OxCon

Oxygen consumption test

ES ANALYTICAL

LABORATORY REPORT

DATE OF ISSUE	4 November 2015
LABORATORY REPORT REFERENCE	RESOL1605

PROJECT	Kinetic Geochemical Test Work for the Resolution Copper Mine
CLIENT	Resolution Copper Mining LLC
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NUMBER OF SAMPLES	4
NUMBER OF TESTS	12

In this Laboratory Report:

- Summary of laboratory results
- Individual test reports
- Test method and terminology

SUMMARY OF LABORATORY RESULTS

Earth Systems was engaged to conduct kinetic geochemical testwork on tailings samples generated from pilot scale metallurgical testwork for the Resolution Copper Mine.

A summary of the data acquired through this testwork is provided on this page, along with a brief explanation of the results. Detailed results can be found in the individual test reports (on the following pages) for each OxCon test.

Sample preparation

The following saturated bulk tailings samples were received for analysis:

- P4 Rougher Tailings
- P4 Cleaner Scavenger Tailings
- P8 Rougher Tailings
- P8 Combined Tailings

Samples were prepared as follows.

- Homogenisation
- Drying at 40 °C until target Volumetric Moisture Content (VMC) was reached;
- Samples were compacted to the desired bulk density.

Sub-samples were submitted for static geochemical characterisation, analysis of major and trace element chemistry, X-ray diffraction analysis for mineralogy, particle size distribution and determination of acid buffering characteristic curves.

Results

A summary of the key static and kinetic geochemical parameters for all of the tested samples is provided in Table 1.

SUMMARY OF LABORATORY RESULTS

Table 1: Key static and kinetic geochemical parameters of tested samples.

Sample ID	Description	Total sulfur	Sulfide sulfur	ANC	GMC	Pyrite oxidation rate (POR)*			Initial NAG rate	Peak NAGR
		wt% S	wt% S	kg H_2SO_4/t	wt% H_2O	wt%/yr FeS_2	$\times10^{-9}$ kg/t/s O_2	kg/t/yr S	kg H_2SO_4/t/yr	kg H_2SO_4/t/yr
P4-RO-05	P4 Rougher Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.55 g/cm^3	0.21	0.15	6.6	3.2	66	59	1.0	<0.1	<0.1
P4-RO-20	P4 Rougher Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.55 g/cm^3	0.21	0.15	6.6	13.0	150	130	2.2	<0.1	<0.1
P4-RO-24	P4 Rougher Tailings. Tested at VMC of 24% (Field Capacity) and bulk density (dry basis) of 1.55 g/cm^3	0.21	0.15	6.6	15.5	230	210	3.5	<0.1	<0.1
P4-CL-05	P4 Cleaner Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.73 g/cm^3	20.60	20.38	7.3	2.9	22	2700	45	<0.1	134.0
P4-CL-20	P4 Cleaner Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.73 g/cm^3	20.60	20.38	7.3	11.9	14	1700	29	<0.1	87.6
P4-CL-40	P4 Cleaner Tailings. Tested at VMC of 40% and bulk density (dry basis) of 1.73 g/cm^3	20.60	20.38	7.3	22.5	0.35	42	0.70	<0.1	2.1
P8-RO-05	P8 Rougher Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.55 g/cm^3	0.20	0.15	7.3	3.2	32	28	0.47	<0.1	<0.1
P8-RO-20	P8 Rougher Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.55 g/cm^3	0.20	0.15	7.3	13.1	40	36	0.60	<0.1	<0.1

SUMMARY OF LABORATORY RESULTS

Table 1 continued: Key static and kinetic geochemical parameters of tested samples.

Sample ID	Description	Total sulfur	Sulfide sulfur	ANC	GMC	Pyrite oxidation rate (POR)*			Initial NAG rate	Peak NAGR
		wt% S	wt% S	kg H_2SO_4/t	wt% H_2O	wt%/yr FeS_2	×10^{-9} kg/t/s O_2	kg/t/yr S	kg H_2SO_4/t/yr	kg H_2SO_4/t/yr
P8-RO-26	P8 Rougher Tailings. Tested at VMC of 26% and bulk density (dry basis) of 1.55 g/cm³	0.20	0.15	7.3	16.9	81	72	1.2	<0.1	0.1
P8-COM-05	P8 Combined Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.73 g/cm³	20.20	19.68	9.3	2.8	5.9	690	12	<0.1	33.0
P8-COM-20	P8 Combined Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.73 g/cm³	20.20	19.68	9.3	11.4	12	1400	24	<0.1	67.0
P8-COM-37	P8 Combined Tailings. Tested at VMC of 37% (Field Capacity) and bulk density (dry basis) of 1.73 g/cm³	20.20	19.68	9.3	21.0	0.21	25	0.41	<0.1	1.1

*POR (wt% FeS_2/yr): Weight percentage of available pyrite oxidised per year (ie. normalised with respect to pyrite content).

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TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-RO-05	Project	Process Tailings Testwork
Sample Description	P4 Rougher Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.21	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

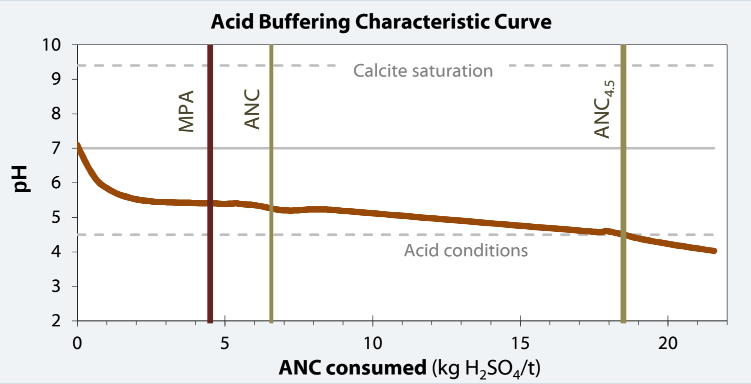
Acid neutralising capacity	ANC	6.6	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.5	
Net acid producing potential	NAPP	−2	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.0	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1	kg H_2SO_4/t

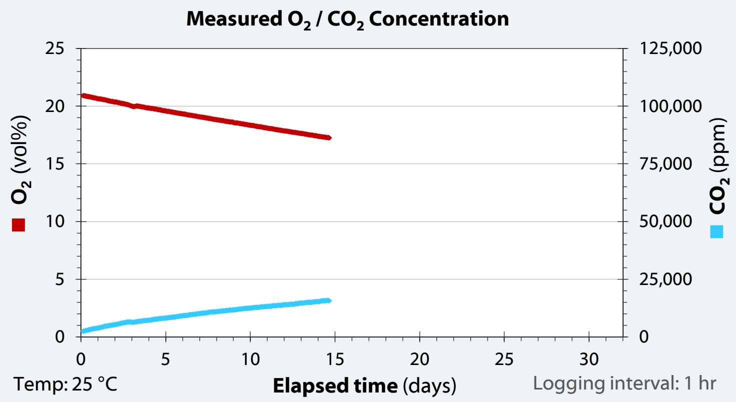
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	18.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	3.2 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.16	mmol/kg/day
Pyrite oxidation rate*	POR	66	wt% Pyr/yr
POR (intrinsic units)		59	$\times10^{-9}$ kg O_2/t/s
		1.0	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	3.0	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.28	wt%	12	508
Magnesium	Mg	1.29	wt%	4	81
Potassium	K	3.48	wt%	12	57
Sodium	Na	0.05	wt%	3	172
Chloride	Cl	70	mg/kg	1	350
Fluoride	F	2950	mg/kg	2.4	2.1
Carbon	C	<0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	0.21	wt%	60	1490
Aluminium	Al	6.83	wt%	0.34	0.02
Iron	Fe	1.55	wt%	<0.05	<0.05
Manganese	Mn	150	mg/kg	0.322	17.4
Phosphorus	P	1190	mg/kg	8.36	1.71
Antimony	Sb	<0.1	mg/kg	<0.001	<0.001
Arsenic	As	2.2	mg/kg	<0.001	<0.001
Barium	Ba	55	mg/kg	–	–
Beryllium	Be	0.4	mg/kg	–	–
Bismuth	Bi	1	mg/kg	<0.001	<0.001
Boron	B	<50	mg/kg	0.05	<0.05
Cadmium	Cd	0.1	mg/kg	0.0008	0.0098
Caesium	Cs	1.1	mg/kg	–	–
Cerium	Ce	3.3	mg/kg	–	–
Chromium	Cr	33.7	mg/kg	0.054	<0.001
Cobalt	Co	4.5	mg/kg	0.004	0.233
Copper	Cu	1010	mg/kg	0.165	0.626
Gallium	Ga	2.5	mg/kg	–	–
Germanium	Ge	<0.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.1	mg/kg	–	–
Lanthanum	La	1.3	mg/kg	–	–
Lead	Pb	3.2	mg/kg	<0.001	<0.001
Lithium	Li	3.2	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	<0.0001
Molybdenum	Mo	48.7	mg/kg	0.368	0.002
Nickel	Ni	25	mg/kg	0.002	0.263
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	34.1	mg/kg	–	–
Selenium	Se	1	mg/kg	<0.01	0.08
Silver	Ag	0.4	mg/kg	<0.001	<0.001
Strontium	Sr	19.6	mg/kg	–	–
Tellurium	Te	0.6	mg/kg	<0.005	<0.005
Thallium	Tl	0.1	mg/kg	<0.001	<0.001
Thorium	Th	0.3	mg/kg	–	–
Tin	Sn	1.1	mg/kg	<0.001	<0.001
Titanium	Ti	4420	mg/kg	–	–
Tungsten	W	1.1	mg/kg	–	–
Uranium	U	0.5	mg/kg	<0.001	<0.001
Vanadium	V	25	mg/kg	0.03	<0.01
Yttrium	Y	2.9	mg/kg	–	–
Zinc	Zn	43.4	mg/kg	0.025	0.314
Zirconium	Zr	<0.5	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.0	
Electrical conductivity (EC)	3.1	mS/cm
Alkalinity	4.0	mg/L $CaCO_3$
Acidity – measured	15	mg/L $CaCO_3$
Acidity – calculated[1]	34	mg/L CaCO
POR based on sulfate release[2]	155	wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.2
Kaolinite	5.5
Microcline	6.4
Muscovite	37.0
Pyrite	0.4
Pyrrhotite-4C?	0.5
Quartz	49.9
Sphalerite?	0.1
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

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TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-RO-20	Project	Process Tailings Testwork
Sample Description	P4 Rougher Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.21	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

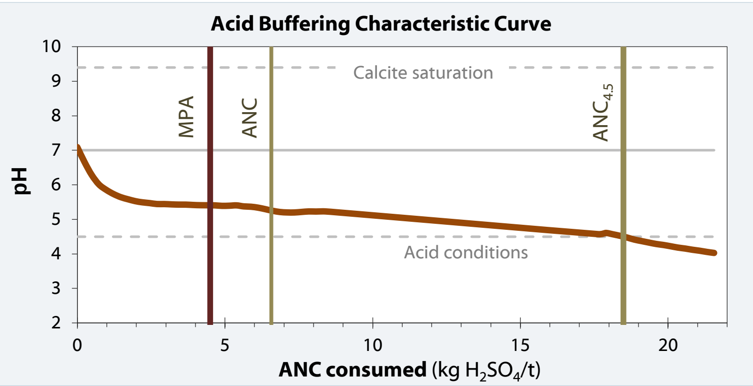
Acid neutralising capacity	ANC	6.6	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.5	
Net acid producing potential	NAPP	−2	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.0	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1.2	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1.2	kg H_2SO_4/t

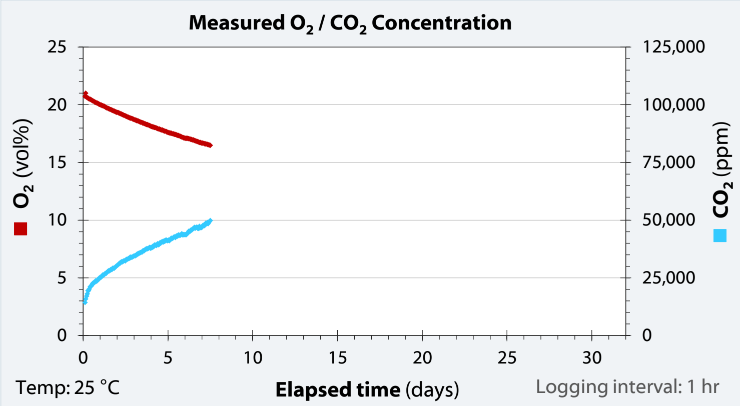
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	18.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	13.0 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.36	mmol/kg/day
Pyrite oxidation rate*	POR	150	wt% Pyr/yr
POR (intrinsic units)		133	$\times10^{-9}$ kg O_2/t/s
		2.2	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	6.9	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

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TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS	NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.28 wt%	12	508
Magnesium	Mg	1.29 wt%	4	81
Potassium	K	3.48 wt%	12	57
Sodium	Na	0.05 wt%	3	172
Chloride	Cl	70 mg/kg	1	350
Fluoride	F	2950 mg/kg	2.4	2.1
Carbon	C	<0.02 wt%	–	–
Sulfur/sulfate	S/SO_4	0.21 wt%	60	1490
Aluminium	Al	6.83 wt%	0.34	0.02
Iron	Fe	1.55 wt%	<0.05	<0.05
Manganese	Mn	150 mg/kg	0.322	17.4
Phosphorus	P	1190 mg/kg	8.36	1.71
Antimony	Sb	<0.1 mg/kg	<0.001	<0.001
Arsenic	As	2.2 mg/kg	<0.001	<0.001
Barium	Ba	55 mg/kg	–	–
Beryllium	Be	0.4 mg/kg	–	–
Bismuth	Bi	1 mg/kg	<0.001	<0.001
Boron	B	<50 mg/kg	0.05	<0.05
Cadmium	Cd	0.1 mg/kg	0.0008	0.0098
Caesium	Cs	1.1 mg/kg	–	–
Cerium	Ce	3.3 mg/kg	–	–
Chromium	Cr	33.7 mg/kg	0.054	<0.001
Cobalt	Co	4.5 mg/kg	0.004	0.233
Copper	Cu	1010 mg/kg	0.165	0.626
Gallium	Ga	2.5 mg/kg	–	–
Germanium	Ge	<0.1 mg/kg	–	–
Hafnium	Hf	<1 mg/kg	–	–
Indium	In	0.1 mg/kg	–	–
Lanthanum	La	1.3 mg/kg	–	–
Lead	Pb	3.2 mg/kg	<0.001	<0.001
Lithium	Li	3.2 mg/kg	–	–
Mercury	Hg	<0.1 mg/kg	<0.0001	<0.0001
Molybdenum	Mo	48.7 mg/kg	0.368	0.002
Nickel	Ni	25 mg/kg	0.002	0.263
Niobium	Nb	<0.1 mg/kg	–	–
Rubidium	Rb	34.1 mg/kg	–	–
Selenium	Se	1 mg/kg	<0.01	0.08
Silver	Ag	0.4 mg/kg	<0.001	<0.001
Strontium	Sr	19.6 mg/kg	–	–
Tellurium	Te	0.6 mg/kg	<0.005	<0.005
Thallium	Tl	0.1 mg/kg	<0.001	<0.001
Thorium	Th	0.3 mg/kg	–	–
Tin	Sn	1.1 mg/kg	<0.001	<0.001
Titanium	Ti	4420 mg/kg	–	–
Tungsten	W	1.1 mg/kg	–	–
Uranium	U	0.5 mg/kg	<0.001	<0.001
Vanadium	V	25 mg/kg	0.03	<0.01
Yttrium	Y	2.9 mg/kg	–	–
Zinc	Zn	43.4 mg/kg	0.025	0.314
Zirconium	Zr	<0.5 mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.0
Electrical conductivity (EC)	3.1 mS/cm
Alkalinity	4.0 mg/L $CaCO_3$
Acidity – measured	15 mg/L $CaCO_3$
Acidity – calculated[1]	34 mg/L $CaCO_3$
POR based on sulfate release[2]	0.8 wt% Pyr/day

[1] Calculated from metal content.

[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.2
Kaolinite	5.5
Microcline	6.4
Muscovite	37.0
Pyrite	0.4
Pyrrhotite-4C?	0.5
Quartz	49.9
Sphalerite?	0.1
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

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TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-RO-24	Project	Process Tailings Testwork
Sample Description	P4 Rougher Tailings. Tested at VMC of 24% (Field Capacity) and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.21	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

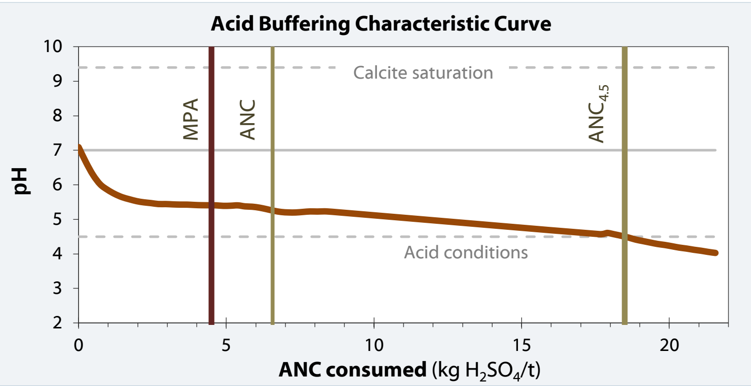
Acid neutralising capacity	ANC	6.6	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.5	
Net acid producing potential	NAPP	−2	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.0	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1.2	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1.2	kg H_2SO_4/t

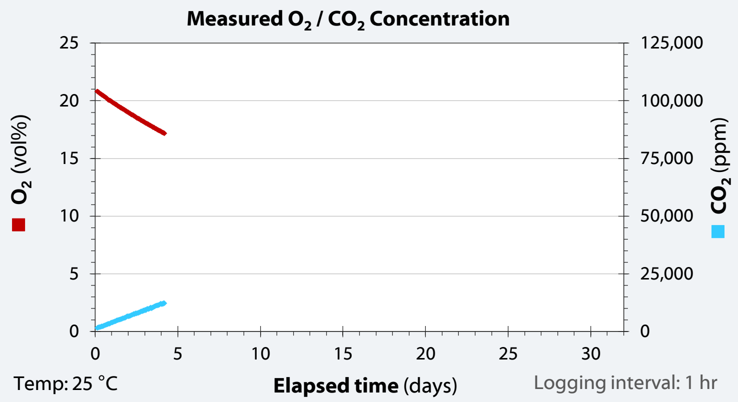
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	18.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	15.5 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.56	mmol/kg/day
Pyrite oxidation rate*	POR	230	wt% Pyr/yr
POR (intrinsic units)		210	$\times 10^{-9}$ kg O_2/t/s
		3.5	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	11	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

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MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS	NAG LEACHATE mg/L	OXCON LEACHATE mg/L
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Sodium	Na	0.05 wt%	3	172
Chloride	Cl	70 mg/kg	1	350
Fluoride	F	2950 mg/kg	2.4	2.1
Carbon	C	<0.02 wt%	–	–
Sulfur/sulfate	S/SO_4	0.21 wt%	60	1490
Aluminium	Al	6.83 wt%	0.34	0.02
Iron	Fe	1.55 wt%	<0.05	<0.05
Manganese	Mn	150 mg/kg	0.322	17.4
Phosphorus	P	1190 mg/kg	8.36	1.71
Antimony	Sb	<0.1 mg/kg	<0.001	<0.001
Arsenic	As	2.2 mg/kg	<0.001	<0.001
Barium	Ba	55 mg/kg	–	–
Beryllium	Be	0.4 mg/kg	–	–
Bismuth	Bi	1 mg/kg	<0.001	<0.001
Boron	B	<50 mg/kg	0.05	<0.05
Cadmium	Cd	0.1 mg/kg	0.0008	0.0098
Caesium	Cs	1.1 mg/kg	–	–
Cerium	Ce	3.3 mg/kg	–	–
Chromium	Cr	33.7 mg/kg	0.054	<0.001
Cobalt	Co	4.5 mg/kg	0.004	0.233
Copper	Cu	1010 mg/kg	0.165	0.626
Gallium	Ga	2.5 mg/kg	–	–
Germanium	Ge	<0.1 mg/kg	–	–
Hafnium	Hf	<1 mg/kg	–	–
Indium	In	0.1 mg/kg	–	–
Lanthanum	La	1.3 mg/kg	–	–
Lead	Pb	3.2 mg/kg	<0.001	<0.001
Lithium	Li	3.2 mg/kg	–	–
Mercury	Hg	<0.1 mg/kg	<0.0001	<0.0001
Molybdenum	Mo	48.7 mg/kg	0.368	0.002
Nickel	Ni	25 mg/kg	0.002	0.263
Niobium	Nb	<0.1 mg/kg	–	–
Rubidium	Rb	34.1 mg/kg	–	–
Selenium	Se	1 mg/kg	<0.01	0.08
Silver	Ag	0.4 mg/kg	<0.001	<0.001
Strontium	Sr	19.6 mg/kg	–	–
Tellurium	Te	0.6 mg/kg	<0.005	<0.005
Thallium	Tl	0.1 mg/kg	<0.001	<0.001
Thorium	Th	0.3 mg/kg	–	–
Tin	Sn	1.1 mg/kg	<0.001	<0.001
Titanium	Ti	4420 mg/kg	–	–
Tungsten	W	1.1 mg/kg	–	–
Uranium	U	0.5 mg/kg	<0.001	<0.001
Vanadium	V	25 mg/kg	0.03	<0.01
Yttrium	Y	2.9 mg/kg	–	–
Zinc	Zn	43.4 mg/kg	0.025	0.314
Zirconium	Zr	<0.5 mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.0
Electrical conductivity (EC)	3.1 mS/cm
Alkalinity	4.0 mg/L $CaCO_3$
Acidity – measured	15 mg/L $CaCO_3$
Acidity – calculated[1]	34 mg/L $CaCO_3$
POR based on sulfate release[2]	1.5 wt% Pyr/day

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.2
Kaolinite	5.5
Microcline	6.4
Muscovite	37.0
Pyrite	0.4
Pyrrhotite-4C?	0.5
Quartz	49.9
Sphalerite?	0.1
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon

Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-CL-05	Project	Process Tailings Testwork
Sample Description	P4 Cleaner Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.73 g/cm3	Texture	Fine Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.6	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.14	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.08	wt% S
Sulfide sulfur	20.4	wt% S
Equivalent pyrite content	38.1	wt% FeS_2

ACID–BASE ACCOUNTING

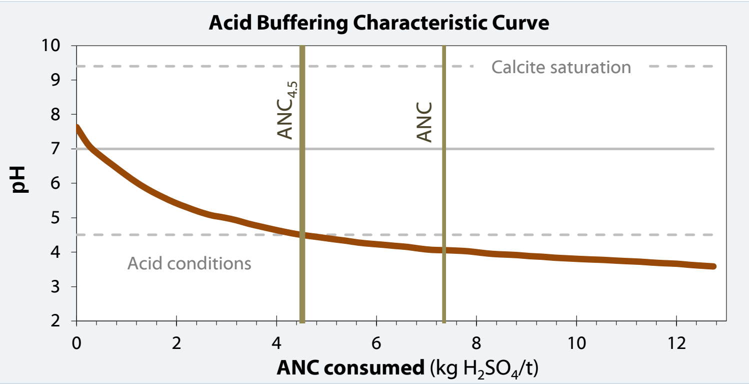
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	623	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+616	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	150	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	193	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		43	kg H_2SO_4/t

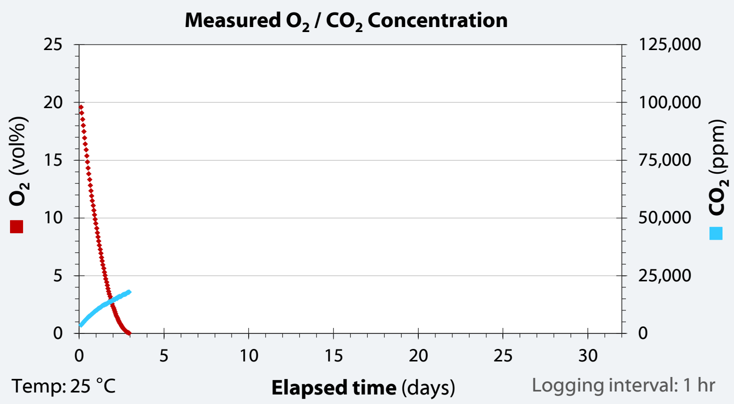
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	4.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	2.9 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	7.2	mmol/kg/day
Pyrite oxidation rate*	POR	22	wt% Pyr/yr
POR (intrinsic units)		2,700	$\times10^{-9}$ kg O_2/t/s
		45	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	137	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE	OXCON LEACHATE
				mg/L	mg/L
Calcium	Ca	0.39	wt%	24	376
Magnesium	Mg	1.07	wt%	9	245
Potassium	K	2.94	wt%	15	1
Sodium	Na	0.04	wt%	3	7
Chloride	Cl	<100	mg/kg	<1	<1
Fluoride	F	2310	mg/kg	0.7	<0.1
Carbon	C	<0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	20.6	wt%	1370	5330
Aluminium	Al	6.25	wt%	19.4	314
Iron	Fe	18.95	wt%	244	171
Manganese	Mn	160	mg/kg	1.33	35.5
Phosphorus	P	1350	mg/kg	5.75	44.9
Antimony	Sb	0.1	mg/kg	<0.001	<0.001
Arsenic	As	13	mg/kg	0.002	<0.001
Barium	Ba	34.1	mg/kg	–	–
Beryllium	Be	0.4	mg/kg	–	–
Bismuth	Bi	4.3	mg/kg	<0.001	<0.001
Boron	B	<50	mg/kg	<0.05	<0.05
Cadmium	Cd	0.3	mg/kg	0.0022	0.185
Caesium	Cs	1	mg/kg	–	–
Cerium	Ce	2.3	mg/kg	–	–
Chromium	Cr	39.6	mg/kg	0.074	0.144
Cobalt	Co	174	mg/kg	0.342	5.51
Copper	Cu	3170	mg/kg	21.1	1000
Gallium	Ga	2.7	mg/kg	–	–
Germanium	Ge	3.8	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.3	mg/kg	–	–
Lanthanum	La	0.9	mg/kg	–	–
Lead	Pb	18.2	mg/kg	0.007	<0.001
Lithium	Li	3.9	mg/kg	–	–
Mercury	Hg	0.1	mg/kg	<0.0001	0.001
Molybdenum	Mo	40.4	mg/kg	<0.001	<0.001
Nickel	Ni	110	mg/kg	0.212	5.46
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	35.7	mg/kg	–	–
Selenium	Se	48	mg/kg	0.06	0.04
Silver	Ag	1.6	mg/kg	<0.001	<0.001
Strontium	Sr	20	mg/kg	–	–
Tellurium	Te	4.1	mg/kg	0.007	<0.005
Thallium	Tl	0.2	mg/kg	<0.001	<0.001
Thorium	Th	0.3	mg/kg	–	–
Tin	Sn	2.8	mg/kg	<0.001	<0.001
Titanium	Ti	3670	mg/kg	–	–
Tungsten	W	1.6	mg/kg	–	–
Uranium	U	0.8	mg/kg	0.003	0.175
Vanadium	V	30	mg/kg	0.02	<0.01
Yttrium	Y	4.5	mg/kg	–	–
Zinc	Zn	63.9	mg/kg	0.281	20.6
Zirconium	Zr	3.1	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	3.3	
Electrical conductivity (EC)	4.0	mS/cm
Alkalinity	<1	mg/L $CaCO_3$
Acidity – measured	3,720	mg/L $CaCO_3$
Acidity – calculated[1]	3,921	mg/L $CaCO_3$
POR based on sulfate release[2]	21	wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Arsenopyrite?	0.3
Chalcopyrite	0.3
Chlorite	0.9
Jarosite	0.2
Kaolinite	5.1
Microcline	4.2
Muscovite	34.3
Pyrite	30.6
Pyrrhotite-4C?	0.2
Quartz	23.8
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-CL-20	Project	Process Tailings Testwork
Sample Description	P4 Cleaner Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.73 g/cm3	Texture	Fine Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.6	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.14	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.08	wt% S
Sulfide sulfur	20.4	wt% S
Equivalent pyrite content	38.1	wt% FeS_2

ACID–BASE ACCOUNTING

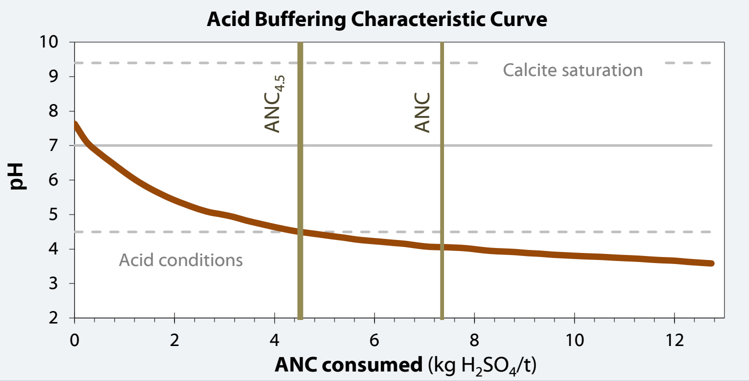
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	623	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+616	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	150	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	193	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		43	kg H_2SO_4/t

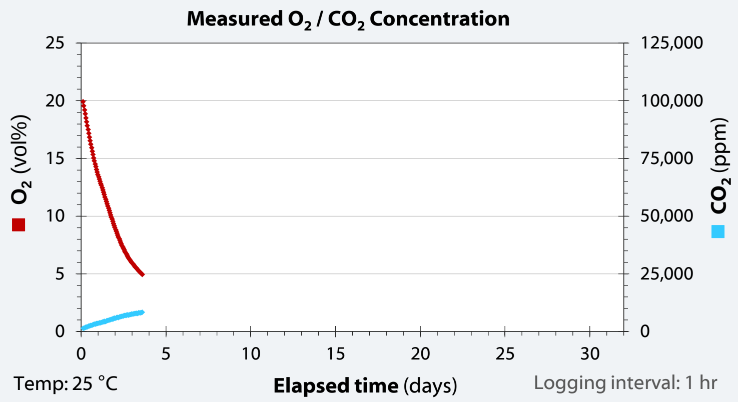
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	4.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	3.99 kg	GMC*	11.9 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	4.7	mmol/kg/day
Pyrite oxidation rate*	POR	14	wt% Pyr/yr
POR (intrinsic units)		1,700	$\times 10^{-9}$ kg O_2/t/s
		29	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	89	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE	OXCON LEACHATE
				mg/L	mg/L
Calcium	Ca	0.39	wt%	24	376
Magnesium	Mg	1.07	wt%	9	245
Potassium	K	2.94	wt%	15	1
Sodium	Na	0.04	wt%	3	7
Chloride	Cl	<100	mg/kg	<1	<1
Fluoride	F	2310	mg/kg	0.7	<0.1
Carbon	C	<0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	20.6	wt%	1370	5330
Aluminium	Al	6.25	wt%	19.4	314
Iron	Fe	18.95	wt%	244	171
Manganese	Mn	160	mg/kg	1.33	35.5
Phosphorus	P	1350	mg/kg	5.75	44.9
Antimony	Sb	0.1	mg/kg	<0.001	<0.001
Arsenic	As	13	mg/kg	0.002	<0.001
Barium	Ba	34.1	mg/kg	–	–
Beryllium	Be	0.4	mg/kg	–	–
Bismuth	Bi	4.3	mg/kg	<0.001	<0.001
Boron	B	<50	mg/kg	<0.05	<0.05
Cadmium	Cd	0.3	mg/kg	0.0022	0.185
Caesium	Cs	1	mg/kg	–	–
Cerium	Ce	2.3	mg/kg	–	–
Chromium	Cr	39.6	mg/kg	0.074	0.144
Cobalt	Co	174	mg/kg	0.342	5.51
Copper	Cu	3170	mg/kg	21.1	1000
Gallium	Ga	2.7	mg/kg	–	–
Germanium	Ge	3.8	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.3	mg/kg	–	–
Lanthanum	La	0.9	mg/kg	–	–
Lead	Pb	18.2	mg/kg	0.007	<0.001
Lithium	Li	3.9	mg/kg	–	–
Mercury	Hg	0.1	mg/kg	<0.0001	0.001
Molybdenum	Mo	40.4	mg/kg	<0.001	<0.001
Nickel	Ni	110	mg/kg	0.212	5.46
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	35.7	mg/kg	–	–
Selenium	Se	48	mg/kg	0.06	0.04
Silver	Ag	1.6	mg/kg	<0.001	<0.001
Strontium	Sr	20	mg/kg	–	–
Tellurium	Te	4.1	mg/kg	0.007	<0.005
Thallium	Tl	0.2	mg/kg	<0.001	<0.001
Thorium	Th	0.3	mg/kg	–	–
Tin	Sn	2.8	mg/kg	<0.001	<0.001
Titanium	Ti	3670	mg/kg	–	–
Tungsten	W	1.6	mg/kg	–	–
Uranium	U	0.8	mg/kg	0.003	0.175
Vanadium	V	30	mg/kg	0.02	<0.01
Yttrium	Y	4.5	mg/kg	–	–
Zinc	Zn	63.9	mg/kg	0.281	20.6
Zirconium	Zr	3.1	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	3.3	
Electrical conductivity (EC)	4.0	mS/cm
Alkalinity	<1	mg/L $CaCO_3$
Acidity – measured	3,720	mg/L $CaCO_3$
Acidity – calculated[1]	3,921	mg/L CaCO
POR based on sulfate release[2]	17	wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Arsenopyrite?	0.3
Chalcopyrite	0.3
Chlorite	0.9
Jarosite	0.2
Kaolinite	5.1
Microcline	4.2
Muscovite	34.3
Pyrite	30.6
Pyrrhotite-4C?	0.2
Quartz	23.8
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P4-CL-40	Project	Process Tailings Testwork
Sample Description	P4 Cleaner Tailings. Tested at VMC of 40% and bulk density (dry basis) of 1.73 g/cm3	Texture	Fine Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.6	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.14	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.08	wt% S
Sulfide sulfur	20.4	wt% S
Equivalent pyrite content	38.1	wt% FeS_2

ACID–BASE ACCOUNTING

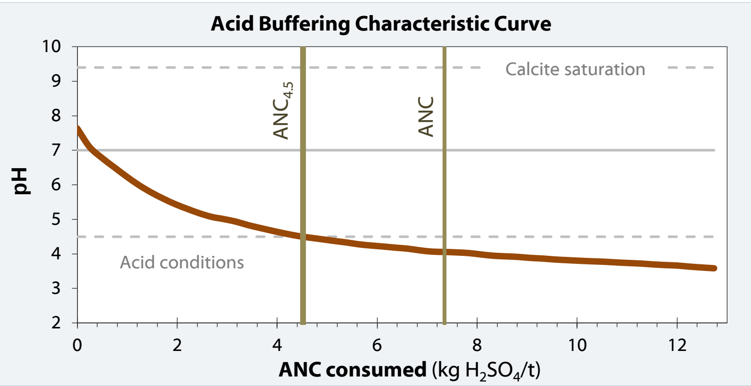
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	623	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+616	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	150	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	193	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		43	kg H_2SO_4/t

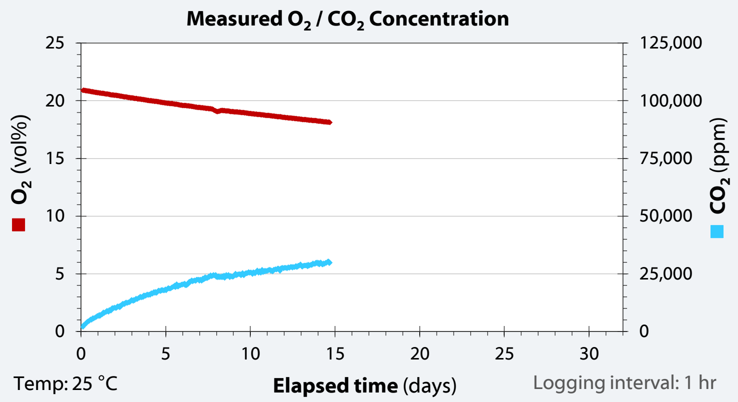
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	4.5	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.02 kg	GMC*	22.5 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.11	mmol/kg/day
Pyrite oxidation rate*	POR	0.35	wt% Pyr/yr
POR (intrinsic units)		42	$\times 10^{-9}$ kg O_2/t/s
		0.70	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	2.2	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS	NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.39 wt%	24	376
Magnesium	Mg	1.07 wt%	9	245
Potassium	K	2.94 wt%	15	1
Sodium	Na	0.04 wt%	3	7
Chloride	Cl	<100 mg/kg	<1	<1
Fluoride	F	2310 mg/kg	0.7	<0.1
Carbon	C	<0.02 wt%	–	–
Sulfur/sulfate	S/SO_4	20.6 wt%	1370	5330
Aluminium	Al	6.25 wt%	19.4	314
Iron	Fe	18.95 wt%	244	171
Manganese	Mn	160 mg/kg	1.33	35.5
Phosphorus	P	1350 mg/kg	5.75	44.9
Antimony	Sb	0.1 mg/kg	<0.001	<0.001
Arsenic	As	13 mg/kg	0.002	<0.001
Barium	Ba	34.1 mg/kg	–	–
Beryllium	Be	0.4 mg/kg	–	–
Bismuth	Bi	4.3 mg/kg	<0.001	<0.001
Boron	B	<50 mg/kg	<0.05	<0.05
Cadmium	Cd	0.3 mg/kg	0.0022	0.185
Caesium	Cs	1 mg/kg	–	–
Cerium	Ce	2.3 mg/kg	–	–
Chromium	Cr	39.6 mg/kg	0.074	0.144
Cobalt	Co	174 mg/kg	0.342	5.51
Copper	Cu	3170 mg/kg	21.1	1000
Gallium	Ga	2.7 mg/kg	–	–
Germanium	Ge	3.8 mg/kg	–	–
Hafnium	Hf	<1 mg/kg	–	–
Indium	In	0.3 mg/kg	–	–
Lanthanum	La	0.9 mg/kg	–	–
Lead	Pb	18.2 mg/kg	0.007	<0.001
Lithium	Li	3.9 mg/kg	–	–
Mercury	Hg	0.1 mg/kg	<0.0001	0.001
Molybdenum	Mo	40.4 mg/kg	<0.001	<0.001
Nickel	Ni	110 mg/kg	0.212	5.46
Niobium	Nb	<0.1 mg/kg	–	–
Rubidium	Rb	35.7 mg/kg	–	–
Selenium	Se	48 mg/kg	0.06	0.04
Silver	Ag	1.6 mg/kg	<0.001	<0.001
Strontium	Sr	20 mg/kg	–	–
Tellurium	Te	4.1 mg/kg	0.007	<0.005
Thallium	Tl	0.2 mg/kg	<0.001	<0.001
Thorium	Th	0.3 mg/kg	–	–
Tin	Sn	2.8 mg/kg	<0.001	<0.001
Titanium	Ti	3670 mg/kg	–	–
Tungsten	W	1.6 mg/kg	–	–
Uranium	U	0.8 mg/kg	0.003	0.175
Vanadium	V	30 mg/kg	0.02	<0.01
Yttrium	Y	4.5 mg/kg	–	–
Zinc	Zn	63.9 mg/kg	0.281	20.6
Zirconium	Zr	3.1 mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	3.3
Electrical conductivity (EC)	4.0 mS/cm
Alkalinity	<1 mg/L $CaCO_3$
Acidity – measured	3,720 mg/L $CaCO_3$
Acidity – calculated[1]	3,921 mg/L $CaCO_3$
POR based on sulfate release[2]	4.1 wt% Pyr/yr

[1] Calculated from metal content.

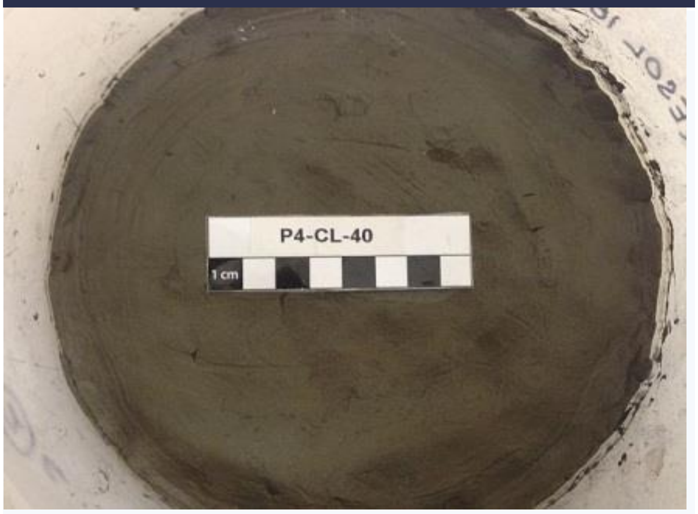
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Arsenopyrite?	0.3
Chalcopyrite	0.3
Chlorite	0.9
Jarosite	0.2
Kaolinite	5.1
Microcline	4.2
Muscovite	34.3
Pyrite	30.6
Pyrrhotite-4C?	0.2
Quartz	23.8
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED



CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-RO-05	Project	Process Tailings Testwork
Sample Description	P8 Rougher Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.20	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	<0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

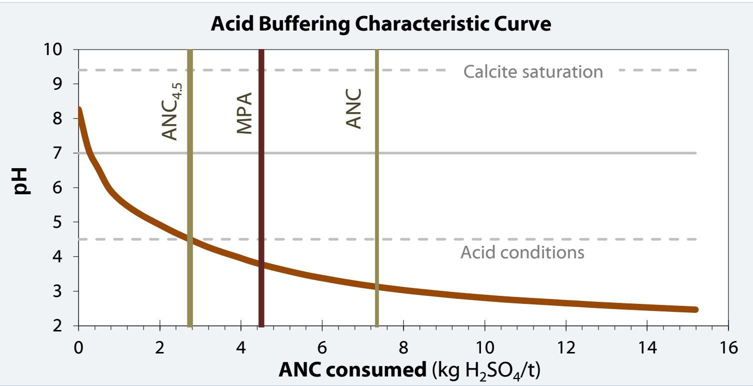
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.6	
Net acid producing potential	NAPP	–3	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.8	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1	kg H_2SO_4/t

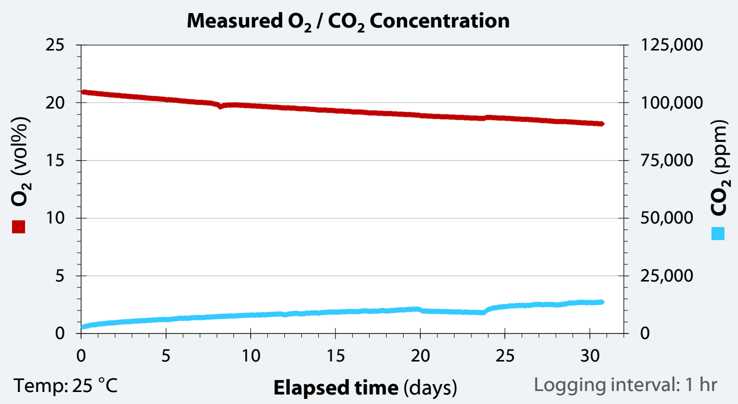
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	2.7	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	3.2 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.076	mmol/kg/day
Pyrite oxidation rate*	POR	32	wt% Pyr/yr
POR (intrinsic units)		28	$\times 10^{-9}$ kg O_2/t/s
		0.47	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	1.4	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS	NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.29 wt%	9	425
Magnesium	Mg	1.27 wt%	3	22
Potassium	K	3.38 wt%	14	52
Sodium	Na	0.05 wt%	2	491
Chloride	Cl	60 mg/kg	3	826
Fluoride	F	3130 mg/kg	3.1	2.4
Carbon	C	<0.02 wt%	–	–
Sulfur/sulfate	S/SO_4	0.2 wt%	33	1150
Aluminium	Al	6.62 wt%	0.04	0.03
Iron	Fe	1.55 wt%	<0.05	<0.05
Manganese	Mn	150 mg/kg	0.037	1.95
Phosphorus	P	1170 mg/kg	7.54	5.05
Antimony	Sb	<0.1 mg/kg	<0.001	<0.001
Arsenic	As	1.1 mg/kg	<0.001	<0.001
Barium	Ba	63.7 mg/kg	–	–
Beryllium	Be	0.4 mg/kg	–	–
Bismuth	Bi	0.5 mg/kg	<0.001	<0.001
Boron	B	<50 mg/kg	<0.05	<0.05
Cadmium	Cd	0.1 mg/kg	<0.0001	0.0008
Caesium	Cs	1.1 mg/kg	–	–
Cerium	Ce	3.9 mg/kg	–	–
Chromium	Cr	38.5 mg/kg	0.049	<0.001
Cobalt	Co	3.9 mg/kg	<0.001	0.006
Copper	Cu	394 mg/kg	0.004	0.059
Gallium	Ga	2.5 mg/kg	–	–
Germanium	Ge	0.1 mg/kg	–	–
Hafnium	Hf	<1 mg/kg	–	–
Indium	In	<0.1 mg/kg	–	–
Lanthanum	La	1.5 mg/kg	–	–
Lead	Pb	3.1 mg/kg	<0.001	0.002
Lithium	Li	3.2 mg/kg	–	–
Mercury	Hg	<0.1 mg/kg	<0.0001	<0.0001
Molybdenum	Mo	24.8 mg/kg	0.264	0.02
Nickel	Ni	27.8 mg/kg	<0.001	0.011
Niobium	Nb	<0.1 mg/kg	–	–
Rubidium	Rb	34.2 mg/kg	–	–
Selenium	Se	<1 mg/kg	<0.01	0.03
Silver	Ag	0.2 mg/kg	<0.001	<0.001
Strontium	Sr	21.2 mg/kg	–	–
Tellurium	Te	<0.5 mg/kg	<0.005	<0.005
Thallium	Tl	0.1 mg/kg	<0.001	<0.001
Thorium	Th	0.4 mg/kg	–	–
Tin	Sn	1 mg/kg	<0.001	<0.001
Titanium	Ti	4420 mg/kg	–	–
Tungsten	W	0.8 mg/kg	–	–
Uranium	U	0.4 mg/kg	<0.001	<0.001
Vanadium	V	24 mg/kg	0.04	<0.01
Yttrium	Y	2.8 mg/kg	–	–
Zinc	Zn	34.3 mg/kg	<0.005	0.013
Zirconium	Zr	0.5 mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.8
Electrical conductivity (EC)	4.2 mS/cm
Alkalinity	22 mg/L $CaCO_3$
Acidity – measured	39 mg/L $CaCO_3$
Acidity – calculated[1]	<5 mg/L $CaCO_3$
POR based on sulfate release[2]	57 wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Kaolinite	4.3
Microcline	5.0
Muscovite	35.6
Pyrite	0.3
Pyrrhotite-4C?	0.2
Quartz	54.5
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-RO-20	Project	Process Tailings Testwork
Sample Description	P8 Rougher Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.20	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	<0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

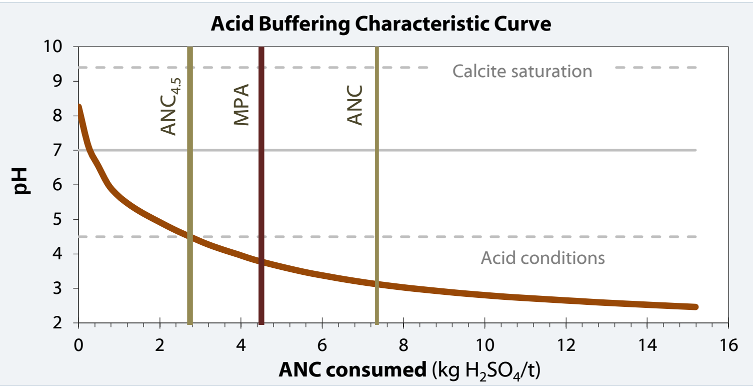
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.6	
Net acid producing potential	NAPP	−3	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.8	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1	kg H_2SO_4/t

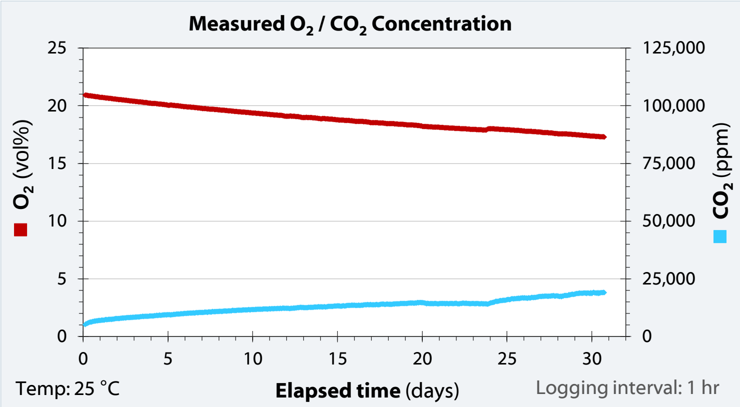
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	2.7	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	3.99 kg	GMC*	13.1 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.096	mmol/kg/day
Pyrite oxidation rate*	POR	40	wt% Pyr/yr
POR (intrinsic units)		36	$\times10^{-9}$ kg O_2/t/s
		0.60	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	1.8	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.29	wt%	9	425
Magnesium	Mg	1.27	wt%	3	22
Potassium	K	3.38	wt%	14	52
Sodium	Na	0.05	wt%	2	491
Chloride	Cl	60	mg/kg	3	826
Fluoride	F	3130	mg/kg	3.1	2.4
Carbon	C	<0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	0.2	wt%	33	1150
Aluminium	Al	6.62	wt%	0.04	0.03
Iron	Fe	1.55	wt%	<0.05	<0.05
Manganese	Mn	150	mg/kg	0.037	1.95
Phosphorus	P	1170	mg/kg	7.54	5.05
Antimony	Sb	<0.1	mg/kg	<0.001	<0.001
Arsenic	As	1.1	mg/kg	<0.001	<0.001
Barium	Ba	63.7	mg/kg	–	–
Beryllium	Be	0.4	mg/kg	–	–
Bismuth	Bi	0.5	mg/kg	<0.001	<0.001
Boron	B	<50	mg/kg	<0.05	<0.05
Cadmium	Cd	0.1	mg/kg	<0.0001	0.0008
Caesium	Cs	1.1	mg/kg	–	–
Cerium	Ce	3.9	mg/kg	–	–
Chromium	Cr	38.5	mg/kg	0.049	<0.001
Cobalt	Co	3.9	mg/kg	<0.001	0.006
Copper	Cu	394	mg/kg	0.004	0.059
Gallium	Ga	2.5	mg/kg	–	–
Germanium	Ge	0.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	<0.1	mg/kg	–	–
Lanthanum	La	1.5	mg/kg	–	–
Lead	Pb	3.1	mg/kg	<0.001	0.002
Lithium	Li	3.2	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	<0.0001
Molybdenum	Mo	24.8	mg/kg	0.264	0.02
Nickel	Ni	27.8	mg/kg	<0.001	0.011
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	34.2	mg/kg	–	–
Selenium	Se	<1	mg/kg	<0.01	0.03
Silver	Ag	0.2	mg/kg	<0.001	<0.001
Strontium	Sr	21.2	mg/kg	–	–
Tellurium	Te	<0.5	mg/kg	<0.005	<0.005
Thallium	Tl	0.1	mg/kg	<0.001	<0.001
Thorium	Th	0.4	mg/kg	–	–
Tin	Sn	1	mg/kg	<0.001	<0.001
Titanium	Ti	4420	mg/kg	–	–
Tungsten	W	0.8	mg/kg	–	–
Uranium	U	0.4	mg/kg	<0.001	<0.001
Vanadium	V	24	mg/kg	0.04	<0.01
Yttrium	Y	2.8	mg/kg	–	–
Zinc	Zn	34.3	mg/kg	<0.005	0.013
Zirconium	Zr	0.5	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.8
Electrical conductivity (EC)	4.2 mS/cm
Alkalinity	22 mg/L $CaCO_3$
Acidity – measured	39 mg/L $CaCO_3$
Acidity – calculated[1]	<5 mg/L CaCO
POR based on sulfate release[2]	57 wt% Pyr/yr

[1] Calculated from metal content.

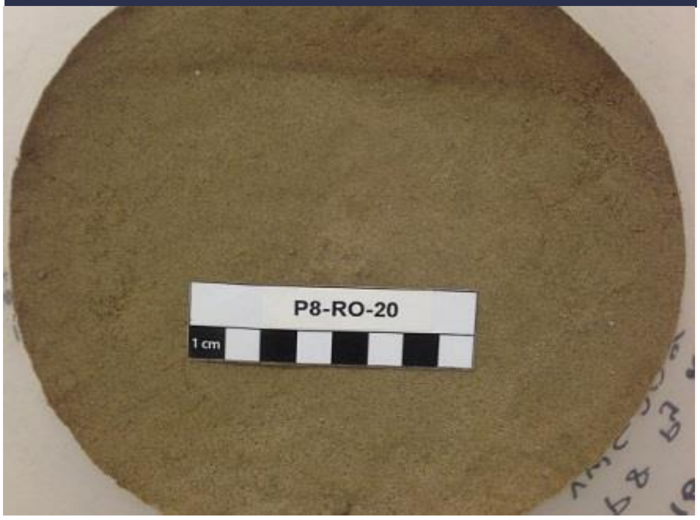
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Kaolinite	4.3
Microcline	5.0
Muscovite	35.6
Pyrite	0.3
Pyrrhotite-4C?	0.2
Quartz	54.5
Stilpnomelane?	0.1
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED



CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

TEST REPORT

SAMPLE DETAILS

Date	14 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-RO-26	Project	Process Tailings Testwork
Sample Description	P8 Rougher Tailings. Tested at VMC of 26% and bulk density (dry basis) of 1.55 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	0.20	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.05	wt% S
Sparingly soluble acid-forming sulfate sulfur	<0.01	wt% S
Sulfide sulfur	0.15	wt% S
Equivalent pyrite content	0.28	wt% FeS_2

ACID–BASE ACCOUNTING

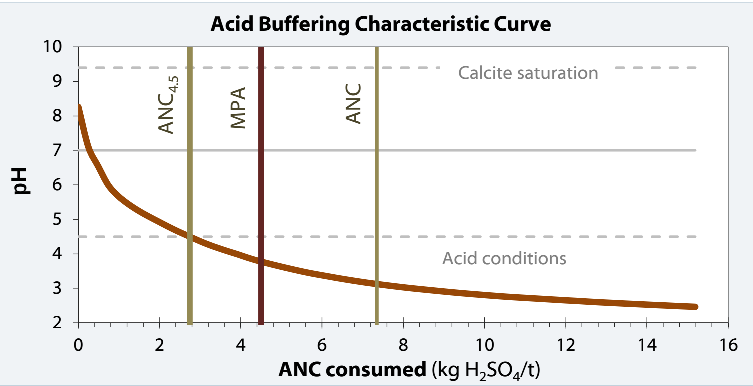
Acid neutralising capacity	ANC	7.3	kg H_2SO_4/t
Maximum potential acidity	MPA	4.5	kg H_2SO_4/t
ANC/MPA ratio		1.6	
Net acid producing potential	NAPP	−3	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	5.8	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	<0.1	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	1	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		1	kg H_2SO_4/t

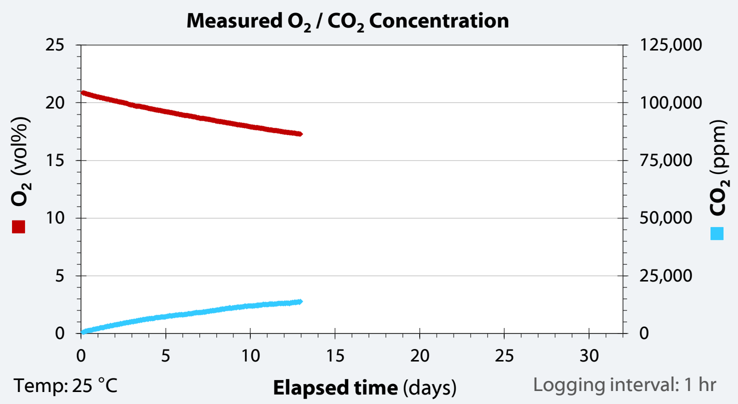
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	2.7	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.00 kg	GMC*	16.9 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.19	mmol/kg/day
Pyrite oxidation rate*	POR	81	wt% Pyr/yr
POR (intrinsic units)		72	$\times 10^{-9}$ kg O_2/t/s
		1.2	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	3.7	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE	OXCON LEACHATE
				mg/L	mg/L
Calcium	Ca	0.29	wt%	9	425
Magnesium	Mg	1.27	wt%	3	22
Potassium	K	3.38	wt%	14	52
Sodium	Na	0.05	wt%	2	491
Chloride	Cl	60	mg/kg	3	826
Fluoride	F	3130	mg/kg	3.1	2.4
Carbon	C	<0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	0.2	wt%	33	1150
Aluminium	Al	6.62	wt%	0.04	0.03
Iron	Fe	1.55	wt%	<0.05	<0.05
Manganese	Mn	150	mg/kg	0.037	1.95
Phosphorus	P	1170	mg/kg	7.54	5.05
Antimony	Sb	<0.1	mg/kg	<0.001	<0.001
Arsenic	As	1.1	mg/kg	<0.001	<0.001
Barium	Ba	63.7	mg/kg	–	–
Beryllium	Be	0.4	mg/kg	–	–
Bismuth	Bi	0.5	mg/kg	<0.001	<0.001
Boron	B	<50	mg/kg	<0.05	<0.05
Cadmium	Cd	0.1	mg/kg	<0.0001	0.0008
Caesium	Cs	1.1	mg/kg	–	–
Cerium	Ce	3.9	mg/kg	–	–
Chromium	Cr	38.5	mg/kg	0.049	<0.001
Cobalt	Co	3.9	mg/kg	<0.001	0.006
Copper	Cu	394	mg/kg	0.004	0.059
Gallium	Ga	2.5	mg/kg	–	–
Germanium	Ge	0.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	<0.1	mg/kg	–	–
Lanthanum	La	1.5	mg/kg	–	–
Lead	Pb	3.1	mg/kg	<0.001	0.002
Lithium	Li	3.2	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	<0.0001
Molybdenum	Mo	24.8	mg/kg	0.264	0.02
Nickel	Ni	27.8	mg/kg	<0.001	0.011
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	34.2	mg/kg	–	–
Selenium	Se	<1	mg/kg	<0.01	0.03
Silver	Ag	0.2	mg/kg	<0.001	<0.001
Strontium	Sr	21.2	mg/kg	–	–
Tellurium	Te	<0.5	mg/kg	<0.005	<0.005
Thallium	Tl	0.1	mg/kg	<0.001	<0.001
Thorium	Th	0.4	mg/kg	–	–
Tin	Sn	1	mg/kg	<0.001	<0.001
Titanium	Ti	4420	mg/kg	–	–
Tungsten	W	0.8	mg/kg	–	–
Uranium	U	0.4	mg/kg	<0.001	<0.001
Vanadium	V	24	mg/kg	0.04	<0.01
Yttrium	Y	2.8	mg/kg	–	–
Zinc	Zn	34.3	mg/kg	<0.005	0.013
Zirconium	Zr	0.5	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	6.8	
Electrical conductivity (EC)	4.2	mS/cm
Alkalinity	22	mg/L $CaCO_3$
Acidity – measured	39	mg/L $CaCO_3$
Acidity – calculated[1]	<5	mg/L $CaCO_3$
POR based on sulfate release[2]	135	wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Kaolinite	4.3
Microcline	5.0
Muscovite	35.6
Pyrite	0.3
Pyrrhotite-4C?	0.2
Quartz	54.5
Stilpnomelane?	0.1
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
TOTAL	100.0

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	5 August 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-COM-05	Project	Process Tailings Testwork
Sample Description	P8 Combined Tailings. Tested at VMC of 5% and bulk density (dry basis) of 1.73 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.2	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.12	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.39	wt% S
Sulfide sulfur	19.7	wt% S
Equivalent pyrite content	36.8	wt% FeS_2

ACID–BASE ACCOUNTING

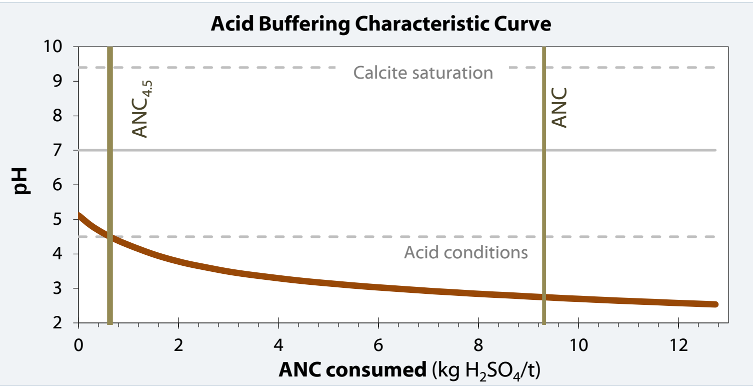
Acid neutralising capacity	ANC	9.3	kg H_2SO_4/t
Maximum potential acidity	MPA	602	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+593	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	97	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	120	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		23	kg H_2SO_4/t

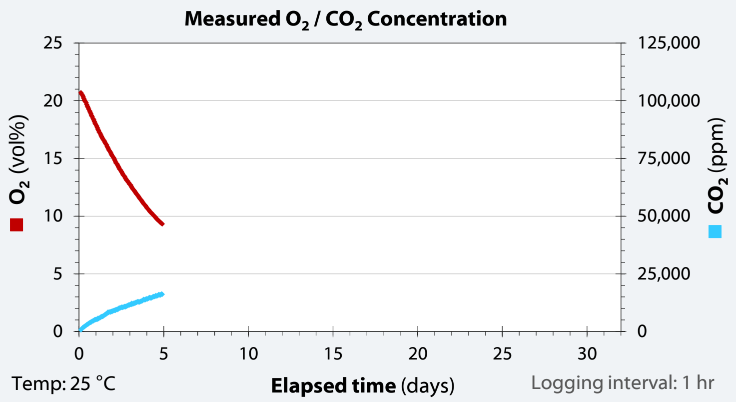
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	0.6	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.01 kg	GMC*	2.8 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	1.9	mmol/kg/day
Pyrite oxidation rate*	POR	5.9	wt% Pyr/yr
POR (intrinsic units)		690	$\times10^{-9}$ kg O_2/t/s
		12	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	36	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.31	wt%	25	481
Magnesium	Mg	1.18	wt%	8	120
Potassium	K	3.15	wt%	20	77
Sodium	Na	0.05	wt%	2	8
Chloride	Cl	60	mg/kg	<1	2
Fluoride	F	2230	mg/kg	1.6	5.9
Carbon	C	0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	20.2	wt%	1140	2670
Aluminium	Al	6.54	wt%	16.3	60.7
Iron	Fe	17.72	wt%	191	1.59
Manganese	Mn	120	mg/kg	0.676	28
Phosphorus	P	1310	mg/kg	8.31	19.8
Antimony	Sb	0.1	mg/kg	<0.001	<0.001
Arsenic	As	18.9	mg/kg	0.003	<0.001
Barium	Ba	33.7	mg/kg	–	–
Beryllium	Be	0.6	mg/kg	–	–
Bismuth	Bi	4	mg/kg	<0.001	<0.001
Boron	B	–	mg/kg	0.1	<0.05
Cadmium	Cd	0.3	mg/kg	0.0026	0.0705
Caesium	Cs	1.2	mg/kg	–	–
Cerium	Ce	2	mg/kg	–	–
Chromium	Cr	45	mg/kg	0.068	<0.001
Cobalt	Co	174	mg/kg	0.292	2.08
Copper	Cu	4350	mg/kg	26	347
Gallium	Ga	2.9	mg/kg	–	–
Germanium	Ge	4.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.4	mg/kg	–	–
Lanthanum	La	0.7	mg/kg	–	–
Lead	Pb	10.1	mg/kg	<0.001	0.001
Lithium	Li	5.6	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	0.0005
Molybdenum	Mo	41.5	mg/kg	<0.001	<0.001
Nickel	Ni	109	mg/kg	0.193	2.3
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	45.7	mg/kg	–	–
Selenium	Se	44	mg/kg	0.05	0.04
Silver	Ag	1.5	mg/kg	<0.001	<0.001
Strontium	Sr	18.3	mg/kg	–	–
Tellurium	Te	4	mg/kg	0.007	<0.005
Thallium	Tl	0.2	mg/kg	<0.001	0.001
Thorium	Th	0.4	mg/kg	–	–
Tin	Sn	3.3	mg/kg	<0.001	<0.001
Titanium	Ti	3410	mg/kg	–	–
Tungsten	W	1.3	mg/kg	–	–
Uranium	U	0.8	mg/kg	0.003	0.021
Vanadium	V	37	mg/kg	0.02	<0.01
Yttrium	Y	4.2	mg/kg	–	–
Zinc	Zn	81.4	mg/kg	0.396	5.67
Zirconium	Zr	2.8	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	4.1	
Electrical conductivity (EC)	2.5	mS/cm
Alkalinity	<1	mg/L $CaCO_3$
Acidity – measured	1,010	mg/L $CaCO_3$
Acidity – calculated[1]	959	mg/L CaCO
POR based on sulfate release[2]	6.3	wt% Pyr/yr

[1] Calculated from metal content.

[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.5
Chalcopyrite	0.2
Chlorite	0.7
Kaolinite	3.9
Microcline	2.8
Muscovite	41.8
Pyrite	21.9
Pyrrhotite-4C?	0.3
Quartz	27.6
Stilpnomelane?	0.2
	0.0
	0.0
	0.0
	0.0
TOTAL	99.9

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	22 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-COM-20	Project	Process Tailings Testwork
Sample Description	P8 Combined Tailings. Tested at VMC of 20% and bulk density (dry basis) of 1.73 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.2	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.12	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.39	wt% S
Sulfide sulfur	19.7	wt% S
Equivalent pyrite content	36.8	wt% FeS_2

ACID–BASE ACCOUNTING

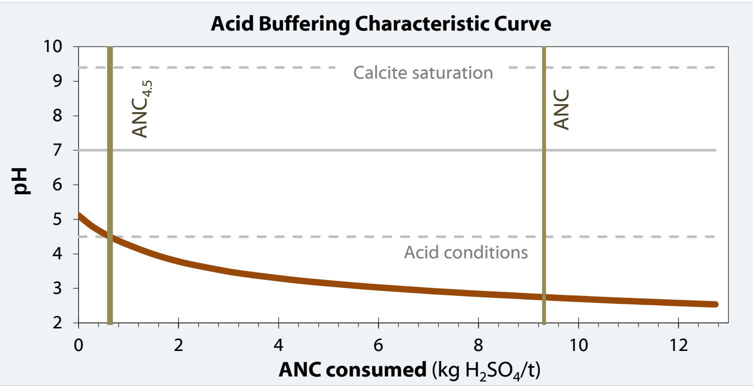
Acid neutralising capacity	ANC	9.3	kg H_2SO_4/t
Maximum potential acidity	MPA	602	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+593	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	97	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	120	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		23	kg H_2SO_4/t

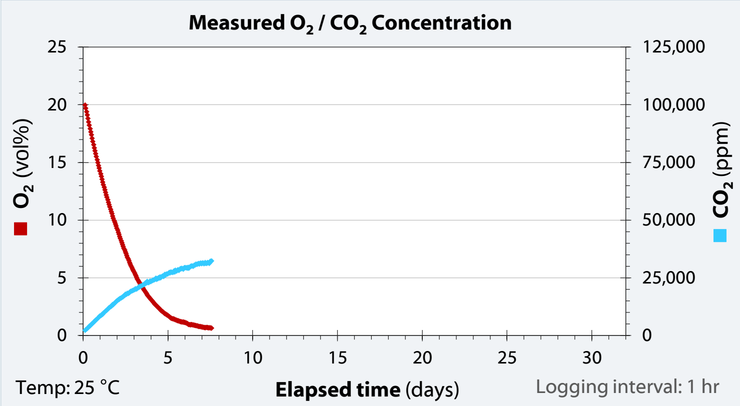
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	0.6	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.01 kg	GMC*	11.4 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	3.8	mmol/kg/day
Pyrite oxidation rate*	POR	12	wt% Pyr/yr
POR (intrinsic units)		1,400	$\times 10^{-9}$ kg O_2/t/s
		24	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	72	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE mg/L	OXCON LEACHATE mg/L
Calcium	Ca	0.31	wt%	25	481
Magnesium	Mg	1.18	wt%	8	120
Potassium	K	3.15	wt%	20	77
Sodium	Na	0.05	wt%	2	8
Chloride	Cl	60	mg/kg	<1	2
Fluoride	F	2230	mg/kg	1.6	5.9
Carbon	C	0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	20.2	wt%	1140	2670
Aluminium	Al	6.54	wt%	16.3	60.7
Iron	Fe	17.72	wt%	191	1.59
Manganese	Mn	120	mg/kg	0.676	28
Phosphorus	P	1310	mg/kg	8.31	19.8
Antimony	Sb	0.1	mg/kg	<0.001	<0.001
Arsenic	As	18.9	mg/kg	0.003	<0.001
Barium	Ba	33.7	mg/kg	–	–
Beryllium	Be	0.6	mg/kg	–	–
Bismuth	Bi	4	mg/kg	<0.001	<0.001
Boron	B	–	mg/kg	0.1	<0.05
Cadmium	Cd	0.3	mg/kg	0.0026	0.0705
Caesium	Cs	1.2	mg/kg	–	–
Cerium	Ce	2	mg/kg	–	–
Chromium	Cr	45	mg/kg	0.068	<0.001
Cobalt	Co	174	mg/kg	0.292	2.08
Copper	Cu	4350	mg/kg	26	347
Gallium	Ga	2.9	mg/kg	–	–
Germanium	Ge	4.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.4	mg/kg	–	–
Lanthanum	La	0.7	mg/kg	–	–
Lead	Pb	10.1	mg/kg	<0.001	0.001
Lithium	Li	5.6	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	0.0005
Molybdenum	Mo	41.5	mg/kg	<0.001	<0.001
Nickel	Ni	109	mg/kg	0.193	2.3
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	45.7	mg/kg	–	–
Selenium	Se	44	mg/kg	0.05	0.04
Silver	Ag	1.5	mg/kg	<0.001	<0.001
Strontium	Sr	18.3	mg/kg	–	–
Tellurium	Te	4	mg/kg	0.007	<0.005
Thallium	Tl	0.2	mg/kg	<0.001	0.001
Thorium	Th	0.4	mg/kg	–	–
Tin	Sn	3.3	mg/kg	<0.001	<0.001
Titanium	Ti	3410	mg/kg	–	–
Tungsten	W	1.3	mg/kg	–	–
Uranium	U	0.8	mg/kg	0.003	0.021
Vanadium	V	37	mg/kg	0.02	<0.01
Yttrium	Y	4.2	mg/kg	–	–
Zinc	Zn	81.4	mg/kg	0.396	5.67
Zirconium	Zr	2.8	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	4.1	
Electrical conductivity (EC)	2.5	mS/cm
Alkalinity	<1	mg/L $CaCO_3$
Acidity – measured	1,010	mg/L $CaCO_3$
Acidity – calculated[1]	959	mg/L CaCO
POR based on sulfate release[2]	4.1	wt% Pyr/yr

[1] Calculated from metal content.

[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.5
Chalcopyrite	0.2
Chlorite	0.7
Kaolinite	3.9
Microcline	2.8
Muscovite	41.8
Pyrite	21.9
Pyrrhotite-4C?	0.3
Quartz	27.6
Stilpnomelane?	0.2
TOTAL	99.9

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

SAMPLE DETAILS

Date	15 July 2015	Prepared for	Resolution Copper Mining LLC
Sample ID	P8-COM-37	Project	Process Tailings Testwork
Sample Description	P8 Combined Tailings. Tested at VMC of 37% (Field Capacity) and bulk density (dry basis) of 1.73 g/cm3	Texture	Silty Clay
		Reference lithology	N/A

SUMMARY OF SAMPLE ENVIRONMENTAL BEHAVIOUR

AMD/NMD/salinity risk	
Longevity of sulfide oxidation	
Predicted water quality impacts	
Leachate elements of concern	
Key reactive minerals	

STATIC GEOCHEMISTRY

SULFUR SPECIATION

Total sulfur	20.2	wt% S
Readily soluble acid-forming sulfate sulfur	<0.02	wt% S
Readily soluble non-acid-forming sulfate sulfur	0.12	wt% S
Sparingly soluble acid-forming sulfate sulfur	0.39	wt% S
Sulfide sulfur	19.7	wt% S
Equivalent pyrite content	36.8	wt% FeS_2

ACID–BASE ACCOUNTING

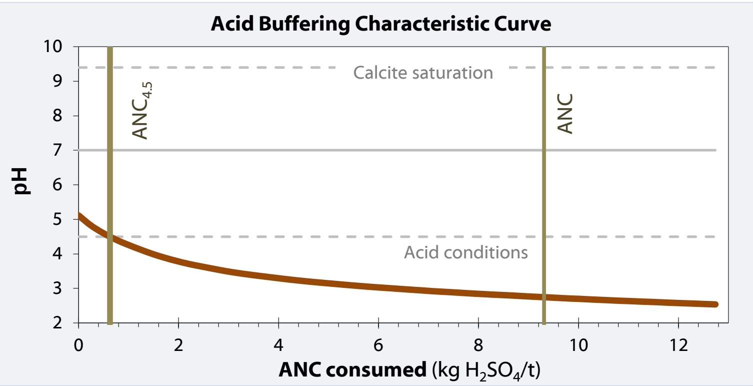
Acid neutralising capacity	ANC	9.3	kg H_2SO_4/t
Maximum potential acidity	MPA	602	kg H_2SO_4/t
ANC/MPA ratio		<0.1	
Net acid producing potential	NAPP	+593	kg H_2SO_4/t

NET ACID GENERATION

pH after oxidation	NAG_{pH}	2.2	(pH)
Net acid generation to pH 4.5	$NAG_{4.5}$	97	kg H_2SO_4/t
Net acid generation to pH 7.0	$NAG_{7.0}$	120	kg H_2SO_4/t
Net acid generation, pH 4.5 to pH 7.0		23	kg H_2SO_4/t

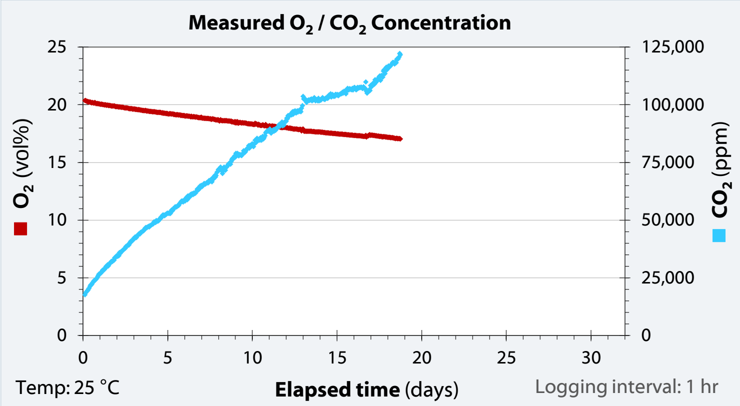
ACID NEUTRALISATION EFFICIENCY

Acid neutralisation capacity to pH 4.5	$ANC_{4.5}$	0.6	kg H_2SO_4/t



KINETIC GEOCHEMISTRY

OXYGEN CONSUMPTION TESTWORK



Sample mass (dry)	4.02 kg	GMC*	21.0 wt% H_2O

*Gravimetric moisture content

PYRITE OXIDATION RATE

Oxygen consumption rate	OCR	0.066	mmol/kg/day
Pyrite oxidation rate*	POR	0.21	wt% Pyr/yr
POR (intrinsic units)		25	$\times 10^{-9}$ kg O_2/t/s
		0.41	kg S/t/yr
Acidity generation rate (intrinsic)	AGR	1.3	kg H_2SO_4/t/yr

*Normalised to sample pyrite content (ie., fraction of pyrite oxidised per year)

NET ACID GENERATION RATE

Initial net acid generation rate	NAGR	<0.1	kg H_2SO_4/t/yr

OxCon
Oxygen consumption test

ES ANALYTICAL

TEST REPORT

MAJOR AND TRACE ELEMENT CHEMISTRY

Element	Symbol	SAMPLE SOLIDS		NAG LEACHATE	OXCON LEACHATE
				mg/L	mg/L
Calcium	Ca	0.31	wt%	25	481
Magnesium	Mg	1.18	wt%	8	120
Potassium	K	3.15	wt%	20	77
Sodium	Na	0.05	wt%	2	8
Chloride	Cl	60	mg/kg	<1	2
Fluoride	F	2230	mg/kg	1.6	5.9
Carbon	C	0.02	wt%	–	–
Sulfur/sulfate	S/SO_4	20.2	wt%	1140	2670
Aluminium	Al	6.54	wt%	16.3	60.7
Iron	Fe	17.72	wt%	191	1.59
Manganese	Mn	120	mg/kg	0.676	28
Phosphorus	P	1310	mg/kg	8.31	19.8
Antimony	Sb	0.1	mg/kg	<0.001	<0.001
Arsenic	As	18.9	mg/kg	0.003	<0.001
Barium	Ba	33.7	mg/kg	–	–
Beryllium	Be	0.6	mg/kg	–	–
Bismuth	Bi	4	mg/kg	<0.001	<0.001
Boron	B	–	mg/kg	0.1	<0.05
Cadmium	Cd	0.3	mg/kg	0.0026	0.0705
Caesium	Cs	1.2	mg/kg	–	–
Cerium	Ce	2	mg/kg	–	–
Chromium	Cr	45	mg/kg	0.068	<0.001
Cobalt	Co	174	mg/kg	0.292	2.08
Copper	Cu	4350	mg/kg	26	347
Gallium	Ga	2.9	mg/kg	–	–
Germanium	Ge	4.1	mg/kg	–	–
Hafnium	Hf	<1	mg/kg	–	–
Indium	In	0.4	mg/kg	–	–
Lanthanum	La	0.7	mg/kg	–	–
Lead	Pb	10.1	mg/kg	<0.001	0.001
Lithium	Li	5.6	mg/kg	–	–
Mercury	Hg	<0.1	mg/kg	<0.0001	0.0005
Molybdenum	Mo	41.5	mg/kg	<0.001	<0.001
Nickel	Ni	109	mg/kg	0.193	2.3
Niobium	Nb	<0.1	mg/kg	–	–
Rubidium	Rb	45.7	mg/kg	–	–
Selenium	Se	44	mg/kg	0.05	0.04
Silver	Ag	1.5	mg/kg	<0.001	<0.001
Strontium	Sr	18.3	mg/kg	–	–
Tellurium	Te	4	mg/kg	0.007	<0.005
Thallium	Tl	0.2	mg/kg	<0.001	0.001
Thorium	Th	0.4	mg/kg	–	–
Tin	Sn	3.3	mg/kg	<0.001	<0.001
Titanium	Ti	3410	mg/kg	–	–
Tungsten	W	1.3	mg/kg	–	–
Uranium	U	0.8	mg/kg	0.003	0.021
Vanadium	V	37	mg/kg	0.02	<0.01
Yttrium	Y	4.2	mg/kg	–	–
Zinc	Zn	81.4	mg/kg	0.396	5.67
Zirconium	Zr	2.8	mg/kg	–	–

OXCON LEACHATE – GENERAL PARAMETERS

pH	4.1	
Electrical conductivity (EC)	2.5	mS/cm
Alkalinity	<1	mg/L $CaCO_3$
Acidity – measured	1,010	mg/L $CaCO_3$
Acidity – calculated[1]	959	mg/L CaCO
POR based on sulfate release[2]	1.7	wt% Pyr/yr

[1] Calculated from metal content.
[2] Strongly influenced by sample storage history.

MINERALOGY

Mineral	wt%
Albite	0.5
Chalcopyrite	0.2
Chlorite	0.7
Kaolinite	3.9
Microcline	2.8
Muscovite	41.8
Pyrite	21.9
Pyrrhotite-4C?	0.3
Quartz	27.6
Stilpnomelane?	0.2
TOTAL	99.9

Mineralogy determined by X-ray diffraction (XRD) analysis.

SAMPLE AS TESTED

CHEMISTRY NOTES

NAG leachate	1:1 00 solid:water leachate after NAG test
OxCon leachate	1:1 solid:water leachate after 8 h contact time

All chemical analyses were conducted by NATA-accredited laboratories.

Ver. 7.3

OxCon is a laboratory-scale kinetic geochemical test for the estimation of sulfide oxidation rates, acidity generation rates and carbonate neutralisation rates for sulfidic geological materials.

The exposure of sulfide minerals, notably pyrite (FeS_2), to oxygen and water can result in acid and metalliferous drainage (AMD), also known as acid rock drainage (ARD). Prediction of the acidity generation potential of sulfidic materials is essential for AMD management and prevention, and is commonly determined through two types of analytical tests:

- *Static geochemical tests.* Measurement of sample composition to provide information on the maximum potential acidity and acid neutralisation capacity of a sample (including sulfur speciation, net acid generation (NAG), and acid–base accounting).
- *Kinetic geochemical tests.* Measurement of the actual acidity generation rate and carbonate neutralisation rate, providing information on the onset, magnitude and duration of acid generation and the potential for neutral metalliferous drainage (NMD) and saline drainage (SD).

The OxCon kinetic geochemical test allows for the fast, accurate and cost-effective determination of acidity generation rates. The OxCon method has the benefit of directly measuring the oxygen consumption associated with the pyrite oxidation reaction and carbon dioxide release during carbonate neutralisation.

As part of the OxCon test, a comprehensive suite of AMD-related sample characteristics are determined, including the net acidity generation rate (NAGR), the pyrite oxidation rate (POR) normalised to pyrite content, the time lag to onset of acid conditions, the longevity of sulfide oxidation, and the elements of concern in leachate. Using this information, high-risk materials can be identified and effective strategies for their long-term management can be developed.

Advantages of oxygen consumption testwork

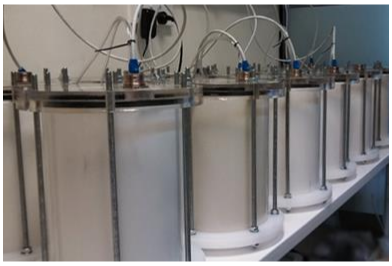
Oxygen consumption techniques have a number of advantages relative to other laboratory-scale kinetic geochemical tests such as column leach and humidity cells tests, including:

- Rapid determination of oxidation rates (usually 1–8 weeks) compared with column leach and humidity cell tests (usually many months to years).
- The ability to quantify acid neutralisation efficiencies.
- Lower cost due to significantly lower analytical costs and shorter test durations.
- Greater accuracy. Direct measurement of oxygen consumption is more accurate than the inference of pyrite oxidation rates based on measurement of leachate sulfate flux (the basis for column leach and humidity cell tests). Leachate sulfate often includes unquantifiable contributions from the dissolution of secondary minerals present in the sample (which can lead to an overestimate of the pyrite oxidation rate) and/or the precipitation of secondary sulfate minerals (which would lead to an underestimate of the pyrite oxidation rate).
- Short test times allow for repeat runs for greater confidence or for testing the influence of variables such as moisture content (influencing oxygen diffusion), oxygen concentration, particle size distribution, carbonate content, sulfide content, sulfide mineralogy, bacterial inoculation, and temperature.
- Small sample size (typically 2–5 kg) and suitability for scaling to larger or smaller samples with relative ease.
- No need for multiple laboratory analyses during testwork, only initial acid–base accounting data and final leachate chemistry are required.
- Ability to test site AMD management strategies (eg. optimum water cover thickness or various waste rock dump designs).

Sample preparation

The preparation of samples for OxCon testing is specific to each project and the goals of analysis. The sample can be submitted for OxCon testing as-received, or can be modified or segregated for more detailed investigations. Additional preparation can include:

- Drying and rewetting to specific gravimetric moisture content
- Segregation by grain size
- Crushing to specific grain size
- Homogenisation
- Splitting to prepare multiple identical samples
- Insertion of a water cover
- Inoculation with bactericides
- Assessment of performance of cover systems
- Quantify oxygen diffusion rates through materials



An array of OxCon modules

Testwork procedure

Prior to the OxCon test, a subsample of the supplied material is submitted for a suite of analyses in order to characterise the sample with respect to its static geochemical properties, chemistry and mineralogy. The suite of analyses is tailored for each sample and may typically include:

- Major and trace element chemistry for geochemical abundance index (GAI) and lithological abundance index (LAI) assessments
- Gravimetric moisture content (GMC)
- Sulfur speciation
- Acid neutralising capacity (ANC)
- Net acid generation ($NAG_{4.5}$ and $NAG_{7.0}$) and oxidation pH (NAG_{pH})
- Mineralogy by x-ray diffraction (XRD)
- Carbon speciation
- Acid buffering characteristic curve
- NAG leache analysis (as required)

Testwork involves isolating a known mass of sulfide-bearing material in a known volume of oxygen inside a hermetically sealed vessel and allowing pyrite oxidation to proceed.

Once the test is initiated, oxygen in the vessel is consumed via pyrite oxidation (see Reaction 1 on page 3). Oxygen consumption is measured directly on an hourly basis and logged over the testwork period (eg. 1-8 weeks). Carbon dioxide may be generated as a result of carbonate neutralisation reactions (see Reaction 2 on page 3) and/or bacterial metabolism of organic carbon (for acid sulfate soils or coal samples). Carbon dioxide generation is measured hourly and logged.

Once the oxidation testwork is complete, the sample is flushed with deionized water at a ratio of 1:1 on a dry weight bases and the leachate analysed for the following parameters:

- pH and electrical conductivity ;
- Acidity and/or alkalinity (as appropriate);
- Major ion and dissolved metal concentrations.

The chemistry of the leachate provides information on key elements of concern and trace element leach rates (using trace element chemistry results), and provides an independent estimate of pyrite oxidation rates based on sulfate flux and acidity/alkalinity released from the sample by leaching.

Oxidation and neutralisation reactions

The OxCon test is designed to directly measure the rate of oxygen consumption associated with the oxidation of pyrite. On exposure to oxygen and water, pyrite oxidises to form iron oxyhydroxides and sulfuric acid (sulfate and acid) by the following reaction:

Reaction 1: Pyrite oxidation

FeS_2	+	$^{15}/_4\,O_2$	+	$^{7}/_2\,H_2O$	→	$2\,SO_4^{2-}$	+	$4\,H^+$	+	$Fe(OH)_3$
pyrite		*oxygen*		*water*		*sulfate*		*acid*		*ferric hydroxide*

The acid produced by the oxidation of pyrite may subsequently be neutralised by carbonate minerals in the sample by the following reaction:

Reaction 2: Carbonate acid neutralisation

H_2SO_4	+	$CaCO_3$	→	Ca^{2+}	+	SO_4^{2-}	+	H_2O	+	$CO_{2\,(g)}\uparrow$
sulfuric acid		*calcium carbonate*		*calcium*		*sulfate*		*water*		*carbon dioxide*

Interpreting OxCon data

The measured oxygen consumption rate (OCR) is proportional to the mass of pyrite in the sample (see Figure 1) and is converted into a pyrite oxidation rate (POR) using the stoichiometry of Reaction 1 and the sample pyrite content. In this way, the oxygen consumption rate is normalised to the sample pyrite content.

The normalized POR can be expressed in units of weight percent of the remaining pyrite (equivalent) that oxidises to form sulfuric acid (equivalent) acidity per year (abbreviated as wt% FeS2/yr). Normalising the oxygen consumption rate to the sample pyrite content allows comparison of results amongst different samples and different variables tested, and also allows results to be applied directly to predict pollution generation rates for materials of similar geology with variable pyrite contents.

The POR is also reported in commonly used units of kilograms of oxygen consumed per tonne of material per second (kg O_2/t/s), and kilograms of sulfur oxidised per tonne of material per year (kg S/t/yr). Unlike the POR given in units of wt% FeS_2/yr, these alternative units are not normalised with respect to pyrite content and are applicable only to the sample under test.

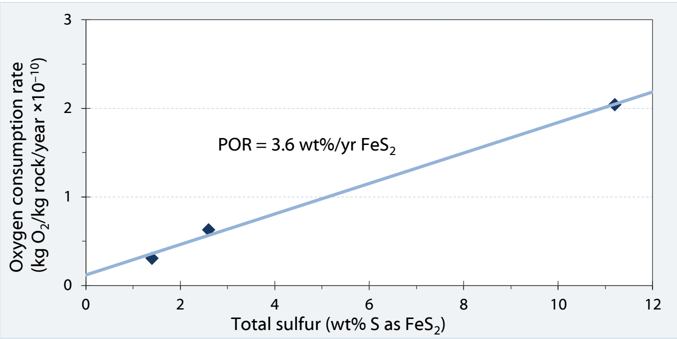


Figure 1: Example of the measured oxygen consumption rate (OCR) vs sample pyrite content for samples of the same rock with different sulfur contents. OCR is linearly related to sulfur content for different samples of the same rock type. The normalised pyrite oxidation rate (POR), in this case approximately 3.6 wt% FeS_2 per year, is an intrinsic property of the pyrite. Note that other sample physical properties such as particle size distribution and moisture content were constant in this example.

Applications of kinetic geochemical data

The primary application of kinetic geochemical data is to estimate the rate of pollution generation (acidity or salinity) from a waste material. Using the pyrite oxidation rate of a sulfidic material (normalized to the sulfur content, wt% FeS_2/yr) and the mass and average pyrite content of a bulk sulfidic waste material, it is possible to estimate the annual acidity generation rate of the material (kg H_2SO_4/t/yr).

For example, if 1 Mt of waste rock with an average pyrite content of 3 wt% FeS_2 and a pyrite oxidation rate of 0.5 wt% FeS_2/yr was exposed to atmospheric oxygen, the estimated acidity generation rate would be approximately 250 t H_2SO_4/yr for all the waste rock, or 0.25 kg of H_2SO_4 per tonne of waste rock each year. This information is vital for identifying high-risk materials and developing effective long-term AMD management or treatment strategies.

Pyrite oxidation rates obtained in the laboratory may vary considerably to those that occur in the environment due to a number of factors, including moisture content (which limits oxygen diffusion to reaction sites), particle size distribution (related to the surface area available to react with oxygen), sulfide mineral mineralogy, oxygen concentration, and temperature. The OxCon test can be used to develop relationships between the pyrite oxidation rate and one or more of these variables to enable more reliable estimates of real-world acidity generation rates. For example, pyrite oxidation rates can be determined for waste rock samples of various particle size fractions. These rates can be used with knowledge of the particle size distribution of waste rock on site to refine estimates of annual acidity generation rates.

Explanation of terms used in OxCon analytical reports

Physical parameters

Gravimetric moisture content (GMC): The relative mass of water in the tested sample, expressed as a percentage of the dry mass.

Sulfur speciation

Total sulfur: Total sample sulfur determined by Leco test.

Readily soluble acid-forming sulfate sulfur: A measure of sulfur present as minerals with relatively high solubility formed by prior oxidation of sulfide minerals and which release acid upon dissolution and oxidation (eg. melanterite).

Readily soluble non-acid-forming sulfate sulfur: A measure of sulfur present as relatively soluble minerals which do not contribute to acidity upon dissolution (eg. gypsum).

Sparingly soluble acid-forming sulfate sulfur: A measure of low solubility acidity storing sulfate minerals (eg. jarosite, alunite).

Sulfide sulfur: Sulfur in the form of sulfide minerals (eg. pyrite, pyrrhotite, chalcopyrite).

Equivalent pyrite content: The pyrite mass equivalent of sulfur, assuming all sulfur is present as pyrite.

Static geochemistry

Acid neutralising capacity (ANC): A measure of the potential acidity buffering capacity of the sample, typically due to the presence of calcium- and/or magnesium-bearing carbonate minerals. The ANC value assumes all of the carbonate material is available for acid neutralisation (kg H_2SO_4/t).

Maximum potential acidity (MPA): A calculation of the maximum amount of sulfuric acid (H_2SO_4) that could be produced if all sulfur in the sample (assumed to be sulfide) is oxidised. This is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/t).

ANC/MPA: The ratio of a samples acid neutralising capacity to its maximum potential acidity, which provides an indication of a samples ability to neutralise any acidity generated.

Net acid production potential (NAPP): A measure of the overall acid-generating potential of the sample, calculated by subtracting the ANC value from MPA (kg H_2SO_4/t).

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Net acid generation pH after oxidation (NAG_{pH}): The pH of a sample after oxidation with an excess of hydrogen peroxide.

Net acid generation to pH 4.5 ($NAG_{4.5}$): The equivalent acidity of a peroxide-oxidised sample titrated to pH 4.5 (kg H_2SO_4/t).

Net acid generation to pH 7.0 ($NAG_{7.0}$): The equivalent acidity of a peroxide-oxidised sample titrated to pH 7.0 (kg H_2SO_4/t).

AMD risk classification: The classification of a sample's potential AMD risk, based on conventional static geochemical parameters..

NMD risk classification: The classification of a sample's potential NMD risk, based on static geochemical parameters.

Salinity risk classification: The classification of a sample's potential saline drainage risk, based on static geochemical parameters.

Pseudo-kinetic test results

Acid buffering characteristic curve (ABCC): The ABCC test involves incremental addition of acid to a sample to determine the behaviour of acid-neutralising minerals. ANC4.5 values are extracted from this test and are considered to represent a more realistic ANC value for most materials than provided by the routine ANC test (see below).

Acid neutralisation capacity to pH 4.5 ($ANC_{4.5}$): Acid neutralisation capacity to pH 4.5 (ANC4.5): This parameter is extracted from ABCC leachate data by selecting the ANC value corresponding to the point at which ABCC leachate becomes acidic (achieves a pH = 4.5).

Acid conditions: A comparison of the maximum potential acidity (MPA) to the equivalent $ANC_{4.5}$ value. If MPA > $ANC_{4.5}$, acid conditions are likely to develop.

OxCon test results

Oxygen consumption rate (OCR): The rate of oxygen consumption due to pyrite oxidation in the sample as determined by the OxCon test, expressed in units of millimoles of oxygen gas (O_2) per kilogram of sample per day (mmol O_2/kg/day).

Major and trace element chemistry

Sample solids: The chemical composition of the solid sample as tested. All analyses are conducted by NATA-accredited laboratories and the results subject to replication and quality assurance.

NAG leachate: The chemical composition of leachate remaining after complete oxidation of the material in hydrogen peroxide. The results are reported as a 1:100 solid:water ratio.

OxCon leachate: The chemical composition of leachate obtained after bottle roll leach of the as-tested sample at a solid:water ratio of 1:1.

Pyrite oxidation and acidity generation rates

Pyrite oxidation rate (POR): The calculated rate of pyrite oxidation in the sample based on the measured OCR and equivalent pyrite content, expressed as a weight percentage of the available pyrite that oxidises each year (eg. a POR of 50 wt% FeS_2/yr indicates that half of the pyrite in the sample would be oxidised in one year). The POR does not take into account the effect of ANC or ANE (wt% FeS_2/yr).

Acidity generation rate (AGR): The rate of acidity generation by sulfide oxidation (kg H_2SO_4/t/yr). This rate is intrinsic to the tested sample and its sulfide content.

Net acidity generation rate (NAGR): An estimate of the net rate of acidity generation by a sample due to pyrite oxidation, accounting for neutralisation by $ANC_{4.5}$ (not ANC).

Estimated lag time to onset of acid conditions: A measure of the initial delay before the development of acid drainage based on the cumulative acidity generation and $ANC_{4.5}$ value.

Estimated peak NAGR: After the onset of acid conditions, acid drainage generation will peak before tapering off as pyrite is consumed by oxidation. The lag time to peak net acid generation and the peak rate of acid generation are estimated from the NAGR evolution curve (ie. using $ANC_{4.5}$).

Estimated half-life of reactive sulfide: The estimated time (in years) for half of the available pyrite in the sample to oxidise based on the POR.

Indicative longevity of sulfide oxidation: The duration of sulfide oxidation processes (and hence primary acid generation and water quality impacts) based on the decay of pyrite by oxidation over time.

Leachate chemistry

Electrical conductivity (EC): A measure of the salinity of the leachate sample.

Alkalinity: For alkaline leachate, the calcium carbonate ($CaCO_3$) equivalent total alkalinity of the sample including hydroxide, carbonate and bicarbonate alkalinity.

Acidity – measured: For acidic leachate, the free acid and mineral acidity of the sample as measured by titration with sodium hydroxide to pH 8.3.

Acidity – calculated: The total acidity of the leachate calculated from the pH and the hydrolysis of metals using the ABATES acidity calculation tool.

POR based on sulfate release: Calculated as the equivalent mass of pyrite oxidised to produce the observed flux of sulfate in leachate, expressed as a weight percentage of the available pyrite that oxidises each year. Provides an independent (but less accurate) measure of pyrite oxidation during the OxCon test, and can be affected by the presence of sulfate salts in the sample.