



Standard Test Method for Analysis of Total and Isotopic Uranium and Total Thorium in Soils by Inductively Coupled Plasma-Mass Spectrometry¹

This standard is issued under the fixed designation C 1345; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of total uranium (U) and thorium (Th) concentrations in soils, as well as the determination of the isotopic weight percentages of ^{234}U , ^{235}U , ^{236}U , and ^{238}U , thereby allowing for the calculation of individual isotopic uranium activity or total uranium activity. This inductively coupled plasma-mass spectroscopy (ICP-MS) method is intended as an alternative analysis to methods such as alpha spectroscopy or thermal ionization mass spectroscopy (TIMS). Also, while this test method covers only those isotopes listed above, the instrumental technique may be expanded to cover other long-lived radioisotopes since the preparation technique includes the preconcentration of the actinide series of elements. The resultant sample volume can be further reduced for introduction into the ICP-MS via an electrothermal vaporization (ETV) unit or other sample introduction device, even though the standard peristaltic pump introduction is applied for this test method. The sample preparation removes organics and silica from the soil by use of a high temperature furnace and hydrofluoric acid digestion. Thus, this test method can allow for sample variability of both organic and silica content. This test method is also described in ASTM STP 1291.

1.2 The analysis is performed after an initial drying and grinding sample preparation process, and the results are reported on a dry weight basis. The sample preparation technique used incorporates into the sample any rocks and organic material present in the soil. The method of sample preparation applied differs from other techniques, such as those found in Practice C 999, which involve simply tumbling and sieving the sample; however, the user may select whichever technique is most appropriate to their needs.

1.3 A linear calibration is performed for total uranium and thorium over a concentration range from 5 to 5000 $\mu\text{g/L}$, using approximately 6 points. As with the data presented, it is suggested that the increments between points be less than or equal to a factor of ten. With a sample dilution factor of 200

resulting from the preparation, this equates to a concentration range in the samples from 1 to 1000 $\mu\text{g/g}$. For those samples estimated to be above that range by initial activity screening, a smaller aliquot is taken to a dilution of 1000, thereby extending the range to 5000 $\mu\text{g/g}$. It is important to note that the concentration measured directly from this calibration is the concentration of ^{238}U . The standard values are adjusted for abundance and the abundances in the instrument database are modified to eliminate any automatic correction, as discussed further in the appropriate sections. The calibration range can be changed based on the needs of the user and the expected variation among samples.

1.4 Corrections to the measured isotopic ratios for mass bias effects are made by determining and applying a mass bias factor (see 13.3.1). This can be performed for each batch analyzed. Refer to Appendix X1 for an optional correction approach where this factor is determined and applied less frequently and a calibration correction of measured versus certified ratios is determined on a batch basis in the range of the samples analyzed.

1.5 The values stated in $\mu\text{g/g}$, $\mu\text{g/L}$ or ng/g concentration, and Becquerel per gram (Bq/g) activity are the acceptable SI units. However, picocurie per gram (pCi/g) is frequently used in radiochemistry and established regulatory guidelines and will, therefore, also be regarded as standard in this test method.

1.6 Many of the quality control (QC) practices or checks in this test method (such as the QC standards used, their frequency and general sequence) reflect the guidelines set forth in EPA Method 6020 in SW-846. EPA Method 6020 is not strictly followed, however, because of the fact that it does not cover uranium and thorium analysis, or radioisotopic determinations. The quality control practices and checks used is subject to the discretion of the laboratory or user, and EPA Method 6020 should be referred to as a guideline.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

¹ This test method is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.05 on Methods of Test.

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