

Certificate of the Reference Material

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Name of the Material : Stable Elements in Seawater

Material Code : UME MetroPOEM CRM

Issue Date : 28.09.2026

Revision Date : 28.09.2026 (Revision history can be found on the last page)

Validity Period of the Certificate : 12 months from the sales date

Certified Values :

Parameter	Certified Value ^[1,2] (mol·mol ⁻¹)	Expanded Uncertainty ^[2,3] (mol·mol ⁻¹)	Coverage Factor, <i>k</i> ^[3]
$n(^{11}\text{B})/n(^{10}\text{B})$	4.2041	0.0062	2.03
$n(^{114}\text{Cd})/n(^{110}\text{Cd})$	2.3038	0.0069	2.07
$n(^{114}\text{Cd})/n(^{111}\text{Cd})$	2.2456	0.0099	2.07
$n(^6\text{Li})/n(^7\text{Li})$	0.07972	0.00043	2.20
$n(^{204}\text{Pb})/n(^{206}\text{Pb})$	0.05503	0.00020	2.13
$n(^{207}\text{Pb})/n(^{206}\text{Pb})$	0.8572	0.0025	2.09
$n(^{208}\text{Pb})/n(^{206}\text{Pb})$	2.0993	0.0050	2.12
$n(^{234}\text{U})/n(^{238}\text{U})$	0.0000626	0.0000013	2.10
$n(^{235}\text{U})/n(^{238}\text{U})$	0.007252	0.000013	2.09

- [1] The certified values were determined by an interlaboratory study and were calculated as the arithmetic means of results obtained by MC-ICP-MS measurements.
- [2] The certified values and the uncertainties are traceable to the International System of Units (SI).
- [3] The expanded uncertainties of certified values includes characterization, homogeneity, stability components and are stated as the standard uncertainty of measurement multiplied by the given coverage factors *k*, corresponding to a probability of approximately 95 % for the calculated effective degrees of freedom. The standard measurement uncertainty has been determined in accordance with GUM "Guide to the Expression of Uncertainty in Measurement".

Sales Date



Assoc. Prof. Mustafa ÇETİNTAŞ
Director

The following pages are an integral part of the certificate. The use of current certificate is customers' responsibility.

Most recent certificate can be downloaded from www.ume.tubitak.gov.tr.

Informative Values

The informative values for $n(^{60}\text{Ni})/n(^{58}\text{Ni})$ and the mass fraction values for the elements whose isotopic values were certified or intended to be measured are given in Table 1 and Table 2, respectively.

Table 1. The informative value for $n(^{60}\text{Ni})/n(^{58}\text{Ni})$ and associated uncertainty in certified reference material

Parameter	Informative Value ^[1] (mol·mol ⁻¹)	Expanded Uncertainty ^[2,3] (mol·mol ⁻¹)
$n(^{60}\text{Ni})/n(^{58}\text{Ni})$	0.38833	0.00060

[1] The value is based on three independent replicates of each of two units obtained by one laboratory.

[2] The uncertainty includes only measurement uncertainty of the laboratory provided the result.

[3] The expanded uncertainty is stated as the standard measurement uncertainty multiplied by a coverage factor $k=2$ corresponding to a probability of approximately 95 % confidence level. The standard measurement uncertainty has been determined in accordance with the GUM "Guide to the Expression of Uncertainty in Measurement".

Table 2. The informative values for the mass fractions of the elements in certified reference material

Element	Mass Fraction (μg·kg ⁻¹)
B [#]	5400
Cd [*]	12.5
Cr [*]	15.6
Li [#]	150
Ni [*]	13.4
Pb [*]	7.3
Sb [#]	9.4
U [#]	2.3

* Determined by ID-ICP-MS by TÜBİTAK UME

[#] Determined by ESI seaFASTSP2 ICP-MS/MS by Hereon

Description

The material is 250 mL seawater in HDPE bottle. The material is acidified with HNO₃ for stabilization of the elements. The material was spiked with the elements with very low concentrations to achieve the mass fractions suitable for the end users. After filling into bottles, the biological activities were terminated by gamma irradiation at 25 kGy. Additional information is available in the certification report.

Intended Use

The material is intended to be used as quality control material for validation of the methods, including trueness, for measurements of isotope ratios in seawater matrices. The material is also suitable for checking the sample preparation processes prior to isotopic ratio measurements for stable elements.

Instructions for Use

Before the use, the CRM bottle should be kept in the laboratory environment to equilibrate with room temperature and should be shaken before opening the cap to avoid a potential bias due to condensed water at the bottleneck. To avoid contamination, it is highly recommended that the bottle should be kept and opened in a clean environment and pipette should not be inserted into the bottle. After use, the bottle should be immediately and tightly recapped.

No study was conducted for the determination of minimum intake which will not result in any within-unit inhomogeneity because the material is in the liquid form, mix well and experiences from previous seawater certification showed no inhomogeneity when 1 mL - 5 mL of sample is used in the analysis. Furthermore, the levels are low and usually larger sample volumes are needed to conduct measurements. Nevertheless, even though no significant inhomogeneity is expected at lower amounts, use of the amounts in the certification studies as given in the certification report (Table 8) may be advised to the end user.

Storage Conditions

This material should be stored at $(+21 \pm 3) ^\circ\text{C}$ in a dark and clean environment as well as additionally packed (e.g. sealed bottle or sealed plastic bag) to minimize evaporation during storage.

TÜBİTAK UME cannot be held responsible for changes that might happen to the material at customer's premises due to noncompliance with the instructions for use, and the storage conditions given in the certificate.

Safety Information

The material contains 2 % (V/V) nitric acid and some of the target elements were spiked into solution. Therefore, the usual laboratory safety measures apply as in the case of similar solutions. The usual laboratory safety measures apply as in the case of similar acidified solutions. It is strongly recommended that the material must be handled and disposed according to the safety guidelines where applicable. Please refer to the Safety Data Sheet (SDS) before any use of the material.

Participants

Information about the laboratories participated in the characterisation study are given in Table 3. The informative values for the mass fractions of the elements were determined by TUBITAK UME and Hereon.

Table 3. Information about the laboratories participated in the certification

Laboratory	Address
TÜBİTAK UME	TÜBİTAK UME, TÜBİTAK Gebze Yerleşkesi, Barış Mahallesi, Dr. Zeki Acar Caddesi No.1, 41470 Gebze, Kocaeli, Türkiye
PTB	Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany
BAM	Bundesanstalt für Materialforschung und -prüfung (BAM), Richard-Willstätter-Straße 11, 12489 Berlin, Germany
JSI	Jožef Stefan Institute (JSI), Jamova cesta 39, SI-1000 Ljubljana, Slovenia
LGC	National Measurement Laboratory, LGC, The Priestley Center, 10 Priestley Road, Guildford, Surrey, GU2 7XY, United Kingdom
MUL	Montanuniversität Leoben (MUL), Department für Chemie, Lehrstuhl Allgemeine und Analytische Chemie, Franz Josef-Straße 18, 8700 Leoben, Austria
Hereon	Helmholtz-Zentrum Hereon, Max-Planck Straße 1, 21502 Geesthacht, Germany
AU and UGOT	Aarhus University (AU), Høegh-Gulbergs Gade 2, 1672, 234 8000 Aarhus, Denmark Gothenburg University (UGOT), Medical Radiation Sciences, Gula stråket 2 B SU/Sahlgrenska, 41345 Göteborg, Sweden
IFE	Institute for Energy Technology (IFE), Postboks 40, 2027 Kjeller, Norway
NIM	National Institute of Metrology (NIM China), No.18, Bei San Huan Dong Lu, Chaoyang District, Beijing 100029, China
ICL	Imperial College London (ICL), Department of Earth Science & Engineering, London SW7 2AZ, United Kingdom
UW	University of Warsaw Biological and Chemical Research Centre, CNBCh UW, ul.Żwirki i Wigury 101, 02-089 Warsaw, Poland
DTU	Technical University of Denmark (DTU), Building 204, Post Center 14, Frederiksborgvej 399, 4000 Roskilde, Denmark
Agilent UK	Agilent Technologies LDA UK Ltd, 5500 Lakeside, Cheadle Royal Business Park, Cheadle, SK8 3GR, United Kingdom

Methods and/or Techniques Used for the Determination of Certified Values

The results obtained by Multi-collector Inductively Coupled Plasma Mass Spectrometry methods with matrix separation optimized for each couple of isotopes was used in the characterization measurements. Two of the participating laboratories used QQQ-ICP-MS and their results were not included in the characterization data. The mass fractions of the elements were determined by either ID-ICP-MS (TÜBİTAK UME) using matrix separation by co-precipitation, or external calibration (Hereon) using ESI seaFAST SP2 coupled to ICP-MS/MS. The detailed information can be found in the certification report.

Revision History

Date	Remarks
28.09.2026	First publication.

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