

## Premium Certified Reference Material RRM Fe - 116

**PRODUCT: IRON ORE**  
**Pilbara Region Western Australia**  
**CERTIFICATE OF ANALYSIS**

Certificate Number: RRM CRM Fe-116 Rev 1

Date: 23<sup>rd</sup> May 2023

**Table 1 Fe-116 Constituents (ISO 2596:2006 Hygroscopic Moisture Corrected)**

Analyte (Unit)	Assigned value	Standard Deviation		95% Confidence Limits		Number of Laboratories	Number of Analyses	Mean of number of analyses per Laboratory
		Within Laboratory	Between Laboratory	Lower	Upper			
Fe (%)	45,28	0,32	0,32	45,13	45,44	8	17	2,1
Fe calculated (%)	45,37	0,13	0,13	45,30	45,43	8	17	2,1
SiO <sub>2</sub> (%)	14,14	0,10	0,10	14,09	14,20	8	17	2,1
Al <sub>2</sub> O <sub>3</sub> (%)	10,02	0,06	0,08	9,98	10,06	8	17	2,1
TiO <sub>2</sub> (%)	0,948	0,006	0,018	0,934	0,961	8	17	2,1
Mn (%)	0,415	0,002	0,005	0,411	0,418	8	17	2,1
CaO (%)	0,144	0,002	0,002	0,143	0,146	8	17	2,1
MgO (%)	0,236	0,002	0,015	0,225	0,247	8	17	2,1
K <sub>2</sub> O (%)	0,068	0,002	0,002	0,067	0,069	8	17	2,1
Na <sub>2</sub> O (%)	0,05	0,005	0,008	0,044	0,056	7	16	2,3
P (%)	0,031	-	0,001	0,030	0,031	8	17	2,1
S (%)	0,057	0,001	0,001	0,056	0,057	7	13	1,9
LOI-371 %	6,40	0,17	0,18	6,28	6,52	2	23	11,5
LOI-425 %	7,05	0,06	0,20	6,89	7,20	7	37	5,3
LOI-650 %	8,18	0,07	0,13	8,09	8,26	7	37	5,3
LOI-1000 %	8,60	0,06	0,14	8,51	8,68	10	40	4,0
As (%)	0,006	-	0,004	0,003	0,009	7	15	2,1
Cl (%)	0,009	0,002	0,003	0,008	0,011	7	16	2,3
Co (%)	-	-	-	-	-	7	16	2,3
Cu (%)	0,001	-	-	-	-	7	16	2,3
Pb (%)	0,023	0,007	0,011	0,015	0,032	7	16	2,3
Zn (%)	0,003	0,001	0,001	0,002	0,004	3	6	2,0
Ba (%)	0,034	0,002	0,002	0,033	0,035	6	12	2,0
Cr (%)	0,014	0,001	0,002	0,013	0,015	7	16	2,3
Ni (%)	0,001	0,001	0,001	-	0,002	7	16	2,3
Sn (%)	-	-	-	-	-	6	12	2,0
Sr (%)	0,004	-	-	0,004	0,004	6	12	2,0
V (%)	0,018	0,001	0,001	0,017	0,019	6	15	2,5
Zr (%)	0,025	0,001	0,003	0,023	0,027	6	15	2,5

**Table 2 Fe-116 Constituents (non-hygroscopically moisture corrected)**

Analyte (Unit)	Assigned value	Standard Deviation		95% Confidence Limits		Number of Laboratories	Number of Analyses	Mean of number of analyses per Laboratory
		Within Laboratory	Between Laboratory	Lower	Upper			
Fe (%)	45,01	0,11	0,39	44,82	45,19	17	62	3,6
Fe calculated (%)	45,02	0,09	0,30	44,48	45,16	17	62	3,6
SiO <sub>2</sub> (%)	14,06	0,07	0,10	14,02	14,10	17	62	3,6
Al <sub>2</sub> O <sub>3</sub> (%)	9,88	0,05	0,12	9,83	9,94	17	62	3,6
TiO <sub>2</sub> (%)	0,941	0,004	0,009	0,937	0,945	17	62	3,6
Mn (%)	0,411	0,001	0,005	0,409	0,414	14	54	3,9
CaO (%)	0,139	0,002	0,008	0,135	0,143	17	62	3,6
MgO (%)	0,240	0,020	0,028	0,229	0,251	17	62	3,6
K <sub>2</sub> O (%)	0,067	0,001	0,003	0,065	0,068	17	62	3,6
Na <sub>2</sub> O (%)	0,047	0,010	0,012	0,042	0,052	12	48	4,0
P (%)	0,031	0,001	0,001	0,031	0,031	17	62	3,6
S (%)	0,053	0,001	0,002	0,053	0,054	16	58	3,6
LOI-371 %	6,93	0,14	0,22	6,81	7,05	9	47	5,2
LOI-425 %	7,51	0,14	0,34	7,27	7,74	7	35	5,0
LOI-650 %	8,70	0,06	0,26	8,54	8,86	11	52	4,7
LOI-1000 %	9,13	0,12	0,30	8,99	9,27	19	85	4,5
As (%)	0,006	0,001	0,002	0,004	0,007	10	33	3,3
Cl (%)	0,010	0,002	0,002	0,009	0,011	9	36	4,0
Co (%)	-	-	-	-	-	6	23	3,8
Cu (%)	0,001	-	0,002	-	0,002	10	37	3,7
Pb (%)	0,027	0,002	0,003	0,026	0,029	10	36	3,6
Zn (%)	0,003	0,002	0,002	0,002	0,004	6	19	3,2
Ba (%)	0,031	0,002	0,005	0,026	0,036	4	13	3,3
Cr (%)	0,015	0,001	0,001	0,014	0,016	6	21	3,5
Ni (%)	0,003	0,002	0,003	0,001	0,005	7	22	3,1
Sn (%)	-	-	-	-	-	3	11	3,7
Sr (%)	0,004	0,001	0,001	0,004	0,005	5	13	2,6
V (%)	0,018	0,001	0,001	0,017	0,018	5	15	3,0
Zr (%)	0,027	0,001	0,002	0,025	0,029	5	17	3,4

### Introduction:

Certified Reference Materials (CRMs) are used by laboratories to prove the value of their service offerings and for clients of laboratories to evaluate and monitor laboratory performance. CRMs must comply with high metrological requirements and ensuring traceability of measurement results.

Since most techniques employing analytical instrumentation are comparative, these techniques require a sample of known composition (CRM) for accurate calibration. Grade and Matrix matched CRM's are thus vital to the core of the analytical chemistry industry.

### **Preparation of Material:**

The material constituting RRM Fe-116 has been according to ISO 17034:2016, and includes the following:

- Drying to constant mass
- Crushing and dry milling to nominal 53µm particle size
- Homogenization
- Systematic rotary division of the entire lot, to final aliquot
- Packaging
- Rotary divided to nominal 250g sealed jars
- Rotary divided to nominal 10g geochem pouches, vacuum sealed in barrier foil
- Custom package sizes available on request

Unique to RRM, rotary division of all material to final packaging.

### **Methods of Analysis:**

The analysis of the test samples has been conducted according to each individual laboratory's routine analytical procedures. The material has been dried at 105°C until constant mass was achieved, or corrected for moisture according to ISO 2596:2006. Each test sample has been prepared, analyzed and reported in duplicate; with results reported on a dry basis.

Elements and Oxides determined as follows:

- Multi-element Iron Ore Suite – XRF fused disc analysis
- Loss on Ignition – Thermo Gravimetric Analysis

### **Homogeneity Evaluation:**

For the evaluation of the homogeneity of the Fe-116 material, 14 samples were selected throughout the batch for analysis in duplicate. ANOVA (one-way analysis of variance) was used to assess the homogeneity for measured Iron and total Loss on Ignition. No significant variation was observed for both 'batch' and 'within unit' exercises. The results and statistical evaluation from the interlaboratory studies (presented in Tables 3, 4, 5 and 6) further validate the homogeneity. The material can thus be considered fit for purpose for use as a CRM.

### **Statistical Evaluation:**

We have grouped the laboratories according to the method of determining moisture. Certain laboratories determine the dry weight of iron ore samples at 105°C, whilst some use the ISO 2596:2006 correction for hygroscopic moisture. Some iron ore types report different moisture values for each of these methods, which in turn influences the chemical analysis as the determined moisture content has an influence on the dry starting mass.

A comprehensive statistical evaluation of the results received from the various laboratories was performed. Outliers were identified and removed from the data sets for the certification exercise.

The assigned values are the mean of means after removal of outliers. All constituents reported with a between laboratory % RSD of <5% are regarded as certified values.

**Table 3 Fe-116 Statistical Evaluation (Hygroscopic Moisture Corrected)**

Analyte (Unit)	Fe (%)	Fe calc (%)	SiO <sub>2</sub> (%)	Al <sub>2</sub> O <sub>3</sub> (%)	TiO <sub>2</sub> (%)	Mn (%)	CaO (%)
Assigned value	45.28	45.37	14.14	10.02	0.948	0.415	0.144
Number of Laboratories	8	8	8	8	8	8	8
Number of Analyses	17	17	17	17	17	17	17
Between Laboratory Standard Deviation	0.32	0.13	0.10	0.08	0.018	0.005	0.002
Within Laboratory Standard Deviation	0.32	0.13	0.10	0.06	0.006	0.002	0.002
Between Laboratory Relative Standard Deviation	0.70 %	0.28 %	0.73 %	0.76 %	1.91 %	1.15 %	1.62 %
Within Laboratory Relative Standard Deviation	0.70 %	0.28 %	0.69 %	0.64 %	0.59 %	0.42 %	1.33 %
Standard Uncertainty	0.079	0.032	0.027	0.022	0.007	0.002	0.001
Lower confidence limit	45.13	45.30	14.09	9.98	0.934	0.411	0.143
Upper confidence limit	45.44	45.43	14.20	10.06	0.961	0.418	0.146
Lower limit of tolerance	44.65	45.11	13.94	9.87	0.912	0.405	0.140
Upper limit of tolerance	45.92	45.62	14.35	10.17	0.984	0.424	0.149

Analyte (Unit)	P (%)	S (%)	MgO (%)	K <sub>2</sub> O (%)	Na <sub>2</sub> O (%)	As (%)	Cl (%)
Assigned value	0.031	0.057	0.236	0.068	0.050	0.006	0.009
Number of Laboratories	8	7	8	8	7	7	7
Number of Analyses	17	13	17	17	16	15	16
Between Laboratory Standard Deviation	0.001	0.001	0.015	0.002	0.008	0.004	0.003
Within Laboratory Standard Deviation	-	0.001	0.002	0.002	0.005	-	0.002
Between Laboratory Relative Standard Deviation	3.82 %	1.75 %	6.15 %	2.82 %	16.8 %	60 %	28 %
Within Laboratory Relative Standard Deviation	1.60 %	1.75 %	1.00 %	2.49 %	9.86 %	1.82 %	24 %
Standard Uncertainty	-	-	0.005	0.001	0.003	0.002	0.001
Lower confidence limit	0.030	0.056	0.225	0.067	0.044	0.003	0.008
Upper confidence limit	0.031	0.057	0.247	0.069	0.056	0.009	0.011
Lower limit of tolerance	0.028	0.055	0.207	0.064	0.033	-	0.004
Upper limit of tolerance	0.033	0.059	0.265	0.072	0.067	0.014	0.015

Analyte (Unit)	Co (%)	Cu (%)	Pb (%)	Zn (%)	Ba (%)	Cr (%)	Ni (%)
Assigned value	-	0.001	0.023	0.003	0.034	0.014	0.001
Number of Laboratories	7	7	7	3	6	7	7
Number of Analyses	16	16	16	6	12	16	16
Between Laboratory Standard Deviation	-	-	0.011	0.001	0.002	0.002	0.001
Within Laboratory Standard Deviation	-	-	0.007	0.001	0.002	0.001	0.001
Between Laboratory Relative Standard Deviation	-	-	47 %	28 %	7.03 %	10.7 %	299 %
Within Laboratory Relative Standard Deviation	-	-	28 %	19.7 %	7.03 %	7.06 %	123 %
Standard Uncertainty	-	-	0.004	-	0.001	0.001	0.001
Lower confidence limit	-	-	0.015	0.002	0.033	0.013	-

Upper confidence limit	-	-	0.032	0.004	0.035	0.015	0.002
Lower limit of tolerance	-	0.001	0.001	0.001	0.029	0.011	-
Upper limit of tolerance	-	0.001	0.045	0.005	0.039	0.018	0.003

Analyte (Unit)	Sn (%)	Sr (%)	V (%)	Zr (%)
Assigned value	-	0.004	0.018	0.025
Number of Laboratories	6	6	6	6
Number of Analyses	12	12	15	15
Between Laboratory Standard Deviation	-	-	0.001	0.003
Within Laboratory Standard Deviation	-	-	0.001	0.001
Between Laboratory Relative Standard Deviation	-	6.37 %	4.54 %	10.2 %
Within Laboratory Relative Standard Deviation	-	6.37 %	4.54 %	2.99 %
Standard Uncertainty	-	-	-	0.001
Lower confidence limit	-	0.004	0.017	0.023
Upper confidence limit	-	0.004	0.019	0.027
Lower limit of tolerance	-	0.003	0.016	0.020
Upper limit of tolerance	-	0.004	0.020	0.030

Table 4 Fe-116 Statistical Evaluation (non-hygroscopically moisture corrected)

Analyte (Unit)	Fe (%)	Fe calc (%)	SiO <sub>2</sub> (%)	Al <sub>2</sub> O <sub>3</sub> (%)	TiO <sub>2</sub> (%)	Mn (%)	CaO (%)
Assigned value	45.01	45.02	14.06	9.88	0.941	0.411	0.139
Number of Laboratories	17	17	17	17	17	14	17
Number of Analyses	62	62	62	62	62	54	62
Between Laboratory Standard Deviation	0.39	0.30	0.10	0.12	0.009	0.005	0.008
Within Laboratory Standard Deviation	0.11	0.09	0.07	0.05	0.004	0.001	0.002
Between Laboratory Relative Standard Deviation	0.86 %	0.66 %	0.74 %	1.19 %	0.98 %	1.17 %	6.07 %
Within Laboratory Relative Standard Deviation	0.24 %	0.19 %	0.50 %	0.52 %	0.41 %	0.34 %	1.55 %
Standard Uncertainty	0.093	0.072	0.020	0.026	0.002	0.001	0.002
Lower confidence limit	44.82	44.88	14.02	9.83	0.937	0.409	0.135
Upper confidence limit	45.19	45.16	14.10	9.94	0.945	0.414	0.143
Lower limit of tolerance	44.24	44.43	13.85	9.65	0.922	0.402	0.123
Upper limit of tolerance	45.78	45.61	14.27	10.12	0.959	0.421	0.156

Analyte (Unit)	P (%)	S (%)	MgO (%)	K <sub>2</sub> O (%)	Na <sub>2</sub> O (%)	As (%)	Cl (%)
Assigned value	0.031	0.053	0.240	0.067	0.047	0.006	0.010
Number of Laboratories	17	16	17	17	12	10	9
Number of Analyses	62	58	62	62	48	33	36
Between Laboratory Standard Deviation	0.001	0.002	0.028	0.003	0.012	0.002	0.002

<b>Within Laboratory Standard Deviation</b>	0.001	0.001	0.020	0.001	0.010	0.001	0.002
<b>Between Laboratory Relative Standard Deviation</b>	3.73 %	3.57 %	11.6 %	4.70 %	26 %	30 %	18.8 %
<b>Within Laboratory Relative Standard Deviation</b>	2.70 %	2.30 %	8.42 %	1.87 %	22 %	9.93 %	15.3 %
<b>Standard Uncertainty</b>	-	-	0.005	0.001	0.002	0.001	-
<b>Lower confidence limit</b>	0.031	0.053	0.229	0.065	0.042	0.004	0.009
<b>Upper confidence limit</b>	0.031	0.054	0.251	0.068	0.052	0.007	0.011
<b>Lower limit of tolerance</b>	0.029	0.050	0.184	0.060	0.023	0.002	0.006
<b>Upper limit of tolerance</b>	0.033	0.057	0.296	0.073	0.071	0.009	0.014

<b>Analyte (Unit)</b>	<b>Co (%)</b>	<b>Cu (%)</b>	<b>Pb (%)</b>	<b>Zn (%)</b>	<b>Ba (%)</b>	<b>Cr (%)</b>	<b>Ni (%)</b>
<b>Assigned value</b>	-	0.001	0.027	0.003	0.031	0.015	0.003
<b>Number of Laboratories</b>	6	10	10	6	4	6	7
<b>Number of Analyses</b>	23	37	36	19	13	21	22
<b>Between Laboratory Standard Deviation</b>	-	0.002	0.003	0.002	0.005	0.001	0.003
<b>Within Laboratory Standard Deviation</b>	-	-	0.002	0.002	0.002	0.001	0.002
<b>Between Laboratory Relative Standard Deviation</b>	-	106 %	10.4 %	73 %	16.1 %	8.41 %	105 %
<b>Within Laboratory Relative Standard Deviation</b>	-	20 %	6.24 %	62 %	4.83 %	5.08 %	66 %
<b>Standard Uncertainty</b>	-	0.001	0.001	0.001	0.002	-	0.001
<b>Lower confidence limit</b>	-	-	0.026	0.002	0.026	0.014	0.001
<b>Upper confidence limit</b>	-	0.002	0.029	0.004	0.036	0.016	0.005
<b>Lower limit of tolerance</b>	-	-	0.022	-	0.021	0.013	-
<b>Upper limit of tolerance</b>	-	0.005	0.033	0.007	0.041	0.018	0.009

<b>Analyte (Unit)</b>	<b>Sn (%)</b>	<b>Sr (%)</b>	<b>V (%)</b>	<b>Zr (%)</b>
<b>Assigned value</b>	-	0.004	0.018	0.027
<b>Number of Laboratories</b>	3	5	5	5
<b>Number of Analyses</b>	11	13	15	17
<b>Between Laboratory Standard Deviation</b>	-	0.001	0.001	0.002
<b>Within Laboratory Standard Deviation</b>	-	0.001	0.001	0.001
<b>Between Laboratory Relative Standard Deviation</b>	-	31 %	6.13 %	8.84 %
<b>Within Laboratory Relative Standard Deviation</b>	-	30 %	3.14 %	2.72 %
<b>Standard Uncertainty</b>	-	-	-	0.001
<b>Lower confidence limit</b>	-	0.004	0.017	0.025
<b>Upper confidence limit</b>	-	0.005	0.018	0.029
<b>Lower limit of tolerance</b>	-	0.002	0.015	0.022
<b>Upper limit of tolerance</b>	-	0.007	0.020	0.031

## LOI Certified Values:

The LOI statistics from the inter-laboratory study are presented in the table below:

**Table 5 Fe-116 LOI Certified Values (Hygroscopic Moisture Corrected)**

Determination (Unit)	LOI-371 %	LOI-425 %	LOI-650 %	LOI-1000 %
Assigned value	6.40	7.05	8.18	8.60
Number of Laboratories	2	7	7	10
Number of Analyses	23	37	37	40
Between Laboratory Standard Deviation	0.18	0.20	0.13	0.14
Within Laboratory Standard Deviation	0.17	0.06	0.07	0.06
Between Laboratory Relative Standard Deviation	2.86 %	2.80 %	1.52 %	1.59 %
Within Laboratory Relative Standard Deviation	2.64 %	0.84 %	0.88 %	0.70 %
Standard Uncertainty	0.061	0.078	0.040	0.043
Lower confidence limit	6.28	6.89	8.09	8.51
Upper confidence limit	6.52	7.20	8.26	8.68
Lower limit of tolerance	6.03	6.65	7.93	8.32
Upper limit of tolerance	6.76	7.44	8.42	8.87

**Table 6 Fe-116 LOI Certified Values (non-hygroscopically corrected moisture)**

Determination (Unit)	LOI-371 %	LOI-425 %	LOI-650 %	LOI-1000 %
Assigned value	6.93	7.51	8.70	9.13
Number of Laboratories	9	7	11	19
Number of Analyses	47	35	52	85
Between Laboratory Standard Deviation	0.22	0.34	0.26	0.30
Within Laboratory Standard Deviation	0.14	0.14	0.06	0.12
Between Laboratory Relative Standard Deviation	3.12 %	4.46 %	2.97 %	3.32 %
Within Laboratory Relative Standard Deviation	1.98 %	1.85 %	0.73 %	1.33 %
Standard Uncertainty	0.059	0.117	0.080	0.069
Lower confidence limit	6.81	7.27	8.54	8.99
Upper confidence limit	7.05	7.74	8.86	9.27
Lower limit of tolerance	6.49	6.84	8.18	8.52
Upper limit of tolerance	7.36	8.17	9.22	9.74

## Origin of Material:

This material originates from the iron ore deposits of the Hamersley Group of the Hamersley Iron Province, central Pilbara Craton in Western Australia. The Hamersley Group rocks are early Proterozoic sediments, i.e. shale, siltstone, mudstone, chert, carbonate rocks and banded iron formations. Some minor volcanic units are also present in the Hamersley Group stratigraphy. There are two banded iron ore deposits within the Hamersley Group, the Brockman Iron Formation (approximately 2481±4 Ma) and the older Marra Mamba Iron Formation (approximately 2597±5 Ma). The Brockman Formation consists of cherts, mudstone, siltstone and banded iron formations; and is the main iron ore zone within the Hamersley Group. The iron formation consists of significant amounts of secondary enriched martite-goethite, which has an iron content of between 56 and 63 wt.%. The Marra Mamba Iron Formation is a surface enriched banded iron formation consisting of martite microplaty hematite ores, containing 60 to 68 wt.% iron.

1. Killick, M. F., H. M. Churchward, R. R. Anand (2003) Hamersley Iron Province, Western Australia. CRC LEME, Exploration and Mining.
2. Morris, R. C., M. Kneeshaw, (2011): Genesis modelling for the Hamersley BIF-hosted iron ores of Western Australia: A critical review. Australian Journal of earth sciences 58.



**Minor Elements and Specific Gravity:**

Informational values for minor elements are provided; results from Lazer Ablation ICP-MS and for Specific Gravity by Helium Pycnometer (results are for a single analysis at one laboratory):

**SG (Helium Pycnometer) 3.72**

**Table 7 Fe-116 Minor Elements**

<b>As ppm</b> 47,8	<b>Ba ppm</b> 331	<b>Be ppm</b> -0,2-	<b>Bi ppm</b> 0,58	<b>Cd ppm</b> -	<b>Ce ppm</b> 20,8	<b>Co ppm</b> 8,6	<b>Cs ppm</b> 0,17
<b>Cu ppm</b> 22	<b>Dy ppm</b> 1,65	<b>Er ppm</b> 1,15	<b>Eu ppm</b> 0,32	<b>Ga ppm</b> 20,8	<b>Gd ppm</b> 1,05	<b>Ge ppm</b> 3,4	<b>Hf ppm</b> 6,87
<b>Ho ppm</b> 0,42	<b>In ppm</b> 0,1	<b>La ppm</b> 6,3	<b>Lu ppm</b> 0,23	<b>Mn ppm</b> 4190	<b>Mo ppm</b> 2,2	<b>Nb ppm</b> 14	<b>Nd ppm</b> 5,6
<b>Ni ppm</b> 36	<b>Pb ppm</b> 266	<b>Pr ppm</b> 1,45	<b>Rb ppm</b> 2,55	<b>Re ppm</b> -	<b>Sb ppm</b> 5,1	<b>Sc ppm</b> 20,2	<b>Se ppm</b> -5-
<b>Sm ppm</b> 1,44	<b>Sn ppm</b> 3,8	<b>Sr ppm</b> 42	<b>Ta ppm</b> 1,59	<b>Tb ppm</b> 0,27	<b>Te ppm</b> 0,6	<b>Th ppm</b> 12,9	<b>Tl ppm</b> -
<b>Tm ppm</b> 0,15	<b>U ppm</b> 2,84	<b>V ppm</b> 185	<b>W ppm</b> 2,75	<b>Y ppm</b> 10,9	<b>Yb ppm</b> 1,17	<b>Zn ppm</b> 35	<b>Zr ppm</b> 247

**XRD Analysis:**

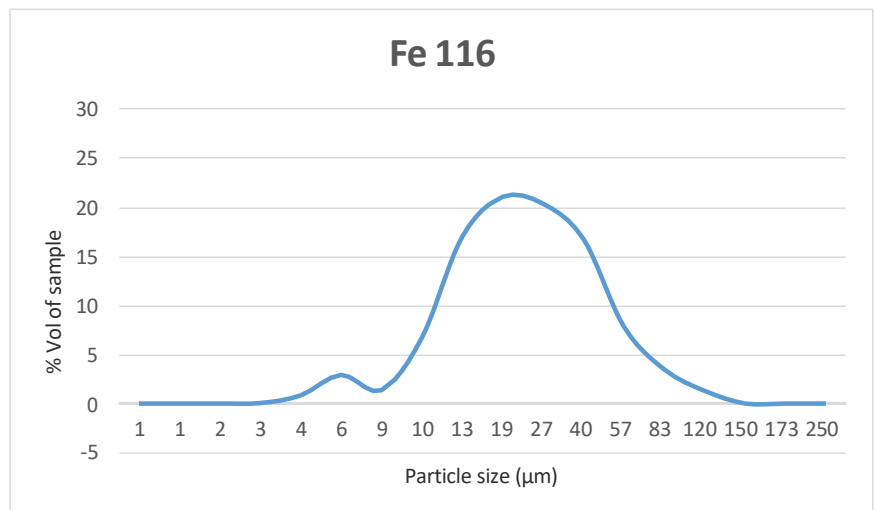
A sample of Fe-116 was submitted for Quantitative X-Ray Diffraction Analysis after drying at 50°C. XRDQUANT01 - Quantitative analysis, crystalline and amorphous content

**Table 8 Fe-116 Mineral Abundance (XRD)**

<b>Mineral</b>	<b>% mass fraction</b>
Hematite Fe <sub>2</sub> O <sub>3</sub>	26
Goethite FeO(OH)	40
Magnetite Fe <sub>3</sub> O <sub>4</sub>	ND
Quartz SiO <sub>2</sub>	1
Kaolin Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	<1
Anatase TiO <sub>2</sub>	1
Amorphous content	32

**Particle Size Distribution:**

A sample of Fe-116 was submitted for particle size analysis by MICROTRAC S3500 Lazer Diffraction System.



**Figure 1 Fe-116 Particle Size Distribution**



**Spectral Analysis:**

A sample of Fe-116 was submitted for analysis by TerraSpec 4 VNIR-SWIR.

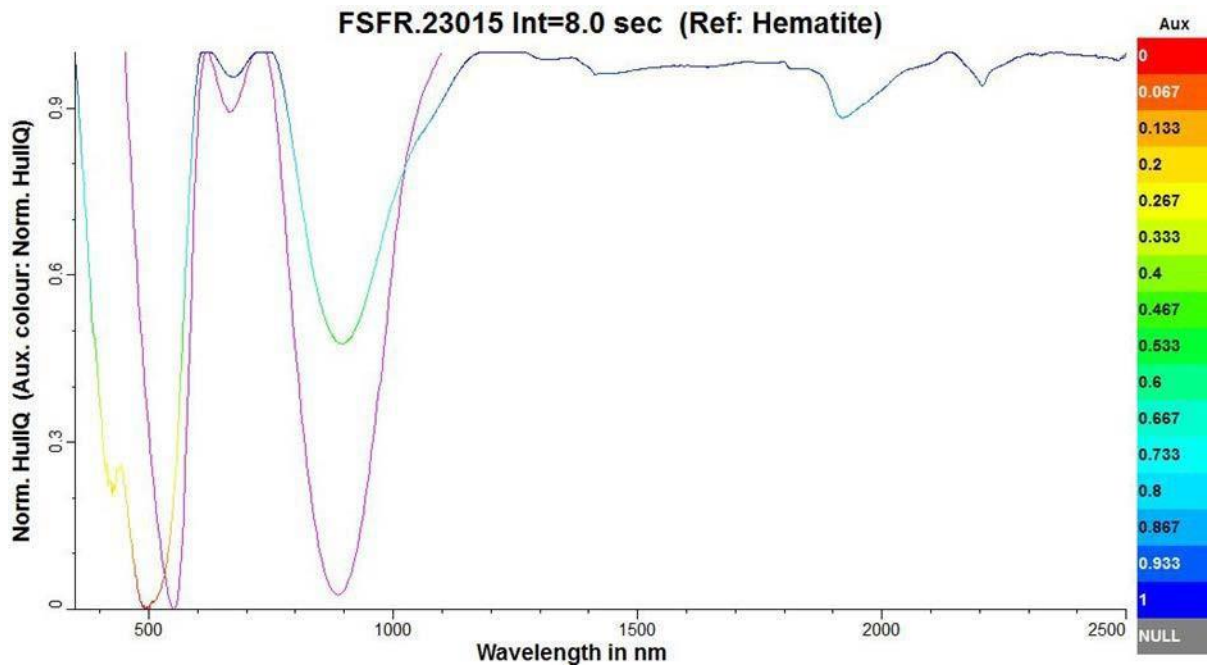


Figure 2 Fe-116 VNIR

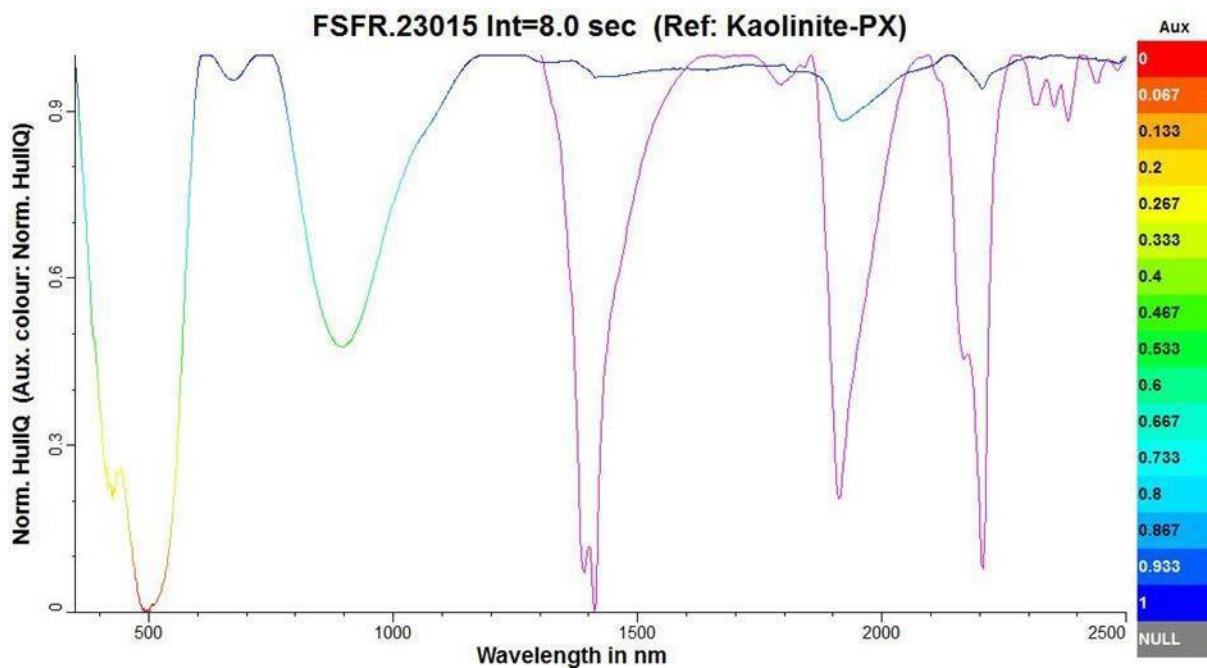
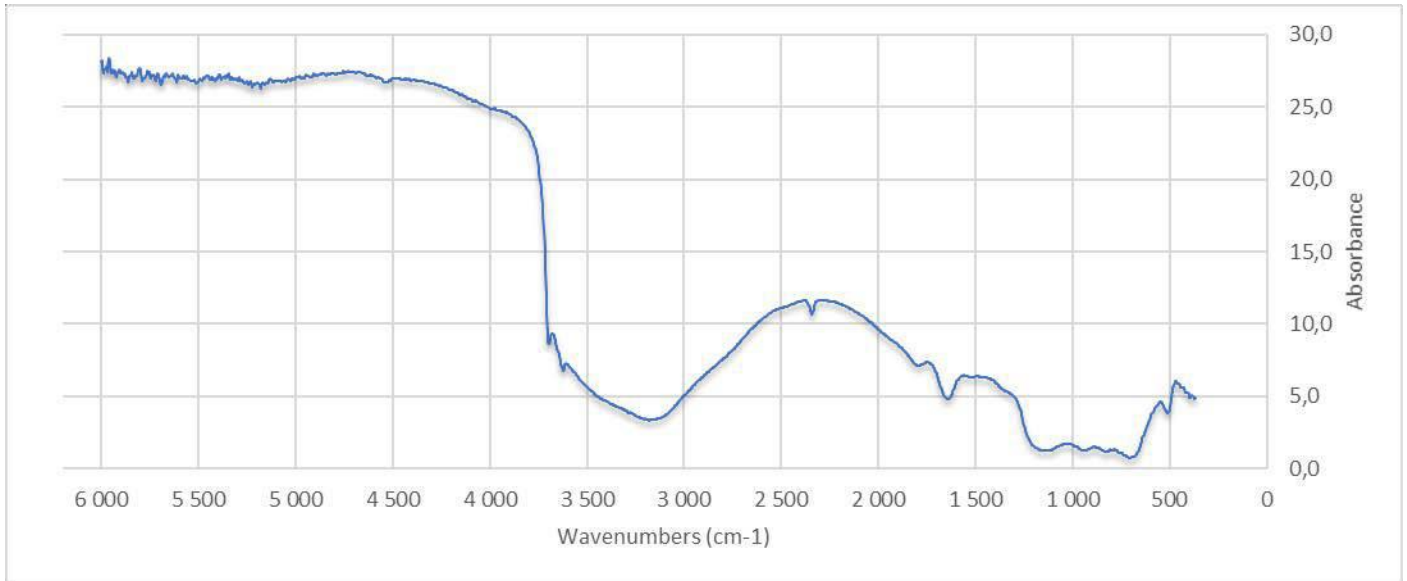


Figure 3 Fe-116 SWIR

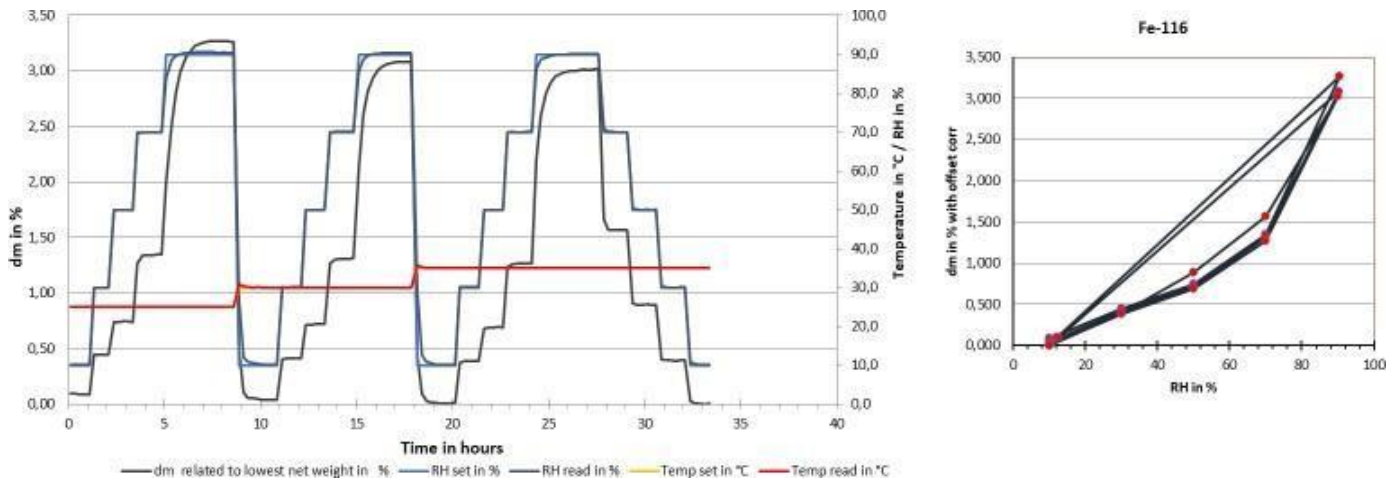
**FTIR Analysis:**



**Figure 4 Fe-116 FTIR Spectra**

**Hygroscopic Moisture:**

To illustrate the effect of hygroscopic moisture a sample of RRM Fe-116 underwent water vapour sorption testing.



**Figure 5 Fe-116 Sorption Testing**

From the tests it is clear that hygroscopic moisture could have an impact on the quality of the chemical analysis results and appropriate storage and pre-treatment is highly recommended.

**Participating Laboratories:**

**Table 9 Fe-116 Participating Laboratories**

ALS Metallurgy, Australia
ALS Iron Ore, Australia
BHP Billiton Nelson Point Laboratory, Australia
BHP Billiton Newman Laboratory Line 1, Australia
BHP Billiton Newman Laboratory Line 2, Australia
BHP Billiton Newman Laboratory Line 3, Australia
BHP Billiton Newman Laboratory Line 4, Australia
Bureau Veritas, South Australia
Bureau Veritas, Western Australia
Citic Pacific Mining Laboratory, Australia
IMP Automation, Australia
Intertek Maddington, Australia
Intertek Robotic Laboratories Anderson Point, Australia
Intertek Robotic Laboratories Christmas Creek, Australia
Intertek Robotic Laboratories Cloudbreak, Australia
Intertek Robotic Laboratories FMG Port, Australia
Intertek Robotic Laboratories Mt Webber, Australia
Intertek Robotic Laboratories Roy Hill Port, Australia
Intertek Robotic Laboratories Solomon, Australia
Intertek, South Africa
Kumba Iron Ore Sishen Mine Laboratory, South Africa
MinAnalytical Laboratory Services, Australia
Rio Tinto Cape Lambert Port A Laboratory, Australia
Rio Tinto Cape Lambert Port B Laboratory, Australia
Rio Tinto Dampier Laboratory, Australia
Rio Tinto Marandoo Laboratory, Australia
Rio Tinto Paraburdoo Laboratory, Australia
Rio Tinto West Angelas Laboratory, Australia
Rio Tinto Yandicoogina Laboratory, Australia
Set Point Laboratories, South Africa

### **Intended Use:**

The Certified Reference Material RRM Fe-116 is intended to be used in analytical laboratories that analyse samples of similar grades (as presented in this certificate of analysis) and matrix.

- Monitoring of routine laboratory performance (both internal and external)
- Method development and method validation
- Instrument calibration

### **Instructions before Use:**

Safety precautions (in-line with safe laboratory practices) for handling fine particulate matter are advised; such as the use of safety glasses, dust masks, gloves and laboratory coats.

### **Minimum Sample Size:**

- Multi-element Iron Ore Suite – XRF fused disc analysis 0.7g
- LOI – 1g

### **Analysis Validity:**

The property values for RRM Fe-116 Certified Reference Material remain valid provided that good laboratory practice is observed during handling and storage.

The material is in fine powder form and may be hygroscopic in nature.

### **Stability and storage:**

This CRM is considered to have long-term stability under normal storage conditions. The CRM is available in different packaging and mass lots. When considering the lot size and said the ISO 16042, which recommends that the total contents of the container holding the CRM prior to its first use be divided in two portions that match the intended test portions.

### **Traceability:**

The characterization of this material has been achieved by inter-laboratory study, each laboratory using an appropriate analytical method. These methods are calibrated against and analysed against high purity materials and appropriate Certified Reference Materials.

### **Additional Information:**

Additional information on material RRM Fe-116 is available on request and includes the following:

- Data Tables
- Statistical Tables
- Particle Size Analysis Data
- Quantitative X-Ray Diffraction Analysis Report
- FTIR Spectral Data
- VNIR-SWIR Spectral Data
- Sorption Testing Data

#### Revisions:

This certificate is version 1.00 for the material RRM-Fe-116; and is intended to be a 'live document' intended to reflect progress in analytical chemistry. In that, any significant new data and information could be added at any time to ensure the currency and relevance of the certification.

This Certificate has been revised to correct discrepancies between Table 1 and Table 3, and Table 2 and Table 4.

Any further revisions to this Certificate of Analysis will be made available via the company website [www.imstandards.com.au](http://www.imstandards.com.au)

#### Legal Notice:

This material has been prepared and a comprehensive statistical evaluation conducted to assign the property values, with appropriate care and attention. The Purchaser, by receipt of this material and certificate, indemnifies and releases Independent Mineral Standards (Pty) Ltd from and against any and all liability and costs arising from the use of this material and certificate and any actions taken thereupon.

#### Prepared and Supplied:

Certified Reference Material RRM Fe-116 has been prepared and certified and is supplied by; Resource Reference Materials (Pty) Ltd 36 Michelson Road Anderbolt, Boksburg South Africa, 1459

E-Mail: [info@resourcereferencematerials.com](mailto:info@resourcereferencematerials.com)

The Material is available from Independent Mineral Standards.

E-Mail: [enquiries@imstandards.com.au](mailto:enquiries@imstandards.com.au)

#### References:

**ISO 17034:2016** General requirements for the competence of reference material producers

**DRAFT ISO GUIDE 35:2016 Reference materials** — Guidance for the characterization and the assessment of the homogeneity and stability of the material

**ISO 5725-2:1994** Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

**ISO 2596:2006 Iron ores** — Determination of hygroscopic moisture in analytical samples — Gravimetric, Karl Fischer and mass-loss methods

**ISO 11536:2015 Iron ores** — Determination of loss on ignition — Gravimetric method

**ISO 9516-1:2003 Iron ores** — Determination of various elements by X-ray fluorescence spectrometry — Part 1: Comprehensive procedure

**ISO 2597: 2006 part 3 Iron ores** — Determination of hygroscopic moisture in analytical samples — Gravimetric, Karl Fischer and mass-loss methods

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