THOR MINING PLC

MOLYHIL PROJECT

GEOCHEMICAL CHARACTERISATION OF PROCESS-TAILINGS, PYRITE-CONCENTRATE AND MAGNETITE-CONCENTRATE SAMPLES

Implications for Process-Stream Management

GRAEME CAMPBELL AND ASSOCIATES PTY LTD
(ACN 061 827674)
FEBRUARY 2007
Job No. 0642

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SUMMARY OF TECHNICAL TERMS EMPLOYED IN THIS REPORT

ACRONYM	PARAMETER	DEFINITION/DETERMINATION	UNIT
AFP	Acid-Formation Potential		
ARD	Acid-Rock Drainage		
Total-S	Total Sulphur	Analysis Result	% (w/w)
Sulphide-S	Sulphide Sulphur	Testwork Result [i.e. Sulphide-S = Total-S - Sulphate-S]	% (w/w)
ANC	Acid-Neutralisation Capacity	Testwork Result	kg H_2SO_4/tonne
MPA	Maximum-Potential Acidity	Calculation	kg H_2SO_4/tonne
NAPP	Net-Acid-Producing Potential	Calculation	kg H_2SO_4/tonne
NAG	Net-Acid Generation	Testwork Result	kg H_2SO_4/tonne
NAF	Non-Acid Forming	Calculation: • Sulphide-S < 0.3 % • Sulphide-S ≥ 0.3 %, and negative-NAPP value with ANC/MPA ≥ 2.0	kg H_2SO_4/tonne
PAF	Potentially-Acid Forming	Calculation: • Sulphide-S ≥ 0.3 %, and any positive-NAPP value • Sulphide-S ≥ 0.3 %, and a negative-NAPP value with ANC/MPA < 2.0	kg H_2SO_4/tonne
PAF-[SL]	PAF-[Short-Lag]	Estimation [e.g. inferred from 'kinetic' testing]	
PAF-[LL]	PAF-[Long-Lag]	Estimation [e.g. inferred from 'kinetic' testing]	
SOR	Sulphide-Oxidation Rate	Testwork Result [e.g. obtained from 'kinetic' testing]	mg SO_4/kg/week,

Notes:

The **PAF-[SL]** classification applies to PAF-materials (e.g. mine-wastes, and/or process-tailings) that are initially circum-neutral, but acidify (viz. pH less than 5) within weeks-to-months when exposed, and subjected to an "aggressive-weathering" regime typical of well-watered environments (e.g. where unsaturated-conditions prevail for at least a few days [via drainage/evaporation processes] between successive infiltration/flushing episodes that, in turn, occur regularly [e.g. monthly rainfall patterns comprising 1-2+ major-raindays of 10+ mm "on-average" during most of the annual hydrological-cycle]). The occurrence of thin, dilute films of pore-fluids on sulphide-grain surfaces which are regularly flushed constitutes an aeration/moisture regime that is near-optimal for sulphide-oxidation. In such well-watered settings, surface-zones of exposed mine-wastes/process-tailings seldom experience total-suctions in excess of 1+ bars (i.e. 0.1+ MPa).

The **PAF-[LL]** classification applies to PAF-materials where exposure for years (even decades+) may be needed before acidification develops. Circum-neutral-pH during "lag-phase" weathering is chiefly due to "at-source" buffering by carbonate-minerals.

Climate directly influences "lag-phase" duration, and a sulphide-gangue assemblage classified as PAF-[SL] in well-watered settings where the SOR is controlled by **O_2-supply**, may instead be classified as PAF-[LL] in water-limited settings where the SOR is controlled by **H_2O-supply** in terms of both total-suction, and infrequency of "flushing-episodes" (Campbell 2004, 2006). The formation of "secondary-oxidation-products" (e.g. Fe-oxyhydroxides) as indurated, and tightly adhering/cohering deposits, is typically enhanced during "lag-phase" weathering in water-limited settings, and is a further mechanism by with sulphide-oxidation is stifled under the ensuing "mild" weathering-regime. Surface-zones of exposed mine-wastes/process-tailings in such environments are typically characterised by total-suctions well in excess of 1 bar for most of the year. At high total-suctions, even the physical meaning of pore-fluid "films" becomes tenuous.

1.0 INTRODUCTION

Thor Mining PLC is developing the Molyhil Project located *c.* 240 kms to the north-east of Alice Springs, Northern Territory.

Ore will be treated in the mill for recovery of molybdenum- and tungsten-minerals, and will result in various streams of process-tailings and by-products (viz. General-Plant-Tailings, Pyrite-Concentrate, and Magnetite-Concentrate). The former two streams will be handled as slurries, and contained on-site either in separate (engineered) tailings-storage facilities (TSFs), or in a single TSF, corresponding to the mixing of the General-Plant-Tailings and Pyrite-Concentrate (i.e. Combined-Tailings). Adoption of either a one-, or two-TSF, option will be influenced by *inter alia* geochemical considerations, especially the measures required for the secure, longer-term containment of pyritic-solids. The Magnetite-Concentrate is also to be contained on-site.

Graeme Campbell & Associates Pty Ltd (GCA) was commissioned to carry out geochemical testwork on slurry samples of the **General-Plant-Tailings**, **Pyrite-Concentrate**, and **Combined-Tailings**. In addition, testing was undertaken on a dry sample of **Magnetite-Concentrate**.

The 'Static-Testwork' Programme focused on the Acid-Formation Potential (AFP), Multi-Element Composition, and Mineralogy of the tailings-solids and concentrate-solids samples.[1] In addition, the quality (viz. major/minor-ion chemistry, and reduced-inorganic-S forms [i.e. "thiosalts"]) of the process-tailings-slurry-water, and pyrite-concentrate-slurry-water, samples was determined.

The testwork results are presented and discussed in this report, and implications for process-stream management highlighted.

[1] A 'Static-Testwork' Programme comprises "whole-rock" analyses and tests.

2.0 STUDY APPROACH

Details of the sampling and testwork programmes, and the calculations and criteria employed for classifying the process-tailings-solids and concentrate-solids samples into AFP categories, are presented and discussed in the following sections.

2.1 Testwork Programme

2.1.1 Samples

The samples submitted to GCA for testing are derived from a pilot-plant-metallurgical study (see Appendix A).

General-Plant-Tailings

The slurry sample of this process-stream was provided in a 20-L, translucent-plastic-pail that was half-filled with slurry. The height of the tailings-solids was approximately one-half of the total-slurry height. The supernatant (viz. tailings-slurry-water) overlying the tailings-solids was decanted via siphoning, vacuum-filtered (0.45-µm-membrane), and preserved for specific analyses.[2] The 'sludge' of tailings-solids was dewatered via vacuum-filtration using a Whatman-No.-2-filter-paper. The tailings-solids were not washed prior to testing.

Pyrite-Concentrate

The slurry sample of this process-stream was provided in a 20-L, translucent-plastic-pail that was two-thirds-filled with slurry. The height of the concentrate-solids was approximately one-sixth of the total-slurry height. The supernatant overlying the concentrate-solids was decanted via siphoning, vacuum-filtered, and preserved for specific

[2] A sub-sample of the 'raw-filtrate' was employed for the analysis of major-parameters, and reduced-inorganic-S forms. A HNO_3-dosed filtrate was subjected to multi-element analyses. The determination of NO_3-N and NH_3-N was performed on a H_2SO_4-dosed filtrate.

analyses, as above. Likewise, the 'sludge' of concentrate-solids was dewatered via vacuum-filtration, as above. The concentrate-solids were not washed prior to testing.

Combined-Tailings

The slurry sample of this process-stream was provided in a 20-L, translucent-plastic-pail that was one-thirds-filled with slurry. The height of the tailings-solids was approximately one-third of the total-slurry height. The supernatant overlying the tailings-solids was decanted via siphoning, vacuum-filtered, and preserved for specific analyses, as above. Likewise, the 'sludge' of tailings-solids was dewatered via vacuum-filtration, as above. The concentrate-solids were not washed prior to testing.

Magnetite-Concentrate

This sample was provided as a dry-powder in a 5-L, opaque-plastic-pail, and was not washed prior to testing.

2.1.2 Testwork

The testwork methods employed in this study are based on recognised procedures for the geochemical characterisation of mine-waste materials, process-liquors and natural-waters (e.g. AMIRA 2002; Morin and Hutt 1997; Smith 1992; Coastech Research 1991; BC AMD Task Force 1989; APHA 1992).

Details of the testwork methods are presented in Appendix B.

Part of the testwork was carried out by Genalysis Laboratory Services [GLS] (Maddington), and SGS Environmental Services [SGS] (Welshpool). The analyses performed by GLS and SGS have NATA endorsement.[3]

[3] NATA = National Association of Testing Authorities.

Specialised testing (viz. auto-titrations and Net-Acid-Generation [NAG] Tests) was undertaken by Dr. Graeme Campbell in the GCA Testing-Laboratory (Bridgetown).

The mineralogical work was performed by Dr. Roger Townend of Roger Townend & Associates (Malaga).

Copies of the laboratory and mineralogical reports are presented in Appendix C.

2.2 Calculated Parameters

The Maximum-Potential-Acidity (MPA) values (in kg H_2SO_4/tonne) of the tailings-solids and concentrate-solids samples were calculated by multiplying the Sulphide-S values (in %) by 30.6. The multiplication-factor of 30.6 reflects both the reaction stoichiometry for the complete- oxidation of pyrite by O_2 to "$Fe(OH)_3$" and H_2SO_4, and the different weight-based units of % and kg H_2SO_4/tonne. The stoichiometry of pyrrhotite-oxidation is discussed further in Appendix B.

The Net-Acid-Producing-Potential (NAPP) values (in kg H_2SO_4/tonne) were calculated from the corresponding MPA and Acid-Neutralisation-Capacity(ANC) values (i.e. NAPP = MPA - ANC).

2.3 Classification Criteria

In terms of AFP, mine-waste materials may be classified into one of the following categories, viz.

- Non-Acid Forming (NAF).
- Potentially-Acid Forming (PAF).

There are **no** unifying, "standard" criteria for classifying the AFP of mine-waste materials (Campbell 2002a,b; Smith 1992), and reflects the diversity of sulphide and gangue-mineral assemblages within (un)mineralised-lithotypes of varying weathering- and alteration-status. Rather, criteria for classifying AFP may need to be tailored to deposit-specific geochemistry, and mineralogy.

The AFP-classification criteria often employed at mining-operations worldwide are:

- **NAF**: Sulphide-S < 0.3 %. For Sulphide-S ≥ 0.3 %, both a negative NAPP value, and an ANC/MPA ratio ≥ 2.0.

- **PAF**: For Sulphide-S ≥ 0.3 %, any positive-NAPP value; negative-NAPP value with an ANC/MPA ratio < 2.0.

In assessing the AFP of mine-waste materials, there is general consensus that lithotypes with Sulphide-S contents less than 0.3 % are unlikely to oxidise at rates fast enough to result in acidification (e.g. pH less than 4-5) [Soregaroli and Lawrence 1997]. This position assumes that the groundmass hosting such "trace-sulphides" is not simply quartz, and/or clays (Price *et al.* 1997), and that for a carbonate-deficient gangue, the sulphides are not unusually reactive (e.g. sulphide-oxidation rates [SORs] less than *c.* 20-40 mg SO_4/kg/week) [= *c.* 1-2 kg SO_4/tonne/year].[4] A "cut-off" of 0.3 % for Sulphide-S also accords with the findings of 'kinetic' testing conducted, since the late-1980s, by Dr. Graeme Campbell for mine-waste samples of diverse mineralogy in terms of AFP.

[4] Although 'steady-state' SORs (at circum-neutral-pH) for Sulphide-S contents less than 0.3 % may indeed exceed 1-2 kg SO_4/tonne/year, such rates are generally restricted to either sedimentary forms (e.g. framboidal-pyrite), or hydrothermal-sulphides that are atypically reactive.

The ANC/MPA criteria for the NAF category reflects the need to compensate for "less-than-perfect" availability of alkalinity-forms (e.g. carbonates) for neutralisation of acid produced through pyrite-oxidation. A "less-than-perfect" availability of alkalinity-forms may arise from:

(a) Restricted accessibility of acid to carbonate-grains.

(b) Rate-limiting dissolution of carbonates-grains near pH=7.

(c) Depletion of carbonate-minerals through rainfall-fed leaching within waste-dumps.[5]

Restricted accessibility of acid to the surfaces of carbonate-grains may occur at different spatial-scales (viz. at the "whole-rock-scale" in which Acid-Rock Drainage [ARD] "by-passes" carbonate-bearing materials via preferential-flow pathways within a waste-dump, and at the "pore/grain-scale" in which the surfaces of individual carbonate-grains are "blinded/rimmed" by precipitates of Fe(III)-oxyhydroxides [e.g. ferrihydrite-type phases]). As shown by Li (1997), ferroan-carbonates (especially "Fe-rich" varieties) are prone to "surface-armouring/rimming" during dissolution: weathering of tailings-solids containing pyrite, ankerites and Mg-siderites produced acidic leachates when less than one-third of the carbonate-grains had dissolved.

To compensate for the effects of (a) to (c) above, some authors advocate that, for a mine-waste sample to be classified as NAF, it must have an ANC/MPA ratio of at least 3.0 (see review of earlier literature by Smith [1992]). In recent years, fundamental-research (especially estimation of reaction-rates for diverse sulphide/gangue-mineral assemblages), and field-experience at mining operations world-wide, have shown that the potential for ARD production is very low for mine-waste materials with ANC/MPA ratios greater than 2.0 (AMIRA 2002; Price *et al.* 1997, Currey *et al.* 1997, and Murray

[5] Depletion of carbonate-minerals through dissolution in meteoric-waters is minimal in semi-arid settings, especially within the "hydrologically-active-zone" (e.g. top 2-3 m) of a waste-dump, since re-precipitation occurs during evapo-concentration when desiccating conditions return after "wet-spells".

et al. 1995).[6] This ANC/MPA ratio is employed in the present work.[7]

The risk posed by handling PAF-lithotypes during the working of a deposit is governed primarily by the duration of the "lag-phase" (i.e. the period during which sulphide-oxidation occurs, but acidification does not develop, due to buffering near pH=7 by gangue-phases).[8] Although the lag-phase applicable to exposed mine-wastes at "field-scale" cannot be accurately predicted *a priori*, estimates (albeit approximate) are still needed to identify the exposure-times for the safe handling of PAF-lithotypes, and so reduce the risk for ARD production. Estimates of the lag-phase are invariably obtained through programmes of kinetic-testing (viz. Weathering-Columns). However, based on experience, 'first-pass' estimates of the lag-phase may be made, and thereby used to further classify PAF-lithotypes into **PAF-[Short-Lag]** and **PAF-[Long-Lag]** sub-categories. Such 'first-pass' estimates are necessarily provisional, and subject to revision, in the light of the outcomes of kinetic-testing, and field observations.

[6] Such ANC/MPA ratios are consistent with those indicated from SORs, and carbonate-depletion rates, as reported in the International-Kinetic Database for mine-waste materials from around the world (Morin and Hutt 1997).

[7] It should be noted that mining-regulators in Nevada (USA) classify a mine-waste sample as NAF, if it is characterised by an ANC/MPA ratio greater than 1.2 (US EPA 1994). This lower ANC/MPA ratio reflects the semi-arid conditions typically encountered at mine-sites in Nevada. Although utilised in the early-1990s, it is understood that an ANC/MPA ratio of 1.2 is still entertained by regulators in Nevada for "screening" PAF and NAF varieties of mine-wastes in semi-arid settings.

[8] SO_4 is still produced by sulphide-oxidation during the lag-phase, and soluble-forms of minor-elements (e.g. As) may be released at circum-neutral-pH during mine-waste weathering.

3.0 GEOCHEMISTRY OF PROCESS-TAILINGS AND PYRITE-CONCENTRATE SAMPLES

3.1 Acid-Base Chemistry of Tailings-Solids and Concentrate-Solids Samples

The testwork results on the acid-base chemistry of the samples are presented in Table 3.1, and shown on Figure 1.

The testwork results show clearly that:

(a) the General-Plant-Tailings-Solids are classified as NAF, due to "trace-sulphides" (chiefly pyrite) in a gangue with "trace/accessory-calcite";

(b) the Pyrite-Concentrate-Solids are classified as PAF, as expected; and,

(c) the Combined-Tailings-Solids are classified as PAF, due to "accessory-sulphides" (chiefly pyrite) in a gangue containing "trace-calcite".

If the sulphide-minerals are not atypically unreactive, then the Pyrite-Concentrate-Solids may be further classified as PAF-[Short-Lag]. Although difficult to project accurately, the surface-zone (e.g. top cm-to-dm) of the tailings-bed in the TSF may acidify (viz. Mud-pH less than 4-5) after only a few flushings from episodic major-raindays (e.g. 5-10+ mm/day), where the tailings-beaches have previously reached the shrinkage-limit (and so now susceptible to desaturation by evaporative-drying). The "window" of such lag-phase (i.e. circum-neutral) weathering should amount to several weeks+ following cessation of tailings-discharge to the active-deposition-area, as governed by both the time required for the beached-tailings to attain the shrinkage-limit, and the distribution of major-raindays during the post-shrinkage-limit stage. It should be noted that these lag-phase-duration projections are 'first-pass' estimations only – quantitative data on sulphide-mineral reactivity would need to be obtained from kinetic-testwork (viz. Weathering-Columns) in order to refine these initial estimations.

If the sulphide-minerals are not atypically reactive, then the Combined-Tailings-Solids may be further classified as PAF-[Long-Lag]. Although again difficult to project accurately, the surface-zone (e.g. top cm-to-dm) of beached-tailings which are beyond the shrinkage-limit may remain circum-neutral for months-to-years. Information from kinetic-testing would be needed to refine this 'first-pass' estimation.

3.2 Multi-Element Composition and Mineralogy of Tailings-Solids and Concentrate-Solids Samples

The multi-element composition and mineralogy of the samples are indicated by the data presented in Table 3.2.[9] The corresponding element-enrichments in the sample, as indicated by the values of the Geochemical-Abundance Index (GAI), are also presented in Table 3.2.[10] It should be noted that these element-enrichments are relative enrichments, based on the element contents typically recorded for unmineralised soils, regoliths and bedrocks (Bowen 1979).

The samples were variously enriched in an array of chalcophyles (viz. As, Bi, Sb, Se, Mo, Ag, Cu, Pb, Co, Sn, U, and W (Table 3.2). The degree of element-enrichment correlates with the Sulphide-S values, as expected. The sulphide-mineral suites were dominated by pyrite over chalcopyrite, and traces of calcite were detected in all samples (Table 3.3).

The analysis results indicate that the samples were all variously enriched in an array of chalcophyles. However, the degree of minor-element enrichment was not marked.

[9] The suite of elements listed in Table 3.2 is grouped into (a) the major-elements (viz. Na, K, Mg, Ca, Al and Fe) making-up the lattices of primary-silicates, sulphides, clays, sesquioxides and carbonates, and (b) minor-elements. A distinction is made between minor-elements which, under neutral-to-alkaline conditions, occur (i) as cationic-hydrolysis forms (e.g. Cu), and (ii) as anions/oxyanions (e.g. As). Anionic forms may exhibit moderate solubility under neutral-to-alkaline conditions.

[10] The GAI is defined in Appendix B.

3.3 Quality of Tailings-Slurry-Water and Concentrate-Slurry-Water Samples

The analysis results for the process-stream-water samples are presented in Table 3.4.

The concentrations of minor-elements were below, or close to, the respective detection-limits (Table 3.4). The low concentrations of soluble metals attest to the efficiency of metal-sorption reactions under neutral-to-alkaline conditions (Sposito 1984).[11] Tetrathionate was the main thiosalt in the slurry-water of the Pyrite-Concentrate sample.

The analysis results indicate that the slurry-waters in the 'ex-mill-process-streams' should be mildly-alkaline (viz. pH 8+/-) with a near-potable salinity, and low concentrations (e.g. within the sub-mg/L range) of minor-elements.

[11] Sorption reactions include both adsorption and precipitation reactions (Sposito 1984).

4.0 GEOCHEMISTRY OF MAGNETITE-CONCENTRATE SAMPLE

The testwork results for the Magnetite-Concentrate sample are presented in Tables 4.1-4.4.

The Magnetite-Concentrate-Solids are classified as PAF, due to "minute/trace-pyrite" in a "gutless-gangue" in terms of circum-neutral buffering (i.e. devoid of carbonate-minerals). Minor-element enrichment is restricted to W and Mo. The contents of water-extractable solutes in the "fresh" Magnetite-Concentrate-Solids are low, and reflects both low total-element contents, and a mildly-alkaline (viz. pH 8-9) state.

5.0 MANAGEMENT IMPLICATIONS

Based on the testwork results obtained in this study, geochemical implications for management of the process-streams are outlined in the following sections. It is necessarily assumed that the samples submitted for testing herein provide a useful geochemical working-model for the respective process-streams to be produced in the full-scale-mill.

5.1 General-Plant-Tailings and Pyrite-Concentrate

Due to insufficient calcite in the General-Plant-Tailings, there would seem limited geochemical benefit to be gained by generating a Combined-Tailings stream, since this stream is classified as PAF, albeit with only "accessory-sulphides", and a gangue that is at least partly calcareous (i.e. extended lag-phase under the water-limited conditions of the mine-site).

Production of a Combined-Tailings means that infiltration-control via a store/release-cover system would need to be effected over a maximum surface-area, compared with that for the Pyrite-Concentrate alone (see below), and so has economic implications.

General-Plant-Tailings-Storage Facility (GP-TSF)

The indications are that the General-Plant-Tailings-Solids should be hospitable to plant growth, so that a final-cover for the GP-TSF at closure should only need to comprise a thin veneer (e.g. few decimetres?) of topsoil mixed with clasts (e.g. gravelly/cobbly-regoliths, and/or [benign] waste-bedrocks) for both erosion control, and to dusting prevention. Agronomic-type advice should be sought to better assess the suitability, or otherwise, of the General-Plant-Tailings-Solids as a rooting-medium for the woody-shrubs and herbaceous-species endemic to the mine-site region. Likewise, engineering advice should be sought to assess TSF-cover-design options. A tailings-bed profile

which is free-draining (i.e. without a membrane-liner) should be adequate for the GP-TSF.

Should the Magnetite-Concentrate (classified as PAF, due to "trace-pyrite") be co-disposed with the General-Plant-Tailings (see below), then it should concentrate near the spigotted-discharge points, due to its high specific-gravity. If the resulting beach-heads in the GP-TSF are enriched in the Magnetite-Concentrate, then there may be implications for covering the peripheral portion of the tailings-bed-upper-surface (e.g. thicker cover for infiltration-control).

Pyrite-Concentrate-Storage Facility (PCSF)

A dedicated facility for containing the Pyrite-Concentrate should be membrane-lined, and be sized in a manner which minimises the final thickness of the concentrate-bed in the filled-PCSF. The decommissioned-PCSF needs to have a modest height, so that rainfall from peak-storms mostly reports as controlled-runoff, thereby minimising the risk of "hydraulically-overloading" the capacity of the store/release-cover system required for infiltration-control. An approach of this kind must ensure that the PCSF-cover permits controlled-runoff without scouring over the longer-term. An 'over-engineered' cover system for the PCSF is recommended, and will require information on *inter alia* the water-retention properties of the soils, regoliths and bedrocks available as candidate-cover materials, together with modelling to assess PCSF-cover thickness for infiltration-control under atmospheric-forcing, etc. It is understood that soil (e.g. some form of *red-earth*) and friable-regolith materials which are pivotal to store/release-cover systems are likely in short supply at the mine-site (Mr Aaron King, *pers. commun.*). Provisionally, it is estimated that the capacity of the PCSF-cover to retain water against gravity will need to be at least 100-150 mm, and so may correspond to a cover-thickness of at least 1 m, as governed by water-retention properties, etc.

5.2 Magnetite-Concentrate

At the time of commencing this study, the Magnetite-Concentrate was to be produced as a dry by-product for on-site containment. However, it is understood that the flow-sheet for the Project has since changed, and that now the Magnetite-Concentrate will be handled as slurry (Mr Aaron King, *pers. commun.*). One possibility is to co-dispose the slurry of Magnetite-Concentrate with the slurry of General-Plant-Tailings, as alluded to above.

If friable/earthy materials for store/release-cover systems at the mine-site prove to be in short supply, then it may be possible to use the Magnetite-Concentrate as a basal-layer in such systems to assist in infiltration-control (e.g. cover on PCSF). However, to be suitable as a rooting-medium, the Magnetite-Concentrate would likely need to be first amended with small amounts of crushed limestone, calcrete, etc. Further work would be needed to assess the merits, or otherwise, of incorporating the Magnetite-Concentrate into cover-profiles for infiltration-control.

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TABLES

Table 3.1: Acid-Base-Analysis and Net-Acid-Generation Results for Process-Tailings-Solids and Pyrite-Concentrate-Solids Samples

GCA-SAMPLE NO.	SAMPLE TYPE	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	AFP CATEGORY
						kg H_2SO_4/tonne				
GCA6547	General-Plant-Tailings	0.22 (0.26)	0.02 (<0.01)	0.25	0.26	48 (46)	-38	<0.5	7.9	NAF
GCA6548	Pyrite-Concentrate	30.1	0.08	30.1	0.21	32	890	480	2.2	**PAF**
GCA6549	Combined-Tailings	3.4	0.04	3.4	0.20	49	56	36	2.9	**PAF**

Notes:
ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; AFP = Acid-Formation Potential; NAF= Non-Acid Forming;
PAF = Potentially-Acid Forming; NAG = Net-Acid Generation.
All results expressed on a dry-weight basis, except for NAG-pH.
Values in parentheses represent duplicates.

Table 3.2: Multi-Element-Analysis Results for Process-Tailings-Solids and Pyrite-Concentrate-Solids Samples

Note: Refer Appendix B for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL-ABUNDANCE	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	General-Plant-Tailings (GCA6547)	Pyrite-Concentrate (GCA6548)	Combined-Tailings (GCA6549)	(mg/kg or %)	General-Plant-Tailings (GCA6547)	Pyrite-Concentrate (GCA6548)	Combined-Tailings (GCA6549)
Al	4.5%	2.5%	4.1%	8.2%	0	0	0
Fe	19.9%	32.6%	22.7%	4.1%	2	2	2
Na	0.86%	0.52%	0.78%	2.3%	0	0	0
K	1.1%	0.42%	0.97%	2.1%	0	0	0
Mg	1.4%	0.65%	1.3%	2.3%	0	0	0
Ca	8.8%	2.7%	7.8%	4.1%	1	0	0
Ag	0.3	0.6	0.5	0.07	2	**3**	2
Cu	150	1,800	340	50	1	**5**	2
Zn	120	150	120	75	0	0	0
Cd	0.3	0.6	<0.1	0.11	1	2	0
Pb	20	230	45	14	0	**3**	1
Cr	54	45	57	100	0	0	0
Ni	62	310	50	80	0	1	0
Co	27	1,200	150	20	0	**5**	2
Mn	2,000	800	1,900	950	0	0	0
Hg	0.04	0.12	0.07	0.05	0	1	0
Sn	110	30	110	2.2	**5**	**3**	**5**
Sr	38	19	33	370	0	0	0
Ba	96	37	87	500	0	0	0
Th	16	7.9	15	12	0	0	0
U	24	58	28	2.4	**3**	**4**	**3**
Tl	0.47	3.1	0.84	0.6	0	2	0
W	820	1,400	1,200	1	**3**	**3**	**3**
V	38	7	36	160	0	0	0
As	16	38	16	1.5	**3**	**4**	**3**
Bi	4.7	3.7	5.6	0.048	**6**	**6**	**6**
Sb	9.0	0.62	8.0	0.2	**5**	1	**5**
Se	0.03	2.6	0.28	0.05	0	**5**	2
Mo	57	940	190	1.5	**5**	**6**	**6**
B	<50	<50	<50	10	0	0	0
P	740	190	750	1,000	0	0	0
F	600	280	590	950	0	0	0

Note: Average-crustal abundance of elements based on Bowen (1979).

Table 3.3: Mineralogical Results for Process-Tailings-Solids and Pyrite-Concentrate-Solids Samples

General-Plant-Tailings (GCA6547)		Pyrite-Concentrate (GCA6548)		Combined-Tailings (GCA6549)	
Component	**Abundance**	**Component**	**Abundance**	**Component**	**Abundance**
		pyrite	dominant		
quartz garnet clinopyroxene	major			quartz magnetite	major
magnetite	minor	magnetite	minor	garnet	minor
plagioclase K-feldspar	accessory	quartz garnet clinopyroxene plagioclase K-feldspar hematite	accessory	**pyrite** clinopyroxene hornblende plagioclase K-feldspar muscovite hematite	accessory
pyrite **chalcopyrite** **calcite** hematite cassiterite wolfram	trace	**chalcopyrite** **molybdenite** **calcite** scheelite wodginite	trace	**chalcopyrite** **calcite** biotite scheelite Mn-tantalite	trace

Notes:

dominant = greater than 50 %; major = 20-50%; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %.

Table 3.4: Analysis Results for Process-Tailings-Slurry-Water and Pyrite-Concentrate-Slurry-Water Samples

Note: All results in mg/L, except for pH and EC (µS/cm).

ELEMENT/ PARAMETER	General-Plant-Tailings (GCA6547)	Pyrite-Concentrate (GCA6548)	Combined-Tailings (GCA6549)	ELEMENT/ PARAMETER	General-Plant-Tailings (GCA6547)	Pyrite-Concentrate (GCA6548)	Combined-Tailings (GCA6549)
Major-Parameters				***Minor-Ions***			
pH	8.3	8.1	8.2	Fe	<0.01	<0.01	<0.01
EC [µS/cm]	810	1,300	900	Cu	0.05	0.06	<0.01
TDS(gravimetric)	470	940	570	Ni	<0.01	0.01	<0.01
				Zn	0.09	0.05	0.02
Major-Ions				Co	0.0005	0.018	0.0003
Na	70	60	69	Al	0.03	<0.01	<0.01
K	5.7	9.5	5.8	Cd	0.00042	0.00010	0.00011
Mg	49	65	54	Pb	0.0011	0.0011	0.0015
Ca	56	160	73	Cr	<0.01	<0.01	<0.01
Cl	76	110	74	Hg	<0.0001	<0.0001	<0.0001
SO_4	61	350	120	As	0.0053	0.0053	0.0062
HCO_3	300	310	360	Sb	0.0015	0.0029	0.0014
CO_3	2	<1	<1	Bi	<0.000005	<0.000005	<0.000005
OH	<5	<5	<5	Se	0.0024	0.0026	0.0023
				B	0.11	0.11	0.10
Nitrogen-Forms				Mo	0.099	0.088	0.13
NH_3-N	0.2	0.8	0.3	P	<0.1	<0.1	<0.1
NO_3-N	0.21	0.39	0.12	F	0.9	0.6	0.8
				Ag	<0.00001	<0.00001	<0.00001
Reduced-S Forms				Ba	0.020	0.053	0.025
SO_3	<10	<10	<10	Sr	0.20	0.34	0.23
S_2O_3	2.8	7.0	<0.2	Tl	0.00013	0.00020	0.00006
S_3O_6	<2	<2	<2	V	<0.01	<0.01	<0.01
S_4O_6	<10	72	<10	W	0.074	0.029	0.046
S_5O_6	<5	5.6	<5	Sn	0.0010	0.0011	0.0006
SCN	<1	<1	<1	U	0.093	0.39	0.13
Monosulphide-S	0.017	0.16	0.016	Th	<0.000005	<0.000005	<0.000005
				Mn	0.03	0.46	0.09

Note:
EC = Electrical Conductivity; TDS = Total-Dissolved Solids; SO_3 = sulphite; S_2O_3 = thiosulphate; S_3O_6 = trithionate; S_4O_6 = tetrathionate; S_5O_6 = pentathionate; and, SCN = thiocyanate.

Table 4.1: Acid-Base-Analysis and Net-Acid-Generation Results for Magnetite-Concentrate Sample

GCA-SAMPLE NO.	SAMPLE TYPE	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	AFP CATEGORY
						kg H_2SO_4/tonne				
GCA6550	Magnetite-Concentrate	0.11	<0.01	0.11	0.03	1	2.4	0.8 (1.0)	4.6 (5.4)	**PAF**

Notes:
ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; AFP = Acid-Formation Potential; PAF = Potentially-Acid Forming; NAG = Net-Acid Generation.
All results expressed on a dry-weight basis, except for NAG-pH.
Values in parentheses represent duplicates.

Table 4.2: Multi-Element-Analysis Results for Magnetite-Concentrate Sample

Note: Refer Appendix B for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)	AV.-CRUSTAL ABUNDANCE	GEOCHEMICAL-ABUNDANCE INDEX (GAI)
	GCA6550	(mg/kg or %)	GCA6550
Al	0.19%	8.2%	0
Fe	66.3%	4.1%	**3**
Na	0.018%	2.3%	0
K	0.018%	2.1%	0
Mg	0.079%	2.3%	0
Ca	0.17%	4.1%	0
Ag	0.1	0.07	0
Cu	32	50	0
Zn	25	75	0
Cd	0.3	0.11	1
Pb	6	14	0
Cr	83	100	0
Ni	16	80	0
Co	13	20	0
Mn	290	950	0
Hg	0.02	0.05	0
Sn	8.8	2.2	1
Sr	1.4	370	0
Ba	2.7	500	0
Th	0.36	12	0
U	5.6	2.4	1
Tl	0.10	0.6	0
W	330	1	**6**
V	82	160	0
As	<1	1.5	0
Bi	0.12	0.048	1
Sb	0.13	0.2	0
Se	0.02	0.05	0
Mo	17	1.5	**3**
B	<50	10	0
P	170	1,000	0
F	180	950	0

Note: Average-crustal abundance of elements based on Bowen (1979).

Table 4.3: Mineralogical Results for Magnetite-Concentrate Sample

GCA6550	
Component	**Abundance**
magnetite	dominant
pyrite	trace
scheelite	
quartz	
garnet	
hematite	

Notes:

dominant = greater than 50 %; and, trace = less than 2 %.

Table 4.4: Water-Extraction-Testwork Results for Magnetite-Concentrate Sample

Note: All results in mg/L, except for pH and EC (µS/cm).

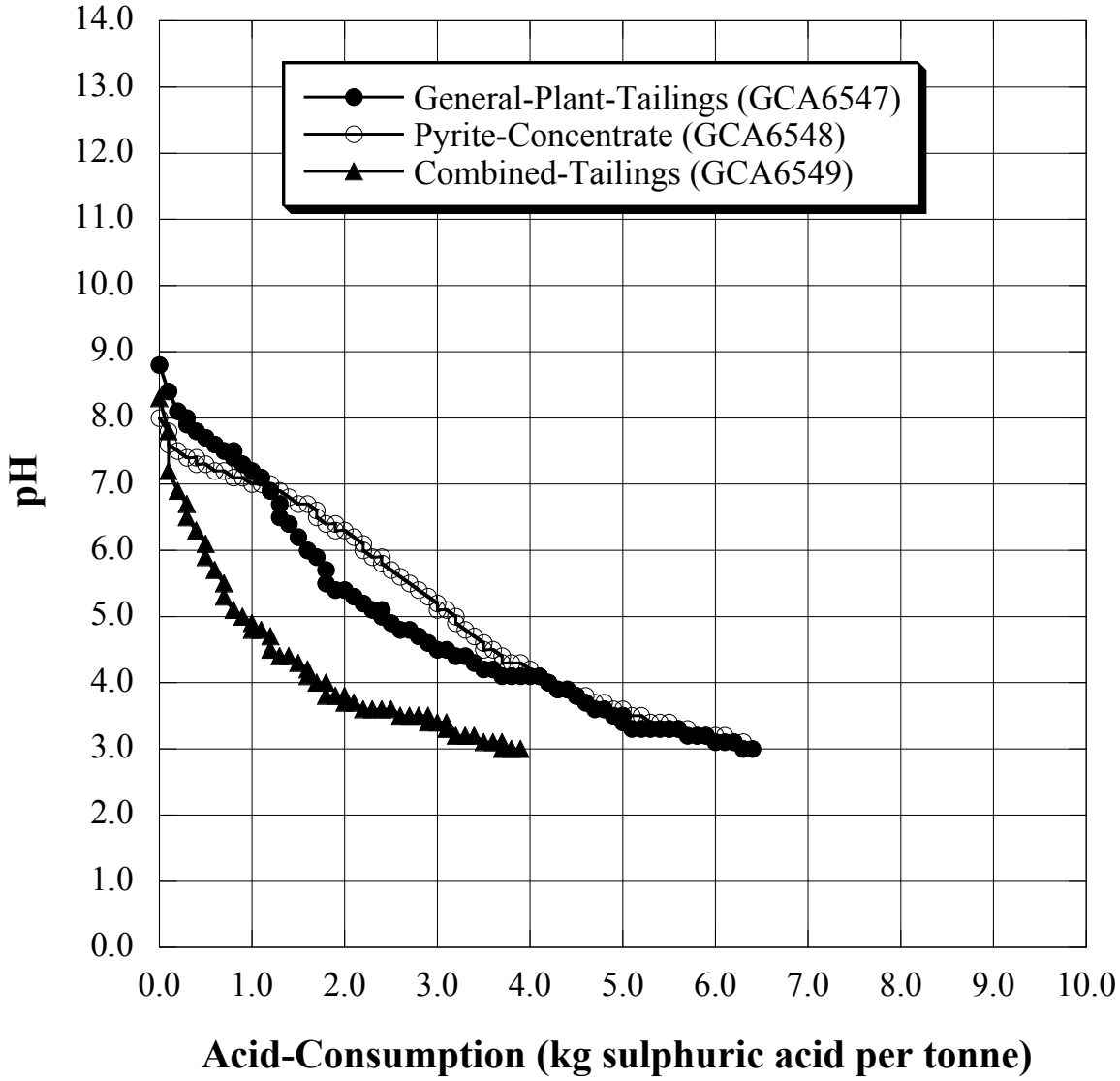
ELEMENT/ PARAMETER	Water-Extract (GCA6550)	ELEMENT/ PARAMETER	Water-Extract (GCA6550)
Major-Parameters		***Minor-Ions***	
pH	8.8	Fe	2.9
EC [µS/cm]	99	Cu	0.11
		Ni	<0.01
Major-Ions		Zn	0.03
		Co	0.0017
Na	8.6	Al	1.3
K	0.6	Cd	0.00018
Mg	1.4	Pb	0.0087
Ca	11	Cr	<0.01
Cl	11	Hg	0.0004
SO_4	9	As	0.0021
		Sb	0.00033
		Bi	0.00015
		Se	<0.0005
		B	<0.01
		Mo	0.057
		P	0.1
		Ag	0.00004
		Ba	0.0080
		Sr	0.015
		Tl	0.00001
		V	<0.01
		W	0.45
		Sn	0.0007
		U	0.0035
		Th	0.00020
		Mn	0.05

Notes:
Water-Extraction Testwork employed slurries prepared from the dry magnetite-concentrate and deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w). Slurries were bottle-rolled for *c.* 1 day, prior to obtaining water-extracts (via vacuum-filtration) for analysis.

FIGURE

Figure 1

pH-Buffering Curves for Process-Tailings-Solids and Pyrite-Concentrate-Solids Samples



Note: The H_2SO_4-addition rates employed in the auto-titrations correspond to sulphide-oxidation rates (SORs) of *c.* 2-3 x 10^3 mg SO_4/kg/flush (= *c.* 10^2 kg H_2SO_4/tonne/year for weekly flushing-drying-cycles) under weathering conditions near-optimal for sulphide-oxidation (viz. typical moisture/aeration-regimes, on a weekly basis, in which sulphide-oxidation is limited by neither the O_2-supply [via diffusion], nor H_2O-supply/flushing).

Given the Sulphide-S values of the General-Plant-Tailings-Solids and Combined-Tailings-Solids samples, these SORs are up to 10^2-10^3 **faster** than those typical for the circum-neutral weathering, under near-optimal conditions, of mine-waste materials that contain "trace/accessory-sulphides" that are not atypically reactive (e.g. framboidal-pyrites, and marcasites). In the case of the Pyrite-Concentrate, these SORs are 'of-the-order' expected for circum-neutral weathering of pyrite-dominant-lithotypes.

APPENDIX A

DETAILS OF SAMPLES SUBMITTED FOR TESTING

APPENDIX B

TESTWORK METHODS

APPENDIX B

TESTWORK METHODS

B1.0 ACID-BASE-CHEMISTRY TESTWORK ON SAMPLES OF TAILINGS-SOLIDS AND MAGNETITE-CONCENTRATE

The acid-base chemistry of the tailings-solids and magnetite-concentrate samples was assessed by determining:

- Total Sulphur (Total-S) and Sulphate Sulphur (SO_4-S).
- Acid-Neutralisation Capacity (ANC), and Carbonate Carbon (CO_3-C).
- Net-Acid-Producing Potential (NAPP).
- Net-Acid Generation (NAG).

Relevant details of the testwork methods employed are discussed briefly below. Further details are presented in the laboratory reports (see Appendix C).

B1.1 Total-S and SO_4-S Tests

The Total-S value was measured by Leco combustion (@ 1300 ^oC) with detection of evolved $SO_{2(g)}$ by infra-red spectroscopy. The SO_4-S value was determined by the Na_2CO_3-Extraction Method (Berigari and Al-Any 1994; Lenahan and Murray-Smith 1986).[1]

The difference between the Total-S and SO_4-S values indicates the Sulphide-S (strictly Non-Sulphate-S) content.

[1] The Na_2CO_3-reagent extracts SO_4-S which occurs as soluble sulphates, and calcium sulphates (e.g. gypsum and anhydrite). It also extracts SO_4 sorbed to the surfaces of sesquioxides, clays and silicates. However, SO_4 present as barytes ($BaSO_4$) is not extracted, and SO_4 associated with jarositic-type and alunitic-type compounds is incompletely extracted.

B1.2 ANC, CO_3-C and pH-Buffering Tests

B1.2.1 ANC Test

The ANC value was determined by a procedure based on that of Sobek *et al.* (1978). This procedure is essentially the "standard" method employed for estimating the ANC values of mine-waste materials (Morin and Hutt 1997; BC AMD Task Force 1989).

The sample was reacted with dilute HCl for *c.* 2 hours at 80-90 ^{o}C, followed by back-titration with NaOH to a pH=7 end-point to determine the amount of acid consumed.[2] The simmering step for *c.* 2 hours differs slightly from the heating treatment of the Sobek *et al.* procedure wherein the test mixtures are heated to near boiling until reaction is deemed to be complete (viz. gas evolution not visually apparent), followed by boiling for one minute. In terms of dissolution of carbonate, primary-silicate and oxyhydroxide minerals, this variation to the Sobek *et al.* method is inconsequential.

The Sobek *et al.* (1978) procedure exposes mine-waste samples to both strongly-acidic conditions (e.g. pH of 1-2), and a near-boiling temperature. Provided excess acid is added, this method ensures that carbonate-minerals (including ferroan- and manganoan-varieties) are dissolved quantitatively, and that at least "traces" of ferro-magnesian-silicates (e.g. amphiboles, pyroxenes, chlorites, micas, etc.), and feldspars, are dissolved. However, under circum-neutral (viz. pH 6-8) conditions required for mine-waste and environmental management, the hydrolysis/dissolution of ferro-magnesian-silicates is kinetically extremely slow (e.g. see review-monograph by White and Brantley [1995]). Near pH=7, the hydrolysis/dissolution rates (under 'steady-state' conditions, and in the absence of inhibiting alteration-rims) of mafic-silicates and feldspars generally correspond to H_2SO_4-consumption rates 'of-the-order' $10^{-11}/10^{-12}$ moles/m^2/s (White and Brantley 1995). As a guide, for minerals of sub-mm grading, such silicate-dissolution rates correspond to Sulphide-Oxidation Rates (SORs) ranging

[2] Two drops of 30 % (w/w) H_2O_2 were added to the test mixtures as the pH=7 end-point was approached, so that any Fe(II) forms released by the acid-attack of ferroan-carbonates and -silicates are oxidised to Fe(III) forms (which then hydrolyse to "$Fe(OH)_3$"). This step ensures that the resulting ANC values are not biased "on-the-high-side", due to the release of Fe(II) during the acidification/digestion step. Such potential bias in ANC values may be marked for mine-waste samples in which "Fe-rich" ferroan-carbonates (e.g. siderite) dominate acid consumption. The addition of the H_2O_2 reagent is <u>not</u> part of the methodology described by Sobek *et al.* (1978).

up to 'of-the-order' 1-10 mg SO_4/kg/week (= *c.* 0.1-1.0 kg H_2SO_4/tonne/year).[3] Maintenance of circum-neutral-pH through hydrolysis/dissolution of primary-silicates is therefore restricted to both "mineral-fines", and slow rates of sulphide-weathering.

Despite the aggressive-digestion conditions employed, the ANC values determined by the Sobek *et al.* (1978) method allow an informed, initial "screening" of mine-waste materials in terms of acid-consuming and pH-buffering properties, especially when due account is taken of gangue mineralogy (Morin and Hutt 1997). Jambor *et al.* (2000, 2002) have presented a compendium of 'Sobek-ANC' values for specific classes of primary-silicates, and assists interpretation of the ANC values recorded for mine-waste materials of varying mineralogy.

B1.2.2 CO_3-C Value

The CO_3-C value is the difference between the Total-C and Total-Organic-C (TOC) values.

The Total-C was measured by Leco combustion (@ 1300 ^oC) with detection of evolved $CO_{2(g)}$ by infra-red spectroscopy. The TOC is determined by Leco combustion on a sub-sample which has been treated with strong HCl to decompose carbonate-minerals.

B1.3 NAPP Calculation

The NAPP values of the tailings-solids and magnetite-concentrate samples were calculated from the Total-S, SO_4-S and ANC values, assuming that **all** of the Non-Sulphate-S occurs in the form of pyrite. The sulphide-mineral suite in the tailings-solids sample was dominated by pyrite (Tables 3.3 and 4.3). NAPP calculations serve as a starting point in the assessment of the acid-formation potential of sulphide-bearing materials.

[3] SORs of this magnitude (at circum-neutral-pH) would typically only be recorded for the oxidation of "trace-sulphides" (e.g. Sulphide-S contents less than 0.5 %).

The complete-oxidation of pyrite may be described by:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O = 2H_2SO_4 + \text{"}Fe(OH)_3\text{"}$$

It may be shown that, if the Sulphide-S (in %S) occurs as pyrite, then the amount of acid (in kg H_2SO_4/tonne) produced through complete-oxidation is given by **30.6 x %S**. The NAPP value of the tailings-solids sample was therefore calculated from the Sulphide-S content (in %S), and 30.6 as the 'conversion-factor' to estimate the amount of acid that may potentially be produced through the aerobic-oxidation of pyrite.

It may be shown that, if the Sulphide-S (in %S) occurs as pyrite, then the amount of acid (in kg H_2SO_4/tonne) produced through complete-oxidation is given by **30.6 x %S**.

> Note: The above treatment of oxidation-reaction stoichiometry is restricted to oxidation by 'atmospheric-O_2' which is the dominant oxidant at circum-neutral-pH. A different oxidation-stoichiometry applies under acidic conditions (e.g. pH less than 3-4) where soluble-Fe(III) forms prevail, and then function as the chief oxidant (e.g. Rimstidt and Newcomb 1993).

Mechanistic aspects of pyrite-oxidation and pyrrhotite-oxidation at the molecular-scale were recently reviewed by Rimstidt and Vaughan (2003).

B1.4 NAG Test

The NAG Test is a direct measure of a sample's potential to produce acid through sulphide oxidation, and also provides an indication of the reactivity of the sulphides, and the availability of the alkalinity-forms contributing to the ANC (Miller *et al.* 1997, 1994).

In this test, the sample is reacted with H_2O_2 to rapidly oxidise contained sulphides, and allow the produced acid to react with the acid-neutralising materials (e.g. carbonates). The NAG Test supplements the NAPP-based assessment of the acid-formation potential of mine-waste materials (Morin and Hutt 1997).

The procedure employed in this study is based on that for the 'Static-NAG Test' in its 'single-addition' mode, as described in AMIRA (2002), and by Miller *et al.* (1994, 1997). The Start-pH of the 15 % (w/w) H_2O_2 solution (prepared from A.R.-grade H_2O_2) was adjusted to pH=4.5 using dilute NaOH. In addition, the boiling treatment to decompose residual, unreacted-H_2O_2 following overnight reaction was carried out in two stages (viz. boiling for *c.* 2 hours initially, cooling and addition of 1 mL of 0.02 M-$CuSO_4$ to the test mixtures, followed by boiling again for *c.* 2 hours). The addition of Cu(II) salts catalyses the decomposition of any unreacted-H_2O_2, and thereby prevents "positive-blank" values being obtained (O'Shay *et al.* 1990). Pulped K-feldspar was employed for the blanks run for the NAG-testwork.

Prior to the boiling-steps, the pH values of the test-mixture suspensions are measured, and invariably correspond to an "overnight-period" of reaction. Such pH values reflect buffering under ambient conditions without accelerated dissolution of gangue-phases through boiling to decompose any unreacted-H_2O_2. In the interpretation of NAG-testwork data, it is important to take note of the pH values recorded prior to the boiling-steps, especially for mine-waste samples that have both Sulphide-S contents less than *c.* 1 %, and ANC values less than *c.* 10 kg H_2SO_4/tonne (as typically recorded for a 'carbonate-deficient' gangue). Furthermore, oxidation by H_2O_2 is generally at least 10^4-10^5 faster than the SORs recorded during 'kinetic' testing (e.g. Weathering-Columns) of mine-waste samples. If circum-neutral conditions are to prevail during NAG testwork, then the rate of acid consumption by gangue-phases must be proportionately faster (c.f. rates for 'ambient-weathering'). This aspect must also be borne in mind when interpreting NAG-testwork data, especially for mine-waste materials that are devoid of carbonates, since the dissolution/hydrolysis kinetics of primary-silicates are strongly pH-dependent.

B2.0 MULTI-ELEMENT ANALYSES ON SAMPLES OF TAILINGS-SOLIDS AND MAGNETITE-CONCENTRATE

The total contents of a wide range of major- and minor-elements in the tailings-solids and magnetite-concentrate samples were determined through the use of various digestion and analytical techniques. The detection-limits employed are appropriate for environmental investigations.

Element enrichments were identified using the *Geochemical Abundance Index (GAI)*.[4]

The GAI quantifies an assay result for a particular element in terms of the average-crustal-abundance of that element.[5] The GAI (based on a log-2 scale) is expressed in 7 integer increments (viz. 0 to 6). A GAI of 0 indicates that the content of the element is less than, or similar to, the average-crustal-abundance; a GAI of 3 corresponds to a 12-fold enrichment above the average-crustal-abundance; and so forth, up to a GAI of 6 which corresponds to a 96-fold, or greater, enrichment above average-crustal-abundances.

B3.0 ANALYSIS OF TAILINGS-SLURRY-WATER SAMPLES

The tailings-slurry-water samples were analysed for pH, Electrical Conductivity (EC), salinity (as Total-Dissolved Solids, TDS), alkalinity forms, Cl, SO_4, NO_3, NH_3-N, and a wide range of major- and minor-elements employing detection-limits appropriate for environmental investigations. The samples were also analysed for an array of reduced-inorganic-S forms (viz. thiosulphate, trithionate, tetrathionate, pentathionate, sulphite, thiocyanate, and monosulphide-S).

All analyses were performed on appropriately-preserved 'splits' for the determination of specific analytes (see Appendix C).

[4] The GAI was developed by Förstner *et al* (1993), and is defined as:

$$GAI = \log_2 [C_n/(1.5 \times B_n)]$$

where:

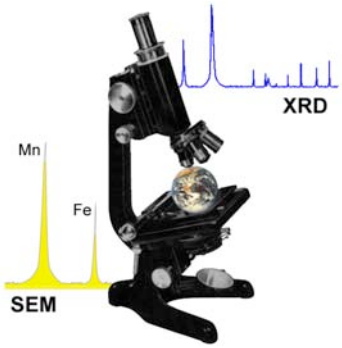
C_n = measured content of n-th element in the sample.

B_n = "background" content of the n-th element in the sample.

[5] The average-crustal-abundances of the elements for the GAI calculations are based on the values listed in Bowen (1979).

APPENDIX C

LABORATORY REPORTS



Roger Townend and Associates
Consulting Mineralogists

Unit 4, 40 Irvine drive, Malaga Western Australia 6062
Phone: (08) 9248 1674 Fax: (08) 9248 1502
email: rogertownend@westnet.com.au

GRAEME CAMPBELL AND ASSOC, 27-1-2007

PO BOX 247,

BRIDGETOWN

WA

OUR REF. 21884

YOUR REF.

XRDE/PLM/SEM ANALYSES OF THTREE TAILINGS

AND ONE MAGNETITE . (MOLYHIL)

R TOWNEND

RESULTS XRD/PLM/SEM

GCA	6547	6548	6549	6550
QUARTZ	MAJOR	ACCESORY	MAJOR	TRACE
GARNET	MAJOR	ACCESSORY	MINOPR	TRACE
CLINOPYROIXENE	MAJOR	ACCESSORY	ACCESSORY	
HORNBLENDE			ACCESSORY	TRACE
PLAGIOLCASE	ACCESSORY	ACCESSORY	ACCECSSORY	
K FELDSPAR	ACCESSORY	ACCESSORY	ACCCESSORY	
BIOTITE			TRACE	
MUSCOVITE			ACCESSORY	
CALCITE	TRACE	TRACE	TRACE	
HEMATITE	TRACE	ACCESSORY	ACCECSSORY	TRACE
MAGNETITE	MINOR	MINOR	MAJOR	DOMINANT
PYRITE	TRACE	DOMIANT	ACCESSORY	TRACE
CHALCOPYRITE	TRACE	TRACE	TRACE	
MOLYBDENITE		TRACE		
CASSITERITE	TRACE			
WOLFRAM	TRACE			
SCHEELITE		TRACE	TRACE	TRACE
WODGINITE		TRACE		
MN TANTALITE			TRACE	

Dr G Campbell
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN WA 6255

JOB INFORMATION

JOB CODE	**143.0/0611965**
No. of SAMPLES	4
CLIENT O/N	GCA0642
PROJECT	Molhil W-Mo Project
STATE	Tailings Soilds
DATE RECEIVED	30th November 2006
DATE COMPLETED	29th December 2006

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

The samples were received as tailings solids which required crushing, drying ,mixing, splitting and fine pulverising in a zirconia bowl.

Results of analysis on:

Element		**S_tot**	**S-SO4**	**C_tot**	**TOC+C**	**C-CO3**
Method		**/LECO**	**Na2CO3/ GRAV**	**/LECO**	**OrgC/ LECO**	**/CALC**
Detection		**0.005**	**0.01**	**0.01**	**0.01**	**0.01**
Units		**%**	**%**	**%**	**%**	**%**
Sample Name						
Control Blank		X	0.01	0.01	X	
GCA6547		0.216	0.02	0.38	0.12	0.26
GCA6547	check	0.251	X	0.38	0.11	0.27
GCA6548		30.035	0.08	0.35	0.14	0.21
GCA6549		3.309	0.04	0.37	0.17	0.2
GCA6550		0.104	X	0.05	0.02	0.03
CD-1		3.096		0.23		
PD-1			4.29			
Graphite-1					1.72	
S_SO4_A			0.59			
S_SO4_B			1.3			

1. The C,S results were determined from the pulverised portion
2. The Carbon and Sulphur was determined according to Genalysis method number SL_W023.
3. S-SO4 was determined by precipitation of BaSO4 according to Genalysis method number ENV_W039
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by LECO after removal of carbonates and soluble organic carbon according to Genalysis method number MPL_W046

Acid Neutralisation Capacity (ANC)

Sample Name		Fizz Rating	Sample Weight (g)	Molarity HCl	Molarity NaOH	Initial Efferves cence	colour change	pH drop	ANC Solution pH	ANC (kg H2SO4/tonne)
GCA6547		3	2	1.0046	0.9940	strong	*		0.79	48
GCA6547	check	3	2	1.0046	0.9940	strong	*		0.89	46
GCA6548		3	2	1.0046	0.9940	strong	*		0.99	32
GCA6549		3	2	1.0046	0.9940	strong	*		0.92	49
GCA6550		0	2	0.4828	0.0965	strong			1.61	1

Notes:

1. ANC was determined on the -2mm portion. Acid concentrations are as stated
2. Colour change: * Indicates the appearance of a green colouration as the pH=7 endpoint was approached. Two drops of hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron
3. pH drop : * Indicates a pH drop to a value below 4 on addition of peroxide
4. This procedure according to Genalysis methods number ENV_W035

NATA ENDORSED DOCUMENT
Company Accreditation Number 3244
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NATA Signatory: A Evers
Chief Chemist

Date: 29th December 2006

This document is issued in accordance with NATA's accreditation requirements.

Graeme Campbell & Associates Pty Ltd

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g) [moist]	Sample Weight (g) [dry]	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.1 M-NaOH] (mL)	NAG (kg H_2SO_4/ tonne)
					pH	EC (µS/cm)		
GCA6547	7.6	6.6	Reaction peaked overnight	7.6	7.9	260	-	<0.5
GCA6548	0.94	0.81	Reaction peaked within 3 hrs	2.2	2.2	2,800	79.20	480
GCA6549	3.4	3.0	Reaction peaked within 3 hrs	2.3	2.9	1,200	21.60	36
GCA6550	-	5.5	Reaction peaked overnight	3.5	4.6	88	0.80	0.8
GCA6550 (Repeat)	-	4.2	Reaction peaked overnight	3.8	5.4	67	0.80	1.0
Blank	-	3.3		5.8	7.3	56	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997). The pH of the 15 % (v/v) H_2O_2 solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Test mixtures boiled for *c.* 2 hours to accelerate reaction with H_2O_2. Then, after allowing the test mixtures to cool, 1.0 mL of 0.016 M-$CuSO_4$ solution was added, and the test mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted H_2O_2 in the test mixtures (O'Shay *et al.* 1990). K-Feldspar was employed for the Blanks.

Dr GD Campbell
18th January 2007

Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-BUFFERING TESTWORK (GCA6547)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH	Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	8.8	17.60	3.7	4.1
0.40	0.1	8.4	18.00	3.8	4.1
0.80	0.2	8.1	18.40	3.9	4.1
1.20	0.3	8.0	18.80	3.9	4.1
1.60	0.3	7.9	19.20	4.0	4.1
2.00	0.4	7.8	19.60	4.1	4.1
2.40	0.5	7.7	20.00	4.2	4.0
2.80	0.6	7.6	20.40	4.3	3.9
3.20	0.7	7.5	20.80	4.4	3.9
3.60	0.8	7.5	21.20	4.5	3.8
4.00	0.8	7.4	21.60	4.5	3.8
4.40	0.9	7.3	22.00	4.6	3.7
4.80	1.0	7.2	22.40	4.7	3.6
5.20	1.1	7.1	22.80	4.8	3.6
5.60	1.2	6.9	23.20	4.9	3.5
6.00	1.3	6.7	23.60	5.0	3.5
6.40	1.3	6.5	24.00	5.0	3.4
6.80	1.4	6.4	24.40	5.1	3.3
7.20	1.5	6.2	24.80	5.2	3.3
7.60	1.6	6.0	25.20	5.3	3.3
8.00	1.7	5.9	25.60	5.4	3.3
8.40	1.8	5.7	26.00	5.5	3.3
8.80	1.8	5.5	26.40	5.5	3.3
9.20	1.9	5.4	26.80	5.6	3.3
9.60	2.0	5.4	27.20	5.7	3.2
10.00	2.1	5.3	27.60	5.8	3.2
10.40	2.2	5.2	28.00	5.9	3.2
10.80	2.3	5.1	28.40	6.0	3.1
11.20	2.4	5.1	28.80	6.0	3.1
11.60	2.4	5.0	29.20	6.1	3.1
12.00	2.5	4.9	29.60	6.2	3.1
12.40	2.6	4.8	30.00	6.3	3.0
12.80	2.7	4.8	30.40	6.4	3.0
13.20	2.8	4.7			
13.60	2.9	4.6			
14.00	2.9	4.6			
14.40	3.0	4.5			
14.80	3.1	4.5			
15.20	3.2	4.4			
15.60	3.3	4.4			
16.00	3.4	4.3			
16.40	3.4	4.3			
16.80	3.5	4.2			
17.20	3.6	4.2			

Note: Titration performed using a Metrohm® 736 Titrino auto-titrator, and 0.05 M-H_2SO_4. Equilibration time between titrant additions was 15 minutes. 27.1 g of moist tailings-solids (= 23.5 g dry-solids) initially dispersed in 150 mL of deionised-water.
Test mixture in contact with air, at ambient temperature, and continuously stirred.
Calibration of pH-Glass Electrode:
Immediately prior to titration: asymmetry potential = -15 mV (pH=7.00); slope-point = 152 mV (pH=4.00); 96.8 % of Nernstian response for 25 ^{o}C.
Immediately following titration: pH=7.00 buffer read pH=7.02 and pH=4.00 buffer read pH=4.03. These discrepancies represent drift in pH-Glass electrode response during course of auto-titration.

Dr GD Campbell
17th January 2007

Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-BUFFERING TESTWORK (GCA6548)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH	Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	8.0	17.60	3.2	5.0
0.40	0.1	7.8	18.00	3.2	4.9
0.80	0.1	7.6	18.40	3.3	4.8
1.20	0.2	7.5	18.80	3.4	4.7
1.60	0.3	7.4	19.20	3.5	4.6
2.00	0.4	7.4	19.60	3.5	4.5
2.40	0.4	7.3	20.00	3.6	4.5
2.80	0.5	7.3	20.40	3.7	4.4
3.20	0.6	7.2	20.80	3.7	4.3
3.60	0.6	7.2	21.20	3.8	4.3
4.00	0.7	7.2	21.60	3.9	4.3
4.40	0.8	7.1	22.00	4.0	4.2
4.80	0.9	7.1	22.40	4.0	4.2
5.20	0.9	7.1	22.80	4.1	4.1
5.60	1.0	7.0	23.20	4.2	4.0
6.00	1.1	7.0	23.60	4.2	4.0
6.40	1.2	7.0	24.00	4.3	3.9
6.80	1.2	6.9	24.40	4.4	3.9
7.20	1.3	6.9	24.80	4.5	3.8
7.60	1.4	6.8	25.20	4.5	3.8
8.00	1.4	6.8	25.60	4.6	3.8
8.40	1.5	6.7	26.00	4.7	3.7
8.80	1.6	6.7	26.40	4.8	3.7
9.20	1.7	6.6	26.80	4.8	3.6
9.60	1.7	6.5	27.20	4.9	3.6
10.00	1.8	6.4	27.60	5.0	3.6
10.40	1.9	6.4	28.00	5.0	3.5
10.80	1.9	6.3	28.40	5.1	3.5
11.20	2.0	6.3	28.80	5.2	3.5
11.60	2.1	6.2	29.20	5.3	3.4
12.00	2.2	6.1	29.60	5.3	3.4
12.40	2.2	6.0	30.00	5.4	3.4
12.80	2.3	5.9	30.40	5.5	3.4
13.20	2.4	5.9	30.80	5.5	3.3
13.60	2.4	5.8	31.20	5.6	3.3
14.00	2.5	5.7	31.60	5.7	3.3
14.40	2.6	5.6	32.00	5.8	3.2
14.80	2.7	5.5	32.40	5.8	3.2
15.20	2.7	5.5	32.80	5.9	3.2
15.60	2.8	5.4	33.20	6.0	3.2
16.00	2.9	5.3	33.60	6.0	3.2
16.40	3.0	5.2	34.00	6.1	3.2
16.80	3.0	5.1	34.40	6.2	3.1
17.20	3.1	5.1	34.80	6.3	3.1

Note: Titration performed using a Metrohm® 736 Titrino auto-titrator, and 0.05 M-H_2SO_4. Equilibration time between titrant additions was 15 minutes. 30.6 g of moist tailings-solids (= 26.5 g dry-solids) initially dispersed in 150 mL of deionised-water.
Test mixture in contact with air, at ambient temperature, and continuously stirred.
Calibration of pH-Glass Electrode:
Immediately prior to titration: asymmetry potential = -16 mV (pH=7.00); slope-point = 156 mV (pH=4.00); 96.6 % of Nernstian response for 25 ^{o}C.
Immediately following titration: pH=7.00 buffer read pH=7.02 and pH=4.00 buffer read pH=4.03. These discrepancies represent drift in pH-Glass electrode response during course of auto-titration.

Dr GD Campbell
17th January 2007

Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-BUFFERING TESTWORK (GCA6549)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH	Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	8.3	17.60	3.0	3.4
0.40	0.1	7.8	18.00	3.1	3.4
0.80	0.1	7.2	18.40	3.1	3.3
1.20	0.2	6.9	18.80	3.2	3.2
1.60	0.3	6.7	19.20	3.3	3.2
2.00	0.3	6.5	19.60	3.3	3.2
2.40	0.4	6.3	20.00	3.4	3.2
2.80	0.5	6.1	20.40	3.5	3.1
3.20	0.5	5.9	20.80	3.5	3.1
3.60	0.6	5.7	21.20	3.6	3.1
4.00	0.7	5.5	21.60	3.7	3.1
4.40	0.7	5.3	22.00	3.7	3.0
4.80	0.8	5.1	22.40	3.8	3.0
5.20	0.9	5.0	22.80	3.9	3.0
5.60	1.0	4.9			
6.00	1.0	4.8			
6.40	1.1	4.8			
6.80	1.2	4.7			
7.20	1.2	4.5			
7.60	1.3	4.4			
8.00	1.4	4.4			
8.40	1.4	4.4			
8.80	1.5	4.3			
9.20	1.6	4.2			
9.60	1.6	4.1			
10.00	1.7	4.0			
10.40	1.8	4.0			
10.80	1.8	3.8			
11.20	1.9	3.8			
11.60	2.0	3.8			
12.00	2.0	3.7			
12.40	2.1	3.7			
12.80	2.2	3.6			
13.20	2.2	3.6			
13.60	2.3	3.6			
14.00	2.4	3.6			
14.40	2.4	3.6			
14.80	2.5	3.6			
15.20	2.6	3.5			
15.60	2.7	3.5			
16.00	2.7	3.5			
16.40	2.8	3.5			
16.80	2.9	3.5			
17.20	2.9	3.4			

Note: Titration performed using a Metrohm® 736 Titrino auto-titrator, and 0.05 M-H_2SO_4. Equilibration time between titrant additions was 15 minutes. 31.8 g of moist tailings-solids (= 28.2 g dry-solids) initially dispersed in 150 mL of deionised-water.
Test mixture in contact with air, at ambient temperature, and continuously stirred.
Calibration of pH-Glass Electrode:
Immediately prior to titration: asymmetry potential = -16 mV (pH=7.00); slope-point = 156 mV (pH=4.00); 96.7 % of Nernstian response for 25 ^{o}C.
Immediately following titration: pH=7.00 buffer read pH=7.02 and pH=4.00 buffer read pH=4.03. These discrepancies represent drift in pH-Glass electrode response during course of auto-titration.

Dr GD Campbell
17th January 2007

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0612295
No. of SAMPLES	:	4
No. of ELEMENTS	:	34
CLIENT O/N	:	GCA0642
SAMPLE SUBMISSION No.	:	
PROJECT	:	Molyhill W-Mo Project
STATE	:	Ex-Pulp
DATE RECEIVED	:	08/12/2006
DATE COMPLETED	:	08/01/2007
DATE PRINTED	:	09/01/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION
12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION
124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION
Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.95 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 4 samples,as listed in the report,were received as being 'Tailings Solids' which had already been dried and crushed on Genalysis report 143.0/0611965. A 100 gram portion was mixed and split from the bulk prior to being fine pulverised in a zirconia bowl.

The results have been determined according to Genalysis methods codes :
Digestions : SL_W001 (A/), SL_W007 (BP/), ENV_W012 (DH/SIE), SL_W013 (D/), and SL_W012 (CM/).
Analytical Finishes: ICP_W004 (/OES), ICP_W005 (/MS) and AAS_W004 (/CVAP).

The results included the assay of blanks and international reference standards OREAS 45P, and STSD-2 and Genalysis in-house standards AE12, TKC5 and HgSTD-3.

The results are expressed as parts per million or percent by mass in the dried and prepared material.

NATA Signatory: A Evers
Chief Chemist

Date: 8th January 2007

This document is issued in accordance with NATA’s accreditation requirements.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.1	20	1	50	0.1	0.01	10	0.1	0.1	2
DIGEST	A/	A/	A/	D/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	MS	OES	MS	OES	MS	MS	OES	MS	MS	OES
SAMPLE NUMBERS										
0001 GCA6547	0.3	4.44%	16	X	95.3	4.61	8.75%	0.3	26.3	54
0002 GCA6548	0.6	2.45%	38	X	37.0	3.63	2.70%	0.6	1183.7	45
0003 GCA6549	0.5	4.07%	16	X	86.4	5.55	7.80%	X	141.4	57
0004 GCA6550	0.1	1875	X	X	2.7	0.12	1630	0.3	13.0	83
CHECKS										
0001 GCA6547	0.5	4.23%	13	X	91.2	4.30	8.46%	0.3	26.6	54
STANDARDS										
0001 HgSTD-3										
0002 OREAS 45P				X						
0003 STSD-2										
0004 TKC5	13.6	5.69%	590		501.1	26.19	2.49%	5.0	148.5	772
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	0.2	X	2
0002 Control Blank	X	X	X		0.1	X	10	0.2	X	2
0003 Control Blank										
0004 Control Blank										
0005 Control Blank				X						
0006 Acid Blank	X	X	X		X	X	X	0.2	X	X
0007 Acid Blank				X						
0008 Control Blank										

ANALYSIS

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	1	50	0.01	0.01	20	20	1	0.1	20	1
DIGEST	A/	DH/	D/	CM/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	SIE	OES	CVAP	OES	OES	OES	MS	OES	OES
SAMPLE NUMBERS										
0001 GCA6547	144	599	19.84	0.04	1.08%	1.31%	1939	56.4	8541	62
0002 GCA6548	1727	278	32.52	0.12	4104	6499	800	931.5	5188	307
0003 GCA6549	331	590	22.70	0.07	9695	1.21%	1803	187.8	7744	50
0004 GCA6550	32	175	66.21	0.02	176	790	283	16.9	171	16
CHECKS										
0001 GCA6547	140	564	19.23	0.03	1.04%	1.27%	1873	52.7	8222	50
STANDARDS										
0001 HgSTD-3				0.32						
0002 OREAS 45P			18.58							
0003 STSD-2		946								
0004 TKC5	1672				1.09%	1.58%	1888	59.4	1.56%	2387
BLANKS										
0001 Control Blank	X	X	X	0.01	X	X	X	X	X	X
0002 Control Blank	1				X	X	1	X	22	2
0003 Control Blank										
0004 Control Blank				0.01						
0005 Control Blank			X							
0006 Acid Blank	X				X	X	X	X	X	X
0007 Acid Blank			X							
0008 Control Blank										

ANALYSIS

ELEMENTS	P	Pb	S	S	Sb	Se	Sn	Sr	Th	Tl
UNITS	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	20	2	10	0.01	0.05	0.01	0.1	0.05	0.01	0.02
DIGEST	A/	A/	A/	D/	A/	BP/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	MS	OES	OES	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA6547	734	20	2180		8.95	0.03	101.9	37.05	15.73	0.47
0002 GCA6548	186	221		27.86	0.62	2.53	29.9	18.79	7.87	3.03
0003 GCA6549	743	45	3.45%		8.00	0.28	105.4	32.91	14.78	0.84
0004 GCA6550	170	6	795		0.13	0.02	8.8	1.31	0.36	0.10
CHECKS										
0001 GCA6547	779	23	2368		8.04	0.03	106.3	34.43	15.42	0.48
STANDARDS										
0001 HgSTD-3										
0002 OREAS 45P				0.03						
0003 STSD-2										
0004 TKC5	2232	1491	1.35%		169.44		6.1	515.74	138.92	23.83
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X
0002 Control Blank	X	X	11		0.05		0.2	X	0.02	0.02
0003 Control Blank						X				
0004 Control Blank										
0005 Control Blank										
0006 Acid Blank	X	X	X		X		X	X	X	0.04
0007 Acid Blank										
0008 Control Blank						X				

ANALYSIS

ELEMENTS	U	V	W	Zn
UNITS	ppm	ppm	ppm	ppm
DETECTION	0.01	2	0.1	1
DIGEST	A/	A/	A/	A/
ANALYTICAL FINISH	MS	OES	MS	OES
SAMPLE NUMBERS				
0001 GCA6547	23.09	38	814.5	111
0002 GCA6548	57.73	7	1333.6	141
0003 GCA6549	27.10	36	1111.3	116
0004 GCA6550	5.53	82	325.4	25
CHECKS				
0001 GCA6547	21.33	37	771.5	114
STANDARDS				
0001 HgSTD-3				
0002 OREAS 45P				
0003 STSD-2				
0004 TKC5	15.26	325	77.6	1151
BLANKS				
0001 Control Blank	X	X	X	X
0002 Control Blank	X	X	0.1	2
0003 Control Blank				
0004 Control Blank				
0005 Control Blank				
0006 Acid Blank	X	X	X	X
0007 Acid Blank				
0008 Control Blank				

METHOD CODE DESCRIPTION

A/MS

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Mass Spectrometry.

A/OES

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

BP/MS

Aqua-Regia digest followed by Precipitation and Concentration. Specific for Selenium. Analysed by Inductively Coupled Plasma Mass Spectrometry.

D/OES

Sodium peroxide fusion (Zirconium crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

DH/SIE

Alkaline fusion (Nickel crucible) specific for Fluorine. Analysed by Specific Ion Electrode.

CM/CVAP

Low temperature Perchloric acid digest specific for Mercury. Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.

LABORATORY REPORT COVERSHEET

DATE:	25 January 2007
TO:	Graeme Campbell & Associates Pty Ltd PO Box 247 BRIDGETOWN WA 6255
ATTENTION:	Dr Graeme Campbell
YOUR REFERENCE:	GCA 0642
OUR REFERENCE:	10137
SAMPLES RECEIVED:	18/12/2006
SAMPLES/QUANTITY:	4 Waters

The above samples were received intact and analysed according to your instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

PETER KEYTE
Business Manager

SAID HIRAD
Project/Validation Chemist

SGS Australia Pty Ltd ABN 44 000 964 278 | Environmental Services | 52 Murray Road | Welshpool 6106 | Western Australia | www.au.sgs.com
t +61 (0)8 9458 7278 f +61 (0)8 9451 3505

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 10137
PROJECT: GCA 0642

LABORATORY REPORT

Your Reference Our Reference Type of Sample	Units	GCA 6547 10137-1 Water	GCA 6548 10137-2 Water	GCA 6549 10137-3 Water	GCA 6550 10137-4 Water
pH	pH Units	8.3	8.1	8.2	[NA]
Conductivity @25^{o}C	µS/cm	810	1,300	900	100
Total Dissolved Solids @ 180^{o}C	mg/L	470	940	570	[NA]
Chloride, Cl	mg/L	76	110	74	11
Sulphate, SO_4	mg/L	61	350	120	9
Bicarbonate, HCO_3	mg/L	300	310	360	[NA]
Carbonate, CO_3	mg/L	2	<1	<1	[NA]
Hydroxide, OH	mg/L	<5	<5	<5	[NA]
Fluoride, F	mg/L	0.9	0.6	0.8	[NA]
Nitrate-Nitrogen, NO_3-N	mg/L	0.21	0.39	0.12	[NA]
Ammonia Nitrogen NH_3-N	mg/L	0.2	0.8	0.3	[NA]

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 10137
PROJECT: GCA 0642

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
--------			
pH	pH Units	0.1	AN-101
Conductivity @25^{o}C	µS/cm	2	AN-106
Total Dissolved Solids @ 180^{o}C	mg/L	10	PEI-002
Chloride, Cl	mg/L	1	PEI-020
Sulphate, SO_4	mg/L	1	PEI-020
Bicarbonate, HCO_3	mg/L	5	PEI-006
Carbonate, CO_3	mg/L	1	PEI-006
Hydroxide, OH	mg/L	5	PEI-006
Fluoride, F	mg/L	0.1	PEI-027
Nitrate-Nitrogen, NO_3-N	mg/L	0.05	PEI-020
Ammonia Nitrogen NH_3-N	mg/L	0.1	PEI-010

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 10137
PROJECT: GCA 0642

LABORATORY REPORT

NOTES:

LOR - Limit of Reporting.

This test is not covered by the scope of our NATA accreditation.

ANALYTICAL SERVICES TASMANIA

c/- Chemistry Department University of Tasmania
Sandy Bay Laboratory

Telephone: (03) 6226 7175 Fax: (03) 6226 7825 Email: astproduction@environment.tas.gov.au

Accredition No. 5589

	Date: 02-Feb-07
	Pages: 4 (including this one)

To: G. Campbell	**From:** Amanda Freeman
Graeme Campbell and Associates Pty Ltd	
Address PO Box 247 BRIDGETOWN WA 6255	
Fax No: 08 97612830	**Fax No** (03) 6226 7825
Phone: 08 97612829	**Phone:** (03) 6226 7175
Mobile:	

Order No 0642

Please find enclosed report number 30775 : issue number 1.

The invoice for this report will follow.

ANALYTICAL SERVICES TASMANIA
Sandy Bay Laboratory
c/- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005
Telephone: (03) 6226 7175 Fax: (03) 6226 7825
Email: astproduction@environment.tas.gov.au

Laboratory Report

Report No: 30775 **Issue No:** 1 **Report Date** 02-Feb-2007 15:07

Status: Full Report

Site Description:

Received: 08-Jan-07

Submitted to: New Town Laboratory

Submitted By: G. Campbell

Client Order No: 0642

Report To: G. Campbell

Client: Graeme Campbell and Associates Pty Ltd

Address: PO Box 247 BRIDGETOWN WA 6255

ANALYTICAL SERVICES TASMANIA

Report No: 30775 **Issue No:** 1 **Report Date:** 02-Feb-2007 15:07

		Lab.No.:	101580	101581	101582
		Sample Id.:	GCA6547	GCA6548	GCA6549
Method	**Analyte**	**Units / Sampled On :**			
1103-Water	Sulphate	mg/L	125	316	117
1105-Water	Sulphide*	µg/L	17	160	16
1113-Water	Pentathionate*	mg/L	<5.0	5.6	<5.0
	Tetrathionate*	mg/L	<10.0	72	<10.0
	Thiocyanate*	mg/L	<1.0	<1.0	<1.0
	Thiosulphate*	mg/L	2.8	7.0	<0.2
	Trithionate*	mg/L	<2.0	<2.0	<2.0
1123-Water	Sulphite*	mg/L	<10	<10	<10
1301a-Water	S Total*	µg/L	57100	159000	47900

* NATA accreditation does not cover this analyte.

Report No: 30775 **Issue No:** 1 **Report Date:** 02-Feb-2007 15:07

Test Method(s) :

Test Date

Inorganic Testing

1105-Water:	Sulphide in Water by APHA Method 4500-S *	19-Jan-2007
	Work Conducted at: Sandy Bay	
1301a-Water:	Metals in Water (a) by APHA Method 3030/3120 *	18-Jan-2007
	Work Conducted at: Sandy Bay	

Authorised By:

Damien Norman
Section Head - Inorganic

1103-Water:	Anions by Ion Chromatography APHA Method 4110C	12-Jan-2007
	Work Conducted at: Sandy Bay	
1123-Water:	Anions by Ion Chromatography *	12-Jan-2007
	Work Conducted at: Sandy Bay	

Authorised By:

Mike Johnson
Manager

Organic and Nutrient Testing

1113-Water:	Thiosalts in Water by HPLC *	18-Jan-2007
	Work Conducted at: New Town	

Authorised By:

Neil Kerr
Chemist

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0612294
No. of SAMPLES	:	3
No. of ELEMENTS	:	32
CLIENT O/N	:	GCA0642
SAMPLE SUBMISSION No.	:	
PROJECT	:	Molyhill W-Mo Project
STATE	:	Solutions
DATE RECEIVED	:	08/12/2006
DATE COMPLETED	:	22/12/2006
DATE PRINTED	:	22/12/2006

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION
12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION
124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION
Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.95 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ***

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 3 samples, GCA6557 to GCA6549, were received as being tailings-slurry-waters which had been filtered and acidified.

The results have been determined by ICP-MS according to Genalysis method code ICP_W004 and by ICP-OES according to method code ICP_W005.

The analysis included the assay of blanks and Genalysis in-house reference standards. The results are expressed as milligrams per litre or micrograms per litre in the solution as received

NATA Signatory: H Pham

Date: 22th December 2006

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l	mg/l
DETECTION	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1	0.01
DIGEST										
ANALYTICAL FINISH	/MS	/OES	/MS	/OES	/MS	/MS	/OES	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA6547	X	0.03	5.3	0.11	19.91	X	55.72	0.42	0.5	X
0002 GCA6548	X	X	5.3	0.11	52.56	X	154.15	0.10	17.1	X
0003 GCA6549	X	X	6.2	0.10	24.88	X	72.98	0.11	0.3	X
CHECKS										
0001 GCA6547	X	0.01	5.2	0.11	19.86	X	55.26	0.43	X	X
STANDARDS										
0001 Alcoa5-OES		2.10		0.94			53.56			0.54
0002 Alcoa7MS	5.06		25.9		5.65	5.133		4.76	506.0	
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na	Ni	P
UNITS	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
DETECTION	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1	0.01	0.1
DIGEST										
ANALYTICAL FINISH	/OES	/OES	/MS	/OES	/OES	/OES	/MS	/OES	/OES	/OES
SAMPLE NUMBERS										
0001 GCA6547	0.05	X	X	5.7	48.01	0.03	98.60	69.5	X	X
0002 GCA6548	0.06	X	X	9.5	64.76	0.46	87.46	59.9	0.01	X
0003 GCA6549	X	X	X	5.8	53.11	0.09	122.75	68.4	X	X
CHECKS										
0001 GCA6547	0.05	X	X	5.6	47.73	0.03	100.55	68.4	X	X
STANDARDS										
0001 Alcoa5-OES	0.25	1.98		4.0	66.75	0.54		243.4	0.57	1.1
0002 Alcoa7MS			5.3				5.34			
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	0.1

ANALYSIS

ELEMENTS	Pb	Sb	Se	Si	Sn	Sr	Th	Tl	U	V
UNITS	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l
DETECTION	0.5	0.01	0.5	0.05	0.1	0.02	0.005	0.01	0.005	0.01
DIGEST										
ANALYTICAL FINISH	/MS	/MS	/MS	/OES	/MS	/MS	/MS	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA6547	1.1	1.47	2.4	11.10	1.0	195.24	X	0.13	92.144	X
0002 GCA6548	1.1	2.86	2.6	12.89	1.1	338.42	X	0.20	388.149	X
0003 GCA6549	1.5	1.40	2.3	11.89	0.6	225.82	X	0.06	128.085	X
CHECKS										
0001 GCA6547	1.5	1.49	2.4	11.07	1.1	197.35	X	0.13	90.547	X
STANDARDS										
0001 Alcoa5-OES				10.91						0.53
0002 Alcoa7MS	5.2	5.53	25.8		5.6	472.23	5.573	4.85	5.552	
BLANKS										
0001 Control Blank	X	0.02	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	W	Zn
UNITS	ug/l	mg/l
DETECTION	0.02	0.01
DIGEST		
ANALYTICAL FINISH	/MS	/OES
SAMPLE NUMBERS		
0001 GCA6547	73.42	0.09
0002 GCA6548	28.06	0.05
0003 GCA6549	45.16	0.02
CHECKS		
0001 GCA6547	74.80	0.07
STANDARDS		
0001 Alcoa5-OES		0.55
0002 Alcoa7MS	2.13	
BLANKS		
0001 Control Blank	X	X

METHOD CODE DESCRIPTION

/MS

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Mass Spectrometry.

/OES

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0612296
No. of SAMPLES	:	1
No. of ELEMENTS	:	34
CLIENT O/N	:	GCA0635
SAMPLE SUBMISSION No.	:	
PROJECT	:	Molyhill W-Mo Project
STATE	:	Ex-Pulp
DATE RECEIVED	:	08/12/2006
DATE COMPLETED	:	04/01/2007
DATE PRINTED	:	04/01/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION
12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION
124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION
Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

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SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.95 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The sample, GCA6550, was received as being a tailings solid which had already been dried and crushed on Genalysis report 143.0/0611965.
A 100 gram portion of the crushed sample was mixed and split from the bulk sample.

The results for the pH, and EC (Conductivity) are based upon a 1:2 (soil:water) extract according to Genalysis method number SL_W018.

The results for all other elements have been determined by ICP-OES or ICP-MS according to Genalysis method numbers ICP_W004_OES and ICP_W005_MS.

The results included the assay of blanks and Genalysis in-house standards

The results are expressed as uS/cm in the extract for the EC and as micrograms per litre or milligrams per litre in the solution for all other elements.

NATA Signatory: A Evers
Chief Chemist

Date: 4th January 2007

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l	mg/l
DETECTION	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1	0.01
DIGEST	W/	W/	W/	W/	W/	W/	W/	W/	W/	W/
ANALYTICAL FINISH	MS	OES	MS	OES	MS	MS	OES	MS	MS	OES
SAMPLE NUMBERS										
0001 GCA6550	0.04	1.21	2.1	X	7.92	0.098	10.92	0.18	1.7	X
CHECKS										
0001 GCA6550	0.04	1.24	1.9	X	7.79	0.146	10.96	0.18	1.7	X
STANDARDS										
0001 Alcoa5-OES	4.94	1.97	24.3	0.89	5.45	4.027	49.79	5.28	510.2	0.50
BLANKS										
0001 Control Blank	X	X	X	X	X	X	0.01	X	X	X
0002 Control Blank	X	X	X	X	X	X	X	X	X	X
0003 Control Blank	X	X	X	X	X	X	X	0.03	X	X

ANALYSIS

ELEMENTS	Cu	EC	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	mg/l	uS/cm	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l
DETECTION	0.01	10	0.01	0.1	0.1	0.01	0.01	0.05	0.1	0.01
DIGEST	W/	W/	W/	W/	W/	W/	W/	W/	W/	W/
ANALYTICAL FINISH	OES	METER	OES	MS	OES	OES	OES	MS	OES	OES
SAMPLE NUMBERS										
0001 GCA6550	0.11	98	2.81	0.4	0.6	1.29	0.04	55.89	8.6	X
CHECKS										
0001 GCA6550	0.11	99	2.87	0.4	0.5	1.31	0.05	56.40	8.6	X
STANDARDS										
0001 Alcoa5-OES	0.24		1.99	4.5	4.0	64.66	0.50	5.76	238.8	0.53
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X
0002 Control Blank	X		X	X	X	X	X	X	X	X
0003 Control Blank	X		X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	P	Pb	pH	Sb	Se	Si	Sn	Sr	Th	Tl
UNITS	mg/l	ug/l	NONE	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l
DETECTION	0.1	0.5	0.1	0.01	0.5	0.05	0.1	0.02	0.005	0.01
DIGEST	W/	W/	W/	W/	W/	W/	W/	W/	W/	W/
ANALYTICAL FINISH	OES	MS	METER	MS	MS	OES	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA6550	0.1	8.7	8.8	0.31	X	2.60	0.7	14.40	0.187	0.01
CHECKS										
0001 GCA6550	X	8.5	8.9	0.33	X	2.69	0.6	14.51	0.197	0.01
STANDARDS										
0001 Alcoa5-OES	1.2	5.5		4.59	22.0	10.61	4.5	507.66	3.990	3.85
BLANKS										
0001 Control Blank	X	X	6.9	X	X	X	X	X	X	X
0002 Control Blank	X	X		X	X	X	X	X	X	0.01
0003 Control Blank	X	X		X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	U	V	W	Zn
UNITS	ug/l	mg/l	ug/l	mg/l
DETECTION	0.005	0.01	0.02	0.01
DIGEST	W/	W/	W/	W/
ANALYTICAL FINISH	MS	OES	MS	OES
SAMPLE NUMBERS				
0001 GCA6550	3.485	X	447.31	0.03
CHECKS				
0001 GCA6550	3.427	X	441.29	0.03
STANDARDS				
0001 Alcoa5-OES	4.064	0.51	5.94	0.51
BLANKS				
0001 Control Blank	X	X	X	X
0002 Control Blank	X	X	0.62	X
0003 Control Blank	X	X	0.22	X

METHOD CODE DESCRIPTION

W/MS

Water Extraction using a sample:water ratio of 1:5. Analysed by Inductively Coupled Plasma Mass Spectrometry.

W/OES

Water Extraction using a sample:water ratio of 1:5. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

W/METER

Water Extraction using a sample:water ratio of 1:2. Analysed with Electronic Meter Measurement