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Development of new low-level method for the analysis of iodine 129 and the isotopic ratio 129I/127I determination

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Iodine is an extremely volatile element naturally present under various organic or inorganic forms. These physico-chemical characteristics complicate its extraction and quantification. Among the 37 iodine isotopes, 127I is the only stable one and 129I is the radioisotope with the longest half-life (16.1 x 106 y). 129I is chronically and regulatory released by fuel reprocessing plants e.g. Sellafield (UK) and La Hague (France) and also released in the atmosphere by nuclear power plants during normal operation process or in case of an accident. 129I quantification and the determination of 129I/127I isotopic ratio is then essential in a post-accidental context, environmental monitoring field or transfer mechanism studies.
129I quantification is usually performed by γ-spectroscopy or Liquid Scintillation Counting (LSC). These methods don't however allow the determination of the isotopic ratio (129I/127I) and obtained limit of detection (20 mBq/L and 10 mBq/L respectively after chemical treatment) are often higher than the environmental background. AMS allows also the quantification of 129I and 129I/127I. Although performances of AMS no longer have to be demonstrated (excellent sensibility and selectivity), this device is not easily accessible.
ICP-MS is an excellent alternative for the determination of 129I and 129I/127I isotopic ratio. However, spectral and non-spectral interferences could disturb the measurement. In the present work, the ICP-MS measurements were performed using an ICP-MS/MS (8900 Agilent®). The measurement medium was meticulously studied to minimize non-spectral interferences such as memory and matrix effects. Concerning spectral interferences, the octopole collision/reaction cell and the two quadrupole mass filters allowed minimizing polyatomic interferences. The isobaric interference due to 129Xe was eliminated after studying different reaction gas (O2, N2O and CO2) with on-mass and mass-shift detection modes.
The new method allows the measurement of iodine 129 either directly or after chemical treatment. The chemical treatment was developed, adapted to ICP-MS measurement medium and validated with reference materials. The turnaround time for the experiment is less than a day. A gain in sensitivity up to a factor 200 was observed and allowed reducing the detection limit up to 0.06 mBq/L after chemical treatment, which is 100 times lower than some current methods.

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