

CERTIFICATE OF ANALYSIS

IMZ 3.61

CERTIFIED REFERENCE MATERIAL IRON ORE

Analysis listed as percent by weight [% m/m]

	Certified value	Expanded uncertainty		Certified value	Expanded uncertainty
Fe	61.16	± 0.26	Na ₂ O	0.005	± 0.002
Mn	0.054	± 0.003	FeO	3.45	± 0.10
TiO ₂	0.072	± 0.003	C	0.288	± 0.008
CaO	0.074	± 0.005	Pb	0.0015	± 0.0007
K ₂ O	0.0059	± 0.0004	Zn	0.0031	± 0.0004
S	0.015	± 0.002	Ni	0.0013	± 0.0002
P	0.082	± 0.002	Cr	0.0031	± 0.0004
SiO ₂	5.60	± 0.10	Ba	0.003	± 0.001
Al ₂ O ₃	2.60	± 0.06	LOI	4.37	± 0.07
MgO	0.027	± 0.004			

the expanded uncertainty bases on statistical evaluation of the contributions the interlaboratory certification analysis and the material homogeneity

Informational values:

Co (0.0005)
V (0.0013)

Cu (0.0013)

Certificate Number: IMZ 3.61-170225
Certificate revision history on page 4

Analysis	Fe	*	Mn	*	TiO ₂	*	CaO	*	K ₂ O	*	S	*	P	*	SiO ₂	*
1	60.65	4	0.0495	3	0.0646	3	0.063	1	0.0057	3	0.0111	2	0.0779	3	5.03	3
2	60.79	1	0.0495	3	0.070	1	0.065	3	0.0058	1	0.012	2	0.0780	3	5.33	5
3	60.85	1	0.050	1	0.070	1	0.0695	3	0.0059	3	0.014	8	0.0780	7	5.43	5
4	60.90	4	0.052	1	0.071	1	0.071	3	0.006	3	0.014	8	0.080	1	5.57	3
5	60.94	1	0.052	3	0.0716	3	0.0713	3	0.006	1	0.015	2	0.080	1	5.58	3
6	61.02	4	0.054	3	0.072	1	0.072	1	0.0077	3	0.0153	3	0.0804	3	5.59	1
7	61.04	4	0.054	3	0.072	1	0.073	1	0.0101	3	0.016	2	0.081	1	5.592	3
8	61.09	1	0.056	1	0.080	3	0.080	3	<0,01	3	0.017	1	0.0810	1	5.597	1
9	61.21	4	0.057	3	0.080	3	0.080	1	<0,01	3	0.018	2	0.0810	7	5.60	3
10	61.30	4	0.058	1	0.0806	7	0.08	1			0.019	2	0.083	1	5.62	1
11	61.40	4	0.059	1			0.080	1					0.083	3	5.65	3
12	61.42	4	0.060	1			0.084	3					0.0839	7	5.67	1
13	61.54	3											0.0840	3	5.76	1
14	61.58	3											0.086	3	5.79	1
15	61.92	1											0.098	1		
16																
Average ¹	61.1569		0.0543		0.0722		0.0741		0.0059		0.0152		0.0815		5.5965	
SD ²	0.3084		0.0037		0.0028		0.0067		0.0002		0.0023		0.0026		0.0625	
u characterization ³	0.09976		0.00135		0.0011		0.00241		0.00007		0.00091		0.00083		0.02094	
u homogeneity ⁴	0.08633		0.00062		0.00084		0.00078		0.00020		0.00025		0.00083		0.04742	
Certified value ⁵	61.16		0.054		0.072		0.074		0.0059		0.015		0.082		5.60	
Expanded uncertainty ⁶	0.26		0.003		0.003		0.005		0.0004		0.002		0.002		0.10	

Analysis	Al ₂ O ₃	*	MgO	*	Na ₂ O	*	FeO	*	C	*	Pb		Zn		Cu**	
1	2.45	1	0.0207	3	0.0047	3	3.30	4	0.277	2	0.0011	3	0.002	3	0.0007	3
2	2.51	3	0.024	3	0.003	3	3.43	4	0.28	8	0.0012	3	0.0022	3	0.0010	3
3	2.514	3	0.024	1	0.0040	3	3.45	4	0.28	2	0.0014	3	0.0029	3	0.0012	3
4	2.52	1	0.024	3	0.0079	3	3.45	4	0.285	2	0.0015	3	0.0030	1	0.0013	1
5	2.59	3	0.027	1	<0,01	3	3.45	4	0.289	2	0.0016	3	0.0031	1	0.0017	3
6	2.60	3	0.037	3	<0,01	3	3.47	4	0.29	8	0.0017	1	0.0032	1	0.002	3
7	2.61	1	0.058	1			3.47	4	0.30	2	0.002	1	0.00336	3	<0.020	3
8	2.613	3	0.062	1			3.60	4	0.301	2	<0.01	3	0.0034	3		
9	2.626	3											0.0036	3		
10	2.639	10											<0.01	3		
11	2.640	7														3
12	2.68	1														
13	2.75	1														
14																
15																
16																
Average ¹	2.6034		0.0272		0.0045		3.453		0.2878		0.0015		0.0031		0.0013	
SD ²	0.0489		0.0047		0.0012		0.027		0.0091		0.0003		0.0004		0.0005	
u characterization ³	0.0170		0.0021		0.0008		0.012		0.0040		0.00014		0.00016		0.00024	
u homogeneity ⁴	0.02447		0.00074		0.00018		0.04772		0.00073		0.00033		0.00012		0.00011	
Certified value ⁵	2.60		0.027		0.005		3.45		0.288		0.0015		0.0031			
Expanded uncertainty ⁶	0.06		0.004		0.002		0.10		0.008		0.0007		0.0004			

Analysis	Ni		Cr		Ba		Co**		V**		LOI		As		Cl	
1	0.0006	3	0.0020	3	0.0033	3	0.0003	3	0.0007	3	4.27	5	0.00019	3	0.0066	1
2	0.0011	3	0.0028	1	0.0034	3	0.0004	3	0.0011	3	4.28	5	0.0002	3	0.0068	3
3	0.0013	3	0.0030	3	0.0034	3	0.0005	3	0.0016	3	4.32	5	0.00064	1	0.0100	4
4	0.0014	1	0.0030	3	0.0035	3	0.0005	3	0.0017	1	4.35	5	0.001	3		
5	0.0014	3	0.0032	1	0.0038	1	0.0006	1			4.36	5	0.0015	3		
6			0.0035	3							4.39	5	<0.001	3		
7			0.0043	1							4.41	5				
8											4.42	5				
9											4.46	5				
10											4.81	5				
Average ¹	0.0013		0.0031		0.0034		0.00046		0.0013		4.3746					
SD ²	0.00015		0.0003		0.00012		0.00011		0.0005		0.0723					
u characterization ³	0.00008		0.00016		0.00007		0.00006		0.00029		0.02863					
u homogeneity ⁴	0.00007		0.00011		0.00060		0.00020		0.00018		0.02052		0.00007		0.00035	
Certified value ⁵	0.0013		0.0031		0.003						4.37					
Expanded uncertainty ⁶	0.0002		0.0004		0.001						0.07					

* - analytical method used

** informative value

All values are based on recommendations of the ISO GUIDE 35:2017(E) standard:

1. **Average** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
2. **Standard deviation** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
3. **Uncertainty of material characterization** is based on the data obtained from the analysis performer by Network of competent labs (Guide clause 9.5) and calculated according to Guide clause B.5.2;
4. **Uncertainty associated with homogeneity** of material is calculated in agreement with Guide clause 7.11 (Uncertainty evaluation from homogeneity studies);
5. **Certified value** is the average value rounded to one or two significant digits of expanded uncertainty;
6. **Expanded uncertainty** is an geometric average of u characterization and u homogeneity multiplied by coverage factor $k = 2$.

Certification Process: Both preparation of this Reference Material and certification process were prepared according to requirements PN-EN 17034 and ISO GUIDE 35:2017(E).

Chemical Analysis: Chemical analyses were carried out on dried at 105°C powder samples. Single values in the above table are the means obtained by individual laboratories. The following methods were used for analysis:

- 1 - wavelength dispersive x-ray fluorescence spectrometry (WD XRF),
- 2 - high frequency infrared absorption (HFIR),
- 3 - inductive coupled plasma atomic emission spectrometry (ICP AES),
- 4 - titrimetry,
- 5 - gravimetry,
- 7 - spectrophotometry,
- 8 - coulometry,
- 10 - flame atomic absorption spectrometry (FA AAS).

The laboratories participating in certification analysis:

- ArcelorMittal, Dąbrowa Górnicza, Poland, PCA 17025 – AB 1449,
- Liberty Steel Group, Ostrava, The Czech Republic, Accreditation Certificate No. 593/2017 by the Czech Accreditation Institute; ČSN EN ISO/IEC 17025:2005,
- ArcelorMittal, Maizières-lès-Metz Cedex, France,
- Envivorm a.s., Trinec, The Czech Republic; Testing Laboratory Nr 1371; Accreditation Certificate No, 219/2016 by the Czech Accreditation Institute; ČSN EN ISO/IEC 17025:2005,
- Institute for Certified Reference Materials, Jekaterinburg, Russia, accreditation RU.0001.510008,
- Instytut Metalurgii Żelaza, Gliwice, Poland; PCA 17025 – AB554,
- Lithea, Ltd. Brno, The Czech Republic,
- PJSC Elektrometallurgical Works Dnepropetsstal, Zaporozhe, Ukraine,

- U.S. Steel Košice, Slovakia; Slovenská národná akreditačná služba ISO/IEC 17025:2005, Reg. No. 026/S-010 and 026/S-011,
- Dunafer Labor Nonprofit Kft., Dunaújváros, Hungary; ISO/IEC 17025; NAH-2-0330/2016,
- Polcargó Medyka, Poland; PCA 17025 - AB 914.

Homogeneity: The homogeneity of this Reference Material was evaluated in accordance with guidelines of ISO GUIDE 35:2017(E) for subsample masses of at least 0,2g. Wavelength dispersive x-ray fluorescence spectrometry method, titrimetric method and high frequency infrared absorption method were used.

Traceability: This Reference Material was found traceable to the following CRMs: JK29, EU 680-1, SARM12, ICRM R38, ICRM 37, ICRM 39, ICRM 8/3, ICRM 5/6, ICRM 25/1, IMZ 2.61/1, IMZ 2.62/1, IMZ 3.55, IMZ 3.56, IMZ 3.57, IPT23A, JSS814-1, JSS831-2, PI 3.20, PI3.21, PI3-23, PI3-24, PI3-25, Č1-1-22, EU687-1, ASCRM 04, SARM11, JK28, Č1-1-21, Č1-1-24, Č1-1-25, DILL1105, DILL1131, DILL1132, DILL 1133, Č1-1-27, PI3-10, PI3-11, PI3-12, PI3-30, PI3-31.

Origin of the material: Livery (Mount Gangra)

Basic mineralogical composition:

magnetite Fe_3O_4	–	$7,4 \pm 0,4 \%$
hematite $\alpha\text{-Fe}_2\text{O}_3$	–	$50,8 \pm 0,9 \%$
goethite $\alpha\text{-FeO(OH)}$	–	$17,1 \pm 1,3 \%$
quartz SiO_2	–	$5,6 \pm 0,4 \%$
non-crystalline component	–	$19,1 \pm 1,6 \%$

Available form: 100g of powder sample, grain size less than 0,2 mm

Intended use: This Reference Material is intended for use in determination of chemical composition of iron ores by x-ray fluorescence spectrometry, UV-Vis spectrometry, AAS, ICP-AES and C,S-analyzers and other wet methods. Chemical analyses should be carried out on samples dried at 105°C .

Validity of certification: The certification of IMZ3.61 is valid for 15 years - until March 2035, within the uncertainty specified provided this Reference Material is stored in accordance with the instructions given in this certificate (see Storage). The certification is nullified if this Reference Material is damaged, contaminated or otherwise modified.

Storage: This Reference Material should be stored in dry place and in environment free from chemical or other aggressive vapours and should be protected against vibration. If the contents become changed (for example oxidized) because of contamination, the whole contents of bottle should be discarded.

Safety: This Reference Material and packing do not contain substances which can directly influence health. Radioactivity less than 0.12 Bq/g equivalent of ^{60}Co

Inquiries regarding this Reference Material should be directed to:
rm@git.lukasiewicz.gov.pl

Approved by
Director of the Institute

Prof. Dr. Hab. Eng. Adam Zieliński

Certificate issue date: 17 February 2025

Certificate revision history:

17 February 2025 (editorial change); 29 July 2024 (editorial changes); 18 March 2020 (Original certificate date)