National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material® 1643e

Trace Elements in Water

This Standard Reference Material (SRM) is intended primarily for use in evaluating methods used in the determination of trace elements in fresh water. SRM 1643e consists of approximately 250 mL of acidified water in a polyethylene bottle, which is sealed in an aluminized plastic bag to maintain stability. SRM 1643e simulates the elemental composition of fresh water. Nitric acid is present at a concentration of approximately 0.8 mol/L to stabilize the trace elements.

Certified Values: The certified values for 29 elements in SRM 1643e are listed in Table 1. All values are reported both as mass fractions (µg/kg) and as mass concentrations (µg/L). A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or accounted for by NIST [1]. The certified values are the average of the gravimetrically prepared value and a value determined by either inductively coupled plasma mass spectrometry (ICP-MS) or inductively coupled plasma optical emission spectrometry (ICP-OES). The expanded uncertainty for each certified value is calculated as

$$U = ku_c$$

where k is the coverage factor for a 95 % confidence interval and u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides [2]. The value of u_c is intended to represent, at the level of one standard deviation, the combined effect of uncertainty components associated with the gravimetric preparation, the ICP-MS or ICP-OES determination, method bias [3], and stability.

Information Value: A rhenium values is listed in Table 2 for information purposes only. An information value is considered to be a value that will be of interest to the SRM user, but insufficient information is available to assess the uncertainty associated with the value [1]. The information value is based on results from one NIST method.

Expiration of Certification: This certification of SRM 1643e is valid, within the measurement uncertainties specified, until **31 March 2014**, provided the SRM is handled in accordance with instructions given in this certificate. This certification is nullified if the SRM is damaged, contaminated, or modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certification, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

Coordination of the NIST technical measurements was under the direction of T.A. Butler and G.C. Turk of the NIST Analytical Chemistry Division. The ICP-MS analyses were performed by T.A. Butler, L.L. Yu, and G.C. Turk. The ICP-OES analyses were performed by T.A. Butler and G.C. Turk.

Statistical analysis of the experimental data was performed by S.D. Leigh and D.D. Leber of the NIST Statistical Engineering Division.

The support aspects involved in the issuance of this SRM were coordinated through the NIST Measurement Services Division.

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See Certificate Revision History on Last Page

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Table 1. Certified Values, Expanded Uncertainties, and Coverage Factors for Trace Elements in SRM 1643e

Element	Mass Fraction (µg/kg)			Mass Concentration (µg/L)			*k*
Aluminum	138.33	±	8.4	141.8	±	8.6	3.2
Antimony	56.88	±	0.60	58.30	±	0.61	2.0
Arsenic	58.98	±	0.70	60.45	±	0.72	2.0
Barium	531.0	±	5.6	544.2	±	5.8	2.0
Beryllium	13.64	±	0.16	13.98	±	0.17	2.0
Bismuth	13.75	±	0.15	14.09	±	0.15	2.0
Boron	154.0	±	3.8	157.9	±	3.9	2.4
Cadmium	6.408	±	0.071	6.568	±	0.073	2.0
Calcium	31 500	±	1 100	32 300	±	1 100	2.8
Chromium	19.90	±	0.23	20.40	±	0.24	2.0
Cobalt	26.40	±	0.32	27.06	±	0.32	2.0
Copper	22.20	±	0.31	22.76	±	0.31	2.1
Iron	95.7	±	1.4	98.1	±	1.4	2.0
Lead	19.15	±	0.20	19.63	±	0.21	2.0
Lithium	17.0	±	1.7	17.4	±	1.7	3.2
Magnesium	7 841	±	96	8 037	±	98	2.0
Manganese	38.02	±	0.44	38.97	±	0.45	2.0
Molybdenum	118.5	±	1.3	121.4	±	1.3	2.0
Nickel	60.89	±	0.67	62.41	±	0.69	2.0
Potassium	1 984	±	29	2 034	±	29	2.1
Rubidium	13.80	±	0.17	14.14	±	0.18	2.0
Selenium	11.68	±	0.13	11.97	±	0.14	2.0
Silver	1.036	±	0.073	1.062	±	0.075	3.2
Sodium	20 230	±	250	20 740	±	260	2.0
Strontium	315.2	±	3.5	323.1	±	3.6	2.0
Tellurium	1.07	±	0.11	1.09	±	0.11	3.2
Thallium	7.263	±	0.094	7.445	±	0.096	2.0
Vanadium	36.93	±	0.57	37.86	±	0.59	2.1
Zinc	76.5	±	2.1	78.5	±	2.2	2.6

Table 2. Information Value for Trace Elements in SRM 1643e

Element	Mass Fraction (µg/kg)	Mass Concentration (µg/L)
Rhenium	110	113

Preparation of Material: SRM 1643e was prepared at NIST using only high purity reagents. The containers were acid cleaned before use. In the preparation, a polyethylene cylindrical tank was filled with deionized water and sufficient nitric acid to make the solution approximately 0.8 mol/L. Known masses of the matrix elements (sodium, potassium, calcium, and magnesium) were added to the tank solution as solutions prepared from the same primary materials used to prepare the SRM 3100 Series of Single Element Solutions. Known masses of the other elements were then added to the tank solution using weighed aliquots of the SRM 3100 Series. The final total mass of the tank solution was determined, allowing calculation of the gravimetrically prepared mass fraction for each element. Mass concentrations were calculated using the measured density of 1.025 g/mL. After mixing thoroughly, the solution was transferred to clean 250 mL polyethylene bottles.

INSTRUCTIONS FOR USE

Precautions: The SRM should be shaken before use because of possible water condensation. To prevent possible contamination of the SRM, **DO NOT** insert pipettes into the bottle. Samples should be decanted at a room temperature of 17 ºC to 27 ºC. After use, the bottle should be recapped tightly and returned to the aluminized plastic bag, which should be folded and sealed with sealing tape. This safeguard will protect the SRM from possible environmental contamination and long-term evaporation.

The accuracy of trace element determinations, especially at the µg/L level, is limited by contamination. Apparatus should be scrupulously cleaned and only high purity reagents employed. Sampling and manipulations, such as evaporations, should be done in a clean environment, such as a Class-100 clean hood.

REFERENCES

[1] May, W.; Parris, R.; Beck, C.; Fassett, J.; Greenberg, R.; Guenther, F.; Kramer, G., Wise; S., Gills, T.; Colbert, J.; Gettings, R.; MacDonald, B.; *Definition of Terms and Modes Used at NIST for Value-Assessment of Reference Materials for Chemical Measurements*; NIST Special Publication 260-136, U.S. Government Printing Office: Washington, DC (2000).

[2] ISO; *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, lst ed. International Organization for Standardization, Geneva, Switzerland, (1993); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office, Washington, DC (1994); (available at http://physics.nist.gov/Pubs/).

[3] Levenson, M.S.; Banks, D.L.; Eberhart, K.R.; Gill, L.M.; Guthrie, W.F.; Liu, H.K.; Vangel, M.G.; Yen, J.H.; Zhang, N.F.; *An Approach to Combining Results From Multiple Methods Motivated by the ISO GUM,* J. Res. Natl. Inst. Stand. Technol., Vol. 105, p. 521 (2000).

Certificate Revision History: 26 March 2009 (Addition of a Rhenium information value and editorial revisions); 16 March 2004 (Original certificate date).

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-2200; fax (301) 926-4751; e-mail srminfo@nist.gov; or via the Internet at http://www.nist.gov/srm.