KALMET RESOURCES NL

MAUD CREEK GOLD PROJECT

GEOCHEMICAL CHARACTERISATION OF WASTE-ROCK AND ORE SAMPLES

Implications for Mine-Waste Management

GRAEME CAMPBELL AND ASSOCIATES PTY LTD
(ACN 061 827674)
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TABLE OF CONTENTS

TABLES, FIGURES & APPENDICES
(At Back of Report Text)

TABLES

TABLES (Cont'd)

FIGURES

APPENDICES

1.0 INTRODUCTION

Kalmet Resources NL (Kalmet) is developing the Maud Creek Gold Project located approximately 50 kms to the south-east of Katherine, Northern Territory.

Ore will be mined from an open pit, and the excavated waste rock placed on waste dumps for on-site containment. Low-grade ore will be stockpiled, and may ultimately be treated in the mill.

Graeme Campbell & Associates Pty Ltd (GCA) was commissioned to geochemically characterise samples of waste-rock and ore materials derived from the Weathered-Zone and Fresh-Zone of the Maud Creek Deposit.[1]

The main aim of the geochemical study is to identify material types that:

- Have the potential to produce Acid-Rock Drainage (ARD) through the oxidation of sulphide minerals.
- Are enriched in elements of potential concern to water quality and revegetation.

The testwork programme focused on the acid-base chemistry, salinity and multi-element composition of a range of waste-rock and ore samples.

The results of the testwork programme are presented and discussed in this report, and important implications for the management of mine-waste materials are highlighted.

[1] In addition to samples of Low-Grade Ore, samples of High-Grade Ore were included in the testwork programme. Also, samples of the surface-soil materials from the general area proposed for waste-rock containment were tested.

2.0 TESTWORK PROGRAMME

2.1 Samples

Thirty-three (33) samples of waste rock, eleven (11) samples of ore, and two (2) samples of soil were provided for testing.

The waste-rock and ore samples were in the form of RC cuttings, and were stored in calico bags.[2]

Sample details are summarised in Table 2.1 and Appendix A. The samples were collected from several drillholes to characterise lateral and down-dip variations in the geochemistry of waste rock from the proposed open pit.

The tested samples represent the major types of waste-rock and ore materials in the Weathered-Zone and Fresh-Zone of the Maud Creek Deposit, viz.

- Waste-Rock Materials
  - Hangingwall Mafic Tuff.
  - Footwall Sediments.[3]
- Ore Materials
  - Stockwork Quartz (Tuff and Sediment Hosted).
  - Massive Quartz (Tuff and Sediment Hosted).

Provisional estimates indicate that the total volume of waste rock to be produced from the open pit will comprise approximately 55 % and 25 % of Hangingwall Mafic Tuff from the Fresh-Zone and Weathered-Zone, respectively. The Footwall Sediments from the Fresh-Zone and

[2] Almost all samples comprised powdery materials. Some samples also contained minor amounts of gravel-size, rock-fragments.

[3] The Footwall Sediments comprise Sandstones and Undifferentiated Sediments (Appendix A).

Weathered-Zone will comprise approximately 15 % and 5 %, respectively, of the total volume of waste rock.[4]

A characteristic feature of the geology of the Maud Creek Deposit is the widespread occurrence of carbonates in the Wall-Waste Zone, associated with the carbonate alteration (both pervasive and veined styles) of the orebody (Appendix A).[5] Calcite is the predominant carbonate in the waste rock from the Weathered-Zone.[6]

The dominant sulphide in the Wall-Waste Zone is pyrite, and occurs as both disseminations of fine-to-coarse forms, and fine veinlets.[7] The sulphides typically comprise less than 1-3 % by volume.

The geology of the Maud Creek Deposit is such that the waste rock from the Wall-Waste Zone typically contains a low content of pyrite, and a high content of carbonates (either calcite or dolomite).

The Weathered-Zone of the Maud Creek Deposit comprises mostly competent waste-rock materials, so that these materials, together with the waste rock from the Fresh-Zone, will report to the waste dumps as chunky rock. Friable waste-rock materials are generally restricted to a thin band of 2-3 m at the top of the geologic profile.

2.2 Testwork

Prior to preparation and testing, all samples were assigned GCA Sample Numbers, and relevant details recorded in the GCA Sample Register.

The waste-rock samples were prepared by crushing (nominal 2 mm) and pulverising (nominal 75 μm) for specific tests.

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[4] It should be noted that these estimated proportions of the different waste-rock types are **indicative only**, and will likely be refined in light of the evolving mine plan and pit design for the Maud Creek Gold Project.

[5] The Ore-Zone itself is generally characterised by a low content of carbonates (Appendix A).

[6] The suite of carbonate minerals prevailing in the Fresh-Zone is not known with certainty. Dolomite may be the dominant carbonate.

[7] In the waste rock close to the Ore-Zone, arsenopyrite may be co-dominant with pyrite.

The testwork methods employed in this study are based on recognised procedures for the geochemical characterisation of mine wastes and soils (e.g. Smith 1992; Coastech Research 1991; BC AMD Task Force 1989). In-house research work by GCA is also refining testing methods for determining the acid-forming and acid-consuming characteristics of mine-waste materials.

Part of the testwork programme, and all analytical work, was carried out by Australian Environmental Laboratories (Welshpool), and Genalysis (Maddington) under direction from Dr. Graeme Campbell. The analyses undertaken by these laboratories have NATA endorsement.[8]

Part of the testwork programme was carried out by Dr. Graeme Campbell in the GCA Testing Laboratory (Bridgetown).

The testwork results obtained for the soil samples are presented in Appendix B, and copies of the laboratory reports for all testing are presented in Appendix C.

2.2.1 Acid-Base Chemistry Testwork

The waste-rock, ore and soil samples were tested for:

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

The pH and EC values of the samples were determined on slurries prepared using deionised water, and a solid:water ratio of approximately 1:2 (w/w).

[8] NATA = National Association of Testing Authorities.

Total-S was determined by Leco combustion, and SO_4-S was determined by an extraction method employing Na_2CO_3.

The ANC was measured by the addition of hydrochloric acid to the samples, allowing the samples time to react (with heating), and back-titration with NaOH to determine the amount of acid consumed. This is the 'standard' method for the determination of the 'Total' ANC of mine-waste samples (BC AMD Task Force, 1989), and exposes the samples to strongly-acidic (viz. pH 1-2) conditions.[9]

The NAPP values of the samples were calculated from the Total-S, SO_4-S and ANC values. The NAPP values were calculated assuming that all of the non-sulphate-sulphur occurs in the form of pyrite.[10]

The NAG Test is a direct measure of a mine-waste sample's potential to produce acid through sulphide oxidation, and also provides an indication of the reactivity of the sulphides, and the acid-neutralising materials (Miller et al. 1994). In this test, the sample is reacted with H_2O_2 to rapidly oxidise contained sulphides, and allow the produced acid to react with the acid-neutralising materials.

2.2.2 Multi-Element Analyses

The total concentration of a wide range of major and minor elements in the waste-rock, ore and soil samples was determined through the use of various digestion and analytical techniques.

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[9] Acid consumption by selected samples was also determined by a method based on the BC Research Initial Test (Coastech Research, 1991). In this test, the sample is reacted with H_2SO_4 under ambient conditions, and the pH is maintained above pH 3 over the course of a few days. This Modified-ANC Test is much less aggressive than the 'standard 'ANC Test, and so provides a better measure of acid-neutralisation within the disposal environment (e.g. waste dump).

The Modified-ANC Tests (and NAG Tests) were carried out by Dr. Graeme Campbell in the GCA Testing Laboratory.

[10] Although arsenopyrite occurs in addition to pyrite in the waste-rock materials of the Maud Creek Deposit, the stoichiometry of its oxidation is complex (e.g. Iglesias and Carranza 1994). Accordingly, in this study, the reaction stoichiometry for the complete oxidation of pyrite is assumed in calculating the loads of acid (viz. H_2SO_4) which may potentially be produced through sulphide oxidation.

Element enrichments were identified using the *Geochemical-Abundance Index (GAI)* which quantifies an assay result for a particular element in terms of the average crustal abundance of that element.[11]

The Geochemical Abundance Index (based on a log 2 scale) is expressed in 7 integer increments (viz. 0 to 6). A value of 0 indicates that the element is present at a concentration less than, or similar to, the average crustal abundance; a value of 3 corresponds to a 12-fold enrichment above the average crustal abundance; and so forth, up to a value of 6 which corresponds to a 96-fold, or greater, enrichment above average crustal abundances.

[11] The average crustal abundances of the elements for the calculations of the Geochemical-Abundance Index are based on the values listed in Bowen (1979) for unmineralised soils and rocks.

3.0 GEOCHEMISTRY OF WASTE-ROCK SAMPLES

The testwork results on the acid-base chemistry, salinity and multi-element composition of the waste-rock samples are presented in Tables 3.1-3.3, and shown Figure 1. These results are discussed in the following sections.

3.1 Acid-Base Chemistry and Salinity

3.1.1 Inherent pH and Salinity

The waste-rock samples from the Weathered-Zone had pH values within the range 8.4-9.2, and EC values within the range 0.038-0.32 mS/cm (Table 3.1).

The waste-rock samples from the Fresh-Zone had pH values within the range 7.6-9.5, and EC values within the range 0.13-1.8 mS/cm (Table 3.1). Most samples had EC values less than 0.5 mS/cm (Table 3.1).

The mildly-alkaline pH values of the samples from both the Weathered-Zone and Fresh-Zone reflect buffering by carbonates, and hydrolysis of ferromagnesian silicates.

The EC values indicate that the waste-rock samples from the Weathered-Zone have a low content of soluble salts.[12] This reflects the heavily-leached state of the rock materials in the Weathered-Zone. The EC values indicate that the samples from the Fresh-Zone also have a low content of soluble salts. Two samples (viz. GCA1519 and GCA1637) of the Footwall Sediments from the Fresh-Zone had moderate-to-high contents of soluble salts, as indicated by EC values of 1.0-1.8 mS/cm (Table 3.1).[13]

The testwork results indicate that the waste-rock samples from the Weathered-Zone and Fresh-Zone were all mildly alkaline, and typically had low contents of soluble salts. Two samples of the Footwall Sediments from the Fresh-Zone had moderate-to-high contents of soluble salts.

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[12] Calculations indicate that the content of salts in the waste-rock samples from the Weathered-Zone is less than 0.05 % (w/w).

[13] Calculations indicate that samples GCA1519 and GCA1637 have soluble-salt contents of 0.15-22 % (w/w). These samples also have Total-S values of 2.1-3.3 % (Table 3.1), so that their soluble salts may be dominated by sulphates.

3.1.2 Sulphur Concentrations

The waste-rock samples from the Weathered-Zone had Total-S values ranging from less than 0.01 % (detection limit), to 0.11 % (Table 3.1).

The waste-rock samples from the Fresh-Zone had Total-S values ranging from less than 0.01 %, to 3.2 % (Table 3.1). The Total-S in the samples tested for SO_4-S was dominated by sulphide-S.

The Total-S values indicate a negligible concentration of sulphide minerals in the waste-rock samples from the Weathered-Zone. The samples of the Hangingwall Mafic Tuff from the Fresh-Zone also had low Total-S values of 0.03-0.33 % (Table 3.1). Four (4) samples of the Footwall Sediments from the Fresh-Zone had Total-S values of 0.71-3.2 % (Table 3.1), so that these samples contained minor-to-moderate amounts of sulphides.

The testwork results indicate that the waste-rock samples from the Weathered-Zone were deficient in sulphide minerals, as expected. The samples of the Hangingwall Mafic Tuff from the Fresh-Zone were also deficient in sulphides.

Certain samples of the Footwall Sediments from the Fresh-Zone contained minor-to-moderate amounts of sulphide minerals.[14]

3.1.3 Acid-Neutralisation Capacity

The waste-rock samples from the Weathered-Zone had ANC values within the range 1.9-490 kg H_2SO_4/ tonne, whereas the samples from the Fresh-Zone had ANC values within the range 32-540 kg H_2SO_4/tonne (Table 3.1).

Samples of Hangingwall Mafic Tuff

As a group, the samples of the Hangingwall Mafic Tuff had the highest ANC values (viz. 23-490 kg H_2SO_4/tonne for the samples from the Weathered-Zone, and 380-540 kg H_2SO_4/tonne for the samples from the Fresh-Zone, Table 3.1). Furthermore, consumption of acid by reactive carbonates (e.g. calcite) contributed to the ANC of the samples, as inferred

[14] Pyrite is expected to be the main sulphide minerals in these rock samples.

by the vigorous effervescence (viz. 'fizzing') produced upon addition of HCl in the ANC Tests.

Selected samples of the Hangingwall Mafic Tuff were titrated with dilute H_2SO_4 to determine 'readily-available' alkalinity forms via the Modified-ANC Test. The samples from the Weathered-Zone and Fresh-Zone had concentrations of 'readily-available' alkalinity forms ranging up to 50 kg H_2SO_4/tonne, and 20 kg H_2SO_4/tonne, respectively (Figure 1). These results indicate that, upon reaction with acid, the waste-rock samples contain a good supply of alkalinity forms capable of buffering near pH 7. The lower concentration of 'readily-available' forms of alkalinity in the samples from the Fresh-Zone likely reflects the reduced content of calcite in the Hangingwall Mafic Tuff from this Zone.[15]

Samples of Footwall Sediments

As a group, the samples of the Footwall Sediments had the lowest ANC values (viz. 1.9-6.7 kg H_2SO_4/tonne for the samples from the Weathered-Zone, and 32-53 kg H_2SO_4/tonne for the samples from the Fresh-Zone, Table 3.1). Consumption of acid by reactive carbonates (e.g. calcite) contributed to the ANC of the samples from the Fresh-Zone, as inferred by the moderate effervescence (viz. 'fizzing') produced upon addition of HCl in the ANC Tests.

One sample of the Footwall Sandstone from the Fresh-Zone was tested for 'readily-available' alkalinity forms. The concentration of 'readily-available' alkalinity forms in this sample was approximately 5 kg H_2SO_4/tonne (Figure 1).

The testwork results indicate that the samples of the Hangingwall Mafic Tuff from the Weathered-Zone and Fresh-Zone had a very-high capacity to consume acid, due to an abundance of carbonates. Furthermore, the samples of this rock type from the Weathered-Zone had a good supply of 'readily-available' alkalinity forms, due to the occurrence of calcite.

The samples of the Footwall Sandstone from the Fresh-Zone had a moderate-to-high capacity to consume acid, whereas the samples of this rock type from the Weathered-Zone had a low capacity to consume acid.

[15] The dissolution of calcite under mildly-acidic conditions is much faster than that for other carbonates (e.g. dolomite, magnesite) [Wollast 1990].

3.1.4 Net-Acid-Producing Potential

The waste-rock samples from the Weathered-Zone had NAPP values that ranged from -420 kg H_2SO_4/tonne, to -1.6 kg H_2SO_4/tonne (Table 3.1).

The waste-rock samples from the Fresh-Zone had NAPP values that ranged from -540 kg H_2SO_4/tonne, to 52 kg H_2SO_4/tonne (Table 3.1). All waste-rock samples from the Fresh-Zone (except for two samples of the Footwall Sediments) had negative NAPP values (Table 3.1).

The negative NAPP values mean that the samples contain an excess of alkalinity forms, compared with the loads of acid that could theoretically be produced through the oxidation of contained pyrite and other sulphides.

The NAPP calculations indicate that the samples of the Hangingwall Mafic Tuff from the Weathered-Zone and Fresh-Zone are all classified as Non-Acid Forming (NAF).

The NAF classification also applies to essentially all samples of the Footwall Sandstone from the Weathered-Zone and Fresh-Zone.

Two (2) High-S samples (viz. GCA1519, Total-S = 2.1 %; and GCA1637, Total-S = 3.2 %) of the Footwall Sediments from the Fresh-Zone are classified as Potentially-Acid Forming (PAF). In terms of the loads of acid which could potentially be produced through sulphide oxidation, these samples may be further classified as PAF[Low-Capacity] and PAF[Moderate-Capacity], respectively.

3.1.5 Net-Acid Generation

The waste-rock samples with Total-S values greater than 0.5 % (viz. GCA1519, GCA1526, GCA1533, GCA1634, GCA1637 and GCA1639) were tested for Net-Acid Generation (NAG).[16]

These samples produced NAG-pH values of 2.5-9.4, and NAG values that ranged from less than the detection limit of 0.5 kg H_2SO_4/tonne, to 36 kg H_2SO_4/tonne (Table 3.1). The NAG-pH values were typically alkaline, and the NAG values typically less than 0.5 kg H_2SO_4/tonne.

[16] Of the samples tested for NAG, five (5) sample were Footwall Sediments and one (1) sample was a Hangingwall Mafic Tuff, all from the Fresh-Zone.

Sample GCA1637 had a NAG-pH value of 2.5, and a NAG value of 36 kg H_2SO_4/tonne (Table 3.1). The NAG value of this sample was similar to the corresponding NAPP value of 52 kg H_2SO_4/tonne (Table 3.1).

Despite having a positive NAPP value of 17 kg H_2SO_4/tonne, sample GCA1519 did not acidify under the strongly-oxidising conditions of the NAG Test. The reason for this discrepancy between the NAPP calculation and NAG measurement is not known with certainty.[17]

3.2 Multi-Element Composition

The multi-element composition of selected waste-rock samples is indicated by the data presented in Table 3.2. Element enrichments in the samples are indicated by the calculated values of the Geochemical-Abundance Index [GAI] (Table 3.3).[18]

The waste-rock samples had concentrations of most elements which were below, or close to, those typically recorded for unmineralised soils and rocks (Tables 3.1 and 3.2).[19]

Samples of Hangingwall Mafic Tuff

The two (2) samples of the Hangingwall Mafic Tuff from the Weathered-Zone were both significantly enriched in As and Sb, and slightly enriched in Cr and Ni. The two (2) samples of this rock type from the Fresh-Zone were both significantly enriched in Sb; one (1) sample was also significantly enriched in As.

The As and Sb may occur as reduced forms associated with sulphide minerals in the rock samples, and/or as oxyanion forms (e.g. arsenate and

[17] It is possible that the oxidation of trace amounts of arsenopyrite in the sample may have protected the pyrite grains through surface 'armouring' by complex iron-arsenate-hydroxide phases.

[18] The Geochemical Abundance Index (GAI) is defined in Section 2.2.2. The samples of the surface-soil materials from the general area proposed for waste-rock containment had concentrations of major and minor elements less than, or close to, those typically recorded for unmineralised soils and rocks (Appendix B). Accordingly, the GAI calculations performed for the waste-rock samples (and ore samples, Section 4.2) are based on the average crustal abundances of the elements, as documented by Bowen (1979).

[19] Several samples were enriched in C, associated with the carbonate minerals in the samples. Elemental-C may also occur in some samples, due to trace amounts of graphitic materials.

antimonate) sorbed to the surfaces of oxide and silicates.[20] The Cr and Ni reflect the mafic origin of the rock samples, and likely reside mostly within the cation sub-lattice of ferromagnesian silicates.

Samples of Footwall Sediments

The two (2) samples of the Footwall Sediments from the Weathered-Zone were significantly enriched in As and Sb, and slightly enriched in B. One (1) sample was also slightly enriched in Ag. The two (2) samples of this rock type from the Fresh-Zone were both significantly enriched in As and Sb, and slightly enriched in B. One (1) sample was also significantly enriched in Ag and Sn.

The As and Sb likely occur in forms similar to those described above for the samples of the Hangingwall Mafic Tuff. The Ag and Sn in the samples of the Footwall Sediments should occur mainly as reduced forms associated with sulphides. The B may occur as sorbed, and/or lattice-incorporated forms.

The analysis results indicate that, environmentally, the assayed waste-rock samples from both the Weathered-Zone and Fresh-Zone are relatively 'clean', with concentrations of most elements below, or close to, those typically recorded for unmineralised soils and rocks.

However, the analysis results indicate that the Hangingwall Mafic Tuff and Footwall Sediments from both the Weathered-Zone and Fresh-Zone may be enriched in As and Sb. The solubility behaviour of these elements is complex; As and Sb may exhibit moderate solubility under neutral-to-alkaline conditions.[21]

[20] Sorption reactions comprise both adsorption and precipitation processes (Sposito 1984).

[21] Kinetic testing would be needed to provide information on the solubility of As and Sb under weathering conditions (viz. wetting-drying cycles) which simulate those experienced by disposed waste rock. There is only limited information available in the scientific literature on the solubility behaviour and mobility of Sb in soils and natural waters (Edwards et al. 1990).

4.0 GEOCHEMISTRY OF ORE SAMPLES

The testwork results on the acid-base chemistry, salinity and multi-element composition of the ore samples are presented in Tables 4.1-4.3, and shown on Figure 2. These results are discussed in the following sections.

Note: It should be noted that the testwork results obtained for the samples of High-Grade Ore (viz. GCA1501, GCA1525 and GCA1531) relate to the geochemical character of the tailings-solids to be produced from the treatment of Oxide Ore, Transition Ore and Primary Ore, and are not discussed in detail in this report.[22]

4.1 Acid-Base Chemistry and Salinity

The ore samples from the Weathered-Zone had pH values within the range 6.0-9.1, and EC values within the range 0.034-0.28 mS/cm. The ore samples from the Fresh-Zone had pH values within the range 8.4-9.1, and EC values within the range 0.17-0.49 mS/cm (Table 4.1).

The testwork results indicate that the samples of Low-Grade Ore were neutral-to-alkaline, with a low-to-moderate content of soluble salts.

The samples of Low-Grade Ore from the Weathered-Zone had Total-S values less than 0.01 % (detection limit), whereas the samples from the Fresh-Zone had Total-S values within the range 0.38-1.5 % (Table 4.1). The Total-S in the samples tested for SO_4-S was dominated by sulphide-S.

The ore samples from the Weathered-Zone had ANC values that ranged from less than 0.5 kg H_2SO_4/tonne (detection limit), to 25 kg H_2SO_4/tonne (Table 4.1). The ore samples from the Fresh-Zone had ANC values within the range 47-380 kg H_2SO_4/tonne (Table 4.1).

Reactive carbonates (e.g. calcite) contributed to acid consumption by the ore samples from the Fresh-Zone, as inferred by the moderate-to-vigorous

[22] Testwork is in hand on samples of tailings-slurries derived from bench-scale and pilot-scale, metallurgical trials carried out for the Maud Creek Gold Project. The geochemical characteristics of the tailings-slurry samples will be presented and discussed in a separate GCA report.

effervescence (viz. 'fizzing') produced upon addition of HCl in the ANC Tests.[23]

The NAPP calculations indicate that the samples of Low-Grade Ore from both the Weathered-Zone and Fresh-Zone are classified as Non-Acid Forming (NAF).[24]

The results of the NAG testwork were consistent with the above NAPP-based, NAF classification (Table 4.1). The samples of Low-Grade Ore did not acidify when subjected to the strongly-oxidising conditions of the NAG Test.

4.2 Multi-Element Composition

The multi-element composition of selected ore samples is indicated by the data presented in Table 4.2. Element enrichments in the samples are indicated by the calculated GAI values (Table 4.3).

The ore samples had concentrations of most elements which were below, or close to, those typically recorded for unmineralised soils and rocks (Tables 4.1 and 4.2).

Samples of Low-Grade Ore

The two (2) samples of Low-Grade Ore from the Weathered-Zone and Fresh-Zone were both significantly enriched in As and Sb, and slightly enriched in B (Table 4.3). The sample from the Weathered-Zone was also slightly enriched in Sn, whereas the sample from the Fresh-Zone was slightly enriched in Ag and C (Table 4.3).

The above suite of enriched elements is similar to that recorded for the waste-rock samples (see Section 3.2).

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[23] A sample of the High-Grade Ore (GCA1531) had a concentration of 'readily-available' alkalinity forms of 5-10 kg H_2SO_4/tonne (Figure 2).

[24] The samples of the Low-Grade Ore had NAPP values that ranged from -350 kg H_2SO_4/tonne, to -4.6 kg H_2SO_4/tonne (Table 4.1). The NAPP value for sample GCA1505 was not calculated, since this sample had Total-S and ANC values less than the respective detection limits. Such Low-Grade Ore is classified as a *Barren Material.*

Samples of High-Grade Ore

The two (2) samples of High-Grade Ore were both significantly enriched in As, Sb, Ag and C (Table 4.3). The Graphitic-Sediment-Hosted sample was also slightly enriched in B and Sn (Table 4.3).

The analysis results indicate that, environmentally, the assayed samples of Low-Grade Ore from both the Weathered-Zone and Fresh-Zone are relatively 'clean', with concentrations of most elements below, or close to, those typically recorded for unmineralised soils and rocks.

However, the analysis results indicate that the Low-Grade Ore from both the Weathered-Zone and Fresh-Zone may be significantly enriched in As and Sb. An enrichment in As and Sb was also recorded for the waste-rock samples (see Section 3.2).

5.0 SUMMARY AND MANAGEMENT IMPLICATIONS

5.1 Summary of Geochemical Testing

In this study, samples of waste-rock and ore materials have been tested for acid-base chemistry, salinity and multi-element composition.

The tested samples represent the major types of waste-rock and ore materials in the Weathered-Zone and Fresh-Zone of the Maud Creek Deposit, viz.

- Waste-Rock Materials
  - Hangingwall Mafic Tuff.
  - Footwall Sediments.
- Ore Materials
  - Stockwork Quartz (Tuff and Sediment Hosted).
  - Massive Quartz (Tuff and Sediment Hosted).

Provisional estimates indicate that the total volume of waste rock to be produced from the open pit will comprise approximately 55 % and 25 % of Hangingwall Mafic Tuff from the Fresh-Zone and Weathered-Zone, respectively. The Footwall Sediments from the Fresh-Zone and Weathered-Zone will comprise approximately 15 % and 5 %, respectively, of the total volume of waste rock.[25]

The tested samples were collected from several drillholes to characterise lateral and down-dip variations in the geochemistry of the mine-waste materials from the proposed open pit.

The major findings of the geochemical-testwork programme are presented below, and management implications are discussed in Section 5.2.

[25] It should be noted that these estimated proportions of the different waste-rock types are **indicative only**, and will likely be refined in light of the evolving mine plan and pit design for the Maud Creek Gold Project.

Waste Rock

- The waste-rock samples from both the Weathered-Zone and Fresh-Zone were all mildly alkaline, and typically had low contents of soluble salts. Two samples of the Footwall Sediments from the Fresh-Zone had moderate-to-high contents of soluble salts.

- All, but two, of the waste-rock samples from the Weathered-Zone and Fresh-Zone were classified as Non-Acid Forming (NAF), due to low contents of pyrite (and other sulphides), and a moderate-to-high capacity to consume acid. Reactive carbonates (e.g. calcite) contribute to acid consumption and pH buffering.

  Two samples of Footwall Sediments from the Fresh-Zone were classified as Potentially-Acid Forming (PAF). These samples had Total-S values of 2.1 % and 3.2 %, and may be further classified as PAF[Low-Capacity] and PAF[Moderate-Capacity], respectively.

  The above findings are consistent with the 'typical' geology and mineralogy of the rock materials in the Wall-Waste Zone of the Maud Creek Deposit (viz. minor pyrite and abundant carbonates).

- The assayed waste-rock samples from the Weathered-Zone and Fresh-Zone had element concentrations below, or close to, those typically recorded for unmineralised soils and rocks. However, the assayed rock samples were enriched in arsenic and antimony.

Low-Grade Ore

- The samples of Low-Grade Ore were geochemically similar to the waste-rock samples.

5.2 Management Implications

The testwork results indicate that Acid-Rock Drainage (ARD) should not be produced by the waste dump(s) at the proposed Maud Creek Gold Mine. This prediction reflects the low content of pyrite and abundance of carbonates in the waste rock to be produced from the Weathered-Zone and Fresh-Zone during pit development. Consequently, the waste dumps may be constructed as a run-of-mine operation without selective material

handling and placement. However, as a contingency measure, it is recommended that provision is made for the deep burial of any High-S varieties of waste rock that may be produced during mining (e.g. High-S units of the Footwall Sediments from the Fresh-Zone).[26] Monitoring of the as-produced waste rock should be undertaken to assess the need for selective material handling during dump construction.[27]

The runoff waters produced by the waste dumps should be circum-neutral (viz. pH 6-8), and of 'fresh' quality (viz. TDS values less than 1,000 mg/L).[28] The leachates within the waste dumps should also be circum-neutral and relatively fresh.[29] Given the abundance of carbonate minerals in the waste rock, the drainage waters produced by the waste dump will likely be 'hard', with a major-ion chemistry dominated by calcium, magnesium and bicarbonate.[30]

The concentrations of dissolved forms of environmentally-significant elements should be very low, due to the expected circum-neutral pH of the drainage waters, and the multi-element composition of the waste-rock materials.[31] Dissolved forms of arsenic and antimony may be exceptions to this prediction, since these elements were enriched in the waste-rock samples, and may exhibit a moderate solubility under neutral-to-alkaline

[26] It is noted that the Footwall Sediments from the Fresh-Zone are provisionally estimated to represent some 15 % of the total volume of waste rock to be produced from the open pit. Only a portion of the Footwall Sediments will be classified as PAF. Pre-planning is required to ensure that any PAF, Footwall Sediments produced from the Fresh-Zone during the latter stages of open-pit mining can be deeply buried within the waste dumps, and **not** left exposed on the top of the dumps.

[27] Such monitoring may comprise simple, on-site testwork (e.g. 'fizz' testing using hydrochloric acid, and Net-Acid-Generation [NAG] testing using hydrogen peroxide), with appropriate off-site analyses (e.g. Total-Sulphur analysis by Leco combustion) for confirmation and verification.

[28] TDS = Total-Dissolved Solids.

[29] The TDS of leachates should exceed that of the dump-runoff waters, due to greater 'pick-up' of solutes along the flow-path of leachate within the dumps.

[30] Sulphate may also be a major anion in the drainage waters, due to the weathering of pyrite and other sulphides. However, the acid produced by such weathering should be effectively neutralised through reaction with the carbonate minerals in the waste rock.

[31] Dissolved forms correspond to the analysis of water samples that have been filtered through a 0.45-µm membrane filter, and appropriately preserved for the determination of specific analytes. The conventional 'cut-off' between dissolved and particulate forms in natural systems is 0.45 µm.

conditions.[32] Monitoring is needed to assess the solubility of arsenic and antimony (and other minor-elements) in the runoff waters produced by the waste dumps.

The quality of the drainage waters produced by stockpiles of Low-Grade Ore should be similar to that of the drainage waters produced by the waste dumps. Monitoring should be undertaken to confirm this prediction.

In brief, based on the testwork results obtained in this study, no major geochemical concerns are foreseen in the management of the waste rock and Low-Grade Ore to be produced at the proposed Maud Creek Gold Mine.

Nevertheless, it is recommended that Kalmet implements an appropriate monitoring programme to allow on-going assessment of the geochemical character of the mine-waste materials, and the quality of drainage waters produced by the waste dumps and ore stockpiles. It is envisaged that only 'low-key' monitoring will be needed to assess the performance of mine-waste management at the mine site.[33]

[32] Certain rock samples were also slightly enriched in B, and this element may similarly exhibit a moderate solubility at circum-neutral pH.

[33] Initially, such monitoring should be more frequent and detailed, and then relaxed, as appropriate, in light of the monitoring results obtained, and the refinement of the geological model and mine plan for the Maud Creek Gold Project.

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TABLES

Table 2.1: Details of Waste-Rock and Ore Samples

GCA SAMPLE NO.	KALMET SAMPLE NO.	DRILLHOLE NO.	DOWN-HOLE INTERVAL (m)	WASTE-ROCK OR ORE TYPE
WASTE-ROCK MATERIALS FROM WEATHERED-ZONE				
GCA1500	B17112	MCP95	10-11	Hangingwall Mafic Tuff
GCA1508	B17120	MCP101	2-3	Hangingwall Mafic Tuff
GCA1509	B17121	MCP101	10-11	Hangingwall Mafic Tuff
GCA1515	B17127	MCP137	9-10	Hangingwall Mafic Tuff
GCA1527	B17139	MCP113	4-5	Hangingwall Mafic Tuff
GCA1528	B17140	MCP113	19-20	Hangingwall Mafic Tuff
GCA1521	B17133	MCP121	9-10	Hangingwall Mafic Tuff
GCA1522	B17134	MCP121	49-50	Hangingwall Mafic Tuff
GCA1516	B17128	MCP137	59-60	Hangingwall Mafic Tuff
GCA1529	B17141	MCP113	39-40	Hangingwall Mafic Tuff
GCA1503	B17115	MCP97	9-10	Footwall Sediments Undifferentiated
GCA1502	B17114	MCP95	37-38	Footwall Sandstone
GCA1504	B17116	MCP97	19-20	Footwall Sandstone
GCA1507	B17119	MCP98	15-16	Footwall Sandstone
WASTE ROCK FROM FRESH-ZONE				
GCA1510	B17122	MCP101	38-39	Hangingwall Mafic Tuff
GCA1511	B17123	MCP101	74-75	Hangingwall Mafic Tuff
GCA1517	B17129	MCP137	99-100	Hangingwall Mafic Tuff
GCA1523	B17135	MCP121	99-100	Hangingwall Mafic Tuff
GCA1630	B17989	MCP113	69-70	Hangingwall Mafic Tuff
GCA1631	B17986	MCP106	65-66	Hangingwall Mafic Tuff
GCA1632	B17987	MCP106	91-92	Hangingwall Mafic Tuff
GCA1633	B17991	MCP132	50-51	Hangingwall Mafic Tuff
GCA1634	B17992	MCP132	130-131	Hangingwall Mafic Tuff
GCA1635	B17993	MCP134	101-102	Hangingwall Mafic Tuff
GCA1636	B17994	MCP134	132-133	Hangingwall Mafic Tuff
GCA1514	B17126	MCP101	98-99	Footwall Sediments Undifferentiated
GCA1637	B17990	MCP113	132-133	Footwall Sediments Undifferentiated
GCA1638	B17988	MCP106	146-147	Footwall Sediments Undifferentiated
GCA1639	B17995	MCP134	150-151	Footwall Sediments Undifferentiated
GCA1519	B17131	MCP137	159-160	Footwall Sandstone
GCA1520	B17132	MCP137	174-175	Footwall Sandstone
GCA1526	B17138	MCP121	159-160	Footwall Sandstone
GCA1533	B17145	MCP113	125-126	Footwall Sandstone
ORE FROM WEATHERED-ZONE				
GCA1501	B17113	MCP95	33-34	Stockwork Quartz - Tuff Hosted [High Grade]
GCA1506	B17118	MCP98	10-11	Stockwork Quartz - Sediment Hosted [Low Grade]
GCA1505	B17117	MCP98	1-2	Massive Quartz - Tuff Hosted [Low Grade/Waste]
ORE FROM FRESH-ZONE				
GCA1512	B17124	MCP101	98-99	Stockwork Quartz - Graphitic Sediment Hosted [Low Grade/Waste]
GCA1518	B17130	MCP137	154-155	Stockwork Quartz - Graphitic Sediment Hosted [Low Grade/Waste]
GCA1513	B17125	MCP101	89-90	Stockwork Quartz - Graphitic Sediment Hosted [Low Grade]
GCA1530	B17142	MCP113	100-101	Stockwork Quartz - Tuff Hosted [Low Grade]
GCA1525	B17137	MCP121	144-145	Massive Quartz - Graphitic Sediment Hosted [High Grade]
GCA1532	B17144	MCP113	114-115	Massive Quartz - Graphitic Sediment Hosted [Low Grade]
GCA1531	B17143	MCP113	108-109	Massive Quartz - Tuff Hosted [High Grade]
GCA1524	B17136	MCP121	130-131	Massive Quartz - Tuff Hosted [Low Grade]

Table 3.1: Acid-Base-Analysis and Net-Acid-Generation Results for Waste-Rock Samples

GCA SAMPLE NO.	DRILLHOLE NO.	DOWN-HOLE INTERVAL (m)	WASTE-ROCK TYPE	pH (1:2)	EC (1:2) (mS/cm)	TOTAL-S (%)	SO_4-S (%)	ANC (kg H_2SO_4/tonne)	NAPP (kg H_2SO_4/tonne)	NAG (kg H_2SO_4/tonne)	NAG pH
WASTE-ROCK MATERIALS FROM WEATHERED-ZONE											
GCA1500	MCP95	10-11	Hangingwall Mafic Tuff	9.2	0.086	<0.01	nm	23	-22	nm	nm
GCA1508	MCP101	2-3	Hangingwall Mafic Tuff	8.6	0.14	<0.01	nm	240	-240	nm	nm
GCA1509	MCP101	10-11	Hangingwall Mafic Tuff	8.8	0.19	<0.01 (<0.01)	nm	410 (360)	-410 (-360)	nm	nm
GCA1515	MCP137	9-10	Hangingwall Mafic Tuff	8.4	0.18	<0.01	nm	390	-390	nm	nm
GCA1527	MCP113	4-5	Hangingwall Mafic Tuff	8.4	0.32	0.02	nm	380	-380	nm	nm
GCA1528	MCP113	19-20	Hangingwall Mafic Tuff	8.5	0.28	0.02	nm	490	-490	nm	nm
GCA1521	MCP121	9-10	Hangingwall Mafic Tuff	8.6	0.18	0.02	nm	340	-340	nm	nm
GCA1522	MCP121	49-50	Hangingwall Mafic Tuff	8.8	0.17	<0.01	nm	340	-340	nm	nm
GCA1516	MCP137	59-60	Hangingwall Mafic Tuff	9.1	0.14	<0.01	nm	350	-350	nm	nm
GCA1529	MCP113	39-40	Hangingwall Mafic Tuff	8.6	0.19	0.03 (0.03)	nm	420 (390)	-420 (-390)	nm	nm
GCA1503	MCP97	9-10	Footwall Sediments Undiff.	8.6	0.038	<0.01	nm	1.9	-1.6	nm	nm
GCA1502	MCP95	37-38	Footwall Sandstone	9.2	0.12	0.10	nm	5.7	-2.7	nm	nm
GCA1504	MCP97	19-20	Footwall Sandstone	8.8	0.15	0.11	nm	6.7 (6.7)	-3.3	nm	nm
GCA1507	MCP98	15-16	Footwall Sandstone	9.1	0.078	<0.01	nm	3.7	-3.4	nm	nm
WASTE ROCK FROM FRESH-ZONE											
GCA1510	MCP101	38-39	Hangingwall Mafic Tuff	9.0 (9.0)	0.19 (0.18)	0.03	nm	540	-540	nm	nm
GCA1511	MCP101	74-75	Hangingwall Mafic Tuff	8.7	0.22	0.13	nm	480	-480	nm	nm
GCA1517	MCP137	99-100	Hangingwall Mafic Tuff	8.7	0.34	0.33	nm	380	-370	nm	nm
GCA1523	MCP121	99-100	Hangingwall Mafic Tuff	8.8	0.22	0.04	nm	510	-510	nm	nm
GCA1630	MCP113	69-70	Hangingwall Mafic Tuff	8.6	0.36	0.21	nm	380*	-370	nm	nm
GCA1631	MCP106	65-66	Hangingwall Mafic Tuff	8.8	0.34	0.10	nm	440*	-430	nm	nm
GCA1632	MCP106	91-92	Hangingwall Mafic Tuff	8.6	0.31	0.16	nm	430* (420*)	-410	nm	nm
GCA1633	MCP132	50-51	Hangingwall Mafic Tuff	8.8	0.28	0.04	nm	280	-270	nm	nm
GCA1634	MCP132	130-131	Hangingwall Mafic Tuff	8.5	0.50	0.93	0.02	400*	-370	<0.5	8.8
GCA1635	MCP134	101-102	Hangingwall Mafic Tuff	8.6	0.37	0.02	nm	330*	-320	nm	nm
GCA1636	MCP134	132-133	Hangingwall Mafic Tuff	8.5	0.55	0.36	nm	460*	-440	nm	nm
GCA1514	MCP101	98-99	Footwall Sediments Undiff.	9.2	0.13	<0.01	nm	53	-53	nm	nm
GCA1637	MCP113	132-133	Footwall Sediments Undiff.	7.8 (7.8)	1.8 (1.8)	3.2	0.10	43* (43*)	52	36	2.5
GCA1638	MCP106	146-147	Footwall Sediments Undiff.	8.8	0.19	0.14	nm	45*	-40	nm	nm
GCA1639	MCP134	150-151	Footwall Sediments Undiff.	8.6	0.47	0.84	0.03 (0.03)	51	-26	<0.5 (<0.5)	8.2 (8.2)
GCA1519	MCP137	159-160	Footwall Sandstone	7.6	1.0	2.0 (2.1)	0.07	43 (45)	17	<0.5	8.5
GCA1520	MCP137	174-175	Footwall Sandstone	9.4 (9.5)	0.17 (0.18)	0.33	nm	47	-37	nm	nm
GCA1526	MCP121	159-160	Footwall Sandstone	8.5	0.47	0.71	0.04 (0.04)	32	-11	<0.5 (<0.5)	9.3 (9.4)
GCA1533	MCP113	125-126	Footwall Sandstone	8.7	0.22	0.99	0.02	35	-5.3	<0.5 (<0.5)	8.7 (8.7)

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; NAG = Net-Acid Generation; nm = not measured.
pH (1:2) and EC (1:2) correspond to measurements of pH and EC on sample slurries prepared using deionised water and a rock:water ratio of approximately 1:2 (w/w).
ANC values labelled with an asterisk indicate that a green suspension as the pH=7 end-point was approached in the ANC Test.
All values expressed on a dry-weight basis, except for pH(1:2), EC (1:2) and NAG pH.
Values in parentheses represent duplicates.

Table 3.2: Multi-Element Composition of Waste-Rock Samples

ELEMENT	TOTAL-ELEMENT CONCENTRATION (mg/kg or %)								AVERAGE CRUSTAL ABUNDANCE (mg/kg or %)
	SAMPLES FROM WEATHERED-ZONE				*SAMPLES FROM FRESH-ZONE*				
	Hanginwall Mafic Tuff (GCA1508)	Hangingwall Mafic Tuff (GCA1522)	Footwall Sed. Undiff. (GCA1503)	Footwall Sandstone (GCA1502)	Hangingwall Mafic Tuff (GCA1510)	Hangingwall Mafic Tuff (GCA1523)	Footwall Sed. Undiff. (GCA1514)	Footwall Sandstone (GCA1519)	
Ag	<0.1	<0.1	<0.1	1.0	<0.1	<0.1	0.4	2.8	0.07
Al	4.1%	3.9%	7.8%	6.4%	3.3%	3.5%	8.2%	8.4%	8.2%
As	78	34	74	110	12	96	40	450	1.5
B	50	50	150	150	50	<50	150	150	10
Ba	140	80	560	350	32	41	480	390	500
Bi	0.1	<0.1	0.1	0.1	<0.1	<0.1	0.2	3.5	0.048
C	2.9%	1.3%	0.075%	0.14%	4.6%	4.0%	0.81%	1.2%	0.048%
Ca	4.6%	5.6%	0.062%	0.24%	7.8%	6.6%	0.88%	1.4%	4.1%
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11
Co	47	82	8	5	60	62	11	32	20
Cr	880	860	68	52	800	800	80	72	100
Cu	47	13	15	28	48	74	28	300	50
F	450	450	700	550	400	500	750	1,100	950
Fe	11%	9.0%	2.6%	3.1%	8.2%	8.6%	3.1%	3.4%	4.1%
Hg	0.01	<0.01	0.01	0.03	0.04	<0.01	0.01	0.05	0.05
K	0.42%	0.028%	3.9%	3.1%	0.012%	0.0080%	4.1%	4.0%	2.1%
Mg	5.4%	10%	0.52%	0.36%	8.0%	8.2%	1.2%	1.4%	2.3%
Mn	2,000	1,100	84	45	2,200	3,700	1,100	720	950
Mo	1.0	<0.5	0.5	1.0	0.5	0.5	0.5	2.5	1.5
Na	0.014%	0.020%	0.044%	0.034%	0.010%	0.014%	0.040%	0.034%	2.3%
Ni	740	740	40	62	600	620	42	49	80
P	700	900	180	360	620	680	440	500	1,000
Pb	26	18	10	12	8	16	12	36	14
Sb	28	7.6	5.4	11	5.6	7.6	9.6	20	0.2
Se	0.03	0.08	0.05	0.28	0.33	0.06	0.09	0.09	0.05
Sn	15	1	18	6	1	1	5	52	2.2
Sr	26	280	34	45	330	34	22	42	370
Th	1.4	1.2	16	14	0.8	1.1	16	18	12
Tl	<0.2	<0.2	0.8	0.8	<0.2	<0.2	0.6	0.8	0.6
U	0.8	0.3	3.4	3.5	0.3	0.3	3.6	3.8	2.4
V	280	230	88	62	180	180	78	80	160
Zn	86	140	18	15	64	74	22	20	75

Note: Average crustal abundance of elements based on Bowen (1979) for unmineralised rocks and soils.

Table 3.3: Indicated Element Enrichments in Waste-Rock Samples

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

ELEMENT	GEOCHEMICAL-ABUNDANCE INDEX (GAI)							
	SAMPLES FROM WEATHERED-ZONE				*SAMPLES FROM FRESH-ZONE*			
	Hanginwall Mafic Tuff (GCA1508)	Hangingwall Mafic Tuff (GCA1522)	Footwall Sed. Undiff. (GCA1503)	Footwall Sandstone (GCA1502)	Hangingwall Mafic Tuff (GCA1510)	Hangingwall Mafic Tuff (GCA1523)	Footwall Sed. Undiff. (GCA1514)	Footwall Sandstone (GCA1519)
Ag	0	0	0	3	0	0	2	5
Al	0	0	0	0	0	0	0	0
As	5	4	5	6	2	5	4	6
B	2	2	3	3	2	0	3	3
Ba	0	0	0	0	0	0	0	0
Bi	0	0	0	0	0	0	1	6
C	5	4	0	1	6	6	3	4
Ca	0	0	0	0	0	0	0	0
Cd	0	0	0	0	1	1	0	0
Co	1	1	0	0	2	2	0	0
Cr	3	3	0	0	0	0	0	0
Cu	0	0	0	0	0	0	0	2
F	0	0	0	0	0	0	0	0
Fe	1	1	0	0	0	0	0	0
Hg	0	0	0	0	0	0	0	0
K	0	0	0	0	1	1	0	0
Mg	1	2	0	0	1	1	0	0
Mn	0	0	0	0	0	0	0	0
Mo	0	0	0	0	0	0	0	0
Na	0	0	0	0	2	2	0	0
Ni	3	3	0	0	0	0	0	0
P	0	0	0	0	0	0	0	1
Pb	0	0	0	0	4	5	5	6
Sb	6	5	4	5	2	0	0	0
Se	0	0	0	2	0	0	1	4
Sn	2	0	2	1	0	0	0	0
Sr	0	0	0	0	0	0	0	0
Th	0	0	0	0	0	0	0	0
Tl	0	0	0	0	0	0	0	0
U	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
Zn	0	0	0	0	0	0	0	0

Table 4.1: Acid-Base-Analysis and Net-Acid-Generation Results for Ore Samples

GCA SAMPLE NO.	DRILLHOLE NO.	DOWN-HOLE INTERVAL (m)	ORE TYPE	pH (1:2)	EC (1:2) (mS/cm)	TOTAL-S (%)	SO_4-S (%)	ANC (kg H_2SO_4/tonne)	NAPP (kg H_2SO_4/tonne)	NAG (kg H_2SO_4/tonne)	NAG pH
ORE FROM WEATHERED-ZONE											
GCA1501	MCP95	33-34	Stockwork Quartz - Tuff Hosted [High Grade]	8.6	0.28	0.51	0.02	25	-10	<0.5	10.6
GCA1506	MCP98	10-11	Stockwork Quartz - Sediment Hosted [Low Grade]	9.1	0.079	<0.01	nm	4.9	-4.6	nm	nm
GCA1505	MCP98	1-2	Massive Quartz - Tuff Hosted [Low Grade/Waste]	6.0	0.034	<0.01	nm	<0.5	nc	nm	nm
ORE FROM FRESH-ZONE											
GCA1512	MCP101	98-99	Stock. Quartz - Graph. Sed. Hosted [Low Grade/Waste]	9.0	0.17	0.48	0.01	47	-33	<0.5	9.5
GCA1518	MCP137	154-155	Stock. Quartz - Graph. Sed. Hosted [Low Grade/Waste]	8.8	0.36	0.80	0.02	90	-66	<0.5 (<0.5)	10.4 (10.5)
GCA1513	MCP101	89-90	Stock. Quartz - Graph. Sed. Hosted [Low Grade]	9.1	0.17	0.38	nm	79	-67	<0.5	9.9
GCA1530	MCP113	100-101	Stockwork Quartz - Tuff Hosted [Low Grade]	8.6 (8.6)	0.41 (0.41)	0.93	0.02	380	-350	<0.5	8.6
GCA1525	MCP121	144-145	Massive Quartz - Graph. Sed. Hosted [High Grade]	8.7	0.29	3.2	0.02	89	8.4	<0.5	7.9
GCA1532	MCP113	114-115	Massive Quartz - Graph. Sed. Hosted [Low Grade]	8.5	0.49	1.5	0.03	160	-110	<0.5	8.7
GCA1531	MCP113	108-109	Massive Quartz - Tuff Hosted [High Grade]	8.4	0.29	0.93	0.02	54 (54)	-26	<0.5	8.6
GCA1524	MCP121	130-131	Massive Quartz - Tuff Hosted [Low Grade]	8.6	0.45	0.83	0.02	140 (140)	-110	<0.5	8.9

Notes:
EC = Electrical Conductivity; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; NAG = Net-Acid Generation; nm = not measured; nc = not calculated.
pH (1:2) and EC (1:2) correspond to measurements of pH and EC on sample slurries prepared using deionised water and a rock:water ratio of approximately 1:2 (w/w).
All values expressed on a dry-weight basis, except for pH(1:2), EC (1:2) and NAG pH.
Values in parentheses represent duplicates.

Table 4.2: Multi-Element Composition of Ore Samples

ELEMENT	TOTAL-ELEMENT CONCENTRATION (mg/kg or %)				AVERAGE CRUSTAL ABUNDANCE (mg/kg or %)
	SAMPLE FROM WEATHERED-ZONE	*SAMPLES FROM FRESH-ZONE*			
	Stockwork Quartz - Sediment Hosted [Low-Grade] (GCA1506)	Stockwork Quartz - Graph.-Sed. Hosted [Low-Grade/Waste] (GCA1518)	Massive Quartz - Graph.-Sed. Hosted [High-Grade] (GCA1525)	Massive Quartz - Tuff Hosted [High-Grade] (GCA1524)	
Ag	0.2	0.6	4.4	1.6	0.07
Al	7.8%	8.2%	4.3%	1.6%	8.2%
As	130	760	9,200	860	1.5
B	200	150	100	50	10
Ba	360	440	250	58	500
Bi	0.3	0.3	3.0	0.4	0.048
C	0.080%	1.5%	1.3%	2.0%	0.048%
Ca	0.22%	2.3%	2.0%	3.1%	4.1%
Cd	<0.1	<0.1	<0.1	<0.1	0.11
Co	4	25	230	27	20
Cr	80	78	140	280	100
Cu	12	140	370	98	50
F	700	900	450	200	950
Fe	4.5%	2.2%	4.1%	2.2%	4.1%
Hg	0.02	0.03	0.06	0.03	0.05
K	3.9%	4.1%	2.0%	0.74%	2.1%
Mg	0.45%	1.8%	1.4%	1.6%	2.3%
Mn	60	900	940	1,600	950
Mo	3.0	0.5	1.5	1.0	1.5
Na	0.030%	0.030%	0.024%	0.016%	2.3%
Ni	13	42	160	240	80
P	320	380	260	280	1,000
Pb	16	22	58	16	14
Sb	20	16	66	30	0.2
Se	0.12	0.04	0.27	0.19	0.05
Sn	28	8	42	1	2.2
Sr	46	24	18	35	370
Th	16	18	8.2	0.8	12
Tl	0.6	1.0	0.4	0.2	0.6
U	3.1	3.9	1.9	0.8	2.4
V	78	74	64	72	160
Zn	10	21	29	19	75

Note: Average crustal abundance of elements based on Bowen (1979) for unmineralised rocks and soils.

Table 4.3: Indicated Element Enrichments in Ore Samples

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

ELEMENT	GEOCHEMICAL-ABUNDANCE INDEX (GAI)			
	SAMPLE FROM WEATHERED-ZONE	*SAMPLES FROM FRESH-ZONE*		
	Stockwork Quartz - Sediment Hosted [Low-Grade] (GCA1506)	**Stockwork Quartz - Graph.-Sed. Hosted [Low-Grade/Waste] (GCA1518)**	**Massive Quartz - Graph.-Sed. Hosted [High-Grade] (GCA1525)**	**Massive Quartz - Tuff Hosted [High-Grade] (GCA1524)**
Ag	1	3	5	4
Al	0	0	0	0
As	6	6	6	6
B	4	3	3	2
Ba	0	0	0	0
Bi	2	2	5	2
C	0	4	4	5
Ca	0	0	0	0
Cd	0	0	0	0
Co	0	0	3	0
Cr	0	0	0	1
Cu	0	1	2	0
F	0	0	0	0
Fe	0	0	0	0
Hg	0	0	0	0
K	0	0	0	0
Mg	0	0	0	0
Mn	0	0	0	0
Mo	0	0	0	0
Na	0	0	0	0
Ni	0	0	0	1
P	0	0	0	0
Pb	0	0	1	0
Sb	6	6	6	6
Se	1	0	2	1
Sn	3	1	4	0
Sr	0	0	0	0
Th	0	0	0	0
Tl	0	0	0	0
U	0	0	0	0
V	0	0	0	0
Zn	0	0	0	0

FIGURES

Figure 1

Titration Curves for Modified-ANC Tests on Waste-Rock Samples

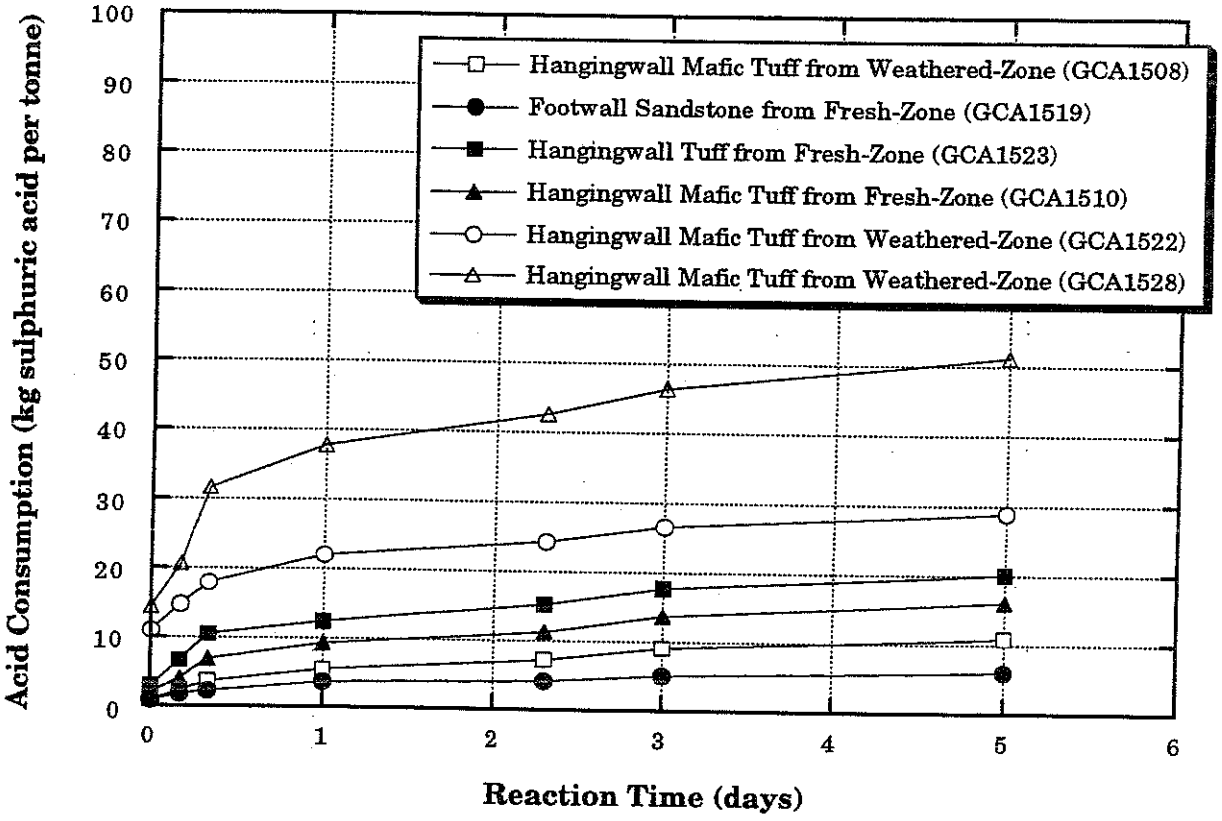
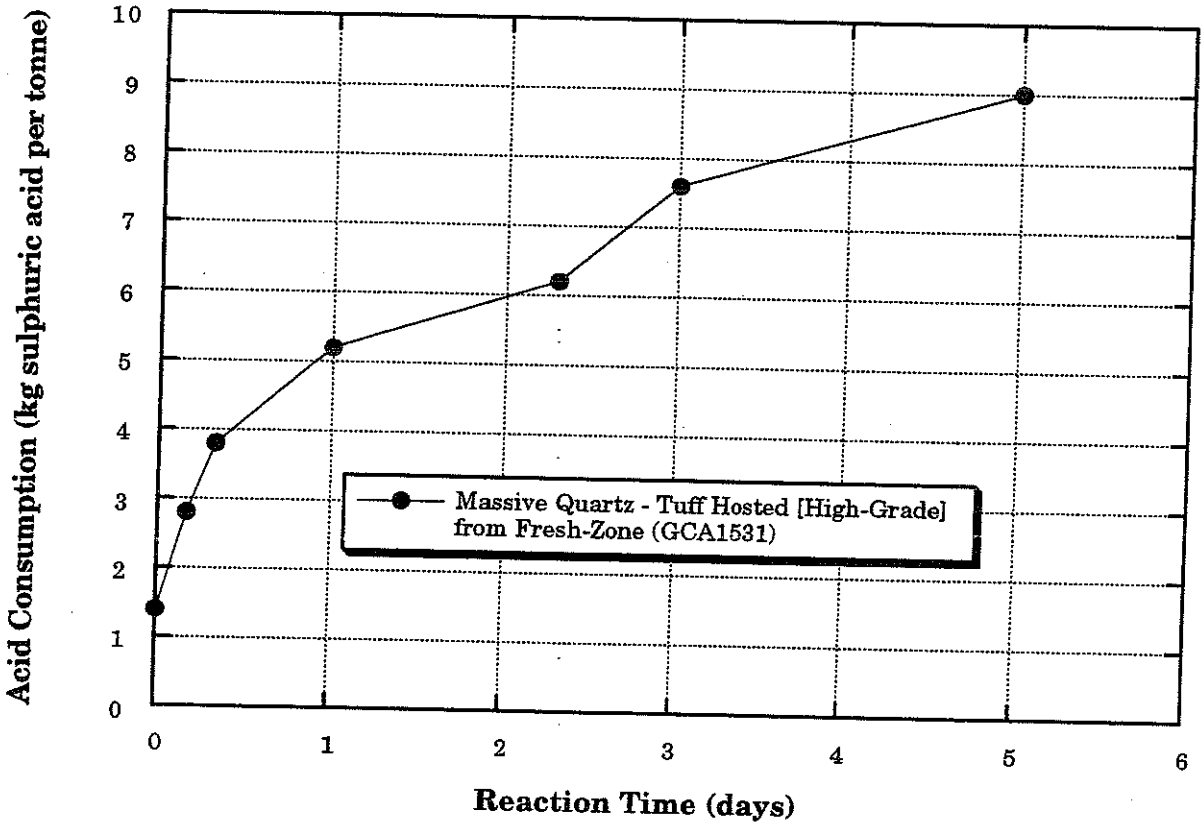


Figure 2

Titration Curve for Modified-ANC Test on Ore Sample



APPENDIX A

DETAILS OF WASTE-ROCK AND ORE SAMPLES

MAUD CREEK GOLD DEPOSIT
WASTE-ROCK CHARACTERIZATION

Description of Samples

To: Graeme Campbell

Copy: Joe Treacy

From: Ian Morrison

Date: 17th September, 1996 (Revised: 25th October, 1996)

1. Geology, Alteration and Mineralization Overview

The Maud Creek gold deposit is centred on the sheared contact between highly altered hangingwall mafic tuffs and footwall fine- to coarse- grained sediments. The bulk of the mineralization is associated with stockwork to massive quartz veining along the contact, with locally significant ore-grade mineralization in the hangingwall tuffs, and minor footwall ore-grade mineralization. The main body of the mineralization dips moderately to steeply to the east and plunges steeply south. Detailed drilling has revealed the body extends roughly 200 metres along strike, is generally 10 to 20 metres wide, and remains open at depth (below 300 metres).

Alteration of hangingwall tuffs includes:

- an outer zone of variably intense pervasive chlorite-carbonate alteration with sparse to dense carbonate and quartz-carbonate stockwork veining. Lesser to minor highly sericite-silica altered intervals tend to more highly mineralized and are very similar to the inner zone alteration noted below. Sulphide content is typically <1% by volume in this zone;

- an inner zone of intense silica-sericite-carbonate±fuchsite±graphite alteration with associated sparse to dense carbonate and quartz stockwork veining. This zone typically contains significantly elevated sulphides (pyrite and arsenopyrite) and associated

anomalous gold grades (locally ore-grade), and extends for 10 to 20 metres into the hangingwall tuffs from the ore zone. Sulphides occur as fine disseminations and fine veinlets and typically comprise roughly 1-3% by volume in this inner zone. Generally lesser to minor intervals of chlorite-carbonate alteration are common within the inner alteration zone and are typically more weakly mineralized.

Alteration of footwall sediments is typically less intense and characterized by any of pervasive sericite-silica-chlorite with typically minor carbonate and quartz veining. Adjacent to the ore zone, sediments are commonly highly graphitic. Fine to coarse disseminated and fine veinlet sulphides (pyrite and arsenopyrite) generally comprise 1-2% by volume of highly graphitic domains, typically confined to roughly five metres into the footwall, although locally more extensive. In general, sulphide content of the footwall rocks is <1%.

The main ore zone is characterized by multiple phases of quartz veining and brecciation, and sulphide deposition. Mineralization consists of tuff-hosted, graphitic sediment- and/or rock-flour-hosted, and mixed lithlogy-hosted varieties. Alteration of host tuffs is identical to the inner zone of hangingwall alteration noted above. Host sediments and rock flour are commonly highly graphite- and/or chlorite-altered. Carbonate contents in the ore zone are generally low. Pyrite and arsenopyrite together generally comprise roughly 2-5% by volume of the ore zone. Very locally, pyrite is semi-massive over intervals of up to one metre (up to 50% pyrite).

2. Oxidation

Rocks are typically highly oxidized (oxidation levels 1 and 2) down to roughly 20 metres below surface, moderately oxidized (oxidation level 3) to about 30 metres depth, and weakly oxidized and fresh (respectively oxidation levels 4 and 5) below 30 metres.

Highly oxidized rock is characterized by the presence of abundant iron-oxides, and abundant pervasive and veinlet calcite (?10-30% calcite). The calcite is probably the product of oxidation of primary ?ankerite/dolomite and, adjacent to and within the ore zone, oxidation of graphite. Highly oxidized pyrite is rarely preserved.

Moderately oxidized rock is moderately pervasively iron-oxide stained with both calcite and ?ankeritic carbonate present. Moderate graphite occurs within and adjacent to the ore zone. Weakly to highly oxidized pyrite is common and arsenopyrite is rare.

Weakly oxidized and fresh rock contain any of the components noted above in the description of the alteration assemblages. Iron oxides and attendant oxidation of sulphides is restricted to fractures and immediate environs.

3. Sample Selection

Samples were selected from several holes to characterize lateral and down-dip variations, and they include all of the main lithologies, alteration and oxidation types that will comprise waste material from open pit mining. Highly oxidized tuff is over-represented. Several samples of low-grade/waste, low-grade and high-grade mineralization from the main ore zone are also included. Tabulated details are presented in Table 1.

Assuming the open pit will extend to the -25mRL (150 metres below surface) with pit walls at 50°, waste rock will comprise roughly 80% hangingwall tuffs and 20% footwall sediments. Roughly 20% of the waste will be highly oxidized, 10% moderately oxidized, and the bulk fresh or weakly oxidized.

Hangingwall Tuff Samples

Highly Oxidized:	B17112, B17120, B17121, B17127, B17128, B17133, B17139, B17140;
Moderately Oxidized:	B17134, B17141;
Fresh/Weakly Oxidized:	B17122, B17123, B17129, B17135

Footwall Sediment Samples

Highly Oxidized:	B17115
Moderately Oxidized:	B17114, B17116, B17119
Fresh/Weakly Oxidized:	B17126, B17131, B17132, B17138, B17145

Ore Zone Samples

Highly Oxidized:	B17113 (high grade), B17117 (low grade/waste)
Moderately Oxidized:	B17118 (low grade)
Fresh/Weakly Oxidized:	B17124, B17130, B17144 (low grade/waste)
	B17125, B17136 and B17142 (low grade)
	B17137 and B17143 (high grade)

4. Table 1 Codes and Abbreviations

The following codes and abbreviations are used in Table 1.

Rock Types

Ttm	Hangingwall mafic tuff
Ssu	Footwall sediments, undifferentiated
Ssn	Footwall sandstone
Zmq	Ore zone, massive quartz (>50% quartz) (T=tuff-hosted, S=sediment-hosted, G=graphitic sediment or rockflour-hosted)
Zsq	Ore zone, stockwork quartz (5-50% quartz). Host rock descriptors as above

Oxidation, Alteration and Mineralization

Oxid'n Level	Oxidation level, expressed as a scale from 1 to 5 (described in Section 2 above)
Pyrite	Expressed as percentage or trace (tr)
A'pyrite	Arsenopyrite, as above
CO3	Carbonate, either calcite (highly oxidized rock) or ?ankerite (fresh/weakly oxidized rock): expressed as a semi-quantitative scale from 1 (trace to 1%) to 5 (?20 to 50%), based on reaction vigour of sample dust in dilute HCl.
Graphite	Expressed as a semi-quantitative scale from 1 (trace to 1%) to 5 (highly graphitic, possibly up to 50% graphite).
Au	Gold: expressed in ppm
As	Arsenic: expressed in ppm

Table 1. Sample descriptions and analyses

Sample	Hole No	Interval (m)	Rock Type	Oxid'n Level	Pyrite %	A'Pyrite %	CO3 Alt'n	Graphite Alt'n	Au ppm	As ppm
B17112	MCP95	10-11	Ttm	2			4		<0.01	200
B17113	MCP95	33-34	ZsqT	2			3		9.65	1030
B17114	MCP95	37-38	Ssn	3	—		1		0.04	120
B17115	MCP97	9-10	Ssu	2					<0.01	40
B17116	MCP97	19-20	Ssn	3			2		<0.01	100
B17117	MCP98	1-2	ZmqT	2					0.26	290
B17118	MCP98	10-11	SsqS	3			3		0.71	180
B17119	MCP98	15-16	Ssn	3			2		0.01	120
B17120	MCP101	2-3	Ttm	1			3		0.04	50
B17121	MCP101	10-11	Ttm	2			3		0.05	20
B17122	MCP101	38-39	Ttm	4			5		<0.01	<20
B17123	MCP101	74-75	Ttm	4			5		<0.01	50
B17124	MCP101	88-89	ZsqG	5	1		2	4	0.03	1180
B17125	MCP101	89-90	ZsqG	5	1		2	4	1.73	1290
B17126	MCP101	98-99	Ssu	5			2	3	0.04	40
B17127	MCP137	9-10	Ttm	1			4		<0.01	30
B17128	MCP137	59-60	Ttm	2			4		0.01	<20
B17129	MCP137	99-100	Ttm	4	Tr		4		0.01	210
B17130	MCP137	154-155	ZsqG	5	1		3	4	0.25	1050
B17131	MCP137	159-160	Ssu	5	1		2	4	0.29	480
B17132	MCP137	174-175	Ssu	5	Tr			4	0.06	60
B17133	MCP121	9-10	Ttm	2			5		0.01	20
B17134	MCP121	49-50	Ttm	3			5		<0.01	30
B17135	MCP121	99-100	Ttm	5			3		<0.01	60
B17136	MCP121	130-131	ZmqT	5	1	Tr	3	2	1.98	790
B17137	MCP121	144-145	ZmqG>T	5	3	0.5	3	4	19.25	8620
B17138	MCP121	159-160	Ssn	5	1		2	1	0.08	440
B17139	MCP113	4-5	Ttm	1			5		0.02	100
B17140	MCP113	19-20	Ttm	2			4		0.13	60
B17141	MCP113	39-40	Ttm	3			5		<0.01	30
B17142	MCP113	100-101	ZsqT	5	Tr		3		1.47	1140
B17143	MCP113	108-109	ZmqT	5	Tr		2	2	13.60	1680
B17144	MCP113	114-115	ZmqG	5	1		2	4	0.54	460
B17145	MCP113	125-126	Ssn	5	1		1	3	0.19	260

MAUD CREEK GOLD DEPOSIT
WASTE-ROCK CHARACTERIZATION

ADDENDUM

To: **Graeme Campbell**
Copy: **Joe Treacy**
From: **Ian Morrison**
Date: **5th February, 1997**

1. Introduction

Ten samples of drill chips and two soil samples were collected and despatched to Graeme Campbell on 19th December, 1996. This second batch of samples are in addition to 34 samples despatched in September, 1996, and will be included in the Waste Rock Characterization Study being prepared by Graeme Campbell and Associates.

Abbreviations and codes used in following descriptions were given in the report prepared on 17th September, 1996, and revised on 25th October, 1996.

2. Sample Selection and Sampling Methods

The 10 samples of drill chips were spear sampled from bulk samples stored on site, with roughly 500-700 grams of sample from each interval. Samples were selected to characterize lateral and down-dip variations within the primary zone of the conceptual open pit, with seven samples from the hangingwall tuff unit (Ttm) and three samples from the footwall sediments (Ssu). Details of drill chip samples are given in Table 1.

The two soil samples were collected from the proposed waste rock dump site. Surface litter was removed and nominally 500 grams of sample collected from 5-15cm depth. The dark grey to black soils overly basalt to the north-west of the proposed open pit. Details of soil samples are noted in Table 2.

Table 1. RC Drill Chip Sample Descriptions and Analyses

Sample No	Hole No	Interval (m)	Rock Type	Oxid'n Level	Pyrite %	A'Pyrite %	CO3 Alt'n	Graphite Alt'n	Au ppm	As ppm
B17986	MCP106	65-66	Ttm	5			4		<0.01	70
B17987	MCP106	91-92	Ttm	5	0.5		4		<0.01	140
B17988	MCP106	146-147	Ssu	5			-		<0.01	40
B17989	MCP113	69-70	Ttm	5			4		0.01	60
B17990	MCP113	132-133	Ssu	5	1		1		0.01	30
B17991	MCP132	50-51	Ttm	4			4		<0.01	60
B17992	MCP132	130-131	Ttm	5	Tr		4		0.05	290
B17993	MCP134	101-102	Ttm	5			3		<0.01	140
B17994	MCP134	132-133	Ttm	5			4		0.07	640
B17995	MCP134	150-151	Ssu	5	2	Tr	3	2	0.06	180

Table 2. Soil Sample Descriptions

Sample No	Location Local Grid Coordinates	Description
B17996	9500N; 18900E	Dark grey to black; 500g collected from 5 to 15 cm depth; overlies basalt
B17997	9800N; 18700E	As Above

APPENDIX B

GEOCHEMISTRY OF SOIL SAMPLES FROM PROPOSED AREA FOR WASTE-ROCK CONTAINMENT

APPENDIX B

GEOCHEMISTRY OF SOIL SAMPLES FROM PROPOSED AREA FOR WASTE-ROCK CONTAINMENT

B.1 ACID-BASE CHEMISTRY AND SALINITY

The two (2) soil samples GCA1628 and GCA1629 had pH (1:2) values of 6.7-7.0, and EC (1:2) values of 0.11-0.15 mS/cm.[1]

These samples also had Total-S values of 0.23-0.33 %, and SO_4-S values that ranged from less than 0.01 %, to 0.02 %.[2] The ANC values of the soil samples were 3.4-5.4 kg H_2SO_4/tonne.

The testwork results indicate that the surface-soil materials in the general area proposed for the containment of waste rock are circum-neutral, and of low salinity.

Such materials are classified as Barren, due to a very-low capacity to both produce and consume acid.

B.2 MULTI-ELEMENT COMPOSITION

The multi-element composition of the soil samples is indicated by the data presented in Table B.1.

The soil samples had concentrations of environmentally-significant elements less than, or close to, those typically recorded for unmineralised soils and rocks.

Sample GCA1629 was significantly enriched in Bi (Table B.1). The Bi should occur predominantly in 'fixed' forms within the cation sub-lattice of oxide and silicate minerals.

---

[1] Refer AEL Report No. GRA203.0560.32352 in Appendix C for the testwork results obtained for the soil samples.

[2] The main form of non-sulphate-sulphur in the soil samples is likely associated with soil organic matter.

Table B.1: Multi-Element Composition of Soil Samples

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

ELEMENT	TOTAL-ELEMENT CONCENTRATION (mg/kg or %)		AVERAGE CRUSTAL ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)	
	50-150 mm [9500N; 18900E] (GCA1628)	50-150 mm [9800N; 18700E] (GCA1629)		50-150 mm [9500N; 18900E] (GCA1628)	50-150 mm [9800N; 18700E] (GCA1629)
Ag	<0.1	0.2	0.07	0	1
Al	5.2%	5.6%	8.2%	0	0
As	1.5	1.5	1.5	0	0
B	<50	<50	10	0	0
Ba	400	520	500	0	0
Bi	0.1	9.6	0.048	0	**6**
C	0.75%	0.61%	0.048%	**3**	**3**
Ca	0.94%	1.1%	4.1%	0	0
Cd	<0.1	<0.1	0.11	0	0
Co	86	140	20	2	2
Cr	56	56	100	0	0
Cu	30	70	50	0	0
F	100	50	950	0	0
Fe	5.8%	7.0%	4.1%	0	0
Hg	<0.01	<0.01	0.05	0	0
K	0.76%	0.94%	2.1%	0	0
Mg	0.66%	0.86%	2.3%	0	0
Mn	3,100	4,300	950	1	2
Mo	0.5	0.5	1.5	0	0
Na	0.36%	0.45%	2.3%	0	0
Ni	43	60	80	0	0
P	100	120	1,000	0	0
Pb	18	24	14	0	0
Sb	<0.2	<0.2	0.2	0	0
Se	0.02	0.04	0.05	0	0
Sn	1	2	2.2	0	0
Sr	30	41	370	0	0
Th	7.8	8.2	12	0	0
Tl	0.2	0.2	0.6	0	0
U	0.9	0.8	2.4	0	0
V	210	230	160	0	0
Zn	32	33	75	0	0

Note: Average crustal abundances of elements based on Bowen (1979) for unmineralised soils and rocks.

APPENDIX C

LABORATORY REPORTS

Australian Environmental Laboratories

21 October 1996

Graeme Campbell & Associates
Attn: Dr G Campbell
PO Box 247
BRIDGETOWN WA 6255

OUR REFERENCE: GRA203.0560.31201
YOUR REFERENCE: GCA9629
NATA REGISTRATION: 1712

Dear Sir

On the 25th of September 1996 you forwarded testwork instructions for thirty four (34) waste rock samples (GCA sample numbers 1500 to 1533) later received at our laboratory.

Each sample was initially crushed to a nominal 2mm particle size with one split retained for analysis and a second pulped to a nominal 75µ particle size. Approximately fifty (50) grams of the pulped sample was forwarded to the GCA Testing Laboratory on the 11/10/96.

Results of the testwork performed at Australian Environmental Laboratories follow:

Sample Number	pH (pH Units)	Conductivity (µS/cm)	Total Sulphur S (%w/w)
GCA1500	9.15	86	<0.01
GCA1501	8.65	280	0.51
GCA1502	9.20	120	0.10
GCA1503	8.60	38	<0.01
GCA1504	8.75	150	0.11
GCA1505	6.05	34	<0.01
GCA1506	9.10	79	<0.01
GCA1507	9.10	78	<0.01
GCA1508	8.55	140	<0.01
GCA1509	8.80	190	<0.01 (<0.01)
GCA1510	9.00	190	0.03
GCA1510 Rpt	9.05	180	-
GCA1511	8.70	220	0.13
GCA1512	8.95	170	0.48
GCA1513	9.10	170	0.38
GCA1514	9.25	130	<0.01
GCA1515	8.40	180	<0.01
GCA1516	9.10	140	<0.01
GCA1517	8.70	340	0.33
GCA1518	8.80	360	0.80
GCA1519	7.65	1000	2.0 (2.1)
GCA1520	9.40	170	0.33
GCA1520 Rpt	9.50	180	-
GCA1521	8.60	180	0.02
GCA1522	8.85	170	<0.01

(Analabs Pty. Ltd.) ACN 004 591 664
52 Murray Road Welshpool Western Australia 6106 Australia
Telephone: (61 9) 458 7278 Facsimile: (61 9) 451 3505

Australian Environmental Laboratories

CLIENT: Graeme Campbell & Associates **OUR REF:** 31201
YOUR REF: GCA9629

Sample Number	pH (pH Units)	Conductivity (µS/cm)	Total Sulphur S (%w/w)
GCA1523	8.75	220	0.04
GCA1524	8.65	450	0.83
GCA1525	8.70	290	3.2
GCA1526	8.50	470	0.71
GCA1527	8.45	320	0.02
GCA1528	8.50	280	0.02
GCA1529	8.65	190	0.03 (0.03)
GCA1530	8.65	410	0.93
GCA1530 Rpt	8.65	410	-
GCA1531	8.40	290	0.93
GCA1532	8.50	490	1.5
GCA1533	8.70	220	0.99

Notes: (1) pH and conductivity were determined on a 1:2 w/w extract of as received crushed sample to deionised water after 24 hours ambient aging.

(2) Total sulphur was determined by LECO induction furnace, IR detection on the as received pulped sample and is reported on that basis. Bracketed results from duplicate analysis.

Acid Neutralisation Capacity ANC

Sample Number	Fizz Rating	Initial Effervescence	Effervescence on Warming	ANC Solution pH	ANC (kg H_2SO_4/tonne)
GCA1500	2	moderate	nil	1.6	23
GCA1501	3	strong	nil	1.5	25
GCA1502	0	nil	nil	1.4	5.7
GCA1503	0	nil	nil	1.3	1.9
GCA1504	1	slight	nil	1.5	6.7
GCA1504 Rpt	1	slight	nil	1.5	6.7
GCA1505	0	nil	nil	1.1	<0.5
GCA1506	0	nil	nil	1.3	4.9
GCA1507	0	nil	nil	1.1	3.7
GCA1508	2	moderate	nil	0.3	240
GCA1509	3	strong	nil	0.5	410
GCA1509 Rpt	3	strong	nil	0.4	360
GCA1510	3	strong	nil	0.8	540
GCA1511	3	strong	nil	0.6	480
GCA1512	1	slight	nil	4.0	21
GCA1513	2	moderate	nil	3.5	57
GCA1514	1	slight	nil	4.1	17
GCA1514 Rpt	1	slight	nil	4.1	18
GCA1515	3	strong	nil	0.5	390
GCA1516	3	strong	nil	0.5	350
GCA1517	2	moderate	nil	0.5	380
GCA1518	2	moderate	nil	2.1	90
GCA1519	1	slight	nil	2.0	43

Australian Environmental Laboratories

CLIENT: Graeme Campbell & Associates **OUR REF:** 31201
YOUR REF: GCA9629

Sample Number	Fizz Rating	Initial Effervescence	Effervescence on Warming	ANC Solution pH	ANC (kg H_2SO_4/tonne)
GCA1519 Rpt	1	slight	nil	2.2	45
GCA1520	2	moderate	nil	2.7	47
GCA1521	3	strong	nil	0.4	340
GCA1522	3	strong	nil	0.5	340
GCA1523	3	strong	nil	0.6	510
GCA1524	3	strong	nil	0.6	140
GCA1524 Rpt	3	strong	nil	0.4	140
GCA1525	3	strong	nil	0.4	89
GCA1526	2	moderate	nil	1.2	32
GCA1527	3	strong	nil	0.5	380
GCA1528	3	strong	nil	0.6	490
GCA1529	3	strong	nil	0.6	420
GCA1529 Rpt	3	strong	nil	0.5	390
GCA1530	3	strong	nil	0.4	380
GCA1531	1	slight	nil	4.7	21
GCA1532	2	moderate	nil	0.4	160
GCA1533	moderate	nil	nil	1.8	35

Acid neutralisation capacity was determined on the as received crushed sample and is reported on that basis.

It is noted that the pH and EC extraction procedure and ANC are not covered by our terms of NATA registration.

Yours faithfully

PETER BAMFORD
Principal Environmental Scientist

MICK KOCH
Manager ICP

Australian Environmental Laboratories

5 November, 1996

Graeme Campbell & Associates Pty Ltd
Att: Dr G Campbell
PO Box 247
BRIDGETOWN WA 6225

Our reference: GRA203.0560-31450
Your reference: GCA9629
NATA registration: 1712

Dear Sir,

On the 25th of October 1996 you forwarded additional testwork instructions for selected samples from the thirty four (34) waste rock samples originally tested on our job number 31201. Twelve (12) crushed 2mm splits of the following samples were forwarded to Genalysis Laboratory Services, Maddington, on the 29/10/96.

GCA sample Numbers: 1508, 1522, 103, 1510, 1523, 1514, 1529, 1506, 1518, 1525 and 1524

The results of additional testwork requested follow:

Sample No.	Sulphate Sulphur (SO_4-S) %w/w
GCA 1501	0.02
GCA 1512	0.01
GCA 1518	0.02
GCA 1519	0.07
GCA 1524	0.02
GCA 1525	0.02
GCA 1526	0.04
GCA 1526 Rpt	0.04
GCA 1530	0.02
GCA 1531	0.02
GCA 1532	0.03
GCA 1533	0.02

Sulphate sulphur was determined in the 2mm crushed sample by Na_2CO_3 extraction, $BaSO_4$ precipitation, with results reported on the as received sample basis.

(Analabs Pty. Ltd.) ACN 004 391 664
52 Murray Road Welshpool Western Australia 6106 Australia
Telephone: (61 9) 458 7278 Facsimile: (61 9) 451 3505

Acid Neutralisation Capacity (ANC)

Sample No.	Fizz Rating	Initial Effervesence	Effervesence on warming	ANC Solution pH	ANC (kg H_2SO_4/tone)
GCA 1512	1	Slight	nil	0.5	47
1513	2	Moderate	nil	0.5	79
1514	1	Slight	nil	0.5	53
1531	1	Slight	nil	0.4	54
GCA 1531(Rpt)	1	Slight	nil	0.6	54

Acid neutralisation capacity was determined on the 2mm crushed sample and is reported on the as received sample weight basis.

Yours faithfully

PETER BAMFORD
Principal Environmental Scientist

Australian Environmental Laboratories

PB/smp

24 January, 1997

Graeme Campbell & Associates P/L
Att: Dr G Campbell
PO Box 247
BRIDGETOWN WA 6255

OUR REF: GRA203.0560.32352
YOUR REF: GCA9629/1
NATA Registration: 1712

Dear Sir

On the 3rd of January 1997 you forwarded testwork instuctions for two (2) soil samples (GCA sample numbers 1628 and 1629) and ten (10) waste rock samples (GCA samples numbers 1630 to 1639) later received at our laboratory together with a plastic cannister containing small,plastic speciman jars.

All twelve (12) samples wre crushed to a nominal 2mm particle size with a split retained for testwork and a second split crushed to a nominal 75µ particle size. The remaining crushed sample of GCA 1628 and GCA 1629, together with the plastic cannister, were forwarded to Genalysis Laboratory Services, Maddington, with the remaining crushed sample of GCA 1630 to GCA 1639 forwarded to the GCA testing laboratory.

The crushed and pulped splits retained for testwork gave results as follow:

Sample Number	pH (pH Units)	Conductivity (mS/cm)	Total Sulphur S (% w/w)
GCA 1628	6.7	110	0.33
GCA 1629	7.0	150	0.23
GCA 1630	8.6	360	0.21
GCA 1631	8.8	340	0.10
GCA 1632	8.6	310	0.16
GCA 1633	8.8	280	0.04
GCA 1634	8.5	500	0.93
GCA 1635	8.6	370	0.02
GCA 1636	8.5	550	0.36
GCA 1637	7.8	1800	3.2
GCA 1637 Rpt	7.8	1800	-
GCA 1638	8.8	190	0.14
GCA 1639	8.6	470	0.84

NOTES: 1. pH and EC were determined on a 1:2 w/w extract of crushed sample to deionised water after 24 hours ambient ageing

2. Total Sulphur was determined on the pulped sample by LECO induction furnace, 1R detection and is reported on the as received sample basis.

(Analabs Pty. Ltd.) ACN 004 591 664
52 Murray Road Welshpool Western Australia 6016 Australia
Telephone: (61 9) 458 7278 Facsimile: (61 9) 451 3505

Australian
Environmental
Laboratories

Acid Neutralisation Capacity (ANC)

Sample Number	Fizz Rating	Initial Effervesence	Effervesence on Warming	ANC Solution pH (pH Units)	ANC (Hg H_2SO_4/tonne)
GCA 1628	0	nil	nil	1.7	5.4
GCA 1629	0	nil	nil	1.9	3.4
GCA 1630*	2	Moderate	nil	0.6	380
GCA 1631*	2	Moderate	nil	0.6	440
GCA 1632*	2	Moderate	nil	0.6	430
GCA 1632 * (Rpt)	2	Moderate	nil	0.5	420
GCA 1633	2	Moderate	nil	0.5	280
GCA 1634*	2	Moderate	nil	0.6	400
GCA 1635*	2	Moderate	nil	0.6	330
GCA 1636*	2	Moderate	nil	0.5	460
GCA 1637*	1	Slight	nil	1.8	43
GCA 1637* (Rpt)	1	Slight	nil	1.8	43
GCA 1638*	1	Slight	nil	2.0	45
GCA 1639	2	Moderate	nil	2.4	51

Acid neutralisation capacity was detemined on the crushed sample and is reported on the as received sample basis. Samples marked with an asterisk (*) gave a green colouration as the titration approached the pH =7 end point.

It is noted that the pH and EC extraction procedure and ANC are not covered by our terms of NATA ragistration.

Yours faithfully
Australian Environmental Laboratories

PETER BAMFORD
Principal Environmental Scientist

National Association of Testing Authorities, Australia
NATA ENDORSED DOCUMENT

MICK KOCH
Manager - ICP

Australian Environmental Laboratories

7 February 1997

Graeme Campbell & Associates Pty Ltd
Attn: Dr G Campbell
PO Box 247
BRIDGETOWN WA 6255

YOUR REFERENCE: GRA203.0560.32650
YOUR REFERENCE: GCA9629/1
NATA REGISTRATION: 1712

Dear Sir

On the 23rd of Janaury 1997 you forwarded testwork instructions for five (5) waste rock samples, (GCA sample numbers 1628, 1629, 1634, 1637 and 1639) already held at our laboratories.

The 2mm crushed sample already held was used for the testwork with results as follows:

Sample No	Sulphate Sulphur (SO_4-S) (%w/w)
GCA1628	0.02
GCA1629	<0.01
GCA1634	0.02
GCA1637	0.10
GCA1639	0.03
GCA1639 Rpt	0.03

Results were determined by Na_2CO_3 extraction followed by $BaSO_4$ precipitation of extracted sulphate and results are reported on the as received sample basis.

Yours faithfully

PETER BAMFORD
Principal Environmental Scientist

(Analabs Pty. Ltd.) ACN 004 591 664
52 Murray Road Welshpool Western Australia 6106 Australia
Telephone: (61 9) 458 7278 Facsimile: (61 9) 451 3505

Graeme Campbell & Associates Pty Ltd

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	As-Received 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)		
GCA1501	1.9	slight fizzing after reacting overnight	6.8	10.6	430	-	<0.5
GCA1512	2.3	moderate fizzing after reacting overnight	6.6	9.5	270	-	<0.5
GCA1513	2.0	slight fizzing after reacting overnight	7.3	9.9	220	-	<0.5
GCA1518	2.4	moderate fizzing after reacting overnight	7.0	10.4	380	-	<0.5
GCA1518 (Repeat)	2.5	moderate fizzing after reacting overnight	7.0	10.5	380	-	<0.5
GCA1519	2.1	moderate fizzing after reacting overnight	6.8	8.5	530	-	<0.5
GCA1524	2.4	boiled in 8 hrs	8.3	8.9	260	-	<0.5
GCA1525	2.0	boiled in 4 hrs	7.2	7.9	1,000	-	<0.5
GCA1526	2.4	moderate fizzing after reacting overnight	7.8	9.3	290	-	<0.5
GCA1526 (Repeat)	2.4	slight fizzing after reacting overnight	7.2	9.4	350	-	<0.5
GCA1530	2.1	slight fizzing after reacting overnight	8.8	8.6	270	-	<0.5
GCA1531	2.5	boiled in 8 hrs	8.5	8.6	300	-	<0.5
GCA1532	2.6	boiled in 4 hrs	9.1	8.7	400	-	<0.5
GCA1533	2.2	slight fizzing after reacting overnight	6.8	8.7	350	-	<0.5
GCA1533 (Repeat)	2.0	slight fizzing after reacting overnight	6.7	8.7	330	-	<0.5
Blank 1	2.5		5.0	6.9	48	0.05	<0.5
Blank 2	2.9		5.1	6.7	44	0.05	<0.5

Notes:

1. The NAG Tests were carried out on pulps of the 'as-received' samples.
2. 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.

Dr GD Campbell
29 October 1996

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)		
GCA1634	2.0	Boiled within 6 hours.	8.7	8.8	350	-	<0.5
GCA1637	2.0	Boiled within 1 hour.	2.7	2.5	2,000	14.40	36
GCA1639	2.0	Boiled overnight.	8.3	8.2	330	-	<0.5
GCA1639 (Repeat)	2.0	Boiled overnight.	8.2	8.2	380	-	<0.5
Feldspar-Blank 1	2.0		5.6	7.3	55	-	<0.5
Feldspar-Blank 2	2.0		5.6	7.3	47	-	<0.5

Notes:

1. The NAG Tests were carried out on pulps of the 'as-received' samples.
2. 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.

Dr GD Campbell
30 January 1997

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1508 (10.7 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	8.3	0.2	0.2	0.9	0.9
0.17	6.2	0.3	0.5	1.4	2.3
0.33	5.9	0.3	0.8	1.4	3.7
1.0	6.8	0.4	1.2	1.8	5.5
2.3	6.8	0.4	1.6	1.8	7.3
3.0	6.6	0.4	2.0	1.8	9.1
5.0	7.2	0.4	2.4	1.8	10.9

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1519 (10.6 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	8.3	0.2	0.2	0.9	0.9
0.17	5.7	0.2	0.4	0.9	1.8
0.33	5.0	0.1	0.5	0.5	2.3
1.0	6.2	0.3	0.8	1.4	3.7
2.3	4.5	0.1	0.9	0.5	4.2
3.0	5.4	0.2	1.1	0.9	5.1
5.0	6.0	0.2	1.3	0.9	6.0

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1523 (10.3 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	8.9	0.6	0.6	2.9	2.9
0.17	6.0	0.8	1.4	3.8	6.7
0.33	5.5	0.8	2.2	3.8	10.5
1.0	5.8	0.4	2.6	1.9	12.4
2.3	5.9	0.6	3.2	2.9	15.3
3.0	5.8	0.5	3.7	2.4	17.7
5.0	6.5	0.5	4.2	2.4	20.1

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1510 (10.0 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	9.1	0.4	0.4	2.0	2.0
0.17	6.1	0.4	0.8	2.0	4.0
0.33	5.8	0.6	1.4	2.9	6.9
1.0	6.0	0.5	1.9	2.4	9.3
2.3	6.0	0.4	2.3	2.0	11.3
3.0	6.0	0.5	2.8	2.4	13.7
5.0	6.7	0.5	3.3	2.4	16.1

Notes:

The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.

The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.

The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.

After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1522 (10.7 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	9.1	2.4	2.4	11.0	11.0
0.17	5.5	0.8	3.2	3.7	14.7
0.33	5.3	0.7	3.9	3.2	17.9
1.0	5.7	0.9	4.8	4.1	22.0
2.3	5.6	0.5	5.3	2.3	24.3
3.0	5.9	0.5	5.8	2.3	26.6
5.0	7.0	0.5	6.3	2.3	28.9

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1528 (10.2 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	9.1	3.0	3.0	14.4	14.4
0.17	5.5	1.3	4.3	6.2	20.6
0.33	5.5	2.3	6.6	11.0	31.6
1.0	5.6	1.3	7.9	6.2	37.8
2.3	5.9	1.0	8.9	4.8	42.6
3.0	5.9	0.8	9.7	3.8	46.4
5.0	6.8	1.0	10.7	4.8	51.2

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Graeme Campbell & Associates Pty Ltd

Laboratory Report

MODIFIED-ANC TESTWORK

(ANC = Acid-Neutralisation Capacity)

GCA1531 (10.2 g)					
REACTION TIME (days)	**pH**	**TITRE OF 0.5 M-H_2SO_4**		**ACID CONSUMPTION**	
		Incremental Titre (mL)	**Cumulative Titre (mL)**	**Incremental**	**Cumulative**
				kg H_2SO_4/tonne	
0.00	8.7	0.3	0.3	1.4	1.4
0.17	6.0	0.3	0.6	1.4	2.8
0.33	5.5	0.2	0.8	1.0	3.8
1.0	5.8	0.3	1.1	1.4	5.2
2.3	5.7	0.2	1.3	1.0	6.2
3.0	5.9	0.3	1.6	1.4	7.6
5.0	6.0	0.3	1.9	1.4	9.0

Notes:
The Modified-ANC Test was carried out on the 'as-received' sample, and using 100 mL of deionised water to prepare the test-mixture slurry prior to addition of 0.5 M-H_2SO_4.
The addition of 0.5 M-H_2SO_4 was undertaken at different times on the test-mixture slurry, agitated using a magnetic stirrer.
The 0.5 M-H_2SO_4 was added until pH 3.0-3.5 was reached.
After this time, the test mixture was left to stand in contact with the air until the next titre addition.

Dr GD Campbell
10 November 1996

Genalysis Laboratory Services Pty. Ltd.

ANALYSTS AND CONSULTING CHEMISTS
ACN: 008 787 237

ATTENTION Dr GRAEME CAMPBELL
CAMPBELL GRAEME & ASSOCIATES
PO BOX 247
BRIDGETOWN WA 6255
AUSTRALIA

Analytical Report

COMMENTS
ATTENTION: G CAMPBELL ..
UNSPEC....

JOB INFORMATION

JOB CODE	:143.0/966815
No. SAMPLES	:12
ELEMENTS	:33
CLIENT O/N	:GCA9629
DATE RECEIVED	:29/10/96
DATE COMPLETED	:12/11/96

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

MAIN OFFICE AND LABORATORY
17 DAVISON ST, MADDINGTON, WA 6109
P.O. BOX 144 GOSNELLS WA 6110
Tel:(09)459 9011 Fax:(09)459 5343

KALGOORLIE SAMPLE PREPARATION DIVISION
12 KEOGH WAY, KALGOORLIE WA 6430
P.O. BOX 388 KALGOORLIE WA 6430
Tel:(090)21 2881 Fax:(090)21 3476

SAMPLE DETAILS

SAMPLE STATE(S) & SAMPLE PREPARATION(S)

Sample State Not Specified
Dry, Single Stage Mix & Grind (zirconia bowl)

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS :
SAMPLE STORAGE OF SOLIDS
Bulk Residues and Pulps will be stored for 60 days without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.20/cubic metre/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.

SAMPLE STORAGE OF SOLUTIONS
Samples received as liquids ,waters or solutions will be held for 6 weeks free of charge then disposed of , unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Registration Number 3244

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

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

The twelve samples, as listed in the report, were received as being waste rock samples, which required drying at 45 Degrees Celcius prior to pulverising in a zirconia bowl.

The samples have been analysed according to standard methods.
The analysis included the assay of blanks and certified reference materials SY3, SY4 and MRG1, as well as in-house reference standards AE06 and HgSTD.

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

T. K. Chan

NATA Signatory: T K Chan
Chief Chemist - Special Projects

Date: 12th November 1996

ANALYSIS

ELEMENTS	B	C	F	Na	Mg	Al	P	S	K	Ca	V
UNITS	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	50	0.005	50	20	20	20	20	10	20	10	2
METHOD	D/OES	/LECO	DH/SIE	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES
SAMPLE NUMBERS											
1 GCA1502	150	0.145	550	340	3600	6.40%	360	1100	3.10%	2350	62
2 GCA1503	150	0.075	700	440	5200	7.80%	180	30	3.90%	620	88
3 GCA1506	200	0.080	700	300	4500	7.80%	320	40	3.90%	2200	78
4 GCA1508	50	2.900	450	140	5.40%	4.10%	700	50	4200	4.60%	280
5 GCA1510	50	4.600	400	100	8.00%	3.30%	620	300	120	7.80%	180
6 GCA1514	150	0.810	750	400	1.18%	8.20%	440	1180	4.10%	8800	78
7 GCA1518	150	1.500	900	300	1.80%	8.20%	380	7400	4.10%	2.30%	74
8 GCA1519	150	1.190	1100	340	1.45%	8.40%	500	1.90%	4.00%	1.35%	80
9 GCA1522	50	1.290	450	200	10.20%	3.90%	900	X	280	5.60%	230
10 GCA1523	X	3.990	500	140	8.20%	3.50%	680	320	80	6.60%	185
11 GCA1524	50	1.990	200	160	1.65%	1.65%	280	7400	7400	3.10%	72
12 GCA1525	100	1.260	450	240	1.35%	4.30%	260	3.00%	2.05%	2.00%	64
Ch.0001(GCA1502)	150	0.150	600	340	3700	6.40%	380	1100	3.20%	2400	62
STD: SY3				2.95%	1.70%	6.20%	2400	500	3.60%	6.00%	54
STD: SY3											
STD: SY3											
STD: AE0-6											
STD: SY3	150										
STD: AE0-6											
STD: MRG1			250								
STD: HgSTD											
STD: AE0-6											
STD: SY4		0.960									

ANALYSIS

ELEMENTS	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Sr	Mo
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	2	1	0.01	1	1	1	1	2	0.01	0.1	0.5
METHOD	A/OES	A/OES	D/OES	A/MS	A/AAS	A/AAS	A/AAS	A/MS	BP/MS	A/MS	A/MS
SAMPLE NUMBERS											
1 GCA1502	52	45	3.10	5	62	28	15	106	0.28	45.0	1.0
2 GCA1503	68	84	2.55	8	40	15	18	74	0.05	34.0	0.5
3 GCA1506	80	60	4.50	4	13	12	10	130	0.12	46.0	3.0
4 GCA1508	880	1950	10.60	47	740	47	86	78	0.03	26.0	1.0
5 GCA1510	800	2200	8.20	60	600	48	64	12	0.33	330.0	0.5
6 GCA1514	80	1100	3.10	11	42	28	22	40	0.09	22.5	0.5
7 GCA1518	78	900	2.15	25	42	140	21	760	0.04	24.5	0.5
8 GCA1519	72	720	3.40	32	49	300	20	450	0.09	42.0	2.5
9 GCA1522	860	1100	9.00	82	740	13	135	34	0.08	280.0	X
10 GCA1523	800	3700	8.60	62	620	74	74	96	0.06	34.0	0.5
11 GCA1524	275	1600	2.15	27	240	98	19	860	0.19	35.0	1.0
12 GCA1525	140	940	4.10	230	165	370	29	9200	* 0.27	17.5	1.5
Ch.0001(GCA1502)	50	44	3.20	4	54	27	13	106	0.24	46.0	0.5
STD: SY3	6	2600									
STD: SY3				11				22		320.0	0.5
STD: SY3					13	18	230				
STD: AE0-6			4.50								
STD: SY3											
STD: AE0-6											
STD: MRG1											
STD: HgSTD											
STD: AE0-6											
STD: SY4									1.45		

ANALYSIS

ELEMENTS	Ag	Cd	Sn	Sb	Ba	Hg	Tl	Pb	Bi	Th	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.1	0.1	1	0.2	1	0.01	0.2	2	0.1	0.1	0.1
METHOD	BX/AAS	BX/AAS	A/MS	A/MS	A/MS	C*CVAP	A/MS	A/AAS	BX/MS	A/MS	A/MS
SAMPLE NUMBERS											
1 GCA1502	1.0	X	6	11.4	350	0.03	0.8	12	0.1	14.5	3.5
2 GCA1503	X	X	18	5.4	560	0.01	0.8	10	0.1	16.0	3.4
3 GCA1506	0.2	X	28	19.5	360	0.02	0.6	16	0.3	16.5	3.1
4 GCA1508	X	X	15	28.5	145	0.01	X	26	0.1	1.4	0.8
5 GCA1510	X	X	1	5.6	32	0.04	X	8	X	0.8	0.3
6 GCA1514	0.4	X	5	9.6	480	0.01	0.6	12	0.2	16.0	3.6
7 GCA1518	0.6	X	8	15.5	440	0.03	1.0	22	0.3	17.5	3.9
8 GCA1519	2.8	X	52	20.5	390	0.05	0.8	36	3.5	17.5	3.8
9 GCA1522	X	X	1	7.6	80	X	X	18	X	1.2	0.3
10 GCA1523	X	X	1	7.6	41	X	X	16	X	1.1	0.3
11 GCA1524	1.6	X	1	29.5	58	0.03	0.2	16	0.4	0.8	0.8
12 GCA1525	4.4	X	42	66.0	250	0.06	0.4	58	3.0	8.2	1.9
Ch.0001(GCA1502)	1.2	X	6	12.0	360	0.03	0.6	12	0.2	15.0	3.4
STD: SY3											
STD: SY3			6	0.4	440		1.0			1020.0	660.0
STD: SY3											
STD: AE0-6	1.2	1.9						140			
STD: SY3											
STD: AE0-6											
STD: MRG1									20.5		
STD: HgSTD											
STD: AE0-6						0.32					
STD: SY4											

METHOD CODE DESCRIPTIONS

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

/LECO
LECO Analyser.

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

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

A/MS
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

A/AAS
Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids.
Analysed by Flame Atomic Absorption Spectrometry.

BP/MS
Aqua-Regia digest followd by Precipitation and Concentration.
Specific for Selenium.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

BX/AAS
Modified Aqua-Regia digest for low detection of indicator elements.
Analysed by Flame Atomic Absorption Spectrometry.

C*CVAP
Modified Perchloric acid digest.
Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.

BX/MS
Modified Aqua-Regia digest for low detection of indicator elements.
Analysed by Inductively Coupled Plasma Mass Spectrometry.

Genalysis Laboratory Services Pty. Ltd.

ANALYSTS AND CONSULTING CHEMISTS
ACN: 008 787 237

ATTENTION Dr GRAEME CAMPBELL
CAMPBELL GRAEME & ASSOCIATES
PO BOX 247
BRIDGETOWN WA 6255
AUSTRALIA

Analytical Report

COMMENTS
ATTENTION: DR G CAMPBELL ..
SOIL....

JOB INFORMATION

JOB CODE	:143.0/970073
No. SAMPLES	:2
ELEMENTS	:33
CLIENT O/N	:GCA9629/1
DATE RECEIVED	:09/01/97
DATE COMPLETED	:24/01/97

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

MAIN OFFICE AND LABORATORY
17 DAVISON ST, MADDINGTON, WA 6109
P.O. BOX 144 GOSNELLS WA 6110
Tel: (09) 459 9011 Fax: (09) 459 5343

KALGOORLIE SAMPLE PREPARATION DIVISION
12 KEOGH WAY, KALGOORLIE WA 6430
P.O. BOX 388 KALGOORLIE WA 6430
Tel: (090) 21 2881 Fax: (090) 21 3476

SAMPLE DETAILS

SAMPLE STATE(S) & SAMPLE PREPARATION(S)

SOIL SAMPLES
Dry, Single Stage Mix & Grind (zirconia bowl)

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS :
SAMPLE STORAGE OF SOLIDS
Bulk Residues and Pulps will be stored for 60 days without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.20/cubic metre/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.

SAMPLE STORAGE OF SOLUTIONS
Samples received as liquids ,waters or solutions will be held for 6 weeks free of charge then disposed of , unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Registration Number 3244

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

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

The two samples, GCA1628 and GCA1629, were received as being soil samples which were mixed and split to 100g portions prior to drying at 45 Degrees Celcius and pulverising in a Zirconia bowl.

The results have been determined according to standard methods for the determination of metals.

The results included the assay of blanks and certified reference materials SY3, MRG1 and CH-3, as well as in-house references AEO-6 and Hg-STD. The results are expressed as parts per million or percent in the dried and prepared sample.

NATA Signatory: T K Chan
Chief Chemist - Special Projects

Date: 24th January 1997

ANALYSIS

ELEMENTS	B	C	F	Na	Mg	Al	P	S	K	Ca	V
UNITS	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	50	0.005	50	20	20	20	20	10	20	10	2
METHOD	D/OES	/LECO	DH/SIE	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES	A/OES
SAMPLE NUMBERS											
1 GCA1628	X	0.750	50	3600	6400	5.20%	100	140	7400	9200	200
2 GCA1629	X	0.610	50	4500	8600	5.60%	120	1180	9400	1.14%	230
Ch.0001(GCA1628)	X	0.745	100	3600	6600	5.20%	100	140	7600	9400	210
STD: SY3				2.95%	1.60%	6.20%	2350	520	3.50%	5.80%	54
STD: SY3											
STD: AE0-6											
STD: AE0-6											
STD: SY3	100										
STD: MRG1			250								
STD: HgSTD											
STD: AE0-6											
STD: CH-3		1.700									

ANALYSIS

ELEMENTS	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Sr	Mo
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	2	1	0.01	1	1	1	1	0.5	0.01	0.1	0.5
METHOD	A/OES	A/OES	D/OES	A/MS	A/AAS	A/AAS	A/AAS	BX/MS	BP/MS	A/MS	A/MS
SAMPLE NUMBERS											
1 GCA1628	54	3100	5.80	84	43	28	30	1.5	0.02	29.0	0.5
2 GCA1629	56	4300	7.00	140	60	70	33	1.5	0.04	41.0	0.5
Ch.0001(GCA1628)	56	3100	5.80	86	41	30	32	1.5	0.02	29.5	0.5
STD: SY3	8	2500									
STD: SY3				10						320.0	1.0
STD: SY3					12	16	230				
STD: AE0-6											
STD: AE0-6											
STD: SY3								255.0			
STD: MRG1			4.60								
STD: HgSTD											
STD: AE0-6											
STD: CH-3									1.40		

ANALYSIS

ELEMENTS	Ag	Cd	Sn	Sb	Ba	Hg	Tl	Pb	Bi	Th	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.1	0.1	1	0.2	1	0.01	0.2	2	0.1	0.1	0.1
METHOD	BX/AAS	BX/AAS	A/MS	A/MS	A/MS	C*CVAP	A/MS	A/AAS	BX/MS	A/MS	A/MS
SAMPLE NUMBERS											
1 GCA1628	X	X	1	X	400	X	X	18	0.1	7.4	0.8
2 GCA1629	0.2	X	2	X	520	X	0.2	24	9.6	8.2	0.9
Ch.0001(GCA1628)	X	X	1	X	400	X	0.2	18	0.1	7.8	0.9
STD: SY3											
STD: SY3			6	0.2	400		1.2			920.0	620.0
STD: SY3											
STD: AE0-6	1.4	2.0						145			
STD: AE0-6											
STD: SY3									20.5		
STD: MRG1											
STD: HgSTD											
STD: AE0-6						0.27					
STD: CH-3											

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