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CERTIFICATE OF ANALYSIS FOR

Zn-Pb-Ag REFERENCE MATERIAL

OREAS 134a

Summary Statistics for Key Analytes (see Table 1 for additional certified values).

Constituent (ppm)	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion						
Ag, Silver (ppm)	201	7	196	205	197	205
Pb, Lead (wt.%)	12.79	0.766	12.34	13.23	12.49	13.08
Zn, Zinc (wt.%)	17.27	0.553	16.95	17.59	16.97	17.57

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1. Certified Values, SD's, 95% Confidence and Tolerance Limits for OREAS 134a.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fusion ICP*						
Ag, Silver (ppm)	197	10	186	209	190	205
Al_2O_3, Aluminium(III) oxide (wt.%)	2.60	0.131	2.49	2.71	2.54	2.67
As, Arsenic (ppm)	218	22	196	239	208	227
Ba, Barium (ppm)	1500	156	1334	1667	1480	1521
CaO, Calcium oxide (wt.%)	6.38	0.197	6.21	6.56	6.30	6.47
Cd, Cadmium (ppm)	546	36	510	581	529	563
Co, Cobalt (ppm)	100	13	90	110	98	103
Fe, Iron (wt.%)	12.32	0.795	11.71	12.94	12.01	12.63
MgO, Magnesium oxide (wt.%)	3.55	0.119	3.45	3.66	3.50	3.61
Pb, Lead (wt.%)	12.95	0.623	12.49	13.40	12.67	13.22
SiO_2, Silicon dioxide (wt.%)	14.81	0.845	14.10	15.53	14.51	15.11
Zn, Zinc (wt.%)	17.49	0.505	17.10	17.88	17.20	17.78
4-Acid Digestion						
Ag, Silver (ppm)	201	7	196	205	197	205
Al_2O_3, Aluminium(III) oxide (wt.%)	2.53	0.117	2.46	2.61	2.49	2.58
As, Arsenic (ppm)	228	23	217	239	220	235
CaO, Calcium oxide (wt.%)	6.04	0.385	5.79	6.29	5.94	6.13
Cd, Cadmium (ppm)	536	36	514	557	523	548
Co, Cobalt (ppm)	105	8	100	110	101	109
Cu, Copper (ppm)	1291	45	1270	1311	1267	1314
Fe, Iron (wt.%)	12.04	0.410	11.83	12.25	11.87	12.21
MgO, Magnesium oxide (wt.%)	3.49	0.184	3.39	3.60	3.43	3.56
Pb, Lead (wt.%)	12.79	0.766	12.34	13.23	12.49	13.08
S, Sulphur (wt.%)	19.27	0.503	18.85	19.70	18.72	19.83
Sb, Antimony (ppm)	115	15	107	124	112	119
Zn, Zinc (wt.%)	17.27	0.553	16.95	17.59	16.97	17.57
Aqua Regia Digestion						
Ag, Silver (ppm)	194	13	186	202	188	199
Al_2O_3, Aluminium(III) oxide (wt.%)	0.774	0.085	0.714	0.833	0.755	0.792
As, Arsenic (ppm)	226	24	212	239	219	232
Cd, Cadmium (ppm)	547	44	520	573	537	556
Co, Cobalt (ppm)	101	8	96	106	99	104
Cu, Copper (ppm)	1279	78	1231	1328	1250	1309
Fe, Iron (wt.%)	11.89	0.973	11.30	12.48	11.65	12.14
MgO, Magnesium oxide (wt.%)	3.43	0.137	3.33	3.52	3.37	3.48
Pb, Lead (wt.%)	12.64	0.759	12.11	13.17	12.34	12.93
S, Sulphur (wt.%)	18.49	1.329	17.35	19.63	18.08	18.90
Zn, Zinc (wt.%)	17.00	0.863	16.44	17.56	16.57	17.43
Infrared Combustion						
S, Sulphur (wt.%)	19.11	0.413	18.81	19.42	18.81	19.41

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.

*except for Ba where two laboratories used pressed powder pellet with XRF.
Please note: intervals may appear asymmetric due to rounding.

Table 2. Indicative Values for OREAS 134a.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Oxidising Fusion XRF								
Al_2O_3	wt.%	*2.57*	Fe_2O_3	wt.%	*17.69*	SnO_2	ppm	*< 13*
As	ppm	*240*	K_2O	wt.%	*0.962*	SO_3	wt.%	*49.29*
BaO	ppm	*1502*	MgO	wt.%	*3.55*	SrO	ppm	*35.5*
CaO	wt.%	*5.94*	MnO	wt.%	*0.459*	TiO_2	wt.%	*0.093*
Cl	ppm	*190*	NiO	ppm	*31.8*	V_2O_5	ppm	*71*
CoO	ppm	*140*	P_2O_5	wt.%	*0.079*	ZnO	ppm	*215350*
Cr_2O_3	ppm	*51*	PbO	ppm	*137774*	ZrO_2	ppm	*40.5*
CuO	ppm	*1646*	SiO_2	wt.%	*14.82*			
Thermogravimetry								
LOI^{1000}	wt.%	*14.59*						
Laser Ablation ICP-MS								
Ag	ppm	*193*	Ge	ppb	*18150*	Se	ppm	*< 5*
As	ppm	*236*	Hf	ppb	*865*	Sm	ppm	*1.34*
Ba	ppm	*1345*	Ho	ppb	*180*	Sn	ppm	*1.00*
Be	ppm	*1.80*	In	ppm	*0.98*	Sr	ppm	*25.5*
Bi	ppm	*0.19*	La	ppm	*8.64*	Ta	ppb	*205*
Cd	ppm	*532*	Lu	ppb	*75.0*	Tb	ppb	*180*
Ce	ppm	*16.3*	Mo	ppm	*6.60*	Te	ppb	*< 200*
Co	ppm	*103*	Nb	ppm	*2.05*	Th	ppm	*2.56*
Cr	ppm	*10.0*	Nd	ppm	*6.88*	Tl	ppm	*81*
Cs	ppm	*1.08*	Ni	ppm	*22.0*	Tm	ppb	*95.0*
Cu	ppm	*1340*	Pb	wt.%	*12.60*	U	ppm	*1.37*
Dy	ppm	*0.81*	Pr	ppm	*1.86*	V	ppm	*13.1*
Er	ppm	*0.48*	Rb	ppm	*24.9*	W	ppm	*0.50*
Eu	ppb	*320*	Re	ppb	*20.0*	Y	ppm	*5.73*
Ga	ppm	*4.55*	Sb	ppm	*118*	Yb	ppb	*515*
Gd	ppm	*1.20*	Sc	ppm	*1.80*	Zr	ppm	*27.8*
Fusion ICP								
Be	ppm	*1.00*	Na	ppm	*653*	Ti	ppm	*613*
Cr	ppm	*80*	P	ppm	*297*	V	ppm	*16.4*
Cu	ppm	*1278*	S	wt.%	*19.39*	Y	ppm	*5.40*
K	wt.%	*0.929*	Sb	ppm	*118*	Zr	ppm	*30.2*
LOI^{1000}	wt.%	*15.12*	Sc	ppm	*2.00*			
Mn	ppm	*3371*	Sr	ppm	*28.8*			
4-Acid Digestion								
B	ppm	*21.0*	K	wt.%	*0.795*	Sm	ppm	*1.38*
Ba	ppm	*< 1400*	La	ppm	*6.10*	Sn	ppm	*1.13*
Be	ppm	*2.00*	Li	ppm	*17.8*	Sr	ppm	*18.3*
Ce	ppm	*13.2*	Lu	ppb	*100*	Ta	ppb	*< 500*

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

Table 2. Indicative Values for OREAS 134a continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Cr	ppm	*16.6*	Mn	ppm	*3424*	Tb	ppb	*180*
Cs	ppm	*1.14*	Mo	ppm	*6.25*	Te	ppb	*90.0*
Dy	ppm	*0.80*	Na	ppm	*303*	Th	ppm	*1.44*
Er	ppm	*0.56*	Nb	ppm	*1.86*	Ti	ppm	*479*
Eu	ppb	*300*	Nd	ppm	*7.42*	Tl	ppm	*93*
Ga	ppm	*4.88*	Ni	ppm	*21.3*	Tm	ppb	*100*
Gd	ppm	*1.24*	P	ppm	*294*	U	ppm	*1.47*
Ge	ppb	*2080*	Pr	ppm	*1.68*	V	ppm	*12.2*
Hf	ppb	*880*	Rb	ppm	*27.4*	W	ppm	*0.52*
Hg	ppb	*2000*	Re	ppb	*< 1*	Y	ppm	*5.18*
Ho	ppb	*200*	Sc	ppm	*1.40*	Yb	ppb	*520*
In	ppm	*1.16*	Se	ppm	*7.44*	Zr	ppm	*27.8*
Aqua Regia Digestion								
Au	ppb	*< 0.5*	In	ppm	*1.20*	Se	ppm	*6.92*
B	ppm	*< 10*	K	wt.%	*0.150*	Sm	ppm	*1.44*
Ba	ppm	*< 600*	La	ppm	*6.54*	Sn	ppm	*0.93*
Be	ppm	*0.70*	Li	ppm	*15.3*	Sr	ppm	*23.8*
CaO	wt.%	*6.09*	Lu	ppb	*< 100*	Ta	ppb	*< 50*
Ce	ppm	*13.0*	Mn	ppm	*3854*	Tb	ppb	*200*
Cr	ppm	*12.9*	Mo	ppm	*6.80*	Te	ppb	*100*
Cs	ppm	*0.68*	Na	ppm	*161*	Th	ppm	*2.18*
Dy	ppm	*1.11*	Nb	ppm	*< 0.1*	Ti	ppm	*60*
Er	ppm	*0.56*	Nd	ppm	*6.37*	Tl	ppm	*67*
Eu	ppb	*360*	Ni	ppm	*21.6*	Tm	ppb	*< 100*
Ga	ppm	*3.13*	P	ppm	*281*	U	ppm	*0.96*
Gd	ppm	*1.34*	Pr	ppm	*1.54*	V	ppm	*7.40*
Ge	ppb	*475*	Rb	ppm	*11.7*	W	ppm	*0.24*
Hf	ppb	*280*	Re	ppb	*2.60*	Y	ppm	*3.00*
Hg	ppb	*2260*	Sb	ppm	*101*	Yb	ppb	*480*
Ho	ppb	*200*	Sc	ppm	*< 0.5*	Zr	ppm	*10.4*

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

INTRODUCTION

OREAS reference materials are intended to provide a low cost method of evaluating and improving the quality of analysis of geological samples. To the geologist they provide a means of implementing quality control in analytical data sets generated in exploration from the grass roots level through to prospect evaluation, and in grade control at mining operations. To the analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

SOURCE MATERIALS

OREAS 134a is one of eight pigeon paired CRM's prepared from zinc-lead mineralised material from Xstrata's Black Star and George Fisher orebodies located in Mt Isa in NW Queensland, Australia. OREAS 134a contains a 4.3% and 4.2% lower relative offset in Pb and Zn grades respectively, to OREAS 134b. The orebodies are sediment hosted 'SEDEX' Zn-Pb-Ag deposits located within the Urquart Shale Formation of the Mount Isa Group, a weakly metamorphosed, 5 km thick sequence composed predominantly of Mesoproterozoic carbonate siltstones, mudstones and shales. The Urquart Shale consists of a sequence of alternating pyrite-rich dolomitic siltstone and shale beds up to 1000 metres thick and was deposited in a lacustrine setting within an intracratonic rift basin. The orebodies lie within the upper 650m and are bounded by the Mount Isa fault on the west and by volcanic greenstones to the east. Comprising galena and sphalerite with pyrite and pyrrhotite, the lead-zinc-silver orebodies are concordant with carbonaceous dolomitic sediments and interfinger with the silica-dolomitic mass hosting copper. OREAS 134a was prepared from a blend of Black Star waste rock, Black Star ore and George Fisher ore.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 134a was prepared in the following manner:

- Drying to constant mass at 65°C;
- Crushing and milling to 100% minus 30 microns;
- Homogenisation and bagging into 20kg lots;
- Packaging into 10g units sealed under nitrogen in laminated foil pouches.

ANALYTICAL PROGRAM

Fifteen commercial laboratories participated in the analytical program to certify Ag, Al_2O_3, As, Ba, CaO, Cd, Co, Cu, Fe, MgO, Pb, S, Sb, SiO_2 and Zn by a range of analytical methods. Tabulated results of all elements together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 134a DataPack-2.0.180516_150805.xlsx**).

The intent of the certification program was to characterise the analytes by:

- Fusion methods - sodium peroxide fusion or lithium borate fusion with ICP (except for Ba where two laboratories used pressed powder pellet with XRF);
- Four acid (HF-HCl-HNO_3-$HClO_4$) digest with ICP or AAS;
- Aqua regia digest with ICP or AAS;
- Leco for sulphur only.

The approximate major and trace element composition of OREAS 133a is provided in Table 2 (Indicative Values).

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. Aqua regia is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions which can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements.

The approach applied here is to report certified values in those instances where reasonable agreement exists amongst a majority of participating laboratories. The results of specific laboratories may differ significantly from the certified values, but will, nonetheless, be valid and reproducible in the context of the specifics of the aqua regia method in use. Users of this reference material should, therefore, be mindful of this limitation when applying the certified values in a quality control program.

For the round robin program a batch of five 25g vacuum-packed pulp samples was submitted to each of the participating laboratories for analysis. The five samples comprising each batch were scoop-split from a random selection of five of ten or more 400g master samples. The latter were taken at regular intervals during the bagging stage and immediately following homogenisation. Table 1 presents the 37 certified values together with their associated 1SD’s, 95% confidence and tolerance limits and Table 2 shows 187 indicative values. Table 3 provides performance gate intervals for the certified values of each method group based on their pooled 1SD’s.

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (Table 1) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. In certain instances statistician’s prerogative has been employed in discriminating outliers. Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if >2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status.

Certified Values are the means of accepted laboratory means after outlier filtering.

Indicative (uncertified) values (Table 2) are provided for the major and trace elements determined by oxidising fusion XRF (Al_2O_3 to ZrO_2), LOI at 1000°C and laser ablation with ICP-MS (Ag to Zr) and are the means of duplicate assays from Bureau Veritas, Perth. Additional indicative values by other analytical methods are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

95% Confidence Limits are inversely proportional to the number of participating laboratories and inter-laboratory agreement. It is a measure of the reliability of the certified value. A 95% confidence interval indicates a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits. *95% Confidence Limits should not be used as control limits for laboratory performance.*

Standard Deviation values (1SDs) are reported in Table 1 and provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. The SD values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. OREAS reference materials have a level of homogeneity such that the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e. after removal of any individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e. the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. **The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.**

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical process and this SD is not directly related to the round robin program.

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include inter-lab bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

Table 3 shows **Performance Gates** calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned. A second method utilises a 5% window calculated directly from the certified value. Standard deviation is also shown in relative per cent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised when concentration levels approach lower limits of detection of the analytical methods employed as performance gates calculated from standard deviations tend to be excessively wide whereas those determined by the 5% method are too narrow.

Tolerance Limits (ISO Guide 3207) were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for Zn by 4-acid digestion, where 99% of the time ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 16.97 and 17.57 wt.%. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover < 95% of the total population (ISO Guide 35).

Table 3. Performance Gates for OREAS 134a.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Fusion ICP*											
Ag, ppm	197	6	185	210	179	216	3.15%	6.30%	9.44%	188	207
Al_2O_3, wt.%	2.60	0.049	2.50	2.70	2.45	2.75	1.89%	3.79%	5.68%	2.47	2.73
As, ppm	218	6	205	230	199	237	2.93%	5.86%	8.79%	207	229
Ba, ppm	1500	35	1430	1571	1395	1606	2.34%	4.68%	7.03%	1425	1575
CaO, wt.%	6.38	0.080	6.22	6.55	6.14	6.63	1.26%	2.51%	3.77%	6.07	6.70
Cd, ppm	546	27	492	600	465	627	4.94%	9.87%	14.81%	519	573
Co, ppm	100	4	93	108	89	112	3.79%	7.59%	11.38%	95	105
Fe, wt.%	12.32	0.247	11.83	12.81	11.58	13.06	2.00%	4.01%	6.01%	11.71	12.94
MgO, wt.%	3.55	0.054	3.45	3.66	3.39	3.72	1.53%	3.06%	4.60%	3.38	3.73
Pb, wt.%	12.95	0.274	12.40	13.49	12.12	13.77	2.12%	4.24%	6.36%	12.30	13.59
SiO_2, wt.%	14.81	0.397	14.02	15.61	13.62	16.00	2.68%	5.36%	8.05%	14.07	15.55
Zn, wt.%	17.49	0.296	16.90	18.08	16.60	18.38	1.69%	3.38%	5.07%	16.62	18.37
4-Acid Digestion											
Ag, ppm	201	2	197	205	194	207	1.07%	2.13%	3.20%	191	211
Al_2O_3, wt.%	2.53	0.041	2.45	2.62	2.41	2.66	1.64%	3.28%	4.92%	2.41	2.66
As, ppm	228	14	200	255	186	269	6.07%	12.13%	18.20%	216	239
CaO, wt.%	6.04	0.098	5.84	6.23	5.74	6.33	1.62%	3.24%	4.86%	5.73	6.34
Cd, ppm	536	11	514	557	503	568	2.03%	4.05%	6.08%	509	562
Co, ppm	105	4	98	112	94	116	3.38%	6.77%	10.15%	100	110
Cu, ppm	1291	33	1225	1356	1192	1389	2.54%	5.09%	7.63%	1226	1355
Fe, wt.%	12.04	0.322	11.39	12.68	11.07	13.01	2.68%	5.36%	8.03%	11.44	12.64
MgO, wt.%	3.49	0.084	3.33	3.66	3.24	3.74	2.39%	4.79%	7.18%	3.32	3.67
Pb, wt.%	12.79	0.264	12.26	13.31	11.99	13.58	2.06%	4.13%	6.19%	12.15	13.43
S, wt.%	19.27	0.358	18.56	19.99	18.20	20.35	1.86%	3.72%	5.57%	18.31	20.24
Sb, ppm	115	6	104	127	98	133	4.93%	9.87%	14.80%	110	121
Zn, wt.%	17.27	0.247	16.77	17.76	16.52	18.01	1.43%	2.87%	4.30%	16.40	18.13
Aqua Regia Digestion											
Ag, ppm	194	4	185	202	181	206	2.09%	4.18%	6.27%	184	203
Al_2O_3, wt.%	0.774	0.019	0.736	0.811	0.718	0.829	2.40%	4.80%	7.20%	0.735	0.812
As, ppm	226	7	212	239	205	246	3.08%	6.16%	9.24%	214	237
Cd, ppm	547	9	528	566	518	575	1.73%	3.46%	5.20%	519	574
Co, ppm	101	3	96	106	93	109	2.56%	5.12%	7.68%	96	106
Cu, ppm	1279	29	1221	1338	1191	1368	2.30%	4.61%	6.91%	1216	1343
Fe, wt.%	11.89	0.264	11.36	12.42	11.10	12.68	2.22%	4.44%	6.65%	11.30	12.49
MgO, wt.%	3.43	0.050	3.33	3.52	3.28	3.57	1.45%	2.90%	4.35%	3.25	3.60
Pb, wt.%	12.64	0.304	12.03	13.24	11.73	13.55	2.40%	4.80%	7.21%	12.01	13.27
S, wt.%	18.49	0.412	17.67	19.32	17.26	19.73	2.23%	4.46%	6.68%	17.57	19.42
Zn, wt.%	17.00	0.318	16.36	17.64	16.04	17.95	1.87%	3.75%	5.62%	16.15	17.85
Infrared Combustion											
S, wt.%	19.11	0.180	18.75	19.47	18.57	19.65	0.94%	1.89%	2.83%	18.16	20.07

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.

*except for Ba where two laboratories used pressed powder pellet with XRF.

Note: intervals may appear asymmetric due to rounding.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 134a is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

PARTICIPATING LABORATORIES

1. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
2. Actlabs, Ancaster, Ontario, Canada
3. ALS, Brisbane, QLD, Australia
4. ALS, Johannesburg, South Africa
5. ALS, Perth, WA, Australia
6. ALS, Vancouver, BC, Canada
7. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
8. Bureau Veritas Amdel Laboratories, Perth, WA, Australia
9. Intertek Genalysis, Perth, WA, Australia
10. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
11. Intertek Testing Services, Cupang, Muntinlupa, Philippines
12. SGS Australia Mineral Services, Perth, WA, Australia
13. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
14. SGS Mineral Services, Townsville, QLD, Australia
15. Bureau Veritas Geoanalytical, Perth, WA, Australia

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 134a has been prepared, certified and is supplied by:

ORE RESEARCH & EXPLORATION

ORE Research & Exploration Pty Ltd
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AUSTRALIA

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Fax: +613-9729 8338
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Email: info@ore.com.au

It is available in 10g units sealed under nitrogen in laminated foil pouches.

INTENDED USE

OREAS 134a is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- For the verification of analytical methods for analytes reported in Table 1;
- For the calibration of instruments used in the determination of the concentration of analytes reported in Table 1.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 134a has been prepared from a blend of sulphide-bearing Black Star waste, Black Star ore and George Fisher ore. To prolong its shelf life it has been packaged under nitrogen in robust foil laminate pouches. It is considered to have long-term stability under normal storage conditions. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR CORRECT USE

The certified values for OREAS 134a refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

Please assay immediately after opening the sealed sachet to avoid oxidation of sulphides. Prolonged exposure to atmospheric oxygen may cause dilution of certified values due to the uptake of oxygen converting sulphides to sulphates. Users who submit sachets of this CRM to an assaying laboratory must communicate these instructions if wording to this effect are not pre-printed on the CRM’s label.

METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This ‘representivity’ was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis.

The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *“Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. In other cases,* ***only a comparison among different laboratories using the same method is possible. In this case, certification takes place on the basis of agreement among independent measurement results*** *(see ISO Guide 35:2006, Clause 10).”*

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. All OREAS CRMs are sourced from natural ore minerals meaning they will display similar behaviour as routine ‘field’ samples in the relevant measurement process. Care should be taken to ensure ‘matrix matching’ as close as practically achievable. The matrix and mineralisation style of the CRM is described in the ‘Source Material’ section and users should select appropriate CRMs matching these attributes to their field samples.

QMS ACCREDITED

ORE Pty Ltd is accredited to ISO 9001:2008 by Lloyd’s Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.

HANDLING INSTRUCTIONS

Fine powders pose a risk to eyes and lungs and therefore standard precautions such as the use of safety glasses and dust masks are advised.

LEGAL NOTICE

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

CERTIFYING OFFICER

Craig Hamlyn (B.Sc. Hons - Geology), Technical Manager - ORE P/L

DOCUMENT HISTORY

Revision No	Date	Changes applied
2	3rd Sep, 2018	Added major and trace element characterisation.
1	11th April, 2016	The Standard Deviations (SD's) were revised to bring them into line with the method used for all other OREAS CRMs (pooled SD method). The original certification used a different method (involving standardising the laboratory means) that generated SD's that were overly constrained for practical use. Indicative values have been added (see Table 2).
0	5th Feb, 2015	First publication.

REFERENCES

ISO Guide 30 (2015), Terms and definitions used in connection with reference materials.

ISO Guide 31 (2015), Reference materials – Contents of certificates and labels.

ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.

ISO Guide 35 (2017), Certification of reference materials - General and statistical principals.