NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

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Standard Reference Material® 330a
Copper Ore Mill Heads
CERTIFICATE OF ANALYSIS

Purpose: The certified values delivered by this Standard Reference Material (SRM) are intended primarily for use in evaluating chemical and instrumental methods of analysis as well as evaluating the accuracy of "material balance" measurements in the copper mining and metallurgical industries.

Description: A unit of SRM 330a consists of one bottle containing approximately 90 g of powder.

Certified Values: Certified values for seven elements in SRM 330a are listed in Table 1. 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 taken into account [1]. The measurands in Table 1 are mass fractions for each analyte reported and metrological traceability is to the International System of Units (SI) derived unit for mass fraction expressed as a percentage [2]. Certified values are based on the weighted means of analyses performed at NIST and collaborating laboratories [3]. The uncertainty listed with each value is an expanded uncertainty based on a 95 % confidence interval and is calculated according to the methods in the ISO/JCGM Guide and its Supplement 1 [4,5].

Table 1. Certified Mass Fractions for SRM 330a Copper Ore Mill Heads

Constituent	Value[a] (%)	Expanded Uncertainty[b] (%)	Coverage Factor[b] (k)
Aluminum (Al)	7.053	0.070	2
Barium (Ba)	0.156	0.011	2
Calcium (Ca)	0.323	0.024	2
Copper (Cu)	0.845	0.065	2
Potassium (K)	5.47	0.27	2
Magnesium (Mg)	0.868	0.074	2
Sodium (Na)	0.657	0.021	2

[a] The assigned value is a weighted mean of the results from two sets of measurements from multiple independent analytical methods using the method of DerSimonian and Laird as described by Rukhin [3].
[b] The uncertainty listed with the value is an expanded uncertainty about the mean, with coverage factor k, calculated by Monte-Carlo simulation of uncertainty components using methods from the ISO/JCGM Guide and its Supplement 1 [4,5].

Non-Certified Values: Non-certified values are provided in Appendix A.

Additional Information: Values of potential interest to users and additional information are provided in Appendix B.

Period of Validity: The certified values delivered by **SRM 330a** are valid within the measurement uncertainty specified until **31 December 2032**. The certified values are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

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Maintenance of Certified Values: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm) and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Safety: Please consult the Safety Data Sheet provided with this material.

Storage: The material should be stored in its original container, tightly capped, in a cool, dry location. Loss on drying was tested at 110 °C for 2 h and found to be approximately 0.87 %.

Use: To relate analytical determinations to the assigned values in this Certificate of Analysis, a minimum test portion of 100 mg is recommended on the basis of homogeneity testing performed at NIST using X-ray fluorescence spectrometry. The powder does not require preparation prior to weighing.

REFERENCES

[1] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Molloy, J.; Nelson, M.A.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sander, L.C.; Schiel, J.E.; Sharpless, K.E.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136, 2021 edition; U.S. Government Printing Office: Washington, DC (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Aug 2024)

[2] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at https://www.nist.gov/pml/special-publication-811 (accessed Aug 2024).

[3] Rukhin, A.L. *Weighted Means Statistics in Interlaboratory Studies*; Metrologia, Vol. 46, pp. 323–331 (2009).

[4] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (2008); available at https://www.bipm.org/en/committees/jc/jcgm/publications (accessed Aug 2024); 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 https://www.nist.gov/pml/nist-technical-note-1297 (accessed Aug 2024).

[5] JCGM 101:2008; *Evaluation of measurement data – Supplement 1 to the "Guide to Expression of Uncertainty in Measurement" – Propagation of Distributions Using a Monte Carlo Method*; Joint Committee for Guides in Metrology (2008); available at https://www.bipm.org/en/committees/jc/jcgm/publications (accessed Aug 2024).

Certificate Revision History: 07 August 2024 (Change of period of validity; updated format; editorial changes); **09 November 2010** (Original certificate date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

Non-Certified Values: Non-certified values are suitable for use in method development, method harmonization, and process control but do not provide metrological traceability to the International System of Units (SI) or other higher-order reference system. Non-certified values for fourteen elements are provided in Table A1. These values are based on the weighted means of analyses performed at NIST and collaborating laboratories [3]. The uncertainty listed with each value is an expanded uncertainty based on a 95 % confidence interval and is calculated according to the methods in the ISO/JCGM Guide and its Supplement 1 [4,5].

Table A1. Non-Certified Mass Fractions Values for SRM 330a Copper Ore Mill Heads

Constituent	Value[a] (%)	Expanded Uncertainty[b] (%)	Coverage Factor[b] (k)
Iron (Fe)	1.06	0.19	2
Silicon (Si)	33.4	1.3	2.47

Constituent	Value[a] (mg/kg)	Expanded Uncertainty[b] (mg/kg)	Coverage Factor[b] (k)
Cadmium (Cd)	3.391	0.027	2
Cerium (Ce)	22.32	0.34	2
Cobalt (Co)	4.542	0.069	2
Chromium (Cr)	77.0	4.0	2
Gallium (Ga)	17.4	0.18	2
Lithium (Li)	22.19	0.30	2
Nickel (Ni)	28.95	0.28	2
Scandium (Sc)	5.693	0.098	2
Strontium (Sr)	218.1	1.5	2
Yttrium (Y)	20.01	0.92	2
Zinc (Zn)	94.9	3.4	2
Zirconium (Zr)	80.5	2.2	2

[a] The assigned value is a weighted mean of the results from two sets of measurements from multiple independent analytical methods using the method of DerSimonian and Laird as described by Rukhin [3].

[b] The uncertainty listed with the value is an expanded uncertainty about the mean, with coverage factor k, calculated by Monte-Carlo simulation of uncertainty components using methods from the ISO/JCGM Guide and its Supplement 1 [4,5].

Maintenance of Non-Certified Values: NIST will monitor this material to the end of its period of validity. If substantive technical changes occur that affect the non-certified values during this period, NIST will update this Reference Material Information Sheet and notify registered users. SRM users can register online from a link available on the NIST SRM website or fill out the user registration form that is supplied with the SRM. Registration will facilitate notification. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

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APPENDIX B

Values of Potential Interest to Users: Values of potential interest to users for seven elements are provided in Table B1.

Table B1. Mass Fractions Values of Potential Interest for SRM 330a Copper Ore Mill Heads

Constituent	Value (mg/kg)
Molybdenum (Mo)	4.5
Niobium (Nb)	5.7
Phosphorus (P)	326
Lead (Pb)	27
Thorium (Th)	7.6
Titanium (Ti)	1 223
Vanadium (V)	43

Material Preparation and Analysis: The material for SRM 330a was provided by C. Bucknam of Newmont Metallurgical Services (Englewood, CO). The material was ground, blended, and bottled at the USGS (Denver, CO) under the supervision of S.G. Wilson. The material was characterized using the methods listed in Table B2.

Table B2. Analytical Methods Used for Characterization of SRM 330a Copper Ore Mill Heads

Constituent	Methods
Al, Ba, Ca, Cu, Fe, K, Mg, Na, Ti	WDXRF, ICP-OES, ICP-MS
Si,	WDXRF
P	WDXRF, ICP-OES,
Cd, Ce, Co, Cr, Ga, Li, Mo, Nb, Ni, Pb, Sc, Sr, Th, Ti, V, Y, Zn, Zr	ICP-OES, ICP-MS

Key to Methods in Table B2:

WDXRF	Wavelength dispersive X-ray fluorescence analyses performed at NIST
ICP-OES	Inductively coupled plasma optical emission spectrometry performed at the collaborating laboratories
ICP-MS	Inductively coupled plasma mass spectrometry performed at the collaborating laboratories

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