

**Determination of extremely low  $(^{236}\text{U})/(^{238}\text{U})$  isotope ratios in environmental samples by sector-field inductively coupled plasma mass spectrometry using high-efficiency sample introduction.**

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**Source**

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**Abstract**

A method by inductively coupled plasma mass spectrometry (ICP-MS) was developed which allows the measurement of  $(^{236}\text{U})$  at concentration ranges down to  $3 \times 10^{-14} \text{g g}^{-1}$  and extremely low  $(^{236}\text{U})/(^{238}\text{U})$  isotope ratios in soil samples of  $10^{-7}$ . By using the high-efficiency solution introduction system APEX in connection with a sector-field ICP-MS a sensitivity of more than 5,000 counts  $\text{fg}^{-1}$  uranium was achieved. The use of an aerosol desolvating unit reduced the formation rate of uranium hydride ions  $\text{UH}^{+}/\text{U}^{+}$  down to a level of  $10^{-6}$ . An abundance sensitivity of  $3 \times 10^{-7}$  was observed for  $(^{236}\text{U})/(^{238}\text{U})$  isotope ratio measurements at mass resolution 4000. The detection limit for  $(^{236}\text{U})$  and the lowest detectable  $(^{236}\text{U})/(^{238}\text{U})$  isotope ratio were improved by more than two orders of magnitude compared with corresponding values by alpha spectrometry. Determination of uranium in soil samples collected in the vicinity of Chernobyl nuclear power plant (NPP) resulted in that the  $(^{236}\text{U})/(^{238}\text{U})$  isotope ratio is a much more sensitive and accurate marker for environmental contamination by spent uranium in comparison to the  $(^{235}\text{U})/(^{238}\text{U})$  isotope ratio. The ICP-MS technique allowed for the first time detection of irradiated uranium in soil samples even at distances more than 200 km to the north of Chernobyl NPP (Mogilev region). The concentration of  $(^{236}\text{U})$  in the upper 0-10 cm soil layers varied from  $2 \times 10^{-9} \text{g g}^{-1}$  within radioactive spots close to the Chernobyl NPP to  $3 \times 10^{-13} \text{g g}^{-1}$  on a sampling site located by  $>200$  km from Chernobyl.