

# The Urinary Concentration and Ratio of Uranium Isotopes in Civilians of the Bibi Mahro Region after Recent Military Operations in Eastern Afghanistan\*

Asaf Durakovic†, Randall R. Parrish‡, Axel Gerdes‡, Isaac Zimmermant

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The aim of this work was to quantitatively evaluate the precise concentration and isotopic ratios of uranium isotopes in the urine of the civilians of eastern Afghanistan following the air raids during Operation Enduring Freedom. Our previous studies reported unusually high concentrations of uranium in the Jalalabad and Kabul regions of Afghanistan.

The current study was conducted in a localized district of Bibi Mahro, Kabul, the area of intense bombing raids. Six male subjects with the clinical presentation of non-specific multi-organ symptoms of respiratory, urinary, musculoskeletal, and neurological alterations had their urine samples collected by the field research team under controlled conditions. All subjects were exposed to the inhalation of dust during the bombing operations of Allied Forces in June, 2002. Twenty-four hours urine samples were analyzed for  $^{234}\text{U}$ ,  $^{235}\text{U}$ ,  $^{236}\text{U}$ , and  $^{238}\text{U}$  by multicollector inductively-coupled plasma ionization mass spectrometry (MC-ICP-MS) as duplicate specimens. Internal urine standard control samples were analyzed by the same methodology.

All samples were processed by the procedure of uranium pre-concentration with co-precipitation, evaporation, organic matter oxidation, ion-exchange chromatography, uranium purification, and mass spectrometry analysis by Thermo-Elemental Plasma54 multicollector ICP-MS with ion counting Daly® detector and multiple Faraday cups. The blank samples contained negligible concentration of less than 50 pg of total uranium. The chemical recovery was greater than 80% for most samples. Internal standard of the urine with 11 ng/L of uranium of natural atomic ratio  $^{238}\text{U}:^{235}\text{U}$  of 137.88 was also analyzed, together with certified isotopic standards of uranium. The results of all analyses were within the correct values for the standards.

The mean concentration of uranium in all six samples was significantly higher (389 ng/L, SD 805, SE 329) than the normal population values (1-20 ng/L) with an exceedingly high concentration (2032 ng/L) in a child, the sole survivor of a direct bomb impact on the family home. The  $^{238}\text{U}:^{235}\text{U}$  ratio was  $138.14 \pm 0.13$ , consistent with natural uranium. The samples showed no evidence of detectable  $^{236}\text{U}$  with measured ratio of  $^{236}\text{U}:^{238}\text{U} < 10^{-6}$ .

These results suggest that the civilian population of the Bibi Mahro region of eastern Afghanistan had significant elevation of total uranium concentration up to 200 times higher than the normal values of the range of the world environmental and geographic areas. The explanation of our findings could be either of two possible mechanisms. 1) exposure to contaminated dust in the areas of the bombing raids by natural uranium containing weapons or 2) unusual geological and environmental excessively high uranium levels contained in the soil or drinking water. Whereas some areas of central Asia have been identified as high uranium regions in the water and soil as a result of uranium mining and processing, such circumstances have not been identified in the Bibi Mahro region of Afghanistan. An interdisciplinary approach to testify these hypotheses is a part of our ongoing studies.

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† Uranium Medical Research Centre

‡ NERC Isotope Geosciences Laboratory, British Geological Survey, Keyworth, Notts, United Kingdom