The Quantitative Analysis of Uranium Isotopes in the Urine of Civilians after Operation Enduring Freedom in Jalalabad, Afghanistan*

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The purpose of this study was to determine the concentration and precise isotopic composition of four uranium isotopes (^{234}U, ^{235}U, ^{236}U, ^{238}U) in the urine specimens of the civilian population of Afghanistan following allied forces Operation Enduring Freedom.

Eight male civilians from Nangarhar-Jalalabad region presenting with symptoms of fatigue, fever, musculoskeletal and neurological alterations, headaches, and respiratory impairment after inhalation of dust during the bombing raids in June, 2002, had their urine samples collected under controlled conditions and analyzed in duplicate for ^{234}U, ^{235}U, ^{236}U and ^{238}U by multicollector inductively coupled plasma ionization mass spectrometry (MC-ICP-MS). Control samples consisting of an internal urine standard were analyzed by the same method.

The analytical methodology involved pre-concentration of the uranium using co-precipitation and/or evaporation, oxidation of organic matter, purification of uranium using ion exchange chromatography, and mass spectrometry using a double focusing Thermo-Elemental Plasma54 multicollector ICP-MS equipped with a Daly® detector for ion counting (for some of the smaller isotopes) and multiple faraday cups. Analytical blanks were negligible at less than 50 picograms U, and chemical recovery was > 80% in most cases. Along with the samples, analyses were conducted of a urine internal standard (with c. 11 ng/L uranium) of natural isotopic composition (atomic ratio 137.88 for ^{238}U:^{235}U) and certified isotopic standards of uranium, both of which returned the correct values for the standards.

The mean concentration of uranium in eight samples was found to be considerably greater (273.05 ng/L, SD 136.81, SE 48.37) than what is regarded as a normal population (1-20 ng/L). The ^{238}U:^{235}U ratio was 137.87 ± 0.20, which is consistent with natural uranium. The ^{234}U:^{238}U ratio for the Afghan samples was 0.000055 ± 0.000001, also consistent with natural uranium. ^{236}U, which usually forms a component of depleted uranium, was not detected (measured ^{236}U:$^{238}U < 10^{-7}$). Our results demonstrate that contamination of Afghanis with a source consistent with natural uranium has resulted in total uranium concentration levels of up to 100 times higher than the normal range of various worldwide geographic and environmental areas.

The cause for this could be either of two contrasting explanations: 1) exposure to uranium contaminated dusts in localized areas (i.e. Jalalabad) as a results of detonation of weapons containing natural uranium during the conflict in the Nangarhar province of Afghanistan or 2) exposure to excessively high levels of uranium contained in drinking water or soils by highly unusual geological circumstances. Our investigations are attempting to test these hypotheses as part of our ongoing studies.

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