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ICP-MS DETERMINATION OF RARE EARTH ELEMENTS AND THORIUM IN URANIUM-RICH GEOLOGICAL SAMPLES

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Abstract

Uranium is the key fuel element in the field of nuclear energy. Hence, it often becomes necessary to determine trace constituents in a variety of uranium-rich samples like uranium concentrates and reactor fuel grade samples as well as in geological samples. Solution inductively coupled plasma mass spectrometry (ICP-MS) has emerged as a powerful and sensitive technique that has been successfully used for accurate direct determination of trace elements in geological materials. But, even with ICP-MS, direct determination of trace constituents in uranium-rich geological materials is extremely difficult because of the high levels of total dissolved salts [TDS] and space charge effects arising from the heavy uranium matrix. Therefore, in the present work, the extent of signal suppression on all rare-earth elements and yttrium due to the uranium matrix has been studied at a single set of operating conditions for different amounts of uranium taken and the tolerance limits have been evaluated. Significant space charge effects on the rare-earth elements and yttrium were observed. Extending the studies to some real samples, selected uranium-rich samples were analysed by ICP-MS in the presence of uranium matrix as well as after solid phase extraction separation of the uranium matrix using activated carbon as sorbent in fluoride medium. The values were in good agreement since the uranium levels in the sample solutions aspirated into the plasma were kept below 50µg/mL by applying appropriate dilution. Sample solutions of two uraninite mineral samples were also analysed after removal of the major uranium matrix. The values obtained by ICP-MS were in good agreement with those reported using inductively coupled plasma optical emission spectrometry (ICP-OES).

Keywords: ICP-MS, ICP-OES, Geological samples, Uranium, Uraninite, Rare Earth Elements Thorium-space-charge effects, Solid phase extraction, Activated carbon.