u>	<u><math>^{234}\text{U} / ^{238}\text{U}</math></u>	<u>Sigma</u>
1	137.65	0.07	$5.53 \times 10^{-5}$	$6.33 \times 10^{-7}$
2	138.09	0.09	$5.43 \times 10^{-5}$	$6.12 \times 10^{-7}$
3	137.55	0.09	$5.55 \times 10^{-5}$	$6.83 \times 10^{-7}$
4	137.95	0.07	$5.44 \times 10^{-5}$	$5.94 \times 10^{-7}$
5	138.08	0.07	$5.45 \times 10^{-5}$	$5.87 \times 10^{-7}$
6	137.98	0.08	$5.44 \times 10^{-5}$	$6.55 \times 10^{-7}$
7	137.82	0.07	$5.62 \times 10^{-5}$	$7.86 \times 10^{-7}$
8	137.86	0.07	$5.63 \times 10^{-5}$	$7.71 \times 10^{-7}$
Average	137.87		$5.51 \times 10^{-5}$	
SD	0.20		$8.20 \times 10^{-7}$	
SE	0.07		$2.90 \times 10^{-8}$	
Internal Urine Control	137.49	1.47	$7.72 \times 10^{-5}$	$2.16 \times 10^{-5}$

## Trip 1: Total Uranium Abundance in Individual Urine Samples

<u>Subject</u>	<u>Uranium ng/L</u>
1	281.21
2	247.06
3	128.97
4	453.26
5	477.88
6	298.64
7	88.52
8	224.81
Average	275.04
SD	137.80
SE	48.72
Internal Urine Control	11.88



# Trip 1: Uranium Abundance in Urine



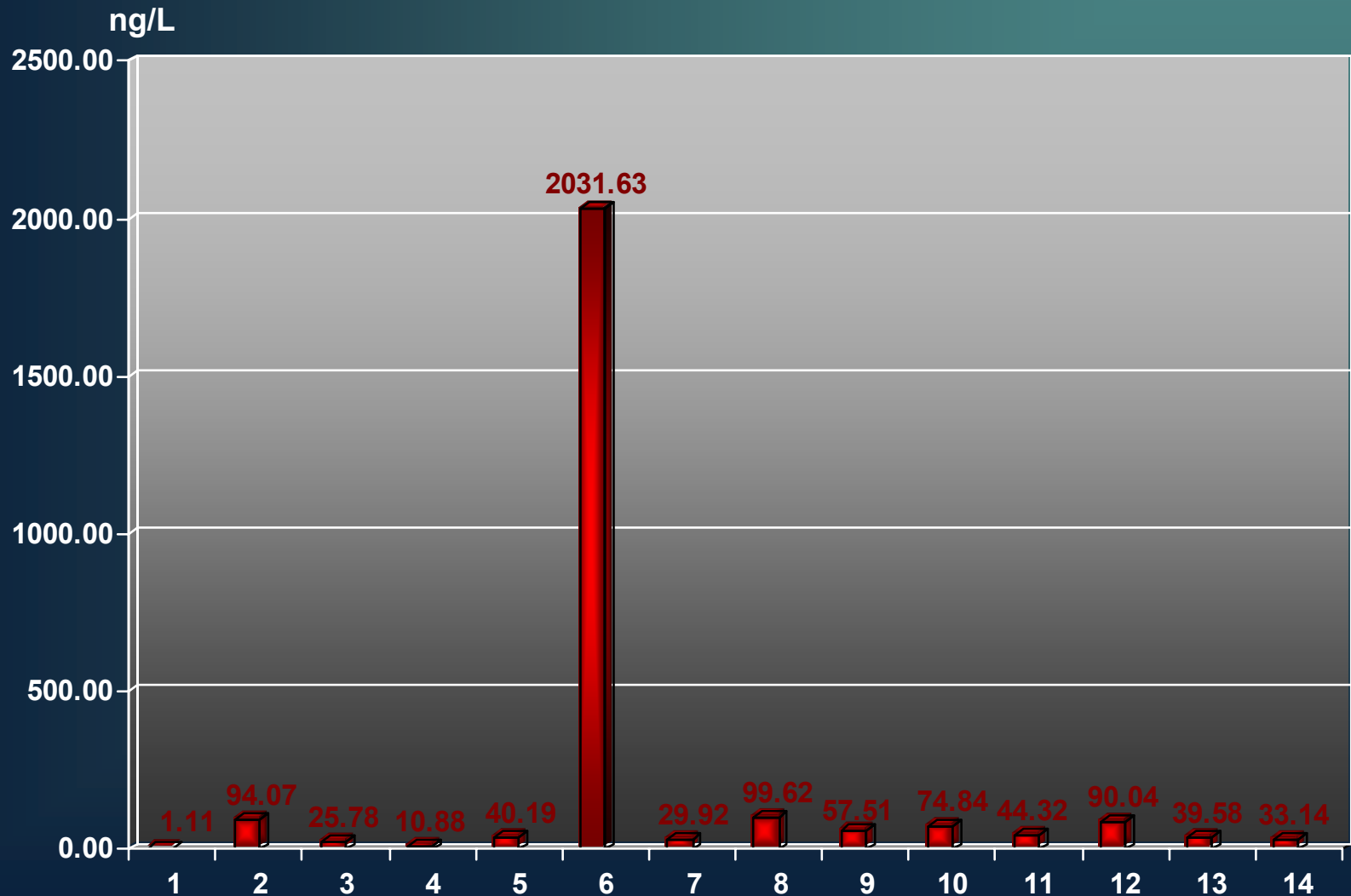
## Trip 2: Uranium Isotopic Ratios in Urine

<u>Subject</u>	<u><math>^{238}\text{U} / ^{235}\text{U}</math></u>	<u>Sigma</u>
1	127.32	0.75
2	138.52	0.25
3	138.93	0.27
4	137.72	0.35
5	137.74	0.27
6	137.91	0.02
7	137.97	0.34
8	138.26	0.34
9	138.50	0.25
10	138.47	0.27
11	138.58	0.25
12	138.68	0.25
13	138.27	0.25
14	137.71	0.26
Average	137.54	0.29
SD	2.96	
SE	0.79	
Afghanistan Control (n=3)	137.50	0.32

## Trip 2: Total Uranium Abundance in Individual Urine Samples

<u>Subject</u>	<u>Uranium ng/L</u>
1	1.11
2	94.07
3	25.78
4	10.88
5	40.19
6	2031.63
7	29.92
8	99.62
9	57.51
10	74.84
11	44.32
12	90.04
13	39.58
14	33.14
Average	190.90
SD	530.67
SE	141.83
Afghanistan Control (n=3)	32.06

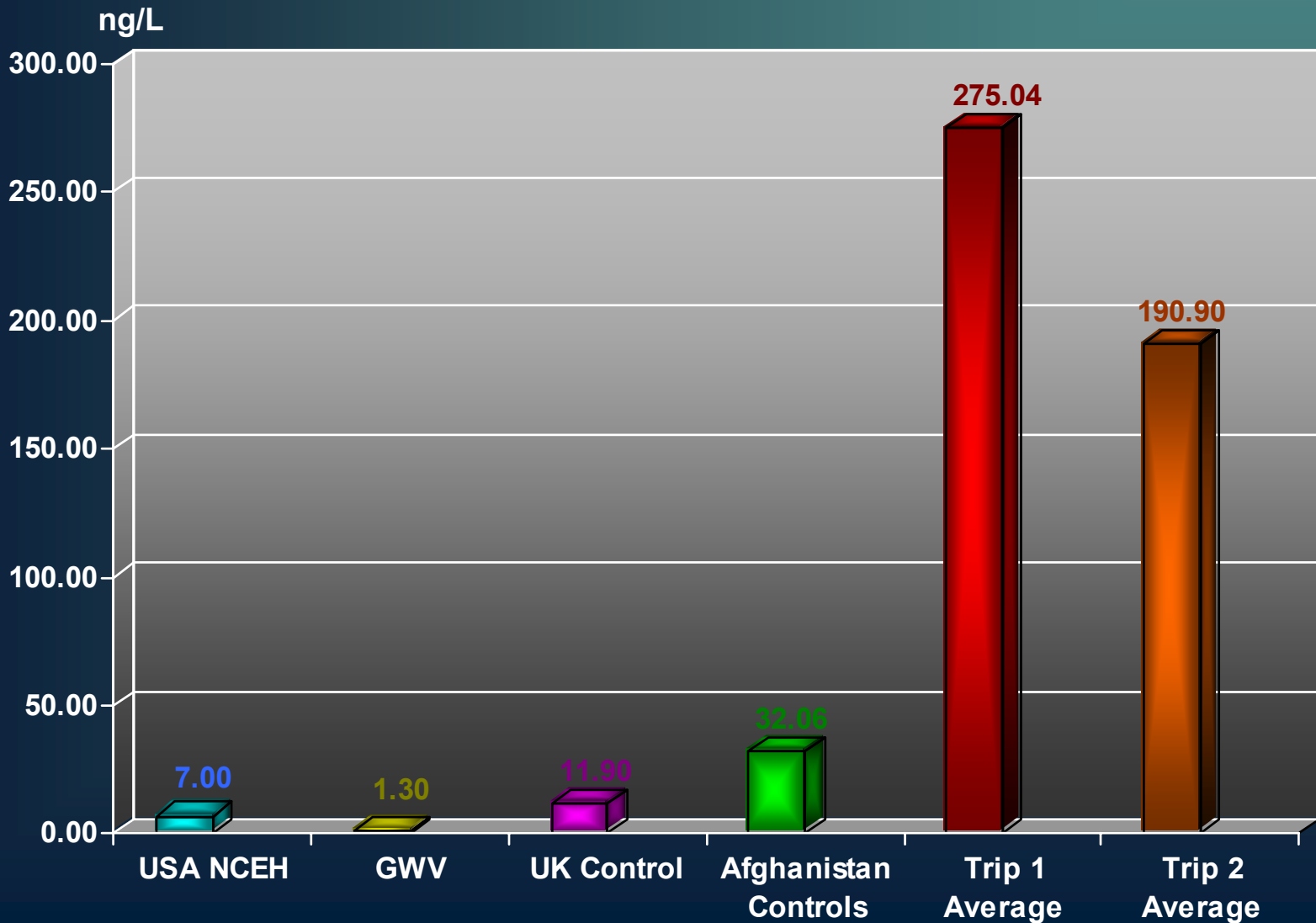
# Trip 2: Uranium Abundance in Urine





Hussein from Bibi Mahro

# Comparison of Uranium Abundance in Urine





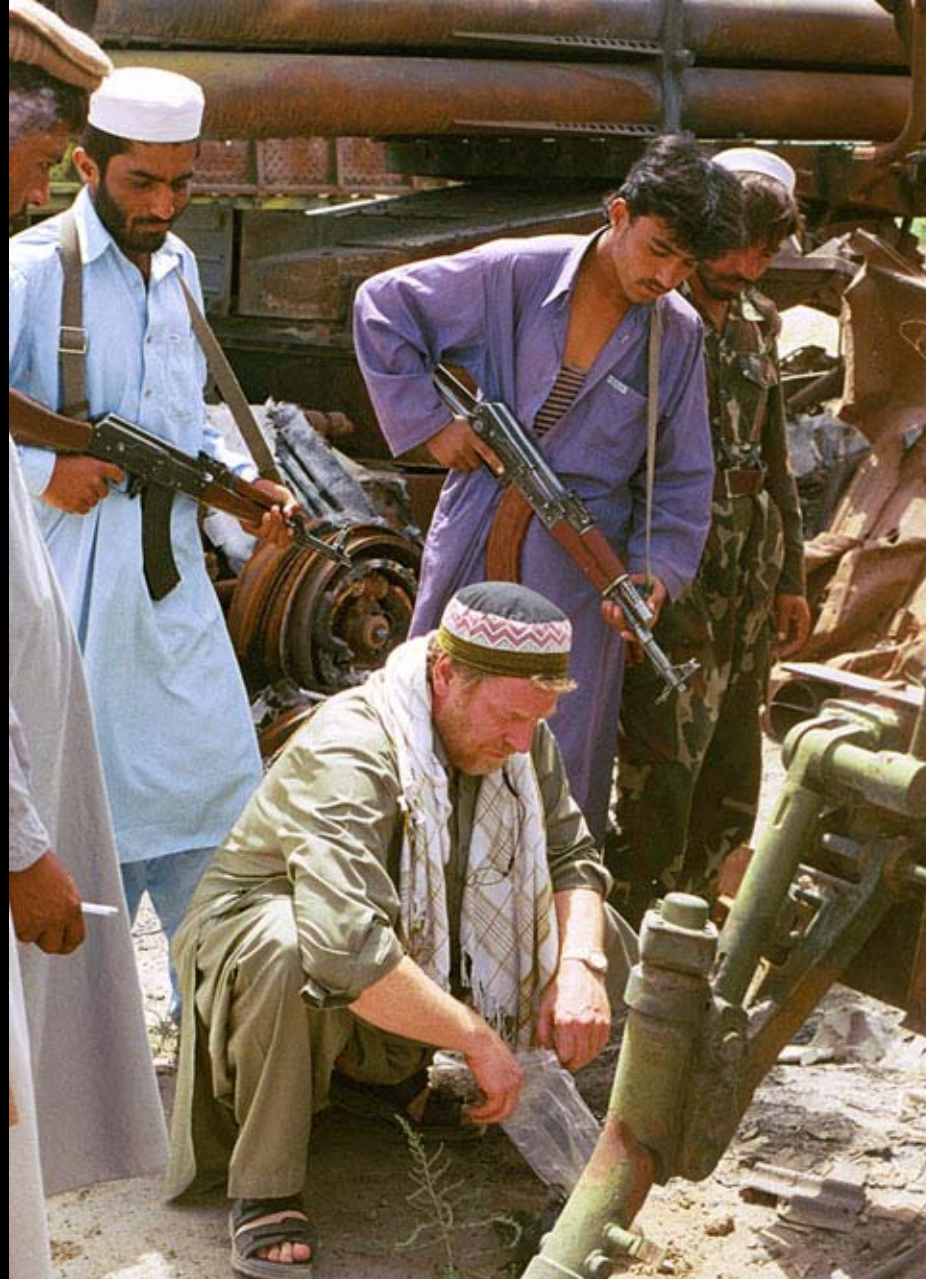


Bunk Buster Crater  
HQ Tank Division 81

## Total Uranium Abundance in Soil Samples

<u>Location</u>	<u>Uranium mg/kg</u>
81 Tank Division (Command Post Crater)	18.6
81 Tank Division (Rocket Launcher)	10.7
Bibi Mahro (Crater Soil)	2.3
Farm Arda (Bunker)	3.7
Farm Arda (Bus)	2.6
Farm Arda (Command Post)	3.9
Lal Mah (Farmer's Field)	4.6
Lal Mah (Karaize Silt)	3.4
Lal Mah (Village Hzrat)	4.2
Mosque	5.7
Yaka Toot (Radio Station)	2.3
Garden Road Jalalabad (Control)	3.4





Dust deposits contain uranium levels 11 times normal





Lal Mah Village - Water samples taken from Karaiz originating in Tora Bora

## Total Uranium Abundance in Water Samples

<u>Location</u>	<u>Uranium ng/L</u>
Garden Road, Jalalabad	56,410
Maqam Khan Farm, Jalalabad	2,201
Maqam Khan Farm, Jalalabad	25,182
Bibi Mahro, Kabul	12,315
Bibi Mahro, Kabul	14,102
Marble Factory, Kabul	13,475
Yaka Toot District, Kabul	38,278
Yaka Toot District Kabul	28,205
WHO Maximum Permissible Concentration	2,000





Children retrieving well water for analysis, Bibi Mahro



The background is a dark blue gradient. In the upper left, there is a bright pinkish-white lens flare with a red circular outline. In the upper right, a bright yellow lens flare with a green circular outline is visible. A diagonal beam of light, transitioning from yellow to green, cuts across the middle of the image. Several other faint, semi-transparent circles in various colors (blue, green, yellow) are scattered across the lower half of the frame.

# Iraq: Gulf War II





# **“Shock and Awe”**

## **Aerial Bombing Campaign**

**International Market, Central Baghdad**



# “Shock and Awe” Sites Investigated

Baghdad area, heavy weight bomb sites:

- Baghdad international airport perimeter
- Baghdad central market
- Baghdad central telephone exchange
- Al Rashid air force base
- Baath party headquarters
- Ministry of information
- Mansour district (April, 2003 leadership decapitation strike, Sector 613)
- Jammah suburb #512, Baghdad



Baghdad Central Telephone Exchange  
CNN view on top of Palestine hotel



# Baghdad International Market





Baghdad International Market



# **“Rapid Dominance” Ground Force Campaign**



Iraqi main battle tank destroyed by A-10 Thunderbolt,  
Suweirah (notice DU penetrator craters in the asphalt)

# “Rapid Dominance” Sites Investigated

## Baghdad combat battlefields:

- Haiyy al Mavalemeen – teacher’s district
- Auweirj coalition/SRG headquarters
- Tank-graveyard
- Baghdad gate

## Central Iraq:

- Suweirah
- An Najaf
- Karbala
- Al Hillah
- An Nasiriyah
- Al Basra
- Umm Qasr





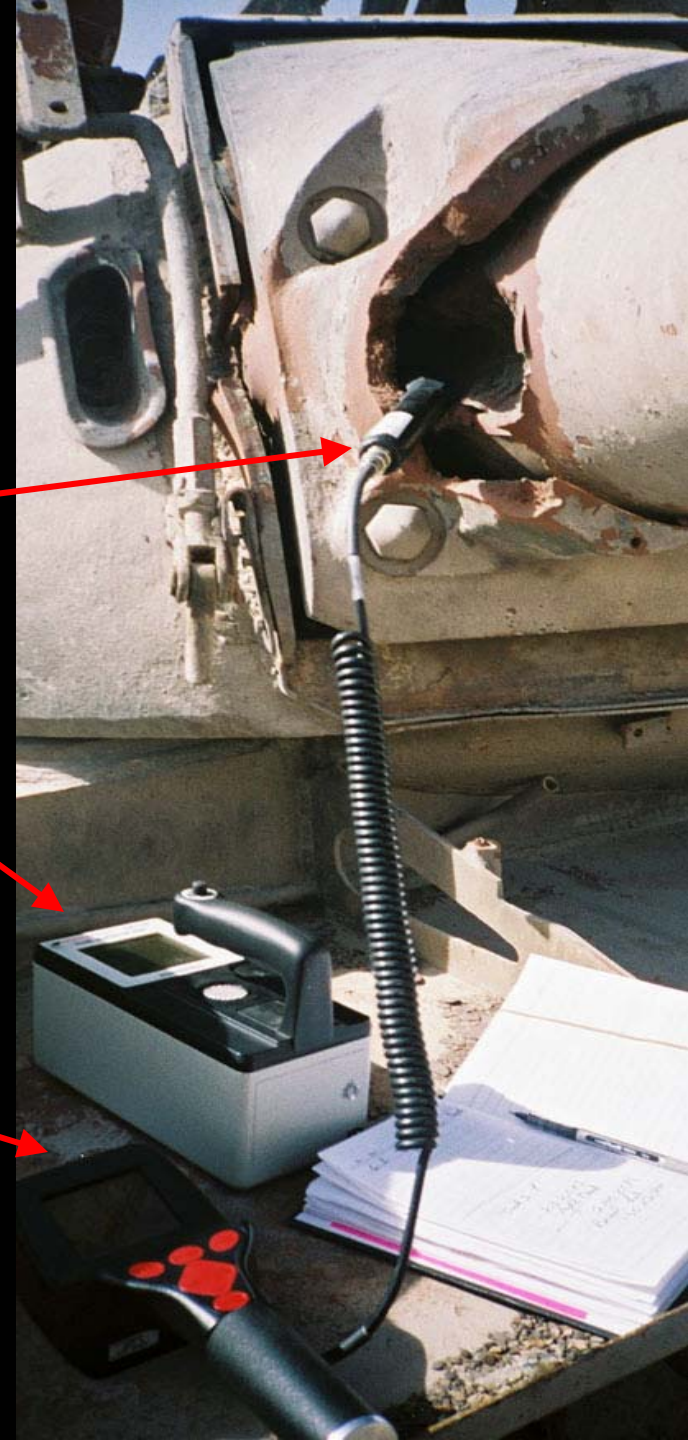
Radioactive tank on perimeter of Baghdad International Airport

# Survey Equipment

Remote Frisking Probe Victoreen  
489-110d

Exploranium Multi-channel Isotope  
Analyzer

Victoreen Advanced Survey Meter  
990 GM Radiation Detector







Inside the engine compartment of a destroyed Iraqi tank

## Radiation probe inserted into penetrator channel



1.11 kcps



# Environmental Radioactivity Baselines and Reference Levels

Location	Ground Surface	Ambient Open-Air
Victoreen Reference for North America	0.83 CPS 49.8 CPM	0.10 CPS 6.0 CPM
Central Baghdad	1.00 CPS 60.0 CPM	1.13 CPS 67.8 CPM
Al-Basra City Center	0.50 CPS 30.0 CPM	N/A

# Radioactivity in Ground Combat Areas

Location of Defeated Iraqi Asset	Penetration Channel (CPS)	Adjacent Horizontal Asset (CPS)	Associated Debris (CPS)	Elevation over Iraq Reference IR: 0.91 CPS
Baghdad Gate	N/A	N/A	350	385 x IR
As Suweirah South of Baghdad	N/A	29	N/A	32 x IR
As Suweirah South of Baghdad	N/A	32	32	35 x IR
Al Ashar Bara Area	1120	23	4.9	1,231 x IR

# Radioactivity in Ground Combat Areas

Location of Defeated Iraqi Asset	Penetration Channel (CPS)	Adjacent Horizontal Asset (CPS)	Associated Debris (CPS)	Elevation over Iraq Reference IR: 0.91 CPS
Al Abu Kasib	2,390	22.4	0.38	2,626 x IR
Al Abu Kasib	1,020	132	8.2	1,121 x IR
An Nasiryiah	392	92	9.0	431 x IR
Baghdad International Airport	530	N/A	N/A	582 x IR

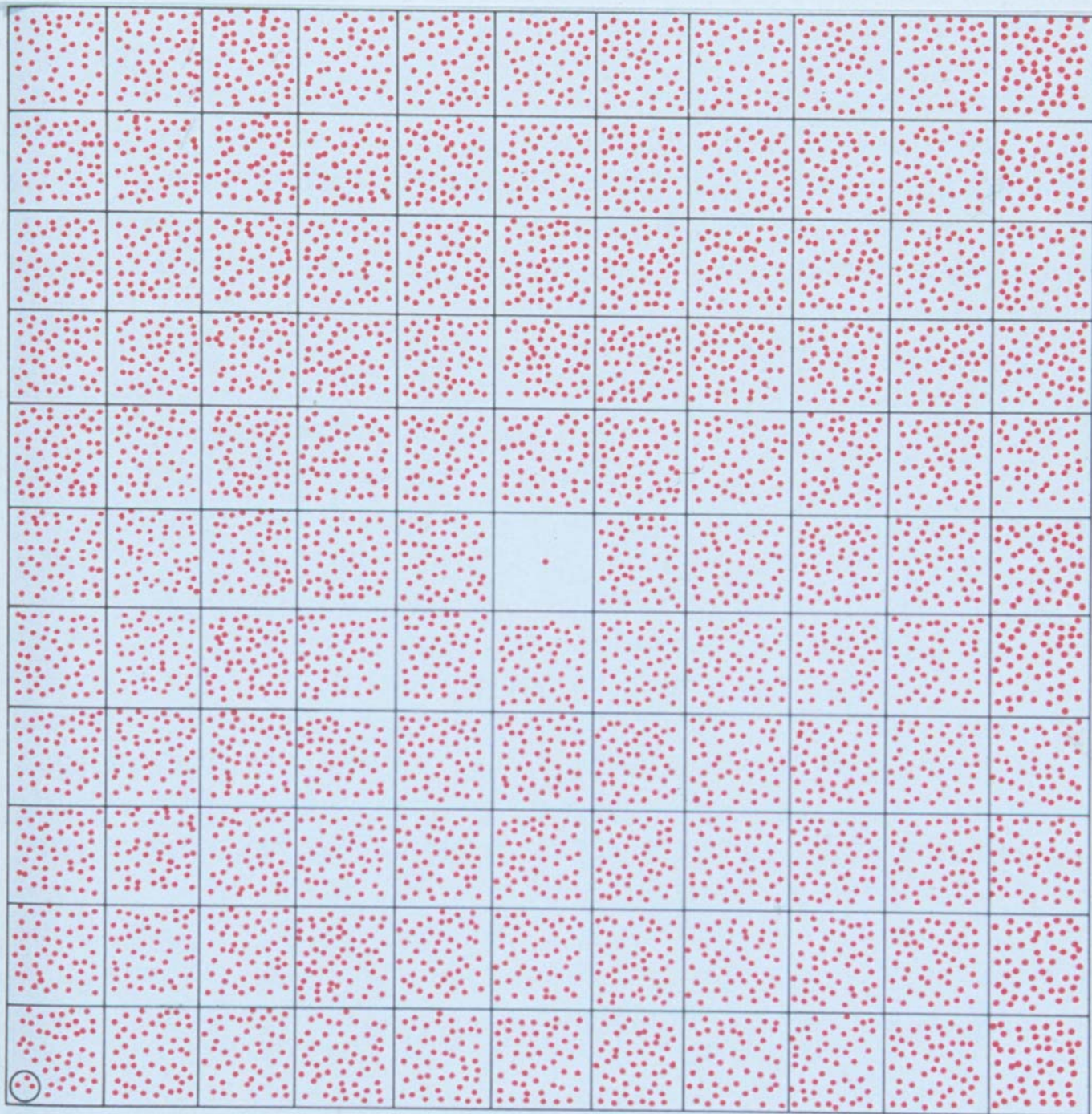
Disabled Iraqi tank featured on MOD website found to be radioactive



The background is a dark blue gradient. In the upper left, there is a bright pinkish-white lens flare with a red circular outline. In the upper right, a bright yellow light source creates a large, diagonal lens flare. Several semi-transparent circles of various sizes are scattered across the lower half of the image, some overlapping the lens flares.

# The Future







**The Current Global Nuclear  
Arsenal is Equivalent to One  
Million Hiroshimas**

