

# Concentration and Ratio of Uranium Isotopes in the Fine-Fraction of Surface Soil from Baghdad and Basra Collected after Operation Iraqi Freedom\*

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The purpose of this study was the quantitative determination of the concentration and ratio of four uranium isotopes in the fine surface-soil fraction after coalition operation Iraqi Freedom.

Ten samples, representing normal as well as obviously contaminated surface soils, were collected by the Uranium Medical Research Centre field team from different sites of Baghdad, Basra, and the Suweirah farming area. Soil fine-fractions (< 150 micrometers), corresponding to 6 to 50% of the total samples, were separated and leached in hot aqua regia leaving most of the natural uranium behind in undissolved minerals. The uranium fraction was purified by ion-exchange chromatography and analyzed by a double-focusing multicollector ICPMS Neptune equipped with a retarding potential quadrupole lens and a secondary electron multiplier for detection of  $^{234}\text{U}$  and  $^{236}\text{U}$ . A certified isotope reference solution of uranium was analyzed along side the samples. Errors were propagated by including all uncertainties involved during analyses, data processing, and data corrections.

The uranium concentration in the soil fine-fraction varies from about 1 to 2,600 mg/kg and is clearly positive correlated with the  $^{238}\text{U}:^{235}\text{U}$  ratio, which ranges from 139.3 to 542.1. The  $^{234}\text{U}:^{238}\text{U}$  ratio ranges from  $7.42 \times 10^{-6}$  to  $7.05 \times 10^{-5}$  and is negative correlated with the  $^{238}\text{U}:^{235}\text{U}$  ratio.  $^{236}\text{U}$  is present in all samples, ranging from 0.23 to 30,724 ng/kg with a  $^{236}\text{U}:^{238}\text{U}$  ratio of  $1.4 \times 10^{-7}$  to  $1.2 \times 10^{-5}$ . The latter generally correlates positive with the  $^{238}\text{U}:^{235}\text{U}$  ratio; the data, however, also suggest the use of depleted uranium with different amounts of  $^{236}\text{U}$ .

Our results demonstrate the presence of depleted uranium (DU) in the superficial soil fine-fraction from all three regions and warrant further objective, interdisciplinary evaluation of the environmental and health impact of the uranium contamination of the biosphere in Iraq.

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