Appendix 9

Geochemistry and Acid Forming Characteristics of Waste Rock

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For:

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Geochemistry and Acid Forming Characteristics of Waste Rock

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1.0 Introduction

Environmental Geochemistry International Pty Ltd (EGi) was commissioned by Compass Resources NL to carry out a geochemical assessment of drill core samples from the Browns polymetallic deposit, located near Batchelor in the Northern Territory. The testing program was designed to complement past investigations^{1.2} of the geochemical characteristics of various rock types within the Browns deposit, which included testing of six drill core samples in 1997 and another 40 samples in 2002. Many of the samples previously tested were from depths below the extent of mining now proposed for the Browns Oxide Project, and hence testing of additional samples representative of near-surface rock was commissioned by Compass to better quantify the geochemical characteristics of waste that will be mined over the proposed life of the oxide project.

An additional 16 drill core samples were provided for geochemical testing. The samples were selected by personnel of Compass Resources and despatched to EGi's laboratory in Sydney for assessment of the following characteristics:

- Acid-base characteristics of the drill core samples and assessment of acid forming potential
- Reactivity of sulphide mineralisation
- Reactivity of carbonate mineralisation
- · Multi-element analysis to identify an enrichments of possible environmental significance

This report presents a description of the tests carried out by EGi and the results obtained.

2.0 Testing Program

2.1 Test Samples

Twelve of the 16 samples were provided as diamond core and the other four samples were provided as percussion chips. Each sample comprised approximately 1 to 1.5 kg of material. Identification and geological descriptions of each sample were provided by Compass Resources and are included in Table 1. Seven samples were described as black shale and the other nine samples were described as dolomite and/or magnesite.

¹ Environmental Geochemistry International Pty Ltd (1997). Acid forming characteristics of drill hole samples, Browns Prospect NT, Report to Compass Resources NL, Document No. 4357/326, October 199972.

² Environmental Geochemistry International Pty Ltd (2002). Browns Project geochemical data. Memorandum to NSR Environmental Consultants (Attn. Kathy Friday), 16 April 2002.

2.2 Analytical Program

Each sample was crushed to nominal 4 mm size then a 200 gm sub-sample of crushed material was pulverised for geochemical testing. All 16 pulps were assayed for the following:

- Total sulphur content
- Acid neutralising capacity (ANC)
- Maximum potential acidity (MPA)
- Net acid producing potential (NAPP)
- Net acid generation (NAG) capacity

Following a review of results for the assays above, selected samples were chosen for analysis of one or more of the following:

- Sequential NAG
- Kinetic NAG
- Acid buffer characteristic curve
- Multi-element composition

2.3 Determination of Acid Forming Characteristics

Total Sulphur Content

The total sulphur content of each sample was determined by the Leco furnace method. Sulphur assays were carried out by Sydney Environmental Laboratory Pty Ltd under a quality assurance system certified as complying with ISO 9002.

Maximum potential acidity of the contained sulphur

The MPA is the maximum amount of acid that could be generated by the sulphur contained within a sample assuming that all the sulphur occurs as reactive pyrite. The MPA of each sample was calculated from the total sulphur content as follows: MPA (kg H_2SO_4/t) = Total %S x 30.6.

Acid neutralising capacity

The acid produced by pyrite oxidation will to some extent react with other minerals contained within a sample. This inherent acid buffering is quantified in terms of the ANC, which has the same units as MPA. The ANC was determined using the Sobek Method. This involved reacting a sample with a known amount of acid at a pH of less than 1 for 1 to 2 hours, then back-titrating the residual acidity to determine the amount of acid consumed by the sample.

Net acid producing potential

The NAPP is the amount of acid that potentially can be produced by a sample after allowing for ANC. It is calculated by subtracting the ANC value from the MPA value. If the NAPP is negative then it is likely that the material has sufficient inherent buffer capacity to prevent acid generation. Conversely, if the NAPP is positive then the material may be acid generating.

ANC/MPA Ratio

The ANC/MPA ratio is essentially another way of looking at the balance between ANC and MPA, and provides an indication of the relative margin of safety with respect to the acid forming potential of a sample. A ratio less than 1 corresponds to a positive NAPP and indicates a material may be acid generating. Conversely, an ANC/MPA ratio of 2 or more generally signifies that there is a high probability that the material will remain circum-neutral in pH (*i.e.* the material should not be problematic with respect to ARD).

Net acid generation

NAG is an alternate method of estimating the acid forming potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals present. Both acid generation and acid neutralisation occur simultaneously during the NAG test, hence the end result represents a direct measurement of the net amount of acid that a sample can generate. If the sample after reaction has a pH of 4.5 or less (*i.e.* NAGpH \leq 4.5) then it is considered to be acid forming. The actual amount of acidity generated can be determined by titration of the mixture.

Sequential NAG Test

The sequential NAG test is a multi-stage procedure involving a series of single addition NAG tests on the one sample (*i.e.* 2.5 g of sample was reacted three times with 250 mL aliquots of 15% hydrogen peroxide). At the end of each stage, the sample was filtered to separate the solids and NAG liquor. The NAG liquor was assayed for pH and acidity, as per a standard NAG test. The solids were recovered for repeat oxidation using another aliquot of hydrogen peroxide the solid residue. The overall NAG capacity of the sample was determined by summing the individual acid capacities from each stage.

Kinetic NAG Testing

The kinetic NAG test provides an indication of the reactivity of sulphides within a sample and provides a quick, qualitative assessment of the likely lag time for acidification to occur under field conditions. The method is similar to the standard NAG test, except that pH and temperature are recorded during the test. The reaction kinetics exhibited in the NAG test are extrapolated to the field situation on the basis of correlations previously derived by EGi from numerous leach column tests and field observations at other mine sites.

Measurement of acid buffering characteristic curves (ABCC)

The ABCC is determined by slowly acidifying a sample with dilute acid to around pH 3 over a 16 to 24-hour period. It represents a far less aggressive treatment of a sample than that applied in the ANC method, and it typically only accounts for more readily-available carbonates such as calcite and dolomite. When present in sufficient quantity, these minerals will typically buffer a waste rock at near-neutral pH, which is essential for maintaining low metal solubilities.

ARD Classification Scheme

The acid forming potential of each sample was classified on the basis of the NAPP and NAG test results into one of the following categories:

- NAF A sample classified as NAF may, or may not, have a significant sulphur content but the content and reactivity of carbonate minerals and ANC within the material is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. Material classified as NAF is considered unlikely to be a source of acidic drainage. The criteria used to define a NAF material are a negative NAPP and a NAGpH greater than 4.5.
- PAF PAF material always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a risk that such a material could oxidise and generate acidic drainage if exposed to atmospheric conditions. The criteria used to define PAF material are a positive NAPP and a NAGpH less than, or equal to 4.5.
- Uncertain An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (*i.e.* when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH \leq 4.5). Uncertain samples are generally given a tentative classification that is shown in brackets *e.g.* UC(PAF), but further testing is required for confirmation.

2.4 Multi-Element Analysis

Multi-element analyses were carried out by Genalysis Laboratory Services Pty Ltd using NATA registered procedures. Samples were digested by multi-acid addition (*i.e.* hydrofluoric, nitric, perchloric and hydrochloric acids) and the digests were analysed for a suite of 29 elements using a combination of inductively coupled plasma mass spectrometry (MS), inductively coupled plasma optical spectrometry (OES), cold vapour generation atomic absorption spectrometry (CVAP) and specific ion electrode (SIE). The multi-element data were then used to calculate Geochemical Abundance Indices (GAI), which compare the actual concentration of an element in a sample with the median soil abundance for that element. GAI is expressed on a log 2 scale which includes 7 integer increments (0 through to 6, respectively). A GAI of 0 indicates the element is present at a concentration similar to, or less than, median soil abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above median soil abundance.

3.0 Results

3.1 ARD Classification

The acid forming characteristics of the 16 core samples and their assigned ARD classifications are given in Table 1. All of the nine carbonate samples had high to very high ANCs and were classified as NAF. Conversely, all of the black shale samples were essentially devoid of ANC. Five of the seven black shale samples had sulphur contents exceeding 1%S and were classified as PAF. The other two black shale samples contained little sulphur and were essentially barren with respect to both acid generation and acid neutralising potential.

Figure 1 shows an acid-base account plot for the drill core samples and Figure 2 shows an ARD classification for the samples. This acid-base plot provides a graphical presentation of the relationship between total sulphur content and ANC, whereas the ARD classification plot compares the NAPP and NAGpH values. Figures 1 and 2 illustrate the disparity in acid forming characteristics of the black shale compared to the carbonate samples.

PAF Black Shale

The sulphur contents in the five black shale samples that were classified as PAF ranged from 1.27 to 3.59 %S and the NAPPs ranged from 39 to 110 kg H_2SO_4/t . These samples all reacted vigorously when oxidised with hydrogen peroxide in the NAG test and acidified to pHs of between 2.2 to 3.

The single stage NAG test correctly identified black shale samples that were potentially acid generating (*i.e.* NAGpH was less than 4.5 after one stage of oxidation) but complete oxidation of sulphides required repeat reaction with more hydrogen peroxide. Typically two or three sequential stages of oxidation were required to achieve greater than 95% oxidation (see Figure 3). The total acidities generated in the sequential NAG tests were generally comparable to the NAPP values based on total sulphur content (see Table 1 and Figure 3), which suggests that almost all of the sulphur in these samples was pyritic.

Three of the PAF black shale samples were selected for kinetic NAG testing. The reaction profiles for pH and temperature are shown in Figure 4. With each of the three samples there was an immediate downward trend in pH with time, indicative of acid being generated by sulphide oxidation. The absence of any initial pH buffering (which would be indicated by an initial plateau in the pH curve at the start of the test) is consistent with the absence of any measurable ANC within the samples. It also suggests that waste rock as represented by the test samples would likely become a source of ARD within a short time of exposure to atmospheric conditions (*i.e.* within weeks to months rather than years).

Barren Black Shale

Two samples described by Compass Resources as "black shale with low %S" were confirmed to have low sulphur contents (*i.e.* 0.02 and <0.01 %S, respectively) and hence negligible potential for acid generation. They also had virtually no ANC, with reported values at the level of analytical detection of 1 kg H_2SO_4/t . The

characteristics of these two samples are indicative of highly weathered rock. Waste that is as represented by these two samples will be NAF and essentially be inert with respect to acid generation/neutralisation.

NAF Dolomite/Magnesite

There is a clear dominance of ANC in the carbonate samples, with ANCs ranging from 243 to 980 kg H_2SO_4/t . This range corresponds to approximately 25 to 100% CaCO₃ equivalent. All of the carbonate samples had ANC/MPA ratios greater than 3, and the ARD classification plot (Figure 2) illustrates that all of the carbonate samples clearly lie within the NAF quadrate.

Some of the carbonate samples had moderate to high sulphur contents which might be expected to generate sulphate rich drainage over time. However, the overwhelming availability of ANC in these samples should ensure that such materials do not acidify to any significant extent. Water extracts involving these samples had pHs between 7.9 to 8.9, and the NAGpH values after oxidation with hydrogen peroxide ranged from 8.1 to 9.2. The results suggest that waste rock as represented by the test materials will be a long term source of alkaline drainage, albeit with some elevation in concentrations of sulphate and calcium and magnesium.

Acid buffer characteristic curves were determined for three samples and are presented in Figure 5. One sample was described by Compass Resources as magnesite, another as dolomite, and the third as magnesite/dolomite. The ANCs of the three samples were 441, 544, and 980 kg H_2SO_4/t , respectively.

As noted in Section 2, the acid buffer characteristic curve is determined by slow addition of weak acid to the sample, which represents a far less aggressive treatment of a sample than that applied in the ANC method. The acid buffer curve provides an indication of the presence of more soluble carbonates within a sample. This type of buffering typically appears as a plateau at the start of the acid buffer curve, as illustrated in Figure 6 for calcite and other reference minerals.

The Browns oxide samples described as magnesite and magnesite/dolomite both exhibited strong buffer plateaus around circum-neutral pH, and the buffer curves indicate that at least 70 % of the ANC can be expected to react and buffer at near neutral pH. In contrast, the sample described as dolomite acidified to less than pH 4 after addition of only 118 kg H₂SO₄/t, which is only one-fifth of the measured ANC of 544 kg H₂SO₄/t. The buffer curve for this sample indicates that the carbonate mineralisation is far less reactive than in the other two samples tested. Similarly low reactivities were observed for some samples from the Browns deposit tested by EGi in 1997 and 2002, including samples representing hangingwall amphibolite and footwall carbonate.

Buffer curves for a range of reference minerals are shown in Figure 6. As noted above, pure calcite and limestone are typically readily available for neutralisation and can maintain pH-neutral conditions up until almost all the ANC is consumed. Dolomite is also usually highly reactive, although the reactivity may decline when significant iron is present (*i.e.* ferroan dolomite). Pure magnesite, on the other hand is often poorly reactive at circum-neutral pH, and significant dissolution of magnesite under laboratory conditions often only occurs when the pH drops below about 3.

The relative reactivities exhibited by the Browns oxide samples described by Compass Resources as magnesite and dolomite seemingly contradict the reactivities of the magnesite and dolomite reference

samples. It is not clear from the information currently available why this should be the case. Nonetheless, the results of this study and previous studies indicate the carbonate waste from the Browns Oxide deposit will likely vary in reactivity, but overall should be more than sufficient to neutralise the acid potential of any sulphides that are likely to occur within sulphidic dolomitic/magnesitic waste.

3.2 Multi-element Composition of Solids

The multi-element data for one sample of sulphidic dolomite and four samples of black shale are given in Table 2. The respective geochemical abundance indices (GAI) are also given in Table 2. As discussed in Section 2.4, the GAI for a particular element provides an indication of the relative enrichment of that element within a sample compared to the median soil abundance³. The main purpose of the GAI is to identify elements that occur at concentrations that may be environmentally significant.

Sulphidic dolomite (#56382)

As one would expect, the sample of sulphidic dolomite was significantly enriched (*i.e.* GAI≥3) with magnesium (20.2 %Mg) and sulphur (4.4 %S). The calcium content (2.2 %Ca) was much lower than the magnesium content, which would suggest that the carbonate mineralogy in this sample was dominated by magnesite, and that dolomite and/or calcite were relatively minor. Other significant enrichments in this sample were arsenic (148 ppm) and molybdenum (254 ppm).

Barren black shale (#56391)

The sample of barren black shale had negligible sulphur content but was significantly enriched with beryllium (5.6 ppm), cobalt (95 ppm), copper (1642 ppm), and lead (2588 ppm). There was also minor enrichment with arsenic (44 ppm) and molybdenum (8.1 ppm).

Sulphidic black shale (#56388, 56389, 56390)

Apart from sulphur, the three sulphidic black shale samples were enriched with one or more of the following; antimony (up to 9 ppm), arsenic (up to 260 ppm), beryllium (up to 2.8 ppm), cobalt (up to 205 ppm), copper (up to 4866 ppm), molybdenum (up to 45 ppm), lead (up to 5709 ppm), and selenium (up to 6.1 ppm).

Amongst the enriched elements mentioned above, it is likely that arsenic, copper, cobalt and lead will be of most concern from an environmental perspective, and their inclusion in the site water quality monitoring program is recommended. It is possible that other non-enriched elements (e.g. manganese, nickel and zinc) could also occur at elevated concentrations in waste rock seepage from PAF black shales in the event that sulphide oxidation and acid generation occurs.

³ Bowen, H.J.M. (1979) Environmental Chemistry of the Elements. Academic Press, New York, p 36-37.

4.0 Summary

Sixteen drill core samples from the Browns polymetallic deposit were provided for geochemical assessment. The samples were taken by site personnel and were representative of black shale and dolomite/magnesite that will be mined during the Browns Oxide Project. The samples were tested by EGi for acid forming potential, sulphide reactivity, carbonate reactivity, and elemental composition. The results of the geochemical testing suggest that waste rock can be categorised on the basis of lithology and acid forming potential into one the following three material types:

PAF Black Shale

The PAF black shale samples had significant sulphur contents and virtually no ANC. The NAG test results suggest that most of the sulphur within the PAF black shale samples was pyritic and was amenable to oxidation. The net acid producing potentials of the five PAF black shale samples tested are considered high, with a range of 39 to 110 kg H₂SO₄/t, and an average of 69 kg H₂SO₄/t. The reaction behaviour exhibited in the kinetic NAG test suggest that PAF black shale with similar characteristics to the test samples will likely become a source of ARD within a short time of exposure to atmospheric conditions. Column leach testing will be required to confirm the length of any lag period, but on the basis of information currently available it is expected that acidification could occur within weeks to months rather than years. In addition to elevated sulphur content, it is likely that PAF black shale will be enriched with one or more of the following elements; antimony, arsenic, beryllium, cobalt, copper, molybdenum, lead, and selenium. It is expected that PAF black shale will need to be carefully managed, and control measures implemented to minimise the potential for sulphide oxidation and generation of ARD within such waste.

Barren Black Shale

Two samples representing barren black shale were tested. By definition, the samples had negligible sulphur contents (*i.e.* \leq 0.02 %S) and hence no potential for acid generation. The two samples were also essentially devoid of ANC. Such material may be suitable for construction of internal barrier layers within dumps, but use as dump surface cover material may be restricted by enrichments with arsenic, copper, cobalt and lead.

NAF Dolomite/Magnesite

Nine samples described as dolomite or magnesite were tested. All had high ANCs, with values ranging from 243 to 980 kg H_2SO_4/t and averaging 618 kg H_2SO_4/t . Some of the samples tested had moderate to high sulphur contents, and there was evidence that some carbonate may not be readily available under pH neutral conditions. It is possible that sulphidic dolomite may generate sulphate rich drainage over time, but overall it is unlikely that carbonate waste rock as represented by the test samples will acidify.

Tables and Figures

Client Sample No.	Rock Type	Drill Hole	From (m)	P D L	Hd	EC	Total %S	MPA	ANC	ANC/MPA Ratio	NAPP	NAG (single)	NAG (seq)	NAGpH	ARD Classification	1 A 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
Black Shale Sé	amples															
O56389	black shale high %S	05BD02	20.00	30.00	4.2	611	3.59	110	v	0~	110	79	105	2.2	PAF	_
O56387	black shale med %S	CDH04	34.00	34.50	5.5	109	3.16	97	7	0.02	95	61	101	2.2	PAF	_
O56386	black shale 2.5%S	02BD03	138.00	140.00	8.3	114	1.95	60	ю	0.05	57	46	57	2.3	PAF	_
O56390	black shale med %S	05BD02	16.00	20.00	4.3	376	1.37	42	v	0~	42	30	42	2.3	PAF	
O56388	black shale low %S	CDH04	12.00	14.00	4.6	116	1.27	39	ř	0~	39	6	32	3.0	PAF	
O56393	black shale low %S	95BD07	22.00	24.00	8.6	207	0.02	~	-	1.6	0	0	па	6.7	NAF (barren)	
O56391	black shale low %S	05BD02	5.00	10.00	7.6	288	<0.01	<0.3	-		5	0	na	6.9	NAF (barren)	_
Carbonate Sar	nples															
O56385	dolomite high sulphide	CDH04	75.80	76.00	7.9	129	2.12	65	243	4	-179	0	na	8.2	NAF	_
O56382	dolomite sulphidic	CDH06	87.25	87.40	8.6	313	4.39	134	412	ę	-277	0	na	8.2	NAF	_
O56380	magnesite	CDH06	85.80	86.00	8.9	203	0.40	12	441	36	-428	0	na	8.1	NAF	_
O56384	dolomite and magnesite	CDH04	79.50	79.65	8.6	276	0.48	15	512	35	-497	0	na	8.5	NAF	_
O56381	dolomite	CDH06	88.05	88.20	8.2	118	0.42	13	544	42	-531	0	na	8.3	NAF	_
O56383	dolomite	CDH04	75.30	75.45	8.3	363	0.70	21	662	31	-641	0	na	8.6	NAF	_
O56395	dolomitic shale med-high %S	95BD10	41.00	42.00	8.5	529	3.52	108	896	Ø	-789	0	na	8.3	NAF	_
O56394	dolomite med %S	95BD10	52.00	52.20	8.4	346	0.35	11	872	81	-861	0	na	8.2	NAF	_
O56392	magnesite/dolomite low S	95BD06	44.50	44.70	8.7	223	<0.01	<0.3	980		-980	0	na	9.2	NAF	_
KEY	oH = pH of 1:2 extract ≣C = Electrical Conductivity of 1:2 e ⊿DA - Anvironus Deteorid A origity 0	sxtract (µS/cm) ניסט בס אי			NAPP = N NAG = Ne NAG = Ne	et Acid Pro t Acid Gen	ducing Pot eration cap	ential (kgH acity (kgH ₂	2 ² SO4/t) SO4/t)			μΖ	PAF = Pot VAF = Noi	entially Acic n-Acid Form	Forming	
	או אומושרא אווזוו דיטופוזען אומווא אטעווא איטוען א ארכ = Acid Neutralising Capacity (I	kgH₂SO₄/t) kgH₂SO₄/t)					inguin									

Table 1: Acid forming characteristics of drill core samples from Browns Oxide Project.

		e ci) ale	ale (ale)) ale	Soil	Ge	ochem	Abunda	nce Ind	ices
Element	Unit	Dolomit (56382	Black Sh (56391	Black Sh (56388	Black Sh (56390	Black Sh (56389	Median S	56382	56391	56388	56390	56389
Al	%	0.7	10.0	7.0	10.0	8.9	7.1	0	0	0	0	0
Са	%	2.2	0.03	0.08	0.02	0.05	1.5	0	0	0	0	0
Fe	%	4.2	5.7	5.7	5.6	5.6	4.0	0	0	0	0	0
К	%	0.03	3.6	2.3	4.3	3.6	1.4	0	1	0	1	1
Mg	%	20	0.59	0.87	0.69	2.9	0.5	5	0	0	0	2
Na	%	0.01	0.13	0.02	0.09	0.07	0.50	0	0	0	0	0
S	%	4.4	<0.01	1.3	1.4	3.6	0.03	6	0	5	5	6
Si	%	5.5	31	31	31	28	33	0	0	0	0	0
As	nom	148	44	260	47	64	6	4	2	5	2	3
Ba	ppm	4 1	951	76	467	350	500	0	0	0	0	0
Be	nnm	14	56	28	2.8	2.8	0.3	2	٩	3	3	3
Cd	nnm	<0.1	0.4	0.2	0.3	0.1	0.4	0	0	0	0	0
Co	ppm	19.1	95	205	52	71	8	1	3	4	2	3
Cr	maa	40	91	154	124	111	70	0	0	1	0	0
Cu	ppm	12	1642	4866	111	136	30	0	5	6	1	2
F	ppm	385	466	581	443	870	200	0	1	1	1	2
Hq	ppm	<0.01	<0.01	0.01	<0.01	<0.01	0.06	0	0	0	0	0
Mn	ppm	344	60	40	79	95	1000	0	0	0	0	0
Мо	ppm	254	8.1	45	6.2	17	1.2	6	2	5	2	3
Ni	ppm	121	160	175	100	150	50	1	1	1	0	1
Р	ppm	517	664	1838	608	208	800	0	0	1	0	0
Pb	ppm	12	2588	5709	110	60	35	0	6	6	1	0
Sb	ppm	1.11	1.25	8.98	3.32	1.77	1	0	0	3	1	0
Se	ppm	2.2	0.3	6.1	3.1	2.2	0.4	2	0	3	2	2
Sn	ppm	0.3	4.5	1.2	4.1	4.4	4	0	0	0	0	0
Sr	ppm	12	31	24	30	11	250	0	0	0	0	0
Th	ppm	1.4	22	14	17	15	9	0	1	0	0	0
U	ppm	14	7.8	9.3	5.8	7.7	2.0	2	1	2	1	1
Zn	maa	6	140	60	73	55	90	0	0	0	0	0

Table 2. Multi-element composition of drill core samples from the Browns Oxide Project

Median soil data from: Bowen, H.J.M. (1997) Environmnetal Chemistry of the Elements



Figure 1. Acid-base account plot for drill core samples from the Browns Oxide Project



Figure 2. ARD classification plot for drill core samples from the Browns Oxide Project



Figure 3. Acidity generated in sequential NAG tests on samples of black shale



Figure 4. Kinetic NAG reaction profiles for selected black shale samples



Figure 5. Acid buffer characteristic curves for selected carbonate samples



Figure 6. Acid buffer characteristic curves for reference carbonate minerals (Note: The ANCs of reference minerals ranged from 188 to 284 kg H₂SO₄/t)