TECHNICAL REPORT

ISO/TR 11945

First edition
1998-02-15

Iron ores — Currently traded international ores

Minerais de fer — Minerais internationaux commercialisés

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

– type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

– type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

– type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until data they provide are considered to be no longer valid or useful.

ISO/TR 11945, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 102, *Iron ores*, Subcommittee SC 2, *Chemical analysis*.

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Iron ores — Currently traded international ores

1 Scope

This Technical Report is a revision of ISO/TC 102/TCR 3, which was prepared to provide the iron ore industry with information regarding the analysis of iron ores that are traded internationally.

It was always intended to update TCR 3 regularly to reflect changes that occur from time to time, and at the last version it was suggested that the information provided in the report was of interest beyond the scope of TC 102. Hence the status of the report has been raised to that ISO technical report, type 3.

The ore grades presented in this Technical Report are subject to change and do not necessarily reflect the analysis of the most recently available products.

2 Statistical evaluation of data

This clause is a compilation of the data presented in the analysis listed at the end of this Technical Report.

Table 1 shows a summary of the statistical evaluation of all elements as in TCR 3, the only difference being that the order of element has been made more logical. It should be noted that no data were received in respect of any ore for the elements Bi, Cl (soluble) and Sb.

The ranges of concentrations of the elements of interest shown in ISO/TC 102/TCR 4, working group operating procedures, are included in table 1 for comparative reference purposes. Data are also indicated for elements that have subsequently had their concentration ranges revised, namely Co, Sn and LOI. These revised values have been substituted for the original ones in the relevant column of table 1 and marked with an asterisk.

Tables 2 to 6, inclusive, give classified data by area relating to selected elements. Figures 1 to 9, inclusive, show histograms for selected elements.

The figures expressed in oxide forms in the listed analyses have been converted to their equivalent metallic values in all tables and figures, in accordance with the principles adopted by TC 102/SC 2.

Points to be noted are as follows:

a) Each "area" covers the following country or countries submitting data:

Africa:	Liberia, Morocco, Mauritania, South Africa
Asia:	India
Australasia:	Australia
Europe:	Norway, Sweden, U.S.S.R.
N. America:	Canada
S. America:	Brazil, Chile, Peru, Venezuela

b) Of the data in the listed analyses, the size distribution characteristics have been excluded from the calculation, as these are not considered relative to the purpose of this evaluation.

Results of the evaluation of analyses of CO_2, Ba, Bi, Mo, Sb, Cd and C are for information, although the determinations of these elements are at present outside the work programme of ISO/TC 102/SC 2. As mentioned above, however, no data were actually received in respect of Bi or Sb.

These elements Co, Sn and LOI, given in TCR 3 for information only, have now been incorporated into the work programme of ISO/TC 102, and are so considered in this document.

c) Not all the data contained in the listed analyses were used to calculate mean values and standard deviations, and certain determinations were made as follows:

- values showing combined content of two or more elements have been excluded from the tables (7 items);
- for values expressed in the form of a range, the median values were adopted as the mean value for evaluation (23 items);
- elements stated only as «Trace» were excluded (7 items);
- for values expressed as «Trace - to some maximum value», the maximum value was used (3 items);
- for values expressed in terms of ± a variant for some basic value, the basic value only was used (4 items);
- for values expressed as < followed by a maximum value, the maximum value was taken (74 items).

d) The mean values appearing in this report are not mass-weighted averages but frequency-weighted ones.

Table 1 — Summary of the data

Element	N	$\overline{X}$ %	σ %	X_{min} %	X_{max} %	Concentration value	
						X_{min} ~ $\overline{X}$ + 3σ	N 457 Annex A
Fe	134	64,156	3,783	46,21	71,60	46,21 to 72[1)]	30 to 72 [1)]
Si	133	2,00	1,93	0,06	11,69	0,06 to 7,790	0,1 to 10
Al	128	0,714	0,762	0,064	4,366	0,064 to 3,000	0,10 to 5
Ti	101	0,007	0,111	0,003	0,78	0,003 to 0,340	0,01 to 5
Ca	106	0,364	0,815	0,007	3,859	0,007 to 2,809	0,01 to 10
Mg	105	0,189	0,375	0,006	3,075	0,006 to 1,314	0,01 to 3
Na	76	0,032	0,040	0,004	0,1700	0,004 to 0,152	0,002 to 1
K	78	0,031	0,041	0,002	0,200	0,002 to 0,154	0,002 to 1
Ba [2)]	10	0,0298	0,064	0,003	0,220	0,003 to 0,222	-
Mn	114	0,200	0,766	0,010	8,050 [3)]	0,010 to 2,498	0,01 to 3
P	134	0,061	0,147	0,005	1,300	0,005 to 0,502	0,003 to 2
S	126	0,031	0,088	0,001	0,900	0,001 to 0,295	0,002 to 1
V	44	0,037	0,070	0,001	0,400	0,001 to 0,247	0,002 to 1
F	9	0,059	0,097	0,001	0,250	0,001 to 0,350	0,005 to 1
Cu	65	0,007	0,012	0,0004	0,060	0,0004 to 0,043	0,001 to 0,5
Pb	29	0,003	0,002	0,001	0,010	0,001 to 0,009	0,001 to 0,5
Zn	33	0,004	0,004	0,001	0,019	0,001 to 0,016	0,001 to 0,5
Cr	38	0,005	0,004	0,001	0,021	0,001 to 0,017	0,003 to 0,1
Ni	29	0,010	0,012	0,001	0,040	0,001 to 0,046	0,003 to 0,1
Co	7	0,010	0,013	0,0008	0,040	0,000 8 to 0,049	0,000 2 to 0,07[4)]
Sn	15	0,0019	0,0019	0,000	0,005	0,000 to 0,076	0,001 to 0,015[4)]
As	23	0,003	0,003	0,000	0,010	0,000 to 0,012	0,000 1 to 0,1
Sb [2)5)]	-	-	-	-	-	-	-
Cd [2)]	6	0,001	0,000	0,001	0,002	0,001 to 0,001	-
Bi [2) 5)]	-	-	-	-	-	-	-
Mo [2)]	6	0,002	0,001	0,001	0,005	0,001 to 0,005	-
Fe^{++}	14	2,659	4,795	0,190	18,50	0,190 to 17,04	-
Cl (Sol)	-	-	-	-	-	-	-
Cl (Total)	9	0,019	0,029	0,001	0,100	0,001 to 0,106	0,005 to 0,1
LOI	81	1,832	1,993	0,010	9,260	0,010 to 7,811	0,1 to 12[4)]
Comb.H_2O	8	1,148	2,519	0,040	7,800	0,040 to 8,705	-
C [2)]	2	0,140	0,120	0,020	0,260	0,020 to 0,500	-
CO_2 [2)]	13	0,253	0,323	0,020	1,150	0,020 to 1,222	-

Legend:

N : number of data used for the statistical evaluation
$\overline{X}$: arithmetic mean of the data (not a weighted mean)
σ : standard deviation (σ_N) of the data
X_{min} : minimum value in the data
X_{max} : maximum value in the data

Footnotes:

1) Theoretical value (Fe_3O_4)
2) For information only
3) Manganiferous iron ores
4) Revised values
5) No data received

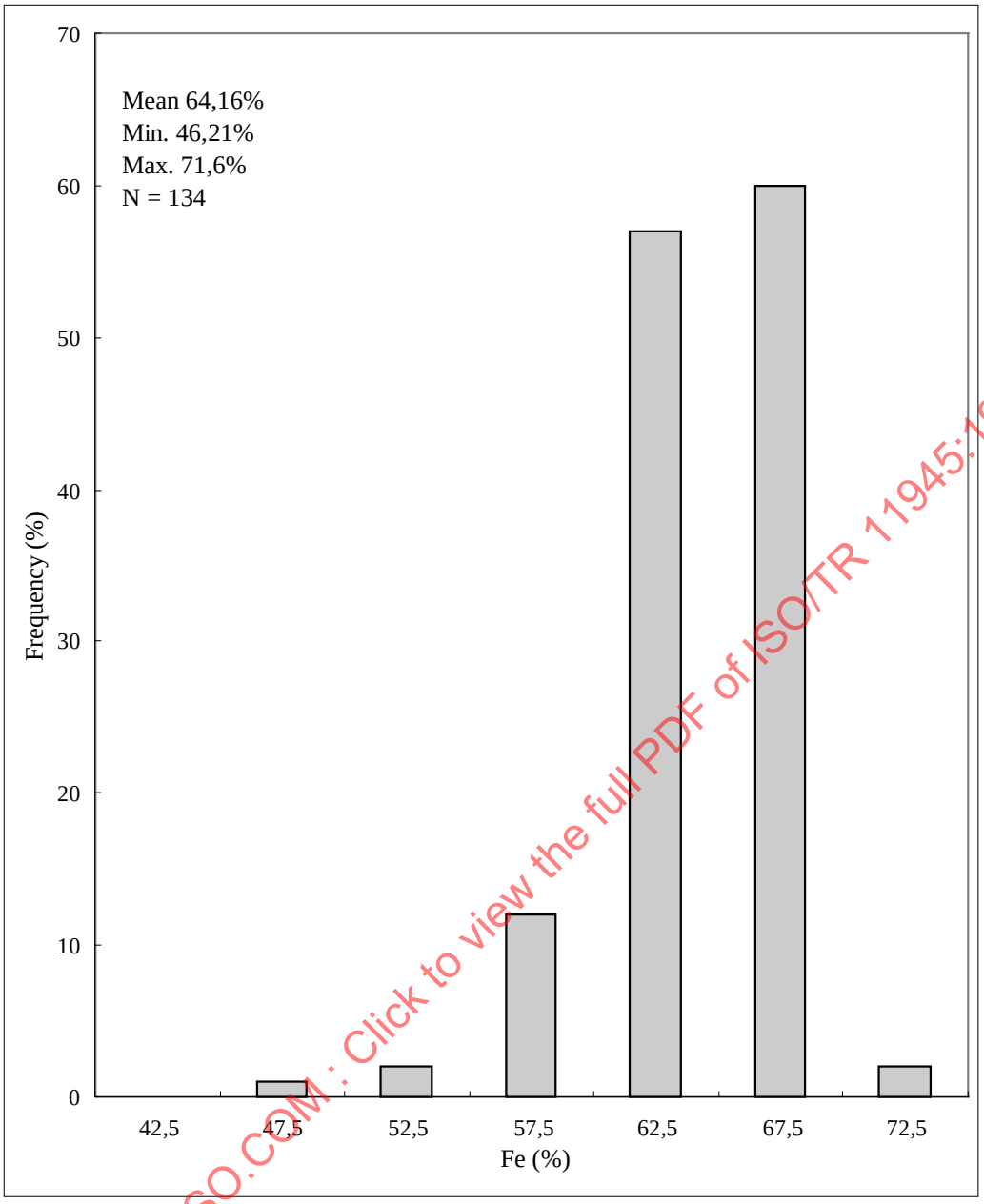
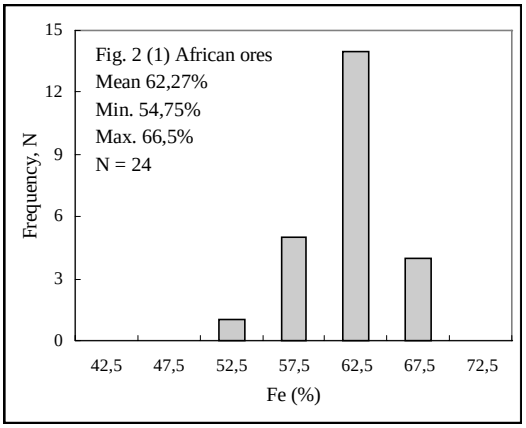
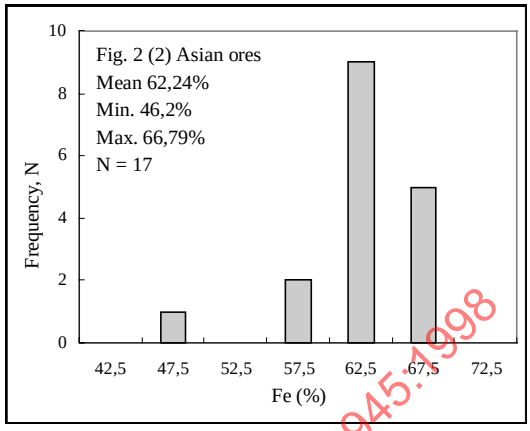
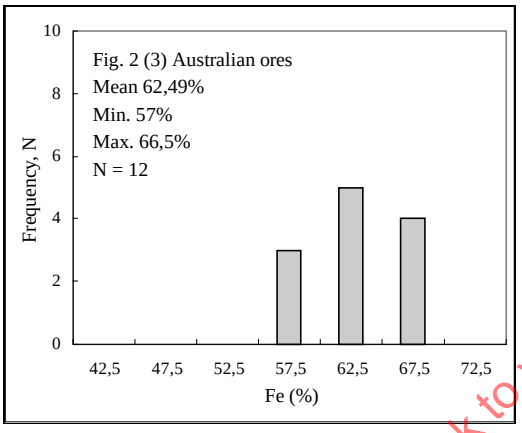
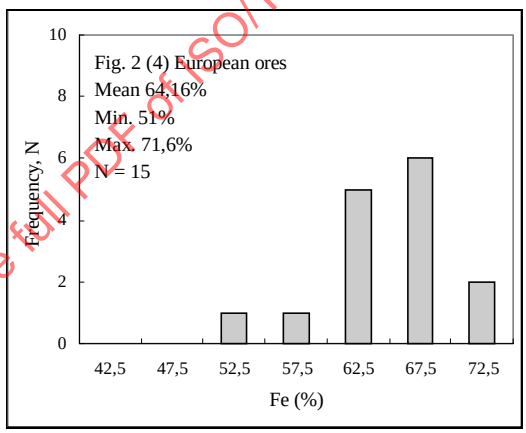


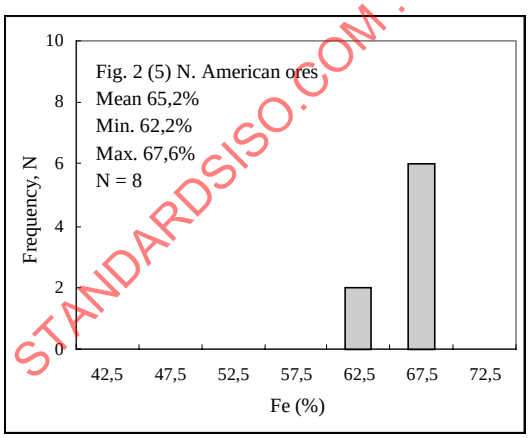
Figure 1 — Overall histogram for Fe











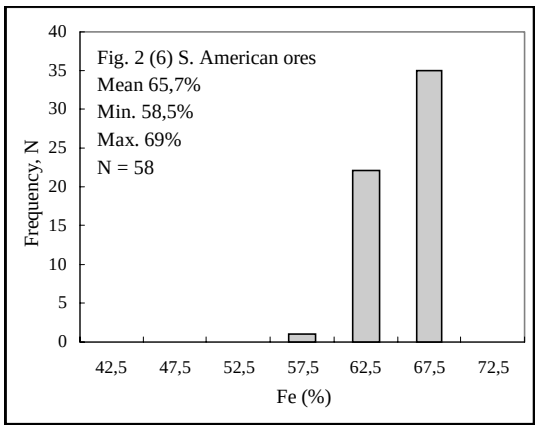


Figure 2 — Histograms for Fe by area

Table 2 — Silicon

Area	N	$\overline{X}$ (%)	X_{min} (%)	X_{max} (%)	s (%)
(1) Africa	23	3,48	0,20	9,35	2,54
(2) Asia	17	1,36	0,58	2,34	0,53
(3) Australasia	12	2,38	0,95	7,15	1,56
(4) Europe	15	2,69	0,06	11,69	3,08
(5) N. America	8	1,77	0,89	2,52	0,61
(6) S. America	58	1,36	0,23	6,08	1,16
Total	133	2,00	0,06	11,69	1,93

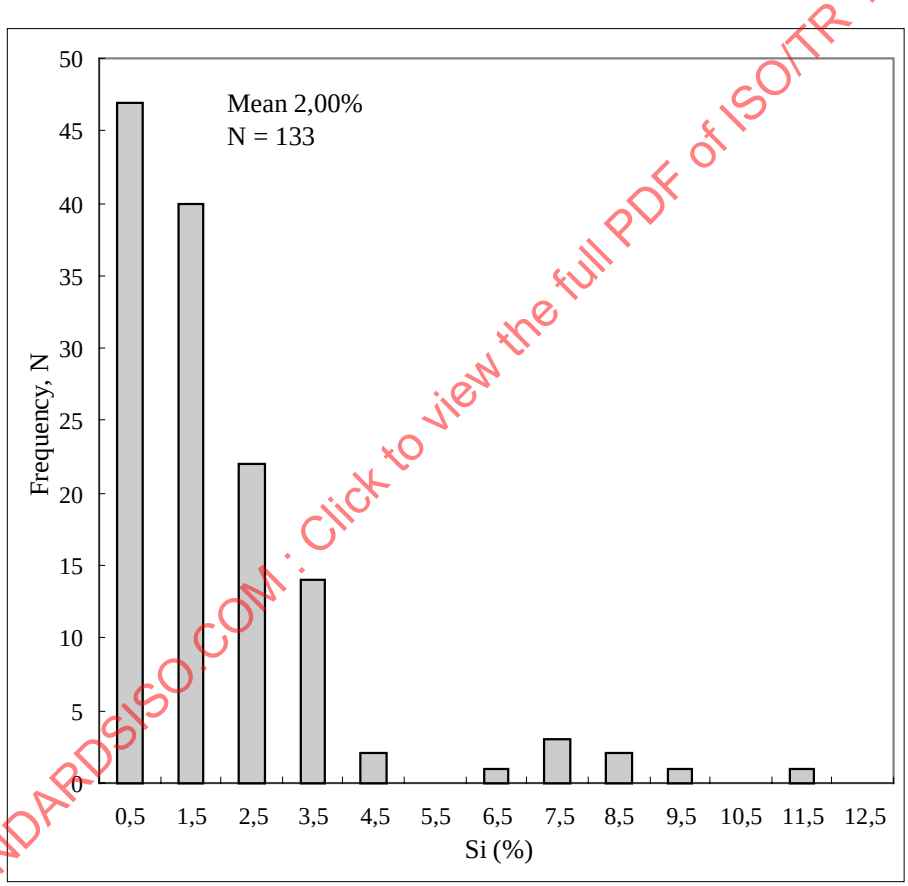
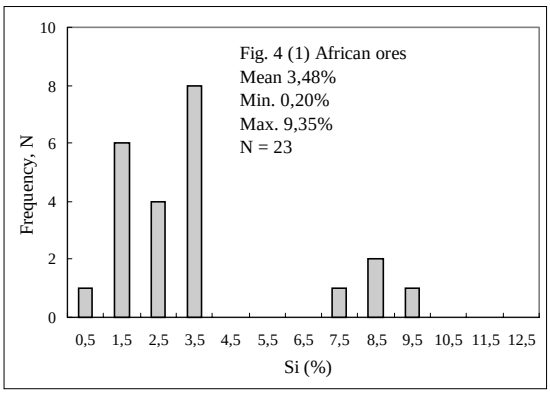
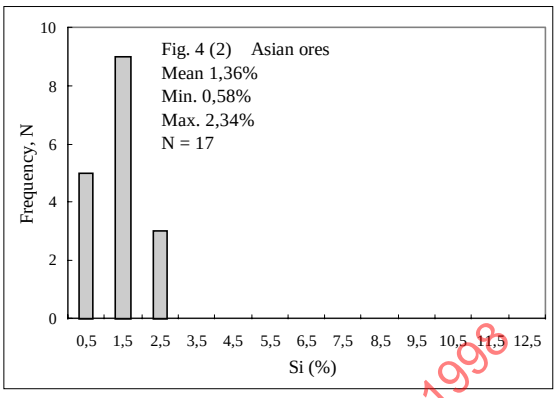
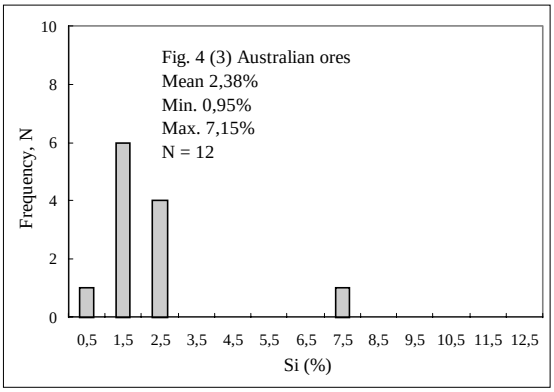
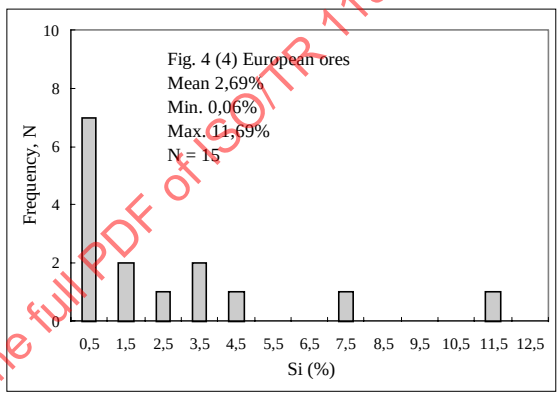


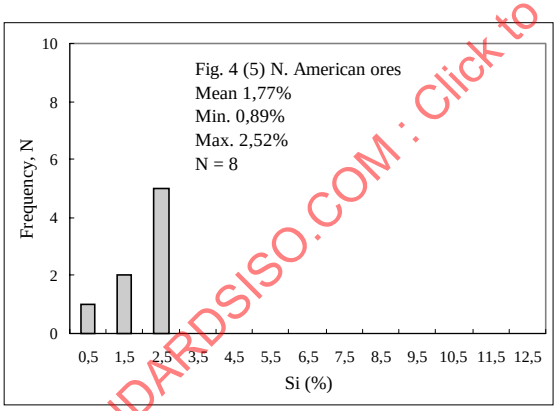
Figure 3 — Histogram for silicon











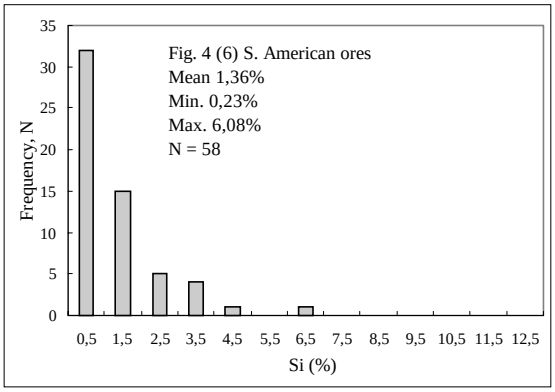


Figure 4 — Histograms for Si by area

Table 3 — Calcium

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	20	0,12	0,007	0,61	0,18
Asia	14	0,13	0,007	1,29	0,32
Australasia	11	0,40	0,029	3,86	1,09
Europe	15	0,89	0,036	3,54	1,25
N. America	8	0,74	0,036	3,037	0,98
S. America	38	0,29	0,007	3,087	0,65
Total	106	0,364	0,007	3,859	0,815

Table 4 — Manganese

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	21	0,086	0,023	0,32	0,08
Asia	13	0,790	0,050	8,05	2,101
Australasia	11	0,130	0,050	0,60	0,151
Europe	15	0,091	0,040	0,35	0,073
N. America	8	0,274	0,010	1,90	0,615
S. America	46	0,126	0,015	0,60	0,119
Total	114	0,200	0,010	8,05	0,766

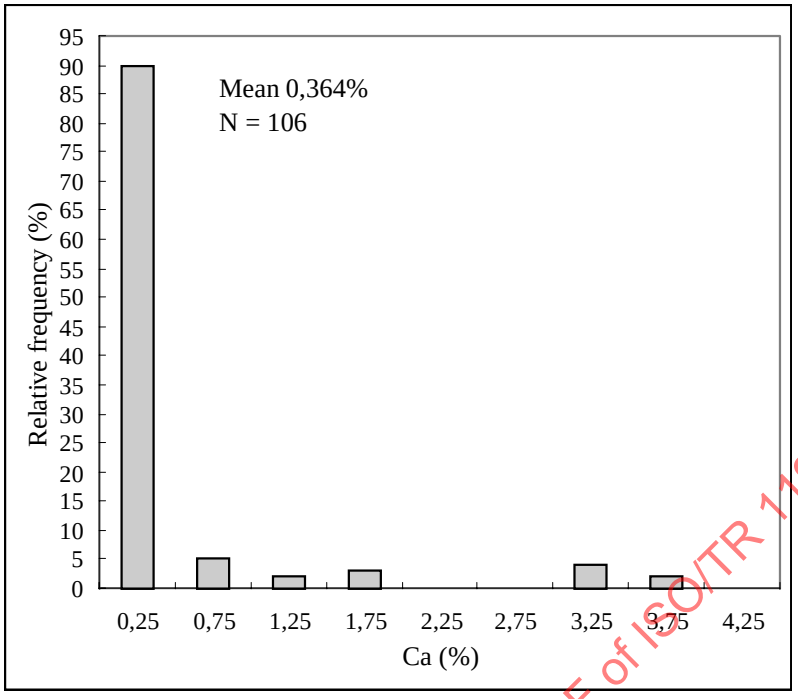


Figure 5 — Histogram for calcium

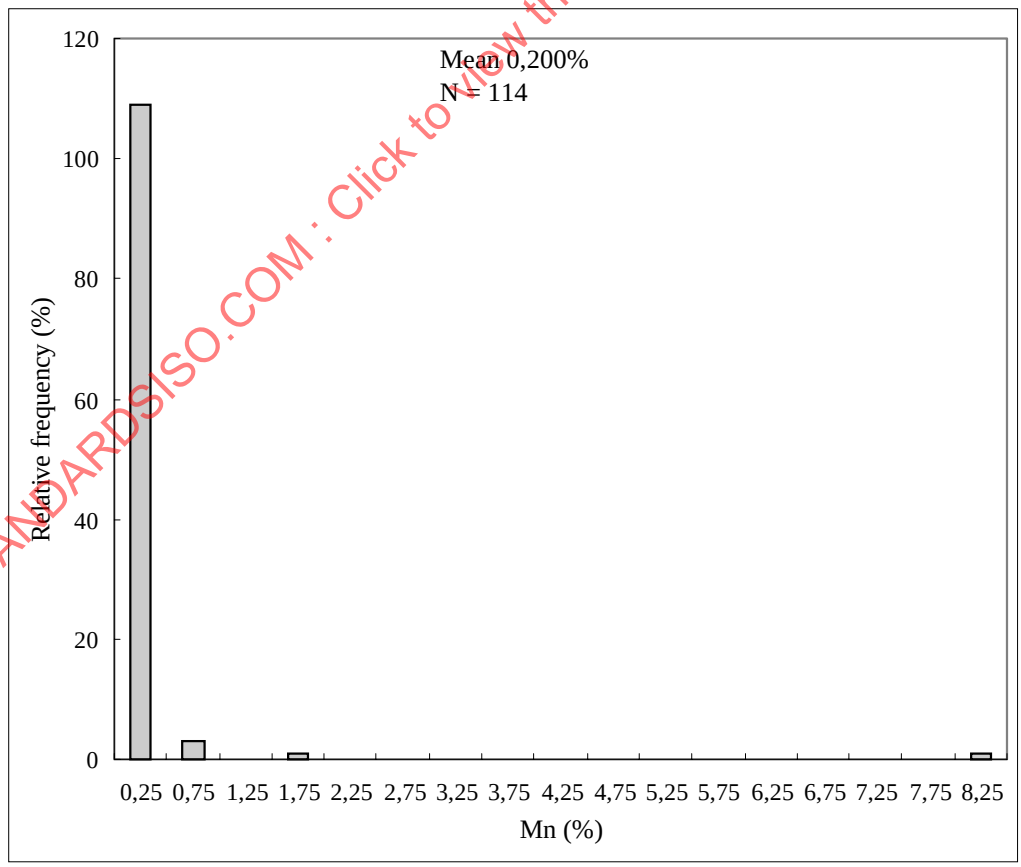


Figure 6 — Histogram for manganese

Table 5 — Aluminium

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	23	0,873	0,122	4,37	0,88
Asia	17	1,91	0,794	3,895	1,006
Australasia	12	0,847	0,196	1,455	0,381
Europe	15	0,286	0,106	1,064	0,259
N. America	8	0,175	0,064	0,233	0,053
S. America	53	0,434	0,079	0,953	0,212
Total	128	0,714	0,064	4,366	0,762

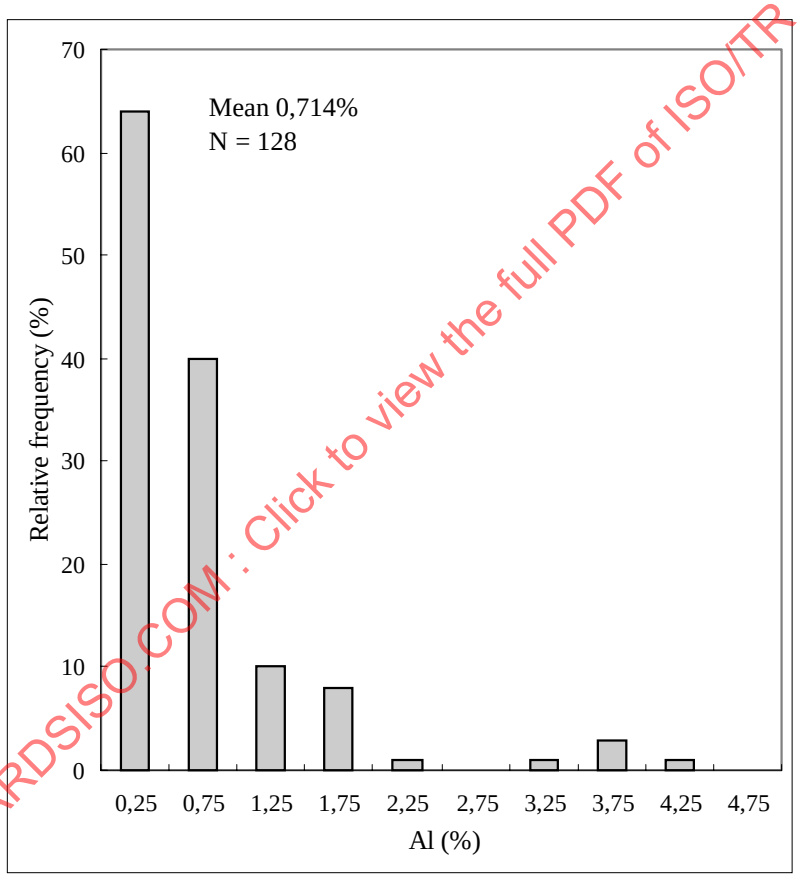
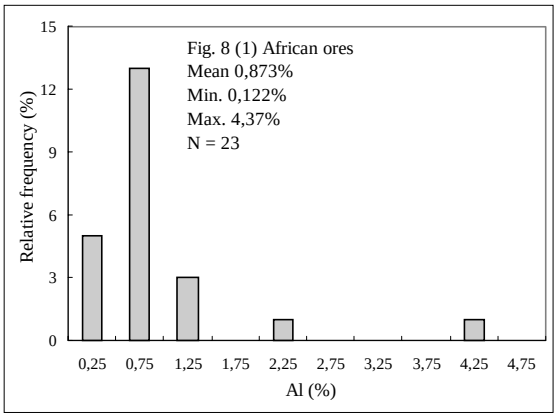
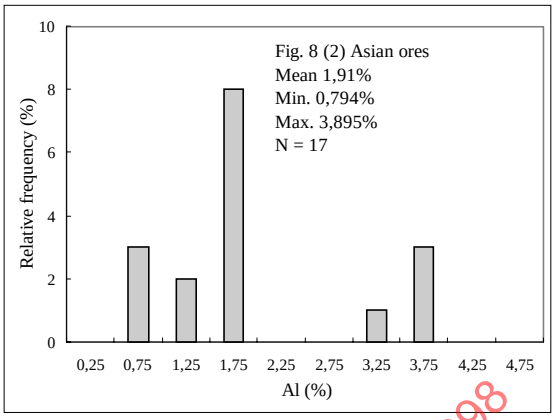
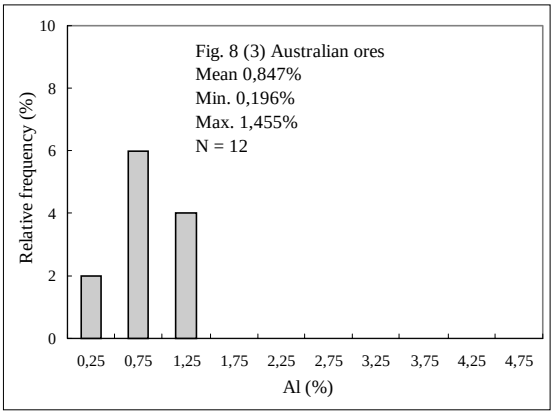
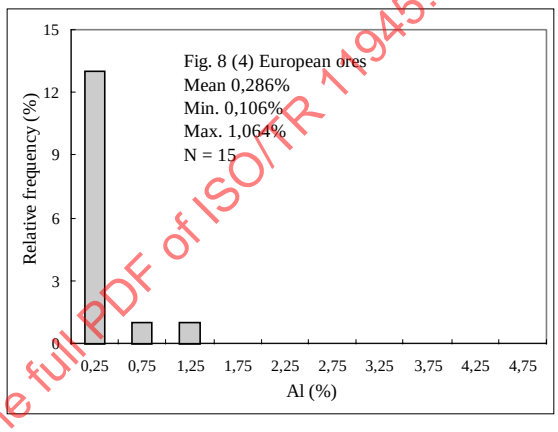


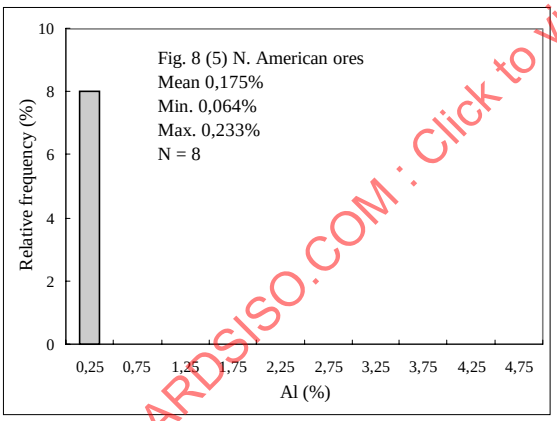
Figure 7 — Histogram for aluminium











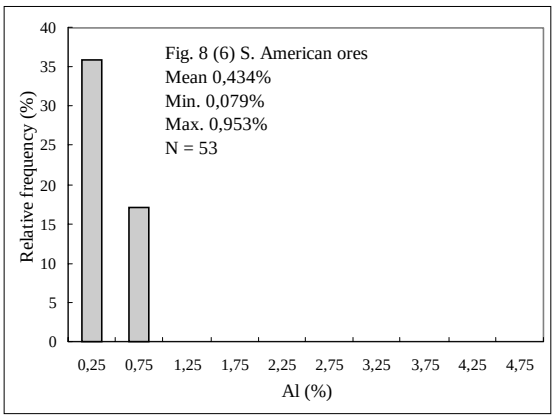


Figure 8 — Histograms for Al by area

Table 6 — Titanium

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	20	0,073	0,012	0,779	0,164
Asia	16	0,086	0,018	0,228	0,065
Australasia	12	0,103	0,030	0,498	0,123
Europe	12	0,147	0,006	0,486	0,126
N. America	7	0,065	0,013	0,096	0,031
S. America	34	0,044	0,003	0,420	0,067
Total	101	0,077	0,003	0,78	0,111

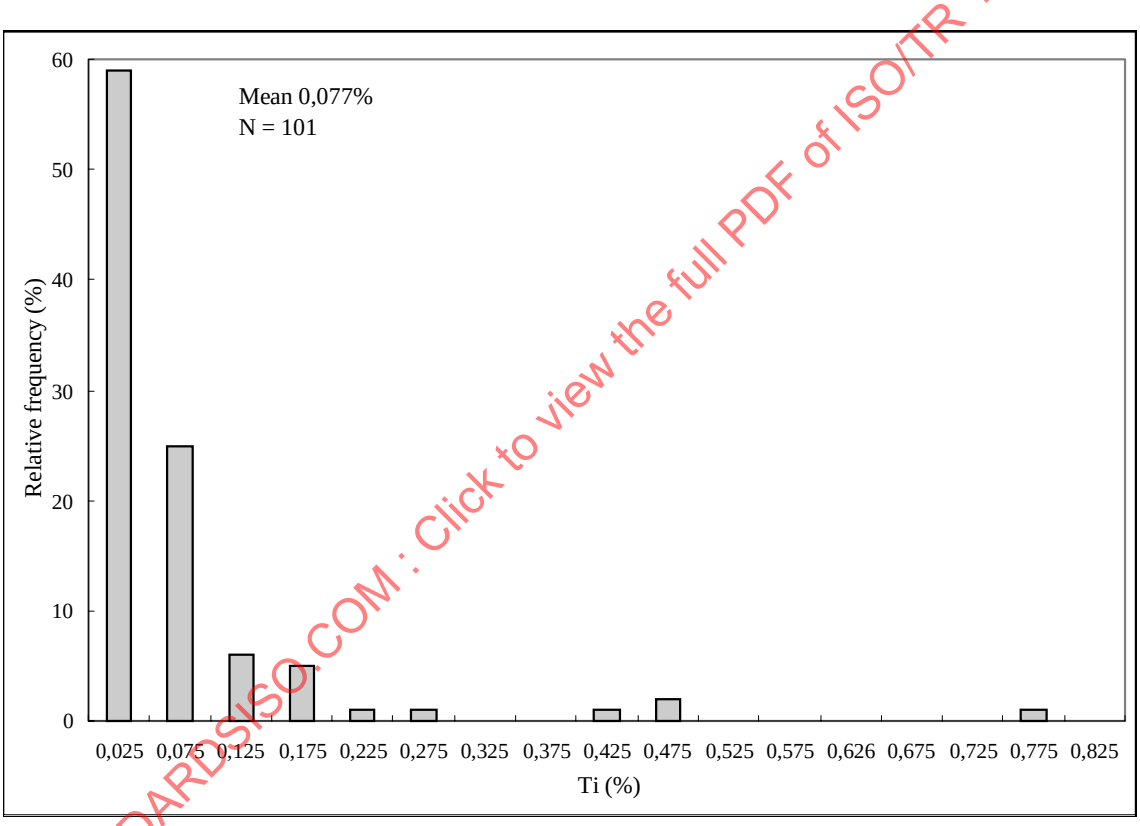


Figure 9 — Histogram for titanium

Table 7 — Magnesium

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	19	0,093	0,006	0,573	0,147
Asia	14	0,049	0,006	0,090	0,024
Australasia	11	0,226	0,018	1,176	0,381
Europe	15	0,593	0,115	3,075	0,712
N. America	8	0,293	0,024	1,025	0,315
S. America	38	0,095	0,006	0,675	0,163
Total	105	0,189	0,006	3,075	0,375

Table 8 — Copper

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	11	0,008	0,0011	0,060	0,016
Asia	1	0,007	0,007	0,007	0,00
Australasia	12	0,003	0,001	0,005	0,001
Europe	12	0,002	0,001	0,007	0,002
N. America	2	0,001	0,001	0,001	0,00
S. America	27	0,012	0,0004	0,04	0,014
Total	65	0,007	0,0004	0.06	0,012

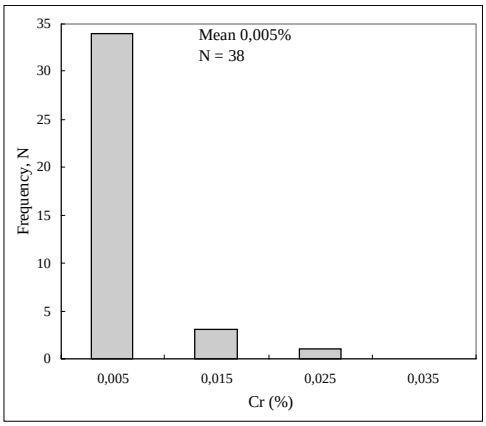


Figure 10 — Histogram for chromium

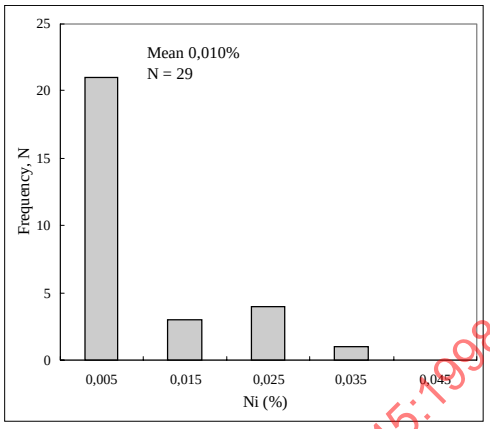


Figure 11 — Histogram for nickel

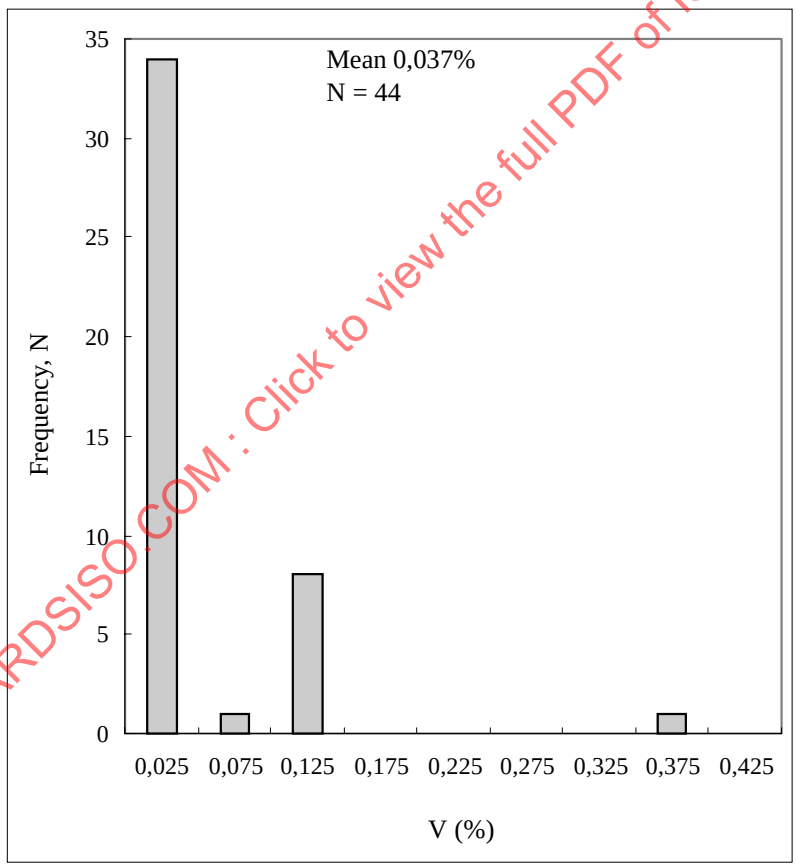


Figure 12 — Histogram for vanadium

Table 9 — Phosphorus

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	24	0,041	0,006	0,081	0,022
Asia	17	0,061	0,025	0,105	0,026
Australasia	12	0,046	0,005	0,071	0,020
Europe	15	0,182	0,006	1,300	0,410
N. America	8	0,010	0,008	0,015	0,003
S. America	58	0,047	0,01	0,15	0,033
Total	134	0,061	0,005	1,30	0,147

Table 10 — Sulfur

Area	N	$\overline{X}$ %	X_{min} %	X_{max} %	σ %
Africa	21	0,018	0,005	0,084	0,019
Asia	17	0,032	0,006	0,100	0,034
Australasia	12	0,013	0,001	0,039	0,011
Europe	15	0,042	0,001	0,22	0,058
N. America	8	0,005	0,001	0,013	0,004
S. America	53	0,041	0,001	0,90	0,129
Total	126	0,031	0,001	0.90	0,088

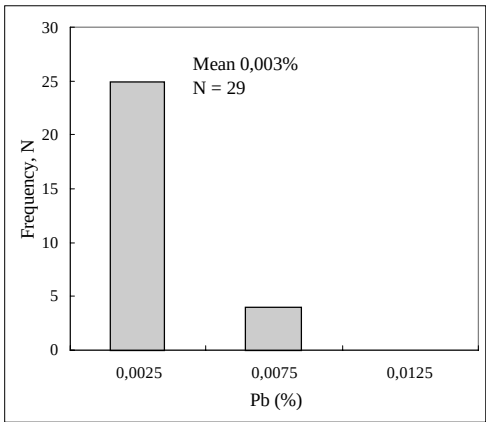


Figure 13 — Histogram for lead

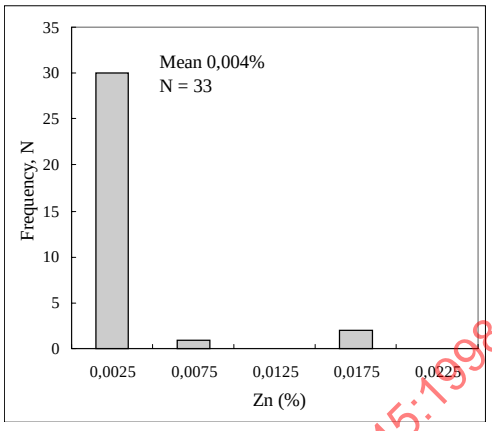


Figure 14 — Histogram for zinc

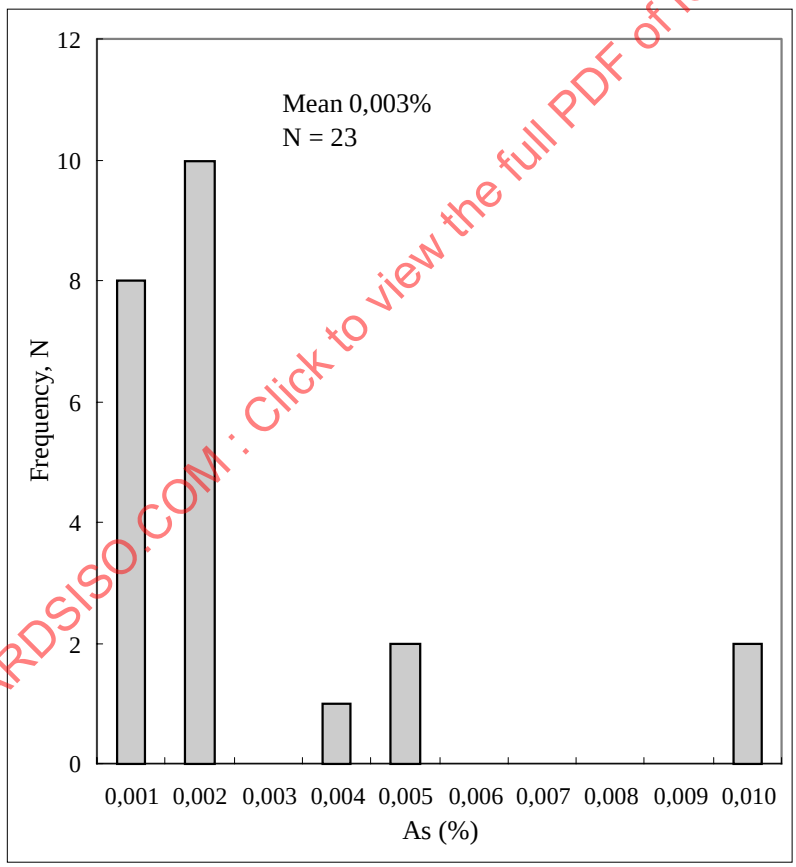


Figure 15 — Histogram for arsenic

AFRICAN ORES

Element	Bong concentrates Liberia	Bong pellets Liberia	Mano River coarse ore washed Liberia	Mano River sinter feed Liberia	Nimba washed lumpy Liberia	Nimba washed fines Liberia
Fe	64,76	64,34	55,65	57,50	63,61	64,31
SiO_2	7,31	0,42	2,30	5,90	4,64	4,25
Al_2O_3	0,23	0,38	8,25	4,60	1,40	1,34
TiO_2	0,031	0,041	0,085	0,117	0,04	0,04
CaO	0,226	0,472	Trace	0,02	0,01	0,02
MgO	0,273	0,345	Trace	0,013	0,02	0,01
Na_2O		0,056	0,09	0,028	0,02	0,02
K_2O		0,061	0,03	0,054	0,02	0,02
BaO			0,0089	0,019		
Mn	0,03	0,065	0,24	0,32	0,10	0,08
P	0,019	0,019	0,056	0,055	0,077	0,066
S		0,008	0,084	0,066	0,008	0,008
V		0,005		0,001	0,002	0,002
F		0,005				
Cu		0,005		0,003	0,002	0,002
Pb		0,008	0,009	0,008	0,002	0,002
Zn		0,005	Trace	0,005		
Cr		0,007		0,001	0,006	0,006
Ni		0,007		0,004		
Co				0,000 8		
Sn			Trace			
As		0,005	0,005	0,002	0,002	0,002
Sb						
Cd						
Bi						
Mo						
Fe^{++}		1,279				
Cl (soluble)						
Cl (total)		0,100				
LOI		0,211		6,25	2,74	2,20
Comb. H_2O		0,100	7,8			
C						
CO_2		0,100	1,15			
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm		0,3 0,3	34 34			
+ 22,4 mm					15 15	
+ 16 mm		2,3 2,6			25 40	
+ 8 mm	0,5 0,5	89,7 92,3	36 70		17 57	
+ 4 mm	0,4 0,9	6,1 98,4		5 5	14 71	17 17
+ 2 mm						14 31
+ 1 mm				15 20		11 42
+ 500 µm						8 50
+ 250 µm				14 49		11 61
+ 180 µm				12 61		7 68
+ 90 µm				9 80		17 85
+ 63 µm				10 90		5 90

Element	Nimba pellets Liberia	Tokadeh run-of-mine Liberia	Rif pellets Morocco	F'Derik rubble feed Mauritania	Guelbs mag conc Mauritania	Guelbs semi-mag conc Mauritania
Fe	63,27	55,05	65,00	63,60	65,70	65,0
SiO_2	5,80	18,30	3,47	6,80	7,30	6,5
Al_2O_3	1,93	1,10	0,25	1,30	0,30	0,5
TiO_2	0,13	0,02		0,04	0,05	0,02
CaO	0,81	0,02	0,86	0,04	0,40	0,10
MgO	0,55	0,01	0,95	0,04	0,40	0,10
Na_2O	0,02	0,02			0,08	0,01
K_2O	0,02	0,02	0,175		0,02	0,02
BaO						
Mn	0,11	0,08	0,06	0,03	0,04	0,025
P	0,069	0,081	0,006	0,04	0,015	0,02
S	0,009	0,008	0,005	0,016	0,012	0,012
V	0,005 6	0,003 9				
F						
Cu	0,002	0,002			0,005	0,008
Pb	0,002	0,002			< 0,002	< 0,002
Zn					0,002	0,002
Cr	0,010	0,006			0,010	0,008
Ni						
Co						
Sn						
As	0,002	0,002			0,001	0,002
Sb						
Cd						
Bi						
Mo						
Fe^{++}					18,5	6,0
Cl (soluble)						
Cl (total)						
LOI		2,20		0,80		< 0,5
Comb. H_2O					0,12	0,5
C						
CO_2				0,02	0,14	0,2
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm		3 3				
+ 22,4 mm		2 5				
+ 16 mm		2 7				
+ 8 mm		2 9	88 88	90 90		
+ 4 mm		3 12	7 95			
+ 2 mm						
+ 1 mm					7 7	8 8
+ 500 µm					13 20	14 22
+ 250 µm					25 45	26 48
+ 180 µm					18 63	19 67
+ 90 µm					20 83	17 84
+ 63 µm					5 88	4 88

Element	Tazadit A run-of-mine Mauritania	Tazadit B run-of-mine Mauritania	Tazadit siliceous run-of-mine Mauritania	Tazadit rubble Mauritania	Tazadit specially sized siliceous Mauritania	Tazadit quality fines Mauritania
Fe	63,80	63,00	56,00	63,60	54,75 ± 0,75	63,20
SiO_2	7,00	7,10	19,00	6,80	20,00 ± 1,00	7,00
Al_2O_3	1,30	1,40	2,00	1,00	1,50	1,20
TiO_2	0,045	0,02		0,03		0,06
CaO	0,15	0,02		0,05	0,01	0,01
MgO	0,04	0,03		0,03		0,02
Na_2O						
K_2O						
BaO						
Mn	0,03	0,03		0,03		0,023
P	0,035	0,03	0,03	0,03	0,025 to 0,030	0,035
S	0,015	0,015	0,01	0,01	0,016	0,008
V						
F						
Cu						
Pb						
Zn						
Cr						
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,00	1,00	1,00	1,00		1,10
Comb. H_2O						
C						
CO_2	0,04	0,03		0,03		0,05
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm						
+ 22,4 mm						
+ 16 mm						
+ 8 mm	50 50	30 30	50 50		80 80	
+ 4 mm				85 85		
+ 2 mm						
+ 1 mm						
+ 500 µm						
+ 250 µm						
+ 180 µm						
+ 90 µm						
+ 63 µm						

Element	Tazadit siliceous fines Mauritania	Assoman calibrated ore South Africa	Assoman fines South Africa	Palabora concentrate South Africa	Sishen north mine lump ore South Africa	Sishen north mine fines South Africa
Fe	56,50 ± 0,60	65,57	64,20	64,00	66,5	65,5
SiO_2	17,00 ± 0,90	3,04	4,95		2,8	3,5
Al_2O_3	1,50	1,54	2,22	2,00	1,2	1,6
TiO_2		0,13	0,09	1,30	0,07	0,07
CaO		0,12	0,06		0,04	0,04
MgO		0,02	0,03		0,03	0,03
Na_2O		0,06	0,06		< 0,02	< 0,02
K_2O		0,05	0,10		0,14	0,20
BaO						
Mn		0,19	0,19		0,05	0,05
P	0,035	0,05	0,032	0,08	0,04	0,05
S	0,01	0,024	0,024		0,013	0,014
V					0,006 0	0,006 0
F						
Cu				0,06	0,001 1	0,001 1
Pb					0,001 8	0,001 8
Zn					0,002 3	0,002 3
Cr				0,01	0,012	0,011
Ni				0,04	0,003 0	0,003 0
Co				0,04	0,002 7	0,002 7
Sn					< 0,000 3	< 0,000 3
As					0,001 9	0,001 9
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,00				0,5	0,8
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm						
+ 22,4 mm					1 1	
+ 16 mm						
+ 8 mm			0,5 0,5		90 91	
+ 4 mm			13 13,5			4 4
+ 2 mm			62,2 75,7			55 59
+ 1 mm						25 84
+ 500 µm			20,7 96,4			
+ 250 µm			1,8 98,2			
+ 180 µm			0,6 98,8			10 94
+ 90 µm	70 70					
+ 63 µm						

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ASIAN ORES

Element	Bailadila grade lumpy ore India	Bandekar lumpy grade India	Bandekar fines grade India	Bandekar fines grade India	Basic grade lumpy ore India	Basic grade lumpy ore India
Fe	65,04	60,0	62,0	60,0	64,0	64,1
SiO_2	1,89	5,0	4,0	5,0	2,72	3,28
Al_2O_3	2,86	7,0	6,0	7,0	3,05	2,53
TiO_2	0,10	0,3	0,3	0,3	0,05	0,09
CaO	0,12				0,05	0,02
MgO	0,15				0,06	0,01
Na_2O						
K_2O						
BaO						
Mn					0,39	0,13
P	0,04	0,10	0,10	0,10	0,04	0,042
S	0,008	0,10	0,10	0,10	0,01	0,012
V						
F						
Cu						
Pb						
Zn						
Cr						
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,73				1,75	2,15
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm		97 97				
+ 22,4 mm						
+ 16 mm						
+ 8 mm	80 80		5 5	5 5	85 85	
+ 4 mm			15 20	9 14		90 90
+ 2 mm			15 35	14 28		
+ 1 mm			15 50	14 42		
+ 500 µm			20 70	18 60		
+ 250 µm						
+ 180 µm						
+ 90 µm			15 85	24 84		
+ 63 µm						

Element	Basic grade calibrated ore India	Donimalai pellets India	Goan black manganiferous India	High grade fines India	Low grade lumpy ore India	Low grade lumpy ore India
Fe	63,88	65,94	46,21	65,63	61,14	61,16
SiO_2	3,62	1,55	2,84	2,72	1,24	2,35
Al_2O_3	2,85	1,50	7,36	2,22	3,19	3,31
TiO_2	0,06		0,38	0,08	0,11	0,14
CaO	0,05	1,80	0,02	0,03	0,05	0,10
MgO	0,08	0,01	0,13	0,08	0,08	0,12
Na_2O		0,088				
K_2O		0,019				
BaO			0,22			
Mn	0,06	0,05	8,05	0,077	0,25	0,56
P	0,04	0,081	0,058	0,025	0,105	0,043
S	0,01	0,038	0,048	0,008	0,006	0,016
V						
F						
Cu			0,007			
Pb						
Zn						
Cr						
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,83	0,0		0,91	7,23	6,02
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm	10 10					
+ 22,4 mm						
+ 16 mm		0,3 0,3				
+ 8 mm		99 99,3		10 10	85 85	85 85
+ 4 mm	78 88	0,3 99,6				
+ 2 mm						
+ 1 mm						
+ 500 µm		0,1 99,7				
+ 250 µm						
+ 180 µm						
+ 90 µm						
+ 63 µm						

Element	Low grade calibrated ore India	Low grade fines India	Medium grade fines India	Super high grade lumpy ore India	Super high grade calibrated ore India
Fe	61,00	61,21	63,37	66,60	66,79
SiO_2	2,43	2,83	4,48	1,75	1,76
Al_2O_3	3,22	2,95	3,00	1,58	1,50
TiO_2	0,15	0,03	0,10	0,06	0,04
CaO	0,09	0,15	0,05	0,01	0,02
MgO	0,07	0,14	0,07	0,10	0,11
Na_2O		0,04			
K_2O		0,03			
BaO					
Mn	0,25	0,80	0,14	0,077	0,10
P	0,26	0,071	0,031	0,04	0,053
S	0,016	0,03	0,01	0,012	0,012
V					
F					
Cu					
Pb					
Zn					
Cr					
Ni					
Co					
Sn					
As		0,002			
Sb					
Cd					
Bi					
Mo					
Fe++					
Cl (soluble)					
Cl (total)					
LOI	6,31	4,80	1,42	1,09	0,88
Comb. H_2O					
C					
CO_2					
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm	10 10				10 10
+ 22,4 mm					
+ 16 mm					
+ 8 mm		2 2	10 10	90 90	
+ 4 mm	75 85	10 12			78 88
+ 2 mm		9 21			
+ 1 mm		17 38			
+ 500 µm					
+ 250 µm					
+ 180 µm					
+ 90 µm					
+ 63 µm					

AUSTRALIAN ORES

Element	Goldsworthy lump Australia	Goldsworthy fines Australia	Goldsworthy high silica run-of-mine Australia	Hamersley sized lump Australia	Harmersley high grade fines Australia	Koolan Island run-of-mine Australia
Fe	63,8	62,8	57,0	65,07	62,73	66,5
SiO_2	5,8	6,1	15,3	2,80	4,21	3,0
Al_2O_3	0,9	1,5	0,98	1,53	2,57	1,0
TiO_2	< 0,06	< 0,10	< 0,06	0,07	0,13	0,16
CaO	< 0,04	< 0,04	< 0,04	0,04	0,06	
MgO	< 0,06	< 0,06	< 0,03	0,03	0,05	
Na_2O	< 0,015	< 0,015	< 0,015	0,008	0,009	0,02
K_2O	< 0,015	< 0,015	< 0,015	0,008	0,009	0,04
BaO						
Mn	0,10	0,12	0,12	0,05	0,07	
P	0,040	0,046	0,045	0,055	0,071	0,013
S	0,008	0,009	0,008	0,010	0,015	0,005
V				0,001	0,001	
F						
Cu	0,001 6	0,002 4	0,001 6	0,001	0,002	0,005
Pb						
Zn						
Cr				0,004	0,004	
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,4	1,8	1,4			
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm	2 2		1,5 1,5	5 5		
+ 22,4 mm				27 32		
+ 16 mm						
+ 8 mm	52,5 54,5			38 70		
+ 4 mm	36,5 91,0	2 2	54,5 56	25 95	7 7	42 42
+ 2 mm		41 43			31 38	
+ 1 mm						
+ 500 µm						
+ 250 µm					37 75	
+ 180 µm						
+ 90 µm		42 85	36 92		8 83	
+ 63 µm						

Element	Mt Newman lump Australia	Mt Newman fines Australia	Savage River pellets Australia	Whyalla blast furnace pellets Australia	Robe River sinter fines Australia	Mt Newman Marra Mamba fines Australia
Fe	65,5	62,5	66,23	59,5	57,23	61,0
SiO_2	3,5	5,6	2,04	4,0	5,60	3,30
Al_2O_3	1,3	2,6	0,37	1,9	2,75	1,80
TiO_2	0,05	0,11	0,83	0,20	0,22	0,07
CaO	0,04	0,05	0,15	5,4	0,07	0,28
MgO	0,10	0,11	1,42	1,95	0,07	0,23
Na_2O	0,01	0,04				
K_2O	0,006	0,03		0,06		0,02
BaO						
Mn	0,05	0,05	0,07	0,60	0,10	0,10
P	0,047	0,069	0,005	0,046	0,040	0,069
S	0,005	0,007	0,001	0,02	0,028	0,039
V			0,40			
F						
Cu	0,002	0,005	0,002 4	0,005	0,002	0,002
Pb						
Zn				0,016	0,010	
Cr						
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI	1,05	1,90			9,26	7,0
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm	3 3					
+ 22,4 mm	15 18					
+ 16 mm	37 55					
+ 8 mm	20 75			90 90	3 3	
+ 4 mm	16 91	3 3		9 99	12 15	1 1
+ 2 mm					40 55	
+ 1 mm						
+ 500 µm						
+ 250 µm						
+ 180 µm						
+ 90 µm		79 82			35 90	71 72
+ 63 µm						

Element	Yandicoogina ore Australia
Fe	59,51
SiO_2	5,03
Al_2O_3	1,25
TiO_2	0,051
CaO	0,042
MgO	0,019
Na_2O	
K_2O	0,008
BaO	
Mn	0,037
P	0,039
S	0,013
V	
F	
Cu	
Pb	
Zn	
Cr	
Ni	
Co	
Sn	
As	
Sb	
Cd	
Bi	
Mo	
Fe^{++}	
Cl (soluble)	
Cl (total)	
LOI	8,28
Comb. H_2O	
C	
CO_2	
Size analysis	**% % cum**
+ 31,5 mm	
+ 22,4 mm	
+ 16 mm	
+ 8 mm	8 8
+ 4 mm	21 36
+ 2 mm	
+ 1 mm	26 62
+ 500 µm	12 74
+ 250 µm	9 83
+ 180 µm	7 90
+ 90 µm	
+ 63 µm	

EUROPEAN ORES

Element	Sydvaranger pellets Norway	Kiruna B fines KBF Sweden	Kiruna D KD Sweden	Kiruna D fines KDF Sweden	LKAB DR oxide pellets MPRD Sweden	LKAB DR oxide fines MAF Sweden
Fe	65,20	69,8	62,0	61,8	67,5	70,7
SiO_2	5,3	1,2	3,5	4,0	0,95	0,70
Al_2O_3	0,40	0,20	0,50	0,70	0,25	0,27
TiO_2		0,45	0,22	0,25	0,18	0,30
CaO	0,35	0,52	4,7	4,5	1,05	0,23
MgO	0,45	0,45	1,1	1,2	0,75	0,45
Na_2O	0,2	0,03	0,14	0,16	0,05	0,03
K_2O		0,07	0,17	0,20	0,03	0,02
BaO						
Mn	0,093	0,06	0,07	0,07	0,06	0,05
P	0,010	0,045	1,3	1,15	0,025	0,030
S	0,008	0,02	0,03	0,03	< 0,001	0,006
V		0,11	0,11	0,11	0,12	0,12
F		0,03	0,25	0,23	< 0,006	0,01
Cu		< 0,002	< 0,002	< 0,002	< 0,002	< 0,001
Pb						
Zn						
Cr						
Ni						
Co						
Sn						
As						
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)		0,02	0,02	0,02	< 0,001	0,007
LOI		0,20	0,60	0,60		0,10
Comb. H_2O						
C						
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm						
+ 22,4 mm						
+ 16 mm	5 5		5 5		4 4	
+ 8 mm	87 92		45 50		92 96	
+ 4 mm	3 95		30 80		3 99	
+ 2 mm		21 21		45 45		2 2
+ 1 mm		17 38		12 57		15 17
+ 500 µm		11 49		8 65		35 52
+ 250 µm		9 58		7 72		26 78
+ 180 µm		5 63		4 76		7 85
+ 90 µm		15 78		9 85		10 95
+ 63 µm		6 84		5 90		2 97

Element	Malmberget A concentrate MAC Sweden	LKAB Olivine pellets KPBO Sweden	LKAB Olivine pellets MPBO Sweden
Fe	71,6	66,7	66,7
SiO_2	0,13	2,1	2,1
Al_2O_3	0,20	0,24	0,45
TiO_2	0,123	0,23	0,30
CaO	0,05	0,25	0,20
MgO	0,30	1,6	1,45
Na_2O	0,006	0,04	0,04
K_2O	0,005	0,03	0,03
BaO			
Mn	0,04	0,06	0,05
P	0,006	0,025	0,009
S	0,006	< 0,001	< 0,001
V	0,132	0,12	0,12
F	0,003	< 0,003	< 0,002
Cu	< 0,001	< 0,001	< 0,001
Pb			
Zn			
Cr			
Ni			
Co			
Sn			
As			
Sb			
Cd			
Bi			
Mo			
Fe^{++}			
Cl (soluble)			
Cl (total)	0,006	< 0,002	< 0,001
LOI	0,01		
Comb. H_2O			
C			
CO_2			
Size analysis	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm			
+ 22,4 mm			
+ 16 mm		2 2	2 2
+ 8 mm		94 96	94 96
+ 4 mm		3 99	3 99
+ 2 mm			
+ 1 mm			
+ 500 µm			
+ 250 µm	3 3		
+ 180 µm			
+ 90 µm			
+ 63 µm	42 45		

Element	Kovdorsky concentrates U.S.S.R.	Krivol Rog run-of-mine U.S.S.R.	Krivol Rog fines U.S.S.R.	Krivol Rog concentrates U.S.S.R.	Krivol Rog pellets U.S.S.R.	Olenogorsky concentrates U.S.S.R.
Fe	63,27	50 to 52	56,60	64,15	60,15	65,27
SiO_2	1,18	25,00	16,00	9,0	8,08	7,06
Al_2O_3	2,01	1,24	0,92	0,25	0,21	0,30
TiO_2	0,81	0,03		0,037	0,01	
CaO	0,63	0,33	0,36	0,17	4,95	0,40
MgO	5,10	0,19	0,31	0,30	0,41	0,70
Na_2O	0,02			Trace	0,05	0,04
K_2O	0,04			Trace	0,04	0,01
BaO	Trace				< 0,02	
Mn	0,35	0,07	0,13	0,08	0,09	0,09
P	0,014	0,025	0,05	0,02	0,009	0,014
S	0,22	0,046	0,13	0,07	0,022	0,044
V	0,062					
F						
Cu	0,007 2	0,004		0,004 8	0,001 6	
Pb	0,010			0,004 7	0,001 9	
Zn	0,019			0,003 2	0,001 6	
Cr	< 0,003			0,004 8	0,002 7	
Ni	0,005 5			0,004 0	0,002 4	
Co	0,019			0,006 3	< 0,001 6	
Sn						
As	0,004 0			0,001 3	< 0,002	
Sb						
Cd						
Bi						
Mo						
Fe^{++}						
Cl (soluble)						
Cl (total)						
LOI						
Comb. H_2O	0,32			0,26		
C						
CO_2	0,37			0,75	0,15	0,26
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm						
+ 22,4 mm						
+ 16 mm					8 8	
+ 8 mm		75 75	16 16		76 84	
+ 4 mm			8 24		11,5 95,5	
+ 2 mm						
+ 1 mm			17 41			0,1 0,1
+ 500 µm			16 57			1,2 1,3
+ 250 µm	16 16		13 70			
+ 180 µm						
+ 90 µm	36 52			17 17		79,8 81,1
+ 63 µm	20 72		27 97	16 33		7,3 88,4

NORTH AMERICAN ORES

Element	Carol Lake concentrates Canada	Carol Lake pellets Canada	Mount Wright sinter feed Canada	Wabush pellets Canada	Mount Wright regular acid pellets Canada	Mount Wright regular fluxed pellets Canada
Fe	65,17	65,757	66,30	63,67	65,3	62,2
SiO_2	4,39	4,74	4,6	1,90	5,4	4,75
Al_2O_3	0,12	0,27	0,3	0,27	0,44	0,40
TiO_2	0,022	0,037	0,15		0,16	0,11
CaO	0,39	0,43	0,05	0,13	0,37	4,25
MgO	0,32	0,33	0,05	0,04	0,25	1,70
Na_2O	0,005	0,026	0,03	0,04	0,04	
K_2O	0,002	0,013			0,02	0,02
BaO						
Mn	0,090	0,100	0,04	1,90	0,02	0,014
P	0,008	0,008	0,015	0,009	0,014	0,010
S	0,003	0,001	0,008	0,005	0,002	0,013
V	< 0,010	< 0,010				
F						
Cu	< 0,001	< 0,001				
Pb	< 0,003	< 0,003				
Zn	0,001	0,003				
Cr	< 0,002	< 0,021				
Ni	< 0,003	< 0,003				
Co						
Sn						
As	0,010	< 0,010				
Sb						
Cd						
Bi						
Mo						
Fe^{++}	6,06	0,23				
Cl (soluble)						
Cl (total)						
LOI	0,080	0,080	0,1			
Comb. H_2O	0,040	0,040				
C	0,26	< 0,02				
CO_2						
Size analysis	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**	**% % cum**
+ 31,5 mm						
+ 22,4 mm						
+ 16 mm		0,7 0,7				
+ 8 mm		87,3 88				
+ 4 mm		10 98				
+ 2 mm		1 99				
+ 1 mm			4 4			
+ 500 µm	2 2		21 25			
+ 250 µm	25 27		33 58			
+ 180 µm	16 43					
+ 90 µm	30 73		34 92			
+ 63 µm	18 91					

Element	Mount Wright low silica pellets Canada	Mount Wright low silica fluxed pellets Canada
Fe	67,6	65,8
SiO_2	2,15	2,40
Al_2O_3	0,43	0,40
TiO_2	0,14	0,14
CaO	0,43	2,15
MgO	0,30	0,90
Na_2O	0,03	0,04
K_2O	0,02	0,02
BaO		
Mn	0,01	0,02
P	0,010	0,008
S	0,003	0,005
V		
F		
Cu		
Pb		
Zn		
Cr		
Ni		
Co		
Sn		
As		
Sb		
Cd		
Bi		
Mo		
Fe++		
Cl (soluble)		
Cl (total)		
LOI		
Comb. H_2O		
C		
CO_2		
Size analysis	**% % cum**	**% % cum**
+ 31,5 mm		
+ 22,4 mm		
+ 16 mm		
+ 8 mm		
+ 4 mm		
+ 2 mm		
+ 1 mm		
+ 500 µm		
+ 250 µm		
+ 180 µm		
+ 90 µm		
+ 63 µm		

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SOUTH AMERICAN ORES