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COMPANY:	Flinders Mines Limited
ATTENTION:	Mick Anstey
FROM:	Graeme Campbell
SUBJECT:	Flinders Pilbara Iron-Ore Project (FPIOP): Geochemical Characterisation of Mine-Waste Samples from Delta, Eagle, and Champion Pits - Implications for Mine-Waste Management

NO. PAGES (including this page): 182 DATE: 15th November 2011

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The occurrences of S, and associated univariate-statistics, for the waste-zones of the Delta, Eagle and Champion Pits, are presented in Attachment I.

Details of the testwork methods employed are presented in Attachment II.

Classification criteria in terms of Acid-Formation Potential (AFP) are summarised in Attachment III.

Copies of the laboratory reports are presented in Attachment IV.

1.0 OREBODY-WIDE APPRAISAL OF SULPHUR-OCCURRENCES

The Exploration-Database (for Delta, Eagle and Champion combined) from which the univariate-statistics of S-occurrences are derived, correspond to Total-S assays at 2-m intervals (Attachment I). The Exploration-Database therefore allows definition of S-occurrences at a "fine-spatial-resolution" within the pit-waste/ore-zones. This "metre-scale-resolution" of S-occurrences is small compared with the likely "mining-resolution" of *c.* 5 m, as controlled by the large equipment to be employed during open-pit mining.

With the exception of the Shale units from within the Basement-Zone (i.e. broadly below the Base-of-Oxidation [BoX]), sulphide-mineral abundance in the various lithotypes is negligible (viz. Total-S values typically less than 0.1 %). This is a generic feature of lithotypes above the BoX at iron-ore mines in the Pilbara.[1]

In terms of assessing the potential for the formation of Acid-Rock Drainage (ARD), a "S-threshold/cutoff" of 0.3 % (as S) is employed herein. Although Sulphide-S values less than 0.3 % may result in acidification, this is restricted to specific assemblages of sulphide- and groundmass-minerals. In particular, it applies to lithotypes for which both the sulphide-minerals include hyper-reactive varieties (e.g. framboidal-pyrite), and

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[1] Campbell (unpublished results since the late -1980s).

the groundmass comprises simply quartz, soil-clays, and sesquioxides (i.e. devoid of reactive-carbonates, and primary-rock-silicates).[2] However, this "type-mineralogy" is not characteristic of the mine-waste streams to be produced from above the BoX during the FPIOP.

The Shale units from the Basement-Zone generally contain trace-to-accessory amounts of pyrite, and so are geochemically distinct from the above-BoX lithotypes. The latter are all classified as Non-Acid Forming (NAF), whereas the former are classified as either NAF, or Potentially-Acid Forming (PAF), depending on pyrite abundance, as discussed further below.

2.0 GEOCHEMISTRY OF SAMPLES FROM DELTA PIT

In the following, the descriptor "waste-regolith" is used broadly for lithotypes from above the BoX, and "waste-bedrock" is used for lithotypes from below the BoX (i.e. from the Basement-Zone).

2.1 Static-Testing Programme

The testwork results are presented in Tables 1-5, and shown on Figure 1.

2.1.1 Acid-Forming Characteristics and Salinity

All waste-regolith samples contained "negligible-sulphides", and were classified as NAF (Table 1), as expected from statistical appraisal of S-occurrences (Attachment I).

The samples were neutral-to-alkaline (viz. pH 7-8) with low contents of soluble-salts. Such pH and salinity regimes are typical of S-deficient-mine-waste streams produced at iron-ore-mines in the Pilbara.[3]

The waste-bedrock samples were variously classified as PAF and NAF (Table 1). The Sulphide-S values ranged up to 2.5 %, and the Acid-Neutralisation-Capacity (ANC) values were 17-45 kg H_2SO_4/tonne. The pH-buffering curves (Figure 1) indicate only a modest capacity for circum-neutral buffering by reactive-carbonates.

Over a 6-m-run, individual-2-m-intervals were either PAF or NAF, and *highlights the "tight-spatial-variation" of pyrite abundance in the Shale units (from Whaleback-Shale and Dales-Gorge members of the Brockman Formation) within the Basement-Zone*. Although only three 6-m-runs from the Basement-Zone were assessed herein, the indications are that, due to the paucity of reactive-carbonates, NAF-intervals provide limited geochemical benefit when "mixed" with adjoining PAF-intervals during mining.

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[2] References:
Price W, 2005, "Criteria Used in Material Characterization and the Prediction of Drainage Chemistry: "Screaming Criteria"", Presentation B.1 in "Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop on "Challenges in the Prediction of Drainage Chemistry", November 30 to December 1, 2005, Vancouver, British Columbia.
Price WA, Morin K and Hutt N, 1997, "Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia: Part II. Recommended Procedures for Static and Kinetic Testing", pp. 15-30 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Volume I, Vancouver.
Campbell GD, unpublished results since the late-1980s.

[3] Campbell (unpublished results).

2.1.2 Multi-Element Composition

All samples were analysed for As, Sb, Se, Mo and B (Table 2). These minor-elements occur as oxyanions (e.g. arsenates, antimonates, etc.) in natural systems, and their pH-solubility relationships are such that concentrations can potentially be within the mg/L+ range at circum-neutral-pH. Selected waste-regolith samples were subjected to multi-element analyses (Table 3).[4] All analyses correspond to detection-limits relevant to environmental, "base-line" assessments.

The samples subjected to multi-element analyses had contents of major- and minor-elements below, or close to, those recorded for soils, regoliths, and bedrocks derived from unmineralised terrain (Table 3).

The ranges in contents of the above "oxyanion-minor-element-suite" were (Table 2):

- 6.7-61 mg/kg for As;
- 0.46-3.7 mg/kg for Sb;
- 0.06-2.6 mg/kg for Se;
- 0.6-5.4 mg/kg for Mo; and,
- less than 50 mg/kg, to 100 mg/kg, for B.

The above Total-As, Total-Sb, Total-Se, Total-Mo, and Total-B contents above fall within the range generally recorded for mine-waste samples derived from other iron-ore mines on the Pilbara block, especially for lithotypes devoid of sulphide-minerals (e.g. located above the BoX).[5] That the waste-bedrock samples also had modest contents of these minor-elements means that, environmentally, the contained pyrite was relatively "clean", and reflects the nature of mineralisation within the Delta Deposit.

2.1.3 Minor-Element Solubility

To assess the stability of major/minor-elements, a range of waste-regolith samples was subjected to Water-Extraction Tests (Table 4).[6] In this testwork, crushed samples (nominal -2 mm) were extracted for *c.* 1 day via the bottle-roll technique, employing slurries prepared from deionised-water, at a solid:solution ratio of *c.* 1:2 (w/w). The resulting water-extracts were centrifuged, filtered (0.45-µm-membrane), and preserved, as appropriate, for specific analyses (see Attachment II).[7]

> Note: To assist interpretation of the Water-Extraction-Test results, a broad comparison may be made between the testwork conditions, and elution of solutes from the surficial-zone of the waste-dumps by rainfall. The solid:solution ratio employed in the testing was *c.* 1:2 (w/w). If the Dry-Bulk-Density (DBD) of the mixture of the fine-earth (viz. -2 mm) fraction, and clasts, is

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[4] Multi-element analyses were undertaken on the composite-waste-bedrock samples subjected to kinetic-testing (Section 2.2.2).

[5] Campbell (unpublished results).

[6] Additional waste-regolith samples were subjected to kinetic-testing (Section 2.2.1). Water-Extraction Tests were not undertaken on "individual-waste-bedrock" samples, since composite-waste-bedrock samples were subjected to kinetic-testing (Section 2.2.2).

[7] It should be noted that, despite centrifuging, it often proved difficult to vacuum-filter the water-extracts through a 0.45µm-membrane, due to "ultrafines" likely approaching near-colloidal dimensions. A combination of low ionic-strengths, and particle-particle abrasion during continuous agitation, likely accounts for the generation of ultrafines during the water-extraction testwork.

> *c.* 2.0 t/m^3, then for an annual rainfall of *c.* 300-400 mm, the "equivalent" solid:solution ratio experienced by the top 0.1 m may be taken as *c.* 1:2 (w/w). Therefore, the testwork results broadly correspond to the efficient leaching of the top decimetre of a mine-waste-profile by a year's worth of rainfall, and where all drainage-waters are collected in a dam without any mixing with runoff-waters derived from up-catchment areas. Although approximate, this comparison assists in placing the testwork results into broad perspective in terms of water-quality contexts for downstream environs. Nonetheless, sight must not be lost of the testwork conditions employed (viz. samples as powders in suspensions that were continuously agitated). The Water-Extraction Tests herein serves simply to identify any weakly-bound forms of solutes which are susceptible to release to solution upon contact with meteoric-waters.

The concentration of minor-elements in the water-extracts were either below, or close to, the respective detection-limits (viz. typically within the range 0.1-10 μg/L) [Table 4]. These results are consistent with the hydrogeochemical expectation of a sparingly-low solubility of minor-elements (at circum-neutral-pH) for mine-wastes which are Fe-rich, weakly-mineralised, and devoid of sulphide- and carbonate-minerals.

The Se concentrations in the water-extracts ranged up to 0.5 μg/L, corresponding to test-slurries with a solid:solution ratio of *c.* 1:2 (w/w). In related water-extraction testwork on ferruginous-overburden samples from the Yandi Iron-Ore Mine, Gardiner (2003) reported Se concentrations in water-extracts of *c.* 21-43 μg/L (see Tables 3.11-3.13 in Gardiner [2003]), corresponding to test-slurries with a solid:solution ratio of *c.* 1:20 (w/w).[8] When expressed in terms of μg of Se extracted per kg of dry-solids, the mine-waste samples tested in the present study had Water-Extractable-Se contents ranging up to *c.* 1 μg Se/kg, whereas Gardiner (2003) reported Water-Extractable-Se contents within the range *c.* 400-900 μg Se/kg. There is therefore more than a 100-fold difference in the Water-Extractable-Se contents between this study, and that of Gardiner (2003). Based on the latter results, it was concluded that elevated Se solubility could be a water-quality issue for pit-lakes at mine-closure. However, there are numerous inconsistencies in the Se (and other) results reported by Gardiner (2003). Given the potential implications of such apparent Se-solubility behaviour to the iron-ore-mining industry generally, it is justified to critique these Se-analysis anomalies.

> Anomalous-Results from Gardiner (2003): Sample LAET-908 had a Total-Se content less than 0.01 mg/kg (Table 3.7), yet its Water-Extractable-Se content (calculated from the Water-Extract-Se concentration of 31.5 μg/L in Table 3.12) is 0.63 mg/kg. Related discrepancies occur for the Zn results. Water-Extract-Fe concentrations ranged up to 13.2 mg/L (Table 3.13) which are untenable for "true" Soluble-Fe forms at circum-neutral-pH, and the oxic-redox conditions of the test-slurries employed in the water-extraction testwork. Finally, several water-extracts had apparent alkalinities greater than 1,000 mg/L (as $CaCO_3$), and Ca concentrations within the range *c.* 200-800 mg/L, yet the corresponding EC values were only *c.* 80-150 μS/cm (Tables 3.11-3.13). These anomalous results can be explained by the occurrence of ultra-fine (i.e. sub-μm-sized) forms of carbonate-minerals (e.g. calcites), clays and Fe/Al-sesquioxides which passed through the 0.45μm-membrane, and then released bound forms of minor-elements (e.g. Se and Zn) to solution when the filtrates were preserved for analysis by acidifying with HNO_3. In a similar fashion, for the analysis of the unacidified water-extracts, consumption of HCl in acidimetric titration to determine alkalinities chiefly reflected dissolution of suspended ultra-fine forms of carbonate-minerals, etc. (c.f. "true" HCO_3 in solution).
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> The net outcome of the above critique is that the stability of Se (and other minor-elements) in S-deficient varieties of mine-wastes at iron-ore-mines in the Pilbara is likely considerably greater, and therefore solubility at circum-neutral-pH considerably lower, than reported by Gardiner

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[8] Gardiner SJ, 2003, "Impacts of Mining and Mine Closure on Water Quality and the Nature of the Shallow Aquifer, Yandi Iron Ore Mine", MSc Thesis, Department of Applied Geology, Curtin University of Technology, Drs R Watkins and C Evans as Supervisors.

> (2003).[9] Selenium (and other minor-elements) certainly correspond to forms of high stability for the mine-waste samples tested herein.

In brief, minor-element solubility at circum-neutral-pH (viz. "metalliferous-drainage") should not be an issue for management of the "gutless" waste-regolith streams produced during from the Delta Pit. This conclusion is further supported by the kinetic-testing discussed below.

2.1.4 Clay-Mineralogy and Clay-Surface-Chemistry

Kaolinite was the sole phyllosilicate (viz. clay-mineral) detected in the waste-regolith samples subjected to mineralogical assessment (Table 5).

The Effective-Cation-Exchange-Capacity (eCEC) values were 2.3-3.2 cmol (p+)/kg, and the Exchangeable-Sodium-Percentage (ESP) values were *c.* 24-34 %. The samples were therefore variously sodic.

2.2 Kinetic-Testing Programme

The testwork results are presented in Tables 6-13.

2.2.1 Waste-regoliths

A range of waste-regolith samples were subjected to kinetic-testing (viz. Weathering-Columns) in order to extend the findings the Water-Extraction Tests above, and thereby allow further assessment of minor-element stability in lithotypes destined to be placed in the outermost sections of the waste-landforms at closure.

Details of the kinetic-testing are presented in Attachment II. In broad terms, the leachates produced from the weathering-columns approximate flushing of the top few decimetres of mine-wastes (comprising a mixture of fine-earth [-2mm], and clast fractions) by a storm-depth of *c.* 40-50 mm. The "store" of solutes produced during the drying-phase broadly corresponds to that associated with evaporative-drying to residual moistures/suctions over the course of a few days.

The samples tested represent the six (6) generic types of waste-regoliths to be produced from the Delta Pit, viz.

- DID1, DID2, DID3, DID4, CID, and BID

Prior to commencing the kinetic-testing, the "bulk-geochemistry" and mineralogy of these samples were characterised (Tables 6-8), and are consistent with the results of the static-testing discussed above.

The leachate-analysis results for up to six (6) weekly-weathering-cycles, including a pre-rinse-cycle, are presented in Table 9. All leachate were subjected to "full-chemical-analysis" comprising the determination of major-parameters, and major/minor-elements via multi-element analyses. The leachates were often turbid, due to "ultra-fines" which often passed through the 0.45-µm-membrane during vacuum-filtration. Accordingly, the Filtrable-Minor-Element concentrations are variously biased "on-the-high-side", due

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[9] This misleading information reported by Gardner (2003) has been flagged in a number of recent GCA-reports for proposed iron-ore Projects in the Pilbara.

to contributions from ultra-fine-particulate forms (e.g. Fe/Al-sesquioxides of "near-nano" dimensions, etc.).[10]

Weathering of the waste-regolith samples yielded negligible amounts of solutes during alternating cycles of desiccation and inundation (e.g. the Leachate-EC values were always less than 100 µS/cm, and could decrease to less than the detection-limit of 10 µS/cm).[11] The concentration of minor-elements in the leachates were either below, or close to, the respective detection-limits (viz. typically within the range 0.1-10 µg/L). Similar results were obtained in the Water-Extraction Tests.

Summarising, the very nature of the "gutless" waste-regoliths means that, weathering-wise, they simply have "nothing-to-give" hydrogeochemically. This reflects their generic "negligible-S-tenor", and heavily-leached state from weathering *in situ* typical of geomedia above the BoX on the Pilbara block. Accordingly, minor-elements occur as stable forms of low solubility at "ambient-pH" (i.e. circum-neutral-pH).

2.2.2 Waste-bedrocks

Three (3) composite-waste-bedrock samples were subjected to kinetic-testing, viz.

- Shl, Shl-(WS), and, Shl-(DGS).

The composites were equal-weight-composites prepared using the crushed-splits (viz. -2 mm) of the respective "individual-samples".

All composites were mildly-acidic (pH *c.* 4-6) with moderate contents of soluble-salts (chiefly sulphates) [Table 10]. The Sulphide-S values were 1.3-2.0 %, corresponding to accessory amounts of pyrite (Table 12). There was also accessory amounts of siderites with a lattice-Mn-mole fraction up to *c.* 5 %. Although variously enriched in As, Sb and Se, the degree of enrichment in these minor-elements was not marked (Table 11).

Over the six (6) weekly-weathering-cycles performed, the Leachate-pH values were typically within the range 5-8 (Table 13).

Calculations indicate that, over Cycle-4 to Cycle-6, steady Sulphide-Oxidation Rates (SORs) of *c.* 50-90 mg SO_4/kg/week were attained. Given the Sulphide-S values of 1.3-2.0 %, and the Leachate-pH values of *c.* 5-8, such SORs indicate that the pyrite in the samples is not atypically reactive.

Manganese was the sole metal which exhibited appreciable solubility (viz. Leachate-Mn concentrations ranging up to *c.* 40-50 mg/L). Such Mn solubility reflects dissolution of the siderites during weathering. Any Fe(II) released from siderite dissolution was effectively oxidised to Fe(III), followed by hydrolysis/precipitation for form Fe(III)-oxyhydroxides, since the Leachate-Fe concentrations were typically less than the detection-limit of 0.01 mg/L.

Summarising, the weathering-cycles completed for the PAF-composite-waste-bedrock samples correspond to the initial "lag-phase" stage of weathering (viz. the period during which sulphide-oxidation occurs, but acidifications is suppressed, due to circum-neutral-buffering by groundmass-minerals). In addition to potable-to-brackish (SO_4-

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[10] Related "ultra-fines" were also recorded in the water-extracts discussed above.

[11] EC = Electrical-Conductivity.

dominated) salinities, lag-phase weathering is associated with Mn concentrations within the mg/L+ range (associated with siderite dissolution).

3.0 GEOCHEMISTRY OF SAMPLES FROM EAGLE PIT

Testing of samples from the Eagle Pit was restricted to static-testing. The testwork results are presented in Tables 14-18.

3.1 Acid-Forming Characteristics and Salinity

All waste-regolith samples contained "negligible-sulphides", and were classified as NAF (Table 14), as expected from statistical appraisal of S-occurrences (Attachment I). The samples were neutral-to-alkaline (viz. pH 7-8) with low contents of soluble-salts.

The waste-bedrock samples were variously classified as PAF and NAF (Table 14). The Sulphide-S values ranged up to 2.5 %, and the ANC values ranged up to 26 kg H_2SO_4/tonne.

Over a 6-m-run, individual-2-m-intervals were either PAF or NAF, and *highlights the "tight-spatial-variation" of pyrite abundance in the Shale units (from Whaleback-Shale and Dales-Gorge members of the Brockman Formation) within the Basement-Zone*.

The above findings closely match those for the mine-waste samples from the Delta Pit.

2.2 Multi-Element Composition

All samples were analysed for As, Sb, Se, Mo and B (Table 15), and selected waste-bedrock samples were subjected to multi-element analyses (Table 16).

The ranges in contents of the above "oxyanion-minor-element-suite" were:

- 7.7-51 mg/kg for As;
- 0.74-4.0 mg/kg for Sb;
- 0.24-3.9 mg/kg for Se;
- 1.0-3.4 mg/kg for Mo; and,
- less than 50 mg/kg for B.

The above Total-As, Total-Sb, Total-Se, Total-Mo, and Total-B contents were similar to those for the samples from the Delta Pit.

3.3 Minor-Element Solubility

The waste-regolith samples subjected to the Water-Extraction Tests produced water-extracts that were circum-neutral, and with concentrations of minor-elements either below, or close to, the respective detection-limits (viz. typically within the range 0.1-10 µg/L) [Table 17].

The waste-bedrock samples produced water-extracts that were acidic, and enriched in Soluble-Fe, -Al, and -Mn forms.

3.4 Clay-Mineralogy and Clay-Surface-Chemistry

Kaolinite was the sole phyllosilicate (viz. clay-mineral) detected in the waste-regolith samples subjected to mineralogical assessment (Table 18).

The eCEC values were 1.6-3.5 cmol (p+)/kg, and the ESP values were *c.* 17-54 %. The samples were therefore variously sodic.

4.0 GEOCHEMISTRY OF SAMPLES FROM CHAMPION PIT

Testing of samples from the Champion Pit was restricted to static-testing. The testwork results are presented in Tables 19-23.

4.1 Acid-Forming Characteristics and Salinity

All <u>waste-regolith</u> samples contained "negligible-sulphides", and were classified as NAF (Table 19), as expected from statistical appraisal of S-occurrences (Attachment I). The samples were circum-neutral (viz. pH 6-8) with low contents of soluble-salts.

The <u>waste-bedrock</u> samples were variously classified as PAF and NAF (Table 19). The Sulphide-S values ranged up to 2.8 %, and the ANC values ranged up to 38 kg H_2SO_4/tonne. Although only a small population of samples was tested, the indications are that the groundmass of the samples from the Champion Pit are less than those for the Delta and Eagle Pits. The pH-buffering curve (Figure 2) for sample GCA9726 (Shl) indicate only a modest capacity for circum-neutral buffering by reactive-carbonates.

There was no systematic variation in the acid-forming characteristics between the "skin" and "core" samples collected from drillhole HPRC0345 (Attachment I).

The above findings accord with those for the mine-waste samples from the Delta and Eagle Pits.

4.2 Multi-Element Composition

All samples were analysed for As, Sb, Se, Mo and B (Table 20), and selected waste-bedrock samples were subjected to multi-element analyses (Table 21).

The ranges in contents of the above "oxyanion-minor-element-suite" were:

- 9.5-91 mg/kg for As;
- 0.94-5.6 mg/kg for Sb;
- 0.28-2.8 mg/kg for Se;
- 0.6-3.6 mg/kg for Mo; and,
- less than 50 mg/kg for B.

The above Total-As, Total-Sb, Total-Se, Total-Mo, and Total-B contents were similar to those for the samples from the Delta and Eagle Pits.

4.3 Minor-Element Solubility

The waste-bedrock samples subjected to the Water-Extraction Tests produced water-extracts that were acidic, and enriched in Soluble-Fe, -Al, -Mn, -Cu, -Ni, -Zn, and -Co forms (Table 22).

4.4 Clay-Mineralogy and Clay-Surface-Chemistry

Kaolinite was the sole phyllosilicate (viz. clay-mineral) detected in the waste-regolith samples subjected to mineralogical assessment (Table 23).

The eCEC values were 2.4-3.1 cmol (p+)/kg, and the ESP values were *c.* 14-57 %. The samples were therefore variously sodic.

5.0 IMPLICATIONS FOR MINE-WASTE MANAGEMENT

The management implications outlined below reflect a working-model of mine-waste geochemistry for the Delta, Eagle and Champion Pits developed from the testwork results obtained in this study, as well as experience with other deposits on the Pilbara block which share a related geology, and style of mineralisation (viz. "channel-type-iron-ore deposits").

5.1 Waste-regoliths

Geochemically, the various waste-regolith units (i.e. lithotypes above the BoX) from all Pits should be benign (i.e. extremes in pH and/or salinity should not place constraints on how such materials are managed). The 'ex-pit' streams of the waste-regolith units should be circum-neutral, and of low salinity. Such pH and salinity regimes should prevail over the longer-term during weathering on the waste-dumps, as governed by the frequency, and penetration-depth, of the seasonal wetting-front.[12]

Since the remnant "chalcophyle-signature" reflecting mineralisation is weak, minor-element enrichments should pose no concerns to water-quality, or uptake by plant-roots. The abundance of Fe-oxyhydroxides should ensure that minor-elements are retained by sorption reactions of the "high-affinity/poorly-reversible" type, as have occurred *in situ* over the eons.

Since the majority of the lithotypes produced during mining are competent, chunky and durable, they are well suited to applications where exposure occurs over the longer-term (e.g. rock-armouring, construction of pit-safety-bund, etc.). Where earthy, friable lithotypes are produced, their susceptibility to erosion should be dampened by the expected abundance of clasts, and the fact that their "fine-earth" fraction (viz. -2 mm) should not be enriched in smectites (i.e. "high-activity" clays that exhibit marked shrink-swell behaviour). Together with topsoils, such lithotypes should be earmarked for use in constructing the outermost-sections of the waste-landforms, so that water-retention capacities, in particular, are favourable to vegetation. However, since friable materials are susceptible to erosion, a balance needs to be struck between creating a

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[12] Campbell GD, 2008, "Mine-Waste Geochemistry, Rainfall Seasonality, and Coincidence of the Wetting/Oxidation-Fronts: A Conceptual Arid-Zone Weathering Model", PowerPoint-presentation delivered at the May 2008 Workshop of the Goldfields Environmental Management Group, Kalgoorlie. Campbell GD, 2007, "Isolation of Reactive Mine-Wastes in the WA Goldfields: How Arid-Zone Weathering and Hydroecology Simplify Cover-Design Studies", Section 8 in "Planning for Mine-Closure Seminar", Australian Centre for Geomechanics, 14-15 June 2007, 40 pp.

profile which is both texturally suitable as a rooting-medium for plant growth, and physically stable. These challenges are generic to mine-waste management at hard-rock mines.

In brief, waste-landform design and rehabilitation should not be constrained by the physicochemical nature of the mine-waste streams. Planning for waste-landform decommissioning should integrate industry best-practice concepts for rehabilitation and mine-site closure (DITR 2006a,b), and the practical know-how from other Pilbara iron-ore mines.[13]

5.2 Waste-bedrocks

It is understood that, based on the current mining-plan, the interbedded Shales and BIFs from the Basement-Zone (i.e. waste-bedrocks below the BoX) of the Pits may, or may not, be disturbed.

If the waste-bedrocks are mined, then the indications are that most truckloads will comprise PAF-rock overall, and reflects the spatial distribution of "trace/accessory-pyrite" in a sideritic-groundmass. The 'ex-pit' streams of such PAF-rock should be potential "source-terms" of moderate strength for circum-neutral-sulphates, and Mn, when inundated by episodic rainfall of sizeable storm-depths (e.g. above 10-20 mm). Provision would therefore need to be made to isolate such lithotypes beneath the reach of the seasonal wetting-front on the waste-dumps.

6.0 CLOSURE

I trust the above is useful to you.

Regards,

Dr GD Campbell
Director

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[13] Department of Industry, Tourism and Resources, 2006a, "Mine Closure and Completion", Leading Practice Sustainable Development Program for the Mining Industry, Canberra.
Department of Industry, Tourism and Resources, 2006b, "Mine Rehabilitation", Leading Practice Sustainable Development Program for the Mining Industry, Canberra.

TABLES

List of Tables

Delta

Eagle

Champion

Table 1: Acid-Base-Analysis and Net-Acid-Generation Results for Mine-Waste Samples (Delta)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	DRILLHOLE & DOWN-HOLE INTERVAL (m)	LITHOTYPE	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO_4-S (%)	SULPHIDE-S (%)	TOTAL-C (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	ANC/MPA RATIO	AFP CATEGORY
											kg H_2SO_4/tonne					
Samples from Above-BoX (= "waste-regoliths"																
GCA9665	HPDS001	HPRC2170, 4-6	RC	8.0	0.16	0.02 [0.011]	<0.01	0.02	0.17 (0.16)	0.11 (0.11)	16 (19)	nc	<0.5	8.3	nc	NAF
GCA9666	HPDS002	HPRC2170, 28-30	DID1	8.0	0.083	0.03 [0.012]	<0.01	0.03	0.07	0.02	4	nc	<0.5	6.5	nc	NAF
GCA9667	HPDS003	HPRC2135, 24-26	DID1	7.9	0.038	0.04 [0.015]	<0.01	0.04	0.08	0.02	3	nc	<0.5	6.1	nc	NAF
GCA9668	HPDS004	HPRC2087, 22-24	DID1	7.7	0.054	0.04 [0.020]	<0.01	0.04	0.06	<0.01	4	nc	<0.5	6.2	nc	NAF
GCA9669	HPDS005	HPRC3152, 10-12	DID2	7.8	0.053	0.04 [0.020]	<0.01	0.04	0.10	0.04	3	nc	<0.5	5.9	nc	NAF
GCA9670	HPDS006	HPRC2105, 14-16	DID2	7.6	0.028	0.03 [0.016]	<0.01	0.03	0.09	0.05	3	nc	<0.5	6.0	nc	NAF
GCA9671	HPDS007	HPRC2218, 20-22	DID2	7.6	0.029	0.04 [0.021]	<0.01	0.04	0.09	0.05	3	nc	<0.5	5.9	nc	NAF
GCA9672	HPDS008	HPRC3152, 22-24	DID3	7.5	0.096	0.05 [0.029]	<0.01	0.05	0.10	0.02	3	nc	<0.5	5.4	nc	NAF
GCA9673	HPDS009	HPRC2105, 32-34	DID3	7.2	0.030	0.03 [0.016]	<0.01	0.03	0.11	0.03	4	nc	<0.5	5.4	nc	NAF
GCA9674	HPDS010	HPRC3013, 22-24	DID3	6.8	0.10	0.03 [0.014]	<0.01	0.03	0.11	0.06	4	nc	<0.5	5.9	nc	NAF
GCA9675	HPDS011	HPRC2171, 52-54	DID4	7.1 (7.2)	0.032 (0.026)	0.03 [0.010]	<0.01	0.03	0.18	0.10	4	nc	<0.5	5.2	nc	NAF
GCA9676	HPDS012	HPRC3152, 40-42	DID4	7.2	0.043	0.02 [0.010]	<0.01	0.02	0.11	0.05	3	nc	<0.5	5.0	nc	NAF
GCA9677	HPDS013	HPRC3013, 24-26	DID4	7.2	0.027	0.02 [0.013]	<0.01	0.02	0.15	0.10	3	nc	<0.5	5.5	nc	NAF
GCA9678	HPDS014	HPRC2177, 84-86	CID	6.8	0.071	0.02 [0.005]	<0.01	0.02	0.19	0.13	4	nc	<0.5	6.0	nc	NAF
GCA9679	HPDS015	HPRC3156, 50-52	BID	7.0	0.042	0.02 [0.008]	<0.01	0.02	0.14	0.09	3	nc	<0.5	6.0	nc	NAF
GCA9680	HPDS016	HPRC3013, 34-36	BID	6.8	0.066	0.02 [0.023]	<0.01	0.02	0.45	0.19	6	nc	<0.5	5.9	nc	NAF
GCA9681	HPDS017	HPRC2105, 42-44	BID	6.9	0.047	0.03 [0.030]	<0.01	0.03	0.31	0.15	5	nc	<0.5	5.6	nc	NAF
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")																
GCA9682	HPDS018	HPRC2197, 50-52	Shl	4.4	1.2	1.2 [1.04]	0.23	1.0	2.3	1.5	25	5.6	2.3 (3.2)	3.7 (3.7)	<1	**PAF**
GCA9683	HPDS019	HPRC2197, 52-54	Shl	3.8	1.6	2.7 [2.36]	0.31	2.5	3.1	2.2	34	43	23	3.6	<1	**PAF**
GCA9684	HPDS020	HPRC2197, 54-56	Bif	6.1	0.59	0.39 [0.382]	0.02	0.37	3.7	3.5	45	-33	<0.5	7.5	>3	NAF
GCA9685	HPDS021	HPRC3027, 42-44	Shl-(WS)	4.6 (4.6)	1.4 (1.4)	2.1 [1.43]	0.21	1.9	3.6	2.8	22 (26)	37	9.5	4.2	<1	**PAF**
GCA9686	HPDS022	HPRC3027, 44-46	Shl-(WS)	5.3	1.8	2.7 [2.50]	0.23	2.5	4.1	3.4	33	44	17	4.0	<1	**PAF**
GCA9687	HPDS023	HPRC3027, 46-48	Bif	6.2	0.39	0.18 [0.197]	<0.01	0.18	3.2	3.0	42	-36	<0.5	8.0	>3	NAF
GCA9688	HPDS024	HPRC2323, 80-82	Shl-(DGS)	5.6	1.2	1.9 [1.68]	0.14	1.8	1.7	0.97	17	39	28	2.7	<1	**PAF**
GCA9689	HPDS025	HPRC2323, 82-84	Bif	6.4	0.32	0.09 [0.126]	<0.01	0.09	1.0	0.94	24	nc	<0.5	8.0	nc	NAF
GCA9690	HPDS026	HPRC2323, 84-86	Shl-(DGS)	6.6	0.41	0.69 [0.531]	0.02	0.67	3.1	3.0	27	-6.4	<0.5	7.7	1.3	**PAF**

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation-Capacity; NAPP = Net-Acid-Producing-Potential; AFP = Acid-Formation-Potential; NAG = Net-Acid Generation; nc = not calculated;
NAF = Non-Acid-Forming; PAF = Potentially-Acid Forming.
pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH. Values in round-parentheses represent duplicates.

N.B. Total-S values in square-parentheses correspond to results from Exploration-Database.

Table 2: Total-Contents of As, Sb, Se, Mo and B in Mine-Waste Samples (Delta)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	DRILLHOLE & DOWN-HOLE INTERVAL (m)	LITHOTYPE	SULPHIDE-S (%)	TOTAL-As (mg/kg)	TOTAL-Sb (mg/kg)	TOTAL-Se (mg/kg)	TOTAL-Mo (mg/kg)	TOTAL-B (mg/kg)
Samples from Above-BoX (= "waste-regoliths"									
GCA9665	HPDS001	HPRC2170, 4-6	RC	0.02	8.8	0.98	0.47	0.8	<50
GCA9666	HPDS002	HPRC2170, 28-30	DID1	0.03	8.6	0.99	0.28	0.9	<50
GCA9667	HPDS003	HPRC2135, 24-26	DID1	0.04	13	1.4	0.34	1.5	<50
GCA9668	HPDS004	HPRC2087, 22-24	DID1	0.04	8.2	1.0	0.52	1.0	<50
GCA9669	HPDS005	HPRC3152, 10-12	DID2	0.04	20	2.2	1.1	2.0	<50
GCA9670	HPDS006	HPRC2105, 14-16	DID2	0.03	12	1.3	0.60	1.5	<50
GCA9671	HPDS007	HPRC2218, 20-22	DID2	0.04	17	1.8	0.49	1.6	<50
GCA9672	HPDS008	HPRC3152, 22-24	DID3	0.05	22	2.1	0.76	1.9	<50
GCA9673	HPDS009	HPRC2105, 32-34	DID3	0.03	16	1.8	0.29	3.2	<50
GCA9674	HPDS010	HPRC3013, 22-24	DID3	0.03	13	2.1	0.26	3.8	<50
GCA9675	HPDS011	HPRC2171, 52-54	DID4	0.03	13	1.8	0.32	3.0	<50
GCA9676	HPDS012	HPRC3152, 40-42	DID4	0.02	13	2.2	0.14	3.7	<50
GCA9677	HPDS013	HPRC3013, 24-26	DID4	0.02	12	2.7	0.34	4.9	<50
GCA9678	HPDS014	HPRC2177, 84-86	CID	0.02	21	2.2	0.39	1.6	<50
GCA9679	HPDS015	HPRC3156, 50-52	BID	0.02	6.7	0.74	0.31	0.7	<50
GCA9680	HPDS016	HPRC3013, 34-36	BID	0.02	17	1.3	2.6	1.6	<50
GCA9681	HPDS017	HPRC2105, 42-44	BID	0.03	17	0.78	1.8	1.5	<50
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")									
GCA9682	HPDS018	HPRC2197, 50-52	Shl	1.0	35	2.8	1.6	2.6	<50
GCA9683	HPDS019	HPRC2197, 52-54	Shl	2.5	48	3.2	2.1	2.7	<50
GCA9684	HPDS020	HPRC2197, 54-56	Bif	0.37	24	0.58	0.41	0.7	66
GCA9685	HPDS021	HPRC3027, 42-44	Shl-(WS)	1.9	44	3.4	1.3	2.9	<50
GCA9686	HPDS022	HPRC3027, 44-46	Shl-(WS)	2.5	37	3.5	1.4	2.6	<50
GCA9687	HPDS023	HPRC3027, 46-48	Bif	0.18	16	0.46	0.19	0.6	100
GCA9688	HPDS024	HPRC2323, 80-82	Shl-(DGS)	1.8	61	3.7	0.82	5.4	<50
GCA9689	HPDS025	HPRC2323, 82-84	Bif	0.09	8.1	0.63	0.06	0.7	<50
GCA9690	HPDS026	HPRC2323, 84-86	Shl-(DGS)	0.67	32	1.1	0.45	1.2	<50

Table 3: Multi-Element-Analysis Results for Mine-Waste Samples (Delta)

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	RC (GCA9665)	DID1 (GCA9667)	DID2 (GCA9669)		RC (GCA9665)	DID1 (GCA9667)	DID2 (GCA9669)
Al	2.2%	2.9%	2.7%	8.2%	0	0	0
Fe	40.2%	50.7%	55.8%	4.1%	**3**	**3**	**3**
Na	0.033%	0.0095%	0.015%	2.3%	0	0	0
K	0.20%	0.08%	0.11%	2.1%	0	0	0
Mg	0.12%	0.06%	0.04%	2.3%	0	0	0
Ca	0.6%	0.2%	0.2%	4.1%	0	0	0
Ag	0.06	0.04	0.02	0.07	0	0	0
Cu	15	12	8	50	0	0	0
Zn	17	8	9	75	0	0	0
Cd	0.09	0.05	<0.02	0.11	0	0	0
Pb	7.8	11	12	14	0	0	0
Cr	160	54	110	100	0	0	0
Ni	10	9	8	80	0	0	0
Co	2.9	2.2	1.7	20	0	0	0
Mn	210	160	110	950	0	0	0
Hg	0.02	<0.01	<0.01	0.05	0	0	0
Sn	1.1	1.7	1.9	2.2	0	0	0
Sr	31	7.9	7.8	370	0	0	0
Ba	110	21	35	500	0	0	0
Th	4.6	6.3	8.4	12	0	0	0
U	0.81	1.4	1.7	2.4	0	0	0
Tl	0.13	0.04	0.03	0.6	0	0	0
V	71	110	55	160	0	0	0
As	11	14	21	1.5	2	**3**	**3**
Bi	0.16	0.21	0.28	0.048	1	2	2
Sb	1.3	1.7	2.5	0.2	2	**3**	**3**
Se	0.45	0.34	1.1	0.05	**3**	2	**4**
Mo	0.9	1.5	2.0	1.5	0	0	0
B	<50	<50	<50	10	0	0	0
P	500	380	360	1,000	0	0	0
F	160	160	120	950	0	0	0

Note:
Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

Table 3 (Cont'd): Multi-Element-Analysis Results for Mine-Waste Samples (Delta)

ELEMENT	**TOTAL-ELEMENT CONTENT (mg/kg or %)**			**AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)**	**GEOCHEMICAL-ABUNDANCE INDEX (GAI)**		
	DID3 (GCA9673)	**DID4 (GCA9676)**	**BID (GCA9681)**		**DID3 (GCA9673)**	**DID4 (GCA9676)**	**BID (GCA9681)**
Al	2.3%	0.49%	1.8%	8.2%	0	0	0
Fe	59.1%	61.0%	55.4%	4.1%	**3**	**3**	**3**
Na	0.0033%	0.0053%	0.0027%	2.3%	0	0	0
K	0.10%	0.09%	0.07%	2.1%	0	0	0
Mg	0.04%	0.04%	0.04%	2.3%	0	0	0
Ca	0.2%	0.2%	0.2%	4.1%	0	0	0
Ag	0.08	0.03	0.08	0.07	0	0	0
Cu	1	<1	12	50	0	0	0
Zn	10	11	34	75	0	0	0
Cd	0.02	<0.02	0.05	0.11	0	0	0
Pb	9.9	5.5	6.0	14	0	0	0
Cr	56	<50	93	100	0	0	0
Ni	5	4	10	80	0	0	0
Co	1.3	1.9	7.3	20	0	0	0
Mn	140	520	440	950	0	0	0
Hg	<0.01	0.05	0.13	0.05	0	0	1
Sn	2.6	2.5	1.3	2.2	0	0	0
Sr	3.6	2.6	1.8	370	0	0	0
Ba	7.4	9.8	51	500	0	0	0
Th	3.9	1.6	1.8	12	0	0	0
U	0.88	0.38	1.2	2.4	0	0	0
Tl	<0.02	<0.02	<0.02	0.6	0	0	0
V	69	47	58	160	0	0	0
As	16	13	18	1.5	**3**	**3**	**3**
Bi	0.23	0.23	0.13	0.048	2	2	1
Sb	2.1	2.5	1.1	0.2	**3**	**3**	2
Se	0.29	0.14	1.8	0.05	2	1	**5**
Mo	3.2	3.8	1.6	1.5	1	1	0
B	<50	<50	<50	10	0	0	0
P	480	750	1,800	1,000	0	0	0
F	150	150	260	950	0	0	0

Table 4: Water-Extraction-Testwork Results for Mine-Waste Samples (Delta)

Note: All results in mg/L, except for pH and Electrical-Conductivity (EC).

ELEMENT/ PARAMETER	**RC (GCA9665)**	**DID2 (GCA9669)**	**DID3 (GCA9673)**	**BID (GCA9680)**	**BID (GCA9681)**
Major-Parameters					
pH	8.4	7.4	6.7	6.9	6.9
EC [µS/cm]	210	46	21	28	35
Major-Ions (mg/L)					
Na	28	11	1.8	1.3	1.8
K	6.8	1.2	1.4	1.7	1.3
Mg	2.5	<0.01	0.58	1.0	1.6
Ca	13	0.05	0.47	0.84	1.7
Cl	5	3	2	2	2
SO_4	7	2	<1	1	2
Fe	0.10	0.23	<0.01	<0.01	<0.01
Al	0.08	0.29	0.02	0.04	0.01
Si	16	20	11	5.8	6.7
Minor-Ions (µg/L)					
Cu	<10	<10	<10	<10	<10
Ni	<10	<10	<10	<10	10
Zn	<10	<10	<10	<10	<10
Co	<0.1	<0.1	0.1	<0.1	<0.1
Cd	<0.02	<0.02	0.02	<0.02	<0.02
Pb	<0.5	<0.5	7.8	3.7	2.7
Cr	<10	<10	10	<10	<10
Hg	<0.1	<0.1	0.1	<0.1	<0.1
As	1.8	0.5	0.2	0.2	0.2
Sb	0.20	0.04	0.05	0.02	0.02
Bi	0.005	<0.005	<0.005	<0.005	<0.005
Se	0.5	<0.5	<0.5	<0.5	<0.5
B	110	90	30	10	10
Mo	1.1	0.14	<0.05	0.08	0.07
P	<100	<100	<100	<100	<100
Ag	0.01	0.01	0.02	<0.01	0.02
Ba	97	46	2.6	2.2	4.2
Sr	130	0.63	6.7	6.0	8.9
Tl	<0.01	<0.01	<0.01	<0.01	<0.01
V	<10	<10	<10	<10	<10
Sn	0.1	0.3	0.2	0.1	0.1
U	0.35	0.018	<0.005	<0.005	<0.005
Th	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	<10	<10	<10	<10	<10

Notes: Water-Extraction Testwork employed crushed-samples (nominal 2-mm), and slurries prepared using 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 centrifugation and vacuum-filtration) for analysis. Values in parentheses represent duplicates.

Table 5: Clay-Mineralogical and Clay-Surface-Chemistry Results for Mine-Waste Samples (Delta)

DID1 (GCA9666)					**DID2 (GCA9670)**				
hematite			dominant		hematite			dominant	
quartz			minor		goethite			minor	
kaolinite			accessory		kaolinite			accessory	
goethite					quartz				
gibbsite			trace		Ti-oxide			trace	
Ti-oxide									
eCEC [cmol (p+)/kg]	**%-Proportion of eCEC**				**eCEC [cmol (p+)/kg]**	**%-Proportion of eCEC**			
	Na	**K**	**Mg**	**Ca**		**Na**	**K**	**Mg**	**Ca**
3.2	24	6	34	36	2.3	34	<1	56	10

Notes:
eCEC = effective-Cation-Exchange Capacity
dominant = greater than 50 %; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %

Table 6: Acid-Base-Analysis and Net-Acid-Generation Results for Waste-regolith Samples for Kinetic-Testing (Delta)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	LITHOTYPE	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO_4-S (%)	SULPHIDE-S (%)	TOTAL-C (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	ANC/ MPA RATIO	AFP CATEGORY
										kg H_2SO_4/tonne					
GCA9728	HPDC001	DID1	6.3	0.12	0.03 (0.03)	<0.01 (<0.01)	0.03	0.08 (0.09)	<0.01 (<0.01)	6 (5)	nc	<0.5	6.2	nc	NAF
GCA9729	HPDC002	DID2	6.5	0.065	0.03	<0.01	0.03	0.11	0.03	3	nc	<0.5	6.1	nc	NAF
GCA9730	HPDC003	DID3	6.4	0.051	0.04	<0.01	0.04	0.13	0.05	2	nc	<0.5	5.7	nc	NAF
GCA9731	HPDC004	DID4	6.5	0.030	0.03	<0.01	0.03	0.19	0.09	1	nc	<0.5	5.5	nc	NAF
GCA9732	HPDC005	CID	6.4	0.041	0.02	<0.01	0.02	0.10	0.02	5	nc	<0.5	6.2	nc	NAF
GCA9733	HPDC006	BID	6.4 (6.4)	0.039 (0.041)	0.03	<0.01	0.03	0.31	0.18	4	nc	<0.5 (<0.5)	5.5 (5.5)	nc	NAF

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation-Capacity; NAPP = Net-Acid-Producing-Potential; AFP = Acid-Formation-Potential; NAG = Net-Acid Generation; nc = not calculated; NAF = Non-Acid-Forming.
pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.
Values in parentheses represent duplicates.

Table 7: Multi-Element-Analysis Results for Waste-regolith Samples for Kinetic-Testing (Delta)

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	DID1 (GCA9728)	DID2 (GCA9729)	DID3 (GCA9730)		DID1 (GCA9728)	DID2 (GCA9729)	DID3 (GCA9730)
Al	2.8%	3.1%	2.9%	8.2%	0	0	0
Fe	46.9%	51.7%	58.9%	4.1%	**3**	**3**	**3**
Na	0.032%	0.028%	0.011%	2.3%	0	0	0
K	<0.05%	0.14%	0.06%	2.1%	0	0	0
Mg	0.10%	0.12%	0.09%	2.3%	0	0	0
Ca	<0.1%	<0.1%	<0.1%	4.1%	0	0	0
Ag	0.09	0.10	0.12	0.07	0	0	0
Cu	15	7	4	50	0	0	0
Zn	6	7	1	75	0	0	0
Cd	0.05	<0.02	0.02	0.11	0	0	0
Pb	8.1	8.3	7.8	14	0	0	0
Cr	<50	<50	<50	100	0	0	0
Ni	5	5	2	80	0	0	0
Co	3.7	2.0	2	20	0	0	0
Mn	170	200	120	950	0	0	0
Hg	<0.01	<0.01	<0.01	0.05	0	0	0
Sn	0.9	1.2	1.7	2.2	0	0	0
Sr	4.6	8.5	3.9	370	0	0	0
Ba	44	36	13	500	0	0	0
Th	5.3	4.8	3.9	12	0	0	0
U	0.79	1.2	0.80	2.4	0	0	0
Tl	0.09	0.13	0.06	0.6	0	0	0
V	93	83	110	160	0	0	0
As	9.7	12	16	1.5	2	2	**3**
Bi	0.16	0.18	0.20	0.048	1	1	1
Sb	1.3	1.3	1.7	0.2	2	2	**3**
Se	0.80	0.72	0.37	0.05	**3**	**3**	2
Mo	1.1	1.6	2.7	1.5	0	0	0
B	<50	<50	<50	10	0	0	0
P	420	450	570	1,000	0	0	0
F	140	180	89	950	0	0	0

Note:
Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

Table 7 (Cont'd): Multi-Element-Analysis Results for Waste-regolith Samples for Kinetic-Testing (Delta)

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	DID4 (GCA9731)	CID (GCA9732)	BID (GCA9733)		DID4 (GCA9731)	CID (GCA9732)	BID (GCA9733)
Al	1.4%	3.5%	1.2%	8.2%	0	0	0
Fe	63.5%	49.9%	60.3%	4.1%	**3**	**3**	**3**
Na	0.0052%	0.0063%	0.0022%	2.3%	0	0	0
K	<0.05%	0.08%	0.08%	2.1%	0	0	0
Mg	0.08%	0.14%	0.08%	2.3%	0	0	0
Ca	<0.1%	<0.1%	<0.1%	4.1%	0	0	0
Ag	0.12	0.09	0.09	0.07	0	0	0
Cu	2	9	12	50	0	0	0
Zn	1	6	3	75	0	0	0
Cd	0.03	0.12	0.04	0.11	0	0	0
Pb	5.9	12	5	14	0	0	0
Cr	<50	<50	<50	100	0	0	0
Ni	<1	19	3	80	0	0	0
Co	1.7	3.5	1.8	20	0	0	0
Mn	330	170	120	950	0	0	0
Hg	0.02	0.66	0.10	0.05	0	**3**	0
Sn	1.9	1.7	1.6	2.2	0	0	0
Sr	2.9	7.5	2.1	370	0	0	0
Ba	11	35	6.2	500	0	0	0
Th	2.4	4.0	1.9	12	0	0	0
U	0.52	2.1	0.73	2.4	0	0	0
Tl	0.05	0.11	0.02	0.6	0	0	0
V	96	110	84	160	0	0	0
As	13	25	19	1.5	**3**	**3**	**3**
Bi	0.22	0.18	0.20	0.048	2	1	1
Sb	1.9	2.3	1.7	0.2	**3**	**3**	**3**
Se	0.35	0.19	1.1	0.05	2	1	**4**
Mo	2.9	2.3	2.4	1.5	0	0	0
B	<50	<50	<50	10	0	0	0
P	720	900	1,300	1,000	0	0	0
F	72	180	82	950	0	0	0

Table 8: Mineralogical Results for Waste-regolith Samples for Kinetic-Testing (Delta)

DID1 (GCA9728)		DID2 (GCA9729)		DID3 (GCA9730)	
Component	**Abundance**	**Component**	**Abundance**	**Component**	**Abundance**
				hematite	dominant
hematite	major	hematite	major		
quartz					
goethite	minor	goethite	minor	goethite	minor
		quartz			
kaolinite	accessory	kaolinite	accessory	kaolinite	accessory
maghemite		maghemite		quartz	
				maghemite	
		mica	trace		

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

DID4 (GCA9731)		CID (GCA9732)		BID (GCA9733)	
Component	**Abundance**	**Component**	**Abundance**	**Component**	**Abundance**
hematite	dominant			goethite	dominant
goethite	major	goethite	major		
		hematite	minor	hematite	minor
kaolinite	accessory	kaolinite	accessory	quartz	accessory
maghemite		maghemite			
quartz		quartz			
				kaolinite	trace

Table 9: Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

DID1 (GCA9728)

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9728)				
		1	**2**	**3**	**4**	**5**
Major-Parameters						
pH	7.6	6.8	6.8	7.3	7.2	7.2
EC [µS/cm]	120	47	40	38	36	30
Major-Ions (mg/L)						
Cl	6	<2	<2	<2	<2	<2
SO_4	11	2	1	<1	<1	<1
Na	21	11	7.9	8.5	8.1	8.0
K	4.7	2.5	2.1	2.3	1.9	1.7
Mg	0.45	0.75	0.69	0.51	0.46	0.36
Ca	0.30	0.40	0.29	0.26	0.28	0.21
Fe	0.23	0.31	0.24	0.23	0.08	0.05
Al	0.29	0.70	0.68	0.49	0.49	0.28
Si	13	16	16	15	15	12
Leachate Wt (kg)	0.73	0.66	0.65	0.66	0.64	0.69

Note: EC = Electrical-Conductivity.

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9728)				
		1	**2**	**3**	**4**	**5**
Minor-Ions (µg/L)						
Cu	<10	<10	<10	<10	<10	10
Ni	<10	<10	<10	20	<10	<10
Zn	20	<10	<10	310	10	<10
Co	0.2	0.3	0.2	<0.1	<0.1	8.6
Cd	<0.02	<0.02	<0.02	0.10	<0.02	0.18
Pb	<0.5	2.0	1.3	2.2	0.9	1.1
Cr	<10	<10	<10	<10	<10	<10
Hg	<0.1	0.3	<0.1	<0.1	0.2	0.5
As	0.7	0.4	0.5	0.6	0.7	1.7
Sb	0.06	0.06	0.04	0.07	0.05	0.22
Bi	0.006	0.005	<0.005	<0.005	<0.005	0.17
Se	0.7	<0.5	<0.5	<0.5	<0.5	1.3
B	200	160	100	100	120	100
Mo	0.24	0.27	0.12	0.52	0.41	0.52
P	<100	<100	<100	<100	<100	<100
Ag	0.01	0.03	<0.01	<0.01	<0.01	0.17
Ba	16	10	8.2	7.2	9.1	5.5
Sr	2.1	2.8	2.2	2.0	1.7	9.4
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	0.17
V	<10	<10	<10	<10	<10	<10
Sn	<0.1	0.1	<0.1	<0.1	<0.1	0.2
U	0.21	0.29	0.21	0.21	0.17	0.40
Th	<0.005	0.009	0.009	0.029	0.009	0.18
Mn	<10	<10	<10	<10	<10	<10

Table 9 (Cont'd): Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

DID2 (GCA9729)

Note: The following results are for the Pre-Rinse-Cycle only, since following completion of the drying-phase of the 1st-Weekly-Weathering-Cycle, the flushing-step did not result in any leachate over a 5-week period, due to clogging of the filter-paper at the base of the rock-bed in the column by "ultra-fines". This weathering-column was subsequently abandoned.

ELEMENT/ PARAMETER	GCA9729	ELEMENT/ PARAMETER	GCA9729
Major-Parameters		***Minor-Ions (µg/L)***	
pH	7.6	Cu	<10
EC [µS/cm]	190	Ni	<10
		Zn	10
Major-Ions (mg/L)		Co	0.4
		Cd	<0.02
Cl	15	Pb	0.7
SO_4	19	Cr	<10
		Hg	<0.1
Na	33	As	1.4
K	4.7	Sb	0.07
Mg	2.3	Bi	0.005
Ca	1.4	Se	1.3
		B	160
Fe	0.25	Mo	0.25
Al	0.48	P	<100
Si	22	Ag	0.02
		Ba	17
		Sr	18
		Tl	0.01
		V	<10
		Sn	<0.1
		U	0.23
		Th	0.018
		Mn	30
Leachate Wt (kg)	0.66		

Note: EC = Electrical-Conductivity.

Table 9 (Cont'd): Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

DID3 (GCA9730)

Note: The following results are for the Pre-Rinse-Cycle and Cycle-1 only, since following completion of the drying-phase of the 2nd-Weekly-Weathering-Cycle, the flushing-step did not result in any leachate over an 8-week period, due to clogging of the filter-paper at the base of the rock-bed in the column by "ultra-fines". This weathering-column was subsequently abandoned.

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEELY-WEATHERING-CYCLES (GCA9730)
		1
Major-Parameters		
pH	7.3	6.6
EC [µS/cm]	91	49
Major-Ions (mg/L)		
Cl	10	4
HCO_3	17	7
SO_4	10	6
Na	16	8.7
K	2.5	1.6
Mg	0.31	0.67
Ca	0.39	0.59
Fe	0.11	0.18
Al	0.12	0.32
Si	9.2	14
Leachate Wt (kg)	0.74	0.55

Note: EC = Electrical-Conductivity.

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEELY-WEATHERING-CYCLES (GCA9730)
		1
Minor-Ions (µg/L)		
Cu	<10	<10
Ni	<10	20
Zn	20	<10
Co	<0.1	<0.1
Cd	<0.02	<0.02
Pb	<0.5	0.9
Cr	<10	<10
Hg	<0.1	<0.1
As	0.9	<0.1
Sb	0.03	<0.01
Bi	0.008	<0.005
Se	1.0	0.7
B	70	70
Mo	0.07	<0.05
P	<100	<100
Ag	0.03	<0.01
Ba	7.1	3.6
Sr	3.0	6.0
Tl	<0.01	<0.01
V	<10	<10
Sn	<0.1	<0.1
U	<0.005	0.025
Th	<0.005	<0.005
Mn	<10	<10

Table 9 (Cont'd): Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

DID4 (GCA9731)

ELEMENT/ PARAMETER	**PRE-RINSING-CYCLE**	**WEEKLY-WEATHERING-CYCLES (GCA9731)**					
		1	**2**	**3**	**4**	**5**	**6**
Major-Parameters							
pH	6.4	6.3	4.4	6.1	6.4	6.3	6.3
EC [µS/cm]	69	22	28	10	<10	<10	<10
Major-Ions (mg/L)							
Cl	5	2	<2	<2	<2	<2	<2
HCO_3	14	6	<1	4	4	4	4
SO_4	3	3	3	1.0	2	<1	<1
Na	9.7	3.2	2.0	1.3	1.1	0.8	0.8
K	3.3	1.3	1.0	0.8	0.6	0.5	0.8
Mg	1.3	0.23	0.25	0.16	0.12	0.12	0.10
Ca	1.4	0.26	0.35	0.15	0.11	0.10	0.12
Fe	<0.01	<0.01	0.21	0.23	0.16	0.18	0.24
Al	<0.01	<0.01	0.19	0.25	0.18	0.20	0.24
Si	5.5	5.2	8.4	7.8	5.6	4.9	5.6
Leachate Wt (kg)	0.81	0.80	0.81	0.80	0.80	0.80	0.80

Note: EC = Electrical-Conductivity.

ELEMENT/ PARAMETER	**PRE-RINSING-CYCLE**	**WEEKLY-WEATHERING-CYCLES (GCA9731)**					
		1	**2**	**3**	**4**	**5**	**6**
Minor-Ions (µg/L)							
Cu	<10	<10	<10	<10	<10	<10	<10
Ni	<10	<10	<10	10	<10	<10	<10
Zn	<10	<10	<10	<10	<10	<10	<10
Co	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cd	0.07	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pb	7.5	<0.5	1.1	<0.5	<0.5	<0.5	<0.5
Cr	<10	<10	<10	<10	<10	<10	<10
Hg	<0.1	0.6	0.3	0.3	0.2	0.2	0.2
As	0.4	0.3	0.2	0.2	<0.1	<0.1	<0.1
Sb	0.04	0.03	0.08	0.03	0.04	<0.01	<0.01
Bi	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005
Se	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
B	30	10	40	40	30	40	30
Mo	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
P	<100	<100	<100	<100	<100	<100	<100
Ag	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ba	6.5	1.7	9.0	3.6	2.1	13	6.5
Sr	11	2.1	2.3	1.5	0.82	0.85	0.98
Tl	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
V	<10	<10	<10	<10	<10	<10	<10
Sn	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
U	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005
Th	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	<10	<10	<10	<10	<10	<10	<10

Table 9 (Cont'd): Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

CID (GCA9732)

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9732)					
		1	2	3	4	5	6
Major-Parameters							
pH	6.8	6.9	6.6	6.8	6.5	6.7	6.6
EC [µS/cm]	190	26	18	24	13	12	11
Major-Ions (mg/L)							
Cl	11	2	<2	<2	<2	2	<2
HCO_3	39	6	7	8	6	6	5
SO_4	10	3	2	2	1	<1	1
Na	15	3.1	2.1	2.3	1.5	1.5	1.3
K	5.5	1.1	1.0	1.4	0.9	0.8	1.0
Mg	7.2	0.53	0.42	0.60	0.5	0.31	0.24
Ca	8.7	0.74	0.45	0.67	0.65	0.32	0.24
Fe	<0.01	0.22	0.25	0.25	0.25	0.29	0.23
Al	0.02	0.26	0.20	0.26	0.36	0.27	0.21
Si	13	11	12	14	9.4	11	11
Leachate Wt (kg)	0.66	0.79	0.77	0.76	0.78	0.77	0.83

Note: EC = Electrical-Conductivity.

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9732)					
		1	2	3	4	5	6
Minor-Ions (µg/L)							
Cu	<10	<10	<10	<10	<10	<10	<10
Ni	<10	<10	10	<10	<10	<10	20
Zn	<10	10	<10	<10	20	<10	<10
Co	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Cd	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pb	3.5	<0.5	<0.5	1.0	<0.5	0.9	<0.5
Cr	<10	<10	<10	<10	<10	<10	<10
Hg	1.4	<0.1	0.2	0.2	0.2	0.1	<0.1
As	0.8	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sb	0.03	0.09	0.05	0.01	0.01	0.02	0.03
Bi	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Se	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
B	20	<10	30	<10	<10	60	50
Mo	0.06	0.07	<0.05	<0.05	<0.05	0.08	0.12
P	<100	<100	<100	<100	<100	<100	<100
Ag	<0.01	<0.01	<0.01	<0.01	0.01	0.78	0.18
Ba	24	110	6.2	4.2	11	79	24
Sr	45	4.3	2.4	3.7	3.4	2.1	1.7
Tl	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
V	<10	<10	<10	<10	<10	<10	<10
Sn	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
U	0.013	0.007	<0.005	0.016	0.034	0.010	0.009
Th	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	<10	<10	<10	<10	<10	<10	<10

Table 9 (Cont'd): Column-Leachate-Analysis Results for Waste-regolith Samples (Delta)

BID (GCA9733)

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9733)					
		1	2	3	4	5	6
Major-Parameters							
pH	6.7	6.3	6.4	6.3	6.3	6.4	6.4
EC [µS/cm]	110	31	30	21	16	15	12
Major-Ions (mg/L)							
Cl	7	3	<2	<2	<2	<2	<2
HCO_3	19	4	5	4	4	4	4
SO_4	3	4	6	4	3	3	2
Na	7.0	1.6	1.2	0.7	0.5	0.6	0.5
K	5.4	1.3	1.3	1.1	0.8	0.9	0.6
Mg	4.3	1.3	1.3	0.85	0.71	0.82	0.64
Ca	4.0	1.1	1.1	0.74	0.58	0.61	0.52
Fe	<0.01	<0.01	0.04	0.03	0.04	0.21	0.15
Al	<0.01	<0.01	0.09	0.03	0.04	0.22	0.20
Si	3.6	4.5	7.8	7.6	5.0	6.6	6.1
Leachate Wt (kg)	0.77	0.79	0.81	0.79	0.78	0.82	0.76

Note: EC = Electrical-Conductivity.

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9733)					
		1	2	3	4	5	6
Minor-Ions (µg/L)							
Cu	<10	<10	<10	<10	<10	<10	<10
Ni	<10	<10	<10	<10	<10	<10	<10
Zn	<10	<10	20	20	10	<10	<10
Co	1.0	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cd	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pb	1.8	0.8	<0.5	2.4	0.9	0.7	<0.5
Cr	<10	<10	<10	<10	<10	<10	<10
Hg	<0.1	<0.1	0.2	0.1	0.2	0.3	0.2
As	1.3	1.1	0.4	0.2	<0.1	0.1	<0.1
Sb	0.07	0.03	0.01	0.02	<0.01	<0.01	<0.01
Bi	0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Se	0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5
B	<10	<10	20	60	<10	40	30
Mo	0.1	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
P	<100	<100	<100	<100	<100	<100	<100
Ag	0.05	<0.01	<0.01	<0.01	<0.01	0.06	<0.01
Ba	7.6	2.1	1.6	2.0	0.83	11	18
Sr	26	6.3	6.6	4.7	3.2	3.5	3.2
Tl	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
V	<10	<10	<10	<10	<10	<10	<10
Sn	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
U	0.016	<0.005	<0.005	<0.005	0.012	<0.005	<0.005
Th	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	<10	<10	<10	<10	<10	<10	<10

Table 10: Acid-Base-Analysis and Net-Acid-Generation Results for Waste-bedrock Samples for Kinetic-Testing (Delta)

GCA-SAMPLE NO.	**LITHOTYPE**	**pH-(1:2)**	**EC-(1:2) [mS/cm]**	**TOTAL-S (%)**	**SO_4-S (%)**	**SULPHIDE-S (%)**	**TOTAL-C (%)**	**CO_3-C (%)**	**ANC**	**NAPP**	**NAG**	**NAG-pH**	**ANC/ MPA RATIO**	**AFP CATEGORY**
									kg H_2SO_4/tonne					
GCA9682/83	Shl	3.7	1.4	1.9 (1.9)	0.30 (0.30)	1.6	2.6 (2.6)	1.8 (1.8)	35 (34)	15	19	3.1	<1	**PAF**
GCA9685/86	Shl-(WS)	4.8	1.5	2.2	0.22	2.0	3.8	3.1	65	-3.8	18	4.2	1.0	**PAF**
GCA9688/90	Shl-(DGS)	5.9 (5.9)	1.1 (1.1)	1.3	0.08	1.3	2.3	1.9	64	-24	9.5 (9.5)	3.6 (3.5)	1.6	**PAF**

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation-Capacity; NAPP = Net-Acid-Producing-Potential; AFP = Acid-Formation-Potential; NAG = Net-Acid Generation; PAF = Potentially-Acid-Forming.
pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.
Values in parentheses represent duplicates.

Table 11: Multi-Element-Analysis Results for Waste-bedrock Samples for Kinetic-Testing (Delta)

ELEMENT	**TOTAL-ELEMENT CONTENT (mg/kg or %)**			**AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)**	**GEOCHEMICAL-ABUNDANCE INDEX (GAI)**		
	Shl (GCA9682/83	**Shl-(WS) (GCA9685/86)**	**Shl-(DGS) (GCA9688/89)**		**Shl (GCA9682/83**	**Shl-(WS) (GCA9685/86)**	**Shl-(DGS) (GCA9688/89)**
Al	4.7%	4.0%	3.4%	8.2%	0	0	0
Fe	14.6%	20.1%	19.3%	4.1%	1	2	2
Na	0.013%	0.0093%	0.015%	2.3%	0	0	0
K	5.8%	5.4%	4.5%	2.1%	1	1	1
Mg	0.66%	1.2%	1.1%	2.3%	0	0	0
Ca	0.3%	0.5%	0.4%	4.1%	0	0	0
Ag	0.2	0.2	0.1	0.07	1	1	0
Cu	44	50	26	50	0	0	0
Zn	68	130	120	75	0	0	0
Cd	0.20	0.21	0.41	0.11	0	0	1
Pb	19	16	22	14	0	0	0
Cr	68	170	<50	100	0	0	0
Ni	34	43	26	80	0	0	0
Co	19	24	14	20	0	0	0
Mn	3,500	6,900	2,000	950	1	2	0
Hg	0.17	0.17	0.23	0.05	1	1	2
Sn	1.4	1.4	1.8	2.2	0	0	0
Sr	14	8.3	9.0	370	0	0	0
Ba	250	230	230	500	0	0	0
Th	8.1	6.4	8.4	12	0	0	0
U	2.8	2.5	2.6	2.4	0	0	0
Tl	0.70	0.75	2.0	0.6	0	0	1
V	73	69	31	160	0	0	0
As	44	40	47	1.5	**4**	**4**	**4**
Bi	0.38	0.31	0.51	0.048	2	2	**3**
Sb	3.3	3.6	2.6	0.2	**3**	**4**	**3**
Se	1.3	1.1	0.62	0.05	**4**	**4**	**3**
Mo	2.8	2.7	3.4	1.5	0	0	1
B	120	120	120	10	**3**	**3**	**3**
P	320	830	550	1,000	0	0	0
F	330	590	360	950	0	0	0

Note:
Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

Table 12: Mineralogical Results for Waste-bedrock Samples for Kinetic-Testing (Delta)

Shl (GCA9682/83		**Shl-(WS) (GCA9685/86)**		**Shl-(DGS) (GCA9688/90)**	
Component	**Abundance**	**Component**	**Abundance**	**Component**	**Abundance**
quartz	dominant	quartz	dominant	quartz	dominant
K-feldspar stilpnomelane	minor	K-feldspar stilpomelane	minor	K-feldspar stilpomelane	minor
pyrite **siderite** chlorite	accessory	**pyrite** **siderite** chlorite	accessory	**pyrite** **siderite** chlorite	accessory

Notes:
dominant = greater than 50 %; minor = 10-20 %; and, accessory = 2-10 %

Electron-micro-probe analyses of different siderite-grains during the SEM investigation showed the following indicative composition, viz.

- GCA9682/83: $(Fe_{0.71}Mg_{0.12}Mn_{0.02}Ca_{0.02})CO_3$
- GCA9685/86: $(Fe_{0.75}Mg_{<0.01}Mn_{0.05}Ca_{0.02})CO_3$
- GCA9688/90: $(Fe_{0.77}Mg_{0.10}Mn_{0.01}Ca_{0.02})CO_3$

Table 13: Column-Leachate-Analysis Results for Waste-bedrock Samples (Delta)

Shl (GCA9682/83)

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9682/83)					
		1	**2**	**3**	**4**	**5**	**6**
Major-Parameters							
pH	3.0	6.4	6.3	5.1	4.7	5.0	4.9
EC [µS/cm]	3,200	1,300	950	970	890	910	1100
acidity (mg H_2SO_4/L)	430	14	13	9	8	7	6
Major-Ions (mg/L)							
Cl	6	35	44	64	66	48	3
SO_4	2,200	810	610	610	570	540	580
Na	2.3	1.1	0.7	0.6	0.5	0.4	0.4
K	72	19	15	15	14	14	13
Mg	270	140	93	91	84	85	97
Ca	160	48	36	33	31	31	33
Fe	100	0.46	0.09	0.11	0.05	0.02	0.02
Al	22	0.11	0.03	0.11	0.08	0.01	<0.01
Mn	150	57	40	34	32	32	31
Si	15	2.4	2.0	2.1	2.0	2.0	1.8
Minor-Ions (µg/L)							
As	4.2	0.9	0.5	0.6	0.9	1.0	0.8
Cu	330	<10	<10	<10	<10	<10	<10
Zn	1,400	50	30	20	20	20	10
Leachate Wt (kg)	2.25	0.72	0.73	0.73	0.71	0.75	0.69

Note: EC = Electrical-Conductivity.

Shl-(WS) [GCA9685/86]

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9685/86)					
		1	**2**	**3**	**4**	**5**	**6**
Major-Parameters							
pH	4.6	5.6	4.3	4.2	6.4	6.0	7.1
EC [µS/cm]	1,700	860	890	940	780	860	920
acidity (mg H_2SO_4/L)	31	5	8	11	10	6	9
Major-Ions (mg/L)							
Cl	5	64	83	93	35	26	<2
SO_4	1,100	550	550	680	480	520	490
Na	1.2	0.3	0.3	0.4	0.4	0.4	0.3
K	59	5.2	4.8	5.9	6.3	6.9	8.1
Mg	140	84	85	91	70	79	76
Ca	100	39	38	42	37	39	44
Fe	1.9	<0.01	0.04	<0.01	<0.01	<0.01	<0.01
Al	2.9	0.08	0.02	0.06	0.02	0.06	<0.01
Mn	78	17	17	18	22	26	38
Si	4.2	0.44	0.43	0.46	0.46	0.46	0.38
Minor-Ions (µg/L)							
As	0.9	0.5	0.5	0.6	0.5	0.3	0.4
Cu	60	<10	<10	<10	<10	<10	<10
Zn	540	20	20	30	20	20	20
Leachate Wt (kg)	5.13	0.74	0.73	0.75	0.76	0.75	0.74

Table 13 (Cont'd): Column-Leachate-Analysis Results for Waste-bedrock Samples (Delta)

Shl-(DGS) [GCA9688/90]

ELEMENT/ PARAMETER	PRE-RINSING-CYCLE	WEEKLY-WEATHERING-CYCLES (GCA9688/90)					
		1	2	3	4	5	6
Major-Parameters							
pH	7.9	7.4	7.7	7.4	7.4	7.4	7.7
EC [µS/cm]	1,400	610	570	610	610	750	700
acidity (mg H_2SO_4/L)	9	8	9	7	8	6	5
Major-Ions (mg/L)							
Cl	8	42	20	8	<2	2	<2
SO_4	670	350	290	300	280	360	330
Na	4.2	0.8	0.7	1.0	1.1	1.4	1.3
K	96	14	14	18	19	27	29
Mg	96	43	39	41	38	46	41
Ca	85	42	39	44	43	53	49
Fe	0.03	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Al	0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01
Mn	11	1.9	2.4	3.3	4.1	6.5	8.3
Si	6.4	2.9	2.9	3.3	3.2	3.6	3.6
Minor-Ions (µg/L)							
As	1.2	0.7	0.5	0.8	0.7	0.6	0.5
Cu	<10	<10	<10	<10	<10	<10	<10
Zn	90	60	20	10	20	20	20
Leachate Wt (kg)	0.98	0.74	0.74	0.72	0.75	0.73	0.71

Table 14: Acid-Base-Analysis and Net-Acid-Generation Results for Mine-Waste Samples (Eagle)

GCA-SAMPLE NO.	**SITE-SAMPLE NO.**	**DRILLHOLE & DOWN-HOLE INTERVAL (m)**	**LITHOTYPE**	**pH-(1:2)**	**EC-(1:2) [mS/cm]**	**TOTAL-S (%)**	**SO$_4$-S (%)**	**SULPHIDE-S (%)**	**TOTAL-C (%)**	**CO$_3$-C (%)**	**ANC**	**NAPP**	**NAG**	**NAG-pH**	**ANC/ MPA RATIO**	**AFP CATEGORY**
											kg H$_2$SO$_4$/tonne					
Samples from Above-BoX (= "waste-regoliths"																
GCA9691	HPES001	HPRC4169, 16-18	RC	7.0	0.22	0.02 [0.009]	<0.01	0.02	0.06	0.02	4	nc	1.0	6.5	nc	NAF
GCA9692	HPES002	HPRC4153, 34-36	DID1	7.2	0.023	0.02 [0.007]	<0.01	0.02	0.06	0.02	4	nc	<0.5	6.0	nc	NAF
GCA9693	HPES003	HPRC4113, 20-22	DID2	7.5	0.019	0.02 [0.013]	<0.01	0.02	0.09	0.01	3	nc	<0.5	6.0	nc	NAF
GCA9694	HPES004	HPRC4113, 24-26	DID3	7.5	0.018	0.02 [0.015]	<0.01	0.02	0.10	0.02	3	nc	1.2	6.0	nc	NAF
GCA9695	HPES005	HPRC4153, 48-50	DID4	7.1 (7.1)	0.024 (0.023)	0.02 [0.013]	<0.01	0.02	0.16	0.02	3	nc	0.7	6.0	nc	NAF
GCA9696	HPES006	HPRC4137, 80-82	CID	6.9	0.034	0.02 [0.009]	<0.01	0.02	0.24	0.06	5	nc	<0.5	6.0	nc	NAF
GCA9697	HPES007	HPRC4155, 58-60	CID	7.1	0.032	0.01 [0.004]	<0.01	0.01	0.08	0.02	4	nc	<0.5	5.7	nc	NAF
GCA9698	HPES008	HPRC4169, 56-58	CID	7.1	0.022	0.01 [0.015]	<0.01	0.01	0.23	0.11	11	nc	0.9	5.3	nc	NAF
GCA9699	HPES009	HPRC4072, 38-40	BID	7.0	0.020	0.02 [0.025]	<0.01	0.02	0.37	0.14	5	nc	<0.5	6.2	nc	NAF
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")																
GCA9700	HPES010	HPRC4093, 34-36	Shl	6.8	0.044	0.16 [0.158]	<0.01	0.16	0.43	<0.01	8	-3.1	<0.5 (<0.5)	6.4 (6.5)	1.6	NAF
GCA9701	HPES011	HPRC4093, 36-38	Shl	5.9	0.32	0.01 [0.012]	<0.01	0.01	0.84	<0.01	6	nc	<0.5	5.0	nc	NAF
GCA9702	HPES012	HPRC4093, 38-40	Bif	2.6	3.1	2.1 [2.37]	0.53	1.6	0.67	<0.01	-11	60	49	2.4	<1	**PAF**
GCA9703	HPES013	HPRC4000, 54-56	Bif	5.0	0.49	0.26 [0.255]	0.02	0.24	0.96	0.60	9	-1.6	1.2	5.9	1.2	NAF
GCA9704	HPES014	HPRC4000, 56-58	Shl	4.7	0.78	1.1 [1.14]	0.09	1.1	2.9	1.9	26	7.7	1.4	5.1	<1	**PAF**
GCA9705	HPES015	HPRC4000, 58-60	Shl	5.1 (5.0)	0.62 (0.68)	0.81 [0.914]	0.06	0.75	3.3	1.7	21 (25)	2.0	1.5	5.6	<1	**PAF**
GCA9706	HPES016	HPRC4019, 22-24	Shl	6.1	0.085	<0.01 [0.004]	<0.01	<0.01	0.12	<0.01	7	nc	<0.5	6.9	nc	NAF
GCA9707	HPES017	HPRC4019, 24-26	Shl	6.1	0.059	0.01 [0.027]	<0.01	0.01	0.14	0.05	6	nc	<0.5	7.9	nc	NAF
GCA9708	HPES018	HPRC4019, 26-28	Bif	4.7	1.3	2.7 [2.7]	0.20	2.5	3.8	3.1	26	51	17	3.8	<1	**PAF**

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation-Capacity; NAPP = Net-Acid-Producing-Potential; AFP = Acid-Formation-Potential; NAG = Net-Acid Generation; nc = not calculated;
NAF = Non-Acid-Forming; PAF = Potentially-Acid Forming.
pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH. Values in round-parentheses represent duplicates.

N.B. Total-S values in square-parentheses correspond to results from Exploration-Database.

Table 15: Total-Contents of As, Sb, Se, Mo and B in Mine-Waste Samples (Eagle)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	DRILLHOLE & DOWN-HOLE INTERVAL (m)	LITHOTYPE	SULPHIDE-S (%)	TOTAL-As (mg/kg)	TOTAL-Sb (mg/kg)	TOTAL-Se (mg/kg)	TOTAL-Mo (mg/kg)	TOTAL-B (mg/kg)
Samples from Above-BoX (= "waste-regoliths"									
GCA9691	HPES001	HPRC4169, 16-18	RC	0.02	9.0	1.2	0.36	1.8	<50
GCA9692	HPES002	HPRC4153, 34-36	DID1	0.02	7.7	1.1	0.26	1.7	<50
GCA9693	HPES003	HPRC4113, 20-22	DID2	0.02	9.7	1.3	0.58	1.4	<50
GCA9694	HPES004	HPRC4113, 24-26	DID3	0.02	13	1.6	0.24	2.1	<50
GCA9695	HPES005	HPRC4153, 48-50	DID4	0.02	11	1.3	0.67	1.8	<50
GCA9696	HPES006	HPRC4137, 80-82	CID	0.02	11	0.74	1.4	1.0	<50
GCA9697	HPES007	HPRC4155, 58-60	CID	0.01	21	1.3	0.61	1.7	<50
GCA9698	HPES008	HPRC4169, 56-58	CID	0.01	18	1.2	1.2	2.1	<50
GCA9699	HPES009	HPRC4072, 38-40	BID	0.02	21	1.3	3.9	1.2	<50
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")									
GCA9700	HPES010	HPRC4093, 34-36	Shl	0.16	36	2.9	1.7	2.6	<50
GCA9701	HPES011	HPRC4093, 36-38	Shl	0.01	43	3.6	1.2	3.4	<50
GCA9702	HPES012	HPRC4093, 38-40	Bif	1.6	38	4.0	1.7	3.0	<50
GCA9703	HPES013	HPRC4000, 54-56	Bif	0.24	25	2.3	0.77	2.9	<50
GCA9704	HPES014	HPRC4000, 56-58	Shl	1.1	42	3.2	0.52	2.9	<50
GCA9705	HPES015	HPRC4000, 58-60	Shl	0.75	51	3.6	0.56	3.4	<50
GCA9706	HPES016	HPRC4019, 22-24	Shl	<0.01	44	3.9	0.51	2.8	<50
GCA9707	HPES017	HPRC4019, 24-26	Shl	0.01	44	3.0	0.83	3.1	<50
GCA9708	HPES018	HPRC4019, 26-28	Bif	2.5	49	3.7	1.3	2.9	<50

Table 16: Multi-Element-Analysis Results for Mine-Waste Samples (Eagle)

ELEMENT	**TOTAL-ELEMENT CONTENT (mg/kg or %)**		**AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)**	**GEOCHEMICAL-ABUNDANCE INDEX (GAI)**	
	Bif (GCA9702)	**Bif (GCA9708)**		**Bif (GCA9702)**	**Bif (GCA9708)**
Al	3.9%	3.8%	8.2%	0	0
Fe	24.0%	20.0%	4.1%	2	2
Na	0.0083%	0.0081%	2.3%	0	0
K	5.1%	5.1%	2.1%	1	1
Mg	0.21%	1.2%	2.3%	0	0
Ca	0.2%	0.5%	4.1%	0	0
Ag	0.11	0.12	0.07	0	0
Cu	28	32	50	0	0
Zn	130	86	75	0	0
Cd	0.06	0.18	0.11	0	0
Pb	20	18	14	0	0
Cr	250	330	100	1	1
Ni	40	42	80	0	0
Co	13	21	20	0	0
Mn	260	4,700	950	0	2
Hg	0.24	0.22	0.05	2	2
Sn	1.5	1.3	2.2	0	0
Sr	7.1	7.7	370	0	0
Ba	190	220	500	0	0
Th	7.7	7.8	12	0	0
U	2.4	2.5	2.4	0	0
Tl	0.70	0.75	0.6	0	0
V	58	46	160	0	0
As	40	49	1.5	**4**	**4**
Bi	0.37	0.37	0.048	2	2
Sb	4.2	3.8	0.2	**4**	**4**
Se	1.7	1.3	0.05	**5**	**4**
Mo	2.9	2.8	1.5	0	0
B	<50	<50	10	0	0
P	690	660	1,000	0	0
F	1,200	460	950	0	0

Note:
Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

Table 17: Water-Extraction-Testwork Results for Mine-Waste Samples (Eagle)

Note: All results in mg/L, except for pH and Electrical-Conductivity (EC).

ELEMENT/ PARAMETER	***Above-BoX***		***Below-BoX (Basement)***		**ELEMENT/ PARAMETER**	***Above-BoX***		***Below-BoX (Basement)***	
	CID (GCA9696)	**BID (GCA9699)**	**Bif (GCA9702)**	**Bif (GCA9708)**		**CID (GCA9696)**	**BID (GCA9699)**	**Bif (GCA9702)**	**Bif (GCA9708)**
Major-Parameters					***Minor-Ions (µg/L)***				
pH	6.8	6.7	2.5	4.9	Cu	<10	<10	1,600	<10
EC [µS/cm]	31	23	4,100	2,400	Ni	<10	<10	2,200	680
					Zn	<10	<10	790	150
					Co	<0.1	<0.1	990	310
Major-Ions (mg/L)					Cd	<0.02	<0.02	4.9	8.6
					Pb	1.5	1.5	270	24
Na	1.7	1.4	0.5	1.7	Cr	<10	<10	1,200	<10
K	1.2	1.3	1.3	30	Hg	<0.1	<0.1	0.5	<0.1
Mg	1.2	0.92	170	280	As	0.1	0.2	49	1.2
Ca	1.4	0.53	110	99	Sb	0.02	0.02	0.53	0.03
Cl	2	2	2	2	Bi	<0.005	<0.005	<0.005	<0.005
SO_4	1	2	3,100	1,600	Se	<0.5	<0.5	4.0	8.1
					B	20	30	<10	<10
Fe	<0.01	<0.01	650	10	Mo	0.14	0.18	0.45	1.4
Al	<0.01	0.04	160	1.2	P	<100	<100	3,500	<100
Si	6.2	7.4	9.3	5.5	Ag	<0.01	<0.01	0.02	<0.01
					Ba	3.5	2.3	3.5	27
					Sr	6.4	4.5	20	96
					Tl	<0.01	<0.01	0.12	0.54
					V	<10	<10	370	<10
					Sn	0.1	0.1	0.2	0.1
					U	<0.005	<0.005	6.8	0.25
					Th	<0.005	<0.005	18	0.026
					Mn	<10	<10	7,500	92,000

Notes: Water-Extraction Testwork employed crushed-samples (nominal 2-mm), and slurries prepared using 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 centrifugation and vacuum-filtration) for analysis. Values in parentheses represent duplicates.

Table 18: Clay-Mineralogical and Clay-Surface-Chemistry Results for Mine-Waste Samples (Eagle)

RC (GCA9691)		DID1 (GCA9692)	
hematite	major	hematite	major
quartz		quartz	
kaolinite	minor		
goethite			
		kaolinite	accessory
		goethite	
Ti-oxide	trace	Ti-oxide	

eCEC [cmol (p+)/kg]	%-Proportion of eCEC				eCEC [cmol (p+)/kg]	%-Proportion of eCEC			
	Na	K	Mg	Ca		Na	K	Mg	Ca
3.5	23	4	44	29	2.0	19	<1	41	40

Notes:
eCEC = effective-Cation-Exchange Capacity
major = 20-50 %; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %

DID2 (GCA9693)		CID (GCA9697)	
hematite	dominant		
		goethite	major
		kaolinite	minor
		quartz	
kaolinite	accessory	Ti-oxide	accessory
goethite			
quartz			
Ti-oxide	trace		

eCEC [cmol (p+)/kg]	%-Proportion of eCEC				eCEC [cmol (p+)/kg]	%-Proportion of eCEC			
	Na	K	Mg	Ca		Na	K	Mg	Ca
1.6	54	<1	28	18	3.4	17	<1	43	40

Notes:
eCEC = effective-Cation-Exchange Capacity
dominant = greater than 50 %; major = 20-50 %; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %

Table 19: Acid-Base-Analysis and Net-Acid-Generation Results for Mine-Waste Samples (Champion)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	DRILLHOLE & DOWN-HOLE INTERVAL (m)	LITHOTYPE	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO_4-S (%)	SULPHIDE-S (%)	TOTAL-C (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	ANC/ MPA RATIO	AFP CATEGORY
											kg H_2SO_4/tonne					
Samples from Above-BoX (= "waste-regoliths"																
GCA9709	HPCS001	HPRC0585, 2-4	RC	5.9	0.18	<0.01 [0.007]	<0.01	<0.01	0.05	<0.01	6	nc	1.2	6.0	nc	NAF
GCA9710	HPCS002	HPRC0641, 10-12	DID1	6.8	0.071	0.02 [0.016]	<0.01	0.02	0.06	<0.01	5	nc	<0.5	6.5	nc	NAF
GCA9711	HPCS003	HPRC0585, 28-30	DID2	6.0	0.080	0.02 [0.015]	<0.01	0.02	0.10	0.03	5	nc	<0.5	5.8	nc	NAF
GCA9712	HPCS004	HPRC0641, 42-44	DID3	6.0	0.043	0.03 [0.021]	<0.01	0.03	0.11	0.04	5	nc	<0.5	5.5	nc	NAF
GCA9713	HPCS005	HPRC0641, 46-48	DID4	6.1	0.035	0.02 [0.018]	<0.01	0.02	0.11	<0.01	4	nc	<0.5	5.6	nc	NAF
GCA9715	HPCS007	HPRC0326, 30-32	BID	6.7 (6.7)	0.037 (0.036)	0.02 [0.013]	0.01	0.01	0.37	0.03	5	nc	<0.5	5.3	nc	NAF
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")																
GCA9716	HPCS008	HPRC0739a, 18-20	Shl	6.6	0.052	<0.01 [0.019]	<0.01	<0.01	0.16	<0.01	5	nc	<0.5	6.7	nc	NAF
GCA9717	HPCS009	HPRC0739a, 20-22	Shl	4.2	0.69	1.4 [1.31]	0.13	1.3	1.3	0.73	10	30	20	2.9	<1	**PAF**
GCA9718	HPCS010	HPRC0739a, 22-24	Shl	4.5	1.6	3.0 [2.11]	0.23	2.8	3.5	2.8	28	58	28 (27)	3.5 (3.6)	<1	**PAF**
GCA9719	HPCS011	HPRC0345, 50-52	Shl-(WS)	2.4	2.9	0.67 [0.729]	0.20	0.47	1.2	<0.01	-12	27	43	2.5	<1	**PAF**
GCA9720	HPCS011-skin			2.7	1.5	2.0	0.49	1.6	1.5	0.03	-2	51	20	2.8	<1	**PAF**
GCA9721	HPCS012	HPRC0345, 52-54	Shl-(WS)	2.6	2.7	1.1 [0.969]	0.61	0.49	1.8	0.02	-9	24	23	2.7	<1	**PAF**
GCA9722	HPCS012-skin			2.5	2.0	0.75	0.36	0.39	1.9	<0.01	-8	20	21	2.7	<1	**PAF**
GCA9723	HPCS013	HPRC0345, 54-56	Shl-(WS)	2.7	1.4	0.41 [0.785]	0.21	0.20	1.4	0.02	-3	9.2	9.5	3.1	<1	**PAF**
GCA9724	HPCS013-skin			2.8	1.1	0.51	0.17	0.34	1.3	<0.01	-5	16	13	2.9	<1	**PAF**
GCA9725	HPCS014	HPRC0757, 68-70	Shl	5.7 (5.7)	1.1 (1.1)	1.4 [1.26]	0.09	1.4	3.3	1.6	21	nc	12	3.7	nc	NAF
GCA9726	HPCS015	HPRC0757, 70-72	Shl	6.1	0.77	0.89 [0.744]	0.06	0.83	3.4	2.2	35 (38)	nc	<0.5	6.9	nc	NAF
GCA9727	HPCS016	HPRC0757, 72-74	Shl	5.5	1.4	1.4 [1.21]	0.14	1.3	1.7	0.99	20	20	6.7	3.4	<1	**PAF**

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation-Capacity; NAPP = Net-Acid-Producing-Potential; AFP = Acid-Formation-Potential; NAG = Net-Acid Generation; nc = not calculated;
NAF = Non-Acid-Forming; PAF = Potentially-Acid Forming.
pH-(1:2) and EC-(1:2) values correspond to pH and EC measured on sample slurries prepared with deionised-water, and a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH. Values in round-parentheses represent duplicates.

N.B. Total-S values in square-parentheses correspond to results from Exploration-Database.

Table 20: Total-Contents of As, Sb, Se, Mo and B in Mine-Waste Samples (Champion)

GCA-SAMPLE NO.	SITE-SAMPLE NO.	DRILLHOLE & DOWN-HOLE INTERVAL (m)	LITHOTYPE	SULPHIDE-S (%)	TOTAL-As (mg/kg)	TOTAL-Sb (mg/kg)	TOTAL-Se (mg/kg)	TOTAL-Mo (mg/kg)	TOTAL-B (mg/kg)
Samples from Above-BoX (= "waste-regoliths"									
GCA9709	HPCS001	HPRC0585, 2-4	RC	<0.01	8.1	0.94	0.28	0.6	<50
GCA9710	HPCS002	HPRC0641, 10-12	DID1	0.02	12	1.2	0.59	1.1	<50
GCA9711	HPCS003	HPRC0585, 28-30	DID2	0.02	9.5	1.4	0.49	2.0	<50
GCA9712	HPCS004	HPRC0641, 42-44	DID3	0.03	8.6	1.3	0.56	1.8	<50
GCA9713	HPCS005	HPRC0641, 46-48	DID4	0.02	6.5	1.3	0.59	1.7	<50
GCA9715	HPCS007	HPRC0326, 30-32	BID	0.01	27	1.5	2.6	2.2	<50
Samples from Basement [= Below-BoX] (i.e. "waste-bedrocks")									
GCA9716	HPCS008	HPRC0739a, 18-20	Shl	<0.01	44	5.2	0.29	2.3	<50
GCA9717	HPCS009	HPRC0739a, 20-22	Shl	1.3	40	3.8	0.98	2.4	<50
GCA9718	HPCS010	HPRC0739a, 22-24	Shl	2.8	38	4.2	1.6	2.7	<50
GCA9719	HPCS011	HPRC0345, 50-52	Shl-(WS)	0.47	50	3.9	0.91	2.9	<50
GCA9720	HPCS011-skin			1.6	91	5.6	2.6	3.4	<50
GCA9721	HPCS012	HPRC0345, 52-54	Shl-(WS)	0.49	70	4.6	1.1	3.6	<50
GCA9722	HPCS012-skin			0.39	54	4.3	0.82	3.6	<50
GCA9723	HPCS013	HPRC0345, 54-56	Shl-(WS)	0.20	49	3.0	0.74	3.1	<50
GCA9724	HPCS013-skin			0.34	57	3.4	0.76	3.1	<50
GCA9725	HPCS014	HPRC0757, 68-70	Shl	1.4	55	4.1	0.72	3.9	<50
GCA9726	HPCS015	HPRC0757, 70-72	Shl	0.83	54	2.9	0.85	3.1	<50
GCA9727	HPCS016	HPRC0757, 72-74	Shl	1.3	43	3.8	2.8	3.6	<50

Table 21: Multi-Element-Analysis Results for Mine-Waste Samples (Champion)

ELEMENT	**TOTAL-ELEMENT CONTENT (mg/kg or %)**		**AVERAGE-CRUSTAL ABUNDANCE (mg/kg or %)**	**GEOCHEMICAL-ABUNDANCE INDEX (GAI)**	
	Shl-(WS) (GCA9719)	**Shl-(WS) (GCA9723)**		**Shl-(WS) (GCA9719)**	**Shl-(WS) (GCA9723)**
Al	3.8%	4.6%	8.2%	0	0
Fe	20.0%	19.4%	4.1%	2	2
Na	0.013%	0.017%	2.3%	0	0
K	2.2%	3.9%	2.1%	0	0
Mg	0.09%	0.15%	2.3%	0	0
Ca	0.2%	0.2%	4.1%	0	0
Ag	0.14	0.14	0.07	0	0
Cu	22	20	50	0	0
Zn	53	40	75	0	0
Cd	0.04	<0.02	0.11	0	0
Pb	19	21	14	0	0
Cr	200	99	100	0	0
Ni	20	15	80	0	0
Co	4.9	3.3	20	0	0
Mn	930	370	950	0	0
Hg	0.17	0.17	0.05	1	1
Sn	1.6	1.8	2.2	0	0
Sr	27	27	370	0	0
Ba	280	420	500	0	0
Th	6.9	8.4	12	0	0
U	2.4	2.8	2.4	0	0
Tl	0.52	0.71	0.6	0	0
V	63	80	160	0	0
As	51	49	1.5	**5**	**4**
Bi	0.36	0.41	0.048	2	**3**
Sb	3.9	3.1	0.2	**4**	**3**
Se	0.91	0.74	0.05	**4**	**3**
Mo	2.8	2.8	1.5	0	0
B	<50	<50	10	0	0
P	530	440	1,000	0	0
F	460	630	950	0	0

Note:
Average-crustal abundance of elements based on Bowen (1979), and the Geochemical-Abundance Index (GAI) is based on Förstner *et al.* (1993). Refer Attachment II.

Table 22: Water-Extraction-Testwork Results for Mine-Waste Samples (Champion)

Note: All results in mg/L, except for pH and Electrical-Conductivity (EC).

ELEMENT/ PARAMETER	*Below-BoX (Basement)*		ELEMENT/ PARAMETER	*Below-BoX (Basement)*	
	Shl-(WS) (GCA9719)	**Shl-(WS) (GCA9723)**		**Shl-(WS) (GCA9719)**	**Shl-(WS) (GCA9723)**
Major-Parameters			***Minor-Ions (µg/L)***		
pH	2.3	2.6	Cu	1,100	710
EC [µS/cm]	4,100	1,600	Ni	1,400	480
			Zn	1,500	450
			Co	710	420
Major-Ions (mg/L)			Cd	2.7	1.1
			Pb	68	40
Na	0.7	0.9	Cr	660	120
K	0.5	13	Hg	<0.1	<0.1
Mg	45	31	As	110	7.8
Ca	16	8	Sb	0.61	0.08
Cl	2	3	Bi	0.005	<0.005
SO_4	3,000	690	Se	<0.5	<0.5
			B	<10	<10
Fe	550	11	Mo	1.4	0.56
Al	200	57	P	600	<100
Si	12	22	Ag	0.03	<0.01
			Ba	13	23
			Sr	15	23
			Tl	0.08	2.2
			V	90	<10
			Sn	0.2	0.1
			U	25	5.4
			Th	75	6.6
			Mn	61,000	28,000

Notes: Water-Extraction Testwork employed crushed-samples (nominal 2-mm), and slurries prepared using 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 centrifugation and vacuum-filtration) for analysis. Values in parentheses represent duplicates.

Table 23: Clay-Mineralogical and Clay-Surface-Chemistry Results for Mine-Waste Samples (Champion)

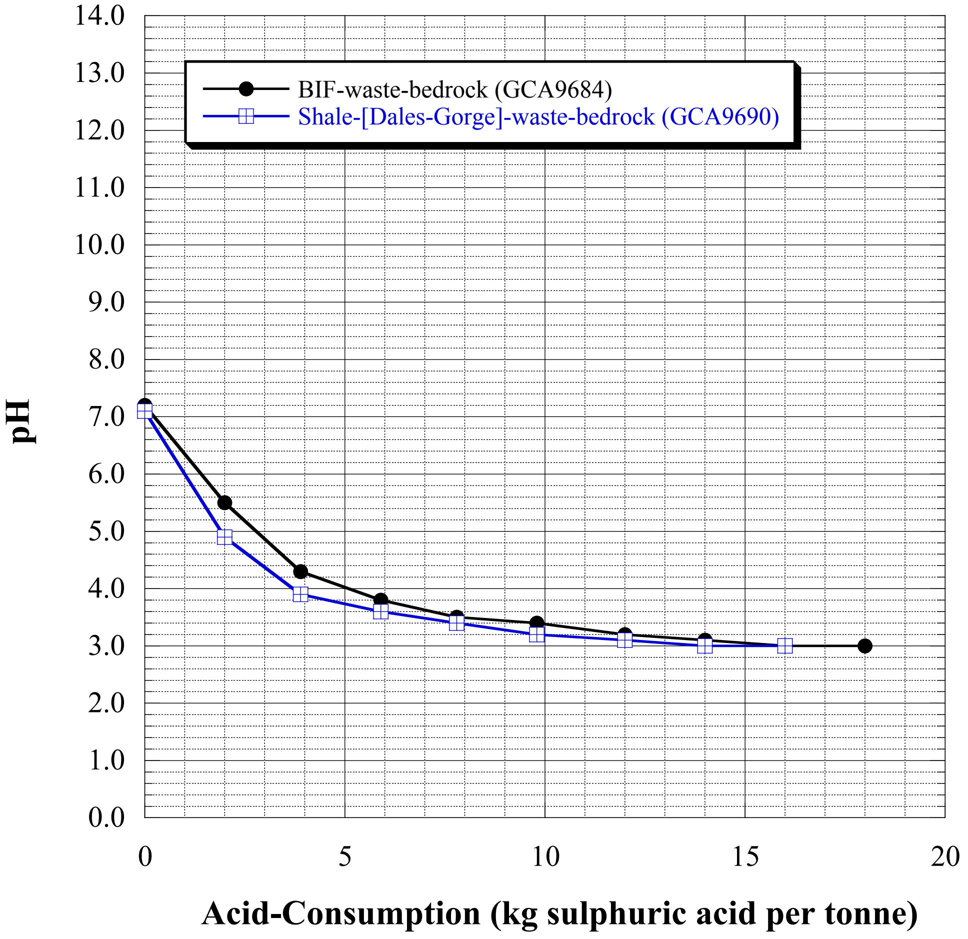
<table>
<tr><th colspan="5">DID1 (GCA9710)</th><th colspan="5">DID2 (GCA9711)</th></tr>
<tr><td colspan="3"></td><td colspan="2"></td><td colspan="3">hematite</td><td colspan="2">dominant</td></tr>
<tr><td colspan="3">hematite</td><td colspan="2">major</td><td colspan="3"></td><td colspan="2">major</td></tr>
<tr><td colspan="3">quartz</td><td colspan="2"></td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="3"></td><td colspan="2"></td><td colspan="3">kaolinite</td><td colspan="2">minor</td></tr>
<tr><td colspan="3">kaolinite</td><td colspan="2">accessory</td><td colspan="3">goethite</td><td colspan="2">accessory</td></tr>
<tr><td colspan="3">goethite</td><td colspan="2"></td><td colspan="3">quartz</td><td colspan="2"></td></tr>
<tr><td colspan="3">Ti-oxide</td><td colspan="2">trace</td><td colspan="3">Ti-oxide</td><td colspan="2">trace</td></tr>
<tr><th rowspan="2">eCEC [cmol (p+)/kg]</th><th colspan="4">%-Proportion of eCEC</th><th rowspan="2">eCEC [cmol (p+)/kg]</th><th colspan="4">%-Proportion of eCEC</th></tr>
<tr><th>Na</th><th>K</th><th>Mg</th><th>Ca</th><th>Na</th><th>K</th><th>Mg</th><th>Ca</th></tr>
<tr><td>3.1</td><td>57</td><td>6</td><td>17</td><td>20</td><td>2.4</td><td>14</td><td><1</td><td>59</td><td>27</td></tr>
</table>

Notes:
eCEC = effective-Cation-Exchange Capacity
dominant = greater than 50 %; major = 20-50 %; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %

FIGURES

Figure 1

pH-Buffering Curves for Waste-bedrock Samples from Delta-Pit



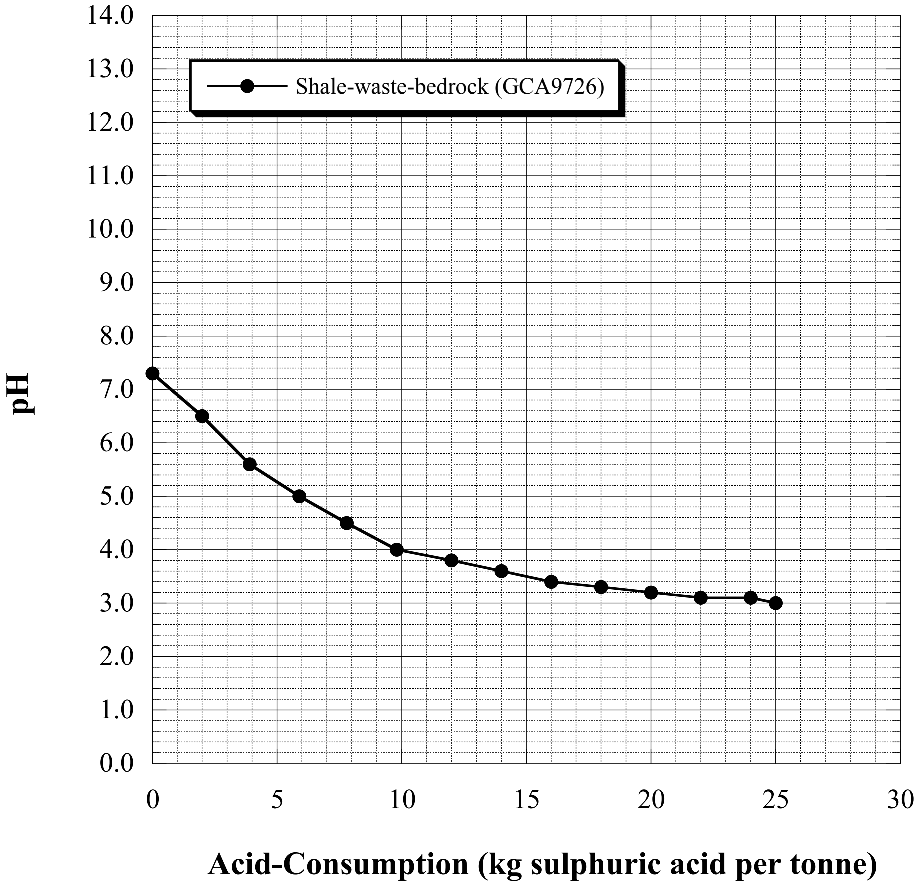
Note:

The H_2SO_4-addition rates employed in the auto-titrations correspond to sulphide-oxidation rates (SORs) up to *c.* 10^6 mg SO_4/kg/flush (= *c.* 10^4 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).

These SORs are therefore up to 10^5-10^6 **faster** than those typical for the circum-neutral weathering, under near-optimal conditions, of mine-wastes which contain "minute/trace-sulphides" that are not hyper-reactive (e.g. framboidal-pyrites, and marcasites).

Figure 2

pH-Buffering Curve for Waste-bedrock Sample from Champion-Pit



Note:

The H_2SO_4-addition rates employed in the auto-titrations correspond to sulphide-oxidation rates (SORs) up to *c.* 10^6 mg SO_4/kg/flush (= *c.* 10^4 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).

These SORs are therefore up to 10^5 **faster** than those typical for the circum-neutral weathering, under near-optimal conditions, of mine-wastes which contain "trace-sulphides" that are not hyper-reactive (e.g. framboidal-pyrites, and marcasites).

ATTACHMENT I

STATISTICS OF SULPHUR-OCCURRENCES AND DETAILS OF SAMPLING PROGRAMME

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MEMO

To	Graeme Campbell	Date	26/8/2011
Company	FMS	Pages	
Cc	Mick Anstey		
From	Graeme McDonald		
Re	Mine Waste Characterisation Study – Sample Selection		

Introduction

In May 2011 Graeme Campbell & Associates Pty Ltd were contracted to undertake a Geochemical Characterisation study of Mine-Waste Samples at the Flinders Mines Pilbara Iron Ore Project (PIOP). I was asked by Mick Anstey to liaise with Graeme Campbell to assist with the selection of samples to be used in the study.

The Pilbara project is located within the Mount Bruce 1:250 000 map sheet. Geological mapping shows the bedrock geology in the region to be the upper parts of the Hamersley Group, a Precambrian sequence dominated by Banded Iron Formation (BIF), shales and chert. In particular the outcropping geology is dominated by members of the Brockman Iron Formation, namely the Whaleback Shale Member, and the Dales Gorge and Joffre Banded Iron Formation (BIF) Members. The majority of drilling penetrates the Whaleback Shale and Dales Gorge units. Within the Blacksmith tenement there are five major valleys, or channels, incised into the bedrock geology; Ajax, Blackjack, Champion, Delta and Eagle. Exploration by Flinders has focussed on exploring these channel systems for Detrital Iron Deposits (DID), Channel Iron Deposits (CID) and the Brockman Iron Formation for Bedded Iron Deposits (BID), both beneath and on the margins of the channels.

This memo documents the sample selection process and methodology.

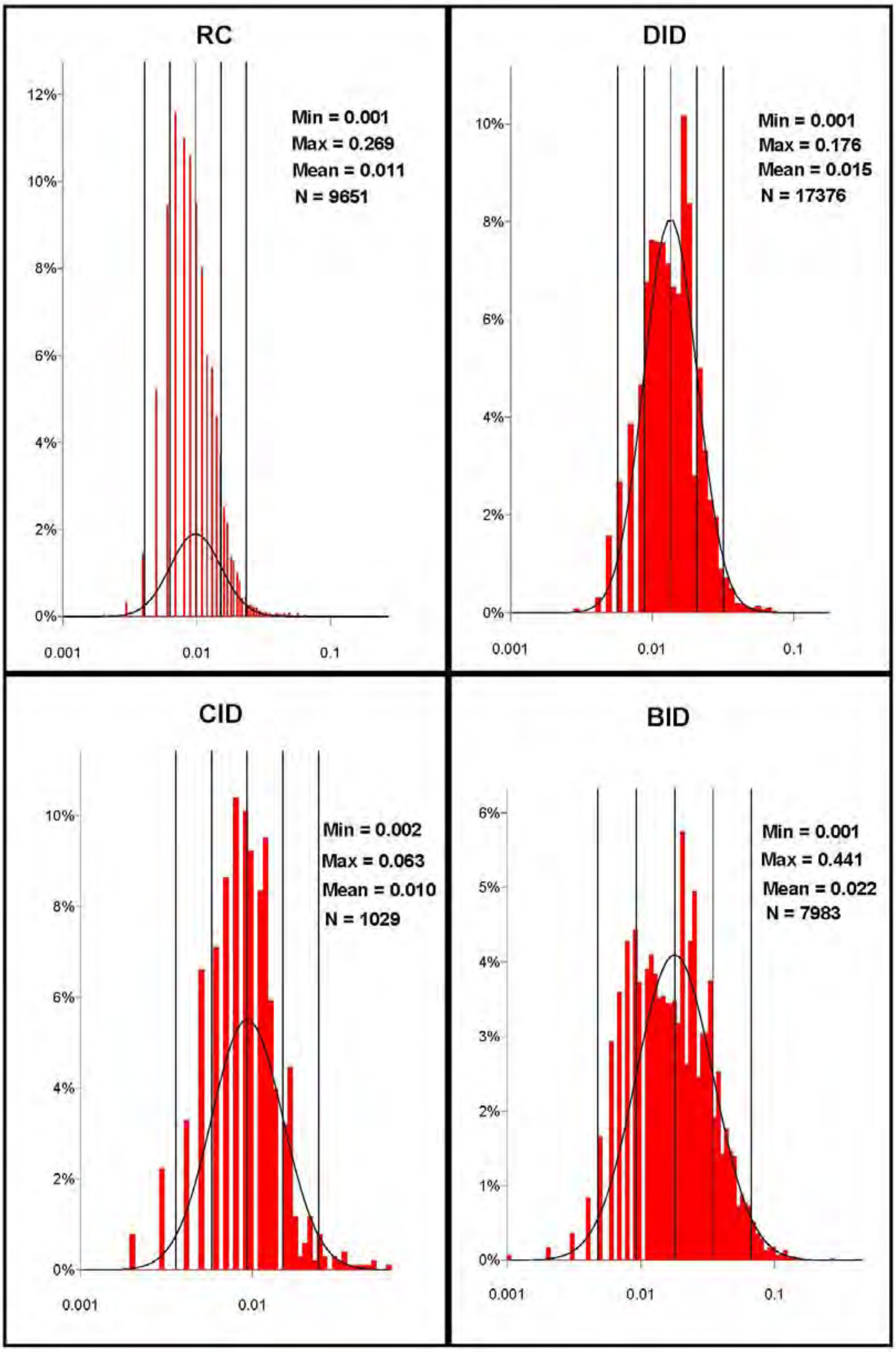
Sulphur Statistics

The presence of sulphur, particularly in the form of sulphides, is a good indicator of the acid forming potential of different rock types. Therefore, the S values determined by XRF as part of our routine sample analysis were investigated as a tool to targeting particular problematic lithologies.

Figure 1 displays S(%) distribution histograms for a range of different lithologies. Recent Colluvium (RC), Detrital Iron Deposit (DID), Channel Iron Deposit (CID) and Bedded Iron Deposit (BID) lithologies essentially shown normal distributions with low mean Sulphur values of 0.01 – 0.022%. Basement lithologies of Banded Iron Formation (BIF) and Shale display positively skewed populations, possibly reflecting a mixing between the two as they can be difficult to identify when logging on a 2m scale. The BIF samples have a mean sulphur value of 0.016% and a maximum of 1.72%. The shales have a much higher mean sulphur value of 0.055% compared to all other samples and a maximum value of 2.59%. Table 1 summarises these results. Based on this analysis the shale units that are below the economic mineralisation have the most elevated sulphur values and when logging these units visible sulphide in the form of pyrite has been noted in some holes. Further investigation has shown the Whaleback Shale to have on average higher sulphur values than the shales within the Dales Gorge BIF unit.

Table 1 : Summary of sulphur values for different lithologies.

Lithology	Mean Sulphur (%)	Max Sulphur (%)
RC	0.011	0.269
DID	0.015	0.176
CID	0.010	0.063
BID	0.022	0.441
BIF	0.016	1.72
Shale	0.055	2.59



RC

DID

CID

BID

Figure 1 : Sulphur distribution histograms for a range of different lithologies

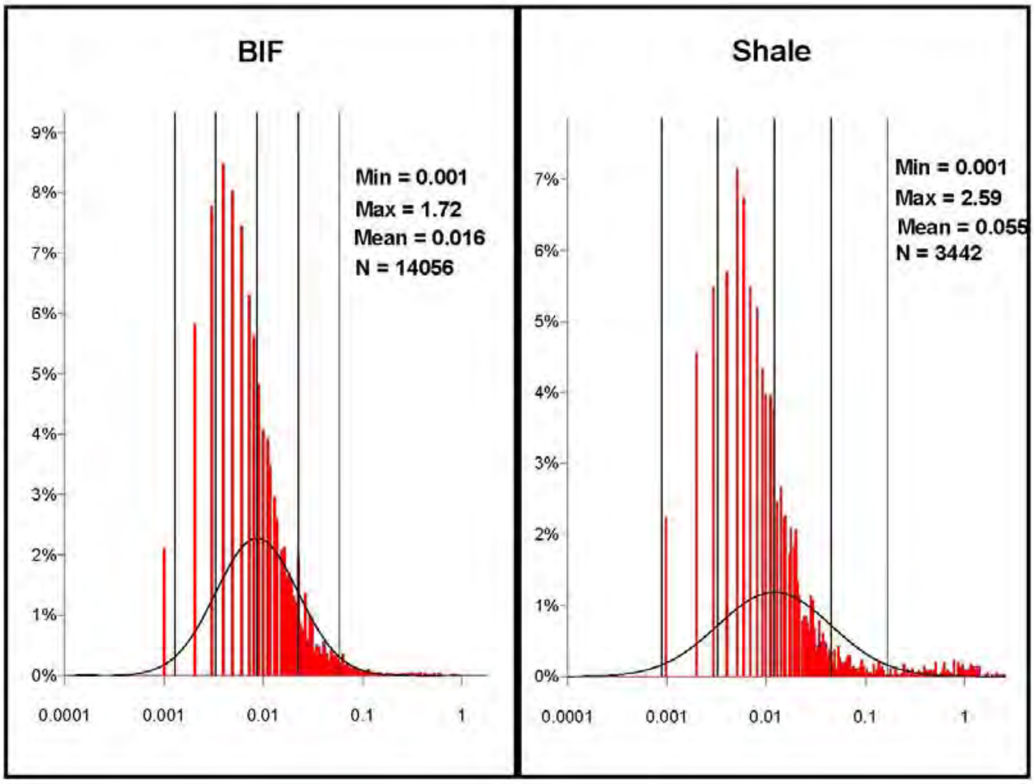


Figure 1 cont:

Sample Locations

Samples were collected across the three main deposits of Delta, Eagle and Champion. They were selected on the basis of lithology and sulphur content with the aim of providing a good representation of the whole project area. A larger number of samples were collected from Delta as this currently represents the area to be mined first. A number of the high sulphur samples were also selected. Drillhole locations are shown in Figure 2.

Sample Collection

Samples were collected from 2m downhole intervals derived from reverse circulation (RC) drilling. Sample piles had been sitting on the surface for up to 3 years, however most holes were less than 2 years old. The minimum amount of sample collected was 2-3kg with up to 5kg collected where possible. In each case the top few centimetres of material (skin) was removed and a grab sample of the ”core” of the pile was taken. This process is demonstrated in the sequence of photographs shown in Figure 3. For a small number of high sulphur samples the outer skin was also collected as demonstrated in Figure 4.

In total 60 samples were collected for static testwork (and 3 “skin” samples) and 18 (6 composites) for kinetic testwork. 33 of the static samples were from above BoX and 27 were from basement units below BoX. All sample details are contained within Table 2.

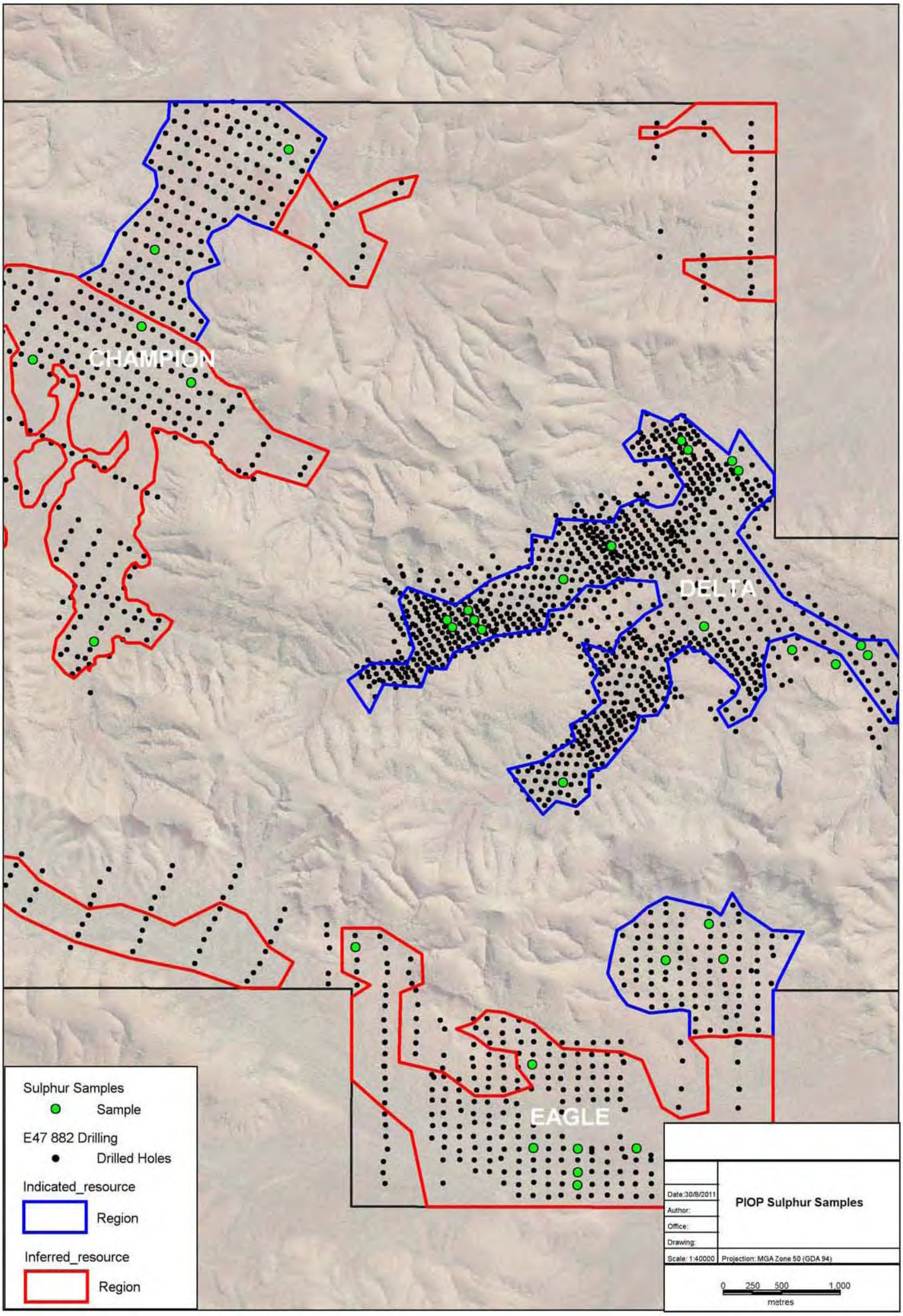
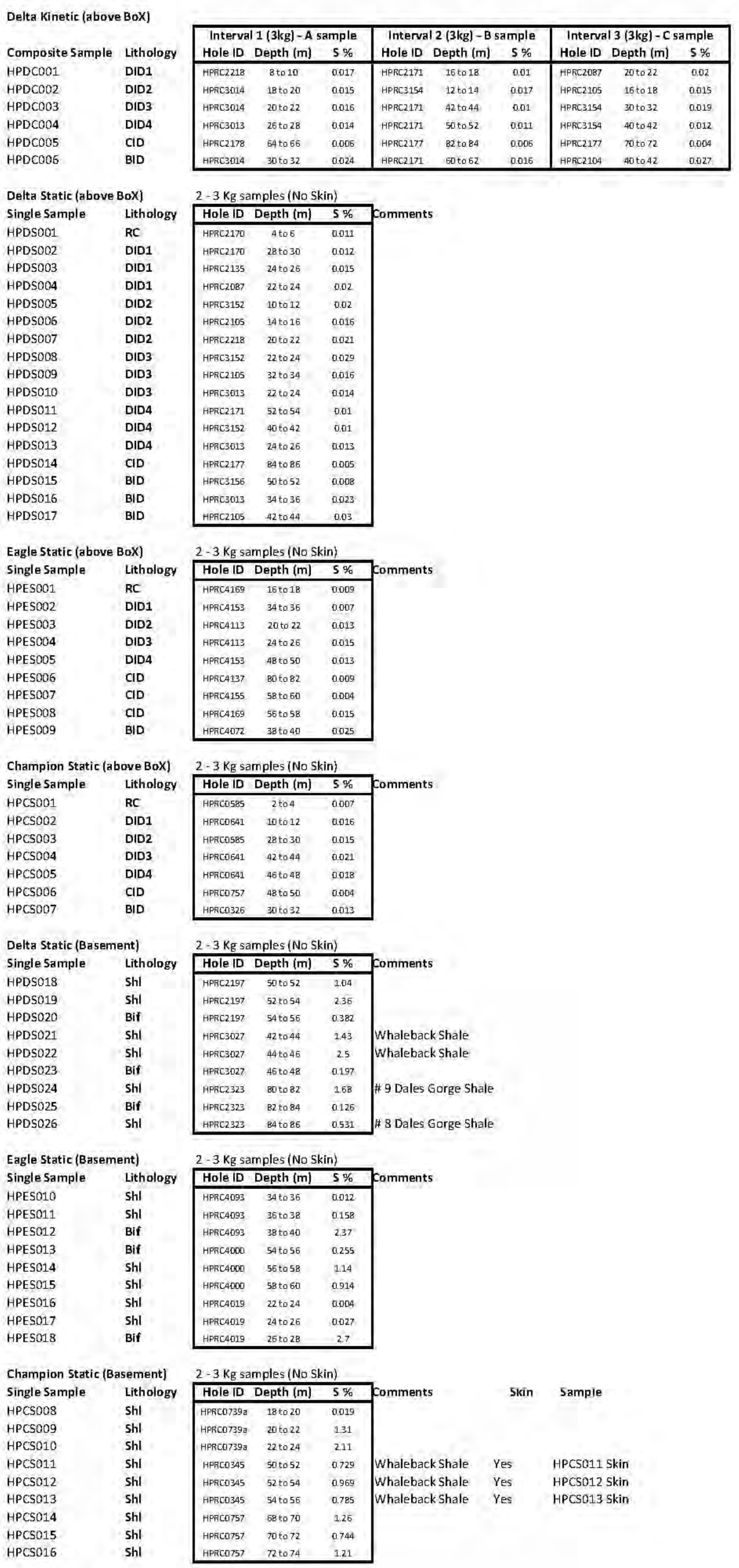


Figure 2 : Location of drillholes from which samples were collected.

Figure 3 : A sequence of photos demonstrating the sampling technique. The outer skin of the pile is moved to the side (top) exposing the inner core (middle) and the sample is then taken (bottom).

Figure 4 : Outer skin of sample pile is collected as it is removed from this high sulphur Whaleback Shale sample.

Table 2 : Sample details



Delta Kinetic (above BoX)

		Interval 1 (3kg) - A sample			Interval 2 (3kg) - B sample			Interval 3 (3kg) - C sample		
Composite Sample	Lithology	Hole ID	Depth (m)	S %	Hole ID	Depth (m)	S %	Hole ID	Depth (m)	S %
HPDC001	DID1	HPRC2218	8 to 10	0.017	HPRC2171	16 to 18	0.01	HPRC2087	20 to 22	0.02
HPDC002	DID2	HPRC3014	18 to 20	0.015	HPRC3154	12 to 14	0.017	HPRC2105	16 to 18	0.015
HPDC003	DID3	HPRC3014	20 to 22	0.016	HPRC2171	42 to 44	0.01	HPRC3154	30 to 32	0.019
HPDC004	DID4	HPRC3013	26 to 28	0.014	HPRC2171	50 to 52	0.011	HPRC3154	40 to 42	0.012
HPDC005	CID	HPRC2178	64 to 66	0.006	HPRC2177	82 to 84	0.006	HPRC2177	70 to 72	0.004
HPDC006	BID	HPRC3014	30 to 32	0.024	HPRC2171	60 to 62	0.016	HPRC2104	40 to 42	0.027

Delta Static (above BoX) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments
HPDS001	RC	HPRC2170	4 to 6	0.011	
HPDS002	DID1	HPRC2170	28 to 30	0.012	
HPDS003	DID1	HPRC2135	24 to 26	0.015	
HPDS004	DID1	HPRC2087	22 to 24	0.02	
HPDS005	DID2	HPRC3152	10 to 12	0.02	
HPDS006	DID2	HPRC2105	14 to 16	0.016	
HPDS007	DID2	HPRC2218	20 to 22	0.021	
HPDS008	DID3	HPRC3152	22 to 24	0.029	
HPDS009	DID3	HPRC2105	32 to 34	0.016	
HPDS010	DID3	HPRC3013	22 to 24	0.014	
HPDS011	DID4	HPRC2171	52 to 54	0.01	
HPDS012	DID4	HPRC3152	40 to 42	0.01	
HPDS013	DID4	HPRC3013	24 to 26	0.013	
HPDS014	CID	HPRC2177	84 to 86	0.005	
HPDS015	BID	HPRC3156	50 to 52	0.008	
HPDS016	BID	HPRC3013	34 to 36	0.023	
HPDS017	BID	HPRC2105	42 to 44	0.03	

Eagle Static (above BoX) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments
HPES001	RC	HPRC4169	16 to 18	0.009	
HPES002	DID1	HPRC4153	34 to 36	0.007	
HPES003	DID2	HPRC4113	20 to 22	0.013	
HPES004	DID3	HPRC4113	24 to 26	0.015	
HPES005	DID4	HPRC4153	48 to 50	0.013	
HPES006	CID	HPRC4137	80 to 82	0.009	
HPES007	CID	HPRC4155	58 to 60	0.004	
HPES008	CID	HPRC4169	56 to 58	0.015	
HPES009	BID	HPRC4072	38 to 40	0.025	

Champion Static (above BoX) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments
HPCS001	RC	HPRC0585	2 to 4	0.007	
HPCS002	DID1	HPRC0641	10 to 12	0.016	
HPCS003	DID2	HPRC0585	28 to 30	0.015	
HPCS004	DID3	HPRC0641	42 to 44	0.021	
HPCS005	DID4	HPRC0641	46 to 48	0.018	
HPCS006	CID	HPRC0757	48 to 50	0.004	
HPCS007	BID	HPRC0326	30 to 32	0.013	

Delta Static (Basement) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments
HPDS018	Shl	HPRC2197	50 to 52	1.04	
HPDS019	Shl	HPRC2197	52 to 54	2.36	
HPDS020	Bif	HPRC2197	54 to 56	0.382	
HPDS021	Shl	HPRC3027	42 to 44	1.43	Whaleback Shale
HPDS022	Shl	HPRC3027	44 to 46	2.5	Whaleback Shale
HPDS023	Bif	HPRC3027	46 to 48	0.197	
HPDS024	Shl	HPRC2323	80 to 82	1.68	# 9 Dales Gorge Shale
HPDS025	Bif	HPRC2323	82 to 84	0.126	
HPDS026	Shl	HPRC2323	84 to 86	0.531	# 8 Dales Gorge Shale

Eagle Static (Basement) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments
HPES010	Shl	HPRC4093	34 to 36	0.012	
HPES011	Shl	HPRC4093	36 to 38	0.158	
HPES012	Bif	HPRC4093	38 to 40	2.37	
HPES013	Bif	HPRC4000	54 to 56	0.255	
HPES014	Shl	HPRC4000	56 to 58	1.14	
HPES015	Shl	HPRC4000	58 to 60	0.914	
HPES016	Shl	HPRC4019	22 to 24	0.004	
HPES017	Shl	HPRC4019	24 to 26	0.027	
HPES018	Bif	HPRC4019	26 to 28	2.7	

Champion Static (Basement) 2 - 3 Kg samples (No Skin)

Single Sample	Lithology	Hole ID	Depth (m)	S %	Comments	Skin	Sample
HPCS008	Shl	HPRC0739a	18 to 20	0.019			
HPCS009	Shl	HPRC0739a	20 to 22	1.31			
HPCS010	Shl	HPRC0739a	22 to 24	2.11			
HPCS011	Shl	HPRC0345	50 to 52	0.729	Whaleback Shale	Yes	HPCS011 Skin
HPCS012	Shl	HPRC0345	52 to 54	0.969	Whaleback Shale	Yes	HPCS012 Skin
HPCS013	Shl	HPRC0345	54 to 56	0.785	Whaleback Shale	Yes	HPCS013 Skin
HPCS014	Shl	HPRC0757	68 to 70	1.26			
HPCS015	Shl	HPRC0757	70 to 72	0.744			
HPCS016	Shl	HPRC0757	72 to 74	1.21			

ATTACHMENT II

TESTWORK METHODS

ATTACHMENT II

TESTWORK METHODS

The testwork methods outlined below are proven approaches to 'static-testing' and 'kinetic-testing' within the Australian, and international mining-industries (e.g. Price 2009; Stewart *et al.* 2006; AMIRA 2002; Morin and Hutt 1997).[1] The MEND-document prepared by Price (2009), and *c.* 10-20 years in the making by an experienced practitioner, is an invaluable source of information on testing methods on mine-waste geochemistry. There is also the Global-Acid-Rock-Drainage-Guide (GARD Guide) which is an INAP initiative (go to: www.gardguide.com). However, in terms of comprehensiveness, structure, and clarity, the document by Price (2009) is recommended.

Part of the acid-base-account (ABA) testing, and all of the multi-element analyses, and clay-surface-chemical determinations, are carried out by Genalysis Laboratory Services Pty Ltd [GLS] (Maddington). Specialised ABA-testing, and kinetic-testing, is undertaken by GCA (Bridgetown). Characterisation of rock- and clay-mineralogy is carried out by Roger Townend & Associates (Malaga).

Samples are crushed to 2mm (nominal) in a jaw/rolls-crusher, and pulverised to 75µm (nominal), for specific tests, as required. These sample-splits are referred to herein as "crushings" and "pulps", respectively.

It should be noted that the testwork methods described below are routinely employed in work programmes undertaken by GCA. However, the testwork methods described are generic, and specific tests may not necessarily be undertaken in a given study.

1.0 ACID-BASE-CHEMISTRY AND SALINITY TESTWORK

Acid-base chemistry and salinity are assessed by determining:

- pH and Electrical-Conductivity (EC) on sample slurries;
- Total-Sulphur (Total-S), and Sulphate-Sulphur (SO_4-S);
- Acid-Neutralisation-Capacity (ANC), and CO_3-C;
- Net-Acid-Producing-Potential (NAPP); and,
- Net-Acid-Generation (NAG).

Relevant details of the testwork methods employed are discussed below. Further details are presented in the laboratory reports.

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[1] 'Static'-testing' corresponds to "whole-rock" analyses and tests.

1.1 pH-(1:2) and EC-(1:2) Tests

Measurements of pH and EC are performed on slurries prepared using deionised-water, and a solid:water ratio of *c.* 1:2 (w/w). The slurries are allowed to age for *c.* 24 hours, prior to measuring pH and EC.[2] These tests are performed on the crushings.

pH-(1:2) and EC-(1:2) values provide a measure of the inherent acidity/alkalinity and salinity.[3]

1.2 Total-S and SO_4-S

Total-S is determined by Leco combustion (@ 1300 °C) with detection of evolved $SO_{2(g)}$ by infra-red spectroscopy. SO_4-S is determined by the Na_2CO_3-Extraction Method (Berigari and Al-Any 1994; Lenahan and Murray-Smith 1986).[4] The difference between Total-S and SO_4-S indicates the Sulphide-S (strictly Non-Sulphate-S) value. The Total-S and SO_4-S tests are performed on pulps.

1.3 Acid-Consuming Properties

1.3.1 ANC

ANC is determined by a procedure based on that of Sobek *et al.* (1978) which is the "standard" ANC-testing method (AMIRA 2002; Morin and Hutt 1997).

Samples (as crushings) are reacted with dilute HCl for *c.* 2 hours at 80-90 °C, followed by back-titration with NaOH to a pH=7 end-point to determine the amount of acid consumed.[5] The simmering step for *c.* 2 hours differs from the Sobek *et al.* procedure wherein test-mixtures are heated to near boiling until reaction is deemed to be complete, followed by boiling for one minute. In terms of the dissolution of carbonate- and primary-silicate-minerals, this variation to the Sobek *et al.* method is inconsequential.

The Sobek *et al.* (1978) procedure subjects samples to both strongly-acidic conditions (e.g. pH of 1-2), and a near-boiling temperature. Provided excess acid is added, the dissolution of carbonate-minerals is near-quantitative, and traces of primary-silicates

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[2] The slurries are stirred at the beginning of the testwork, and once again immediately prior to measuring pH and EC.

[3] The pH-(1:2) values approximate the "Abrasion-pH" values for identifying minerals in the field (e.g. Stevens and Carron 1948).

[4] The Na_2CO_3-reagent extracts SO_4 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 primary-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.

[5] A few drops of 30 % (w/w) H_2O_2 are added to the test mixtures as the pH=7 end-point is approached, so that 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 unduly biased "on-the-high-side", due to the release of Fe(II) during the acid-digestion step (AMIRA 2002), provided that the ferroan-carbonate content is not excessive (e.g. siderite-C values less than 1.5 % [Stewart *et al.* 2006]).

also dissolve. However, at circum-neutral-pH (viz. pH 6-8) relevant to mine-waste and environmental management, the dissolution of primary-silicates is kinetically limiting (e.g. see review-monograph by White and Brantley [1995]).

In the absence of inhibiting alteration-rims, dissolution rates of mafic/felsic-silicates generally equate to H_2SO_4-consumption rates 'of-the-order' 10^{-11}-10^{-12} moles/m^2/s. Accordingly, for particle-sizes within the sub-mm range, circum-neutral-dissolution rates of primary-silicates correspond to Sulphide-Oxidation Rates (SORs) 'of-the-order' 1-10 mg SO_4/kg/week (= *c.* 0.1-1.0 kg H_2SO_4/tonne/year).[6] In practice, circum-neutral buffering through the surface-hydrolysis/dissolution of primary-silicates is therefore restricted to both particle-gradings akin to "rock-flour" (viz. sub-mm), and slow rates of sulphide-oxidation (e.g. as exhibited by "trace-sulphides" which are not atypically reactive).[7]

Despite aggressive-digestion conditions, the ANC values determined by the Sobek *et al.* (1978) method allow an informed "screening" of acid-consuming properties, especially when due regard is given to groundmass-mineralogy (Morin and Hutt 1997). Jambor *et al.* (2005, 2002, 2000) list 'Sobek-ANC' values for different types of primary-silicates which assists interpretation of ANC-testwork results.

That the ANC value is not an intrinsic property of a sample of geologic media, but rather the outcome of the particular ANC-testwork method employed, is shown by Morin and Hutt (2009).

1.3.2 CO_3-C

CO_3-C is the difference between the Total-C and Total-Organic-C (TOC). Total-C is measured by Leco combustion (@ 1300 °C) with detection of evolved $CO_{2(g)}$ by infra-red spectroscopy. TOC is determined by Leco combustion on a sub-sample which had been treated with strong HCl to decompose carbonate-minerals. Pulps are used for these determinations.

1.3.3 pH-Buffering Properties

pH-Buffering properties are determined via a Metrohm® 736 Titrino auto-titrator, and 0.05 M-H_2SO_4. Auto-titrations comprise regular addition of H_2SO_4 to decrease the pH values of the test-suspensions (prepared using pulps) to 3.0 typically over the course of

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[6] 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 *c.* 0.5 %) which are not hyper-reactive, and so excludes *inter alia* framboidal-pyrite, and marcasite.

[7] Primary-particle-sizes within the "rock-flour" range is a given for process-tailings-solids. In the case of mine-wastes, despite its usually small weight-based abundance, this size-fraction is invariably the main seat of geochemical-weathering reactions within waste-dumps, and thereby the main "source-term" for solute generation (e.g. Price and Kwong 1997). Such "rock-flour" occurs in two forms: that obtained via dry-sieving, and that associated with the surfaces of clasts of wide-ranging sizes, and which can only be obtained via wet-sieving.

c. 1 day.[8] Despite taking up to 1 day to complete, the H_2SO_4-addition rates employed in the auto-titrations are 'orders-of-magnitude' faster than the sulphide-oxidation rates typically observed under "ambient-weathering" conditions.

1.4 NAPP Calculations

NAPP values are calculated from Total-S, SO_4-S and ANC values, assuming that **all** of the Sulphide-S occurs in the form of pyrite, and/or pyrrhotite. NAPP values facilitate assessment of Acid-Formation Potential (AFP).

The complete-oxidation of pyrite (and/or marcasite) may be described by:

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

The complete-oxidation of pyrrhotite may be described by:

$$\text{"}FeS\text{"} + 9/2O_2 + 5/2H_2O = H_2SO_4 + \text{"}Fe(OH)_3\text{"}$$

Since pyrrhotite is non-stoichiometric, expressing it as "FeS" is approximate (Janzen *et al.* 2000). Elemental-S may also be produced during pyrrhotite weathering (Nicholson and Scharer 1994), especially at low-pH. However, Elemental-S is ultimately oxidised to H_2SO_4.

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

> 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- and pyrrhotite-oxidation were reviewed by Rimstidt and Vaughan (2003), and Belzile *et al.* (2004), respectively.

1.5 NAG Tests

The NAG Test is a direct measure of the potential for acid-production through sulphide-oxidation, and also provides an indication of the reactivity of the sulphide-minerals, and the availability of alkalinity-forms (AMIRA 2002; Miller *et al.* 1997, 1994). Since this test is performed on pulps, sulphide-grains are fully liberated, and available for reaction.

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[8] In titrating to a pH=3.0 end-point, any Fe(II) released through acid attack of ferroan-carbonates and -silicates is not quantitatively oxidised to Fe(III), and subsequently hydrolysed/precipitated to "$Fe(OH)_3$". The equivalent of *c.* 0.5 kg H_2SO_4/tonne is generally required to decrease the pH of the "solution-only" to pH=3.0. No correction is made for this "electrolyte-consumption" of H_2SO_4.

The sample is reacted with H_2O_2 to oxidise sulphide-minerals, and allow the produced acid to react with the acid-neutralising components (chiefly carbonate-minerals). The results from NAG testwork supplement the NAPP-based assessment of AFP (Stewart *et al.* 2006; Shaw 2005; Morin and Hutt 1997).

The NAG-testing methodology used by GCA is the 'Static-NAG Test' in its "single-addition" mode, with NaOH-titration to a pH=7 end-point (AMIRA 2002; Miller *et al.* 1994, 1997). The Start-pH of the 15 % (v/v) H_2O_2 solution (prepared from A.R.-grade H_2O_2) is adjusted to pH=4.5 using 0.1 M-NaOH. The boiling treatment to decompose residual, unreacted-H_2O_2 following overnight reaction is carried out in two stages (viz. boiling for *c.* 2 hours initially, cooling and addition of 1 mL of 0.02 M-$CuSO_4$, followed by boiling for a further *c.* 2 hours). The addition of Cu(II) catalyses the decomposition of unreacted-H_2O_2, and thereby prevents "positive-blank" values (McElnea and Ahern 2004; O'Shay *et al.* 1990).[9]

Prior to the boiling steps, the pH values of the test-suspensions are measured. Such pH values reflect buffering under ambient conditions without accelerated dissolution of groundmass-minerals through boiling. In the interpretation of NAG-testwork results, it is important to note the pH values prior to the boiling steps, especially for lithotypes characterised by "trace-sulphides" (e.g. Sulphide-S within the sub-% range), and ANC values less than *c.* 10-20 kg H_2SO_4/tonne (e.g. a groundmass devoid of carbonate-minerals). The rates of "peroxide-oxidation" are orders-of-magnitude faster than those of "ambient-oxidation" (viz. SORs recorded in kinetic-testing employing Weathering-Columns). If circum-neutral-pH is to prevail during NAG testwork, then the rate of acid-consumption must be proportionately faster than that for "ambient-oxidation", and is essentially restricted to buffering by reactive-carbonate-minerals (e.g. calcites, dolomites, and ankerites). This aspect must be borne in mind when interpreting NAG-testwork results, especially for samples that contain "trace-sulphides" in a carbonate-deficient groundmass.

2.0 MULTI-ELEMENT ANALYSES

The total content of a wide range of major- and minor-elements are determined through the use of various digestion and analytical techniques. The respective detection-limits are appropriate for environmental investigations.

Element enrichments are identified using the *Geochemical Abundance Index (GAI)*.[10] The GAI quantifies an assay result for a particular element in terms of the average-

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[9] Where samples contain sufficient Cu(II), then Cu(II) forms will be released to solution during reaction with H_2O_2, especially at low-pH.

[10] 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.

crustal-abundance of that element.[11] The latter corresponds to the typical composition of soils, regoliths and bedrocks derived from unmineralised terrain.

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.

3.0 MINERALOGY AND CLAY-SURFACE CHEMISTRY

The semi-quantitative mineralogy, and clay-surface chemistry (generally restricted to waste-regoliths, oxide-ores, and/or soils), are determined using methods routinely used in geology, and soil science.

Indicative abundances of mineral fall into one of the following broad classes, viz.

dominant	greater than 50 %
major	20-50 %
minor	10-20 %
accessory	2-10 %
trace	less than 2 %

Randomly- and preferentially-oriented specimens are prepared, and variously treated with sodium-hexametaphosphate (dispersant), ethylene-glycol, and heating, to quantify non-expansive, and expansive (e.g. smectites), varieties of clay-minerals.

The Effective-Cation-Exchange Capacity (eCEC), and suite of Exchangeable-Cations, are determined by different methods for samples (as crushings) of non-calcareous and calcareous materials (Rengasamy and Churchman 1999). In both cases, soluble-salts are initially removed via pre-washing using a "mixed-organic-solvent" (viz. ethylene-glycol and ethanol). Method 15A2 in Rayment and Higginson (1992) is then employed for non-calcareous samples to determine eCEC, and Exchangeable-Sodium Percentage (ESP). In the case of calcareous samples, a method based on that described by Pierce and Morris (2004) is used, and prevents the dissolution of carbonate-minerals (e.g. calcites and dolomites).[12] After the initial pre-washing step above, extraction is carried out with 1 M-NH_4Cl buffered at pH=8.5 in an ethanolic-aqueous solution. Without such precautions to suppress dissolution of carbonate-minerals, the eCEC is biased "on-the-high-side", and ESP biased "on-the-low-side". Depending on the abundance and nature of the carbonate-minerals, the magnitude of this bias can be marked.

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

[12] The procedure described by Pierce and Morris (2004) is closely related to that originally developed by Tucker (1974).

4.0 SOLUBILITY OF MAJOR/MINOR-ELEMENTS

4.1 Water-Extraction Testwork

Water-Extraction Testwork on the crushings is performed via the bottle-roll technique, and using deionised-water. The test-slurries have a solid:solution ratio of *c.* 1:2 (w/w), and are bottle-rolled for *c.* 1 day before being left to "still-stand" for *c.* 1 day to allow suspended mineral-fines to settle. The resulting supernatants are decanted, vacuum-filtered (0.45µm-membrane), and preserved, as appropriate, for specific analyses. Where required, centrifuging at *c.* 4,000 G for 30 minutes is undertaken to expedite solid-solution separation for vacuum-filtration. The Water-Extraction Testwork is performed in the GCA-Testing Laboratory.

4.2 Na_2EDTA-Extraction Testwork

Na_2EDTA-Extraction Testwork (at pH=6) is carried out on the crushings, based on the method described by Clayton and Tiller (1979). The test-slurries have a solid:solution ratio of *c.* 1:2 (w/w), and are bottle-rolled for *c.* 7 days. This testwork provides a measure of the "metal-pool" potentially available for uptake by biota (e.g. absorption by plant roots).

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KINETIC-TESTING METHODOLOGY EMPLOYED
IN THE GCA-TESTING LABORATORY

1.0 WEATHERING-COLUMNS

- The (short) weathering-columns allow assessment of reaction dynamics under aeration and moisture regimes which are near-optimal for sulphide-oxidation.

  The sample-bed-lengths in the columns are typically within the range 5-7 cm.

- The weathering-columns, and the geometry of the gantry housing the columns and flood-lamps (see Plate 1a), are based on those described in AMIRA (2002).[1]

  The main departures from AMIRA (2002) are:

  - the power, and operation, of the flood-lamps in order to constrain the maximum/minimum-temperatures of the sample-beds during the drying-phase; and,

  - the use of weekly-weathering-cycles (i.e. weekly-flushing), and a greater rate of deionised-water addition during flushing.

  Salient details of the above are discussed below.

1.1 Sample-Bed-Temperature Control

- The gantry housing the weathering-columns is located in a modern, high-ceiling (*c.* 10 m), workshop-type area fitted with roof-venting-whirlygigs, but without air-conditioning.[2] Accordingly, ambient-temperatures vary both diurnally, and seasonally, under the Mediterranean climate of Bridgetown in the south-west of WA.

- In order to constrain variations in the sample-bed-temperatures, 80W-flood-lamps are employed, and turned-on intermittently during the night-time (via automatic-timers) as follows (see Plate 1b):

  - June to September

    9 hrs: 17.00-19.00, 22.00-24.00, 2.00-5.00, and, 7.00-9.00

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[1] Six (6) flood-lamps are employed per ten (10) weathering-columns to ensure that the "end-column-pairs" receive the same daily heat-loads as the other "internal-column-pairs" (c.f. the use of 4 flood-lamps per 10 columns, as per AMIRA [2002], where the "end-column-pairs" receive reduced daily heat-loads).

[2] To routinely operate multiple (e.g. 20-30+) heat-lamps simultaneously to dewater multiple columns, and then to "air-condition" the working area via refrigerated-air-conditioning, would be environmentally irresponsible.

- <u>October to May</u>

  6 hrs: 22.00-24.00, 2.00-5.00, and, 8.00-9.00

- The above differs from that described in AMIRA (2002) where 150W-flood-lamps are turned-on continuously during the daytime for *c.* 8-10 hrs. Although it is implied in AMIRA (2002) that this setup maintains a surface-temperature of *c.* 30-35 ^{o}C, this is not the case under the conditions of our laboratory.

  GCA-research (unpublished) using columns instrumented with thermistors and soil-moisture sensors, and automatically logged hourly (see Plate 2), has shown that, during the latter stages of drying when residual-moisture contents are attained, the methodology described in AMIRA (2002) results in summer-peak-temperatures (for *c.* 1-2 hrs in mid-afternoon) up to *c.* 70-80 ^{o}C in the top *c.* 10 mm on the side of columns closest to the centre of the flood-lamps (i.e. near-lamp-side). However, with the 80W-flood-lamps operated intermittently during the night-time, the near-lamp-side temperature in the top *c.* 10 mm ranges up to *c.* 40 ^{o}C only on extreme-summer-days. Since the peak-temperature is in the top *c.* 10 mm on the near-lamp-side, the remainder of the sample-bed has temperatures ranging up to no greater than 30-40 ^{o}C.

  Likewise, during winter, the operation of the 80W-flood-lamps during the night-time ensures that the basal-section of the sample-beds on the far-lamp-side have winter-peak-temperatures typically above 10-15 ^{o}C during the coldest nights. The flood-lamps are operated 9 hrs per day during winter (c.f. 6 hrs per day for the rest of year) to ensure that sulphide-oxidation is not limited by restricted evaporative-drying.[3]

- Summarising, under the conditions employed in the GCA-Testing Laboratory, use of the 80W-flood-lamps operated intermittently has been proved to constrain the maximum temperature of the sample-beds to within 30-40 ^{o}C during the latter stages of the drying-phase, even on extreme-summer days.

  In terms of assessing the temperature dependence of sulphide-oxidation rates (SORs), the winter- and summer-peak-SORs broadly correspond to mean-temperatures of 20 ^{o}C, and 30 ^{o}C, respectively. Therefore, where SORs have more-or-less stabilised during kinetic-testing (as often observed during circum-neutral-weathering), the difference between the peak-seasonal-SORs, together with the peak-seasonal-temperature variation of 10 ^{o}C, then allows estimation of the activation-energy (E_a) for sulphide-oxidation specific to the tested-lithotype.[4] Such lithotype-specific estimates of E_a serve as useful input to geochemical modelling of sulphide-oxidation at field-scale.

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[3] Pan-evaporation (E_{pan}) rates are routinely determined, and range from 3-5 mm/day over the winter-peak, to 6-8 mm/day over the summer-peak.

[4] In practice, it generally means that the kinetic-testing programme would need to run for at least 1-2 years in order to capture the seasonal-extremes of "stable-SORs" for E_a estimation.

1.2 Weekly-Weathering-Cycles

- The columns are weighed each day to track the rate, and extent, of dewatering.[5]

  Where the attainment of residual-moisture contents is not desired (e.g. for mine-sites in well-watered settings), an addition of 0.10-0.20 kg of deionised-water is added to "wet" (but not "flush") the sample-beds part way through the drying-phase of each weathering-cycle.

- The flood-lamps are operated intermittently commencing on Monday, Tuesday, Wednesday, and Thursday evenings/nights (i.e. flood-lamps operated over four nights during each weathering-cycle). The flushing-step is undertaken late-morning on Fridays, and corresponds to a "flood-addition" of deionised-water. Where required, the top 5-10 mm of the sample-bed-surface is worked-over with a spatula to fill-in, and seal-over, any cracks developed during the drying-phase, and thereby prevent inefficient leaching from "breakthrough", and "by-pass".

- The AMIRA (2002) procedure involves the wetting of the sample-beds at the end of Week-1, Week-2, and Week-3, and then flushing at the end of Week-4 to produce leachates for analysis (i.e. 4-weekly-flushing regime with weekly-wetting between). The rate of deionised-water addition (viz. 0.10 kg deionised-water per kg solids) in the wetting-step is typically shy of "field-capacity" (enhanced by the seepage-face-lower-boundary condition), so there is generally no drainage.

  Weekly-weathering-cycles (i.e. flushing with leachate collection on a weekly basis) are employed in the GCA procedure.

- 1.00 kg of deionised-water is employed for flushing, corresponding to 0.66 kg of deionised-water per kg of solids (i.e. 1.00 kg of deionised-water used to flush 1.50 kg [dry-solids-equivalent] of sample). This rate of water addition exceeds the 0.40 kg per kg solids advocated in AMIRA (2002) which occurs every 4-weeks (c.f. *c.* 2.7 kg of deionised-water per kg solids over 4-weeks herein).

  The weekly-flushing regime, and rate of deionised-water addition, employed by GCA is similar to that typically employed in "humidity-cell" testing in Canada, and the USA (Price 2006; Morin and Hutt 1997; ASTM 2007).

- The residence-time of water during the flushing-step is generally ranges up to *c.* 12 hrs, as governed by sample texture.

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[5] Due to the "sub-decimetre" thickness of the sample-beds, and the seepage-face-lower-boundary condition, the actual-evaporation rates (E_{actual}) are typically close to the corresponding E_{pan} rates until residual-moisture/suctions are approached.

- The leachates are collected in beakers beneath the columns, and the so-collected leachates are left to "age" under ambient conditions until Monday when the next weathering-cycle commences.

  All leachates are weighed (for mass-balance calculations), prior to Leachate-pH and Leachate-EC values being determined, followed by vacuum-filtering (0.45-µm-membrane), and preservation, as appropriate, for the determination of specific analytes.

- Prior to commencing the weathering-cycles, the GCA-columns are subjected to a thorough pre-rinsing treatment using deionised-water to elute pre-existing solutes. Pre-rinsing is continued using 1.00-kg lots of deionised-water until the Electrical-Conductivity (EC) value of the "last-incremental-leachate" (e.g. last 100 mL) is less than *c.* 300-500 µS/cm. This pre-rinsing step facilitates interpretation of the kinetic-testing results overall.

2.0 REFERENCES

AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd

ASTM, 2007, "Standard Test Method for Laboratory Weathering of Solid Materials Using a Humidity Cell", ASTM D 5744-07.

Morin KA and Hutt NM, 1997, "Environmental Geochemistry of Minesite Drainage: Practical Theory and Case Studies", MDAG Publishing, Vancouver

Price W, 2009, "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials", MEND Report 1.20.1

Plate 1a: **Typical Weathering-Column Assembly**

Layout and configuration-geometry as per AMIRA (2002).

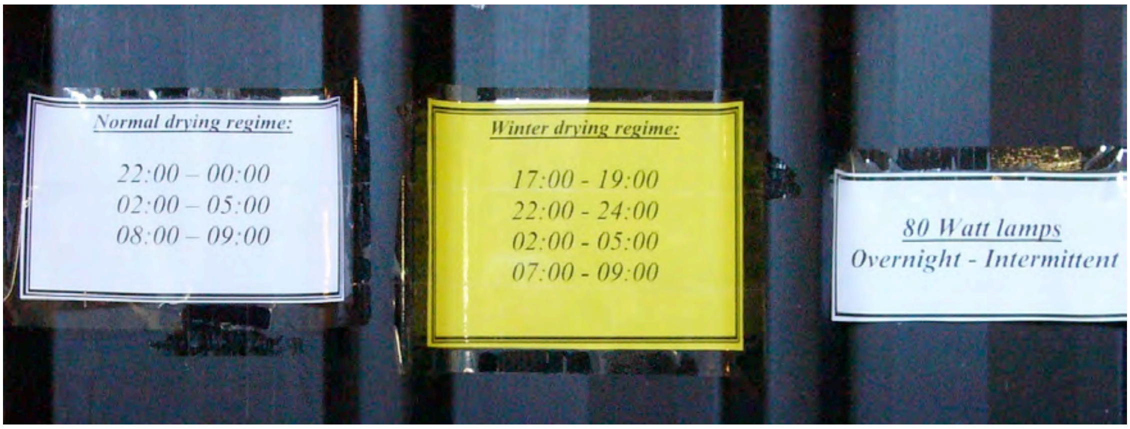

Plate 1b: **Seasonal and Diurnal Schedule for Operation of 80W-Flood-Lamps.**

Required variation to AMIRA (2002) in order to constrain maximum-temperatures of sample-beds to within 30-40 °C.

Plate 2: **GCA-Research Project: Instrumented-Weathering-Column with -4.75mm Fraction of Trace-Sulphide/Calcareous-Basalt-waste-bedrock Sample.**

Circum-neutral Weathering.
Volumetric-Water Content (VWC) of upper-half and lower-half of sample-beds logged hourly using calibrated MP406-sensors.
Temperature of top *c.* 10 mm, and bottom *c.* 10 mm, on both the near-lamp-side, and far-lamp-side (as seen in front of columns in photograph), logged hourly using thermistors.
Daily-pan-evaporation rates determined via daily weighing of perspex-container to the left of columns.

ATTACHMENT III

ACID-FORMATION POTENTIAL (AFP):

CALCULATED PARAMETERS AND CLASSIFICATION CRITERIA

ATTACHMENT III

ACID-FORMATION POTENTIAL (AFP):

CALCULATED PARAMETERS AND CLASSIFICATION CRITERIA

Notes: The geochemically-based parameters, and AFP-classification criteria, indicated below apply equally to samples of mine-wastes (e.g. waste-regoliths and waste-bedrocks), low-grade-ores, and process-tailings-solids. The generic descriptor "test-sample" is employed below.

1.0 CALCULATED PARAMETERS

Maximum-Potential-Acidity (MPA) values (in kg H_2SO_4/tonne) of test-samples are typically 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.

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

2.0 CLASSIFICATION CRITERIA

In terms of AFP, test-samples 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 test-samples (e.g. Price 2009; AMIRA 2002), 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, mineralogy, and site-specific climate.

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 AFP, lithotypes from hard-rock mines with Sulphide-S values less than 0.3 % are unlikely to acidify (e.g. pH less than 4-5) through sulphide-oxidation. This position holds especially where the groundmass hosting the "trace-sulphides" is not simply quartz, soil-clays, and/or sesquioxides (Price *et al.* 1997), and where the sulphide-minerals are not hyper-reactive varieties (e.g. framboidal-pyrite). A "cut-off" of 0.3 % for Sulphide-S also accords with the findings of kinetic-testing, since the late-1980s, by Dr. Graeme Campbell for test-samples of diverse mineralogy in terms of sulphide-weathering dynamics, and solubility behaviour.

The risk posed by PAF-lithotypes during the active-mine-life 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 circum-neutral buffering by gangue-phases [chiefly reactive-carbonate-minerals]).[1] Although the duration of the lag-phase for mine-wastes at field-scale cannot be accurately predicted *a priori*, estimates may still be needed to identify threshold exposure-times for the safe handling of PAF-lithotypes. Lag-phase duration may be estimated via kinetic-testing (viz. Weathering-Columns), and consideration of the moisture/aeration/thermal-regimes of exposed (i.e. uncovered) mine-wastes under the site's climatic conditions. In the absence of results from kinetic-testing, experience permits "first-pass" estimates of sulphide-oxidation rates and lag-phase duration to be made from the results of static-testing, and thereby classify PAF-lithotypes into **PAF-[Short-Lag]** and **PAF-[Long-Lag]** sub-categories. Such "first-pass" estimations are necessarily provisional, and subject to revision, in the light of the outcomes of kinetic-testing, and field observations.

3.0 REFERENCES

AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd

Price W, 2009, "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials", MEND Report 1.20.1

Price WA, Morin K and Hutt N, 1997, "Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia: Part II. Recommended Procedures for Static and Kinetic Testing", pp. 15-30 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Volume I, Vancouver

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[1] SO_4 is still produced by sulphide-oxidation during the lag-phase, and appreciable amounts of soluble-forms of certain minor-elements (e.g. Ni and As) may be released at circum-neutral-pH during lag-phase weathering. However, in the latter case, the mine-wastes would need to be sufficiently enriched in Total-Ni and Total-As to begin with.

ATTACHMENT IV

LABORATORY REPORTS

Note:

The laboratory-reports in the following pages correspond to the static-testing programme carried out on the sixty-three (63) "individual-samples" of **waste-regoliths and waste-bedrocks** variously derived from the **Delta-Pit**, **Eagle-Pit**, and **Champion-Pit**.

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GRAEME CAMPBELL AND ASSOCIATES 6-9-2011

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BRIDGETOWN

WA

OUR REFERENCE 22969

YOUR REFERENCE: 1112

XRD/PLM /SEM ANALYSIS OF EIGHT ROCK PULPS.

R & D TOWNEND

MINERAL	GCA9666	GCA9670	GCA9691	GCA9692
HEMATITE	DOMINANT	DOMINANT	MAJOR	MAJOR
QUARTZ	MINOR	ACCESSORY	MAJOR	MAJOR
GOETHITE	ACCESSORY	MINOR	MINOR	ACCESSORY
GIBBSITE	TRACE			
KAOLINITE	ACCESSORY?	ACCESSORY?	MINOR	ACCESSORY?
TI OXIDE	TRACE	TRACE	TRACE	TRACE

MINERAL	GCA9693	GCA9697	GCA9710	GCA9711
HEMATITE	DOMINANT	ACCESSORY	MAJOR	DOMINANT
QUARTZ	ACCESSORY	MINOR	MAJOR	ACCESSORY
GOETHITE	ACCESSORY	MAJOR	ACCESSORY	ACCESSORY
KAOLINITE	ACCESSORY?	MINOR	ACCESSORY?	MINOR?
TI OXIDE	TRACE	ACCESSORY	TRACE	TRACE

COMMENT

The kaolinite quantification values with a question mark above are samples that did not have kaolinite identified by XRD. The XRD traces of the samples found kaolinite only in samples GCA9691 and GCA9697. The geochemistry of the samples indicated alumina levels of between 4.23% and 14.16%. The previous two samples mentioned had the greatest alumina levels. Due to iron background interference kaolinite (and other low concentration minerals) identification may be inhibited by XRD.

SEM examination of the polished sections, of goethite containing grains, consistently found silica and alumina. All analyses found silica greater than alumina. This would indicate with strong confidence the presence of kaolin and/or kaolin plus quartz or some alumino silicate.

Further XRD analysis can be undertaken using a specialized tube to reduce the interference effects of iron. This may resolve the issue of the alumino silicates within the samples.

Dr G Campbell
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JOB INFORMATION

JOB CODE	143.0/1107090
No. of SAMPLES	62
CLIENT O/N	GCA 1112
PROJECT	PIOP Flinders mine
STATE	Ex pulp
DATE RECEIVED	24/05/2011
DATE COMPLETED	9/06/2011

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 pulp (-75µm nominal) and crushings (-2mm nominal) 'splits' ex job 1106867

Results of analysis on:

Element		C	TOC+C	C-CO3	S	S-SO4
Method		/CSA	C71/CSA	/CALC	/CSA	S72/GR
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
Sample Name						
Control Blank		0.01	X	0.01	0.01	X
GCA9665		0.16	0.05	0.11	0.02	X
GCA9665	check	0.17	0.06	0.11	0.01	X
GCA9666		0.07	0.05	0.02	0.03	X
GCA9667		0.08	0.06	0.02	0.04	X
GCA9668		0.06	0.07	-0.01	0.04	X
GCA9669		0.1	0.06	0.04	0.04	X
GCA9670		0.09	0.04	0.05	0.03	X
GCA9671		0.09	0.04	0.05	0.04	X
GCA9672		0.1	0.08	0.02	0.05	X
GCA9673		0.11	0.08	0.03	0.03	X
GCA9674		0.11	0.05	0.06	0.03	X
GCA9675		0.18	0.08	0.1	0.03	X
GCA9676		0.11	0.06	0.05	0.02	X
GCA9677		0.15	0.05	0.1	0.02	0.01
GCA9678		0.19	0.06	0.13	0.02	X
GCA9679		0.14	0.05	0.09	0.02	X
GCA9680		0.45	0.26	0.19	0.02	X
GCA9681		0.31	0.16	0.15	0.03	X
GCA9682		2.21	0.63	1.58	1.13	0.23
GCA9683		3.1	0.81	2.29	2.61	0.31

Element		C	TOC+C	C-CO3	S	S-SO4
Method		/CSA	C71/CSA	/CALC	/CSA	S72/GR
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
GCA9684		3.7	0.17	3.53	0.39	0.02
GCA9685		3.52	0.68	2.84	2.02	0.22
GCA9685	check	3.52	0.68	2.84	2.01	0.21
GCA9686		4.01	0.6	3.41	2.62	0.23
GCA9687		3.16	0.07	3.09	0.18	X
GCA9688		1.63	0.66	0.97	1.87	0.14
GCA9689		1	0.06	0.94	0.09	X
GCA9690		3.09	0.04	3.05	0.69	0.02
GCA9691		0.06	0.04	0.02	0.02	X
GCA9692		0.06	0.04	0.02	0.02	X
GCA9693		0.09	0.08	0.01	0.02	X
GCA9694		0.1	0.08	0.02	0.02	X
GCA9695		0.16	0.14	0.02	0.02	X
GCA9696		0.24	0.18	0.06	0.02	X
GCA9697		0.08	0.06	0.02	0.01	X
GCA9698		0.23	0.12	0.11	0.01	X
GCA9699		0.37	0.23	0.14	0.02	X
GCA9700		0.43	0.43	0	0.16	0.03
GCA9701		0.84	0.84	0	0.01	X
GCA9702		0.67	0.67	0	2.06	0.53
GCA9703		0.96	0.36	0.6	0.26	0.02
GCA9704		2.9	0.94	1.96	1.02	0.09
GCA9705		3.16	1.4	1.76	0.79	0.07
GCA9705	check	3.23	1.36	1.87	0.81	0.06
GCA9706		0.12	0.12	0	X	X
GCA9707		0.14	0.09	0.05	0.01	X
GCA9708		3.73	0.59	3.14	2.66	0.2
GCA9709		0.05	0.05	0	X	X
GCA9710		0.06	0.07	-0.01	0.02	X
GCA9711		0.1	0.07	0.03	0.02	X
GCA9712		0.11	0.07	0.04	0.03	X
GCA9713		0.11	0.11	0	0.02	X
GCA9715		0.37	0.34	0.03	0.02	0.01
GCA9716		0.16	0.18	X	X	X
GCA9717		1.22	0.49	0.73	1.32	0.13
GCA9718		3.42	0.53	2.89	2.95	0.23
GCA9719		1.18	1.18	0	0.67	0.2
GCA9720		1.49	1.46	0.03	1.95	0.49
GCA9721		1.78	1.76	0.02	1.06	0.61
GCA9722		1.86	1.9	-0.04	0.75	0.36
GCA9723		1.34	1.32	0.02	0.41	0.21
GCA9724		1.24	1.25	X	0.51	0.17
GCA9725		3.23	1.62	1.61	1.36	0.09
GCA9726		3.37	1.11	2.26	0.89	0.06
GCA9726	check	3.35	1.12	2.23	0.85	0.06
GCA9727		1.62	0.63	0.99	1.31	0.14
MA-1b		2.46			1.25	
MA-3a		2.65			1.14	
SO4 STD A						0.57
SO4 STD B						1.22
TOC-1			1.6			

1. Total-S and Total-C were determined on the pulps
2. Total-C and Total-S was determined using an induction furnace according to Genalysis method number MPL_W043. The samples are ignited in oxygen ~1700C and the CO2 and SO2 measured by infrared detectors
3. S-SO4 was determined on the pulps by precipitation of BaSO4 according to Genalysis method number ENV_W039, after digestion with Na2CO3
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by a C&S analyser after removal of carbonates and soluble organic carbon using hot hydrochloric acid according to Genalysis method number MPL_W046.

Results of analysis on:

sample name		Fizz Rate	volume ml	HCl M	NaOH M	Colour Change	pH Drop	ANC soln pH	ANC (kgH2SO4/t)
GCA9665		0	8	0.558	0.188	N		1.4	16
GCA9665	check	0	8	0.558	0.188	N		1.4	19
GCA9666		0	8	0.558	0.188	N		1.3	4
GCA9667		0	8	0.558	0.188	N		1.4	3
GCA9668		0	8	0.558	0.188	N		1.4	4
GCA9669		0	8	0.558	0.188	N		1.4	3
GCA9670		0	8	0.558	0.188	N		1.4	3
GCA9671		0	8	0.558	0.188	N		1.4	3
GCA9672		0	8	0.558	0.188	N		1.4	3
GCA9673		0	8	0.558	0.188	N		1.3	4
GCA9674		0	8	0.558	0.188	N		1.4	4
GCA9675		0	8	0.558	0.188	N		1.4	4
GCA9676		0	8	0.558	0.188	N		1.4	3
GCA9677		0	8	0.558	0.188	N		1.4	3
GCA9678		0	8	0.558	0.188	N		1.4	4
GCA9679		0	8	0.558	0.188	N		1.4	3
GCA9680		0	8	0.558	0.188	N		1.4	6
GCA9681		0	8	0.558	0.188	N		1.4	5
GCA9682		0	20	0.558	0.481	N	2.4	1.1	25
GCA9683		0	20	0.558	0.481	N	2.2	1.4	34
GCA9684		0	20	0.558	0.481	Y	2.5	1.8	45
GCA9685		0	20	0.558	0.481	Y	2.2	1.4	22
GCA9685	check	0	20	0.558	0.481	Y	2.2	1.4	26
GCA9686		0	20	0.558	0.481	Y	2.2	1.6	33
GCA9687		0	20	0.558	0.481	Y	2.3	1.5	42
GCA9688		0	8	0.558	0.188	Y	2.5	1.8	17
GCA9689		0	8	0.558	0.188	Y	2.9	1.6	24
GCA9690		0	20	0.558	0.481	Y	2.2	1.5	27
GCA9691		0	8	0.558	0.188	N		1.5	4
GCA9692		0	8	0.558	0.188	N		1.3	4
GCA9693		0	8	0.558	0.188	N		1.3	3
GCA9694		0	8	0.558	0.188	N		1.3	3
GCA9695		0	8	0.558	0.188	N		1.3	3
GCA9696		0	8	0.558	0.188	N		1.4	5
GCA9697		0	8	0.558	0.188	N		1.4	4
GCA9698		0	8	0.558	0.188	N		1.6	11
GCA9699		0	8	0.558	0.188	N		1.4	5
GCA9700		0	8	0.558	0.188	N		1.4	8
GCA9701		0	8	0.558	0.188	N		1.4	6
GCA9702		0	8	0.558	0.188	N		1.5	-11
GCA9703		0	8	0.558	0.188	N	2.7	1.6	9
GCA9704		0	20	0.558	0.481	Y	2.5	1.3	26
GCA9705		0	20	0.558	0.481	Y	2.4	1.3	21

sample name		Fizz Rate	volume ml	HCl M	NaOH M	Colour Change	pH Drop	ANC soln pH	ANC (kgH2SO4/t)
GCA9705	check	0	20	0.558	0.481	Y	2.3	1.5	25
GCA9706		0	8	0.558	0.188	N		1.5	7
GCA9707		0	8	0.558	0.188	N		1.4	6
GCA9708		0	20	0.558	0.481	Y	2.2	1.6	26
GCA9709		0	8	0.558	0.188	N		1.5	6
GCA9710		0	8	0.558	0.188	N		1.4	5
GCA9711		0	8	0.558	0.188	N		1.4	5
GCA9712		0	8	0.558	0.188	N		1.3	5
GCA9713		0	8	0.558	0.188	N		1.4	4
GCA9715		0	8	0.558	0.188	N		1.4	5
GCA9716		0	8	0.558	0.188	N	0.0	1.3	5
GCA9717		0	8	0.558	0.188	N	2.4	1.7	10
GCA9718		0	20	0.558	0.481	Y	2.2	1.6	28
GCA9719		0	8	0.558	0.188	N	2.8	1.4	-12
GCA9720		0	8	0.558	0.188	N	3.5	1.5	-2
GCA9721		0	8	0.558	0.188	N	3.9	1.4	-9
GCA9722		0	8	0.558	0.188	N	2.9	1.5	-8
GCA9723		0	8	0.558	0.188	N	0.0	1.4	-3
GCA9724		0	8	0.558	0.188	N	3.2	1.3	-5
GCA9725		0	20	0.558	0.481	Y	2.4	1.3	21
GCA9726		0	20	0.558	0.481	Y	2.3	1.3	35
GCA9726	check	0	20	0.558	0.481	Y	2.3	1.5	38
GCA9727		0	8	0.558	0.188	N	2.5	1.8	20

Notes:

1. ANC was determined on 2g of the crushings -. Acid concentrations are as stated.
2. Colour change: Y indicates the appearance of a green colouration as the pH=7 endpoint was approached. N indicates no colour change. Two drops of 30 % hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron.
3. pH drop : Result reported when the pH drops to a value below 4 on addition of peroxide
4. This "Bulk-ANC" static-testing procedure is based on AMIRA (2002), according to Genalysis method number ENV_W035

Element		As	B	Mo	Sb	Se
Method		4A/MS	FP1/OE	4A/MS	4A/MS	SE1/MS
Detection		0.5	50	0.1	0.05	0.01
Units		ppm	ppm	ppm	ppm	ppm
Sample Name						
Control Blank		X	X	X	X	X
GCA9665		8.8	X	0.7	0.98	0.45
GCA9665	check	8.4	X	0.8	0.97	0.47
GCA9666		8.6	X	0.9	0.99	0.28
GCA9667		12.3	X	1.5	1.38	0.34
GCA9668		8.2	X	1	1	0.52
GCA9669		19.4	X	2	2.15	1.07
GCA9670		11.2	X	1.5	1.25	0.6
GCA9671		16.1	X	1.6	1.71	0.49
GCA9672		21.3	X	1.9	2.08	0.76
GCA9673		15.4	X	3.2	1.75	0.29
GCA9674		12.4	X	3.8	2.01	0.26
GCA9675		12.1	X	3	1.74	0.32
GCA9676		12.2	X	3.7	2.18	0.14
GCA9677		11.4	X	4.9	2.68	0.34
GCA9678		20.7	X	1.6	2.12	0.39
GCA9679		6.7	X	0.7	0.74	0.31
GCA9680		16.9	X	1.6	1.22	2.59
GCA9681		16.7	X	1.5	0.78	1.71

Element		As	B	Mo	Sb	Se
Method		4A/MS	FP1/OE	4A/MS	4A/MS	SE1/MS
Detection		0.5	50	0.1	0.05	0.01
Units		ppm	ppm	ppm	ppm	ppm
Sample Name						
GCA9682		34.2	X	2.6	2.77	1.57
GCA9683		47.2	X	2.7	3.16	2.01
GCA9684		23.6	66	0.7	0.58	0.41
GCA9685		43.7	X	2.8	3.36	1.2
GCA9685	check	43.9	X	2.9	3.37	1.25
GCA9686		36.5	X	2.6	3.42	1.32
GCA9687		15.9	100	0.6	0.46	0.19
GCA9688		60.8	X	5.4	3.62	0.82
GCA9689		8.1	X	0.7	0.63	0.06
GCA9690		31.2	X	1.2	1.03	0.45
GCA9691		9	X	1.8	1.13	0.36
GCA9692		7.7	X	1.7	1.03	0.26
GCA9693		9.7	X	1.4	1.24	0.58
GCA9694		12.2	X	2.1	1.6	0.24
GCA9695		10.7	X	1.8	1.25	0.67
GCA9696		10.2	X	1	0.74	1.31
GCA9697		20.1	X	1.7	1.27	0.61
GCA9698		18	X	2.1	1.13	1.11
GCA9699		20.1	X	1.2	1.25	3.85
GCA9700		35.6	X	2.6	2.85	1.62
GCA9701		42.1	X	3.4	3.57	1.11
GCA9702		37.4	X	3	3.98	1.64
GCA9703		25	X	2.9	2.23	0.77
GCA9704		41.3	X	2.9	3.2	0.52
GCA9705		49.6	X	3.4	3.53	0.56
GCA9705	check	50.3	X	3.4	3.53	0.56
GCA9706		44	X	2.8	3.81	0.51
GCA9707		43.6	X	3.1	2.99	0.83
GCA9708		48.5	X	2.9	3.63	1.22
GCA9709		8.1	X	0.6	0.94	0.28
GCA9710		11.1	X	1.1	1.18	0.59
GCA9711		9.5	X	2	1.34	0.49
GCA9712		8.6	X	1.8	1.25	0.56
GCA9713		6.5	X	1.7	1.22	0.59
GCA9715		26.6	X	2.2	1.41	2.57
GCA9716		44	X	2.3	5.13	0.29
GCA9717		39.5	X	2.4	3.78	0.98
GCA9718		37.3	X	2.7	4.17	1.55
GCA9719		49.2	X	2.9	3.88	0.91
GCA9720		90.2	X	3.4	5.54	2.58
GCA9721		69.5	X	3.6	4.57	1.08
GCA9722		53.9	X	3.6	4.21	0.82
GCA9723		48.7	X	3.1	2.99	0.74
GCA9724		56.2	X	3.1	3.31	0.76
GCA9725		54.3	X	3.9	4.06	0.72
GCA9726		53.3	X	3.1	2.81	0.85
GCA9726	check	53.5	X	3.2	2.89	0.84
GCA9727		42.7	X	3.6	3.76	2.78
AMIS0076		542.7		8.5	51	
AMIS0076			X			
AMIS0082			X			
AMIS0085		68.6		3.8	9.42	
MPL-4		643.4		8.9	171.46	
OREAS 97.01						0.68
OREAS 97.01						0.66

Element		As	B	Mo	Sb	Se
Method		4A/MS	FP1/OE	4A/MS	4A/MS	SE1/MS
Detection		0.5	50	0.1	0.05	0.01
Units		ppm	ppm	ppm	ppm	ppm
Sample Name						
OREAS 97.01						0.65
Control Blank		X		X	0.11	
Control Blank			X			
Control Blank						X
Acid Blank		X		X	X	
Acid Blank			X			

Notes:

The results have been determined according to Genalysis methods codes:
Digestions: MPL_W001 (4A/), 4 acid digest using HF
MPL_W005 (SE1/) precipitation of Se from an aqua regia digest
MPL_W011 (FP1/), peroxide fusion followed by HCl digest of melt
Analytical Finishes: ICP_W004 (/OE), ICP_W005 (/MS)
The results included the assay of blanks and international reference standards
AMIS0085 AMIS0076 and AMIS0082
Genalysis in-house standards MPL-4 and OREAS 97.01
The results are expressed as parts per million by mass in the dried and prepared material.

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NATA Signatory: Ann Evers

Ann Evers

Date: 9/06/2011

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NATA accreditation requirements.

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

JOB INFORMATION

JOB CODE	143.0/1107355
No. of SAMPLES	1
CLIENT O/N	GCA 1112
PROJECT	PIOP Flinders mine
STATE	solid
DATE RECEIVED	31/05/2011
DATE COMPLETED	14/06/2011

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 sample was received as solid which required drying and crushing to a nominal -2mm.
A split was taken and fine pulverised in a zirconia bowl to give (-75µm nominal) pulp

Results of analysis on:

Element		C	TOC+C	C-CO3	S	S-SO4
Method		/CSA	C71/CSA	/CALC	/CSA	S72/GR
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
Sample Name						
Control Blank		X	X		X	X
GCA9714		3.31	1.5	1.81	1.28	0.04
GCA9714	check	3.24	1.51	1.73	1.17	0.05
MA-1b		2.46			1.21	
SO4 STD A						0.59
SO4 STD B						1.31
TOC-1			1.54			

1. Total-S and Total-C were determined on the pulps
2. Total-C and Total-S was determined using an induction furnace according to Genalysis method number MPL_W043. The samples are ignited in oxygen ~1700C and the CO_2 and SO_2 measured by infrared detectors
3. S-SO4 was determined on the pulps by precipitation of $BaSO_4$ according to Genalysis method number ENV_W039, after digestion with Na_2CO_3
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by a C&S analyser after removal of carbonates and soluble organic carbon using hot hydrochloric acid according to Genalysis method number MPL_W046.

Results of analysis on:

sample name		Fizz Rate	volume ml	HCl M	NaOH M	Colour Change	pH Drop	ANC soln pH	ANC (kgH2SO4/t)
GCA9714		0	20	0.558	0.481	N	2.4	1.3	23
GCA9714	check	0	20	0.558	0.481	N	2.6	1.3	26

Notes:

1. ANC was determined on 2g of the crushings -. Acid concentrations are as stated.
2. Colour change: Y indicates the appearance of a green colouration as the pH=7 endpoint was approached. N indicates no colour change. Two drops of 30 % hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron.
3. pH drop : Result reported when the pH drops to a value below 4 on addition of peroxide
4. This "Bulk-ANC" static-testing procedure is based on AMIRA (2002), according to Genalysis method number ENV_W035

Element		As	B	Mo	Sb	Se
Method		4A/MS	FP1/OE	4A/MS	4A/MS	SE1/MS
Detection		0.5	50	0.1	0.05	0.01
Units		ppm	ppm	ppm	ppm	ppm
Sample Name						
Control Blank		X	X	X	X	X
GCA9714		54.8	X	3.4	3.91	0.6
GCA9714	check	57	X	3.5	4.01	0.46
MPL-4		664.4		9	179.33	
CRM No. 782-1			X			
OREAS 97.01						0.67
Control Blank		X		X	0.11	
Control Blank			X			
Control Blank						X
Acid Blank		X		X	X	
Acid Blank			X			

Notes:
The results have been determined according to Genalysis methods codes:
Digestions: MPL_W001 (4A/), 4 acid digest using HF
MPL_W005 (SE1/) precipitation of Se from an aqua regia digest
MPL_W011 (FP1/), peroxide fusion followed by HCl digest of melt
Analytical Finishes: ICP_W004 (/OE), ICP_W005 (/MS)
The results included the assay of blanks and international reference standards
CRM No 782-1
Genalysis in-house standards MPL-4 and OREAS 97.01
The results are expressed as parts per million by mass in the dried and prepared material.

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NATA Signatory: Ann Evers

Ann Evers

Date: 14/06/2011

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Laboratory Report

pH-(1:2) & EC-(1:2) TESTWORK

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (µS/cm)
GCA9665	30.0	60.0	8.0	160
GCA9666	30.0	60.0	8.0	83
GCA9667	30.0	60.0	7.9	38
GCA9668	30.0	60.0	7.7	54
GCA9669	30.0	60.0	7.8	53
GCA9670	30.0	60.0	7.6	28
GCA9671	30.0	60.0	7.6	29
GCA9672	30.0	60.0	7.5	96
GCA9673	30.0	60.0	7.2	30
GCA9674	30.0	60.0	6.8	100
GCA9675	30.0	60.0	7.1	32
GCA9675-1	30.0	60.0	7.2	26
GCA9676	30.0	60.0	7.2	43
GCA9677	30.0	60.0	7.2	27
GCA9678	30.0	60.0	6.8	71
GCA9679	30.0	60.0	7.0	42
GCA9680	30.0	60.0	6.8	66
GCA9681	30.0	60.0	6.9	47
GCA9682	30.0	60.0	4.4	1,200
GCA9683	30.0	60.0	3.8	1,600
GCA9684	30.0	60.0	6.1	590
GCA9685	30.0	60.0	4.6	1,400
GCA9685-1	30.0	60.0	4.6	1,400
GCA9686	30.0	60.0	5.3	1,800
GCA9687	30.0	60.0	6.2	390
GCA9688	30.0	60.0	5.6	1,200
GCA9689	30.0	60.0	6.4	320
GCA9690	30.0	60.0	6.6	410
GCA9691	30.0	60.0	7.0	220
GCA9692	30.0	60.0	7.2	23
GCA9693	30.0	60.0	7.5	19
GCA9694	30.0	60.0	7.5	18
GCA9695	30.0	60.0	7.1	24
GCA9695-1	30.0	60.0	7.1	23
GCA9696	30.0	60.0	6.9	34
GCA9697	30.0	60.0	7.1	32
GCA9698	30.0	60.0	7.1	22
GCA9699	30.0	60.0	7.0	20
GCA9700	30.0	60.0	6.8	44
GCA9701	30.0	60.0	5.9	320
GCA9702	30.0	60.0	2.6	3,100
GCA9703	30.0	60.0	5.0	490
GCA9704	30.0	60.0	4.7	780
GCA9705	30.0	60.0	5.1	620
GCA9705-1	30.0	60.0	5.0	680
GCA9706	30.0	60.0	6.1	85
GCA9707	30.0	60.0	6.1	59
GCA9708	30.0	60.0	4.7	1,300
GCA9709	30.0	60.0	5.9	180
GCA9710	30.0	60.0	6.8	71
GCA9711	30.0	60.0	6.0	80
GCA9712	30.0	60.0	6.0	43

SAMPLE NO.	**SAMPLE WEIGHT (g)**	**SAMPLE + DEION.-W WEIGHT (g)**	**pH-(1:2)**	**EC-(1:2) (µS/cm)**
GCA9713	30.0	60.0	6.1	35
GCA9714	30.0	60.0	6.1	570
GCA9715	30.0	60.0	6.7	37
GCA9715-1	30.0	60.0	6.7	36
GCA9716	30.0	60.0	6.6	52
GCA9717	30.0	60.0	4.2	690
GCA9718	30.0	60.0	4.5	1,600
GCA9719	30.0	60.0	2.4	2,900
GCA9720	30.0	60.0	2.7	1,500
GCA9721	30.0	60.0	2.6	2,700
GCA9722	30.0	60.0	2.5	2,000
GCA9723	30.0	60.0	2.7	1,400
GCA9724	30.0	60.0	2.8	1,100
GCA9725	30.0	60.0	5.7	1,100
GCA9725-1	30.0	60.0	5.7	1,100
GCA9726	30.0	60.0	6.1	770
GCA9727	30.0	60.0	5.5	1,400

Note: EC = Electrical-Conductivity.
Testwork performed on the as-supplied 'pulp' samples (nominal -75 µm).
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ratio of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 5 µS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

Dr GD Campbell
17th May 2011

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)		
GCA9665	3.0	Reaction peaked overnight	6.9	8.3	130	-	<0.5
GCA9666	3.0	Reaction peaked overnight	5.8	6.5	27	0.30	<0.5
GCA9667	3.0	Reaction peaked overnight	5.5	6.1	17	0.10	<0.5
GCA9668	3.0	Reaction peaked overnight	5.7	6.2	22	0.20	<0.5
GCA9669	3.0	Reaction peaked overnight	5.4	5.9	19	0.10	<0.5
GCA9670	3.0	Reaction peaked overnight	5.3	6.0	21	0.30	<0.5
GCA9671	3.0	Reaction peaked overnight	5.3	5.9	19	0.20	<0.5
GCA9672	3.0	Reaction peaked overnight	5.3	5.4	22	0.30	<0.5
GCA9673	3.0	Reaction peaked overnight	5.2	5.4	16	0.20	<0.5
GCA9674	3.0	Reaction peaked overnight	5.4	5.9	23	0.10	<0.5
GCA9675	3.0	Reaction peaked overnight	5.0	5.2	14	0.20	<0.5
GCA9676	3.0	Reaction peaked overnight	5.2	5.0	24	0.30	<0.5
GCA9677	3.0	Reaction peaked overnight	5.3	5.5	20	0.30	<0.5
GCA9678	3.0	Reaction peaked overnight	5.3	6.0	20	0.10	<0.5
GCA9679	3.0	Reaction peaked overnight	5.3	6.0	20	0.20	<0.5
GCA9680	3.0	Reaction peaked overnight	5.4	5.9	20	0.30	<0.5
GCA9681	3.0	Reaction peaked overnight	5.6	5.6	21	0.20	<0.5
GCA9682	3.0	Reaction peaked overnight	3.1	3.7	670	1.40	2.3
GCA9682-1	3.0	Reaction peaked overnight	3.1	3.7	570	1.90	3.2
BLANK1	3.0	Reaction peaked overnight	5.7	7.2	68	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th June 2011

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)		
GCA9683	3.0	Reaction peaked overnight	2.7	3.6	1,200	14.00	23
GCA9684	3.0	Reaction peaked overnight	7.2	7.5	250	-	<0.5
GCA9685	3.0	Reaction peaked overnight	3.0	4.2	1,100	5.80	9.5
GCA9686	3.0	Reaction peaked overnight	2.9	4.0	1,100	9.80	17
GCA9687	3.0	Reaction peaked overnight	8.1	8.0	240	-	<0.5
GCA9688	3.0	Reaction peaked overnight	2.5	2.7	2,000	17.00	28
GCA9689	3.0	Reaction peaked overnight	7.7	8.0	130	-	<0.5
GCA9690	3.0	Reaction peaked overnight	4.8	7.7	380	-	<0.5
GCA9691	3.0	Reaction peaked overnight	5.6	6.5	30	0.60	1.0
GCA9692	3.0	Reaction peaked overnight	5.4	6.0	24	0.20	<0.5
GCA9693	3.0	Reaction peaked overnight	5.3	6.0	19	0.20	<0.5
GCA9694	3.0	Reaction peaked overnight	5.2	6.0	24	0.70	1.2
GCA9695	3.0	Reaction peaked overnight	5.2	6.0	20	0.40	0.7
GCA9696	3.0	Reaction peaked overnight	5.3	6.0	24	0.20	<0.5
GCA9697	3.0	Reaction peaked overnight	5.3	5.7	16	0.30	<0.5
GCA9698	3.0	Reaction peaked overnight	5.1	5.3	14	0.50	0.9
GCA9699	3.0	Reaction peaked overnight	5.6	6.2	24	0.20	<0.5
GCA9700	3.0	Reaction peaked overnight	6.1	6.4	42	0.30	<0.5
GCA9700-1	3.0	Reaction peaked overnight	6.1	6.5	39	0.20	<0.5
BLANK2	3.0	Reaction peaked overnight	5.8	7.1	59	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th June 2011

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)		
GCA9701	3.0	Reaction peaked overnight	4.7	5.0	120	0.10	<0.5
GCA9702	3.0	Reaction peaked overnight	2.3	2.4	2,600	29.90	49
GCA9703	3.0	Reaction peaked overnight	4.8	5.9	190	0.70	1.2
GCA9704	3.0	Reaction peaked overnight	3.5	5.1	480	0.80	1.4
GCA9705	3.0	Reaction peaked overnight	3.5	5.6	490	0.90	1.5
GCA9706	3.0	Reaction peaked overnight	6.4	6.9	62	-	<0.5
GCA9707	3.0	Reaction peaked overnight	8.4	7.9	38	-	<0.5
GCA9708	3.0	Reaction peaked overnight	3.0	3.8	1,100	9.90	17
GCA9709	3.0	Reaction peaked overnight	6.0	6.0	39	0.70	1.2
GCA9710	3.0	Reaction peaked overnight	5.8	6.5	35	0.10	<0.5
GCA9711	3.0	Reaction peaked overnight	5.3	5.8	19	0.20	<0.5
GCA9712	3.0	Reaction peaked overnight	5.2	5.5	20	0.30	<0.5
GCA9713	3.0	Reaction peaked overnight	5.1	5.6	19	0.30	<0.5
GCA9714	3.0	Reaction peaked overnight	2.9	3.7	690	7.10	12
GCA9715	3.0	Reaction peaked overnight	5.2	5.3	22	0.30	<0.5
GCA9716	3.0	Reaction peaked overnight	7.4	6.7	31	0.20	<0.5
GCA9717	3.0	Reaction peaked overnight	2.7	2.9	1,200	11.80	20
GCA9718	3.0	Reaction peaked overnight	2.6	3.5	1,300	16.70	28
GCA9718-1	3.0	Reaction peaked overnight	2.6	3.6	1,300	16.50	27
BLANK3	3.0	Reaction peaked overnight	5.8	7.2	69	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th June 2011

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)		
GCA9719	3.0	Reaction peaked overnight	2.4	2.5	2,700	26.20	43
GCA9720	3.0	Reaction peaked overnight	2.7	2.8	1,100	12.00	20
GCA9721	3.0	Reaction peaked overnight	2.7	2.7	1,500	13.80	23
GCA9722	3.0	Reaction peaked overnight	2.7	2.7	1,400	12.40	21
GCA9723	3.0	Reaction peaked overnight	2.9	3.1	560	5.80	9.5
GCA9724	3.0	Reaction peaked overnight	2.7	2.9	830	7.80	13
GCA9725	3.0	Reaction peaked overnight	2.9	3.7	650	7.20	12
GCA9726	3.0	Reaction peaked overnight	5.1	6.9	420	-	<0.5
GCA9727	3.0	Reaction peaked overnight	2.9	3.4	1,100	4.10	6.7

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th June 2011

pH-BUFFERING TESTWORK (GCA9684)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	7.2
0.40	2.0	5.5
0.80	3.9	4.3
1.20	5.9	3.8
1.60	7.8	3.5
2.00	9.8	3.4
2.40	12	3.2
2.80	14	3.1
3.20	16	3.0
3.60	18	3.0

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. 1.00 g of pulped sample 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 = 3 mV (pH=7.00); slope-point = 172 mV (pH=4.00); 94.7 % 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
16th June 2011

Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-BUFFERING TESTWORK (GCA9690)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	7.1
0.40	2.0	4.9
0.80	3.9	3.9
1.20	5.9	3.6
1.60	7.8	3.4
2.00	9.8	3.2
2.40	12	3.1
2.80	14	3.0
3.20	16	3.0

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. 1.00 g of pulped sample 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 = 3 mV (pH=7.00); slope-point = 177 mV (pH=4.00); 97.9 % of Nernstian response for 25 °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
16th June 2011

pH-BUFFERING TESTWORK (GCA9726)

Cumulative Volume of Acid Added (mL)	Cumulative Acid Consumption (kg H_2SO_4/tonne)	pH
0.00	0.0	7.3
0.40	2.0	6.5
0.80	3.9	5.6
1.20	5.9	5.0
1.60	7.8	4.5
2.00	9.8	4.0
2.40	12	3.8
2.80	14	3.6
3.20	16	3.4
3.60	18	3.3
4.00	20	3.2
4.40	22	3.1
4.80	24	3.1
5.20	25	3.0

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. 1.00 g of pulped sample 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 = 4 mV (pH=7.00); slope-point = 177 mV (pH=4.00); 97.9 % 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
16th June 2011

ANALYTICAL REPORT

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

JOB INFORMATION

JOB CODE	: 143.0/1110718
No. of SAMPLES	: 10
No. of ELEMENTS	: 32
CLIENT O/N	: GCA1112 (Job 1 of 1)
SAMPLE SUBMISSION No.	:
PROJECT	: PIOP, Flinders Mine
STATE	: Ex-Pulp
DATE RECEIVED	: 13/06/2011
DATE COMPLETED	: 29/07/2011
DATE PRINTED	: 29/07/2011
PRIMARY LABORATORY	: Genalysis Main Laboratory

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
OV	= Value over-range for Package

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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 $3.30 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 $100.00 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 samples as listed were received as being 'Tailing-Solids' which had been dried and pulverised in a zirconia bowl as per Genalysis job number 143_0_1107964.

The results have been determined according to Genalysis methods codes :
Digestions : MPL_W001 (4A/), ENV_W012 (FC7/SIE), MPL_W011 (FP1/),MPL_W008 (HG1/).

Analytical Finishes: ICP_W004 (/OE), ICP_W005 (/MS), and AAS_W004 (/CV).

The results included the assay of blanks and international reference standards STSD-2 and AMIS0140 and Genalysis in-house standards HgSTD-3 and OREAS 97.01

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: 29/07/2011
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
DETECTION LIMIT	0.01	0.01	0.5	50	0.1	0.01	0.1	0.02	0.1	50
DIGEST	4A/	FP1/	4A/	FP1/	4A/	4A/	FP1/	4A/	4A/	FP1/
ANALYTICAL FINISH	MS	OE	MS	OE	MS	MS	OE	MS	MS	OE
SAMPLE NUMBERS										
0001 GCA9665	0.06	2.14	10.8	X	109.1	0.16	0.6	0.09	2.9	151
0002 GCA9667	0.04	2.87	13.3	X	21.0	0.21	0.2	0.05	2.2	54
0003 GCA9669	0.02	2.61	20.2	X	34.8	0.28	0.2	X	1.7	105
0004 GCA9673	0.08	2.24	16.0	X	7.4	0.23	0.2	0.02	1.3	56
0005 GCA9676	0.03	0.49	12.8	X	9.8	0.23	0.2	X	1.9	X
0006 GCA9681	0.08	1.79	18.0	X	50.8	0.13	0.2	0.05	7.3	93
0007 GCA9702	0.11	3.90	39.2	X	182.6	0.37	0.2	0.06	12.9	244
0008 GCA9708	0.12	3.73	48.6	X	212.1	0.37	0.5	0.18	20.1	330
0009 GCA9719	0.14	3.77	50.1	X	273.1	0.36	0.2	0.04	4.9	199
0010 GCA9723	0.14	4.58	48.2	X	416.8	0.41	0.2	X	3.3	99
CHECKS										
0001 GCA9665	0.04	2.23	9.7	X	107.8	0.14	0.6	0.02	2.9	103
STANDARDS										
0001 AMIS0140		0.73		X			0.3			485
0002 HgSTD-3										
0003 MPL-4	14.92		688.4		175.4	15.58		4.93	80.1	
0004 STSD-2										
BLANKS										
0001 Control Blank	X	X	X	X	0.7	0.01	X	X	X	X
0002 Control Blank	0.06		X		0.2	0.02		X	X	
0003 Control Blank		X		X			0.2			X
0004 Control Blank										
0005 Acid Blank	0.04		X		0.2	X		X	X	
0006 Acid Blank		X		X			X			X
0007 Acid Blank										

ANALYSIS

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	%	%	ppm	ppm	ppm	ppm
DETECTION LIMIT	1	50	0.01	0.01	0.05	0.01	1	0.1	20	1
DIGEST	4A/	FC7/	FP1/	HG1/	FP1/	FP1/	4A/	4A/	4A/	4A/
ANALYTICAL FINISH	OE	SIE	OE	CV	OE	OE	OE	MS	OE	OE
SAMPLE NUMBERS										
0001 GCA9665	15	153	40.19	0.02	0.20	0.12	203	0.9	323	10
0002 GCA9667	12	153	50.63	X	0.08	0.06	157	1.5	95	9
0003 GCA9669	8	111	55.75	X	0.11	0.04	109	2.0	149	8
0004 GCA9673	1	147	59.11	X	0.10	0.04	139	3.2	33	5
0005 GCA9676	X	141	61.00	0.05	0.09	0.04	515	3.8	53	4
0006 GCA9681	12	259	55.38	0.13	0.07	0.04	435	1.6	27	10
0007 GCA9702	28	1147	23.94	0.24	5.01	0.21	253	2.9	83	40
0008 GCA9708	32	454	19.91	0.22	5.03	1.13	4645	2.8	81	42
0009 GCA9719	22	454	19.57	0.17	2.14	0.09	923	2.8	127	20
0010 GCA9723	20	627	19.31	0.17	3.89	0.15	365	2.8	168	15
CHECKS										
0001 GCA9665	16	187	41.37	0.03	0.24	0.13	207	0.8	328	10
STANDARDS										
0001 AMIS0140			1.62		0.35	0.13				
0002 HgSTD-3				0.35						
0003 MPL-4	1504						1506	8.6	4.42%	1546
0004 STSD-2		1057								
BLANKS										
0001 Control Blank	1	54	X	X	X	X	1	X	X	X
0002 Control Blank	3						2	X	22	X
0003 Control Blank			0.03		0.13	X				
0004 Control Blank				X						
0005 Acid Blank	1						3	X	X	X
0006 Acid Blank			X		X	X				
0007 Acid Blank				X						

ANALYSIS

ELEMENTS	P	Pb	S	Sb	Si	Sn	Sr	Th	Tl	U
UNITS	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	50	0.5	50	0.05	0.1	0.1	0.05	0.01	0.02	0.01
DIGEST	4A/	4A/	4A/	4A/	FP1/	4A/	4A/	4A/	4A/	4A/
ANALYTICAL FINISH	OE	MS	OE	MS	OE	MS	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA9665	496	7.8	69	1.21	15.7	1.1	30.06	4.52	0.13	0.81
0002 GCA9667	376	10.4	115	1.61	7.4	1.7	7.84	6.21	0.04	1.39
0003 GCA9669	357	11.1	175	2.41	5.6	1.9	7.72	8.34	0.03	1.67
0004 GCA9673	473	9.9	120	2.07	2.7	2.6	3.56	3.87	X	0.88
0005 GCA9676	743	5.5	61	2.50	1.0	2.5	2.51	1.53	X	0.38
0006 GCA9681	1770	6.0	204	1.06	1.3	1.3	1.77	1.76	X	1.14
0007 GCA9702	687	19.4	1.93%	4.15	21.2	1.5	7.08	7.68	0.70	2.38
0008 GCA9708	653	18.0	2.52%	3.74	20.4	1.3	7.61	7.80	0.75	2.46
0009 GCA9719	524	18.2	5637	3.88	27.4	1.6	26.44	6.82	0.52	2.32
0010 GCA9723	431	20.5	3487	3.04	25.6	1.8	26.87	8.34	0.71	2.78
CHECKS										
0001 GCA9665	493	7.4	69	1.10	15.8	1.0	29.68	4.45	0.12	0.80
STANDARDS										
0001 AMIS0140					46.0					
0002 HgSTD-3										
0003 MPL-4	1690	1475.4	1.16%	165.99		2.5	135.02	88.19	8.01	10.99
0004 STSD-2										
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X
0002 Control Blank	X	1.0	X	0.17		0.3	0.14	0.03	X	X
0003 Control Blank					X					
0004 Control Blank										
0005 Acid Blank	X	0.6	X	0.15		0.3	0.08	0.01	X	0.02
0006 Acid Blank					X					
0007 Acid Blank										

ANALYSIS

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION LIMIT	1	1
DIGEST	4A/	4A/
ANALYTICAL FINISH	OE	OE
SAMPLE NUMBERS		
0001 GCA9665	71	17
0002 GCA9667	106	8
0003 GCA9669	55	9
0004 GCA9673	69	10
0005 GCA9676	47	11
0006 GCA9681	58	34
0007 GCA9702	58	122
0008 GCA9708	46	86
0009 GCA9719	63	53
0010 GCA9723	80	40
CHECKS		
0001 GCA9665	72	15
STANDARDS		
0001 AMIS0140		
0002 HgSTD-3		
0003 MPL-4	141	1021
0004 STSD-2		
BLANKS		
0001 Control Blank	1	X
0002 Control Blank	2	2
0003 Control Blank		
0004 Control Blank		
0005 Acid Blank	2	X
0006 Acid Blank		
0007 Acid Blank		

METHOD CODE DESCRIPTION

4A/MS Genalysis Main Laboratory

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

4A/OE Genalysis Main Laboratory

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

FC7/SIE Genalysis Main Laboratory

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

FP1/OE Genalysis Main Laboratory

Sodium peroxide fusion (Nickel crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Pl

HG1/CV Genalysis Main Laboratory

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

ANALYTICAL REPORT

Dr G. CAMPBELL
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JOB INFORMATION

JOB CODE	:	143.0/1107130
No. of SAMPLES	:	8
No. of ELEMENTS	:	14
CLIENT O/N	:	GCA1112 (Job 1 of 1)
SAMPLE SUBMISSION No.	:	
PROJECT	:	Flinders, PIOP
STATE	:	Ex-Pulp
DATE RECEIVED	:	24/05/2011
DATE COMPLETED	:	13/06/2011
DATE PRINTED	:	13/06/2011
PRIMARY LABORATORY	:	Genalysis Main Laboratory

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
OV = Value over-range for Package

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SAMPLE DETAILS

DISCLAIMER

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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 $3.30 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 $100.00 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.

ANALYSIS

ELEMENTS	Al2O3	CaO	Cr2O3	Fe2O3	K2O	LOI	MgO	MnO	Na2O	P2O5
UNITS	%	%	%	%	%	%	%	%	%	%
DETECTION LIMIT	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.002
DIGEST	FB1/	FB1/	FB1/	FB1/	FB1/		FB1/	FB1/	FB1/	FB1/
ANALYTICAL FINISH	XRF50	XRF50	XRF50	XRF50	XRF50	/TGA	XRF50	XRF50	XRF50	XRF50
SAMPLE NUMBERS										
0001 GCA9666	4.85	0.08	X	68.91	0.03	2.56	0.10	0.03	0.04	0.097
0002 GCA9670	5.83	0.02	X	77.13	0.04	2.29	0.07	0.01	0.02	0.104
0003 GCA9691	7.71	0.05	0.01	50.94	0.26	3.49	0.13	0.03	0.06	0.106
0004 GCA9692	5.36	0.03	0.01	52.73	0.04	2.30	0.07	0.02	0.03	0.083
0005 GCA9693	6.08	0.03	X	76.89	0.03	2.57	0.05	0.01	0.03	0.095
0006 GCA9697	14.16	0.04	X	54.39	0.01	11.95	0.07	X	0.01	0.077
0007 GCA9710	4.23	0.06	0.01	59.72	0.08	2.66	0.08	0.03	0.07	0.126
0008 GCA9711	7.16	0.03	X	75.03	0.08	3.35	0.09	0.02	0.02	0.120
CHECKS										
0001 GCA9666	4.88	0.08	X	68.77	0.03	2.54	0.10	0.03	0.03	0.095
STANDARDS										
0001 GenFe-7						23.04				
0002 SY-4	20.63	8.01	X	6.19	1.66		0.52	0.11	7.17	0.129
BLANKS										
0001 Control Blank	X	X	X	X	X	0.03	X	X	X	X

ANALYSIS

ELEMENTS	SO3	SiO2	TiO2	Total
UNITS	%	%	%	%
DETECTION LIMIT	0.002	0.01	0.01	0.01
DIGEST	FB1/	FB1/	FB1/	FB1/
ANALYTICAL FINISH	XRF50	XRF50	XRF50	XRF50
SAMPLE NUMBERS				
0001 GCA9666	0.030	23.04	0.40	100.20
0002 GCA9670	0.038	13.97	0.50	100.03
0003 GCA9691	0.022	36.07	0.67	99.61
0004 GCA9692	0.024	38.41	0.48	99.61
0005 GCA9693	0.033	13.15	0.57	99.57
0006 GCA9697	0.015	18.33	1.09	100.21
0007 GCA9710	0.041	32.82	0.31	100.24
0008 GCA9711	0.034	12.95	0.98	99.90

CHECKS				
0001 GCA9666	0.028	22.96	0.39	99.98

STANDARDS				
0001 GenFe-7				
0002 SY-4	0.040	49.56	0.29	99.35

BLANKS				
0001 Control Blank	X	99.42	X	99.45

METHOD CODE DESCRIPTION

/TGA Genalysis Main Laboratory

No digestion or other pre-treatment undertaken. Analysed by Thermal Gravimetric Analyser

FB1/XRF50 Genalysis Main Laboratory

Fused Disk preparation for XRF analysis Analysed by XRF Spectrometry. Clay Minerals Package

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JOB INFORMATION

JOB CODE	143.0/1107389
No. of SAMPLES	8
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Crushings
DATE RECEIVED	24/5/2011
DATE COMPLETED	27/06/2011

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 crushings and were indicated to be non calcareous

The digest NH4Cl7 was used as follows for these non calcareous samples:
2g of each of the samples were weighed into a centrifuge tube and pre- washed with 2x 25ml 10 % (v/v) deionised ethylene glycol in 90 % (v/v) ethanol which has been previously deionised by passing through Amberlite resin
After the centrifuge stage there may be finely dispersed material in suspension. If this is the case a few drops of PVA may be necessary. The PVA aqueous solution is 0.05 % (w/v) polyvinyl alcohol. No additions.

Extraction step for Exchangeable cations
After decanting following completion of the 2nd pre-wash, the residue in centrifuge tube is subjected to 2 x 30-minute extractions via end-over-end tumbling at approx. 10 rpm. Each extraction uses 20 ml of 1 M-NH_4Cl buffered at pH 7.0 using ammonia solution 28 % (w/w). At the completion of each extraction, the suspensions are centrifuged and the supernatants decanted and collected into a communal extract. The final communal extract is brought to 50 ml with 4 M-HCl.
Sample analysed for Ca,Mg,K and Na by OES

Reference:
Based on procedure 15B2
Australian laboratory handbook of soil and water chemical methods / G.E. Rayment and F.R. Higginson 1992
Inkata Press

Results of analysis on:

Element		Ca	K	Mg	Na	eCEC	Ca	K	Mg	Na
Method		NH4Cl7/OE	NH4Cl7/OE	NH4Cl7/OE	NH4Cl7/OE		exch	exch	exch	exch
										ESP
Units		cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg		%	%	%	%
GCA9666		0.99	0.18	0.86	0.66	2.69	36.6	6.8	32.1	24.4
GCA9666	check	1.12	0.19	1.06	0.75	3.12	35.9	6.1	34.0	24.0
GCA9670		0.23	0.00	1.29	0.77	2.29	10.1	0.0	56.5	33.5
GCA9691		1.00	0.13	1.55	0.79	3.46	28.8	3.6	44.7	22.9
GCA9692		0.80	0.00	0.80	0.37	1.97	40.4	0.0	40.6	19.0
GCA9693		0.27	0.00	0.44	0.83	1.53	17.3	0.0	28.5	54.2
GCA9697		1.32	0.00	1.46	0.57	3.35	39.4	0.0	43.5	17.1
GCA9710		0.60	0.17	0.53	1.72	3.03	19.7	5.7	17.7	56.9
GCA9711		0.64	0.00	1.37	0.32	2.33	27.3	0.0	58.9	13.8
ASPAC-33		42.00	1.47	32.16	2.06	77.69	54.1	1.9	41.4	2.6

Ann Evers

27/06/2011

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JOB INFORMATION

JOB CODE	143/1108765
No. of SAMPLES	26
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Water extracts
DATE RECEIVED	16/06/2011
DATE COMPLETED	18/07/2011

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

A series water extracts were received. GCA9665 and GCA9669 were received as turbid extracts, these samples were centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3
The pH, EC and Cl of the "raw" samples was measured Genalysis method codes ENV-W001, ENV-W002, ENV_W013 and the alkalinity measured using APHA method code 2320B

APHA code refers to "Standard methods for the examination of water and wastewater", 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

The charge balance was calculated and found to be within +/- 10% only for samples pH>4.5

Results of analysis on:

Element		Cl	EC	pH	HCO3
Method		/COL	/MTR	/MTR	/VOL
Detection		2	10	0.1	1
Units		mg/l	uS/cm	NONE	mgHCO3/L
Sample Name					
Control Blank		X			
GCA9665 Raw		5	202	8.4	106
GCA9665 Raw	check	5	204	8.4	105
GCA9669 Raw		3	46	7.4	21
GCA9673 Raw		2	21	6.7	8
GCA9680 Raw		2	28	6.9	8
GCA9681 Raw		2	35	6.9	11
GCA9696 Raw		2	31	6.8	10
GCA9699 Raw		2	23	6.7	7
GCA9702 Raw		2	4050	2.5	X
GCA9708 Raw		2	2304	4.9	4
GCA9714 Raw		2	1016	7.5	73
GCA9719 Raw		2	4100	2.3	X
GCA9723 Raw		3	1580	2.6	X

Element		Ag	Al	As	B	Ba	Bi	Ca	Cd	Co
Method		/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection		0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1
Units		ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name										
Control Blank		0.01	0.02	X	0.01	X	X	X	X	X
GCA9665 HNO3		0.01	0.08	1.8	0.11	96.49	0.005	12.18	X	X
GCA9669 HNO3		0.01	0.29	0.5	0.09	45.17	X	0.05	X	X
GCA9673 HNO3		0.02	0.02	0.2	0.03	2.51	X	0.47	X	0.1
GCA9680 HNO3		X	0.04	0.2	0.01	2.14	X	0.84	X	X
GCA9681 HNO3		0.02	0.01	0.2	0.01	4.19	X	1.63	X	X
GCA9696 HNO3		X	X	0.1	0.02	3.45	X	1.34	X	X
GCA9699 HNO3		X	0.04	0.2	0.03	2.23	X	0.53	X	X
GCA9702 HNO3		0.02	152.4	48.6	X	3.42	X	109.91	4.84	980.1
GCA9708 HNO3		X	1.2	1.2	X	26.81	X	98.56	8.59	307.8
GCA9708 HNO3	check	X	1.14	0.9	X	26.56	X	98.2	8.21	305.2
GCA9714 HNO3		0.02	X	0.8	X	28.03	0.008	102.04	0.12	9.7
GCA9719 HNO3		0.03	190.3	104.4	X	12.01	0.005	15.02	2.61	701.3
GCA9723 HNO3		X	56.9	7.8	X	22.66	X	7.12	1.1	415.2
WET Blank HNO3		0.02	0.02	0.2	X	0.49	X	0.02	X	0.1
WET-DW HNO3		X	0.03	0.2	X	0.14	X	X	X	X
Alcoa16-MS		5.35		28.5		6.63	4.794		5.28	541.5
Alcoa10-OES			1.88		1.11			48.5		

Element		Cr	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na
Method		/OE	/OE	/OE	/MS	/OE	/OE	/OE	/MS	/OE
Detection		0.01	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1
Units		mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l
Sample Name										
Control Blank		X	X	X	X	0.2	X	X	X	X
GCA9665 HNO3		X	X	0.1	X	6.8	2.46	X	1.09	27.8
GCA9669 HNO3		X	X	0.23	X	1.2	X	X	0.14	10.3
GCA9673 HNO3		0.01	X	X	X	1.4	0.58	X	X	1.8
GCA9680 HNO3		X	X	X	X	1.7	1	X	0.08	1.3
GCA9681 HNO3		X	X	X	X	1.3	1.54	X	0.07	1.8
GCA9696 HNO3		X	X	X	X	1.2	1.18	X	0.14	1.7
GCA9699 HNO3		X	X	X	X	1.3	0.92	X	0.18	1.4
GCA9702 HNO3		1.2	1.54	640.82	0.5	1.3	160.1	7.48	0.45	0.5
GCA9708 HNO3		X	X	9.94	X	29.8	272.69	91.11	1.34	1.7
GCA9708 HNO3	check	X	X	9.96	X	29.6	271.12	90.84	1.4	1.7
GCA9714 HNO3		X	X	X	X	27.3	66.14	8.23	1.1	1.5
GCA9719 HNO3		0.66	2.02	548.19	X	0.5	44.3	60.78	1.4	0.7
GCA9723 HNO3		0.12	0.71	10.7	X	12.2	30.16	27.31	0.56	0.9
WET Blank HNO3		X	X	0.05	X	0.1	X	X	X	0.1
WET-DW HNO3		X	X	0.03	X	0.1	X	X	X	0.1
Alcoa16-MS					2.5				5.97	
Alcoa10-OES		0.49	0.25	2		3.8	56.75	0.5		237.5

Element		Ni	P	Pb	S	Sb	Se	Si	Sn	Sr
Method		/OE	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection		0.01	0.1	0.5	0.1	0.01	0.5	0.05	0.1	0.02
Units		mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name										
Control Blank		X	X	X	X	X	X	X	X	X
GCA9665 HNO3		X	X	X	2.1	0.2	0.5	15.55	0.1	124.27
GCA9669 HNO3		X	X	X	0.6	0.04	X	19.01	0.3	0.63
GCA9673 HNO3		X	X	7.8	X	0.05	X	10.18	0.2	6.69
GCA9680 HNO3		X	X	3.7	0.3	0.02	X	5.76	0.1	5.92
GCA9681 HNO3		0.01	X	2.7	0.5	0.02	X	6.64	0.1	8.81
GCA9696 HNO3		X	X	1.5	0.3	0.02	X	6.2	0.1	6.35
GCA9699 HNO3		X	X	1.5	0.4	0.02	X	7.31	0.1	4.5
GCA9702 HNO3		2.18	3.5	261.3	1033.2	0.53	4	9.21	0.2	19.07
GCA9708 HNO3		0.68	X	23.4	525.6	0.03	8.1	5.41	0.1	95.91
GCA9708 HNO3	check	0.72	X	23	510.4	0.03	7.9	5.5	0.1	95.03
GCA9714 HNO3		0.02	X	0.8	167.1	0.51	9.1	4.4	0.2	71.44
GCA9719 HNO3		1.31	0.6	67.3	937.4	0.61	X	11.45	0.2	14.2
GCA9723 HNO3		0.48	X	39.2	223.2	0.08	X	21.32	0.1	22.98
WET Blank HNO3		X	X	9.2	0.2	0.01	X	X	X	0.08
WET-DW HNO3		X	X	X	0.1	X	X	X	X	X
Alcoa16-MS				6.6		5.53	27		5.8	583.24
Alcoa10-OES		0.53	0.9		19.8			26.94		

Element		Th	Tl	U	V	Zn
Method		/MS	/MS	/MS	/OE	/OE
Detection		0.005	0.01	0.005	0.01	0.01
Units		ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name						
Control Blank		X	X	X	X	X
GCA9665 HNO3		X	X	0.341	X	X
GCA9669 HNO3		X	X	0.018	X	X
GCA9673 HNO3		X	X	X	X	X
GCA9680 HNO3		X	X	X	X	X
GCA9681 HNO3		X	X	X	X	X
GCA9696 HNO3		X	X	X	X	X
GCA9699 HNO3		X	X	X	X	X
GCA9702 HNO3		17.255	0.12	6.783	0.37	0.79
GCA9708 HNO3		0.026	0.54	0.25	X	0.15
GCA9708 HNO3	check	0.027	0.53	0.245	X	0.15
GCA9714 HNO3		X	0.26	0.125	X	X
GCA9719 HNO3		74.645	0.08	24.85	0.09	1.5
GCA9723 HNO3		6.53	2.18	5.316	X	0.45
WET Blank HNO3		X	X	X	X	X
WET-DW HNO3		X	X	X	X	X
Alcoa16-MS		5.259	5.02	5.53		
Alcoa10-OES					0.49	0.46

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NATA Signatory: Ann Evers

Ann Evers

Date: 18/07//2011

NATA

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Note:

The laboratory-reports, and column-worksheets, in the following pages correspond to the kinetic-testing programme carried out on the six (6) samples of **composite-waste-regoliths** (viz. GCA9728 to GCA9733) from the **Delta-Pit**.

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GRAEME CAMPBELL AND ASSOCIATES 14-9-2011

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BRIDGETOWN

WA

OUR REFERENCE 23011

YOUR REFERENCE: 1112 (FLINDERS PIOP)

XRD/PLM ANALYSIS OF SIX ROCK PULPS.

R & D TOWNEND

MINERAL	GCA9728	GCA9729	GCA9730
HEMATITE	MAJOR	MAJOR	DOMINANT
GOETHITE	MINOR	MINOR	MINOR
MAGHEMITE	ACCESSORY	ACCESSORY	ACCESSORY
QUARTZ	MAJOR	MINOR	ACCESSORY
KAOLINITE	ACCESSORY	ACCESSORY	ACCESSORY
MICA		TRACE	

MINERAL	GCA9731	GCA9732	GCA9733
HEMATITE	DOMINANT	MINOR	MINOR
GOETHITE	MAJOR	MAJOR	DOMINANT
MAGHEMITE	ACCESSORY	ACCESSORY	
QUARTZ	ACCESSORY	ACCESSORY	ACCESSORY
KAOLINITE	ACCESSORY	ACCESSORY	TRACE

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JOB INFORMATION

JOB CODE	143.0/1107089
No. of SAMPLES	6
CLIENT O/N	GCA 1112
PROJECT	PIOP Flinders mine
STATE	Ex pulp
DATE RECEIVED	24/05/2011
DATE COMPLETED	14/06/2011

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 pulp (-75µm nominal) and crushings (-2mm nominal) 'splits' ex job 1106867

Results of analysis on:

Element		S	S-SO4	C	TOC+C	C-CO3
Method		/CSA	S72/GR	/CSA	C71/CSA	/CALC
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
Sample Name						
Control Blank		X	0.01	0.01	X	X
GCA9728		0.03	X	0.08	0.08	0
GCA9728	check	0.03	X	0.08	0.09	-0.01
GCA9729		0.03	X	0.11	0.08	0.03
GCA9730		0.04	X	0.13	0.08	0.05
GCA9731		0.03	X	0.19	0.1	0.09
GCA9732		0.02	X	0.1	0.08	0.02
GCA9733		0.03	X	0.31	0.13	0.18
SY-4		0.02		1.06		
TOC-1					1.44	
SO4-STD A			0.55			
SO4-STD B			1.23			

1. Total-S and Total-C were determined on the pulps
2. Total-C and Total-S was determined using an induction furnace according to Genalysis method number MPL_W043. The samples are ignited in oxygen ~1700C and the CO2 and SO2 measured by infrared detectors
3. S-SO4 was determined on the pulps by precipitation of BaSO4 according to Genalysis method number ENV_W039, after digestion with Na2CO3
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by a C&S analyser after removal of carbonates and soluble organic carbon using hot hydrochloric acid according to Genalysis method number MPL_W046.

Results of analysis on:

sample		Fizz	volume	HCl	NaOH	Colour	pH	ANC	ANC
name		Rate	ml	M	M	Change	Drop	soln pH	(kgH2SO4/t)
GCA9728		0	8	0.558	0.188	N	X	1.4	6
GCA9728	check	0	8	0.558	0.188	N	X	1.3	5
GCA9729		0	8	0.558	0.188	N	X	1.5	3
GCA9730		0	8	0.558	0.188	N	X	1.3	2
GCA9731		0	8	0.558	0.188	N	X	1.4	1
GCA9732		0	8	0.558	0.188	N	X	1.4	5
GCA9733		0	8	0.558	0.188	N	X	1.3	4

Notes:

1. ANC was determined on 2g of the crushings -. Acid concentrations are as stated.
2. Colour change: Y indicates the appearance of a green colouration as the pH=7 endpoint was approached. N indicates no colour change. Two drops of 30 % hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron.
3. pH drop : Result reported when the pH drops to a value below 4 on addition of peroxide
4. This "Bulk-ANC" static-testing procedure is based on AMIRA (2002), according to Genalysis method number ENV_W035

Element		Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
Method		4A/MS	FP1/OE	4A/MS	FP1/OE	4A/MS	4A/MS	FP1/OE	4A/MS	4A/MS	FP1/OE
Detection		0.01	0.01	0.5	50	0.1	0.01	0.1	0.02	0.1	50
Units		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Duplicates											
Sample Name											
Control Blank		0.01	X	X	X	X	0.02	X	X	X	X
GCA9728		0.09	2.78	9.7	X	43.3	0.16	X	0.05	3.7	X
GCA9728	check	0.08	2.92	9.6	X	43.9	0.14	X	0.02	3.7	X
GCA9729		0.1	3.05	11.9	X	35.8	0.18	X	X	2	X
GCA9730		0.12	2.81	15.6	X	12.6	0.2	X	0.02	2	X
GCA9731		0.12	1.33	12.8	X	11	0.22	X	0.03	1.7	X
GCA9732		0.09	3.41	24.1	X	34.1	0.18	X	0.12	3.5	X
GCA9733		0.09	1.17	18.7	X	6.2	0.2	X	0.04	1.8	X
AMIS0076		3.89		554.5		93.9	2.4		0.83	121.2	
STSD-2											
MPL-4			6.44		333			0.8			1649
HgSTD-4											
OREAS 97.01											
Control Blank			X		X			X			X
Control Blank											
Control Blank											
Acid Blank				X		X	X		X	X	
Acid Blank			X		X			X			X
Control Blank											

Element		Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
Method		4A/OE	FC7/SIE	FP1/OE	HG1/CV	FP1/OE	FP1/OE	4A/OE	4A/MS	4A/OE	4A/OE
Detection		1	50	0.01	0.01	0.05	0.01	1	0.1	20	1
Units		ppm	ppm	%	ppm	%	%	ppm	ppm	ppm	ppm
Duplicates											
Sample Name											
Control Blank		X	54	0.03	X	X	X	X	X	X	X
GCA9728		15	134	46.84	X	X	0.1	167	1.1	311	5
GCA9728	check	14	203	48.24	X	0.19	0.11	162	1.1	281	3
GCA9729		7	179	51.62	X	0.14	0.12	200	1.6	273	5
GCA9730		4	89	58.88	X	0.06	0.09	116	2.7	102	2
GCA9731		2	72	63.48	0.02	X	0.08	324	2.9	52	X
GCA9732		9	179	49.81	0.66	0.08	0.14	165	2.3	63	19
GCA9733		12	82	60.28	0.1	0.08	0.08	115	2.4	22	3
AMIS0076		90						368	8.5	921	193
STSD-2			1062								
MPL-4				2.19		1.57	0.87				
HgSTD-4					0.34						
OREAS 97.01											
Control Blank				0.02			X				
Control Blank					X						
Control Blank											
Acid Blank		X						X	X	X	X
Acid Blank				X		X	X				

Element		P	Pb	S	Sb	Se	Si	Sn	Sr	Th	Tl
Method		4A/OE	4A/MS	4A/OE	4A/MS	SE1/MS	FP1/OE	4A/MS	4A/MS	4A/MS	4A/MS
Detection		50	0.5	50	0.05	0.01	0.1	0.1	0.05	0.01	0.02
Units		ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Duplicates											
Sample Name											
Control Blank		X	X	X	X	X	X	X	X	X	0.07
GCA9728		411	8.1	158	1.22	0.8	11.4	0.9	4.52	5.25	0.09
GCA9728	check	378	7.2	170	1.13	0.37	11.8	0.8	4.63	5.06	0.05
GCA9729		449	8.3	176	1.24	0.72	8.7	1.2	8.42	4.79	0.13
GCA9730		567	7.8	105	1.7	0.37	3.3	1.7	3.83	3.83	0.06
GCA9731		711	5.9	142	1.88	0.35	1.7	1.9	2.88	2.35	0.05
GCA9732		896	11.8	59	2.21	0.19	6.5	1.7	7.44	3.92	0.11
GCA9733		1251	5	235	1.65	1.01	1.4	1.6	2.05	1.9	0.02
AMIS0076		170	670.4	22498	51.64			1.9	31.93	148.8	0.27
STSD-2											
MPL-4							32.3				
HgSTD-4											
OREAS 97.01						0.68					
Control Blank							X				
Control Blank											
Control Blank						X					
Acid Blank		X	X	X	X			X	X	0.02	0.03
Acid Blank							X				

Element		U	V	Zn
Method		4A/MS	4A/OE	4A/OE
Detection		0.01	1	1
Units		ppm	ppm	ppm
Duplicates				
Sample Name				
Control Blank		X	X	X
GCA9728		0.79	93	6
GCA9728	check	0.8	98	5
GCA9729		1.17	83	7
GCA9730		0.8	109	1
GCA9731		0.52	96	1
GCA9732		2.01	110	6
GCA9733		0.73	84	3
AMIS0076		1561.64	24	454
STSD-2				
MPL-4				
HgSTD-4				
OREAS 97.01				
Control Blank				
Control Blank				
Control Blank				
Acid Blank		0.04	X	X
Acid Blank				
Control Blank				

Notes:

The results have been determined according to Genalysis methods codes:
Digestions: MPL_W001 (4A/), 4 acid digest using HF
MPL_W005 (SE1/) precipitation of Se from an aqua regia digest
MPL_W011 (FP1/), peroxide fusion followed by HCl digest of melt
ENV_W012 (FC7/SIE) Alkaline fusion in a nickel crucible Specific Ion Electrode using FC7/ digest solution
MPL_W008 (HG1/) Low temperature Perchloric acid digest specific for Mercury.
Analytical Finishes: ICP_W004 (/OE), ICP_W005 (/MS) and AAS_W004 (/CV).
The results included the assay of blanks and international reference standards
STSD-2 AMIS0076
Genalysis in-house standards MPL-4 HgSTD 4and OREAS 97.01
The results are expressed as parts per million by mass in the dried and prepared material.

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NATA Signatory: Ann Evers

Ann Evers

Date: 14/06/2011

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Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-(1:2) & EC-(1:2) TESTWORK

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (µS/cm)
GCA9728	30.0	60.0	6.3	120
GCA9729	30.0	60.0	6.5	65
GCA9730	30.0	60.0	6.4	51
GCA9731	30.0	60.0	6.5	30
GCA9732	30.0	60.0	6.4	41
GCA9733	30.0	60.0	6.4	39
GCA9733-1	30.0	60.0	6.4	41

Note: EC = Electrical-Conductivity.
Testwork performed on the as-supplied 'pulp' samples (nominal -75 µm).
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ratio of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 5 µS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

Dr GD Campbell
17th May 2011

Graeme Campbell & Associates Pty Ltd

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)**		
GCA9728	3.0	Reaction peaked overnight	5.9	6.2	40	0.10	<0.5
GCA9729	3.0	Reaction peaked overnight	5.8	6.1	37	0.20	<0.5
GCA9730	3.0	Reaction peaked overnight	5.5	5.7	24	0.20	<0.5
GCA9731	3.0	Reaction peaked overnight	5.3	5.5	18	0.20	<0.5
GCA9732	3.0	Reaction peaked overnight	5.8	6.2	22	0.10	<0.5
GCA9733	3.0	Reaction peaked overnight	5.3	5.5	16	0.20	<0.5
GCA9733-1	3.0	Reaction peaked overnight	5.3	5.5	16	0.20	<0.5
BLANK4	3.0	Reaction peaked overnight	5.7	7.2	74	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th June 2011

Graeme Campbell & Associates Pty Ltd
Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9728
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9728**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	0.99
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.73
pH	6.8
EC (µS/cm)	150

	GCA9728
Weathering-Cycles	
Cycle No.	**1**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	6/6/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	1.99
Gravimetric-Water-Content (%, w/w)	**11.3**
Wt Leachate + Beaker (kg)	0.92
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.66
Leachate-pH	7.0
Leachate-EC (µS/cm)	63

N.B. Approx. 2 weeks to complete draining.

	GCA9728
Weathering-Cycles	
Cycle No.	**2**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	27/6/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	2.00
Gravimetric-Water-Content (%, w/w)	**12.0**
Wt Leachate + Beaker (kg)	0.91
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.65
Leachate-pH	6.6
Leachate-EC (µS/cm)	49

N.B. Approx. 2 weeks to complete draining.

	GCA9728
Weathering-Cycles	
Cycle No.	**3**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	18/7/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	2.01
Gravimetric-Water-Content (%, w/w)	**12.7**
Wt Leachate + Beaker (kg)	0.92
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.66
Leachate-pH	7.0
Leachate-EC (µS/cm)	35

N.B. Approx. 2 weeks to complete draining.

	GCA9728
Weathering-Cycles	
Cycle No.	**4**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	8/08/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	1.97
Gravimetric-Water-Content (%, w/w)	**10.0**
Wt Leachate + Beaker (kg)	0.90
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.64
Leachate-pH	6.8
Leachate-EC (µS/cm)	28

N.B. Approx. 2 weeks to complete draining.

	GCA9728
Weathering-Cycles	
Cycle No.	**5**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	29/08/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	1.98
Gravimetric-Water-Content (%, w/w)	**10.7**
Wt Leachate + Beaker (kg)	0.95
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.69
Leachate-pH	6.6
Leachate-EC (µS/cm)	29

N.B. Approx. 2 weeks to complete draining.

Graeme Campbell & Associates Pty Ltd
Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9729
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9729**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	0.92
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.66
pH	6.2
EC (µS/cm)	250

N.B. No drainage obtained after approx. 5 weeks. Therefore column abandoned.

Graeme Campbell & Associates Pty Ltd

Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9730
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9730**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	1.00
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.74
pH	6.2
EC (µS/cm)	100

	GCA9730
Weathering-Cycles	
Cycle No.	**1**
DAY-1 (i.e. Start-of-Day-1) [Monday]	
Lamps-On: Date	6/6/11
Lamps-On: Time	17:00
Wt Deionised-Water Added (kg)	1.00
(Lamps remain off)	
After-Flushing	
Wt Drained-Column(kg)	1.99
Gravimetric-Water-Content (%, w/w)	**11.3**
Wt Leachate + Beaker (kg)	0.81
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.55
Leachate-pH	6.5
Leachate-EC (µS/cm)	63

N.B. Approx. 3 weeks for drainage to be completed for Cycle-1.
After completing the drying-phase for Cycle-2 and flushing, less than 100 mL of leachate was obtained in 8 weeks. This column was therefore abandoned.

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9731
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9731**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	1.07
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.81
pH	5.7
EC (µS/cm)	79

	GCA9731	**GCA9731**	**GCA9731**
Weathering-Cycles			
Cycle No.	**1**	**2**	**3**
DAY-1 [Monday]			
Lamps-On: Date	6/6/11	13/6/11	20/6/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.86	1.93	1.94
Gravimetric-Water Content (%, w/w)	**2.7**	**7.3**	**8.0**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	1.84	1.88	1.88
Gravimetric-Water Content (%, w/w)	**1.3**	**4.0**	**4.0**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.84	1.85	1.85
Gravimetric-Water Content (%, w/w)	**1.3**	**2.0**	**2.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.83	1.84	1.84
Gravimetric-Water Content (%, w/w)	**0.7**	**1.3**	**1.3**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	1.99	2.00	2.01
Gravimetric-Water Content (%, w/w)	**11.3**	**12.0**	**12.7**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.06	1.07	1.06
Wt Leachate (kg)	0.80	0.81	0.80
Leachate-pH	5.9	5.7	5.6
Leachate-EC (µS/cm)	25	18	12

	GCA9731	**GCA9731**	**GCA9731**
Weathering-Cycles			
Cycle No.	**4**	**5**	**6**
DAY-1 [Monday]			
Lamps-On: Date	27/6/11	4/7/11	11/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.94	1.95	1.94
Gravimetric-Water Content (%, w/w)	**8.0**	**8.7**	**8.0**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	1.88	1.90	1.87
Gravimetric-Water Content (%, w/w)	**4.0**	**5.3**	**3.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.85	1.86	1.85
Gravimetric-Water Content (%, w/w)	**2.0**	**2.7**	**2.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.84	1.84	1.83
Gravimetric-Water Content (%, w/w)	**1.3**	**1.3**	**0.7**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	2.01	2.01	2.01
Gravimetric-Water Content (%, w/w)	**12.7**	**12.7**	**12.7**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.06	1.06	1.06
Wt Leachate (kg)	0.80	0.80	0.80
Leachate-pH	6.0	5.4	5.6
Leachate-EC (µS/cm)	16	8	9

Graeme Campbell & Associates Pty Ltd

Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9732
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9732**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	0.92
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.66
pH	6.5
EC (µS/cm)	210

	GCA9732	**GCA9732**	**GCA9732**
Weathering-Cycles			
Cycle No.	**1**	**2**	**3**
DAY-1 [Monday]			
Lamps-On: Date	6/6/11	13/6/11	4/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.02	2.04	2.03
Gravimetric-Water Content (%, w/w)	**13.3**	**14.7**	**14.0**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	2.00	1.98	1.98
Gravimetric-Water Content (%, w/w)	**12.0**	**10.7**	**10.7**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.97	1.93	1.94
Gravimetric-Water Content (%, w/w)	**10.0**	**7.3**	**8.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.94	1.90	1.90
Gravimetric-Water Content (%, w/w)	**8.0**	**5.3**	**5.3**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	2.10	2.10	2.11
Gravimetric-Water Content (%, w/w)	**18.7**	**18.7**	**19.3**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.05	1.03	1.02
Wt Leachate (kg)	0.79	0.77	0.76
Leachate-pH	6.3	6.0	6.0
Leachate-EC (µS/cm)	26	21	15

	GCA9732	**GCA9732**	**GCA9732**
Weathering-Cycles			
Cycle No.	**4**	**5**	**6**
DAY-1 [Monday]			
Lamps-On: Date	11/7/11	18/7/11	25/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.06	2.06	2.10
Gravimetric-Water Content (%, w/w)	**16.0**	**16.0**	**18.7**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	2.02	2.01	2.07
Gravimetric-Water Content (%, w/w)	**13.3**	**12.7**	**16.7**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.97	1.96	2.03
Gravimetric-Water Content (%, w/w)	**10.0**	**9.3**	**14.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.93	1.92	1.98
Gravimetric-Water Content (%, w/w)	**7.3**	**6.7**	**10.7**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	2.11	2.12	2.11
Gravimetric-Water Content (%, w/w)	**19.3**	**20.0**	**19.3**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.04	1.03	1.09
Wt Leachate (kg)	0.78	0.77	0.83
Leachate-pH	6.1	6.2	6.3
Leachate-EC (µS/cm)	14	12	11

Graeme Campbell & Associates Pty Ltd
Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9733
Column-Packing	
Wt Column-Only (kg)	0.32
Wt Column + Sample (kg)	1.82
Wt Sample (kg)	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9733**
Wt DW Added (kg)	1.00
Wt Leach. + Beaker (kg)	1.03
Wt Beaker (kg)	0.26
Wt Leachate (kg)	0.77
pH	6.2
EC (µS/cm)	130

	GCA9733	GCA9733	GCA9733
Weathering-Cycles			
Cycle No.	**1**	**2**	**3**
DAY-1 [Monday]			
Lamps-On: Date	6/6/11	13/6/11	20/6/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.93	1.97	1.99
Gravimetric-Water Content (%, w/w)	**7.3**	**10.0**	**11.3**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	1.90	1.91	1.93
Gravimetric-Water Content (%, w/w)	**5.3**	**6.0**	**7.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.88	1.87	1.88
Gravimetric-Water Content (%, w/w)	**4.0**	**3.3**	**4.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.86	1.86	1.86
Gravimetric-Water Content (%, w/w)	**2.7**	**2.7**	**2.7**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	2.04	2.03	2.05
Gravimetric-Water Content (%, w/w)	**14.7**	**14.0**	**15.3**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.05	1.07	1.05
Wt Leachate (kg)	0.79	0.81	0.79
Leachate-pH	6.1	6.1	5.9
Leachate-EC (µS/cm)	32	35	24

	GCA9733	**GCA9733**	**GCA9733**
Weathering-Cycles			
Cycle No.	**4**	**5**	**6**
DAY-1 [Monday]			
Lamps-On: Date	27/6/11	4/7/11	11/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.99	2.02	1.99
Gravimetric-Water Content (%, w/w)	**11.3**	**13.3**	**11.3**
DAY-3 [Wednesday]			
Time	09.00	09.00	09.00
Wt Column (kg)	1.94	1.98	1.91
Gravimetric-Water Content (%, w/w)	**8.0**	**10.7**	**6.0**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.89	1.94	1.87
Gravimetric-Water Content (%, w/w)	**4.7**	**8.0**	**3.3**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Column (kg)	1.87	1.90	1.85
Gravimetric-Water Content (%, w/w)	**3.3**	**5.3**	**2.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (end-of-Day-7) [Sunday]			
Wt Column(kg)	2.06	2.05	2.06
Gravimetric-Water Content (%, w/w)	**16.0**	**15.3**	**16.0**
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate + Beaker (kg)	1.04	1.08	1.02
Wt Leachate (kg)	0.78	0.82	0.76
Leachate-pH	6.1	5.9	5.6
Leachate-EC (µS/cm)	17	18	15

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JOB INFORMATION

JOB CODE	143/1107725
No. of SAMPLES	11
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	3/06/2011
DATE COMPLETED	30/06/2011

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

A set of leachates were received some of which (GCA9729-0, GCA9728-0 Raw and GCA9730-0 Raw) were turbid. These samples were centrifuged and filtered (0.45um filter) a split was then taken and dosed with HNO3
GCA9729-0 and GCA9728-0 were still coloured even after filtering through 0.1um filters and were not analysed for HCO3
The pH, EC and Cl of the "raw" sample was measured Genalysis method codes ENV-W001, ENV-W002, ENV_W013 and the alkalinity measured using APHA method code 2320B

APHA code refers to "Standard methods for the examination of water and wastewater", 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

The charge balance was calculated and found to be within +/- 10% for sample GCA9730-0 only suggesting the presence of colloids in the filtered acidified samples

Results of analysis on:

Element		Cl	EC	HCO3	pH
Method		/COL	/MTR	/VOL	/MTR
Detection		2	10	1	0.1
Units		mg/l	uS/cm	mgHCO3/L	NONE
Sample Name					
Control Blank					
GCA9728-0 Raw		6	119		7.5
GCA9728-0 Raw	check	6	114		7.6
GCA9729-0 Raw		15	183		7.6
GCA9730-0 Raw		10	91	17	7.3
GCA9731-0 Raw		5	69	14	6.4
GCA9732-0 Raw		11	183	39	6.8
GCA9733-0 Raw		7	109	19	6.7

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co
Method	/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank	0.02	X	X	X	0.06	X	X	X	X
GCA9728-0 HNO3	0.01	0.29	0.7	0.2	15.33	0.006	0.3	X	0.2
GCA9729-0 HNO3	0.02	0.48	1.4	0.16	16.36	0.005	1.39	X	0.4
GCA9730-0 HNO3	0.03	0.12	0.9	0.07	7.06	0.008	0.39	X	X
GCA9731-0 HNO3	0.01	X	0.4	0.03	6.42	X	1.32	0.07	0.2
GCA9732-0 HNO3	X	0.02	0.8	0.02	23.57	X	8.63	X	X
GCA9733-0 HNO3	0.05	X	1.3	X	7.54	0.02	4	X	1
BLANK-0 HNO3	X	X	0.2	X	0.11	X	0.02	X	X
DW-0 HNO3	0.01	X	0.1	X	X	0.006	X	X	0.4
Alcoa16-MS	4.94		25.6		5.99	4.768		4.95	584.5
Alcoa10-OES		1.82		1.12			49.64		

Element	Cr	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na
Method	/OE	/OE	/OE	/MS	/OE	/OE	/OE	/MS	/OE
Detection	0.01	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1
Units	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l
Sample Name									
Control Blank	X	X	X	X	X	X	X	X	X
GCA9728-0 HNO3	X	X	0.23	X	4.7	0.45	0.01	0.24	20.9
GCA9729-0 HNO3	X	X	0.25	X	4.7	2.25	0.03	0.25	33
GCA9730-0 HNO3	X	X	0.11	X	2.5	0.31	X	0.07	16
GCA9731-0 HNO3	X	X	X	X	3.3	1.29	X	X	9.7
GCA9732-0 HNO3	X	X	X	1.4	5.5	7.17	X	0.06	14.4
GCA9733-0 HNO3	X	X	X	X	5.4	4.23	X	0.1	7
BLANK-0 HNO3	X	X	X	X	0.2	X	X	X	0.3
DW-0 HNO3	X	X	X	X	X	0.02	X	X	X
Alcoa16-MS				2.5				5.78	
Alcoa10-OES	0.49	0.25	1.99		3.9	57.61	0.49		233.3

Element	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr
Method	/OE	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection	0.01	0.1	0.5	0.1	0.01	0.5	0.05	0.1	0.02
Units	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank	X	X	X	X	X	X	X	X	0.08
GCA9728-0 HNO3	X	X	X	3.4	0.06	0.7	12.14	X	2.01
GCA9729-0 HNO3	X	X	0.7	6.2	0.07	1.3	21.03	X	17.24
GCA9730-0 HNO3	X	X	X	3.1	0.03	1	9.11	X	2.93
GCA9731-0 HNO3	X	X	7.5	0.7	0.04	X	5.43	X	10.25
GCA9732-0 HNO3	X	X	3.5	3.1	0.03	0.7	12.93	X	45
GCA9733-0 HNO3	X	X	1.8	0.7	0.07	0.5	3.6	X	25.83
BLANK-0 HNO3	X	X	3.9	X	0.01	X	X	X	0.14
DW-0 HNO3	X	X	X	X	X	X	X	X	0.37
Alcoa16-MS			5.3		4.94	28.4		5.1	552.78
Alcoa10-OES	0.52	0.9		19.4			24.71		

Element	Th	Tl	U	V	Zn
Method	/MS	/MS	/MS	/OE	/OE
Detection	0.005	0.01	0.005	0.01	0.01
Units	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name					
Control Blank	X	X	X	X	X
GCA9728-0 HNO3	X	X	0.201	X	0.02
GCA9729-0 HNO3	0.018	0.01	0.229	X	0.01
GCA9730-0 HNO3	X	X	X	X	0.02
GCA9731-0 HNO3	X	0.01	X	X	X
GCA9732-0 HNO3	X	0.01	0.013	X	X
GCA9733-0 HNO3	0.011	0.03	0.016	X	X
BLANK-0 HNO3	X	X	X	X	0.01
DW-0 HNO3	X	X	X	X	X
Alcoa16-MS	5.187	4.73	5.481		
Alcoa10-OES				0.48	0.48

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NATA Signatory: Ann Evers

Ann Evers

Date: 30/06//2011

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JOB INFORMATION

JOB CODE	143/1108764
No. of SAMPLES	7
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	16/06/2011
DATE COMPLETED	13/07/2011

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

A series of column leachates were received. GCA9732 was received as a turbid column leachate, this sample was centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3
The pH, EC and Cl of the “raw” sample was measured Genalysis method codes ENV-W001, ENV-W002, ENV_W013 and the alkalinity measured using APHA method code 2320B

APHA code refers to “Standard methods for the examination of water and wastewater”, 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

The charge balance was calculated and found to be within +/- 10%

Results of analysis on:

Element		Cl	EC	HCO3	pH
Method		/COL	/MTR	/VOL	/MTR
Detection		2	10	1	0.1
Units		mg/l	uS/cm	mgHCO3/L	NONE
Sample Name					
Control Blank		X			
GCA9731-1 Raw		2	22	6	6.3
GCA9731-1 Raw	check	2	22	6	6.3
GCA9732-1 Raw		2	26	6	6.9
GCA9733-1 Raw		3	31	4	6.3

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co
Method	/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank	X	X	X	0.01	0.09	X	X	X	X
GCA9731-1 HNO3	X	X	0.3	0.01	1.65	X	0.26	X	X
GCA9732-1 HNO3	X	0.26	0.1	X	103.05	X	0.74	X	X
GCA9733-1 HNO3	X	X	1.1	X	2.06	X	1.06	X	0.1
Blank-1 HNO3	X	0.02	X	X	0.28	X	X	X	X
DW-1 HNO3	X	X	X	0.01	X	X	X	X	X
Alcoa16-MS	5.29		25.8		6.15	4.904		5.08	504.3
Alcoa10-OES		1.83		1.08			48.68		

Element	Cr	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na
Method	/OE	/OE	/OE	/MS	/OE	/OE	/OE	/MS	/OE
Detection	0.01	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1
Units	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l
Sample Name									
Control Blank	X	X	X	X	X	X	X	X	X
GCA9731-1 HNO3	X	X	X	0.6	1.3	0.23	X	X	3.2
GCA9732-1 HNO3	X	X	0.22	X	1.1	0.53	X	0.07	3.1
GCA9733-1 HNO3	X	X	X	X	1.3	1.3	X	0.05	1.6
Blank-1 HNO3	X	X	X	X	X	X	X	X	0.1
DW-1 HNO3	X	X	X	X	X	0.02	X	X	X
Alcoa16-MS				2.5				5.78	
Alcoa10-OES	0.48	0.24	1.95		3.7	56.68	0.48		234.8

Element	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr
Method	/OE	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection	0.01	0.1	0.5	0.1	0.01	0.5	0.05	0.1	0.02
Units	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank	X	X	X	X	X	X	X	X	0.03
GCA9731-1 HNO3	X	X	X	0.8	0.03	X	5.18	X	2.08
GCA9732-1 HNO3	X	X	X	1	0.09	X	10.7	X	4.24
GCA9733-1 HNO3	X	X	0.8	1.2	0.03	X	4.44	X	6.25
Blank-1 HNO3	X	X	X	X	0.01	X	0.05	X	0.07
DW-1 HNO3	X	X	X	X	X	X	X	X	X
Alcoa16-MS			6		5.36	25.8		5.9	600.62
Alcoa10-OES	0.52	0.9		18.9			26.71		

Element	Th	Tl	U	V	Zn
Method	/MS	/MS	/MS	/OE	/OE
Detection	0.005	0.01	0.005	0.01	0.01
Units	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name					
Control Blank	X	X	X	X	X
GCA9731-1 HNO3	X	X	X	X	X
GCA9732-1 HNO3	X	X	0.007	X	0.01
GCA9733-1 HNO3	X	X	X	X	X
Blank-1 HNO3	X	X	X	X	X
DW-1 HNO3	X	X	X	X	X
Alcoa16-MS	5.179	4.92	5.376		
Alcoa10-OES				0.48	0.45

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NATA Signatory: Ann Evers

Ann Evers

Date: 13/07//2011

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JOB INFORMATION

JOB CODE	143/1111216
No. of SAMPLES	32
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	27/07/2011
DATE COMPLETED	17/08/2011

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

A series of column leachates were received, some were slurries. These samples were centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3
The pH and EC of each “raw” sample was measured Genalysis method codes ENV-W001, ENV-W002 and the alkalinity measured using APHA method code 2320B
APHA code refers to “Standard methods for the examination of water and wastewater”, 21st Edition 2005
Due to the brown colour of some of the filtered raw samples the alkalinity was not measured (NA)
The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004).The charge balance was calculated as requested but due to the low TDS was not generally found to be within +/- 10%
Results of analysis on:

Element		Cl	EC	HCO3	pH
Method		/COL	/MTR	/VOL	/MTR
Detection		2	10	1	0.1
Units		mg/l	uS/cm	mgHCO3/L	NONE
Sample Name					
Control Blank		X			
GCA9728-1 Raw		X	50	NA	6.8
GCA9728-1 Raw	check	X	47	NA	6.8
GCA9728-2 Raw		X	40	NA	6.8
GCA9730-1 Raw		4	49	7	6.6
GCA9731-2 Raw		X	28	X	4.4
GCA9731-3 Raw		X	10	4	6.1
GCA9731-4 Raw		X	X	4	6.4
GCA9731-5 Raw		X	X	4	6.3
GCA9731-6 Raw		X	X	4	6.3
GCA9732-2 Raw		X	18	7	6.6
GCA9732-3 Raw		X	24	8	6.8
GCA9732-4 Raw		X	13	6	6.5
GCA9733-2 Raw		X	30	5	6.4
GCA9733-3 Raw		X	21	4	6.3
GCA9733-4 Raw		X	16	4	6.3
GCA9733-5 Raw		X	15	4	6.4
GCA9733-6 Raw		X	12	4	6.4

Element		Ag	Al	As	B	Ba	Bi	Ca	Cd
Method		/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS
Detection		0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02
Units		ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l
Sample Name									
Control Blank		X	0.01	X	0.01	X	X	X	X
GCA9728-1 HNO3		0.03	0.7	0.4	0.16	9.93	X	0.4	X
GCA9728-2 HNO3		X	0.68	0.5	0.1	8.18	X	0.29	X
GCA9730-1 HNO3		X	0.32	X	0.07	3.54	X	0.59	X
GCA9731-2 HNO3		X	0.19	0.2	0.04	9	0.007	0.35	X
GCA9731-3 HNO3		X	0.25	0.2	0.04	3.59	X	0.15	X
GCA9731-3 HNO3	check	0.01	0.24	0.1	0.01	3.65	X	0.16	X
GCA9731-4 HNO3		X	0.18	X	0.03	2.07	X	0.11	X
GCA9731-5 HNO3		X	0.2	X	0.04	12.87	X	0.1	X
GCA9731-6 HNO3		X	0.24	X	0.03	6.44	X	0.12	X
GCA9732-2 HNO3		X	0.2	X	0.03	6.11	X	0.45	X
GCA9732-3 HNO3		X	0.26	X	X	4.19	X	0.67	X
GCA9732-4 HNO3		0.01	0.36	X	X	10.19	X	0.65	X
GCA9733-2 HNO3		X	0.09	0.4	0.02	1.52	X	1.01	X
GCA9733-3 HNO3		X	0.03	0.2	0.06	1.95	X	0.74	X
GCA9733-4 HNO3		X	0.04	X	X	0.83	X	0.58	X
GCA9733-5 HNO3		0.06	0.22	0.1	0.04	10.99	X	0.61	X
GCA9733-6 HNO3		X	0.2	X	0.03	17.09	X	0.52	X
Alcoa17-MS		5.21		28.1		5.43	4.748		5.15
Alcoa10-OES			1.85		1.14			50.15	

Element		Co	Cr	Cu	Fe-Sol	Hg	K	Mg	Mn
Method		/MS	/OE	/OE	/OE	/MS	/OE	/OE	/OE
Detection		0.1	0.01	0.01	0.01	0.1	0.1	0.01	0.01
Units		ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
Sample Name									
Control Blank		X	X	X	X	X	X	X	X
GCA9728-1 HNO3		0.3	X	X	0.31	0.3	2.5	0.75	X
GCA9728-2 HNO3		0.2	X	X	0.24	X	2.1	0.69	X
GCA9730-1 HNO3		X	X	X	0.18	X	1.6	0.67	X
GCA9731-2 HNO3		X	X	X	0.21	0.3	1	0.25	X
GCA9731-3 HNO3		X	X	X	0.23	0.3	0.8	0.16	X
GCA9731-3 HNO3	check	0.1	X	0.01	0.2	0.1	0.9	0.17	X
GCA9731-4 HNO3		X	X	X	0.16	0.2	0.6	0.12	X
GCA9731-5 HNO3		X	X	X	0.18	0.2	0.5	0.12	X
GCA9731-6 HNO3		X	X	X	0.24	0.2	0.8	0.1	X
GCA9732-2 HNO3		X	X	X	0.25	0.2	1	0.42	X
GCA9732-3 HNO3		X	X	X	0.25	0.2	1.4	0.6	X
GCA9732-4 HNO3		0.1	X	X	0.25	0.2	0.9	0.5	X
GCA9733-2 HNO3		X	X	X	0.04	0.2	1.3	1.29	X
GCA9733-3 HNO3		X	X	X	0.03	0.1	1.1	0.85	X
GCA9733-4 HNO3		X	X	X	0.04	0.2	0.8	0.71	X
GCA9733-5 HNO3		X	X	X	0.21	0.3	0.9	0.82	X
GCA9733-6 HNO3		X	X	X	0.15	0.2	0.6	0.64	X
Alcoa17-MS		531.3				5.4			
Alcoa10-OES			0.5	0.25	2		3.9	59.25	0.49

Element		Mo	Na	Ni	P	Pb	S	Sb	Se
Method		/MS	/OE	/OE	/OE	/MS	/OE	/MS	/MS
Detection		0.05	0.1	0.01	0.1	0.5	0.1	0.01	0.5
Units		ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank		X	X	X	X	X	X	X	X
GCA9728-1 HNO3		0.27	10.1	X	X	2	0.6	0.06	X
GCA9728-2 HNO3		0.12	7.9	X	X	1.3	0.3	0.04	X
GCA9730-1 HNO3		X	8.7	0.02	X	0.9	1.9	X	0.7
GCA9731-2 HNO3		X	2	X	X	1.1	0.9	0.08	X
GCA9731-3 HNO3		X	1.3	0.01	X	X	0.3	0.03	X
GCA9731-3 HNO3	check	X	1.2	X	X	X	0.7	0.03	X
GCA9731-4 HNO3		X	1.1	X	X	X	0.4	0.04	X
GCA9731-5 HNO3		X	0.8	X	X	X	X	X	X
GCA9731-6 HNO3		X	0.8	X	X	X	0.1	X	X
GCA9732-2 HNO3		X	2.1	0.01	X	X	0.4	0.05	X
GCA9732-3 HNO3		X	2.3	X	X	1	0.6	0.01	X
GCA9732-4 HNO3		X	1.5	X	X	X	0.2	0.01	X
GCA9733-2 HNO3		X	1.2	X	X	X	1.8	0.01	0.5
GCA9733-3 HNO3		X	0.7	X	X	2.4	1.2	0.02	X
GCA9733-4 HNO3		X	0.5	X	X	0.9	0.8	X	X
GCA9733-5 HNO3		X	0.6	X	X	0.7	0.8	X	X
GCA9733-6 HNO3		X	0.5	X	X	X	0.6	X	X
Alcoa17-MS		5.54				4.9		5.22	27.7
Alcoa10-OES			241.2	0.55	1		21.2		

Element		Si	Sn	Sr	Th	Tl	U	V	Zn
Method		/OE	/MS	/MS	/MS	/MS	/MS	/OE	/OE
Detection		0.05	0.1	0.02	0.005	0.01	0.005	0.01	0.01
Units		mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name									
Control Blank		X		0.02	X	X	X	X	X
GCA9728-1 HNO3		15.65	0.1	2.77	0.009	X	0.283	X	X
GCA9728-2 HNO3		15.41	X	2.17	0.009	X	0.201	X	X
GCA9730-1 HNO3		13.99	X	5.91	X	X	0.025	X	X
GCA9731-2 HNO3		8.37	0.1	2.26	X	X	X	X	X
GCA9731-3 HNO3		7.75	X	1.42	X	X	0.007	X	X
GCA9731-3 HNO3	check	7.77	X	1.41	X	X	0.008	X	X
GCA9731-4 HNO3		5.59	X	0.82	X	X	X	X	X
GCA9731-5 HNO3		4.84	X	0.85	X	X	X	X	X
GCA9731-6 HNO3		5.58	X	0.98	X	X	X	X	X
GCA9732-2 HNO3		11.94	X	2.4	X	X	X	X	X
GCA9732-3 HNO3		13.87	X	3.63	X	X	0.016	X	X
GCA9732-4 HNO3		9.34	X	3.38	X	X	0.034	X	0.02
GCA9733-2 HNO3		7.8	X	6.56	X	X	X	X	0.02
GCA9733-3 HNO3		7.59	X	4.65	X	X	X	X	0.02
GCA9733-4 HNO3		5	X	3.15	X	X	0.012	X	0.01
GCA9733-5 HNO3		6.54	X	3.44	X	X	X	X	X
GCA9733-6 HNO3		6.1	X	3.17	X	X	X	X	X
Alcoa17-MS			5.2	536.44	5.381	4.52	4.887		
Alcoa10-OES		27.35						0.48	0.52

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NATA Signatory: Ann Evers

Ann Evers

Date: 17/08//2011

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JOB INFORMATION

JOB CODE	143/1111961
No. of SAMPLES	4
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	10/08/2011
DATE COMPLETED	31/08/2011

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

A series of column leachates were received, some were slurries. These samples were centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3.

The pH, EC and Cl of each "raw" sample was measured using Genalysis method codes: ENV-W001, ENV-W002, ENV_W013 and the alkalinity measured using APHA method code 2320B
APHA code refers to "Standard methods for the examination of water and wastewater", 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004).The charge balance was calculated as requested and found to be within +/- 10%

Results of analysis on:

Element		Cl	EC	HCO3	pH
Method		/COL	/MTR	/VOL	/MTR
Detection		2	10	1	0.1
Units		mg/l	uS/cm	mgHCO3/L	NONE
Sample Name					
Control Blank		X			
GCA9732-5 Raw		2	12	6	6.7
GCA9732-5 Raw	check	2	12	6	6.7
GCA9732-6 Raw		X	11	5	6.6
N191		98			

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd
Method	/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l
Sample Name								
Control Blank	X	X	X	X	X	X	X	X
GCA9732-5 HNO3	0.78	0.27	X	0.06	78.82	X	0.32	X
GCA9732-6 HNO3	0.18	0.21	X	0.05	23.36	X	0.24	X
Alcoa17-MS	5.06		27.2		5.99	4.634		5.53
Alcoa11-OES		2.04		0.96			50.52	

Element	Co	Cr	Cu	Fe-Sol	Hg	K	Mg	Mn
Method	/MS	/OE	/OE	/OE	/MS	/OE	/OE	/OE
Detection	0.1	0.01	0.01	0.01	0.1	0.1	0.01	0.01
Units	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
Sample Name								
Control Blank	0.1	X	X	X	X	X	X	X
GCA9732-5 HNO3	X	X	X	0.29	0.1	0.8	0.31	X
GCA9732-6 HNO3	X	X	X	0.23	X	1	0.24	X
Alcoa17-MS	559.1				5.6			
Alcoa11-OES		0.52	0.51	2.09		3.8	49.86	0.51

Element	Mo	Na	Ni	P	Pb	S	Sb	Se
Method	/MS	/OE	/OE	/OE	/MS	/OE	/MS	/MS
Detection	0.05	0.1	0.01	0.1	0.5	0.1	0.01	0.5
Units	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l
Sample Name								
Control Blank	X	0.3	0.01	X	X	X	X	X
GCA9732-5 HNO3	0.08	1.5	X	X	0.9	X	0.02	X
GCA9732-6 HNO3	0.12	1.3	0.02	X	X	0.2	0.03	X
Alcoa17-MS	5.58				5.5		5.68	28
Alcoa11-OES		243.9	0.51	0.9		16.5		

Element	Si	Sn	Sr	Th	Tl	U	V	Zn
Method	/OE	/MS	/MS	/MS	/MS	/MS	/OE	/OE
Detection	0.05	0.1	0.02	0.005	0.01	0.005	0.01	0.01
Units	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name								
Control Blank	X	X	X	X	X	X	X	X
GCA9732-5 HNO3	10.17	X	2.01	X	X	0.009	X	X
GCA9732-6 HNO3	10.77	X	1.61	X	X	0.009	X	X
Alcoa17-MS		5.5	549.69	5.25	5.05	5.114		
Alcoa11-OES	17.82						0.53	0.49

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NATA Signatory: Ann Evers

Ann Evers

Date: 31/08//2011

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JOB INFORMATION

JOB CODE	143/1113002
No. of SAMPLES	1
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachate/slurry
DATE RECEIVED	23/08/2011
DATE COMPLETED	23/09/2011

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

A column leachate was received as slurry. The sample was centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3
The pH, EC and Cl of the ñrawòsamples was measured Genalysis method codes ENV-W001, ENV-W002 and ENV_W013
Due to the brown colour of the filtered raw samples the alkalinity was not measured

The HNO3 dosed filtered solution was analysed for the requested element suite by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

Results of analysis on:

Element		Cl	EC	pH
Method		/COL	/MTR	/MTR
Detection		2	10	0.1
Units		mg/l	uS/cm	NONE
Sample Name				
Control Blank		X		
GCA9728-3 Raw		X	37	7.3
GCA9728-3 Raw	check	X	38	7.3
N191		97		

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd
Method	/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l
Sample Name								
Control Blank	X	X	0.1	X	0.07	X	X	X
GCA9728-3 HNO3	X	0.49	0.6	0.1	7.19	X	0.26	0.1
Alcoa11-OES		1.94		0.99			48.91	
AlcoaHi3-OES		47.5		19.74			951.67	
Alcoa-High4-MS	20.52		107.2		20.99	20.446		21.52

Element	Co	Cr	Cu	Fe-Sol	Hg	K	Mg	Mn
Method	/MS	/OE	/OE	/OE	/MS	/OE	/OE	/OE
Detection	0.1	0.01	0.01	0.01	0.1	0.1	0.01	0.01
Units	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
Sample Name								
Control Blank	0.2	X	X	X	X	0.3	X	X
GCA9728-3 HNO3	X	X	X	0.23	X	2.3	0.51	X
Alcoa11-OES		0.5	0.52	2.03		3.8	48.67	0.49
AlcoaHi3-OES		19.61	2.61	93.86		476.8	201.92	19.27
Alcoa-High4-MS	984.1				21.2			

Element	Mo	Na	Ni	P	Pb	S	Sb	Se
Method	/MS	/OE	/OE	/OE	/MS	/OE	/MS	/MS
Detection	0.05	0.1	0.01	0.1	0.5	0.1	0.01	0.5
Units	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l
Sample Name								
Control Blank	X	X	X	X	X	X	X	X
GCA9728-3 HNO3	0.52	8.5	0.02	X	2.2	0.2	0.07	X
Alcoa11-OES		245.4	0.5	0.9		16.7		
AlcoaHi3-OES		1958.7	19.68	47.6		261.4		
Alcoa-High4-MS	20.89				21		22.64	104.9

Element	Si	Sn	Sr	Th	Tl	U	V	Zn
Method	/OE	/MS	/MS	/MS	/MS	/MS	/OE	/OE
Detection	0.05	0.1	0.02	0.005	0.01	0.005	0.01	0.01
Units	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name								
Control Blank	X	X	X	X	X	X	X	X
GCA9728-3 HNO3	14.74	X	1.97	0.029	X	0.206	X	0.31
Alcoa11-OES	17.98						0.52	0.5
AlcoaHi3-OES	100.87						20.16	19.97
Alcoa-High4-MS		22.1	1041.81	22.237	20.58	22.874		

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NATA Signatory: Ann Evers

Ann Evers

Date: 23/09//2011

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JOB INFORMATION

JOB CODE	143/1114205
No. of SAMPLES	1
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachate/slurry
DATE RECEIVED	16/09/2011
DATE COMPLETED	3/10/2011

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 column leachates were received as slurries. The samples were centrifuged and filtered (0.45um) a split was then taken and dosed with HNO3
The pH, EC and Cl of the ñrawòsamples was measured Genalysis method codes ENV-W001, ENV-W002 and ENV_W013
Due to the brown colour of the filtered raw samples the alkalinity was not measured

The HNO3 dosed filtered solution was analysed for the requested element suite by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

Results of analysis on:

Element		Cl	EC	pH
Method		/COL	/MTR	/MTR
Detection		2	10	0.1
Units		mg/l	uS/cm	NONE
Sample Name				
Control Blank				
GCA9728-4 Raw		X	36	7.2
GCA9728-4 Raw	check	X	36	7.2
GCA9728-5 Raw		X	30	7.2
N191		97		

Element	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co
Method	/MS	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/MS
Detection	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1
Units	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l
Sample Name									
Control Blank	X	0.03	X	X	X	X	X	X	X
GCA9728-4 HNO3	X	0.49	0.7	0.12	9.02	X	0.28	X	0.2
GCA9728-5 HNO3	0.17	0.28	1.7	0.1	5.46	0.162	0.21	0.18	8.6
Alcoa17-MS	5.19		25		6.11	4.554		5.59	540.1
Alcoa11-OES		1.98		1.03			52.27		
Alcoa-High4-MS	20.62		102.3		20.47	18.514		20.8	1073.1
AlcoaHi3-OES		50.25		19.81			998.93		

Element	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Na
Method	/OE	/OE	/OE	/MS	/OE	/OE	/OE	/MS	/OE
Detection	0.01	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1
Units	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l
Sample Name									
Control Blank	X	X	X	0.1	X	0.01	X	X	X
GCA9728-4 HNO3	X	X	0.08	0.2	1.9	0.46	X	0.41	8.1
GCA9728-5 HNO3	X	0.01	0.05	0.5	1.7	0.36	X	0.52	8
Alcoa17-MS				5.4				5.48	
Alcoa11-OES	0.54	0.55	2		4.2	52.06	0.55		261.1
Alcoa-High4-MS				20.5				20.78	
AlcoaHi3-OES	20.53	2.76	101.54		505.9	213.49	20.61		2054.8

Element	Ni	P	Pb	S	Sb	Se	Si	Sn	SO4
Method	/OE	/OE	/MS	/OE	/MS	/MS	/OE	/MS	/CALC
Detection	0.01	0.1	0.5	0.1	0.01	0.5	0.05	0.1	0.3
Units	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	mg/l
Sample Name									
Control Blank	X	X	X	X	X	X	X	X	X
GCA9728-4 HNO3	X	X	0.9	0.2	0.05	X	14.67	X	0.5
GCA9728-5 HNO3	X	X	1.1	0.2	0.22	1.3	11.87	0.2	0.5
Alcoa17-MS			5.3		5.55	27.9		5.7	
Alcoa11-OES	0.51	0.9		17.9			17.76		53.5
Alcoa-High4-MS			20		21.47	107.1		21.5	
AlcoaHi3-OES	20.6	44.9		258.7			93.27		775.1

Element	Sr	Th	Tl	U	V	Zn
Method	/MS	/MS	/MS	/MS	/OE	/OE
Detection	0.02	0.005	0.01	0.005	0.01	0.01
Units	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
Sample Name						
Control Blank	X	X	X	X	X	0.01
GCA9728-4 HNO3	1.63	0.009	X	0.167	X	0.02
GCA9728-5 HNO3	9.33	0.173	0.17	0.399	X	X
Alcoa17-MS	518.05	5.218	4.72	5.161		
Alcoa11-OES					0.57	0.53
Alcoa-High4-MS	1037.91	20.445	19.2	20.697		
AlcoaHi3-OES					21.14	20.52

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NATA Signatory: Ann Evers

Ann Evers

Date: 3/10//2011

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Note:

The laboratory-reports, and column-worksheets, in the following pages correspond to the kinetic-testing programme carried out on the three (3) samples of **composite-waste-bedrocks** (viz. GCA9682/83, GCA9685/86, and GCA9688/90) from the **Delta-Pit**.

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GRAEME CAMPBELL AND ASSOC 23-10-2011

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BRIDGE TOWN

WA

OUR REFERENCE 23061

XRD/PLM/SEM ANALYSES OF THREE WASTE ROCK SAMPLES .

R TOWNEND

Correspondence to Box 3129, Malaga D.C. WA 6945
ACN 069 920 476 ABN 92 076 109 663

RESULTS XRD/PLM/SEM

GCA	**9682**	**9685`**	**9688**
QUARTZ	DOMINANT	DOMINANT	DOMINANT
STILPNOMELANE	MINOR	MINOR	MINOR
K FELDSPAR	MINOR	MINOR	,MINOR
CHLORITE	ACCESSORY	ACCESSORY	ACCESSORY
SIDERITE	ACCESSORY	ACCESSORY	ACCESSORY
PYRITE	ACCESSORY	ACCESSORY	ACCESSORY

SIDERITE ANALYSES	WT%	MgO	CaO	MnO	FeO
9682		5	1	1.5	51.3
9685		<1	1.2	3.8	54
9688		4	0.9	0.6	55.1

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JOB INFORMATION

JOB CODE	143/1111022
No. of SAMPLES	3
CLIENT O/N	GCA 1112
PROJECT	Flinders -PIOP
STATE	Mine Waste
DATE RECEIVED	26/07/2011
DATE COMPLETED	16/08/2011

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 mine wastes. The samples were dried 80C crushed to a nominal -2mm. A split was taken and fine pulverised to a nominal -75um

Results of analysis on:

Element		S	S-SO4	C	TOC+C	C-CO3
Method		/CSA	S72/GR	/CSA	C71/CSA	/CALC
Detection		0.01	0.01	0.01	0.01	0.01
Units		%	%	%	%	%
Sample Name						
Control Blank		X	X	X	X	
GCA9682/83		1.88	0.3	2.55	0.75	1.8
GCA9682/83	check	1.9	0.3	2.55	0.72	1.83
GCA9685/86		2.18	0.22	3.78	0.63	3.14
GCA9688/90		1.27	0.08	2.28	0.34	1.94
MA-3a		0.98		2.64		
MA-1b		1.17		2.46		
CD-1		3.13		0.2		
SO4-S STD A			0.57			
SO4-S STD B			1.3			

Notes

1. Total-S and Total-C were determined on the pulps
2. Total-C and Total-S was determined using an induction furnace according to Genalysis method number MPL_W043. The samples are ignited in oxygen ~1700C and the CO2 and SO2 measured by infrared detectors
3. S-SO4 was determined on the pulps by precipitation of BaSO4 according to Genalysis method number ENV_W039, after digestion with Na2CO3
4. TOC+C (acid insoluble carbon compounds and elemental carbon) by a C&S analyser after removal of carbonates and soluble organic carbon using hot hydrochloric acid according to Genalysis method number MPL_W046.

Results of analysis on:

sample name		Fizz Rate	volume ml	HCl M	NaOH M	Colour Change	pH Drop	ANC soln pH	ANC (kgH2SO4/t)
GCA9682/83		0	20	0.539	0.512	N	2.8	1.4	35
GCA9682/83	check	0	20	0.539	0.512	N	2.8	1.4	34
GCA9685/86		0	20	0.539	0.512	N	2.7	1.7	65
GCA9688/90		0	20	0.539	0.512	N	2.9	1.4	64

Notes:

1. ANC was determined on 2g of the crushings **-**. Acid concentrations are as stated.
2. Colour change: Y indicates the appearance of a green colouration as the pH=7 endpoint was approached. N indicates no colour change. Two drops of 30 % hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron.
3. pH drop : Result reported when the pH drops to a value below 4 on addition of peroxide
4. This "Bulk-ANC" static-testing procedure is based on AMIRA (2002), according to Genalysis method number ENV_W035

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NATA Signatory: Ann Evers

Ann Evers

Date: 16/08/2011

This document is issued in accordance with
NATA accreditation requirements.

Laboratory Report

pH-(1:2) & EC-(1:2) TESTWORK

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (µS/cm)
GCA9682/83	30.0	60.0	3.7	1,400
GCA9685/86	30.0	60.0	4.8	1,500
GCA9688/90	30.0	60.0	5.9	1,100
GCA9688/90-1	30.0	60.0	5.9	1,100

Note: EC = Electrical-Conductivity.
Testwork performed on the as-supplied 'pulp' samples (nominal -75 µm).
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ratio of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 5 µS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

Dr GD Campbell
17th August 2011

Graeme Campbell & Associates Pty Ltd

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	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)		
GCA9682/83	3.0	Reaction peaked overnight	2.4	3.1	940	11.10	19
GCA9685/86	3.0	Reaction peaked overnight	2.5	4.2	890	10.60	18
GCA9688/90	3.0	Reaction peaked overnight	2.7	3.6	500	5.80	9.5
GCA9688/90-1	3.0	Reaction peaked overnight	2.7	3.5	640	5.80	9.5
BLANK1	3.0	Reaction peaked overnight	5.8	7.1	46	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997), and AMIRA (2002) for the 'Static-NAG-Test' in its "Single-Additon-Mode". 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. Following an overnight-reaction period, the test-mixtures were boiled for *c.* 2 hours. Then, after allowing the test-mixtures to cool, *c.* 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 (McElnea and Ahern 2004; O'Shay *et al.* 1990). K-Feldspar was employed for the Blank.

Dr GD Campbell
12th August 2011

ANALYTICAL REPORT

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

JOB INFORMATION

JOB CODE : 143.0/1111024
No. of SAMPLES : 3
No. of ELEMENTS : 32
CLIENT O/N : GCA1112 (Job 2 of 2)
SAMPLE SUBMISSION No. :
PROJECT : Flinders-PIOP
STATE : Ex-Pulp
DATE RECEIVED : 26/07/2011
DATE COMPLETED : 18/08/2011
DATE PRINTED : 16/09/2011
PRIMARY LABORATORY : Genalysis Main Laboratory

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
OV = Value over-range for Package

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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 $3.30 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 $100.00 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.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
DETECTION LIMIT	0.1	0.01	0.5	50	0.1	0.01	0.1	0.02	0.1	50
DIGEST	4A/	FP1/	4A/	FP1/	4A/	4A/	FP1/	4A/	4A/	FP1/
ANALYTICAL FINISH	MS	OE	MS	OE	MS	MS	OE	MS	MS	OE
SAMPLE NUMBERS										
0001 GCA9682/83	0.2	4.66	43.9	115	246.8	0.38	0.3	0.20	18.3	68
0002 GCA9685/86	0.2	3.98	39.7	111	227.0	0.31	0.5	0.21	23.5	169
0003 GCA9688/90	0.1	3.31	46.6	112	228.6	0.51	0.4	0.41	13.1	X
CHECKS										
0001 GCA9682/83	0.3	4.81	44.3	69	256.0	0.39	0.3	0.26	18.4	207
STANDARDS										
0001 CRM No. 782-1		0.03		71			18.5			X
0002 HgSTD-4										
0003 OREAS 45P	0.3		11.6		302.7	0.20		0.10	120.7	
0004 OREAS 97.01										
0005 STSD-2										
BLANKS										
0001 Control Blank	0.1	X	X	73	X	0.07	X	X	X	X
0002 Control Blank	X		X		X	X		X	X	
0003 Control Blank		X		X			X			68
0004 Control Blank										
0005 Control Blank										
0006 Acid Blank	X		X		X	X		X	X	
0007 Acid Blank		X		X			X			X

ANALYSIS

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	%	%	ppm	ppm	ppm	ppm
DETECTION LIMIT	1	50	0.01	0.01	0.05	0.01	1	0.1	20	1
DIGEST	4A/	FC7/	FP1/	HG1/	FP1/	FP1/	4A/	4A/	4A/	4A/
ANALYTICAL FINISH	OE	SIE	OE	CV	OE	OE	OE	MS	OE	OE
SAMPLE NUMBERS										
0001 GCA9682/83	44	329	14.52	0.17	5.71	0.66	3446	2.8	124	34
0002 GCA9685/86	50	581	20.04	0.17	5.38	1.12	6892	2.7	93	43
0003 GCA9688/90	26	357	19.22	0.23	4.46	1.02	1937	3.4	146	26
CHECKS										
0001 GCA9682/83	47	420	14.70	0.25	5.81	0.69	3428	2.7	102	37
STANDARDS										
0001 CRM No. 782-1			0.32		0.13	11.18				
0002 HgSTD-4				0.34						
0003 OREAS 45P	700						1234	2.1	838	348
0004 OREAS 97.01										
0005 STSD-2		1023								
BLANKS										
0001 Control Blank	2	X	0.01	X	0.05	X	1	X	X	X
0002 Control Blank	2						X	X	X	X
0003 Control Blank			0.01		X	X				
0004 Control Blank				X						
0005 Control Blank										
0006 Acid Blank	2						1	X	X	X
0007 Acid Blank			X		X	X				

ANALYSIS

ELEMENTS	P	Pb	S	Sb	Se	Sn	Sr	Th	Tl	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION LIMIT	50	0.5	50	0.05	0.01	0.1	0.05	0.01	0.02	0.01
DIGEST	4A/	4A/	4A/	4A/	SE1/	4A/	4A/	4A/	4A/	4A/
ANALYTICAL FINISH	OE	MS	OE	MS	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA9682/83	314	18.1	1.85%	3.29	1.29	1.4	13.07	8.07	0.70	2.77
0002 GCA9685/86	821	15.8	2.07%	3.56	1.08	1.4	8.21	6.39	0.75	2.41
0003 GCA9688/90	550	21.9	1.21%	2.59	0.62	1.8	8.94	8.32	1.97	2.59
CHECKS										
0001 GCA9682/83	316	18.4	1.81%	3.33	1.41	1.5	13.07	8.25	0.73	2.81
STANDARDS										
0001 CRM No. 782-1										
0002 HgSTD-4										
0003 OREAS 45P	379	20.0	303	0.84		2.8	33.28	9.26	0.23	2.16
0004 OREAS 97.01					0.63					
0005 STSD-2										
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										
0004 Control Blank										
0005 Control Blank					0.01					
0006 Acid Blank	X	X	X	X		X	X	X	X	X
0007 Acid Blank										

ANALYSIS

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION LIMIT	1	1
DIGEST	4A/	4A/
ANALYTICAL FINISH	OE	OE
SAMPLE NUMBERS		
0001 GCA9682/83	73	68
0002 GCA9685/86	69	127
0003 GCA9688/90	31	117
CHECKS		
0001 GCA9682/83	75	69
STANDARDS		
0001 CRM No. 782-1		
0002 HgSTD-4		
0003 OREAS 45P	250	126
0004 OREAS 97.01		
0005 STSD-2		
BLANKS		
0001 Control Blank	X	X
0002 Control Blank	X	X
0003 Control Blank		
0004 Control Blank		
0005 Control Blank		
0006 Acid Blank	X	X
0007 Acid Blank		

METHOD CODE DESCRIPTION

4A/MS Genalysis Main Laboratory

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

4A/OE Genalysis Main Laboratory

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

FC7/SIE Genalysis Main Laboratory

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

FP1/OE Genalysis Main Laboratory

Sodium peroxide fusion (Nickel crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Pl

HG1/CV Genalysis Main Laboratory

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

SE1/MS Genalysis Main Laboratory

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

Graeme Campbell & Associates Pty Ltd
Testing-Laboratory, Unit B, 15 Rose St. Bridgetown, WA 6255

KINETIC-TESTING WORKSHEET (WEATHERING-COLUMNS)

Job No: 1112

Client: Flinders-PIOP

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Column-Packing			
Wt Column-Only (kg)	0.32	0.32	0.32
Wt Column + Sample (kg)	1.82	1.82	1.82
Wt Sample (kg)	1.50	1.50	1.50

Pre-Rinse Cycle (Cycle-0)	**GCA9682/83**	**GCA9685/86**	**GCA9688/90**
Wt DW Added (kg)	3.00	6.00	4.38
Wt Leach. + Beaker (kg)	3.49	6.37	1.24
Wt Beaker (kg)	1.24	1.24	0.26
Wt Leachate (kg)	2.25	5.13	0.98
pH	3.1	4.4	7.9
EC (µS/cm)	4,500	2,400	2,000

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**1**	**1**	**1**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	27/6/11	27/6/11	27/6/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.05	2.01	2.01
Gravimetric-Water-Content (%, w/w)	**15.3**	**12.7**	**12.7**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.99	1.95	1.96
Gravimetric-Water-Content (%, w/w)	**11.3**	**8.7**	**9.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.92	1.89	1.91
Gravimetric-Water-Content (%, w/w)	**6.7**	**4.7**	**6.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.88	1.86	1.88
Gravimetric-Water-Content (%, w/w)	**4.0**	**2.7**	**4.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.13	2.08	2.10
Gravimetric-Water-Content (%, w/w)	**20.7**	**17.3**	**18.7**
Wt Leachate + Beaker (kg)	0.98	1.00	1.00
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.72	0.74	0.74
Leachate-pH	5.7	6.3	6.4
Leachate-EC (µS/cm)	1,900	1,300	840

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**2**	**2**	**2**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	4/7/11	4/7/11	4/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.07	2.02	2.05
Gravimetric-Water-Content (%, w/w)	**16.7**	**13.3**	**15.3**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	2.02	1.95	1.99
Gravimetric-Water-Content (%, w/w)	**13.3**	**8.7**	**11.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.96	1.89	1.93
Gravimetric-Water-Content (%, w/w)	**9.3**	**4.7**	**7.3**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.90	1.85	1.88
Gravimetric-Water-Content (%, w/w)	**5.3**	**2.0**	**4.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.13	2.08	2.10
Gravimetric-Water-Content (%, w/w)	**20.7**	**17.3**	**18.7**
Wt Leachate + Beaker (kg)	0.99	0.99	1.00
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.73	0.73	0.74
Leachate-pH	5.8	6.3	6.3
Leachate-EC (µS/cm)	1,500	1,300	800

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**3**	**3**	**3**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	11/7/11	11/7/11	11/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.07	2.01	2.05
Gravimetric-Water-Content (%, w/w)	**16.7**	**12.7**	**15.3**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	2.00	1.94	1.99
Gravimetric-Water-Content (%, w/w)	**12.0**	**8.0**	**11.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.94	1.87	1.94
Gravimetric-Water-Content (%, w/w)	**8.0**	**3.3**	**8.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.88	1.84	1.88
Gravimetric-Water-Content (%, w/w)	**4.0**	**1.3**	**4.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.12	2.07	2.09
Gravimetric-Water-Content (%, w/w)	**20.0**	**16.7**	**18.0**
Wt Leachate + Beaker (kg)	0.99	1.01	0.98
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.73	0.75	0.72
Leachate-pH	5.7	6.2	6.4
Leachate-EC (µS/cm)	1,400	1,400	900

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**4**	**4**	**4**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	18/7/11	18/7/11	18/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.06	2.02	2.03
Gravimetric-Water-Content (%, w/w)	**16.0**	**13.3**	**14.0**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.98	1.97	1.98
Gravimetric-Water-Content (%, w/w)	**10.7**	**10.0**	**10.7**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.92	1.92	1.93
Gravimetric-Water-Content (%, w/w)	**6.7**	**6.7**	**7.3**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.87	1.87	1.88
Gravimetric-Water-Content (%, w/w)	**3.3**	**3.3**	**4.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.13	2.07	2.09
Gravimetric-Water-Content (%, w/w)	**20.7**	**16.7**	**18.0**
Wt Leachate + Beaker (kg)	0.97	1.02	1.01
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.71	0.76	0.75
Leachate-pH	5.7	6.2	6.6
Leachate-EC (µS/cm)	880	770	580

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**5**	**5**	**5**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	25/7/11	25/7/11	25/7/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.08	2.02	2.03
Gravimetric-Water-Content (%, w/w)	**17.3**	**13.3**	**14.0**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	2.03	1.96	1.96
Gravimetric-Water-Content (%, w/w)	**14.0**	**9.3**	**9.3**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.97	1.90	1.88
Gravimetric-Water-Content (%, w/w)	**10.0**	**5.3**	**4.0**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.91	1.85	1.85
Gravimetric-Water-Content (%, w/w)	**6.0**	**2.0**	**2.0**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.13	2.06	2.09
Gravimetric-Water-Content (%, w/w)	**20.7**	**16.0**	**18.0**
Wt Leachate + Beaker (kg)	1.01	1.01	0.99
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.75	0.75	0.73
Leachate-pH	5.7	6.0	6.2
Leachate-EC (µS/cm)	920	880	750

	GCA9682/83	**GCA9685/86**	**GCA9688/90**
Weathering-Cycles			
Cycle No.	**6**	**6**	**6**
DAY-1 (i.e. Start-of-Day-1) [Monday]			
Lamps-On: Date	1/08/11	1/08/11	1/08/11
Lamps-On: Time	17:00	17:00	17:00
DAY-2 [Tuesday]			
Time	09:00	09:00	09:00
Wt Column (kg)	2.04	2.00	2.00
Gravimetric-Water-Content (%, w/w)	**14.7**	**12.0**	**12.0**
DAY-3 [Wednesday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.96	1.93	1.91
Gravimetric-Water-Content (%, w/w)	**9.3**	**7.3**	**6.0**
DAY-4 [Thursday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.89	1.88	1.87
Gravimetric-Water-Content (%, w/w)	**4.7**	**4.0**	**3.3**
DAY-5 [Friday]			
Time	09:00	09:00	09:00
Wt Drying-Column (kg)	1.83	1.83	1.84
Gravimetric-Water-Content (%, w/w)	**0.7**	**0.7**	**1.3**
Wt Deionised-Water Added (kg)	1.00	1.00	1.00
(Lamps remain off)			
DAY-7 (i.e. End-of-Day-7)			
Wt Drained-Column(kg)	2.11	2.05	2.08
Gravimetric-Water-Content (%, w/w)	**19.3**	**15.3**	**17.3**
Wt Leachate + Beaker (kg)	0.95	1.00	0.97
Wt Beaker (kg)	0.26	0.26	0.26
Wt Leachate (kg)	0.69	0.74	0.71
Leachate-pH	5.5	5.9	6.2
Leachate-EC (µS/cm)	990	900	700

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JOB INFORMATION

JOB CODE	143/1112030
No. of SAMPLES	36
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	10/08/2011
DATE COMPLETED	31/08/2011

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

A series of column leachates were received.

The pH, EC and Cl of each "raw" sample was measured using Genalysis method codes: ENV-W001, ENV-W002, and ENV_W013
The acidity of requested samples was measured by titration to pH=8.3(Acidy) using sodium hydroxide and expressed as mgH2SO4/L. APHA method code 2310B

APHA code refers to "Standard methods for the examination of water and wastewater", 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite (including S) by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004).

Results of analysis on:

Element		Acidy	Cl	EC	pH
Method		/VOL	/COL	/MTR	/MTR
Detection		1	2	10	0.1
Units		mgH2SO4/L	mg/l	uS/cm	NONE
Sample Name					
Control Blank			X		
9682/83-0 Raw		427	6	3160	3.0
9682/83-0 Raw	check	418	7	3160	3.0
9682/83-1 Raw		14	35	1282	6.4
9682/83-2 Raw		13	44	945	6.3
9682/83-3 Raw		9	64	961	5.1
9682/83-4 Raw		8	66	883	4.7
9682/83-5 Raw		7	48	906	5.0
9685/86-0 Raw		31	5	1658	4.6
9685/86-1 Raw		5	64	852	5.6
9685/86-2 Raw		8	83	882	4.3
9685/86-3 Raw		11	93	936	4.2
9685/86-4 Raw		10	35	780	6.4
9685/86-5 Raw		6	26	860	6.0
9688/90-0 Raw		9	8	1349	7.9
9688/90-1 Raw		8	42	603	7.4
9688/90-2 Raw		9	20	565	7.7
9688/90-3 Raw		7	8	610	7.4
9688/90-4 Raw		8	X	606	7.4
9688/90-5 Raw		6	2	748	7.4
N191			96		

Element		Al	As	Ca	Cu	Fe-Sol	K
Method		/OE	/MS	/OE	/OE	/OE	/OE
Detection		0.01	0.1	0.01	0.01	0.01	0.1
Units		mg/l	ug/l	mg/l	mg/l	mg/l	mg/l
Sample Name							
Control Blank		X	X	X	X	X	X
9682/83-0 HNO3		21.77	4.2	157.3	0.33	99.54	71.7
9682/83-1 HNO3		0.11	0.9	47.58	X	0.46	18.9
9682/83-2 HNO3		0.03	0.5	34.35	X	0.1	13.8
9682/83-2 HNO3	check	0.03	0.6	35.11	X	0.09	14.2
9682/83-3 HNO3		0.11	0.9	32.88	X	0.11	14.4
9682/83-4 HNO3		0.08	1	30.45	X	0.05	13.5
9682/83-5 HNO3		0.01	1.1	30.26	X	0.02	13.1
9685/86-0 HNO3		2.89	0.9	99.94	0.06	1.82	58.4
9685/86-1 HNO3		0.08	0.5	38.83	X	X	5.2
9685/86-2 HNO3		0.02	0.5	37.11	X	0.04	4.8
9685/86-3 HNO3		0.06	0.6	41.39	X	X	5.9
9685/86-4 HNO3		0.02	0.5	36.57	X	X	6.3
9685/86-5 HNO3		0.06	0.3	38.96	X	X	6.9
9688/90-0 HNO3		0.01	1.2	84.77	X	0.03	95.9
9688/90-1 HNO3		X	0.7	41.97	X	X	13.6
9688/90-2 HNO3		0.02	0.5	38.87	X	X	13.6
9688/90-3 HNO3		0.02	0.8	43.1	X	X	17.2
9688/90-4 HNO3		X	0.7	42.52	X	0.01	19
9688/90-5 HNO3		X	0.6	52.45	X	X	26.7
Alcoa17-MS			26				
Alcoa11-OES		1.94		47.27	0.51	2.02	3.7

Element		Mg	Mn	Na	S	Si	Zn
Method		/OE	/OE	/OE	/OE	/OE	/OE
Detection		0.01	0.01	0.1	0.1	0.05	0.01
Units		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Sample Name							
Control Blank		X	X	X	0.2	X	X
9682/83-0 HNO3		264.13	146.96	2.3	742.8	14.62	1.33
9682/83-1 HNO3		131.82	56.69	1.1	267	2.39	0.05
9682/83-2 HNO3		91.16	38.32	0.7	200.6	1.9	0.03
9682/83-2 HNO3	check	92.76	39.11	0.7	192.6	1.93	0.03
9682/83-3 HNO3		90.39	33.72	0.6	200.1	2.1	0.02
9682/83-4 HNO3		83.56	31.37	0.5	188.8	1.93	0.02
9682/83-5 HNO3		84.18	31.18	0.4	177.5	1.97	0.02
9685/86-0 HNO3		135.11	77.61	1.2	349.6	4.15	0.54
9685/86-1 HNO3		83.36	16.89	0.3	182.5	0.44	0.02
9685/86-2 HNO3		84.37	16.7	0.3	180.7	0.43	0.02
9685/86-3 HNO3		90.43	17.99	0.4	225.8	0.46	0.03
9685/86-4 HNO3		69.36	21.81	0.4	159	0.46	0.02
9685/86-5 HNO3		78.87	25.82	0.4	171.3	0.46	0.02
9688/90-0 HNO3		95.4	10.54	4.2	222.4	6.38	0.09
9688/90-1 HNO3		42.63	1.87	0.8	114.9	2.84	0.06
9688/90-2 HNO3		38.92	2.34	0.7	95.9	2.83	0.02
9688/90-3 HNO3		40.29	3.29	1	100.2	3.22	0.01
9688/90-4 HNO3		37.88	4.07	1.1	92.7	3.14	0.02
9688/90-5 HNO3		45.75	6.5	1.4	117.1	3.58	0.02
Alcoa17-MS							
Alcoa11-OES		47.05	0.54	232.3	17.4	18.57	0.5

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NATA Signatory: Ann Evers

Ann Evers

Date: 31/08//2011

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JOB INFORMATION

JOB CODE	143/1113001
No. of SAMPLES	6
CLIENT O/N	GCA 1112
PROJECT	Flinders PIOP
STATE	Column leachates
DATE RECEIVED	31/08/2011
DATE COMPLETED	23/09/2011

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

A series of column leachates were received
The pH, EC and Cl of the ñrawòsamples was measured Genalysis method codes ENV-W001, ENV-W002 and ENV_W013. The acidity to pH 8.3 was also measured using APHA method code 2310B
APHA code refers to “Standard methods for the examination of water and wastewater”, 21st Edition 2005

The HNO3 dosed filtered solution was analysed for the requested element suite by ICPMS and /or ICPOES: Genalysis method codes (ICP_W003, ICP_W004)

Results of analysis on:

Element		Acidy	Cl	EC	pH
Method		/VOL	/COL	/MTR	/MTR
Detection		1	2	10	0.1
Units		mgH2SO4/L	mg/l	uS/cm	NONE
Sample Name					
Control Blank			X		
9682/83-6 Raw		6	3	1011	4.9
9682/83-6 Raw	check	6	2	1009	5.2
9685/86-6 Raw		9	X	914	7.1
9688/90-6 Raw		5	X	700	7.7
N191			97		

Element	Al	As	Ca	Cu	Fe-Sol	K
Method	/OE	/MS	/OE	/OE	/OE	/OE
Detection	0.01	0.1	0.01	0.01	0.01	0.1
Units	mg/l	ug/l	mg/l	mg/l	mg/l	mg/l
Sample Name						
Control Blank	X	x	X	X	X	X
9682/83-6 HNO3	X	0.8	32.68	X	0.02	13.2
9685/86-6 HNO3	X	0.4	43.2	X	X	8.1
9688/90-6 HNO3	X	0.5	48.81	X	X	28.8
Alcoa11-OES	1.94	255.4	48.86	0.52	2.03	3.9
AlcoaHi3-OES	47.17		974.62	2.61	93.61	473.4

Element	Mg	Mn	Na	S	Si	Zn
Method	/OE	/OE	/OE	/OE	/OE	/OE
Detection	0.01	0.01	0.1	0.1	0.05	0.01
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Sample Name						
Control Blank	X	X	X	X	X	X
9682/83-6 HNO3	96.51	30.78	0.4	192.2	1.74	0.01
9685/86-6 HNO3	75.84	37.8	0.3	163.3	0.38	0.02
9688/90-6 HNO3	41	8.26	1.3	108.8	3.52	0.02
Alcoa11-OES	47.78	0.49	241.6	16.5	18.61	0.5
AlcoaHi3-OES	196.15	19.27	1993	259.2	105.65	20.05

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