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CERTIFICATE OF ANALYSIS FOR

LATERITIC SOIL LITHOGEOCHEM REFERENCE MATERIAL

OREAS 45e

Table 1. Fire Assay - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay with ICP-OES / ICP-MS / AAS (undried basis)						
Gold, Au (ppb)	53	3	52	54	52	54
Palladium, Pd (ppb)	75	5	73	78	73	78
Platinum, Pt (ppb)	110	6	107	112	105	114

Note: intervals may appear asymmetric due to rounding.

Table 2. Fusion XRF - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fusion XRF (dry basis)						
Aluminium Oxide, Al_2O_3 (wt.%)	13.04	0.107	12.98	13.09	12.95	13.12
Calcium Oxide, CaO (wt.%)	0.089	0.011	0.082	0.095	IND	IND
Chromium Oxide, Cr_2O_3 (ppm)	1568	62.7	1533	1603	1524	1612
Iron(III) Oxide, Fe_2O_3 (wt.%)	35.46	0.292	35.32	35.60	35.21	35.72
Potassium Oxide, K_2O (wt.%)	0.405	0.006	0.403	0.407	0.396	0.413
Magnesium Oxide, MgO (wt.%)	0.268	0.010	0.261	0.274	0.258	0.277
Manganese Oxide, MnO (wt.%)	0.072	0.006	0.068	0.075	IND	IND
Sodium Oxide, Na_2O (wt.%)	0.078	0.010	0.072	0.084	IND	IND
Phosphorus Oxide, P_2O_5 (wt.%)	0.081	0.003	0.080	0.083	0.079	0.083
Silicon Dioxide, SiO_2 (wt.%)	40.13	0.273	40.01	40.24	39.84	40.41
Titanium Oxide, TiO_2 (wt.%)	0.989	0.021	0.976	1.001	0.976	1.001
Vanadium Oxide, V_2O_5 (ppm)	588	15.3	574	602	IND	IND
Loss on ignition, LOI (wt.%)	8.69	0.175	8.60	8.78	8.62	8.76

Note: intervals may appear asymmetric due to rounding.

Table 3. 4-Acid ICP - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Four Acid Digestion ICP-OES / ICP-MS (undried basis)						
Silver, Ag (ppm)	0.311	0.062	0.269	0.353	0.259	0.364
Aluminium, Al (wt.%)	6.78	0.170	6.69	6.86	6.64	6.91
Arsenic, As (ppm)	16.3	1.53	15.7	16.9	15.4	17.2
Barium, Ba (ppm)	252	12.2	247	258	245	260
Beryllium, Be (ppm)	0.62	0.11	0.56	0.68	0.49	0.75
Bismuth, Bi (ppm)	0.28	0.03	0.26	0.30	0.26	0.30
Calcium, Ca (wt.%)	0.065	0.006	0.062	0.067	0.061	0.068
Cerium, Ce (ppm)	23.5	2.20	22.1	24.8	22.8	24.2
Cobalt, Co (ppm)	57	3.9	55	59	55	59
Chromium, Cr (ppm)	979	74.4	941	1018	957	1002
Cesium, Cs (ppm)	1.26	0.049	1.23	1.29	1.22	1.31
Copper, Cu (ppm)	780	23.4	771	790	761	800
Dysprosium, Dy (ppm)	2.05	0.200	1.81	2.29	1.90	2.21
Erbium, Er (ppm)	1.20	0.14	1.03	1.36	1.08	1.32
Iron, Fe (wt.%)	24.12	1.322	23.44	24.79	23.72	24.51
Gallium, Ga (ppm)	16.5	1.23	15.7	17.2	16.0	17.0
Gadolinium, Gd (ppm)	1.99	0.27	1.65	2.34	IND	IND
Hafnium, Hf (ppm)	3.11	0.144	3.05	3.17	2.96	3.26
Indium, In (ppm)	0.099	0.008	0.094	0.103	0.090	0.107

Table 3 continued

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Potassium, K (wt.%)	0.324	0.008	0.320	0.328	0.314	0.334
Lanthanum, La (ppm)	11.0	0.97	10.4	11.5	10.7	11.3
Lithium, Li (ppm)	6.58	0.490	6.36	6.80	6.21	6.96
Lutetium, Lu (ppm)	0.17	0.03	0.14	0.20	IND	IND
Magnesium, Mg (wt.%)	0.156	0.012	0.150	0.161	0.151	0.160
Manganese, Mn (wt.%)	0.055	0.003	0.054	0.057	0.054	0.056
Molybdenum, Mo (ppm)	2.40	0.157	2.35	2.45	2.28	2.52
Sodium, Na (wt.%)	0.059	0.003	0.058	0.061	0.057	0.062
Niobium, Nb (ppm)	6.80	0.180	6.73	6.87	6.51	7.10
Neodymium, Nd (ppm)	9.57	1.28	8.20	10.94	9.04	10.10
Nickel, Ni (ppm)	454	24.8	442	465	443	465
Phosphorus, P (wt.%)	0.034	0.002	0.033	0.036	0.033	0.036
Lead, Pb (ppm)	18.2	1.9	17.4	19.1	17.5	18.9
Praseodymium, Pr (ppm)	2.57	0.38	2.07	3.06	2.45	2.68
Rubidium, Rb (ppm)	21.2	1.18	20.6	21.9	20.6	21.9
Sulphur, S (wt.%)	0.046	0.005	0.043	0.048	0.045	0.047
Antimony, Sb (ppm)	1.00	0.096	0.94	1.05	0.95	1.04
Scandium, Sc (ppm)	93	4.6	91	95	90	96
Selenium, Se (ppm)	2.97	0.223	2.85	3.09	2.61	3.33
Samarium, Sm (ppm)	2.28	0.133	2.16	2.41	2.12	2.44
Tin, Sn (ppm)	1.32	0.074	1.28	1.36	IND	IND
Strontium, Sr (ppm)	15.9	0.81	15.5	16.3	15.4	16.4
Tantalum, Ta (ppm)	0.56	0.06	0.53	0.60	0.52	0.60
Thorium, Th (ppm)	12.9	1.04	12.3	13.5	12.4	13.4
Titanium, Ti (wt.%)	0.559	0.034	0.540	0.578	0.546	0.572
Thallium, Tl (ppm)	0.15	0.03	0.13	0.17	0.14	0.16
Uranium, U (ppm)	2.41	0.189	2.31	2.50	2.30	2.51
Vanadium, V (ppm)	322	15.4	314	330	314	330
Tungsten, W (ppm)	1.07	0.21	0.94	1.19	IND	IND
Yttrium, Y (ppm)	8.28	0.558	7.96	8.60	7.94	8.62
Ytterbium, Yb (ppm)	1.19	0.12	1.06	1.32	1.13	1.26
Zinc, Zn (ppm)	46.7	5.7	43.7	49.6	44.9	48.4
Zirconium, Zr (ppm)	110	14	102	118	105	116

Note: intervals may appear asymmetric due to rounding.

Table 4. Fusion ICP - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fusion ICP-OES / ICP-MS (undried basis)						
Aluminium, Al (wt.%)	6.78	0.167	6.70	6.86	6.66	6.89
Barium, Ba (ppm)	246	7.8	242	251	236	256
Calcium, Ca (wt.%)	0.063	0.011	0.058	0.068	0.055	0.072
Cerium, Ce (ppm)	23.5	0.92	22.8	24.2	22.6	24.4
Cobalt, Co (ppm)	59	4.7	56	61	57	61
Chromium, Cr (ppm)	1067	46.5	1046	1088	1042	1092
Cesium, Cs (ppm)	1.20	0.106	1.15	1.25	1.15	1.24
Copper, Cu (ppm)	756	43.9	731	781	735	777
Dysprosium, Dy (ppm)	2.28	0.170	2.22	2.33	2.08	2.47
Erbium, Er (ppm)	1.41	0.086	1.38	1.45	1.29	1.54
Europium, Eu (ppm)	0.55	0.042	0.53	0.57	0.52	0.58

Table 4 continued

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Iron, Fe (wt.%)	24.19	0.567	23.91	24.47	23.80	24.58
Gallium, Ga (ppm)	16.2	0.88	15.7	16.7	15.4	16.9
Gadolinium, Gd (ppm)	2.00	0.128	1.95	2.05	1.80	2.20
Hafnium, Hf (ppm)	6.31	0.416	6.04	6.59	6.02	6.61
Holmium, Ho (ppm)	0.46	0.039	0.44	0.48	0.42	0.50
Potassium, K (wt.%)	0.336	0.024	0.325	0.346	0.325	0.346
Lanthanum, La (ppm)	11.1	0.66	10.6	11.6	10.6	11.6
Lutetium, Lu (ppm)	0.23	0.018	0.22	0.24	0.21	0.25
Magnesium, Mg (wt.%)	0.158	0.010	0.153	0.162	0.152	0.164
Manganese, Mn (wt.%)	0.056	0.002	0.055	0.057	0.054	0.057
Molybdenum, Mo (ppm)	2.95	0.59	2.64	3.25	IND	IND
Sodium, Na (wt.%)	0.058	0.005	0.054	0.061	0.054	0.062
Niobium, Nb (ppm)	7.40	0.75	6.99	7.80	7.06	7.73
Neodymium, Nd (ppm)	9.46	0.852	8.92	9.99	8.86	10.05
Nickel, Ni (ppm)	459	30.9	436	482	435	483
Praseodymium, Pr (ppm)	2.50	0.094	2.44	2.56	2.37	2.63
Rubidium, Rb (ppm)	20.8	1.29	20.0	21.6	20.1	21.5
Scandium, Sc (ppm)	91	2.6	88	94	88	93
Silicon, Si (wt.%)	18.56	0.442	18.35	18.77	18.28	18.84
Samarium, Sm (ppm)	2.13	0.166	2.06	2.20	1.90	2.35
Strontium, Sr (ppm)	15.9	1.37	15.4	16.5	15.1	16.8
Tantalum, Ta (ppm)	0.63	0.08	0.59	0.66	IND	IND
Terbium, Tb (ppm)	0.36	0.032	0.35	0.37	0.33	0.40
Thorium, Th (ppm)	13.0	0.50	12.7	13.3	12.5	13.5
Titanium, Ti (wt.%)	0.584	0.016	0.576	0.593	0.574	0.594
Thulium, Tm (ppm)	0.22	0.02	0.21	0.23	0.20	0.24
Uranium, U (ppm)	2.54	0.140	2.48	2.60	2.40	2.68
Vanadium, V (ppm)	317	28.4	299	336	309	325
Tungsten, W (ppm)	1.06	0.20	0.92	1.20	IND	IND
Yttrium, Y (ppm)	10.6	0.66	10.1	11.0	10.2	11.0
Ytterbium, Yb (ppm)	1.48	0.110	1.43	1.54	1.35	1.62
Zirconium, Zr (ppm)	242	14.5	232	253	235	250

Note: intervals may appear asymmetric due to rounding.

Table 5. Aqua Regia ICP - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion ICP-OES / ICP-MS (undried basis)						
Aluminium, Al (wt.%)	3.32	0.260	3.18	3.46	3.23	3.41
Arsenic, As (ppm)	11.4	1.7	10.6	12.2	10.7	12.1
Gold, Au (ppm)	0.050	0.006	0.047	0.054	0.047	0.053
Barium, Ba (ppm)	139	9.0	134	143	134	143
Calcium, Ca (wt.%)	0.032	0.003	0.031	0.034	0.031	0.033
Cerium, Ce (ppm)	17.7	2.3	15.4	19.9	16.9	18.5
Cobalt, Co (ppm)	52	6	49	55	50	54
Chromium, Cr (ppm)	849	70.9	810	888	828	870
Cesium, Cs (ppm)	0.77	0.11	0.63	0.91	0.71	0.83
Copper, Cu (ppm)	709	52.4	682	737	688	730
Iron, Fe (wt.%)	22.65	1.333	21.94	23.35	21.87	23.43

Table 5 continued

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Gallium, Ga (ppm)	11.7	1.7	10.7	12.7	11.2	12.2
Indium, In (ppm)	0.090	0.008	0.080	0.100	IND	IND
Potassium, K (wt.%)	0.053	0.005	0.050	0.055	0.051	0.054
Magnesium, Mg (wt.%)	0.095	0.007	0.092	0.098	0.091	0.099
Manganese, Mn (wt.%)	0.040	0.003	0.038	0.042	0.039	0.041
Sodium, Na (wt.%)	0.027	0.005	0.025	0.030	0.026	0.029
Nickel, Ni (ppm)	357	26.3	343	371	349	365
Phosphorus, P (wt.%)	0.029	0.002	0.028	0.031	0.028	0.030
Lead, Pb (ppm)	14.3	2.4	12.9	15.6	13.7	14.8
Rubidium, Rb (ppm)	7.93	1.25	6.72	9.15	7.55	8.32
Sulphur, S (wt.%)	0.044	0.005	0.040	0.047	IND	IND
Scandium, Sc (ppm)	78	5.5	74	81	75	80
Tin, Sn (ppm)	0.97	0.10	0.86	1.08	IND	IND
Strontium, Sr (ppm)	4.05	0.78	3.60	4.50	3.80	4.30
Thorium, Th (ppm)	10.7	0.83	10.0	11.4	10.3	11.1
Thallium, Tl (ppm)	0.072	0.007	0.063	0.080	IND	IND
Uranium, U (ppm)	1.73	0.18	1.58	1.89	1.67	1.79
Vanadium, V (ppm)	295	15.1	286	305	288	303
Yttrium, Y (ppm)	5.74	0.80	5.16	6.33	5.45	6.03
Ytterbium, Yb (ppm)	0.86	0.13	0.68	1.04	IND	IND
Zinc, Zn (ppm)	30.6	4.8	28.1	33.1	29.4	31.8

Note: intervals may appear asymmetric due to rounding.

Table 6. IR Combustion - Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 45e

IR Combustion Furnace (undried basis)						
Carbon, C (wt.%)	0.546	0.026	0.532	0.561	0.535	0.557
Sulphur, S (wt.%)	0.043	0.006	0.040	0.046	IND	IND

Note: intervals may appear asymmetric due to rounding; NA = Not Applicable

Table 7. Indicative Values for OREAS 45e

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Fusion XRF (dry basis)								
As	ppm	20.0	Cu	ppm	713	Sn	ppm	178
BaO	ppm	264	Ni	ppm	458	Sr	ppm	21.6
Cl	ppm	138	Pb	ppm	< 100	Zr	ppm	241
Co	ppm	104	S	wt.%	0.048			
Fusion ICP-OES / ICP-MS (undried basis)								
Ag	ppm	4.55	In	ppm	0.10	Se	ppm	< 50
As	ppm	45.1	Li	ppm	7.63	Sn	ppm	1.48
B	ppm	22.5	P	wt.%	0.032	Te	ppm	< 5
Be	ppm	0.68	Pb	ppm	18.8	Tl	ppm	< 0.5
Bi	ppm	0.48	Re	ppm	< 0.1	Zn	ppm	73
Cd	ppm	0.082	S	wt.%	0.051			
Ge	ppm	3.01	Sb	ppm	1.08			

Table 7 continued

Four Acid Digestion ICP-OES / ICP-MS (undried basis)								
Au	ppm	< 0.1	Hg	ppm	0.020	Te	ppm	0.20
Cd	ppm	0.028	Ho	ppm	0.41	Tm	ppm	0.19
Eu	ppm	0.55	Re	ppm	0.003			
Ge	ppm	1.06	Tb	ppm	0.34			
Aqua Regia Digestion ICP-OES / ICP-MS (undried basis)								
Ag	ppm	0.272	Hg	ppm	0.34	Re	ppm	< 0.05
B	ppm	8.12	Ho	ppm	0.29	Sb	ppm	0.64
Be	ppm	0.47	La	ppm	8.19	Se	ppm	2.09
Bi	ppm	0.26	Li	ppm	3.29	Sm	ppm	1.65
Cd	ppm	0.042	Lu	ppm	0.11	Ta	ppm	< 0.05
Dy	ppm	1.54	Mo	ppm	1.78	Tb	ppm	0.26
Er	ppm	0.82	Nb	ppm	0.43	Te	ppm	0.11
Eu	ppm	0.45	Nd	ppm	6.67	Ti	wt.%	0.106
Gd	ppm	1.67	Pd	ppb	66	Tm	ppm	0.10
Ge	ppm	0.26	Pr	ppm	1.91	W	ppm	< 10
Hf	ppm	0.82	Pt	ppb	108	Zr	ppm	26.6

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.

SOURCE MATERIALS

Multi-element standard OREAS 45e was prepared from lateritic soil with anomalous precious and base metal content. The soil is developed over a Ni-Cu-PGE mineralised contact between gabbro and pyroxenite in a layered mafic intrusive from the Southern Murchison region of Western Australia.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 45e was prepared in the following manner:

- drying to constant mass at 105°C;
- crushing and milling;
- homogenisation;
- packaging in 10g and 60g units into laminated foil pouches and in 500g units into plastic jars.

ANALYTICAL PROGRAM

Twenty commercial analytical laboratories participated in the program to characterise the elements reported in Tables 1 to 7. The following methods were employed:

- Lithium borate fusion for full suite X-ray fluorescence (14 laboratories)
- Sodium peroxide fusion or lithium borate fusion for full suite ICP-OES and ICP-MS (18 laboratories)
- Four acid digestion for full suite ICP-OES and ICP-MS (20 laboratories)
- Aqua regia digestion for full suite ICP-OES and ICP-MS (18 laboratories)
- Fire assay with ICP-OES and ICP-MS for Au, Pd and Pt (Au: 20 laboratories; Pd and Pt: 19 laboratories)
- Instrumental neutron activation analysis for Au on 1g subsamples to confirm homogeneity (1 laboratory)
- Infra-red combustion furnace for C and S (15 laboratories)
- Thermogravimetry for LOI (17 laboratories)

For the round robin program fifteen 1kg test units were taken at predetermined intervals during the bagging stage, immediately following final blending, and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 110g scoop splits from each of three separate 1kg test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e. to ascertain whether between-unit variance is greater than within-unit variance. Tables 1-6 present the certified values together with their associated 1SD's, 95% confidence and tolerance limits. Indicative values are provided (Table 7) for those analytes for which the analytical data are insufficient to permit determination of certified values. Table 8 provides performance gate intervals for the certified values based on their 1SD's. Tabulated results of all elements (including Au INAA analyses) together with uncorrected means, medians, standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM^3) are presented in the detailed certification data for this CRM (**OREAS 45e Datapack.xlsx**).

STATISTICAL ANALYSIS

Certified Values, Standard Deviations, Confidence and Tolerance Limits have been determined for each analytical method following removal of individual and laboratory outliers (see Tables 1-6). Certified Values are the mean of means after outlier filtering. The 95% Confidence Limit is a measure of the reliability of the certified value, i.e. the narrower the Confidence Interval the greater the certainty in the Certified Value. It should not be used as a control limit for laboratory performance.

Indicative values (Table 7) are provided where i) the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification; ii) interlaboratory consensus is poor; or iii) a significant proportion of results are outlying or reported as less than detection limits.

Standard Deviation values (1SDs) are reported in Tables 1-6 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. They take into account errors attributable to

measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. 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 all 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.

Performance Gates (Table 8) are 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 percent 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 copper 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 761 and 800 ppm. 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 less than 95% of the total population (IS0 Guide 35).

For gold the tolerance has been determined by INAA using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the latter parameter is substantially reduced to a point where most of the variability in replicate assays is due to inhomogeneity of the reference material and measurement error becomes negligible. In this instance a subsample weight of 1 gram was employed and confirms the high level of gold homogeneity in OREAS 45e.

The homogeneity of OREAS 45e has also been evaluated in an ANOVA study for all certified analytes. This study indicates no evidence that between-unit variance is greater than within-unit variance (i.e. no p-values <0.05).

Based on the statistical analysis of the results of the interlaboratory certification program it can be concluded that OREAS 45e is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Table 8. Performance Gates for OREAS 45e

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 XRF (dry basis)											
Al_2O_3, wt.%	13.04	0.107	12.82	13.25	12.71	13.36	0.82%	1.64%	2.46%	12.38	13.69
CaO, wt.%	0.089	0.011	0.066	0.111	0.055	0.123	12.75%	25.51%	38.26%	0.084	0.093
Cr_2O_3, ppm	1568	62.7	1443	1693	1380	1756	4.00%	7.99%	11.99%	1489	1646
Fe_2O_3, wt.%	35.46	0.292	34.88	36.05	34.58	36.34	0.82%	1.65%	2.47%	33.69	37.23
K_2O, wt.%	0.405	0.006	0.393	0.416	0.387	0.422	1.45%	2.90%	4.35%	0.384	0.425
MgO, wt.%	0.268	0.010	0.247	0.289	0.237	0.299	3.86%	7.71%	11.57%	0.254	0.281
MnO, wt.%	0.072	0.006	0.059	0.084	0.053	0.091	8.73%	17.47%	26.20%	0.068	0.075
Na_2O, wt.%	0.078	0.010	0.057	0.099	0.047	0.110	13.37%	26.74%	40.11%	0.074	0.082
P_2O_5, wt.%	0.081	0.003	0.075	0.087	0.072	0.090	3.72%	7.45%	11.17%	0.077	0.085
SiO_2, wt.%	40.13	0.273	39.58	40.67	39.31	40.95	0.68%	1.36%	2.04%	38.12	42.13
TiO_2, wt.%	0.989	0.021	0.946	1.031	0.924	1.053	2.16%	4.32%	6.49%	0.939	1.038
V_2O_5, ppm	588	15.3	558	619	542	634	2.60%	5.21%	7.81%	559	618
Fusion ICP-OES / ICP-MS (undried basis)											
Al, wt.%	6.78	0.167	6.44	7.11	6.28	7.28	2.46%	4.92%	7.38%	6.44	7.12
Ba, ppm	246	7.8	231	262	223	270	3.17%	6.33%	9.50%	234	258
Ca, wt.%	0.063	0.011	0.041	0.086	0.030	0.097	17.57%	35.14%	52.71%	0.060	0.066
Ce, ppm	23.5	0.92	21.7	25.3	20.8	26.3	3.90%	7.80%	11.70%	22.3	24.7
Co, ppm	59	4.7	49	68	45	73	8.03%	16.05%	24.08%	56	62
Cr, ppm	1067	46.5	974	1160	928	1206	4.36%	8.71%	13.07%	1014	1120
Cs, ppm	1.20	0.106	0.98	1.41	0.88	1.52	8.90%	17.81%	26.71%	1.14	1.26
Cu, ppm	756	43.9	668	844	624	888	5.81%	11.62%	17.42%	718	794
Dy, ppm	2.28	0.170	1.94	2.61	1.77	2.78	7.45%	14.90%	22.36%	2.16	2.39
Er, ppm	1.41	0.086	1.24	1.59	1.16	1.67	6.10%	12.19%	18.29%	1.34	1.48
Eu, ppm	0.55	0.042	0.46	0.63	0.42	0.67	7.64%	15.27%	22.91%	0.52	0.58
Fe, wt.%	24.19	0.567	23.05	25.32	22.49	25.89	2.35%	4.69%	7.04%	22.98	25.40
Ga, ppm	16.2	0.88	14.4	17.9	13.5	18.8	5.45%	10.89%	16.34%	15.4	17.0
Gd, ppm	2.00	0.128	1.75	2.26	1.62	2.39	6.37%	12.74%	19.11%	1.90	2.10
Hf, ppm	6.31	0.416	5.48	7.15	5.07	7.56	6.59%	13.18%	19.77%	6.00	6.63
Ho, ppm	0.46	0.039	0.38	0.54	0.34	0.58	8.53%	17.06%	25.59%	0.44	0.48
K, wt.%	0.336	0.024	0.287	0.384	0.263	0.408	7.24%	14.49%	21.73%	0.319	0.352
La, ppm	11.1	0.66	9.8	12.4	9.1	13.1	5.96%	11.92%	17.88%	10.5	11.7
Lu, ppm	0.23	0.018	0.19	0.27	0.17	0.29	8.04%	16.08%	24.12%	0.22	0.24
Mg, wt.%	0.158	0.010	0.138	0.178	0.128	0.187	6.28%	12.55%	18.83%	0.150	0.166
Mn, wt.%	0.056	0.002	0.052	0.059	0.051	0.060	2.92%	5.83%	8.75%	0.053	0.058
Mo, ppm	2.95	0.59	1.77	4.12	1.18	4.71	19.96%	39.92%	59.87%	2.80	3.09
Na, wt.%	0.058	0.005	0.048	0.067	0.043	0.072	8.41%	16.82%	25.23%	0.055	0.061
Nb, ppm	7.40	0.75	5.89	8.90	5.13	9.66	10.20%	20.40%	30.60%	7.03	7.77
Nd, ppm	9.46	0.852	7.75	11.16	6.90	12.01	9.01%	18.01%	27.02%	8.98	9.93
Ni, ppm	459	30.9	397	521	366	552	6.73%	13.46%	20.19%	436	482
Pr, ppm	2.50	0.094	2.31	2.69	2.22	2.78	3.75%	7.51%	11.26%	2.38	2.63
Rb, ppm	20.8	1.29	18.2	23.4	16.9	24.7	6.20%	12.41%	18.61%	19.8	21.8
Sc, ppm	91	2.6	85	96	83	98	2.85%	5.70%	8.54%	86	95
Si, wt.%	18.56	0.442	17.68	19.44	17.23	19.89	2.38%	4.76%	7.15%	17.63	19.49
Sm, ppm	2.13	0.166	1.80	2.46	1.63	2.63	7.78%	15.57%	23.35%	2.02	2.24

Note: intervals may appear asymmetric due to rounding.

Table 8. Fusion ICP-OES/MS results continued

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
Sr, ppm	15.9	1.37	13.2	18.7	11.8	20.1	8.58%	17.16%	25.74%	15.1	16.7
Ta, ppm	0.63	0.08	0.47	0.78	0.39	0.86	12.45%	24.89%	37.34%	0.60	0.66
Tb, ppm	0.36	0.032	0.30	0.43	0.27	0.46	8.89%	17.78%	26.68%	0.35	0.38
Th, ppm	13.0	0.50	12.0	14.0	11.5	14.5	3.85%	7.71%	11.56%	12.3	13.6
Ti, wt.%	0.584	0.016	0.552	0.616	0.536	0.633	2.77%	5.54%	8.30%	0.555	0.613
Tm, ppm	0.22	0.02	0.17	0.27	0.14	0.29	11.44%	22.88%	34.32%	0.21	0.23
U, ppm	2.54	0.140	2.26	2.82	2.12	2.96	5.50%	11.00%	16.50%	2.41	2.67
V, ppm	317	28.4	260	374	232	402	8.95%	17.89%	26.84%	301	333
W, ppm	1.06	0.20	0.66	1.46	0.46	1.66	18.89%	37.78%	56.68%	1.01	1.11
Y, ppm	10.6	0.66	9.3	11.9	8.6	12.6	6.25%	12.50%	18.75%	10.1	11.1
Yb, ppm	1.48	0.110	1.26	1.70	1.15	1.81	7.40%	14.80%	22.20%	1.41	1.56
Zr, ppm	242	14.5	213	271	199	286	5.98%	11.96%	17.94%	230	255
Four Acid Digestion ICP-OES / ICP-MS (undried basis)											
Ag, ppm	0.311	0.062	0.187	0.435	0.126	0.497	19.90%	39.79%	59.69%	0.296	0.327
Al, wt.%	6.78	0.170	6.44	7.12	6.27	7.29	2.51%	5.01%	7.52%	6.44	7.12
As, ppm	16.3	1.53	13.2	19.4	11.7	20.9	9.41%	18.81%	28.22%	15.5	17.1
Ba, ppm	252	12.2	228	277	216	289	4.83%	9.66%	14.49%	240	265
Be, ppm	0.62	0.11	0.41	0.83	0.31	0.94	16.96%	33.93%	50.89%	0.59	0.65
Bi, ppm	0.28	0.03	0.22	0.34	0.19	0.37	11.06%	22.13%	33.19%	0.27	0.29
Ca, wt.%	0.065	0.006	0.052	0.077	0.046	0.083	9.40%	18.80%	28.20%	0.061	0.068
Ce, ppm	23.5	2.20	19.1	27.9	16.9	30.1	9.38%	18.77%	28.15%	22.3	24.6
Co, ppm	57	3.9	49	65	45	69	6.77%	13.55%	20.32%	54	60
Cr, ppm	979	74.4	831	1128	756	1203	7.59%	15.18%	22.77%	930	1028
Cs, ppm	1.26	0.049	1.16	1.36	1.11	1.41	3.91%	7.83%	11.74%	1.20	1.33
Cu, ppm	780	23.4	734	827	710	850	3.00%	5.99%	8.99%	741	819
Dy, ppm	2.05	0.200	1.65	2.45	1.45	2.65	9.76%	19.51%	29.27%	1.95	2.15
Er, ppm	1.20	0.14	0.91	1.48	0.77	1.62	11.80%	23.60%	35.40%	1.14	1.26
Fe, wt.%	24.12	1.322	21.47	26.76	20.15	28.08	5.48%	10.96%	16.44%	22.91	25.32
Ga, ppm	16.5	1.23	14.0	18.9	12.8	20.2	7.49%	14.98%	22.47%	15.7	17.3
Gd, ppm	1.99	0.27	1.46	2.53	1.19	2.80	13.46%	26.91%	40.37%	1.89	2.09
Hf, ppm	3.11	0.144	2.82	3.40	2.68	3.54	4.63%	9.25%	13.88%	2.95	3.26
In, ppm	0.099	0.008	0.083	0.114	0.075	0.122	8.00%	16.01%	24.01%	0.094	0.103
K, wt.%	0.324	0.008	0.307	0.341	0.299	0.349	2.61%	5.21%	7.82%	0.308	0.340
La, ppm	11.0	0.97	9.0	12.9	8.1	13.9	8.83%	17.66%	26.48%	10.4	11.5
Li, ppm	6.58	0.490	5.60	7.56	5.11	8.05	7.44%	14.88%	22.32%	6.25	6.91
Lu, ppm	0.17	0.03	0.12	0.23	0.09	0.26	16.47%	32.94%	49.40%	0.16	0.18
Mg, wt.%	0.156	0.012	0.133	0.179	0.121	0.191	7.41%	14.82%	22.23%	0.148	0.164
Mn, wt.%	0.055	0.003	0.049	0.062	0.046	0.065	5.78%	11.55%	17.33%	0.052	0.058
Mo, ppm	2.40	0.157	2.08	2.71	1.93	2.87	6.55%	13.10%	19.66%	2.28	2.52
Na, wt.%	0.059	0.003	0.052	0.066	0.049	0.070	5.82%	11.65%	17.47%	0.056	0.062
Nb, ppm	6.80	0.180	6.44	7.16	6.26	7.34	2.65%	5.29%	7.94%	6.46	7.14
Nd, ppm	9.57	1.28	7.02	12.12	5.74	13.40	13.33%	26.66%	39.99%	9.09	10.05
Ni, ppm	454	24.8	404	503	379	528	5.48%	10.95%	16.43%	431	476
P, wt.%	0.034	0.002	0.030	0.039	0.028	0.041	6.48%	12.96%	19.43%	0.033	0.036
Pb, ppm	18.2	1.9	14.5	21.9	12.6	23.8	10.20%	20.40%	30.60%	17.3	19.1

Note: intervals may appear asymmetric due to rounding.

Table 8. Four Acid Digestion ICP-OES/MS results continued

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
Pr, ppm	2.57	0.38	1.81	3.32	1.43	3.70	14.73%	29.46%	44.19%	2.44	2.69
Rb, ppm	21.2	1.18	18.9	23.6	17.7	24.8	5.55%	11.10%	16.65%	20.2	22.3
S, wt.%	0.046	0.005	0.037	0.055	0.032	0.059	9.85%	19.71%	29.56%	0.043	0.048
Sb, ppm	1.00	0.096	0.80	1.19	0.71	1.28	9.68%	19.35%	29.03%	0.95	1.05
Sc, ppm	93	4.6	84	102	79	107	4.98%	9.95%	14.93%	88	98
Se, ppm	2.97	0.223	2.52	3.42	2.30	3.64	7.50%	14.99%	22.49%	2.82	3.12
Sm, ppm	2.28	0.133	2.02	2.55	1.88	2.68	5.83%	11.65%	17.48%	2.17	2.40
Sn, ppm	1.32	0.074	1.17	1.47	1.10	1.54	5.59%	11.18%	16.77%	1.25	1.39
Sr, ppm	15.9	0.81	14.3	17.5	13.5	18.3	5.09%	10.18%	15.26%	15.1	16.7
Ta, ppm	0.56	0.06	0.45	0.68	0.39	0.73	10.30%	20.59%	30.89%	0.53	0.59
Th, ppm	12.9	1.04	10.8	15.0	9.8	16.0	8.07%	16.13%	24.20%	12.3	13.6
Ti, wt.%	0.559	0.034	0.491	0.627	0.457	0.661	6.09%	12.18%	18.28%	0.531	0.587
Tl, ppm	0.15	0.03	0.09	0.20	0.07	0.23	18.70%	37.40%	56.09%	0.14	0.16
U, ppm	2.41	0.189	2.03	2.78	1.84	2.97	7.85%	15.69%	23.54%	2.29	2.53
V, ppm	322	15.4	291	353	276	368	4.79%	9.58%	14.37%	306	338
W, ppm	1.07	0.21	0.65	1.48	0.45	1.68	19.35%	38.70%	58.05%	1.01	1.12
Y, ppm	8.28	0.558	7.16	9.39	6.61	9.95	6.73%	13.47%	20.20%	7.87	8.69
Yb, ppm	1.19	0.12	0.94	1.44	0.82	1.56	10.44%	20.89%	31.33%	1.13	1.25
Zn, ppm	46.7	5.7	35.2	58.1	29.5	63.8	12.24%	24.48%	36.72%	44.3	49.0
Zr, ppm	110	14	81	139	67	154	13.06%	26.11%	39.17%	105	116
Aqua Regia Digestion ICP-OES / ICP-MS (undried basis)											
Al, wt.%	3.32	0.260	2.80	3.84	2.54	4.10	7.83%	15.66%	23.49%	3.15	3.48
As, ppm	11.4	1.7	8.0	14.8	6.3	16.6	14.97%	29.94%	44.90%	10.9	12.0
Au, ppm	0.050	0.006	0.039	0.062	0.034	0.067	11.11%	22.22%	33.33%	0.048	0.053
Ba, ppm	139	9.0	121	157	111	166	6.51%	13.03%	19.54%	132	145
Ca, wt.%	0.032	0.003	0.026	0.038	0.023	0.042	9.88%	19.75%	29.63%	0.030	0.034
Ce, ppm	17.7	2.3	13.0	22.3	10.7	24.7	13.14%	26.27%	39.41%	16.8	18.6
Co, ppm	52	6	40	64	35	70	11.24%	22.48%	33.72%	50	55
Cr, ppm	849	70.9	707	991	637	1062	8.35%	16.69%	25.04%	807	892
Cs, ppm	0.77	0.11	0.56	0.98	0.45	1.09	13.78%	27.55%	41.33%	0.73	0.81
Cu, ppm	709	52.4	604	814	552	866	7.39%	14.77%	22.16%	674	745
Fe, wt.%	22.65	1.333	19.98	25.31	18.65	26.65	5.88%	11.77%	17.65%	21.52	23.78
Ga, ppm	11.7	1.7	8.3	15.1	6.7	16.7	14.32%	28.65%	42.97%	11.1	12.3
In, ppm	0.090	0.008	0.074	0.106	0.066	0.114	8.82%	17.64%	26.46%	0.086	0.095
K, wt.%	0.053	0.005	0.043	0.062	0.038	0.067	9.06%	18.13%	27.19%	0.050	0.055
Mg, wt.%	0.095	0.007	0.082	0.108	0.075	0.115	6.85%	13.69%	20.54%	0.090	0.100
Mn, wt.%	0.040	0.003	0.033	0.046	0.030	0.050	8.26%	16.51%	24.77%	0.038	0.042
Na, wt.%	0.027	0.005	0.017	0.037	0.012	0.043	18.46%	36.91%	55.37%	0.026	0.029
Ni, ppm	357	26.3	305	410	278	436	7.36%	14.73%	22.09%	339	375
P, wt.%	0.029	0.002	0.024	0.034	0.022	0.037	8.52%	17.04%	25.56%	0.028	0.031
Pb, ppm	14.3	2.4	9.4	19.2	6.9	21.6	17.17%	34.34%	51.51%	13.5	15.0
Rb, ppm	7.93	1.25	5.43	10.44	4.18	11.69	15.76%	31.51%	47.27%	7.54	8.33
S, wt.%	0.044	0.005	0.033	0.054	0.027	0.060	12.38%	24.77%	37.15%	0.041	0.046
Sc, ppm	78	5.5	67	89	61	94	7.11%	14.23%	21.34%	74	82
Sn, ppm	0.97	0.10	0.76	1.18	0.66	1.28	10.64%	21.28%	31.92%	0.92	1.02

Note: intervals may appear asymmetric due to rounding.

Table 8. Aqua Regia Digestion ICP-OES/MS results continued

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
Sr, ppm	4.05	0.78	2.49	5.62	1.71	6.40	19.30%	38.60%	57.90%	3.85	4.25
Th, ppm	10.7	0.83	9.0	12.4	8.2	13.2	7.77%	15.54%	23.31%	10.2	11.2
Tl, ppm	0.072	0.007	0.057	0.086	0.050	0.093	9.99%	19.99%	29.98%	0.068	0.075
U, ppm	1.73	0.18	1.37	2.10	1.18	2.28	10.58%	21.16%	31.74%	1.65	1.82
V, ppm	295	15.1	265	326	250	341	5.12%	10.24%	15.36%	281	310
Y, ppm	5.74	0.80	4.14	7.34	3.34	8.15	13.96%	27.93%	41.89%	5.45	6.03
Yb, ppm	0.86	0.13	0.59	1.13	0.46	1.26	15.59%	31.17%	46.76%	0.82	0.90
Zn, ppm	30.6	4.8	20.9	40.3	16.1	45.1	15.81%	31.62%	47.43%	29.1	32.1
Fire Assay with ICP-OES / ICP-MS / AAS (undried basis)											
Au (ppb)	53	3	48	58	45	61	5.12%	10.25%	15.37%	50	56
Pd, ppb	75	5	66	85	61	89	6.22%	12.45%	18.67%	72	79
Pt, ppb	110	6	99	121	93	126	5.07%	10.14%	15.21%	104	115
IR Combustion Furnace (undried basis)											
C, wt.%	0.546	0.026	0.493	0.599	0.467	0.626	4.84%	9.68%	14.52%	0.519	0.574
S, wt.%	0.043	0.006	0.030	0.056	0.023	0.062	15.16%	30.32%	45.48%	0.041	0.045
Thermogravimetry (dry basis)											
LOI, wt.%	8.69	0.175	8.34	9.04	8.17	9.22	2.01%	4.02%	6.02%	8.26	9.13

Note: intervals may appear asymmetric due to rounding

PARTICIPATING LABORATORIES

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ALS, Callao, Lima, Peru
ALS, Johannesburg, South Africa
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BV Amdel, Adelaide, SA, Australia
BV Ultra Trace, Perth, WA, Australia
Intertek Genalysis, Perth, WA, Australia
Intertek Testing Services, Beijing, China
Intertek Testing Services, Jakarta, Indonesia
Kalassay, Perth, WA, Australia
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SGS Mineral Services, Toronto, Ontario, Canada
Shiva Analyticals, Bangalore North, Karnataka, India
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PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 45e has been prepared, certified and is supplied by:

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It is available in unit sizes of 10g, 60g (single-use laminated foil pouches) and 500g (plastic jars).

INTENDED USE

OREAS 45e is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of analytes reported in Tables 1-6 in geological samples
- for the verification of analytical methods for analytes reported in Tables 1-6
- for the calibration of instruments used in the determination of the concentration of analytes reported in Tables 1-6

STABILITY AND STORAGE INSTRUCTIONS

OREAS 45e was prepared from mineralised lateritic soil. In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR THE CORRECT USE OF THE REFERENCE MATERIAL

The certified values for lithium borate fusion XRF and for LOI are on a dry basis whilst all other certified values are reported on an “as received” basis. Mean moisture content for the packaged samples is 1.54 wt.% but may vary after equilibration with the local atmosphere.

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)

REFERENCES

Ingamells, C. O. and Switzer, P. (1973), Talanta 20, 547-568.

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

ISO Guide 35 (2006), Certification of reference materials - General and statistical principals.