



High Precision Urinary Uranium Isotopes Analysis to Assess Depleted Uranium Exposure

Research Project: "High precision urinary uranium isotopes analysis to assess depleted uranium exposure"

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Reliable evidence of depleted uranium (DU) exposure is essential if any link is to be clearly established between such exposure (especially if via the inhalation pathway) and health, and to elucidate the relationship, if any, between Gulf War Illness and DU. Evidence can consist of confirmed aerosol exposure (for instance from a source of airborne pollution) or it could be confirmed contamination by a test following a short term or chronic exposure. Because DU munitions that are aerosolized during warfare are able to combust and oxidize, fine particles are rendered much less soluble than would otherwise be the case. Inhalation of respirable particles could lead to long term lung contamination, which in due course would lead to a detectable contribution in urine over and above that produced by natural uranium ingestion of uncontaminated food and water. We have developed a very precise method of uranium isotope analysis that uses chemical precipitation separation of uranium from urine followed by multicollector ICP-MS mass spectrometry. This method is able to reliably determine the isotopic composition of uranium extracted from urine with a precision of $\pm 1\%$ at the 95% confidence interval on total amounts of uranium in urine as low as 0.2 ppt (parts per trillion; e.g. 0.1 nanogram in 500ml urine). The presence of the DU contaminant U-236 in the fg/L range (10^{-15} g/L) supports detection of the urinary excretion of DU in the low pictogram per litre range (< 2 nBq/L) or at fractions as low as 0.2% of the total urinary uranium concentration.

This methodology provides a way to measure very small amounts of excreted DU that may be an indicator of larger inhalation exposure many years or even decades prior. We have been involved in the measurement of uranium isotopes in individuals from Afghanistan (2001), Iraq during the Gulf War of 1991, Iraq during the recent conflict, and in other areas where DU has been a prominent pollutant. The interpretation of DU contamination, in terms of health implications, is complex but very much dependent upon the exposure pathway, chemical and physical form of the uranium, and the quantity of uranium contaminant.

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Publications

1. Parrish RR, Thirwall M, Pickford C, Horstwood M, Gerdes A, Anderson J, Coccon D, 2006. Determination of $^{238}\text{U}/^{235}\text{U}$, $^{236}\text{U}/^{238}\text{U}$ and uranium concentration in urine using SF-ICP-MS and MC-ICP-MS: An interlaboratory comparison. *Health Physics*, in press.

Conference presentations

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2. Gerdes A, Weyer S, Brey G. Environmental monitoring of long-lived radionuclides using Multi-Collector ICP-MS. International Conference on isotopes in environmental studies, IAEA, Aquatic Forum, Monaco, 25-29 October 2004, abstract volume.
3. Gerdes A, Weyer S, Brey G, Durakovic A. Precise monitoring of Depleted Uranium in humans and environment of South Iraq using MC- ICP-MS. ECORAD 2004, Aix-en-provence, 5-10. September, 2004.
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6. Durakovic A, Gerdes A, Zimmerman, I. Uranium Isotopes Bioassay in the Civilians of Baghdad and Al Basra after Operation Iraqi Freedom. Radiological Society of North America, Chicago, 28.11 – 3.12.2004
7. Durakovic A, Parrish RR, Gerdes A, Zimmerman, I. 2004. Internal Contamination with Uranium Isotopes after Operation Enduring Freedom in the Civilian Population of Jalalabad

and Kabul, Afghanistan. 8th Asia & Oceania Congress of Nuclear Medicine and Biology, Beijing, 9-13. October 2004.

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9. Durakovic A, Gerdes A, Parrish RR, Zimmerman I, Gresham S. 2004. The Urinary Concentration and Ratio of Uranium Isotopes in Civilians of the Bibi Mahro Region after Recent Military Operations in Eastern Afghanistan. 11th International Congress of the International Radiation Protection Association, Madrid, Spain, May 23-28, 2004.

10. Durakovic A, Gerdes A, Zimmerman, I. 2004. Quantitative Analysis of Concentration and Ratio of Uranium Isotopes in the US Military Personnel Deployed at Samawah, Iraq during Operation Iraqi Freedom. *European Society for Radiation Biology*, Budapest, 25.-28 August 2004.

11. Gerdes A: Detection of U-236 and Pu isotopes in human urine at ppq to sub-ppq level. *European Winter Conference on Plasma Spectrochemistry*, Budapest, 30.1-2.02.2005.

12. Durakovic A, Gerdes A, Zimmerman, I. The Bioassay of Uranium Isotopes in the Civilians of Baghdad and International Research Team Members after Operation Iraqi Freedom. *European Association of Nuclear Medicine*, Vienna, October 2005.

13. Durakovic A, Gerdes A, Zimmerman, I. Quantitative Analysis of Uranium Isotopes in the Civilians of Iraq after Operation Iraqi Freedom. *Croatian Society of Nuclear Medicine*, Opatija, Croatia, May 2005.

14. Parrish RR & Gerdes A: Depleted Uranium screening using high precision isotope analysis to assess DU exposure, *International Environmental Health Conference*, Amman, Jordan, September 19-22. *International Journal of Toxicology*, 2005

15. Gerdes A & Parrish RR: High precision uranium isotopes analysis to assess depleted uranium exposure. *Workshop on U isotopes measurements, IRMM*, Geel, Belgium, 16-17 March 2006.