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TECHNICAL MEMORANDUM

DATE	23 November 2022	**REF**	NSWDPE239607
TO	Ms Rose-Anne Hawkeswood – NSW Department of Planning and Environment	**REV**	1
FROM	Sophie Pape, Earth Systems Jeff Taylor, Earth Systems	**PROJECT**	Bowdens Silver Mine

UPDATE ON INDEPENDENT REVIEW – ACID AND METALLIFEROUS DRAINAGE

INTRODUCTION

The New South Wales Department of Planning and Environment (NSWDPE) has requested an independent review and advice in relation to acid and metalliferous drainage (AMD), water balance modelling and surface water management aspects of the proposed Bowden Silver Mine. Earth Systems were key authors of the Federal Government's Leading Practice handbooks on "*Managing Acid and Metalliferous Drainage*" (DITR, 2007) and "*Preventing Acid and Metalliferous Drainage*" (DIIS, 2016).

A Memorandum was prepared on 31 May 2022, summarising the key findings of Earth Systems' independent high level review with a focus on AMD / geochemical characterisation, impact assessment and related management aspects of the proposed mine development. The Memorandum is included as Attachment A.

One of the key conclusions documented in Earth Systems (2022a) was that the AMD risk classification was considered inappropriate for the Project, resulting in inaccurate predictions of potentially acid forming (PAF) and non acid forming (NAF) material tonnages. This will affect waste rock dump design and the availability of NAF materials for construction / rehabilitation requirements. A subsequent Memorandum prepared by Earth Systems (2022b) focussed on the issue of AMD risk classification, to provide further clarification of concerns regarding the AMD risk classification system proposed by Bowdens Silver and outline additional work that would assist in addressing these concerns (refer to Attachment B).

A response to Earth Systems' Memorandum dated 31 May 2022, was subsequently received in October 2022 (Corkery, 2022).

Independent assessment of all available static geochemistry data – sourced from GCA (2020) – has been conducted by Earth Systems using AMDact software, which is based on industry standard AMD risk classification methods (refer to Attachment C and D).

With all of the above taken into consideration, NSWDPE has requested an update of Earth Systems advice relating to AMD for the proposed Bowdens Silver Mine, as outlined below.

UPDATED CONCLUSIONS

A significant proportion of waste rock (anywhere between 44% and >57%; refer to Attachment B) and the majority of low grade ore, ore and tailings generated from the Project is expected to be potentially acid forming (PAF). Acid and metalliferous drainage (AMD) is therefore a significant potential water quality risk for the Project, that is likely to commence during operations and continue into the long term post-closure, based on the current AMD management strategy. Key concerns are summarised in Table 1.

Table 1. Summary of key conclusions from Earth Systems' Memorandum dated 31 May 2022, additional relevant information, and potential conditions for NSWDPE approval. Refer to Attachment A for further context to Earth Systems' conclusions and more detailed recommendations to support the potential conditions outlined here.

Earth Systems Conclusions - 31 May 2022	Additional Information	Potential Conditions for NSWDPE Approval
1. Geochemical characterisation work conducted to date is considered to be preliminary only. Much more static geochemistry data are required to establish a reliable and practical AMD risk classification system for the Project.	Additional information collected by Bowdens Silver since the EIS includes multi-element assay data, hyperspectral scanning, petrological observations, SEM analyses and XRD analysis (Corkery, 2022). The above methods can only be used to support AMD risk classification system development if samples are subjected to conventional static geochemistry analyses (including ABA, NAG suite, sulfur and carbon speciation) in parallel with one or more of these methods. No additional static geochemistry analysis (including ABA, NAG suite, sulfur and carbon speciation) has been conducted since the EIS. It is a concern that 6.3 Mt of "PZ2" material (defined as having Total Sulfur 0.1-0.3 wt.% S and "situated chiefly in northern section of the main open cut pit"; Corkery, 2022) is classified as NAF, but static geochemistry data are available for only 5 samples from the northern section of the proposed main pit with Total Sulfur of 0.1-0.3 wt.% S, and 2 of these 5 samples were classified as PAF (GCA, 2020; Table 14).	Noting that geochemical characterisation work conducted to date is preliminary only: • Prior to mining, conduct detailed static geochemistry test work including ABA, NAG suite, sulfur and carbon speciation, on at least 1 representative sample per 10,000 tonnes of waste rock material to determine whether a suitable AMD risk classification system can be developed for the northern section of the proposed main open cut pit. and/or • Prior to mining, conduct QXRD test work on sufficient representative samples from the northern section of the proposed main open cut pit to verify suitability of proposed "residual" wt.%S algorithm with a 0.0 wt.% S cutoff value applied to delineate PAF and NAF waste rock. and

Earth Systems Conclusions - 31 May 2022	Additional Information	Potential Conditions for NSWDPE Approval
	Bowdens Silver's high level of confidence in the "spatial uniformity of the environmental geochemistry of the waste zones" (Corkery, 2022) does not address this concern. If the static geochemistry data are believed to be representative, then 40% of "PZ2" materials could be classified as PAF, confirming that the AMD classification system is not suitable. Independent assessment of all available static geochemistry data (GCA, 2020) has been conducted by Earth Systems using AMDact software, which is based on industry standard AMD risk classification methods. Separate AMDact assessments were conducted as follows (refer to Attachment C and D): ▸ 127 samples from the 2012-13 static geochemistry dataset, broadly representing the "weathered and fresh rock zones of the geologic profile" (GCA, 2020). ▸ 16 samples from the 2017-18 static geochemistry dataset, focussing on the northern section of the main pit. Assay data for 90 samples collected in 2017-18 were also considered (including Total Sulfur, Total Carbon and CO_3-carbon). The 2012-13 data assessment (Attachment C) indicates that a more conservative Total Sulfur cutoff value may be warranted for the main pit excluding the northern section (ie. 0.2 wt.%S), noting that some waste rock with 0.25 wt.% S may be PAF (NAG pH <4.5). The 2017-18 data assessment (Attachment D) also indicates that the proposed Total Sulfur cutoff value of 0.3 wt.% S for the northern section of the main pit is not suitable. Assay data (for 90 samples collected in 2017-18) were found to be unreliable for predicting static geochemistry characteristics (eg. poor correlation between CO_3-C and laboratory ANC data). A reliable AMD risk classification method for this part of the deposit could not be identified from the limited static geochemistry data (noting only 16 samples were available).	• For the main pit excluding the northern section, utilise a more conservative Total Sulfur cutoff value (0.2 wt.%S) during the initial stages of mining, with the potential to transition to a 0.3 wt.% S cutoff value if this can be supported by more detailed static geochemistry analysis conducted during mining, including Total Sulfur (by Leco furnace), ANC and/or NAG pH as a minimum.

Earth Systems Conclusions - 31 May 2022	Additional Information	Potential Conditions for NSWDPE Approval
2. The behaviour of sulfidic mine waste materials over time is poorly understood and additional kinetic test work is required to address this. From the test work conducted to date, it has not been possible to quantify the rate of pyrite oxidation / acidity generation processes, the "lag time" before acid conditions will develop, or the longevity of AMD generation from PAF waste rock or tailings.	No additional kinetic geochemistry test work has been conducted since the EIS. As such, it has not been possible to quantify the rate of pyrite oxidation / acidity generation processes nor the longevity of AMD generation from PAF waste rock or tailings. Corkery (2022) estimated that the "lag time" for PAF waste rock could range up to approximately 12 months and noted that a number of PAF samples were acidic at the commencement of the kinetic testing program (ie. effectively zero "lag time"), indicating that AMD generation could commence immediately upon dewatering / disturbance of PAF waste rock. No tailings samples have been subjected to kinetic test work to date.	Prior to mining, use kinetic test work data to quantify pyrite oxidation / acidity generation rates and the duration of acid generation from PAF waste rock. and Prior to mining, develop an AMD Treatment Plan, as part of a site-wide AMD Management Plan, noting the potential for immediate / short term AMD generation from PAF waste rock upon dewatering / disturbance. and Upon commencement of ore processing, conduct kinetic test work to quantify the rate of pyrite oxidation / acidity generation processes, the "lag time" before acid conditions will develop, and the longevity of AMD generation from PAF tailings. and During mining, conduct field-based kinetic test work to develop an understanding of the depth of O_2 diffusion into PAF waste rock and tailings.
3. The AMD risk classification system is considered inappropriate for this Project, resulting in inaccurate predictions of PAF and NAF material tonnages. This will affect waste rock dump design and the availability of non acid forming (NAF) materials for construction / rehabilitation requirements. The mine block model and materials schedule will need to be updated to better quantify tonnages based on geochemistry / water quality risk and suitability for construction or rehabilitation.	Refer to Item 1 (above).	Refer to Item 1 (above).

<table>
<tr><th>Earth Systems Conclusions - 31 May 2022</th><th>Additional Information</th><th>Potential Conditions for NSWDPE Approval</th></tr>
<tr><td>4. There appears to be a significant potential for acidic drainage (associated with alunite and jarosite) or neutral and metalliferous drainage (NMD) from mine materials that have been classified as “NAF”. The EIS appears to assume that “NAF” waste rock is benign and drainage water quality will be suitable for discharge without treatment / management. A clear strategy is required to address these potential water quality risks from “NAF” waste rock.</td><td>Regarding alunite and jarosite:
▸ Corkery (2022) notes that just 9 alunite intervals and 7 jarosite intervals were identified from 9,922 hyperspectral measurements of 5,500 m of drilling, and these occurrences were principally constrained to waste material classed as PZ3 (PAF).
▸ This observation appears to be at odds with:
• GCA (2020) which states that, of the 54 samples with Total Sulfur <0.3 wt.%, the Total Sulfur occurs almost exclusively as SO_4-S, with the main SO_4-bearing minerals being alunite and jarosite.
• Appendix 1 (Corkery, 2022) which notes the presence of minor jarosite in the oxidised zone.
• The definitions of “NAF” WZ1 materials and “NAF” PZ2 materials in Table 2 of Corkery (2022).
▸ Hyperspectral data may not have sufficient resolution to identify the presence of these mineral/s at minor concentrations, but even minor (10-20%) or trace (up to 2%) concentrations may be an issue noting their presence in relatively large tonnages of “NAF” WZ1 materials (10 Mt) and “NAF” PZ2 materials (6.3 Mt).
Regarding NMD:
▸ Bowdens Silver acknowledges that other potential sources of NMD relating to the presence of manganese in reactive carbonate forms do occur in waste material classed as NAF (Corkery, 2022).
▸ GCA(2020) considered the future demarcation of sub-variants of the PZ2 mining stream based on manganese content (eg. 0.1% Mn cut-off between 'Low-Mn' and 'High-Mn’ PZ2 sub-variants) which is now supported by Bowdens Silver (Corkery, 2022).</td><td>Prior to mining, develop a management strategy for “NAF” mine materials that contain alunite and jarosite, as part of a site-wide AMD Management Plan, noting the uncertainty / inconsistency in information collected to date.*#
and
Prior to mining, review static and kinetic geochemistry data, or conduct additional static and kinetic geochemistry test work, to assess the suitability of the suggested method for identifying NMD risk.
and
Avoid the use of “NAF” waste rock with potential for acidic drainage (associated with alunite and jarosite)* or neutral and metalliferous drainage (NMD) for construction purposes, including the southern barrier that encroaches on the current alignment of Blackmans Gully.

** Use of a more conservative Total Sulfur cutoff value than the proposed 0.3 wt.% S (refer to Item 1) may enable effective segregation of waste rock containing alunite / jarosite alongside other (pyritic) PAF waste rock.*
 # Management strategies could simply involve strategic blending with high-ANC NAF waste rock and/or limestone.</td></tr>
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<table>
<tr><th>Earth Systems Conclusions - 31 May 2022</th><th>Additional Information</th><th>Potential Conditions for NSWDPE Approval</th></tr>
<tr><td>5. Earth Systems has little confidence in the current AMD management strategy for waste rock and tailings. For example:
► The waste rock dump design is unproven and appears substantially problematic, with initial indications that the site could be establishing the need for water treatment in perpetuity. Large-scale laboratory test work and/or field trials with appropriate instrumentation are needed prior to construction, to demonstrate that waste rock placement methods will sufficiently limit air entry to PAF waste rock and allow water quality objectives to be achieved. Additional management measures are required for the outer layer of PAF waste rock (eg. 10-metre oxygen diffusion front as reported) that remains exposed to air entry during operations / post closure. Additional measures are required to manage other water quality risks from “NAF” rock. Near-surface PAF material in the final waste rock dump landform should be avoided.
► More detailed assessment of potential AMD impacts from tailings during operations and post-closure is warranted. AMD from the tailings (surface water and seepage) could become a particularly significant issue post-closure as the tailings are progressively drained. Kinetic test work and a strategy for management of PAF tailings is required.
► Store-and-release covers are used widely, but almost never in recent years for the</td><td>No changes have been made to the proposed waste rock dump design since the EIS.
The current design still includes near-surface PAF material in the final waste rock dump landform, directly beneath a GCL and 1.8-3.0 m NAF / subsoil and topsoil layer. Considering the limited design life of any GCL, long term control of air entry and AMD generation from PAF waste rock (or tailings) remains a key concern.
Corkery (2022) states that:
“The proposed approach and alternative options for the cover system of the WRE would be tested during development of the WRE to inform Mine closure. Alternative options may include a greater depth of NAF waste rock applied to the surface or additional liners such as the GCL, however based on the current understanding of the local setting and the materials to be encapsulated the current approach is considered the most appropriate. The testing of cover options for the WRE and triggers for the implementation of alternative approaches would be described in the Mine’s Rehabilitation Management Plan with commitments to testing and the presentation of outcomes described in the Forward Program and annual Rehabilitation Report”.
and
“Reliance would be placed on technical guidance such as that provided in Rock Placement Strategies to Enhance Operational and Closure Performance of Mine Rock Stockpiles (INAP, 2020). That document in particular describes opportunities to improve closure performance by reducing lift heights, improving layering density of materials and the use of methods to improve encapsulation, incorporate oxygen consuming materials and incorporate sulfide passivation.”</td><td>Prior to construction, update waste rock dump design based on large-scale laboratory test work and/or field trials with appropriate instrumentation, to demonstrate that waste rock placement methods will sufficiently limit air entry to PAF waste rock and allow water quality objectives to be achieved. As part of the waste rock dump design:
► Additional management measures are required for the outer layer of PAF waste rock (oxygen diffusion front) that is exposed to air entry during operations / post closure.
► Avoid near-surface PAF material in the final waste rock dump landform, noting that GCL liners have a limited design life, store-and-release covers are not suitable for AMD control, and the longevity of AMD generation from PAF waste rock is unknown but may continue for hundreds of years.
► Provide documentation with detailed supporting data to justify the specific strategies selected (eg. from INAP, 2020) and the detailed design specifications.
and
Upon commencement of ore processing:
► Develop an AMD management strategy for tailings including the potential need for treatment of AMD / NMD in TSF seepage and decant water, during operations and post closure.
► Avoid reliance on TSF covers for long term post-closure AMD control, noting that GCL</td></tr>
</table>

Earth Systems Conclusions - 31 May 2022	Additional Information	Potential Conditions for NSWDPE Approval
purposes of AMD control. The proposed store-and-release cover systems are not considered an appropriate strategy for PAF waste rock or PAF tailings management.		liners have a limited design life, store-and-release covers are not suitable for AMD control, and the longevity of AMD generation from PAF tailings is unknown but may continue for hundreds of years. and Prior to mining, integrate waste rock and tailings management strategies into a site-wide AMD Management Plan.
6. Pit lake water quality issues associated with AMD generation within the pit wallrock, including floor rock and highwall materials, have not been considered for the operations or post-closure phases of the Project. Potential AMD impacts on pit water quality should be assessed and a management strategy developed.	Potential AMD impacts on pit water quality have not been assessed in any detail.	Prior to mining, conduct an assessment of the potential AMD impacts on pit water quality during operations and post-closure, and integrate pit void water treatment / management strategies into a site-wide AMD Management Plan.

ADDITIONAL RECOMMENDATIONS

Further to the potential conditions for NSWDPE approval outlined in Table 1, the following additional recommendations are provided:

- Prior to mining, develop a stand-alone site-wide AMD Management Plan and employ a qualified geochemist to ensure its effective implementation throughout the mine life.
- Prior to construction, develop an AMD management strategy for low grade ore as part of the updated waste rock dump design (refer to Table 1).
- During mining, conduct geochemical characterisation of “oxide ore” material to assess the risk of AMD or other water quality issues similar to those for weathered waste rock material.
- Prior to construction of the southern barrier in Blackmans Gully, assess the potential implications of seepage from ”NAF” waste rock material into receiving surface water, noting that suitability of the suggested method for identifying NMD risk has not yet been verified with static and kinetic geochemistry data (refer to Table 1).
- Prior to mining, develop an AMD management strategy for stockpiled PAF ore material as part of a site-wide AMD Management Plan.

Refer to Attachments A and B for further context and more detailed findings and comments to support the above recommendations.

REFERENCES

Advisian (2020a). *Preliminary Design of PAF Waste Rock Emplacement, Oxide Ore Stockpile and the Southern Barrier. Bowdens Silver Project.* Consultants report prepared by Advisian for Bowdens Silver Pty Ltd. 7 May 2020. 201010-00790—REP-002.

Advisian (2020b). *TSF and WRE Closure Cover Design. Bowdens Silver Project.* Consultants report prepared by Advisian for Bowdens Silver Pty Ltd. 7 May 2020. 201012-00683-SS-REP-0001.

Corkery (2022). *Response to Earth Systems Review – Acid and Metalliferous Drainage*. Consultants report prepared by R. W. Corkery & Co. Pty Ltd. October 2022.

DIIS (2016). *Preventing Acid and Metalliferous Drainage*. Leading Practice for Sustainable Development Program for the Mining Industry. Australian Government. Department of Industry, Innovation and Science. September 2016.

DITR (2007). *Managing Acid and Metalliferous Drainage*. Leading Practice for Sustainable Development Program for the Mining Industry. Australian Government. Department of Industry, Tourism and Resources. February 2007.

Earth Systems (2022). *Independent Review – Acid and Metalliferous Drainage. Bowdens Silver Mine*. Technical memorandum prepared for the New South Wales Department of Planning and Environment (NSWDPE).

GCA (2020). Materials Characterisation Assessment. *Bowdens Silver Project.* Consultants report prepared by Graeme Campbell & Associates Pty Ltd for Bowdens Silver Pty Ltd. May 2020.

GCA (2022). *Bowdens Silver Project: Computational Approach Employing %S, %Ca and %Mg Assays in Geological Database for Mining-Stream Classification*. Memorandum prepared by Graeme Campbell & Associates Pty Ltd for Bowdens Silver Pty Ltd. 11 August 2022.

INAP (2020). *Rock Placement Strategies to Enhance Operational and Closure Performance of Mine Rock Stockpiles*. Prepared by Earth Systems and O'Kane Consultants for the International Network on Acid Prevention.

Attachment A

Independent Review - Acid and Metalliferous Drainage

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TECHNICAL MEMORANDUM

DATE	31 May 2022	**REF**	NSWDPE239603
TO	Ms Rose-Anne Hawkeswood – NSW Department of Planning and Environment	**REV**	0
FROM	Sophie Pape, Earth Systems Jeff Taylor, Earth Systems	**PROJECT**	Bowdens Silver Mine

INDEPENDENT REVIEW - ACID AND METALLIFEROUS DRAINAGE

INTRODUCTION

The New South Wales Department of Planning and Environment (NSWDPE) has requested an independent review and advice in relation to acid and metalliferous drainage (AMD), water balance modelling and surface water management aspects of the proposed Bowden Silver Mine.

Earth Systems were key authors of the Federal Government's Leading Practice handbooks on "*Managing Acid and Metalliferous Drainage*" (2007) and "*Preventing Acid and Metalliferous Drainage*" (2016).

This Memorandum provides a summary of the documents available for review and the key findings of Earth Systems' independent high level review with a focus on AMD / geochemical characterisation, impact assessment and related management aspects of the proposed mine development. Water balance modelling and surface water management aspects have been reviewed in a separate memorandum.

SCOPE OF REVIEW

Sections of the following reports relevant to AMD / geochemistry were included in the review:

"EIS" documents:

- EIS Bowdens Silver Project – 2020. 764 pages.
- Vol 1_Part 3_Materials Charact - May 2020. 562 pages.
- Vol 5_Part 16A_TSF Design Report - May 2020 (TSF Preliminary Design). 91 pages.
- Vol 5_Part 16B_Prelim Design - WRE, Oxide Ore (Preliminary Design of PAF Waste Rock Emplacement, Oxide Ore Stockpile and the Southern Barrier). 44 pages.
- Vol 5_Part 16C_Closure Cover Design – May (TSF and WRE Closure Cover Design). 44 pages.

Submission and Response documents:

- Submissions:
  - Dr Haydn Washington, environmental scientist, former Experimental Scientist in CSIRO working on heavy metal pollution from mine sites, 16/7/20. 7 pages.
  - Dr Haydn Washington, environmental scientist, former Experimental Scientist in CSIRO working on heavy metal pollution from mine sites, 12/8/21. 10 pages.
  - 4.12. WRE and Leachate Dam. 3 pages.
  - 4.11. TSF leakage risk. 4 pages.
- Submissions Report - Response to Submissions on EIS - June 2021. 514 pages.

REVIEW FINDINGS

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
A "*Materials Characterisation Assessment*", including static and kinetic geochemistry test work was completed by GCA in May 2020.	The static geochemistry test work undertaken to date is considered preliminary based on: ▸ 143 waste rock samples being tested (127 samples in 2012-13 and 16 samples in 2017-18) as a basis for characterising 46.4 million tonnes of waste rock (only 1 sample per 325,000 tonnes of waste rock). ▸ 5 low grade ore and 2 ore samples being tested as a basis for characterising around 30 million tonnes of ore (only 1 sample per 4.3 million tonnes of low grade ore / ore).	Ongoing static geochemical characterisation test work will be required throughout the Project life to verify the assumptions developed from preliminary test work and inform day to day mine material handling.
	Kinetic geochemistry test work was conducted on 18 samples using weathering columns, and provides some preliminary insights into kinetic geochemical behaviour and components of concern in drainage water quality. However, the use of weathering columns (column leach tests) has a number of limitations as outlined in the Federal Government Leading Practice Handbook "*Preventing Acid and Metalliferous Drainage*" (DIIS, 2016) and discussed further below.	Additional kinetic test work will be required to quantify pyrite oxidation / acidity generation rates, the "lag time" or delay before onset of acid conditions, and the duration of acid generation from PAF materials.
The static geochemistry test work included: ▸ 54 waste rock samples with Total S < 0.3% tested in 2012-13. ▸ 73 waste rock samples with Total S > 0.3% tested in 2012-2013. ▸ 16 samples of fresh waste rock with Total S < 0.3% tested in 2017-18.	The primary focus of sample selection should be to obtain samples that are representative of the deposit, based on spatial location (position and depth), extent of weathering, lithologies, etc. (eg. DIIS, 2016). However, the sample selection process employed by GCA (2020) appears to be more focussed on Total Sulfur values, with the presumption that an arbitrary 0.3 % Total S cutoff may be appropriate for defining PAF versus NAF materials. However, some waste rock with 0.1-0.3 % S is PAF (see comments below).	Ongoing static geochemical characterisation test work will be required throughout the Project life to verify the assumptions developed from preliminary test work and inform day to day mine material handling. The AMD risk classification system should be reviewed (as per Recommendations below).

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
Key findings from GCA (2020) include: ▸ Most of the waste rock lithologies comprise PAF material, with sandstone being the only lithology that was regarded as NAF. ▸ All lithologies are generally deficient in carbonate materials. Furthermore, where carbonates are present, they are dominated by rhodochrosite (manganese-carbonate) which is not an acid neutralising carbonate and can be associated with elevated manganese in drainage water. ▸ The low grade ore and ore samples were classified as PAF. ▸ The process tailings were classified as PAF. ▸ The soil-clays were classified as NAF.	The potential for acid and metalliferous drainage (AMD) from sulfidic waste rock, low grade ore, ore and tailings is a significant water quality risk for the Project, in both the short-medium term (during operations) and the long term (post-closure), if not managed effectively.	A stand-alone site-wide AMD Management Plan will need to be developed and a qualified geochemist employed to ensure its effective implementation throughout the mine life.
For the 54 waste rock samples with Total S < 0.3% tested in 2012-13: ▸ Most samples were classified as "NAF" based on the classification system in Annexure 5 of GCA (2020). Four exceptions were classified as "Uncertain" though "likely NAF". ▸ Despite most samples being considered "NAF" by GCA (2020), sulfate-bearing minerals such as alunite and jarosite were identified, which represent another source of acidity and a potential source of water quality impacts. Indeed, a significant proportion of samples (12 out of 54) had pH 1:2 values below 4.5 despite their "NAF" classification. The kinetic test work results demonstrate initial drainage from this material may be slightly acidic (pH 5) but this eventually increases towards pH 6 as trace alunite and jarosite are depleted.	Many of the samples classified as "NAF" could have an impact on water quality due to the presence of sulfate-bearing minerals such as alunite and jarosite. Materials containing alunite and jarosite could be generated throughout the mine life, therefore water quality issues could be expected to occur over a period of at least 15-20 years, if "NAF" materials are not managed effectively. Also, at least one of the four "Uncertain though likely NAF" samples would be regarded as PAF by Earth Systems, based on a NAG pH value of 4.2.	A management strategy will be required for "NAF" mine materials that contain alunite and jarosite, as part of the site AMD management strategy. The AMD risk classification system should be reviewed (as per Recommendations below).

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
Elevated metals, in particular manganese (up to 5.2 mg/L after 10 weeks and consistently 1-2 mg/L over ~3 years) were identified in the kinetic test results. Up to ~60% of the Total S was removed over the ~3 year kinetic test program.		
For the 73 waste rock samples with Total S > 0.3% tested in 2012-2013: ▸ The sulfur content ranged up to 5.2% and was increasingly dominated by Sulfide S (eg. pyrite and marcasite) with depth in the deposit, however Sulfate S (eg. alunite and jarosite) was also present throughout these samples. ▸ Only 4 of these 73 samples were classified as NAF, therefore the assessment concluded that all such materials should be collectively treated as PAF. ▸ Relatively high manganese concentrations were observed in the kinetic tests (~30 mg/L at the end of testing for a 0.3-0.5 % S sample). Manganese (eg. 10-20 mg/L), zinc (eg. 2-3 mg/L) and arsenic (50-60 mg/L) were identified as the key components of concern in drainage from samples with >0.5% S. ▸ Oxygen Consumption Rates (OCR) were measured for 3 samples and reported as 6.3×10^{-11}, 1.4×10^{-11} and 5.4×10^{-11} kg O_2/kg/s.	The conclusion that all materials with Total S > 0.3% should be collectively treated as PAF is considered reasonable, but some waste rock with Total S < 0.3 % is also PAF (see comments below). Some PAF waste rock will generate acid and metalliferous drainage (AMD) in the short term, characterised by low pH, elevated dissolved metal concentrations and elevated (sulfate) salinity. Most PAF waste rock will generate near neutral but metalliferous drainage (NMD) in the short term, prior to the onset of acid (low pH) conditions. The delay before acid drainage commences is referred to as the "lag time" or "lag phase". Key components of concern in drainage water quality (NMD) from PAF materials during this "lag time" will include manganese, zinc and arsenic. Following the lag phase, low pH and a wider range of dissolved metals would also be of concern if PAF waste rock is not managed appropriately. For further information on AMD / NMD refer to Attachment A. OCRs will vary with Sulfide S content, oxygen concentration and moisture content, and therefore it is not clear whether the estimated OCR values are representative or not. Furthermore, it is unclear how such figures were used to estimate the depth of an "O_2 diffusion front" at 10 metres in a constructed waste rock dump.	Further kinetic test work on PAF materials is required to understand: ▸ Normalised Pyrite Oxidation Rates (POR) that can be extrapolated to other materials based on Sulfide S content, oxygen concentration and moisture content; ▸ The duration of the "lag time" before the onset of acid generation; and ▸ The longevity of pyrite oxidation (acid generation). Field-based kinetic test work will also be required to develop a better understanding of the depth of O_2 diffusion into PAF waste rock (and tailings).
GCA (2020) noted that the majority of the waste rock and ore expected to be extracted from the proposed open cut pit would have Total S > 0.5%. This indicates that most waste rock and ore material is expected to be PAF (and is confirmed by subsequent reports). For example, Advisian (2020a) reports an estimated 57% of waste rock is PAF.	*Specific comments relating to the proportion of PAF and NAF mine materials is provided below.*	*Specific recommendations relating to the proportion of PAF and NAF mine materials is provided below.*

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
Follow up static geochemistry test work was conducted in 2017-18 on 16 samples of fresh waste rock with Total S contents of < 0.3%, to assess its potential for use as a construction material or a resource during decommissioning and closure works. ▸ 13 of the 16 samples were classified as NAF, therefore 3 samples were PAF (ie. 19% of samples). ▸ Carbonates were detected at least in "trace" concentrations. While some neutralising carbonate was identified (eg. dolomite), other carbonate forms (eg. siderite and rhodochrosite) will not neutralise acidity from the PAF materials or are only partially acid neutralising (eg. ankerite). Indeed, the risk of locally elevated manganese concentrations in drainage from these potential construction / rehabilitation materials was noted.	Nearly 20% of potential construction / rehabilitation materials tested (fresh rock with Total S < 0.3% S) were identified as PAF. Based on this information, there may be a deficit of geochemically suitable construction materials for the Project. It is unclear if there would be sufficient NAF waste rock from the weathered zone to meet all construction requirements. This is discussed further below. There is also a risk of NMD from "NAF" construction / rehabilitation materials.	The Total S cutoff value of 0.3 % is not suitable for identification of NAF rock for use as a construction material or resource, and should be reviewed (as per Recommendations below). A management strategy will be required for "NAF" mine materials that contain metalliferous carbonates (eg. siderite, rhodochrosite and ankerite), as part of a site AMD Management Plan.
Geochemical characterisation test work has not specifically been conducted for the pit wallrock materials. Section 2.4.2 of the EIS notes that the rim of the main open cut pit varies from 597 m AHD within Blackmans Gully to 652 m AHD on the north-eastern edge (the deepest section of the pit is at 456 m AHD, approximately 180 m below natural ground level).	These figures indicate a pit highwall of up to 55 metres at the time of closure. With an average weathered zone depth of only 20-30 metres, suldific wallrock could be exposed within this highwall, representing a potential long term (post closure) AMD risk. Furthermore, the potential for AMD from pit wallrock, including floor rock and highwall materials, during operations was not considered in the GCA (2020) study.	The potential risk associated with AMD in pit water, both during operations and post-closure, needs to be assessed and managed.
Geochemical characterisation test work has not specifically been conducted for the silver/lead concentrate or zinc concentrate products.	Given the sulfidic nature of the concentrates, this test work would be recommended if concentrate was to be stockpiled or exposed to atmospheric oxygen / incident rainfall prior to being transported off site.	Consideration should be given to concentrate storage and handling procedures, and the potential duration of exposure to atmospheric oxygen / incident rainfall (if at all) prior to off site transport.

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
A site-specific AMD risk classification system was developed by GCA (2020) based on the samples tested, to inform material types and management options. The proposed classification system is outlined below: ▸ Weathered Zone • WZ1: Total S < 0.3% = initially sub-neutral (acidic pH) but evolving to NAF over time as "trace alunites" are leached with buffering from interactions with smectites. • WZ2: Total S > 0.3% = PAF (">" assumed by Earth Systems to mean "≥"). ▸ Primary Zone • PZ1: Total S < 0.1% = NAF. • PZ2: Total S 0.1-0.3% within the northern section of proposed main open cut pit = NAF. • PZ3: Total S > 0.3%; Total S 0.1-0.3% distant from the northern section of proposed main open cut pit = PAF. It is noted that the classification system recommended by GCA (2020) for the Project, differs from the classification system used for the assessment of samples by GCA (2020; Annexure 5) which is based on Total S as well as Sulfide S and ANC/MPA ratios.	The AMD risk classification system recommended for the Project by GCA (2020) would be more practical and cost-effective than the system used for the samples tested in 2012-13 and 2017-18, however it may have some limitations associated with: ▸ The potential for NMD from some "NAF" materials (ie. NAF materials are not sub-classified into NAF-NMD or NAF-Inert). ▸ Unclear method for demarcation of the "northern" section of the pit and hence PZ2 vs PZ3 materials. ▸ The accuracy of site assay data for Total S (some discrepancies between assay data and GCA data for Total S were noted). Notwithstanding these potential limitations, the system recommended by GCA (2020) does not appear to have followed through correctly to the mine block model and waste rock schedule that form the basis of the waste rock dump design by Advisian (7 May 2020). A simpler classification appears to have been used by Advisian (2020a) – based only on a 0.3 % Total S cutoff – which could result in some PAF material being inadvertently classified as NAF. Similarly, the EIS has used the 0.3 % Total S cutoff (only) which ignores the potential for PAF waste rock in the 0.1-0.3 % Total S range.	The mine block model and waste rock schedule should be reviewed, and Project design implications considered prior to construction.
According to mine scheduling developed by AMC, around 10 million tonnes of WZ1 material would be produced, corresponding to 22% of the total tonnage of waste rock (GCA, 2020).	Estimates for PZ2 and PZ3 materials are considered inaccurate as they are not based on the original classification definitions recommended by GCA (2020). Therefore: ▸ For the PZ2 category, there could be significantly lower tonnages of NAF waste rock than 6.3 million tonnes. ▸ For the PZ3 category, there could be significantly higher tonnages of PAF waste rock than 22.5 million tonnes.	See Recommendation above.

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
Tonnages for the other material categories (WZ2, PZ1, PZ2 and PZ3) were not specifically reported by GCA (2020) but were documented in Section 2.5.2 of the EIS, as summarised below: ▶ WZ1 –10 million tonnes of NAF waste rock. ▶ WZ2 – 4.1 million tonnes of PAF waste rock. ▶ PZ1 – 3.5 million tonnes of NAF waste rock. ▶ PZ2 – 6.3 million tonnes of NAF waste rock. ▶ PZ3 – 22.5 million tonnes of PAF waste rock.	Therefore, while the EIS / Advisian (2020a) indicate that approximately 57% of waste rock is PAF and the remaining 43% is NAF, the proportion of PAF waste rock may be under-estimated as it is based on the incorrect assumption that all waste rock with <0.3 % Total S is NAF (whereas GCA identified some waste rock with 0.1-0.3 % Total S as PAF). This is a concern given that: ▶ "NAF" waste rock (some of which may be PAF) is planned to be used for the TSF embankment raises, acoustic barrier, waste rock dump haul road and final cover of the waste rock dump and TSF. Furthermore, the potential for acidic drainage (associated with alunite and jarosite) or NMD from NAF rock has not been addressed in the waste rock dump design. ▶ The waste rock dump is designed to accommodate 26.6 million tonnes of PAF waste rock, and may not have sufficient capacity to accommodate additional PAF waste rock.	
To address the potential for elevated manganese (around 1-2 mg/L) in drainage from WZ1 waste rock materials, GCA (2020) suggested: ▶ Site wide application of agricultural lime (ie. crushed limestone). ▶ Ensuring that the outermost section of the Southern Barrier has < 1,000 mg/kg Mn.	Limestone would not produce a high enough pH to remove all manganese from solution. Additional treatment may be required. It is unclear whether the second recommendation would be practical in terms of both (i) waste rock scheduling and (ii) field-based classification and segregation of waste rock. Notwithstanding the above, neither of these recommendations were adopted in the waste rock dump design (Advisian, 2020a).	A clear strategy to manage this potential water quality risk (NMD from WZ1 "NAF" waste rock material) is needed.
To address the potential for elevated manganese in drainage from PZ2 waste rock materials, GCA (2020) suggested: ▶ Consider screening highly siliceous volcanic breccia to +50mm to remove the fines which are considered a greater manganese risk due to their higher surface area. ▶ Develop sub-variants of the PZ2 classification, with a 0.1% Mn cutoff use to segregate Low/High manganese rock.	As noted above and acknowledged by GCA (2020) the logistics, economics and indicative volumes of such sub-variants are unknown. Notwithstanding this, neither of these recommendations were adopted in the waste rock dump design report (Advisian, 2020a).	A clear strategy to manage this potential water quality risk (NMD from "NAF" PZ2 waste rock material) is needed.

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
To address the potential for AMD from WZ2 and PZ3 waste rock materials: ▸ GCA (2020) suggested: • Construction and development of the waste rock dump to prevent pervious, preferential pathways (resulting from segregation of larger cobbles and boulders) which are conduits for rapid ingress of air and water, which enhance sulfide oxidation rates and AMD generation. • Placement of low permeability material over the footprint of the waste rock dump, to prevent seepage to groundwater and surface discharge to downstream watercourses. ▸ From the preliminary waste rock dump design report (Advisian, 2020a) the dump would be developed in a staged fashion via cells and with a bottom-up method of lift construction via paddock dumping. Each 10 m lift would comprise 2 m layers of compacted waste rock.	It is positive to note that the proposed method of PAF waste rock placement is consistent with current leading practice (eg. INAP, 2020) although large-scale laboratory test work and/or field trials with appropriate instrumentation are needed prior to construction to demonstrate that these construction specifications will sufficiently limit air entry to PAF waste rock and allow water quality objectives to be achieved. The predicted O_2 diffusion front of 10 metres (GCA, 2020) indicates that AMD generation could still be an issue from the outer layer of PAF waste rock that remains exposed to air entry during operations / post closure. This is a particular concern for post-closure given that PAF waste rock appears to extend to the near-surface in the final waste rock dump landform. A store-and-release cover was designed (Advisian, 2020b) based on "current best practice" with reference to MEND (2004) guidelines, but the MEND (2004) guidelines are considerably out of date and while store-and-release cover systems may still be an appropriate from a revegetation perspective, they are not considered leading practice from an AMD risk management perspective. Earth Systems is unaware of any store-and-release cover systems that have proven to be successful for AMD control.	Large-scale laboratory test work and/or field trials are required to support the proposed PAF waste rock placement method. As noted above, field-based kinetic test work will also be required to develop a better understanding of the depth of O_2 diffusion into PAF waste rock (and tailings). Additional management measures will be required for the outer layer of PAF waste rock (eg. O_2 diffusion front of 10 metres as reported) that remains exposed to air entry during operations / post closure. Near-surface PAF waste rock in the final waste rock dump landform should be avoided. An AMD management strategy for PAF waste rock should avoid reliance on a store-and-release cover system for long term control of infiltration and oxygen ingress to waste rock.
Regarding the management of low grade ore stockpiles, which are expected to be PAF, GCA (2020) notes that this material would either be processed, or capped in a method similar to the waste rock dump.	*The comments above for PAF waste rock are equally applicable to low grade ore stockpiles.*	*The recommendations above for PAF waste rock are equally applicable to low grade ore stockpiles.*
An "oxide ore" stockpile is discussed by Advisian (2020a), however this material was not specifically characterised by GCA (2020). A total of 1.78 million tonnes of oxide ore would be produced over the mine life, and this may be integrated into the final waste rock dump landform if it is uneconomical to process.	Oxide ore is generally a lower AMD risk than sulfidic ore, but could have comparable water quality issues to WZ1 or WZ2 waste rock. It is positive to note that oxide ore would be placed "in accordance with the methodology presented in Section 3.2" for waste rock (Advisian, 2020a).	Geochemical characterisation of "oxide ore" material is required. *The recommendations above for WZ1 and WZ2 waste rock could be applicable to "oxide ore" stockpiles.*

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
The outer slope of the flood protection bund extends into the modelled 1:100 AEP flood area, and this bund would be removed during rehabilitation and closure of the waste rock dump (Advisian, 2020a).	It is therefore conceivable that at some stages post-closure, extreme floodwaters could come into contact with PAF material in the base of the waste rock dump. The potential implications for both flood water quality and stability of the waste rock dump have not been specifically discussed.	Consideration should be given to the potential implications for both flood water quality and stability of the waste rock dump.
A section of the southern barrier encroaches on the current alignment of Blackmans Gully, resulting in the need to create a zone of permeable fill to reduce the impoundment of water from the upstream catchment (Advisian, 2020a).	The potential implications for impoundment water quality in contact with “NAF” material (eg. manganese or other NMD issues) have not been specifically discussed.	Consideration should be given to the potential implications for impoundment water quality in contact with “NAF” material (eg. manganese or other NMD issues).
The waste rock dump capping layer will comprise a 1 metre thick layer of “oxide PAF” to create a smooth cushion layer above the “general PAF” (Advisian, 2020a).	Earth Systems assumes “oxide PAF” corresponds to WZ2 material. As this would be mined earlier than “general PAF”, this would require separate temporary stockpiling and double-handling of “oxide PAF”, although this doesn’t appear to have been considered. Notwithstanding this, near-surface PAF material in the final waste rock dump landform remains a concern, as noted above.	Near-surface PAF material in the final waste rock dump landform should be avoided.
A number of additional studies were recommended by Advisian (2020a) for the next phase of the design process.	Earth Systems supports their inclusion in Project consent conditions. They are however limited to water management, physical / geotechnical properties and stability of the waste rock dump, rather than geochemical stability / water quality issues outlined above.	Future studies should focus on geochemistry / water quality aspects as well as water management, physical / geotechnical stability aspects of the waste rock dump.
Tailings are expected to be PAF but GCA (2020; Annexure 2) suggested that near-saturated conditions will suppress pyrite oxidation and that PAF tailings beaches will not remain exposed for longer than several months. This implies that AMD from PAF tailings will not be an issue during operations, hence there is currently no AMD management strategy for PAF tailings within the TSF design report (ATC, 2020).	This assumption is considered optimistic and cannot be verified without kinetic geochemistry test work on representative tailings material (to quantify the “lag time” before the onset of acid generation) which has not been conducted to date.	Kinetic geochemistry test work needs to be conducted on representative PAF tailings materials. An AMD management strategy for PAF tailings is required.

Review Finding	Earth Systems Comment	Recommendation to NSWDPE
Despite the predicted near-neutral drainage, GCA (2020) noted that tailings pore water manganese concentrations could be 10-30 mg/L (ie. during the lag phase before the onset of acid generation) and TSF seepage control would be required.	Seepage collection and recovery during operations is addressed by ATC (2020) from a water management perspective only, however the likely requirement for treatment of TSF seepage water (and decant water) is not specifically discussed by GCA (2020) or ATC (2020).	An AMD management strategy for PAF tailings should consider the potential need for treatment of AMD / NMD in TSF seepage and decant water.
The potential need for management of TSF seepage post-closure has not been considered.	This could become an increasing water quality concern as the tailings are allowed to naturally drain post-closure, leading to pyrite oxidation and AMD generation.	An AMD management strategy for PAF tailings should consider the risk of AMD in TSF seepage post-closure.
For the closure phase, GCA (2020) recommended a TSF cover system to restrict both infiltration and oxygen ingress to the tailings. A store-and-release cover was designed (Advisian, 2020b) based on "current best practice" with reference to MEND (2004) guidelines.	*See earlier comments regarding store-and-release cover systems.*	An AMD management strategy for PAF tailings should avoid reliance on a store-and-release cover system for long term control of infiltration and oxygen ingress to tailings.
The TSF has been designed as a water-holding structure for the operations phase (only).	A water-holding TSF structure is positive from an AMD risk perspective as it will enable a significant proportion of PAF tailings to remain saturated, thereby limiting the extent of pyrite oxidation (notwithstanding the concerns regarding beached tailings noted above) at least during operations. It is unclear whether consideration was given to maintaining the TSF as a water-holding structure post-closure, and whether this would be practical under the post-closure water balance conditions. If feasible, this could potentially avoid the risk of AMD generation as the tailings progressive drain over time post-closure.	Consideration should be given to the potential for a permanent water-holding TSF to as part of the AMD management strategy for PAF tailings.
Around 2.9 million m^3 and up to 1.3 million m^3 of NAF rock would be required for the TSF and waste rock dump cover systems (Advisian, 2020b). NAF rock is also required for the TSF embankment (3.3 million m^3), waste rock dump construction (assume ~0.3 million m^3) and satellite pit backfill (assume ~1.0 million m^3). This equates to ~8.8 million m^3 of NAF rock required. Around 10 Mt of WZ1 material (5.99 million m^3) and ~3.5 Mt of PZ1 material (1.90 million m^3 at 1.84 t/m^3) would be produced ("NAF Oxide"; Advisian, 2020a).	Notwithstanding the concerns above regarding (i) store and release covers for TSFs and waste rock dumps; and (ii) the potential for acidic drainage or NMD from some "NAF" materials, these quantities indicate a potential shortfall in suitable NAF waste rock (ie. that meets both geochemical and geotechnical requirements) for construction and rehabilitation purposes, which will depend on the proportion of PZ2 material that is actually NAF and can be readily segregated during mining.	Predicted quantities of suitable NAF rock for construction and rehabilitation purposes need to be reviewed, and Project design implications considered prior to construction.

KEY CONCLUSIONS AND RECOMMENDATIONS

The majority of waste rock, low grade ore, ore and tailings generated from the Project is expected to be potentially acid forming (PAF). Acid and metalliferous drainage (AMD) is therefore a significant potential water quality risk for the Project, that is likely to commence during operations and continue into the long term post-closure, based on the current AMD management strategy. Key concerns are summarised below:

- Geochemical characterisation work conducted to date is considered to be preliminary only. Much more static geochemistry data are required to establish a reliable and practical AMD risk classification system for the Project.
- The behaviour of sulfidic mine waste materials over time is poorly understood and additional kinetic test work is required to address this. From the test work conducted to date, it has not been possible to quantify the rate of pyrite oxidation / acidity generation processes, the "lag time" before acid conditions will develop, or the longevity of AMD generation from PAF waste rock or tailings.
- The AMD risk classification system is considered inappropriate for this Project, resulting in inaccurate predictions of PAF and NAF material tonnages. This will affect waste rock dump design and the availability of non acid forming (NAF) materials for construction / rehabilitation requirements. The mine block model and materials schedule will need to be updated to better quantify tonnages based on geochemistry / water quality risk and suitability for construction or rehabilitation.
- There appears to be a significant potential for acidic drainage (associated with alunite and jarosite) or neutral and metalliferous drainage (NMD) from mine materials that have been classified as "NAF". The EIS appears to assume that "NAF" waste rock is benign and drainage water quality will be suitable for discharge without treatment / management. A clear strategy is required to address these potential water quality risks from "NAF" waste rock.
- Earth Systems has little confidence in the current AMD management strategy for waste rock and tailings. For example:
  - The waste rock dump design is unproven and appears substantially problematic, with initial indications that the site could be establishing the need for water treatment in perpetuity. Large-scale laboratory test work and/or field trials with appropriate instrumentation are needed prior to construction, to demonstrate that waste rock placement methods will sufficiently limit air entry to PAF waste rock and allow water quality objectives to be achieved. Additional management measures are required for the outer layer of PAF waste rock (eg. 10-metre oxygen diffusion front as reported) that remains exposed to air entry during operations / post closure. Additional measures are required to manage other water quality risks from "NAF" rock. Near-surface PAF material in the final waste rock dump landform should be avoided.
  - More detailed assessment of potential AMD impacts from tailings during operations and post-closure is warranted. AMD from the tailings (surface water and seepage) could become a particularly significant issue post-closure as the tailings are progressively drained. Kinetic test work and a strategy for management of PAF tailings is required.
  - Store-and-release covers are used widely, but almost never in recent years for the purposes of AMD control. The proposed store-and-release cover systems are not considered an appropriate strategy for PAF waste rock or PAF tailings management.
- Pit lake water quality issues associated with AMD generation within the pit wallrock, including floor rock and highwall materials, have not been considered for the operations or post-closure phases of the Project. Potential AMD impacts on pit water quality should be assessed and a management strategy developed.

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Attachment A

Background to Acid and Metalliferous Drainage

Background to AMD

Key Geochemical Principles for Environmental Management

In order to understand AMD and associated risks, it is important to consider the mechanism of AMD generation in some detail. AMD refers to the acidic, saline and metalliferous water that can occur as drainage from mine waste stockpiles, TSFs, pit walls, underground workings (if any) and potentially other mine infrastructure such as Run Of Mine (ROM) pads and road embankments. AMD is a common problem for mines worldwide and one of the most significant obstacles to pollution prevention and minimisation during operations and post-closure.

AMD commonly occurs when previously water-saturated sulfide mineral bearing rocks or sediments are excavated and stored in an unsaturated setting, as is typical in mining operations that store mine waste materials and tailings in unsaturated or partially unsaturated piles and impoundments. Desaturation of in-situ rocks / sediments (eg. associated with mine dewatering) can also generate AMD.

The key terms and processes involved in the generation, release and treatment of AMD are described in the following sections.

Sulfide Oxidation

AMD can be produced when reactive sulfide minerals such as pyrite (iron sulfide, FeS_2) are disturbed or dewatered as part of mine operations. Many sulfide minerals, particularly pyrite but also chalcopyrite (copper sulfide, $CuFeS_2$), pyrrhotite (iron sulfide, FeS) and some others, naturally undergo oxidation when exposed to atmospheric oxygen and moisture. Oxidation of sulfides results in decomposition of the mineral to release sulfur in the form of sulfuric acid (H_2SO_4), and soluble metals such as iron, which contribute to 'mineral acidity'. The acid conditions and soluble iron generated during pyrite oxidation can attack and dissolve other minerals, resulting in elevated soluble concentrations of other metals such as aluminium, manganese, copper, lead, zinc, nickel, cobalt, cadmium, chromium, arsenic, antimony and mercury.

Under oxidising conditions, sulfide oxidation continues until all reactive sulfides have been converted to acid and metals. Different sulfides oxidise at different rates. It is not unusual for sulfide oxidation (and hence AMD issues) to persist for hundreds of years. The amount of acid produced by sulfide oxidation per year tends to decrease over time as the bulk concentration of source sulfides decreases (eg. within an overburden pile).

Some sulfide minerals, such as galena (PbS), sphalerite (ZnS), arsenopyrite (FeAsS) and stibnite (Sb_2S_3), are relatively geochemically stable (unreactive) and slow to oxidise. However, these minerals can be dissolved by exposure to acid conditions and dissolved iron, resulting in the release of soluble metals, which contribute to acidity.

Secondary Acid Sulfate Minerals

Acidity generated as a result of sulfide oxidation can react with silicate minerals to form secondary acid sulfate salts such as melanterite, jarosite and alunite. Melanterite is highly soluble in water, jarosite is sparingly soluble, and alunite is approximately ten times less soluble than jarosite. Acidity stored in these minerals is released by dissolution in water, and is not sensitive to oxygen availability.

Depending on the rate of sulfide oxidation, jarosite (or alunite) formation as a result of sulfide oxidation can proceed faster than the rate of jarosite dissolution, resulting in an accumulation of jarosite in stockpiles of potentially acid forming (PAF) materials. Melanterite, if formed, is highly soluble and does not tend to accumulate in non-arid environments.

Acid Neutralisation

Certain carbonate minerals, primarily calcium- and magnesium-bearing carbonates such as calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$), can neutralise the acidity produced by sulfide oxidation. The neutralisation potential of a rock or sediment as determined through test work is referred to as its acid neutralisation capacity (ANC). Iron- and manganese-bearing components of carbonates have no net contribution to ANC, as the metals oxidise and hydrolyse, thereby contributing to acidity.

Acid produced by sulfide oxidation can also react (slowly) with common silicate minerals, partially neutralising acidity and storing some acidity in precipitated secondary minerals such as jarosite or alunite. Due to the slow rate of reaction, relatively long acidity contact times are required to induce silicate neutralisation, which can be achieved by ensuring slow water migration rates.

Acid and Acidity

In determining AMD risk, it is important to take into account both acid (H^+) and dissolved metals (latent mineral acidity) concentrations as a combined measurement of 'acidity' in units of milligrams of calcium carbonate (equivalent) per litre (mg $CaCO_3$/L). The measurement of acidity is equivalent to the amount of neutralising agent (such as calcium carbonate) that would need to be added to the affected water to raise the pH to 8.3. Observations of pH alone, while a reasonable qualitative indicator of water quality, are insufficient to estimate total acidity. For example, water with a pH of 3.0 can have an acidity of as low as 50 mg $CaCO_3$/L and as high as 10,000 mg $CaCO_3$/L or more.

Kinetics of Sulfide Oxidation

Sulfide oxidation occurs at a rate that is determined by the intrinsic geochemical and physical properties of the sulfide minerals (eg. mode of formation, geological history and crystal size), the grain size of the rock, temperature, moisture availability, oxygen availability and bacterial activity.

Sulfide oxidation is a first-order decay reaction that can be described in terms of a percentage of the sulfides that oxidises each year. For example, if the sulfide oxidation rate is 50 wt.% sulfide / year, half of the sulfide exposed to atmospheric oxygen would be oxidised (to form acid and soluble metal ions) in the first year, and then half of the remaining sulfide (25% of the starting total) would be oxidised in the second year. The rate of acid generated by this process decays over time accordingly. The rate of oxidation can be determined through kinetic geochemical tests such as oxygen consumption cell tests and column leach tests.

The kinetics of sulfide oxidation can therefore be used to estimate the duration or longevity of sulfide oxidation and acid generation (before neutralisation reactions).

For materials or sediments of the same geological characteristics (ie. from the same lithological unit) and grain size, the rate of sulfide oxidation is largely uniform and independent of absolute sulfide concentration. This means that oxidation rates (in wt.% sulfide/year) determined through kinetic geochemical test work can be applied to rocks of the same lithology for any sulfide-sulfur content. The sulfide oxidation rate is typically normalised to pyrite equivalent units for convenience (ie. wt.% FeS_2 / year).

Lag Period

Once the sulfide oxidation rate has been determined, the annual acidity generation rate (AGR) and ANC can be used to determine the lag time before the onset of acid conditions. In materials or sediments that contain reactive carbonate minerals (as ANC), any acidity generated as a result of sulfide oxidation will be neutralised until the effective ANC has been exhausted.

If the ANC of the material is less than the total acid generating potential of the sulfides, acid conditions will eventually develop. The net acidity generation rate (NAGR) is the amount of acidity released after neutralisation reactions. The evolution of NAGR can be predicted over time using the sulfide oxidation rate and ANC.

Depending on the balance of Maximum Potential Acidity (MPA) and ANC, sulfidic materials or sediments can display three general lag-related behaviours:

- No lag period with immediate onset of acid conditions (ANC = 0 , MPA > 0).
- A discrete lag period followed by the onset of acid conditions (MPA > ANC).
- Onset of acid conditions unlikely to occur (ANC >> MPA).

In the second case described above, drainage will be near-neutral, but may be metalliferous and / or saline, during the lag phase. This is referred to as neutral metalliferous drainage or saline drainage (see following sections).

Neutral Metalliferous Drainage (NMD)

Neutral metalliferous drainage (NMD), also referred to as or neutral mine drainage, can occur when there is sufficient ANC to neutralise the acidity produced by sulfide oxidation, but the drainage still contains elevated dissolved and/or total metal concentrations and (sulfate) salinity.

Some metals, particularly manganese (Mn), cadmium (Cd) and arsenic (As), as well as others, remain in solution even at elevated pH. Neutralisation of AMD by carbonates can raise the pH of the drainage to near-neutral levels (eg. pH 6–8), but this can be insufficient to precipitate all metals, leaving a certain metalliferous component in solution. This is referred to as NMD.

Furthermore, some metals in some scenarios, such as zinc, can precipitate at elevated pH, but can remain suspended in drainage and resist sedimentation. This can result in elevated total metal concentrations, with implications for regulatory compliance.

Saline Drainage

Saline drainage can occur when there is sufficient ANC to neutralise the acidity produced by sulfide oxidation and the resulting drainage does not contain metals at toxic concentrations. The sulfate salinity of the neutralised drainage depends on the relative proportions of calcium and magnesium in the neutralising minerals. Due to the high solubility of magnesium sulfate, higher salinity is likely to occur in deposits where magnesium is a significant component of the neutralising material. Conversely, if calcium is the dominant component of the neutralising material, gypsum precipitation may contribute to lower salinity (sulfate) levels.

Attachment B

Development of Sampling Program and AMD Risk Classification System

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TECHNICAL MEMORANDUM

DATE	9 September 2022	**REF**	NSWDPE239607
TO	Ms Rose-Anne Hawkeswood – NSW Department of Planning and Environment	**REV**	0
FROM	Sophie Pape, Earth Systems Jeff Taylor, Earth Systems	**PROJECT**	Bowdens Silver Mine

DEVELOPMENT OF SAMPLING PROGRAM AND AMD RISK CLASSIFICATION SYSTEM

INTRODUCTION

The New South Wales Department of Planning and Environment (NSWDPE) has requested an independent review and advice in relation to acid and metalliferous drainage (AMD), water balance modelling and surface water management aspects of the proposed Bowden Silver Mine. Earth Systems were key authors of the Federal Government's Leading Practice handbooks on "*Managing Acid and Metalliferous Drainage*" (DITR, 2007) and "*Preventing Acid and Metalliferous Drainage*" (DIIS, 2016).

A Memorandum was prepared on 31 May 2022, summarising the key findings of Earth Systems' independent high level review with a focus on AMD / geochemical characterisation, impact assessment and related management aspects of the proposed mine development.

One of the key conclusions documented in Earth Systems (2022) was that the AMD risk classification was considered inappropriate for the Project, resulting in inaccurate predictions of potentially acid forming (PAF) and non acid forming (NAF) material tonnages. This will affect waste rock dump design and the availability of NAF materials for construction / rehabilitation requirements. The Memorandum is focussed on the issue of AMD risk classification. Once addressed, the next priority will be PAF waste rock management strategy development, informed by AMD risk classification and updated block modelling.

INITIAL AMD RISK CLASSIFICATION SYSTEM

As noted in Earth Systems (2022), a site-specific AMD risk classification system was developed by GCA (2020) based on 143 waste rock samples tested, to inform material types and management options. The AMD risk classification system proposed by GCA (2020) is outlined below:

- Weathered Zone
  - WZ1: Total S < 0.3% = initially sub-neutral (acidic pH) but evolving to NAF over time as "trace alunites" are leached with buffering from interactions with smectites.
  - WZ2: Total S > 0.3% = PAF (">" assumed by Earth Systems to mean "≥").
- Primary Zone
  - PZ1: Total S < 0.1% = NAF.
  - PZ2: Total S 0.1-0.3% within the northern section[1] of proposed main open cut pit = NAF.
  - PZ3: Total S > 0.3%; Total S 0.1-0.3% distant from the northern section of proposed main open cut pit = PAF.

The system recommended by GCA (2020) does not appear to have followed through correctly to the mine block model and waste rock schedule that form the basis of the waste rock dump design by Advisian (7 May 2020). A simpler classification was used by Advisian (2020a) – based only on a 0.3 wt.% Total S cutoff – which could result in some PAF material being inadvertently classified as NAF. Similarly, the EIS has used the 0.3 wt.% Total S cutoff (only) which ignores the potential for PAF waste rock in the 0.1-0.3 wt.% Total S range.

The sections below provide clarification of current concerns regarding the AMD risk classification system proposed by Bowdens Silver and outline additional work that would assist in addressing these concerns.

PROPOSED CHANGES TO AMD RISK CLASSIFICATION SYSTEM

The AMD risk classification system developed by GCA (2020) was based on detailed static geochemistry test work – including acid base accounting (ABA), net acid generation (NAG) suite, some sulfur and carbon speciation, and major/trace element geochemistry – albeit on a limited number of samples across the deposit. This included 143 waste rock samples in total, of which 16 samples were selected from the northern section of proposed main open cut pit. This sampling density corresponds to only 1 sample per 325,000 tonnes of waste rock. Around 20 samples were also subjected to semi-quantitative X-Ray Diffraction (XRD) test work to investigate sample mineralogy (GCA, 2020).

Extensive assay data (including sulfur, calcium and magnesium) and hyperspectral scanning data has been subsequently presented (Corkery, 2022), but no further detailed static geochemistry test work (ABA, NAG, QXRD[2], etc) has been undertaken since 2020 as a basis for updating the original AMD risk classification method (GCA, 2020). Assay data may become useful for AMD risk block model development, only if an

[1] Bowdens Silver indicated during discussion in August 2022 that the "northern section" has been subsequently well defined.

[2] Total Sulfur and ANC analyses are used to infer mineralogy and estimate acid base accounting (ABA) characteristics accordingly. QXRD data provide a more accurate understanding of sample mineralogy and hence can be used to calculate ABA parameters more accurately than total sulfur and ANC analyses.

appropriate AMD risk classification system can be verified for the Bowdens deposit from detailed and representative static geochemistry or QXRD data.

It is understood from recent discussions and new information (Corkery, 2022; GCA, 2022) that:

1. ***For waste rock in the northern section of the proposed main open cut pit (only)***, Bowdens Silver now proposes to use an algorithm developed by GCA (2022) to estimate a "residual" wt.%S and assign AMD risk classifications accordingly, based on assay data (sulfur, calcium and magnesium content). This method assumes that all calcium and magnesium is present in the form of acid neutralising minerals such as calcium carbonate and dolomite. However, there may be calcium- and magnesium-bearing minerals present that are not carbonates. XRD test work conducted to date includes only 3 samples in the northern section of the proposed main open cut pit, and is only semi-quantitative (mineral quantities are reported as either major, minor or trace).
2. ***For waste rock in the majority of the deposit, excluding the northern section of the main pit***, Bowdens Silver still appears to be using the simpler AMD risk classification system based only on a 0.3 wt.% Total S cutoff (Corkery, 2022). This remains at odds with the PZ3 definition originally recommended by GCA (2020).

With reference to Point 1 above:

- The proposed AMD risk classification method for waste rock in the northern section of the proposed main open cut pit (only), may be suitable if it can be verified with a sufficient number of QXRD analyses that all calcium and all magnesium are present in acid neutralising minerals only, and that other calcium and magnesium bearing minerals are absent. The minimum number of QXRD analyses required will depend on factors such as the total tonnage of material being represented, the number and type/complexity of lithologies present, weathering types, etc. and could be around 50-100 in total.
- If the proposed AMD risk classification method for waste rock in the northern section of the proposed main open cut pit (only) is verified to be accurate, a "residual" 0.00 wt.%S cutoff value for assigning PAF and NAF classifications would be more appropriate than the "residual" 0.10 wt.% S cutoff proposed by GCA (2022).
- As an alternative, or in combination with the QXRD test work recommended above, a substantial amount of additional drill core analysis for detailed static geochemistry parameters would be required to develop a reliable AMD risk classification system (eg. sulfur cutoff value) for waste rock in the northern section of the proposed main open cut pit. Several hundred representative samples (eg. DITR, 2007) may be required to develop an AMD risk classification system, if indeed this is possible for the Bowdens deposit. Further guidance on sampling is provided in Attachment A.

With reference to Point 2 above:

- Bowdens Silver acknowledges that PAF material dominates the majority of the deposit, excluding the northern section of the proposed main open cut pit, as indicated by spatial mapping (Corkery, 2022). Nevertheless, it remains unclear whether the use of a 0.3 wt.% S cutoff rather than the 0.1 wt.% S cutoff recommended by GCA (2020) has had much effect on overall PAF versus NAF waste rock tonnage estimates, ie. whether the estimated PAF tonnage would have been greater than 57% (reported in the EIS) if a 0.1 wt.% S cutoff was used for waste rock in the majority of the deposit (excluding the northern section of the main pit).

SUGGESTED WAY FORWARD

1. Conduct QXRD test work on sufficient representative samples from the northern section of the proposed main open cut pit to verify suitability of proposed “residual” wt.%S algorithm ***and/or*** conduct detailed static geochemistry test work including ABA, NAG suite, sulfur and carbon speciation, on at least 1 representative sample per 10,000 tonnes of waste rock material to determine whether a suitable AMD risk classification system can be developed for this part of the deposit.
2. Clarify the potential implications of the 0.1 wt.% S cutoff recommended by GCA (2020) for the majority of the deposit, excluding the northern section of the proposed main open cut pit, in terms of PAF and NAF waste rock tonnages.
3. Regardless of final estimates of PAF versus NAF waste rock tonnages, it is clear that the proportion of PAF waste rock will be substantial (eg. anywhere between 44% and >57% based on information reviewed to date). There remains considerable opportunity for improvement of the currently proposed AMD management strategy, supported by field or laboratory-based verification test work, in advance of project development. Leading practice approaches are provided in INAP (2020).
4. An additional benefit of the test work suggested above could be the potential to identify resources (eg. acid consuming or oxygen consuming NAF materials) and incorporate these into the site AMD risk classification system. A better understanding of the tonnages, proportion and scheduling of such materials may assist with waste rock dump strategy development.

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Attachment A

Extract from Leading Practice Handbook on Preventing Acid and Metalliferous Drainage

Sampling for Characterisation (DIIS, 2016; Section 4.2)

Overview (DIIS, 2016; Section 4.2.1)

Selecting samples and the methods used to collect them are critical tasks that need careful consideration at all stages of the project. As the project progresses from exploration through to feasibility, the range of samples tested should ultimately represent each type of material that will be excavated or exposed throughout the mine's life and after its closure. Enough samples should be obtained for each of the types of exposed material to determine the extent of significant variability in their material properties. Key mine material types to be sampled include waste rock, overburden, ore (run-of-mine and low-grade) and wall rock (open-cut/underground). While overburden might not contain much sulfide, it could still be geochemically enriched in metals and require specific management.

Each mine material type may consist of several different lithologies. In addition, each specific lithology can be weathered or oxidised to differing extents and, as this will influence the reactivity and AMD potential, the altered zones also need to be sampled and characterised. Even if sulfide concentrations are low or absent due to weathering processes, metalliferous drainage may still be an issue at some deposits. This highlights the importance of conducting geochemical sampling (and characterisation) of all material types.

Conducting representative sampling involves identifying the number and types of lithologies and the alteration and weathering sub-variants that constitute the bulk (>95%) of the total tonnage of materials to be excavated or exposed to oxidising conditions. Where possible, this sampling should span the full lateral and vertical extent of the ore deposit and associated waste and surrounding materials. It is important for expert advice to be sought at an early stage of project development to provide input into the design of the exploration drilling program and associated sampling for geochemical characterisation.

Representative samples of process/product/concentrate streams and tailings or other process waste streams should be obtained from metallurgical test work conducted during the feasibility and development stages of the project. Those samples are needed in addition to samples of ore, waste and surrounding materials to provide geochemical characterisation information for the tailings and product components of the AMD waste management system. Sulfide mineral concentrates can be very reactive and may require specific management where they are stockpiled (on site, during transport, or in intermediate storage at ports).

The numbers and type of samples selected will be site-specific and depend on the phase of the project (see Table 2 for guidance on sample numbers by project phase). Sufficient samples must be obtained to represent the variability/heterogeneity in each mine material as described above. Factors such as habit, grain size, structural defects, extent of alteration and dissemination or veining of reactive minerals (for example, sulfide minerals, carbonate minerals) must be addressed as part of the sample selection process to ensure that the full range of relevant properties is captured for each type of mine material.

Sample collection and handling requirements also need to consider the degree of weathering (for example, fresh, partially oxidised or fully oxidised) at the time of sampling, and implications for subsequent static or kinetic geochemical test work results. This is particularly important for aged drill core materials, weathered samples from brownfield or legacy sites, and sulfidic materials that are highly reactive and/or prone to spontaneous combustion. Ideally, samples from drill cores should be taken and tested as soon as possible after drilling. If that is not possible, the drill core should be stored under cover (for example, in a core shed) to minimise exposure to weathering processes until sampling and testing can occur. Drill chips should be stored in sealed heavy-duty plastic sample bags to minimise the potential for oxidation before testing.

In-place mine materials (DIIS, 2016; Section 4.2.2)

Although drilling and sampling tends to focus on ore zones in the exploration, pre-feasibility and feasibility phases, sufficient samples of potential wastes and exposed wall-rock material should also be collected to confirm that the future risk of AMD from those sources is not substantially underestimated. As the project develops, samples of waste rock and wall rock should be increasingly represented. This progressive development ensures that adequate data is available to produce a robust AMD block model and associated mine materials management schedule. Geostatistical analysis will ultimately be able to be used to inform and optimise the sampling strategy and to refine the block model. However, a sufficient number of samples representing the different lithologies, and the lateral distribution of properties within those lithologies, must initially be available before such analysis can be applied with a reasonable degree of confidence.

Sampling guidelines for static and kinetic geochemistry test work for initially in-place (that is, yet-to-be-mined) materials are summarised in [Box 1]. Indicative sampling frequencies are provided in Table 2 [of DIIS, 2016].

Samples collected for AMD assessment during operations are normally obtained from holes drilled for blasting or underground development. The inferred waste and ore boundaries are marked up using the geological block model on a map of the current bench plans for an open-cut mine (or on a map of the drive and stope development plans for an underground mine) and checked before and after blasting. The results from the characterisation of the blast hole samples are used to reconcile the geological model and AMD block model.

BOX 1: Sampling guidelines for in-place mine materials.

- *Multiple bulk samples, for both static and kinetic geochemical test work, are required to represent each lithology and weathering type from different parts of the deposit (that is, to ensure representative lateral and vertical variation).*
- *Continuous drillhole sampling should be completed where discrete samples collected for characterisation comprise a single lithology and weathering type, rather than spanning more than one type.*
- *Drillholes for sampling should be selected based on an even grid spacing and, in the case of metalliferous mines, should be sampled from surface (hanging wall) to the footwall of the ore body. Waste rock, ore and surrounding rock should be sampled. Diamond core provides the best source for sampling (since the intact material can be visually logged), followed by reverse circulation (RC) drill chips.[a] A similar sampling regime should be employed for coalmines, although sulfidic materials are often concentrated near and within coal seams, so the sampling intensity may be skewed towards those areas.*
- *Each bulk sample should be taken from a drillhole interval length sufficient to sample a single lithology (typically 0.5 m to 10 m), unless differential patterns of alteration indicate otherwise. Multiple lithologies should not be mixed. At coalmines, it is important to include specific coal seam roof, floor and major parting samples in the range of samples taken down a drillhole.*
- *Each bulk sample should comprise at least quarter core (minimum) extracted from the entire length of the selected drillhole interval to ensure that the sample is fully representative of that interval.*
- *Samples for geochemical test work should generally not be composited within each drillhole unless the subsamples used to produce the composite are obtained from the same lithology and drillhole interval. Sample compositing (for example, if a larger sample size is required for kinetic tests) can sometimes be undertaken after the results from initial geochemical screening tests have been acquired and interpreted,*

- *Each bulk sample should be crushed to <20 mm aggregate (or finer) to facilitate representative subsampling by 'splitting'. Representative subsamples cannot be achieved by grab sampling small masses of material from the bulk. Splitting using standard equipment (such as a rotary splitter or riffle splitter) and procedures produces representative subsamples of the required mass for static and/or kinetic geochemical analysis.*
- *For static geochemical test work, a minimum representative bulk subsample mass of 1 kg of aggregate is generally sufficient to submit to a laboratory. Additional sample preparation by laboratories includes further crushing to <2 mm or <4 mm, riffle splitting and pulverising to <100 µm, and the resultant pulp is subsampled for analysis.*
- *Bulk sample quantities are required for kinetic test work (Section 4.5). The samples can be around 2–5 kg for oxygen consumption test work, up to 35 kg for column leach test work, and up to 100 kg for oxygen diffusion test work.*
- *For kinetic geochemical test work, samples should ideally be prepared and tested in a manner that most closely simulates field conditions. However, for laboratory-based tests a smaller sample size means that waste rock needs to be crushed to ensure an adequate particle surface area and contact time with the leaching solution (typically deionised water or site rainwater). Bulk samples are typically crushed to pass a top size ranging from 5 mm to 40 mm, depending on the dimensions of the leaching apparatus. Tailings should be tested at the milled size that will be used for the process.*
- *Representative subsamples of the material used for kinetic geochemical test work (rather than similar/comparable mine material types) should be collected for static geochemical test work to assist in the interpretation of the findings.*

[a] *In most metalliferous deposits, RC drilling or open-hole rotary air blast (RAB) drilling is commonly used to drill through the waste rock material, and coring using a diamond drill bit is used to sample the ore material. Thus, the bulk of the mine material available for sampling and testing for waste properties may be RC or RAB drill chips, with limited diamond core available for testing waste.*

Attachment C

AMD Assessment and Classification Tool (AMDact) Report on 2012-13 Static Geochemistry Data

CERTIFICATE OF ASSESSMENT

Client :	NSW Dept. of Planning and Environment	Pages :	45
Project :	Bowdens Silver	Project Code :	NSWDPE2396
Location :	Central NSW	Report No.:	NSWDPE2396.08.A
		Contact :	Sophie Pape
Client Order No.:		Address :	ES Analytical - Melbourne Unit 4, 290 Salmon Street, Port Melbourne Victoria 3207, AUSTRALIA.
Client Contact :	Rose-Anne Hawkeswood		
Client Email :	rose-anne.hawkeswood@planning.nsw.gov.a	Email :	lab@esanalytical.com
Client Phone :	02 9274 6324	Phone :	(61-3) 9810 7500
Data received :	21/11/2022	No. of samples received :	127
Date assessed :	21/11/2022	No. samples classified :	127

Notes

Where available, Chromium-(SCr) was entered into AMDACT. When it was NOT available a calculated (Total S - SO4-S) equivalent was used.

Report Approval

This report has been approved for distribution by:

Name : Dr. Jeff Taylor

Position : Senior Principal Environmental Geochemist

Date released: 21/11/2022

Client : NSW Dept. of Planning and Environment
Project : Bowdens Silver

DATA SUMMARY

	Units	Data	Source	Notes**
Net Acid Producing Potential				
Net Acid Producing Potential (NAPP) :	kg H_2SO_4 / tonne	✓*		* Calculated by AMDACT
Acid Neutralising Capacity				
ANC as H_2SO_4:	kg H_2SO_4 / tonne	✓		
ANC as $CaCO_3$:	% $CaCO_3$	×		not provided
ANC - Excess (ANC-E) :	% $CaCO_3$			
Net Acid Generation				
NAG pH :	pH units	✓		
NAG 4.5 :	kg H_2SO_4 / tonne	✓		Limited Data
NAG 7.0 :	kg H_2SO_4 / tonne	✓		
NAG 9.5 :	kg H_2SO_4 / tonne	×		not provided
Acidity				
Potassium Chloride pH (pH-KCl) :	pH units	×		not provided
Titratable Actual Acidity (TAA) :	mol H^+/ tonne	×		not provided
Peroxide oxidised pH (pH-ox) :	pH units	×		not provided
Titratable Peroxide Acidity (TPA) :	mol H^+/ tonne	×		not provided
Sulfur Speciation				
Total Sulfur (S-TOT):	% S	✓		
Cr-reducible Sulfur (S-Cr):	% S	✓		
Peroxide Sulfur (Sp) :	% S	×		not provided
1M KCl extractable sulfur (S-KCl) :	% S	×		not provided
4M HCl extractable sulfur (S-HCl) :	% S	×		not provided
Residual Acid soluble Sulfur (S-RAS) :	% S	×		not provided
Carbon Speciation				
Total Carbon (C-TOT) :	% C	✓		
Organic Carbon (C-Org) :	% C	×		not provided
Inorganic Carbon (C-In) :	% C	✓		

** Limited Data (<50% of samples), Incomplete Data (50% - 99% of Samples)

This report is not to be used for purposes other than those for which it was intended. The geochemical risk assessment and classification of Acid Generating Potential of the suite of samples provided is based on the parameters indicated above. All of the data has been provided by the CLIENT and sourced from third party laboratories unless otherwise stated.

The Acid Generating Potential may vary greatly from the actual Acid Generating Capacity due a number of factors and, as a result, some samples may require additional static and kinetic testwork. Where possible additional suggested testwork has been indicated. It is recommended that any additional work be discussed with a qualified professional environmental geochemist.

Where sample parameters are reported as less than ("<"), or below detection ("B.D.") one half the reported detection limit has been used for the statistical analysis.

This report has been automatically generated byAMDACTv.5.2.8 (release date 24/06/2019) using data indicated above and supersedes any previous report(s) issued under the same work order / report number.

Sample Details		AMD Risk Classification - No. of Samples										
		General Classification			Detailed Classification							Totals
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available	
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data	Sub-total
Sandstone	No. Samples	2	17	0	0	0	0	2	14	0	3	19
	Proportion	10.5%	89.5%	0.0%	0.0%	0.0%	0.0%	10.5%	73.7%	0.0%	15.8%	-
Crystal Tuff	No. Samples	18	19	0	12	6	0	3	12	0	8	41
	Proportion	53.7%	46.3%	0.0%	29.3%	14.6%	0.0%	7.3%	29.3%	0.0%	19.5%	-
Ignimbrite	No. Samples	17	10	0	11	2	2	2	4	0	6	27
	Proportion	63.0%	37.0%	0.0%	40.7%	7.4%	7.4%	7.4%	14.8%	0.0%	22.2%	-
Volcanic Breccia	No. Samples	5	22	0	1	1	2	1	18	0	4	27
	Proportion	18.5%	81.5%	0.0%	3.7%	3.7%	7.4%	3.7%	66.7%	0.0%	14.8%	-
Laminated Tuff	No. Samples	0	10	0	0	0	0	0	5	0	5	10
	Proportion	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%	-
Ignimbrite Lithic Tuff	No. Samples	0	3	0	0	0	0	0	1	0	2	3
	Proportion	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	66.7%	-
All Samples	No. Samples	46	81	0	24	9	4	8	54	0	28	127
	Proportion	36.2%	63.8%	0.0%	18.9%	7.1%	3.1%	6.3%	42.5%	0.0%	22.0%	-

Table B-1: Summary of the relative proportions (in percentage) of primary sample types in each of the AMD Risk Classification categories, relative to the total number of samples assessed. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

Sample Details		AMD Risk Classification - No. of Samples											
		General Classification			Detailed Classification							Totals	
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available		
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data	Sub-total (lithology)	Sub-total (mine material type)
Sandstone	Sandstone	2	17	0	0	0	0	2	14	0	3	**19**	**19**
Crystal Tuff	Crystal Tuff	22	19	0	12	6	0	3	12	0	8	**41**	**41**
Ignimbrite	Ignimbrite	17	10	0	11	2	2	2	4	0	6	**27**	**27**
Volcanic Breccia	Volcanic Breccia	5	22	0	1	1	2	1	18	0	4	**27**	**27**
Laminated Tuff	Laminated Tuff	0	10	0	0	0	0	0	5	0	5	**10**	**10**
Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	0	3	0	0	0	0	0	1	0	2	**3**	**3**
Sub-Total		46	81	0	24	5	4	8	54	0	32	**127**	**127**

Table B-2: Summary of the number of samples in each of the AMD Risk Classification categories. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

Sample Details		AMD Risk Classification - % of Samples									
		General Classification			Detailed Classification						
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data
Sandstone	Sandstone	10.5%	89.5%	0.0%	0.0%	0.0%	0.0%	10.5%	73.7%	0.0%	15.8%
Crystal Tuff	Crystal Tuff	53.7%	46.3%	0.0%	29.3%	14.6%	0.0%	7.3%	29.3%	0.0%	19.5%
Ignimbrite	Ignimbrite	63.0%	37.0%	0.0%	40.7%	7.4%	7.4%	7.4%	14.8%	0.0%	22.2%
Volcanic Breccia	Volcanic Breccia	18.5%	81.5%	0.0%	3.7%	3.7%	7.4%	3.7%	66.7%	0.0%	14.8%
Laminated Tuff	Laminated Tuff	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%
Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	66.7%

Table B-3: Summary of the relative proportions (in percentage) of samples in each of the AMD Risk Classification categories, relative to the total number of samples assessed. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

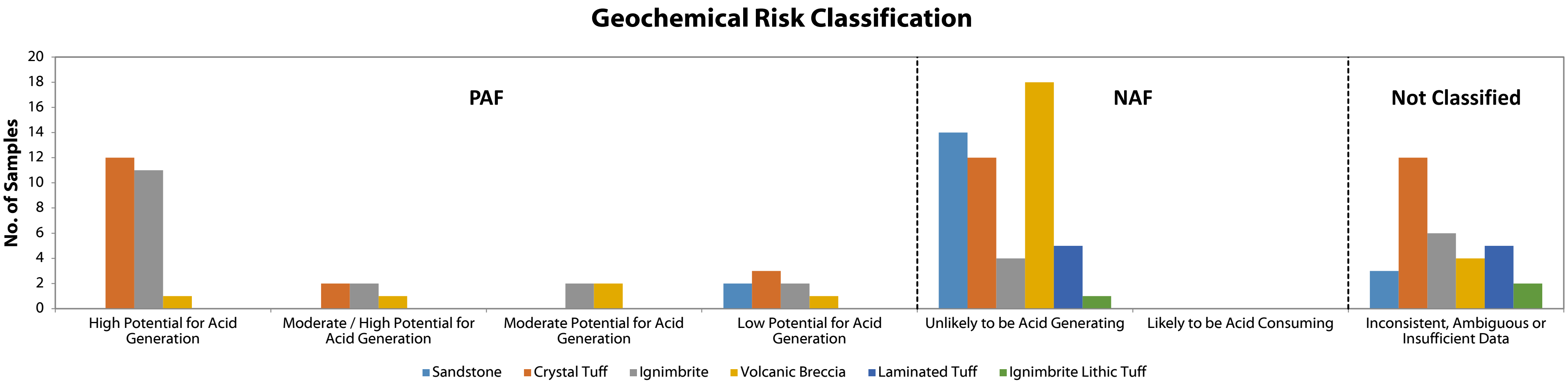

Figure C1: A chart showing the distribution of samples in each of the geochemical risk classification categories.

Generated using: AMDact v.5.2.8.2

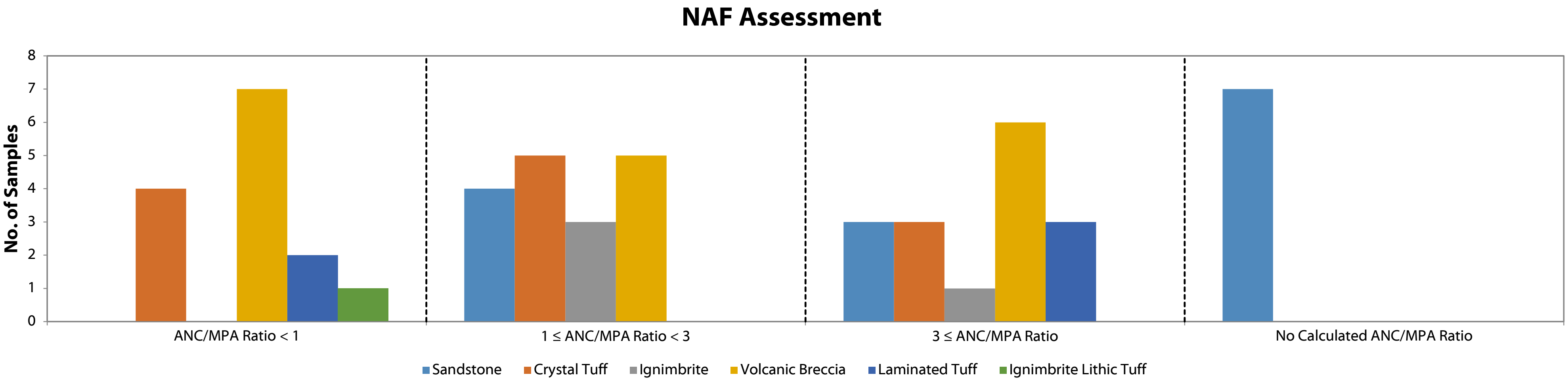

Figure C2: The distribution of NAF samples with various ANC/MPA ratios. Samples with no calculated ratio have Total Sulfur below detection and therefore an MPA of zero.

Generated using: AMDact v.5.2.8.2

Sample Details			Geochemical Risk Classification			
			AMD / ARD Risk Classification		Additional Risk Classification	
Sample ID	Sample Type	Sample Sub-Type	General Classification	Detailed Classification	Neutral Metalliferous Drainage (NMD/ML)	Saline Drainage (SD)
GCA10651	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10652	Sandstone	Sandstone	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10676	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10677	Sandstone	Sandstone	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10653	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10654	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10655	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10656	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10657	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10658	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10660	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10661	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10662	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10663	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10664	Sandstone	Sandstone	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10684	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10685	Sandstone	Sandstone	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10665	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10666	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10668	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10669	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10670	Crystal Tuff	Crystal Tuff	PAF*	Inconsistent Data*	Insufficient Data	Not assessed
GCA10671	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10672	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10673	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10674	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10675	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10667	Ignimbrite	Ignimbrite	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10681	Ignimbrite	Ignimbrite	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10682	Ignimbrite	Ignimbrite	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10683	Ignimbrite	Ignimbrite	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10700	Ignimbrite	Ignimbrite	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10701	Ignimbrite	Ignimbrite	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10678	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10679	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10680	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10686	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10687	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10690	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10691	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10692	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10693	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10694	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10705	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10715	Laminated Tuff	Laminated Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10716	Laminated Tuff	Laminated Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10717	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10723	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10724	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10695	Laminated Tuff	Laminated Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10696	Laminated Tuff	Laminated Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10697	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10698	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10699	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10702	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10703	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10704	Volcanic Breccia	Volcanic Breccia	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10706	Volcanic Breccia	Volcanic Breccia	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10707	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10708	Volcanic Breccia	Volcanic Breccia	PAF	Moderate Potential for Acid Generation	-	Unlikely to Generate SD
GCA10744	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10745	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10746	Volcanic Breccia	Volcanic Breccia	NAF*	Inconsistent Data*	Insufficient Data	
GCA10747	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10748	Volcanic Breccia	Volcanic Breccia	NAF*	Inconsistent Data*	Insufficient Data	
GCA10750	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10751	Volcanic Breccia	Volcanic Breccia	PAF	Moderate / High Potential for Acid Generation	-	Unlikely to Generate SD

Sample Details			Geochemical Risk Classification			
			AMD / ARD Risk Classification		Additional Risk Classification	
Sample ID	Sample Type	Sample Sub-Type	General Classification	Detailed Classification	Neutral Metalliferous Drainage (NMD/ML)	Saline Drainage (SD)
GCA10753	Volcanic Breccia	Volcanic Breccia	PAF	Moderate Potential for Acid Generation	-	Unlikely to Generate SD
GCA10712	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10713	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10719	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10720	Crystal Tuff	Crystal Tuff	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10721	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10722	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10730	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10731	Crystal Tuff	Crystal Tuff	PAF	Moderate / High Potential for Acid Generation	-	Unlikely to Generate SD
GCA10732	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10042	Crystal Tuff	Crystal Tuff	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10740	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10741	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10742	Laminated Tuff	Laminated Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10709	Ignimbrite	Ignimbrite	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10710	Ignimbrite	Ignimbrite	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10718	Ignimbrite	Ignimbrite	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
GCA10725	Ignimbrite	Ignimbrite	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10726	Ignimbrite	Ignimbrite	PAF	Moderate / High Potential for Acid Generation	-	Unlikely to Generate SD
GCA10047	Ignimbrite	Ignimbrite	PAF	Moderate Potential for Acid Generation	-	Unlikely to Generate SD
GCA10050	Ignimbrite	Ignimbrite	PAF	Moderate / High Potential for Acid Generation	-	Unlikely to Generate SD
GCA10051	Ignimbrite	Ignimbrite	NAF*	Inconsistent Data*	Insufficient Data	
GCA10052	Ignimbrite	Ignimbrite	PAF	Moderate Potential for Acid Generation	-	Unlikely to Generate SD
GCA10053	Ignimbrite	Ignimbrite	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10738	Sandstone	Sandstone	PAF	Low Potential for Acid Generation	-	Unlikely to Generate SD
GCA10739	Sandstone	Sandstone	NAF*	Inconsistent Data*	Insufficient Data	
GCA10733	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10734	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10736	Crystal Tuff	Crystal Tuff	PAF*	Moderate / High Potential for Acid Generation	Not assessed	Not assessed
GCA10754	Crystal Tuff	Crystal Tuff	PAF	Moderate / High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10755	Crystal Tuff	Crystal Tuff	NAF*	WARNING: The NAG 7.0 is too low for the NAG pH.	Not assessed	Low Potential to Generate SD
GCA10756	Crystal Tuff	Crystal Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	
GCA10041	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10043	Crystal Tuff	Crystal Tuff	PAF*	Moderate / High Potential for Acid Generation	Not assessed	Not assessed
GCA10044	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10045	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Moderate Potential to Generate SD
GCA10046	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11075	Crystal Tuff	Crystal Tuff	PAF*	Moderate / High Potential for Acid Generation	Not assessed	Not assessed
GCA11076	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11077	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11078	Crystal Tuff	Crystal Tuff	PAF*	Moderate / High Potential for Acid Generation	Not assessed	Not assessed
GCA11079	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11081	Crystal Tuff	Crystal Tuff	PAF	Low Potential for Acid Generation	-	Low Potential to Generate SD
GCA11080	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11082	Crystal Tuff	Crystal Tuff	NAF*	Inconsistent Data*	Insufficient Data	
GCA11084	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11083	Crystal Tuff	Crystal Tuff	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10727	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10728	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10048	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10039	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10040	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11069	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11070	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11071	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11072	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11073	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA11074	Ignimbrite	Ignimbrite	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10743	Volcanic Breccia	Volcanic Breccia	PAF	High Potential for Acid Generation	-	Low Potential to Generate SD
GCA10749	Volcanic Breccia	Volcanic Breccia	NAF*	Inconsistent Data*	Insufficient Data	

NAF	NAF Safety Factor Warning (ANC/MPA < 1)
NAF	NAF Safety Factor Warning (1 < ANC/MPA < 3)

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	Sample ID		GCA10651	GCA10652	GCA10676	GCA10677	GCA10653	GCA10654	GCA10655	GCA10656	GCA10657	GCA10658
Sample Details	Sample Type		Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
	Sample Sub-Type		Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
	General Classification		NAF	NAF*	NAF	NAF*	NAF	NAF	NAF	NAF	NAF	NAF
	Detailed Classification		Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-0.4	-0.4	1.2	0.5	-1.0	-1.0	-0.4	-0.4	-1.0	0.6
	NNP	kg $CaCO_3$ / tonne	0.4	0.4	-1.3	-0.5	1.0	1.0	0.4	0.4	1.0	-0.6
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-1.0	-0.4	0.0	-0.7	-1.0	-1.0	-1.0	-0.4	-1.0	0.0
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	1.0	0.4	0.0	0.7	1.0	1.0	1.0	0.4	1.0	0.0
	MPA	kg H_2SO_4 / tonne	0.6	0.6	1.2	1.5	-	-	0.6	0.6	-	0.6
	AP	kg $CaCO_3$ / tonne	0.6	0.6	1.3	1.6	-	-	0.6	0.6	-	0.6
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	-	0.6	-	0.3	-	-	-	0.6	-	-
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	-	0.6	-	0.3	-	-	-	0.6	-	-
	ANC	kg H_2SO_4 / tonne	1.0	1.0	<1	1.0	1.0	1.0	1.0	1.0	1.0	<1
	NP	kg $CaCO_3$ / tonne	1.0	1.0	<1	1.0	1.0	1.0	1.0	1.0	1.0	<1
	ANC/MPA	-	1.6	1.6	-	0.7	-	-	1.6	1.6	-	-
	NPR (NP/AP)	-	1.6	1.6	-	0.7	-	-	1.6	1.6	-	-
	$Pyrite_{(STOT)}$	% Pyrite	0.0	0.0	0.1	0.1	-	-	0.0	0.0	-	0.0
	$Pyrite_{(SCr)}$	% Pyrite	-	0.0	-	0.0	-	-	-	0.0	-	-
	Paste pH	pH units										
	NAG_{pH}	pH units	6.6	6.5	5.5	5.8	6.2	6.0	5.8	5.6	5.7	5.4
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	0.70	<0.5	0.70	<0.5	0.90	0.90	0.90	0.70	0.70	1.00
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.02	0.02	0.04	0.05	<0.01	<0.01	0.02	0.02	<0.01	0.02
	S_{Cr}	wt% S	<0.01	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	<0.01	0.0	<0.01	0.0	<0.01	<0.01	<0.01	0.0	<0.01	<0.01
	Pyrite (equiv.)	wt%	-	0.0	-	0.0	-	-	-	0.0	-	-
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+ / tonne										
	TPA	mol H^+ / tonne										
	TSA	mol H^+ / tonne										
	Potential Acidity	mol H^+ / tonne	0.0	12.5	0.0	6.2	0.0	0.0	0.0	12.5	0.0	0.0
	Actual Acidity	mol H^+ / tonne										
	Retained Acidity	mol H^+ / tonne										
	Net Acidity	mol H^+ / tonne										
Carbon	C_{TOT}	wt% C	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.0	0.0	0.0	0.0	<0.01	<0.01	<0.01	0.0	0.0	0.0
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	0.166657231	0.166657231	0.499971693	0.42	0.17	0.17	0.08	0.58	0.33	0.17
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.33	0.17	0.08
Assessment	Additional Potential Risks		Insufficient Data	Not assessed / Unlikely to Generate SD	Insufficient Data	Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
	Details [a]		12, 17, 24, 43, 99		12, 17, 24, 43, 99		12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62		16, 16.1, 16.2, 16.3, 62		16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

* Calculated values based on:

AMIRA (2002). ARD Test Handbook - Project P387A Prediction & Kinetic Control of Acid Mine Drainage. AMIRA International

Ahern CR, McElnea AE, Sullivan LA (2004). Acid Sulfate Soils Laboratory Methods Guidelines. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3
0.1	SCr calculated from Total S - SO4-S
PAF* / NAF*	Where there is inconsistency between static data the PAF/NAF classification is based soley on NAGpH when available.

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Sample Details	Sample ID		GCA10660	GCA10661	GCA10662	GCA10663	GCA10664	GCA10684	GCA10685	GCA10665	GCA10666	GCA10668
	Sample Type		Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Crystal Tuff	Crystal Tuff	Crystal Tuff
	Sample Sub-Type		Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Crystal Tuff	Crystal Tuff	Crystal Tuff
	General Classification		NAF	NAF	NAF	NAF	PAF	NAF	NAF	NAF	NAF	NAF
	Detailed Classification		Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Low Potential for Acid Generation	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-2.4	-3.4	2.1	0.6	7.7	-0.8	-8.8	0.5	1.4	-0.4
	NNP	kg $CaCO_3$ / tonne	2.4	3.5	-2.2	-0.6	-7.8	0.8	9.0	-0.5	-1.4	0.4
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-2.4	-3.4	0.9	0.6	0.9	-1.4	-9.4	-1.0	-1.4	-1.0
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	2.4	3.5	-0.9	-0.6	-0.9	1.4	9.6	1.0	1.4	1.0
	MPA	kg H_2SO_4 / tonne	0.6	0.6	2.1	0.6	7.7	1.2	1.2	1.5	3.4	0.6
	AP	kg $CaCO_3$ / tonne	0.6	0.6	2.2	0.6	7.8	1.3	1.3	1.6	3.4	0.6
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	0.6	0.6	0.9	0.6	0.9	0.6	0.6	-	0.6	-
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	0.6	0.6	0.9	0.6	0.9	0.6	0.6	-	0.6	-
	ANC	kg H_2SO_4 / tonne	3.0	4.0	<1	<1	<1	2.0	10.0	1.0	2.0	1.0
	NP	kg $CaCO_3$ / tonne	3.1	4.1	<1	<1	<1	2.0	10.2	1.0	2.0	1.0
	ANC/MPA	-	4.9	6.5	-	-	-	1.6	8.2	0.7	0.6	1.6
	NPR (NP/AP)	-	4.9	6.5	-	-	-	1.6	8.2	0.7	0.6	1.6
	$Pyrite_{(STOT)}$	% Pyrite	0.0	0.0	0.1	0.0	0.5	0.1	0.1	0.1	0.2	0.0
	$Pyrite_{(SCr)}$	% Pyrite	0.0	0.0	0.1	0.0	0.1	0.0	0.0	-	0.0	-
	Paste pH	pH units										
	NAG_{pH}	pH units	6.3	6.1	4.6	4.8	4.2	5.7	8.1	5.0	4.9	5.1
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	0.90	1.00	1.50	1.40	2.30	0.70	<0.5	1.20	1.20	1.50
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.02	0.02	0.07	0.02	0.25	0.04	0.04	0.05	0.11	0.02
	S_{Cr}	wt% S	0.02	0.02	0.03	0.02	0.03	0.02	0.02	<0.01	0.02	<0.01
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.01	0.0	<0.01
	Pyrite (equiv.)	wt%	0.0	0.0	0.1	0.0	0.1	0.0	0.0	-	0.0	-
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	12.5	12.5	18.7	12.5	18.7	12.5	12.5	0.0	12.5	0.0
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	<0.01	<0.01
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	<0.01	<0.01
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.3	0.4	0.0	0.0	0.0	0.2	1.0	0.1	0.2	0.1
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	0.50	0.58	0.67	0.25	0.50	0.50	0.83	0.17	0.00	0.00
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.08	0.08	0.50	0.17	0.33	0.17	0.67	0.17	0.00	0.00
Assessment	Additional Potential Risks		Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
	Details [a]		12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Section	Parameter	Unit	GCA10669	GCA10670	GCA10671	GCA10672	GCA10673	GCA10674	GCA10675	GCA10667	GCA10681	GCA10682
Sample Details	Sample ID		GCA10669	GCA10670	GCA10671	GCA10672	GCA10673	GCA10674	GCA10675	GCA10667	GCA10681	GCA10682
	Sample Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Ignimbrite	Ignimbrite	Ignimbrite
	Sample Sub-Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Ignimbrite	Ignimbrite	Ignimbrite
	General Classification		NAF	PAF*	NAF*	NAF	NAF	NAF	NAF	NAF	NAF*	NAF*
	Detailed Classification		Unlikely to be Acid Generating	Inconsistent Data*	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	WARNING: The NAG 7.0 is too low for the NAG pH.
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	0.2	2.6	-1.4	-1.8	-9.4	0.6	-5.4	-0.5	-4.6	-9.9
	NNP	kg $CaCO_3$ / tonne	-0.2	-2.6	1.4	1.8	9.6	-0.6	5.5	0.5	4.6	10.1
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-0.4	-1.7	-1.4	-1.8	-9.4	-3.7	-5.4	-2.0	-5.2	-9.9
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	0.4	1.7	1.4	1.8	9.6	3.8	5.5	2.0	5.3	10.1
	MPA	kg H_2SO_4 / tonne	1.2	4.6	0.6	1.2	0.6	4.6	0.6	1.5	2.4	2.1
	AP	kg $CaCO_3$ / tonne	1.3	4.7	0.6	1.3	0.6	4.7	0.6	1.6	2.5	2.2
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	0.6	0.3	0.6	1.2	0.6	0.3	0.6	-	1.8	2.1
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	0.6	0.3	0.6	1.3	0.6	0.3	0.6	-	1.9	2.2
	ANC	kg H_2SO_4 / tonne	1.0	2.0	2.0	3.0	10.0	4.0	6.0	2.0	7.0	12.0
	NP	kg $CaCO_3$ / tonne	1.0	2.0	2.0	3.1	10.2	4.1	6.1	2.0	7.1	12.2
	ANC/MPA	-	0.8	0.4	3.3	2.5	16.3	0.9	9.8	1.3	2.9	5.6
	NPR (NP/AP)	-	0.8	0.4	3.3	2.4	16.3	0.9	9.8	1.3	2.9	5.6
	$Pyrite_{(STOT)}$	% Pyrite	0.1	0.3	0.0	0.1	0.0	0.3	0.0	0.1	0.1	0.1
	$Pyrite_{(SCr)}$	% Pyrite	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-	0.1	0.1
	Paste pH	pH units										
	NAG_{pH}	pH units	4.9	4.5	5.9	5.9	7.3	4.7	5.8	5.3	4.6	6.7
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	1.20	2.20	<0.5	0.70	<0.5	1.70	0.70	0.70	<0.5	<0.5
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.04	0.15	0.02	0.04	0.02	0.15	0.02	0.05	0.08	0.07
	S_{Cr}	wt% S	0.02	0.01	0.02	0.04	0.02	0.01	0.02	<0.01	0.06	0.07
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.01	0.1	0.1
	Pyrite (equiv.)	wt%	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-	0.1	0.1
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	12.5	6.2	12.5	24.9	12.5	6.2	12.5	0.0	37.4	43.7
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.1	0.0	0.1	0.1	0.5	0.0	<0.01	0.0	<0.01	0.6
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.1	<0.01	0.1	0.1	0.5	<0.01	<0.01	<0.01	<0.01	0.6
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.1	0.2	0.2	0.3	1.0	0.4	0.6	0.2	0.7	1.2
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	0.50	0.08	0.83	0.92	4.17	0.08	0.00	0.25	0.00	5.33
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.50	0.00	0.58	0.83	3.75	0.00	0.00	0.00	0.00	5.25
Assessment	Additional Potential Risks		Insufficient Data	Not assessed	Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD
	Details [a]		12, 17, 24, 43, 99	74 (66), 170		12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99		
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62	10.4, 10.5, 11, 61, 66		16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62		

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA10683	GCA10700	GCA10701	GCA10678	GCA10679	GCA10680	GCA10686	GCA10687	GCA10690	GCA10691
	Sample Type		Ignimbrite	Ignimbrite	Ignimbrite	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	Sample Sub-Type		Ignimbrite	Ignimbrite	Ignimbrite	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	General Classification		**NAF**	**NAF***	**NAF***	**NAF**	**NAF**	**NAF**	**NAF**	**NAF**	**NAF**	**NAF**
	Detailed Classification		Unlikely to be Acid Generating	**WARNING: The NAG 7.0 is too low for the NAG pH.**	**WARNING: The NAG 7.0 is too low for the NAG pH.**	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-12.1	0.2	0.2	2.8	3.3	1.3	-2.9	-23.5	-4.4	-22.5
	NNP	kg $CaCO_3$ / tonne	12.3	-0.2	-0.2	-2.9	-3.4	-1.3	3.0	23.9	4.5	22.9
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-12.1	-0.7	-0.7	-3.0	-3.4	-2.7	-3.9	-23.5	-4.4	-22.8
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	12.3	0.7	0.7	3.1	3.5	2.7	3.9	23.9	4.5	23.2
	MPA	kg H_2SO_4 / tonne	0.9	1.2	1.2	5.8	7.3	4.3	3.1	1.5	0.6	1.5
	AP	kg $CaCO_3$ / tonne	0.9	1.3	1.3	5.9	7.5	4.4	3.1	1.6	0.6	1.6
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	0.9	0.3	0.3	-	0.6	0.3	2.1	1.5	0.6	1.2
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	0.9	0.3	0.3	-	0.6	0.3	2.2	1.6	0.6	1.3
	ANC	kg H_2SO_4 / tonne	13.0	1.0	1.0	3.0	4.0	3.0	6.0	25.0	5.0	24.0
	NP	kg $CaCO_3$ / tonne	13.3	1.0	1.0	3.1	4.1	3.1	6.1	25.5	5.1	24.5
	ANC/MPA	-	14.2	0.8	0.8	0.5	0.5	0.7	2.0	16.3	8.2	15.7
	NPR (NP/AP)	-	14.2	0.8	0.8	0.5	0.5	0.7	2.0	16.3	8.2	15.7
	$Pyrite_{(STOT)}$	% Pyrite	0.1	0.1	0.1	0.4	0.4	0.3	0.2	0.1	0.0	0.1
	$Pyrite_{(SCr)}$	% Pyrite	0.1	0.0	0.0	-	0.0	0.0	0.1	0.1	0.0	0.1
	Paste pH	pH units										
	NAG_{pH}	pH units	7.1	5.8	5.8	4.6	4.7	4.9	5.7	8.7	7.0	9.1
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	<0.5	<0.5	<0.5	1.40	1.20	0.90	0.90	<0.5	<0.5	<0.5
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.03	0.04	0.04	0.19	0.24	0.14	0.10	0.05	0.02	0.05
	S_{Cr}	wt% S	0.03	0.01	0.01	<0.01	0.02	0.01	0.07	0.05	0.02	0.04
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.0	0.0	0.0	<0.01	0.0	0.0	0.1	0.1	0.0	0.0
	Pyrite (equiv.)	wt%	0.1	0.0	0.0	-	0.0	0.0	0.1	0.1	0.0	0.1
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	18.7	6.2	6.2	0.0	12.5	6.2	43.7	31.2	12.5	24.9
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.5	0.0	0.0	0.0	<0.01	0.0	0.1	0.5	0.1	0.4
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	0.4	0.0	0.4
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	1.3	0.1	0.1	0.3	0.4	0.3	0.6	2.6	0.5	2.4
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	4.50	0.25	0.25	0.17	0.00	0.17	0.92	3.83	0.58	3.50
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	4.42	0.00	0.00	0.00	0.00	0.00	0.75	3.67	0.33	3.33
Assessment	Additional Potential Risks		Insufficient Data	Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
	Details [a]		12, 17, 24, 43, 99			12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62			16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Group	Parameter	Unit	GCA10692	GCA10693	GCA10694	GCA10705	GCA10715	GCA10716	GCA10717	GCA10723	GCA10724	GCA10695
Sample Details	Sample ID		GCA10692	GCA10693	GCA10694	GCA10705	GCA10715	GCA10716	GCA10717	GCA10723	GCA10724	GCA10695
	Sample Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff
	Sample Sub-Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff	Laminated Tuff
	General Classification		NAF	NAF	NAF	NAF	NAF*	NAF*	NAF	NAF	NAF	NAF*
	Detailed Classification		Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-5.4	-11.4	-11.9	-6.1	-2.1	-2.1	-6.4	-3.4	-3.7	-3.7
	NNP	kg $CaCO_3$ / tonne	5.5	11.6	12.2	6.2	2.1	2.1	6.5	3.5	3.8	3.8
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-5.4	-11.4	-11.9	-8.6	-3.0	-2.7	-7.0	-4.0	-3.7	-3.7
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	5.5	11.6	12.2	8.7	3.1	2.7	7.1	4.1	3.8	3.8
	MPA	kg H_2SO_4 / tonne	0.6	0.6	3.1	8.9	0.9	0.9	0.6	0.6	0.3	0.3
	AP	kg $CaCO_3$ / tonne	0.6	0.6	3.1	9.1	0.9	0.9	0.6	0.6	0.3	0.3
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	0.6	0.6	3.1	6.4	-	0.3	-	-	0.3	0.3
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	0.6	0.6	3.1	6.6	-	0.3	-	-	0.3	0.3
	ANC	kg H_2SO_4 / tonne	6.0	12.0	15.0	15.0	3.0	3.0	7.0	4.0	4.0	4.0
	NP	kg $CaCO_3$ / tonne	6.1	12.2	15.3	15.3	3.1	3.1	7.1	4.1	4.1	4.1
	ANC/MPA	-	9.8	19.6	4.9	1.7	3.3	3.3	11.4	6.5	13.1	13.1
	NPR (NP/AP)	-	9.8	19.6	4.9	1.7	3.3	3.3	11.4	6.5	13.1	13.1
	$Pyrite_{(STOT)}$	% Pyrite	0.0	0.0	0.2	0.5	0.1	0.1	0.0	0.0	0.0	0.0
	$Pyrite_{(SCr)}$	% Pyrite	0.0	0.0	0.2	0.4	-	0.0	-	-	0.0	0.0
	Paste pH	pH units										
	NAG_{pH}	pH units	7.0	8.4	8.7	6.9	6.6	6.3	7.0	7.1	7.8	6.8
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.02	0.02	0.10	0.29	0.03	0.03	0.02	0.02	0.01	0.01
	S_{Cr}	wt% S	0.02	0.02	0.10	0.21	<0.01	0.01	<0.01	<0.01	0.01	0.01
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.0	0.0	0.1	0.2	<0.01	0.0	<0.01	<0.01	0.0	0.0
	Pyrite (equiv.)	wt%	0.0	0.0	0.2	0.4	-	0.0	-	-	0.0	0.0
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	12.5	12.5	62.4	131.0	0.0	6.2	0.0	0.0	6.2	6.2
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.1	0.3	0.4	0.2	0.0	0.1	0.0	0.1	0.0	0.0
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.1	0.2	0.3	0.1	0.0	<0.01	<0.01	0.0	<0.01	<0.01
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.6	1.2	1.5	1.5	0.3	0.3	0.7	0.4	0.4	0.4
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	0.50	2.08	2.92	1.67	0.33	0.42	0.33	0.50	0.25	0.17
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.42	1.83	2.75	1.17	0.08	0.00	0.00	0.17	0.00	0.00
Assessment	Additional Potential Risks		Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD
	Details [a]		12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99			12, 17, 24, 43, 99	12, 17, 24, 43, 99	12, 17, 24, 43, 99	
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62			16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62	

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA10696	GCA10697	GCA10698	GCA10699	GCA10702	GCA10703	GCA10704	GCA10706	GCA10707	GCA10708
	Sample Type		Laminated Tuff	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	Sample Sub-Type		Laminated Tuff	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	Ignimbrite Lithic Tuff	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	General Classification		NAF*	NAF*	NAF*	NAF	NAF	NAF	NAF*	PAF	NAF	PAF
	Detailed Classification		WARNING: The NAG 7.0 is too low for the NAG pH.	WARNING: The NAG 7.0 is too low for the NAG pH.	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	Low Potential for Acid Generation	Unlikely to be Acid Generating	Moderate Potential for Acid Generation
Static Geochemistry	NAPP	kg H_2SO_4/ tonne	-4.5	-0.4	0.2	2.4	-3.7	4.4	1.2	6.2	-3.4	16.9
	NNP	kg $CaCO_3$/ tonne	4.6	0.4	-0.2	-2.4	3.8	-4.5	-1.3	-6.4	3.5	-17.2
	$NAPP_{(SCr)}$	kg H_2SO_4/ tonne	-5.4	-0.4	-0.4	0.2	-9.5	-3.0	-3.7	1.0	-9.2	8.3
	$NNP_{(SCr)}$	kg $CaCO_3$/ tonne	5.5	0.4	0.4	-0.2	9.7	3.0	3.7	-1.0	9.4	-8.5
	MPA	kg H_2SO_4/ tonne	1.5	0.6	1.2	3.4	15.3	14.4	12.2	16.2	15.6	23.9
	AP	kg $CaCO_3$/ tonne	1.6	0.6	1.3	3.4	15.6	14.7	12.5	16.6	15.9	24.4
	$MPA_{(SCr)}$	kg H_2SO_4/ tonne	0.6	0.6	0.6	1.2	9.5	7.0	7.3	11.0	9.8	15.3
	$AP_{(SCr)}$	kg $CaCO_3$/ tonne	0.6	0.6	0.6	1.3	9.7	7.2	7.5	11.3	10.0	15.6
	ANC	kg H_2SO_4/ tonne	6.0	1.0	1.0	1.0	19.0	10.0	11.0	10.0	19.0	7.0
	NP	kg $CaCO_3$/ tonne	6.1	1.0	1.0	1.0	19.4	10.2	11.2	10.2	19.4	7.1
	ANC/MPA	-	3.9	1.6	0.8	0.3	1.2	0.7	0.9	0.6	1.2	0.3
	NPR (NP/AP)	-	3.9	1.6	0.8	0.3	1.2	0.7	0.9	0.6	1.2	0.3
	$Pyrite_{(STOT)}$	% Pyrite	0.1	0.0	0.1	0.2	0.9	0.9	0.7	1.0	1.0	1.5
	$Pyrite_{(SCr)}$	% Pyrite	0.0	0.0	0.0	0.1	0.6	0.4	0.4	0.7	0.6	0.9
	Paste pH	pH units										
	NAG_{pH}	pH units	6.5	6.8	6.6	4.6	7.3	7.2	5.6	4.3	7.3	3.7
	$NAG_{4.5}$	kg H_2SO_4/ tonne										
	$NAG_{7.0}$	kg H_2SO_4/ tonne	<0.5	<0.5	<0.5	1.40	<0.5	<0.5	<0.5	6.10	<0.5	9.00
	$NAG_{9.5}$	kg H_2SO_4/ tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.05	0.02	0.04	0.11	0.50	0.47	0.40	0.53	0.51	0.78
	S_{Cr}	wt% S	0.02	0.02	0.02	0.04	0.31	0.23	0.24	0.36	0.32	0.50
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.0	0.0	0.0	0.0	0.3	0.2	0.2	0.4	0.3	0.5
	Pyrite (equiv.)	wt%	0.0	0.0	0.0	0.1	0.6	0.4	0.4	0.7	0.6	0.9
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	12.5	12.5	12.5	24.9	193.3	143.5	149.7	224.5	199.6	311.9
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.1	0.0	0.1	0.0	0.3	0.3	0.2	0.1	0.4	0.1
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.1	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.3	0.1
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.6	0.1	0.1	0.1	1.9	1.0	1.1	1.0	1.9	0.7
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	0.67	0.33	0.42	0.33	2.17	2.50	1.67	0.92	3.17	0.92
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.42	0.08	0.33	0.17	1.92	2.00	1.17	0.42	2.67	0.67
Assessment	Additional Potential Risks		Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD	Unlikely to Generate SD	Insufficient Data	Unlikely to Generate SD
	Details [a]					12, 17, 24, 43, 99	9, 17, 24, 43, 74 (64, 111), 202	9, 17, 24, 43, 74 (64, 111), 202		7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	9, 17, 24, 43, 74 (64, 111), 202	7,16, 24, 41, 99, 151, 205
	Recommendations [b]					16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7		1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	1, 30, 30.1, 30.3, 30.4

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF	NAF Safety Factor Warning
0.5	ANC/MPA < 1
NAF	NAF Safety Factor Warning
2.1	1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA10744	GCA10745	GCA10746	GCA10747	GCA10748	GCA10750	GCA10751	GCA10753	GCA10712	GCA10713
	Sample Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Crystal Tuff	Crystal Tuff
	Sample Sub-Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Crystal Tuff	Crystal Tuff
	General Classification		NAF	NAF	NAF*	NAF	NAF*	NAF	PAF	PAF	NAF*	NAF*
	Detailed Classification		Unlikely to be Acid Generating	Unlikely to be Acid Generating	Inconsistent Data*	Unlikely to be Acid Generating	Inconsistent Data*	Unlikely to be Acid Generating	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	WARNING: The NAG 7.0 is too low for the NAG pH.	WARNING: The NAG 7.0 is too low for the NAG pH.
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	2.4	1.6	6.1	3.4	7.1	-2.4	23.6	9.2	14.6	3.9
	NNP	kg $CaCO_3$ / tonne	-2.4	-1.7	-6.2	-3.5	-7.2	2.4	-24.1	-9.4	-14.9	-4.0
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	2.4	-1.1	0.9	0.1	0.3	-6.1	14.7	5.9	7.5	-8.1
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	-2.4	1.1	-0.9	-0.1	-0.4	6.2	-15.0	-6.0	-7.7	8.2
	MPA	kg H_2SO_4 / tonne	14.4	11.6	14.1	17.4	14.1	15.6	30.6	12.2	23.6	23.9
	AP	kg $CaCO_3$ / tonne	14.7	11.9	14.4	17.8	14.4	15.9	31.3	12.5	24.1	24.4
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	14.4	8.9	8.9	14.1	7.3	11.9	21.7	8.9	16.5	11.9
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	14.7	9.1	9.1	14.4	7.5	12.2	22.2	9.1	16.9	12.2
	ANC	kg H_2SO_4 / tonne	12.0	10.0	8.0	14.0	7.0	18.0	7.0	3.0	9.0	20.0
	NP	kg $CaCO_3$ / tonne	12.2	10.2	8.2	14.3	7.1	18.4	7.1	3.1	9.2	20.4
	ANC/MPA	-	0.8	0.9	0.6	0.8	0.5	1.2	0.2	0.2	0.4	0.8
	NPR (NP/AP)	-	0.8	0.9	0.6	0.8	0.5	1.2	0.2	0.2	0.4	0.8
	$Pyrite_{(STOT)}$	% Pyrite	0.9	0.7	0.9	1.1	0.9	1.0	1.9	0.7	1.4	1.5
	$Pyrite_{(SCr)}$	% Pyrite	0.9	0.5	0.5	0.9	0.4	0.7	1.3	0.5	1.0	0.7
	Paste pH	pH units										
	NAG_{pH}	pH units	4.7	7.1	6.2	7.1	4.7	7.1	3.4	3.7	5.7	6.5
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	1.40	<0.5	0.70	<0.5	2.00	<0.5	8.70	6.30	<0.5	<0.5
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.47	0.38	0.46	0.57	0.46	0.51	1.00	0.40	0.77	0.78
	S_{Cr}	wt% S	0.47	0.29	0.29	0.46	0.24	0.39	0.71	0.29	0.54	0.39
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.5	0.3	0.3	0.5	0.2	0.4	0.7	0.3	0.5	0.4
	Pyrite (equiv.)	wt%	0.9	0.5	0.5	0.9	0.4	0.7	1.3	0.5	1.0	0.7
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	293.1	180.9	180.9	286.9	149.7	243.2	442.8	180.9	336.8	243.2
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.3	0.2	0.1	0.4	0.1	0.4	0.1	0.0	0.3	0.4
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.3	0.2	0.1	0.4	0.1	0.3	0.1	<0.01	0.2	0.4
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	1.2	1.0	0.8	1.4	0.7	1.8	0.7	0.3	0.9	2.0
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.83	1.58	1.00	3.50	0.92	2.92	1.17	0.17	2.33	3.42
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	2.67	1.33	0.92	3.33	0.67	2.75	0.92	0.00	1.92	3.17
Assessment	Additional Potential Risks		Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Unlikely to Generate SD	Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD
	Details [a]		9, 17, 24, 43, 74 (64, 111), 202	9, 17, 24, 43, 74 (64, 111), 202	7, 69 (63, 97), 74, 172	9, 17, 24, 43, 74 (64, 111), 202	7, 69 (63, 97), 74, 172	9, 17, 24, 43, 74 (64, 111), 202	7, 15, 24, 41, 65, 90, 99, 151, 205	7,16, 24, 41, 99, 151, 205		
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	1, 30, 30.1, 30.3, 30.4, 64	1, 30, 30.1, 30.3, 30.4		

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF	NAF Safety Factor Warning
0.5	ANC/MPA < 1
NAF	NAF Safety Factor Warning
2.1	1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA10719	GCA10720	GCA10721	GCA10722	GCA10730	GCA10731	GCA10732	GCA10042	GCA10740	GCA10741
	Sample Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Laminated Tuff	Laminated Tuff
	Sample Sub-Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Laminated Tuff	Laminated Tuff
	General Classification		NAF	PAF	NAF	NAF	NAF*	PAF	NAF*	PAF	NAF	NAF
	Detailed Classification		Unlikely to be Acid Generating	Low Potential for Acid Generation	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	Moderate / High Potential for Acid Generation	WARNING: The NAG 7.0 is too low for the NAG pH.	Low Potential for Acid Generation	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-5.7	7.4	-4.6	-30.6	15.0	14.7	6.5	8.2	4.8	4.7
	NNP	kg $CaCO_3$ / tonne	5.8	-7.6	4.6	31.2	-15.3	-15.0	-6.7	-8.3	-4.9	-4.8
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-9.1	1.6	-10.1	-30.6	0.0	9.5	0.1	7.5	1.4	-3.6
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	9.2	-1.7	10.3	31.2	0.0	-9.7	-0.1	-7.7	-1.4	3.6
	MPA	kg H_2SO_4 / tonne	15.3	17.4	17.4	10.4	15.0	14.7	16.5	28.2	13.8	10.7
	AP	kg $CaCO_3$ / tonne	15.6	17.8	17.8	10.6	15.3	15.0	16.9	28.8	14.1	10.9
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	11.9	11.6	11.9	10.4	-	9.5	10.1	27.5	10.4	2.4
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	12.2	11.9	12.2	10.6	-	9.7	10.3	28.1	10.6	2.5
	ANC	kg H_2SO_4 / tonne	21.0	10.0	22.0	41.0	<1	<1	10.0	20.0	9.0	6.0
	NP	kg $CaCO_3$ / tonne	21.4	10.2	22.5	41.8	<1	<1	10.2	20.4	9.2	6.1
	ANC/MPA	-	1.4	0.6	1.3	3.9	-	-	0.6	0.7	0.7	0.6
	NPR (NP/AP)	-	1.4	0.6	1.3	3.9	-	-	0.6	0.7	0.7	0.6
	$Pyrite_{(STOT)}$	% Pyrite	0.9	1.1	1.1	0.6	0.9	0.9	1.0	1.7	0.8	0.7
	$Pyrite_{(SCr)}$	% Pyrite	0.7	0.7	0.7	0.6	-	0.6	0.6	1.7	0.6	0.1
	Paste pH	pH units										
	NAG_{pH}	pH units	7.9	4.5	8.3	8.4	5.0	3.3	6.4	4.1	5.6	5.6
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	<0.5	3.20	<0.5	<0.5	<0.5	8.20	<0.5	7.90	1.20	1.00
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.50	0.57	0.57	0.34	0.49	0.48	0.54	0.92	0.45	0.35
	S_{Cr}	wt% S	0.39	0.38	0.39	0.34	<0.01	0.31	0.33	0.90	0.34	0.08
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.4	0.4	0.4	0.3	<0.01	0.3	0.3	0.9	0.3	0.1
	Pyrite (equiv.)	wt%	0.7	0.7	0.7	0.6	-	0.6	0.6	1.7	0.6	0.1
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	243.2	237.0	243.2	212.1	0.0	193.3	205.8	561.3	212.1	49.9
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.3	0.2	0.3	0.8	0.1	0.0	0.3	0.6	0.1	0.1
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.2	0.1	0.2	0.7	0.0	<0.01	0.2	0.1	0.1	0.1
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	2.1	1.0	2.2	4.2	0.0	0.0	1.0	2.0	0.9	0.6
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.42	1.42	2.58	6.42	0.50	0.33	2.42	5.25	1.08	1.00
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	2.00	0.83	1.83	6.08	0.33	0.00	1.83	0.42	0.83	0.75
Assessment	Additional Potential Risks		Insufficient Data	Unlikely to Generate SD	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD	Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Unlikely to Generate SD	Insufficient Data	Insufficient Data
	Details [a]		9, 17, 24, 43, 74 (64, 111), 202	7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	9, 17, 24, 43, 74 (64, 111), 202	12, 17, 24, 43, 99		7, 15, 24, 41, 65, 90, 99, 151, 205		7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	9, 17, 24, 43, 74 (64, 111), 202	9, 17, 24, 43, 74 (64, 111), 202
	Recommendations [b]		16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	16, 16.1, 16.2, 16.3, 62		1, 30, 30.1, 30.3, 30.4, 64		1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Group	Parameter	Unit	GCA10742	GCA10709	GCA10710	GCA10718	GCA10725	GCA10726	GCA10047	GCA10050	GCA10051	GCA10052
Sample Details	Sample ID		GCA10742	GCA10709	GCA10710	GCA10718	GCA10725	GCA10726	GCA10047	GCA10050	GCA10051	GCA10052
	Sample Type		Laminated Tuff	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite
	Sample Sub-Type		Laminated Tuff	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite
	General Classification		NAF*	NAF	NAF	NAF*	PAF	PAF	PAF	PAF	NAF*	PAF
	Detailed Classification		WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	Unlikely to be Acid Generating	WARNING: The NAG 7.0 is too low for the NAG pH.	Low Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Moderate / High Potential for Acid Generation	Inconsistent Data*	Moderate Potential for Acid Generation
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	7.5	-13.5	-12.4	3.2	9.2	19.6	9.3	12.5	9.3	8.3
	NNP	kg $CaCO_3$ / tonne	-7.7	13.8	12.6	-3.3	-9.4	-20.0	-9.5	-12.7	-9.5	-8.4
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-2.6	-16.0	-14.8	-4.4	1.8	10.1	8.4	11.5	8.7	7.0
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	2.6	16.3	15.1	4.5	-1.9	-10.3	-8.6	-11.8	-8.9	-7.2
	MPA	kg H_2SO_4 / tonne	20.5	9.5	11.6	16.2	9.2	19.6	22.3	28.5	26.3	23.3
	AP	kg $CaCO_3$ / tonne	20.9	9.7	11.9	16.6	9.4	20.0	22.8	29.1	26.9	23.8
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	10.4	7.0	9.2	8.6	1.8	10.1	21.4	27.5	25.7	22.0
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	10.6	7.2	9.4	8.8	1.9	10.3	21.9	28.1	26.3	22.5
	ANC	kg H_2SO_4 / tonne	13.0	23.0	24.0	13.0	<1	<1	13.0	16.0	17.0	15.0
	NP	kg $CaCO_3$ / tonne	13.3	23.5	24.5	13.3	<1	<1	13.3	16.3	17.3	15.3
	ANC/MPA	-	0.6	2.4	2.1	0.8	-	-	0.6	0.6	0.6	0.6
	NPR (NP/AP)	-	0.6	2.4	2.1	0.8	-	-	0.6	0.6	0.6	0.6
	$Pyrite_{(STOT)}$	% Pyrite	1.3	0.6	0.7	1.0	0.6	1.2	1.4	1.7	1.6	1.4
	$Pyrite_{(SCr)}$	% Pyrite	0.6	0.4	0.6	0.5	0.1	0.6	1.3	1.7	1.6	1.3
	Paste pH	pH units										
	NAG_{pH}	pH units	6.8	7.7	8.3	5.5	4.5	3.4	4.0	3.2	8.7	3.6
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	<0.5	<0.5	<0.5	<0.5	1.80	9.50	1.50	9.80	<0.5	5.60
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.67	0.31	0.38	0.53	0.30	0.64	0.73	0.93	0.86	0.76
	S_{Cr}	wt% S	0.34	0.23	0.30	0.28	0.06	0.33	0.70	0.90	0.84	0.72
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.3	0.2	0.3	0.3	0.1	0.3	0.7	0.9	0.8	0.7
	Pyrite (equiv.)	wt%	0.6	0.4	0.6	0.5	0.1	0.6	1.3	1.7	1.6	1.3
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+ / tonne										
	TPA	mol H^+ / tonne										
	TSA	mol H^+ / tonne										
	Potential Acidity	mol H^+ / tonne	212.1	143.5	187.1	174.6	37.4	205.8	436.6	561.3	523.9	449.1
	Actual Acidity	mol H^+ / tonne										
	Retained Acidity	mol H^+ / tonne										
	Net Acidity	mol H^+ / tonne										
Carbon	C_{TOT}	wt% C	0.2	0.4	0.5	0.2	0.1	0.1	0.2	0.3	0.2	0.2
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.2	0.3	0.4	0.2	<0.01	0.0	0.0	0.0	<0.01	0.0
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	1.3	2.3	2.4	1.3	0.0	0.0	1.3	1.6	1.7	1.5
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	1.83	3.08	3.92	1.75	0.42	0.42	1.58	2.58	1.75	1.83
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	1.67	2.67	3.50	1.25	0.00	0.08	0.08	0.08	0.00	0.08
Assessment	Additional Potential Risks		Not assessed / Unlikely to Generate SD	Insufficient Data	Insufficient Data	Not assessed / Unlikely to Generate SD	Unlikely to Generate SD	Unlikely to Generate SD	Unlikely to Generate SD	Unlikely to Generate SD	Insufficient Data	Unlikely to Generate SD
	Details [a]			12, 17, 24, 43, 99	12, 17, 24, 43, 99		7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7,16, 24, 41, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 69 (63, 97), 74, 172	7,16, 24, 41, 99, 151, 205
	Recommendations [b]			16, 16.1, 16.2, 16.3, 62	16, 16.1, 16.2, 16.3, 62		1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	1, 30, 30.1, 30.3, 30.4, 64	1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4, 64	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	1, 30, 30.1, 30.3, 30.4

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Section	Parameter	Unit	GCA10053	GCA10738	GCA10739	GCA10733	GCA10734	GCA10736	GCA10754	GCA10755	GCA10756	GCA10041
Sample Details	Sample ID		GCA10053	GCA10738	GCA10739	GCA10733	GCA10734	GCA10736	GCA10754	GCA10755	GCA10756	GCA10041
	Sample Type		Ignimbrite	Sandstone	Sandstone	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff
	Sample Sub-Type		Ignimbrite	Sandstone	Sandstone	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff
	General Classification		PAF	PAF	NAF*	PAF	PAF	PAF*	PAF	NAF*	NAF	PAF
	Detailed Classification		Low Potential for Acid Generation	Low Potential for Acid Generation	Inconsistent Data*	High Potential for Acid Generation	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate / High Potential for Acid Generation	WARNING: The NAG 7.0 is too low for the NAG pH.	Unlikely to be Acid Generating	High Potential for Acid Generation
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	0.5	15.6	17.4	52.0	70.4	38.9	20.0	-3.3	-32.5	42.3
	NNP	kg $CaCO_3$ / tonne	-0.5	-15.9	-17.8	-53.1	-71.9	-39.7	-20.4	3.3	33.2	-43.2
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-0.4	0.9	0.3	33.7	42.8	38.9	4.7	-9.4	-59.2	42.3
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	0.4	-0.9	-0.3	-34.4	-43.8	-39.7	-4.8	9.6	60.4	-43.2
	MPA	kg H_2SO_4 / tonne	20.5	15.6	17.4	52.0	70.4	45.9	49.0	36.7	28.5	67.3
	AP	kg $CaCO_3$ / tonne	20.9	15.9	17.8	53.1	71.9	46.9	50.0	37.5	29.1	68.8
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	19.6	0.9	0.3	33.7	42.8	45.9	33.7	30.6	1.8	67.3
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	20.0	0.9	0.3	34.4	43.8	46.9	34.4	31.3	1.9	68.8
	ANC	kg H_2SO_4 / tonne	20.0	<1	<1	<1	<1	7.0	29.0	40.0	61.0	25.0
	NP	kg $CaCO_3$ / tonne	20.4	<1	<1	<1	<1	7.1	29.6	40.8	62.2	25.5
	ANC/MPA	-	1.0	-	-	-	-	0.2	0.6	1.1	2.1	0.4
	NPR (NP/AP)	-	1.0	-	-	-	-	0.2	0.6	1.1	2.1	0.4
	$Pyrite_{(STOT)}$	% Pyrite	1.3	1.0	1.1	3.2	4.3	2.8	3.0	2.2	1.7	4.1
	$Pyrite_{(SCr)}$	% Pyrite	1.2	0.1	0.0	2.1	2.6	2.8	2.1	1.9	0.1	4.1
	Paste pH	pH units										
	NAG_{pH}	pH units	4.2	4.5	4.7	2.7	2.5	3.2	3.1	5.4	8.7	2.7
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	2.00	2.30	1.80	38.00	56.00	15.00	12.00	<0.5	<0.5	39.00
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.67	0.51	0.57	1.70	2.30	1.50	1.60	1.20	0.93	2.20
	S_{Cr}	wt% S	0.64	0.03	0.01	1.10	1.40	1.50	1.10	1.00	0.06	2.20
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	0.6	0.0	0.0	1.1	1.4	1.5	1.1	1.0	0.1	2.2
	Pyrite (equiv.)	wt%	1.2	0.1	0.0	2.1	2.6	2.8	2.1	1.9	0.1	4.1
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	399.2	18.7	6.2	686.1	873.2	935.6	686.1	623.7	37.4	1372.1
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.3	0.0	0.1	0.1	0.1	0.4	0.9	0.8	1.6	0.5
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.0	<0.01	<0.01	<0.01	0.0	0.4	0.8	0.8	1.4	0.0
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	2.0	0.0	0.0	0.0	0.0	0.7	3.0	4.1	6.2	2.6
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.08	0.33	1.17	0.50	0.58	3.67	7.08	7.00	13.33	4.42
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.08	0.00	0.00	0.00	0.25	3.25	6.75	6.50	11.67	0.33
Assessment	Additional Potential Risks		Unlikely to Generate SD	Unlikely to Generate SD	Insufficient Data	Low Potential to Generate SD	Low Potential to Generate SD	Not assessed	Low Potential to Generate SD	Not assessed / Low Potential to Generate SD	Insufficient Data	Low Potential to Generate SD
	Details [a]		7, 16, 24, 42, 99, 151, 205	7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205	7, 69 (63, 97), 74, 172	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205		9, 17, 24, 43, 74 (64, 111), 202	7, 15, 24, 41, 65, 90, 99, 151, 205
	Recommendations [b]		1, 30, 30.1, 30.3, 30.4	1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4, 64		16, 16.1, 16.2, 16.3, 62, 84, 84.1, 84.3, 84.4, 84.5, 84.6, 84.7	1, 30, 30.1, 30.3, 30.4, 63

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA10043	GCA10044	GCA10045	GCA10046	GCA11075	GCA11076	GCA11077	GCA11078	GCA11079	GCA11081
	Sample Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff
	Sample Sub-Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff
	General Classification		PAF*	PAF	PAF	PAF	PAF*	PAF	PAF	PAF*	PAF	PAF
	Detailed Classification		Moderate / High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	High Potential for Acid Generation	Low Potential for Acid Generation
Static Geochemistry	NAPP	kg H_2SO_4/ tonne	37.1	60.6	131.1	84.0	33.0	29.7	39.8	34.1	56.3	18.9
	NNP	kg $CaCO_3$/ tonne	-37.9	-61.9	-133.9	-85.8	-33.7	-30.4	-40.6	-34.9	-57.5	-19.3
	$NAPP_{(SCr)}$	kg H_2SO_4/ tonne	21.8	36.1	131.1	84.0	33.0	29.7	39.8	31.1	53.2	18.9
	$NNP_{(SCr)}$	kg $CaCO_3$/ tonne	-22.3	-36.9	-133.9	-85.8	-33.7	-30.4	-40.6	-31.8	-54.3	-19.3
	MPA	kg H_2SO_4/ tonne	58.1	79.6	159.1	101.0	49.0	36.7	39.8	58.1	64.3	45.9
	AP	kg $CaCO_3$/ tonne	59.4	81.3	162.5	103.1	50.0	37.5	40.6	59.4	65.6	46.9
	$MPA_{(SCr)}$	kg H_2SO_4/ tonne	42.8	55.1	159.1	101.0	49.0	36.7	39.8	55.1	61.2	45.9
	$AP_{(SCr)}$	kg $CaCO_3$/ tonne	43.8	56.3	162.5	103.1	50.0	37.5	40.6	56.3	62.5	46.9
	ANC	kg H_2SO_4/ tonne	21.0	19.0	28.0	17.0	16.0	7.0	-3.0	24.0	8.0	27.0
	NP	kg $CaCO_3$/ tonne	21.4	19.4	28.6	17.3	16.3	7.1	-3.0	24.5	8.2	27.6
	ANC/MPA	-	0.4	0.2	0.2	0.2	0.3	0.2	-	0.4	0.1	0.6
	NPR (NP/AP)	-	0.4	0.2	0.2	0.2	0.3	0.2	-	0.4	0.1	0.6
	$Pyrite_{(STOT)}$	% Pyrite	3.6	4.9	9.7	6.2	3.0	2.2	2.4	3.6	3.9	2.8
	$Pyrite_{(SCr)}$	% Pyrite	2.6	3.4	9.7	6.2	3.0	2.2	2.4	3.4	3.7	2.8
	Paste pH	pH units										
	NAG_{pH}	pH units	3.1	2.6	2.4	2.5	3.1	2.9	3.0	3.4	2.5	4.1
	$NAG_{4.5}$	kg H_2SO_4/ tonne										
	$NAG_{7.0}$	kg H_2SO_4/ tonne	23.00	47.00	89.00	59.00	13.00	21.00	12.00	9.70	42.00	5.30
	$NAG_{9.5}$	kg H_2SO_4/ tonne										
Sulfur Speciation	S_{TOT}	wt% S	1.90	2.60	5.20	3.30	1.60	1.20	1.30	1.90	2.10	1.50
	S_{Cr}	wt% S	1.40	1.80	5.20	3.30	1.60	1.20	1.30	1.80	2.00	1.50
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	1.4	1.8	5.2	3.3	1.6	1.2	1.3	1.8	2.0	1.5
	Pyrite (equiv.)	wt%	2.6	3.4	9.7	6.2	3.0	2.2	2.4	3.4	3.7	2.8
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	873.2	1122.7	3243.2	2058.2	997.9	748.4	810.8	1122.7	1247.4	935.6
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.8	0.3	0.4	0.3	0.6	0.3	0.0	1.2	0.4	0.9
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.1	0.0	0.0	0.0	0.5	0.2	<0.01	1.1	0.4	0.8
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	2.1	1.9	2.9	1.7	1.6	0.7	0.0	2.4	0.8	2.8
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	6.33	2.67	3.42	2.42	4.75	2.08	0.17	10.00	3.25	7.25
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	0.58	0.08	0.25	0.17	4.42	1.83	0.00	9.17	3.08	6.92
Assessment	Additional Potential Risks		Not assessed	Low Potential to Generate SD	Moderate Potential to Generate SD	Low Potential to Generate SD	Not assessed	Low Potential to Generate SD	Low Potential to Generate SD	Not assessed	Low Potential to Generate SD	Low Potential to Generate SD
	Details [a]		7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 14, 24, 41, 90, 96 (63, 92), 151, 203, 205
	Recommendations [b]		1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4	1, 10.4, 10.5, 30, 30.1, 30.3, 30.4, 61, 65	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4	1, 30, 30.1, 30.3, 30.4, 63	1, 80, 80.2, 80.4, 80.5, 80.6, 80.7, 80.8

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA11080	GCA11082	GCA11084	GCA11083	GCA10727	GCA10728	GCA10048	GCA10039	GCA10040	GCA11069
	Sample Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite
	Sample Sub-Type		Crystal Tuff	Crystal Tuff	Crystal Tuff	Crystal Tuff	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite
	General Classification		PAF	NAF*	PAF	PAF	PAF	PAF	PAF	PAF	PAF	PAF
	Detailed Classification		High Potential for Acid Generation	Inconsistent Data*	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	44.0	20.7	35.9	48.1	39.8	40.9	14.7	45.0	35.8	45.9
	NNP	kg $CaCO_3$ / tonne	-44.9	-21.1	-36.7	-49.2	-40.6	-41.8	-15.0	-45.9	-36.5	-46.9
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	44.0	20.7	35.9	48.1	25.4	24.4	14.7	29.7	35.8	45.9
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	-44.9	-21.1	-36.7	-49.2	-25.9	-24.9	-15.0	-30.3	-36.5	-46.9
	MPA	kg H_2SO_4 / tonne	49.0	33.7	45.9	58.1	39.8	45.9	36.7	49.0	39.8	45.9
	AP	kg $CaCO_3$ / tonne	50.0	34.4	46.9	59.4	40.6	46.9	37.5	50.0	40.6	46.9
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	49.0	33.7	45.9	58.1	25.4	29.4	36.7	33.7	39.8	45.9
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	50.0	34.4	46.9	59.4	25.9	30.0	37.5	34.4	40.6	46.9
	ANC	kg H_2SO_4 / tonne	5.0	13.0	10.0	10.0	<1	5.0	22.0	4.0	4.0	<1
	NP	kg $CaCO_3$ / tonne	5.1	13.3	10.2	10.2	<1	5.1	22.5	4.1	4.1	<1
	ANC/MPA	-	0.1	0.4	0.2	0.2	-	0.1	0.6	0.1	0.1	-
	NPR (NP/AP)	-	0.1	0.4	0.2	0.2	-	0.1	0.6	0.1	0.1	-
	$Pyrite_{(STOT)}$	% Pyrite	3.0	2.1	2.8	3.6	2.4	2.8	2.2	3.0	2.4	2.8
	$Pyrite_{(SCr)}$	% Pyrite	3.0	2.1	2.8	3.6	1.6	1.8	2.2	2.1	2.4	2.8
	Paste pH	pH units										
	NAG_{pH}	pH units	2.6	5.0	2.9	2.6	2.7	2.8	3.0	2.6	2.7	2.4
	$NAG_{4.5}$	kg H_2SO_4 / tonne										
	$NAG_{7.0}$	kg H_2SO_4 / tonne	31.00	2.30	20.00	31.00	39.00	25.00	14.00	43.00	34.00	42.00
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	1.60	1.10	1.50	1.90	1.30	1.50	1.20	1.60	1.30	1.50
	S_{Cr}	wt% S	1.60	1.10	1.50	1.90	0.83	0.96	1.20	1.10	1.30	1.50
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	1.6	1.1	1.5	1.9	0.8	1.0	1.2	1.1	1.3	1.5
	Pyrite (equiv.)	wt%	3.0	2.1	2.8	3.6	1.6	1.8	2.2	2.1	2.4	2.8
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+ / tonne										
	TPA	mol H^+ / tonne										
	TSA	mol H^+ / tonne										
	Potential Acidity	mol H^+ / tonne	997.9	686.1	935.6	1185.0	517.7	598.8	748.4	686.1	810.8	935.6
	Actual Acidity	mol H^+ / tonne										
	Retained Acidity	mol H^+ / tonne										
	Net Acidity	mol H^+ / tonne										
Carbon	C_{TOT}	wt% C	0.3	0.7	0.3	0.3	0.1	0.2	0.3	<0.01	0.1	0.0
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.3	0.6	0.2	0.3	0.0	0.1	0.0	<0.01	<0.01	<0.01
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	0.5	1.3	1.0	1.0	0.0	0.5	2.2	0.4	0.4	0.0
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.58	5.50	2.67	2.83	0.58	1.50	2.83	0.00	0.83	0.08
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	2.42	5.08	2.00	2.33	0.25	1.00	0.17	0.00	0.00	0.00
Assessment	Additional Potential Risks		Low Potential to Generate SD	Insufficient Data	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD
	Details [a]		7, 15, 24, 41, 65, 90, 99, 151, 205	7, 69 (63, 97), 74, 172	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205
	Recommendations [b]		1, 30, 30.1, 30.3, 30.4, 63	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 10.4, 10.5, 30, 30.1, 30.3, 30.4, 61, 65	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		GCA11070	GCA11071	GCA11072	GCA11073	GCA11074	GCA10743	GCA10749
	Sample Type		Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Volcanic Breccia	Volcanic Breccia
	Sample Sub-Type		Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Ignimbrite	Volcanic Breccia	Volcanic Breccia
	General Classification		PAF	PAF	PAF	PAF	PAF	PAF	NAF*
	Detailed Classification		High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	High Potential for Acid Generation	Inconsistent Data*
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	27.8	41.0	56.1	57.3	27.7	30.7	17.7
	NNP	kg $CaCO_3$ / tonne	-28.4	-41.8	-57.3	-58.5	-28.3	-31.4	-18.0
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	27.8	41.0	56.1	57.3	27.7	18.5	6.6
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	-28.4	-41.8	-57.3	-58.5	-28.3	-18.9	-6.8
	MPA	kg H_2SO_4 / tonne	39.8	49.0	58.1	67.3	33.7	36.7	33.7
	AP	kg $CaCO_3$ / tonne	40.6	50.0	59.4	68.8	34.4	37.5	34.4
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	39.8	49.0	58.1	67.3	33.7	24.5	22.6
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	40.6	50.0	59.4	68.8	34.4	25.0	23.1
	ANC	kg H_2SO_4 / tonne	12.0	8.0	2.0	10.0	6.0	6.0	16.0
	NP	kg $CaCO_3$ / tonne	12.2	8.2	2.0	10.2	6.1	6.1	16.3
	ANC/MPA	-	0.3	0.2	0.0	0.1	0.2	0.2	0.5
	NPR (NP/AP)	-	0.3	0.2	0.0	0.1	0.2	0.2	0.5
	$Pyrite_{(STOT)}$	% Pyrite	2.4	3.0	3.6	4.1	2.1	2.2	2.1
	$Pyrite_{(SCr)}$	% Pyrite	2.4	3.0	3.6	4.1	2.1	1.5	1.4
	Paste pH	pH units							
	NAG_{pH}	pH units	2.9	2.7	2.4	2.7	2.8	2.9	5.5
	$NAG_{4.5}$	kg H_2SO_4 / tonne							
	$NAG_{7.0}$	kg H_2SO_4 / tonne	42.00	28.00	47.00	32.00	21.00	20.00	1.50
	$NAG_{9.5}$	kg H_2SO_4 / tonne							
Sulfur Speciation	S_{TOT}	wt% S	1.30	1.60	1.90	2.20	1.10	1.20	1.10
	S_{Cr}	wt% S	1.30	1.60	1.90	2.20	1.10	0.80	0.74
	S_P	wt% S							
	S_{KCl}	wt% S							
	S_{HCl}	wt% S							
	S_{TOS}	wt% S							
	S_{NAS}	wt% S							
	S_{POS}	wt% S							
	S_{RAS}	wt% S							
	Sulfide Sulfur	wt% S	1.3	1.6	1.9	2.2	1.1	0.8	0.7
	Pyrite (equiv.)	wt%	2.4	3.0	3.6	4.1	2.1	1.5	1.4
	Readily soluble non-acid storing Sulfate-S	wt% S							
	Gypsum (equiv.)	wt%							
	Readily soluble acid storing Sulfate-S	wt% S							
	Melanterite (equiv.)	wt%							
	Sparingly soluble acid storing Sulfate-S	wt% S							
	Jarosite (equiv.)	wt%							
Acidity	pH_{KCl}	pH units							
	pH_{ox}	pH units							
	TAA	mol H^+/ tonne							
	TPA	mol H^+/ tonne							
	TSA	mol H^+/ tonne							
	Potential Acidity	mol H^+/ tonne	810.8	997.9	1185.0	1372.1	686.1	499.0	461.5
	Actual Acidity	mol H^+/ tonne							
	Retained Acidity	mol H^+/ tonne							
	Net Acidity	mol H^+/ tonne							
Carbon	C_{TOT}	wt% C	0.3	0.3	0.0	0.8	0.2	0.1	0.4
	C_{TO}	wt% C							
	C_{IN}	wt% C	0.3	0.3	<0.01	0.7	0.2	0.1	0.3
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$							
	$CaCO_3$ based on ANC	% $CaCO_3$	1.2	0.8	0.2	1.0	0.6	0.6	1.6
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.42	2.75	0.33	6.25	1.75	0.50	2.92
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	2.17	2.42	0.00	5.83	1.50	0.50	2.42
Assessment	Additional Potential Risks		Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Low Potential to Generate SD	Insufficient Data
	Details [a]		7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 15, 24, 41, 65, 90, 99, 151, 205	7, 69 (63, 97), 74, 172
	Recommendations [b]		1, 10.4, 10.5, 30, 30.1, 30.3, 30.4, 61, 65	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 30, 30.1, 30.3, 30.4, 63	1, 10.4, 10.5, 30, 30.1, 30.3, 30.4, 61, 65	1, 30, 30.1, 30.3, 30.4, 63	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

Generated using: AMDact v.5.2.8.2

Statistic	Paste pH	Total Sulfur	Chromium Reducible Sulfur	Max. Potential Acidity	Acid Neutralising Capacity		Net Acid Production Potential	ANC / MPA Ratio	Net Acid Generation				Neutral Meatlliferous Drainage / Metal Leachate Potential		Sulfide sulfur	Sparingly soluble acid forming sulfate sulfur	Readily soluble acid forming sulfate sulfur	Readily soluble non-acid forming sulfate sulfur
		S_{Total}	S_{Cr}	MPA	ANC		NAPP		pH (OX)	NAG (pH 4.5)	NAG (pH 7.0)	NAG (pH 9.5)	NAG7.0 - NAG4.5 1	NAG9.5 - NAG7.0 2				
	pH units	%	%	kg H_2SO_4/tonne	kg H_2SO_4 equiv./tonne	% $CaCO_3$	kg H_2SO_4/tonne	-	pH units	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	%	%	%	%
Sandstone (19 Samples)																		
n=	-	19	19	19	19	19	19	9	19	-	19	-	-	-	19	-	-	-
Minimum		<0.01	<0.01	0.0	<1	<0.1	-8.8	0.7	4.2		<0.5				<0.01			
Average		0.09	0.02	2.8	1.6	0.2	1.4	3.2	5.7		1.0				0.0			
Median		0.02	0.02	0.6	1.0	0.1	-0.4	1.6	5.7		0.9				0.0			
Maximum		0.57	0.03	17.4	10.0	1.0	17.4	8.2	8.1		2.3				0.0			
Crystal Tuff (41 Samples)																		
n=	-	41	41	41	41	41	41	36	41	-	41	-	-	-	41	-	-	-
Minimum		0.02	<0.01	0.6	-3.0	-0.3	-32.5	0.1	2.4		<0.5				<0.01			
Average		1.14	0.97	34.9	13.4	1.4	21.4	1.5	4.5		14.6				1.0			
Median		0.93	0.90	28.5	10.0	1.0	14.7	0.6	4.5		3.2				0.9			
Maximum		5.20	5.20	159.1	61.0	6.2	131.1	16.3	8.7		89.0				5.2			
Ignimbrite (27 Samples)																		
n=	-	27	27	27	27	27	27	23	27	-	27	-	-	-	27	-	-	-
Minimum		0.03	<0.01	0.9	<1	<0.3	-13.5	0.0	2.4		<0.5				<0.01			
Average		0.85	0.75	26.0	9.3	1.0	16.7	1.6	4.4		14.8				0.7			
Median		0.76	0.72	23.3	8.0	0.8	9.3	0.6	3.6		5.6				0.7			
Maximum		2.20	2.20	67.3	24.0	2.4	57.3	14.2	8.7		47.0				2.2			
Volcanic Breccia (27 Samples)																		
n=	-	27	27	27	27	27	27	27	27	-	27	-	-	-	27	-	-	-
Minimum		0.02	<0.01	0.6	3.0	0.3	-23.5	0.2	2.9		<0.5				<0.01			
Average		0.41	0.27	12.4	10.9	1.1	1.5	3.4	6.1		2.4				0.3			
Median		0.40	0.24	12.2	10.0	1.0	1.6	0.8	6.2		<0.5				0.2			
Maximum		1.20	0.80	36.7	25.0	2.6	30.7	19.6	9.1		20.0				0.8			
Laminated Tuff (10 Samples)																		
n=	-	10	10	10	10	10	10	10	10	-	10	-	-	-	10	-	-	-
Minimum		0.01	<0.01	0.3	3.0	0.3	-6.4	0.6	5.6		<0.5				<0.01			
Average		0.16	0.08	5.0	5.9	0.6	-0.9	5.6	6.6		0.4				0.1			
Median		0.03	0.01	0.9	5.0	0.5	-2.7	3.6	6.7		<0.5				0.0			
Maximum		0.67	0.34	20.5	13.0	1.3	7.5	13.1	7.8		1.2				0.3			
Ignimbrite Lithic Tuff (3 Samples)																		
n=	-	3	3	3	3	3	3	3	3	-	3	-	-	-	3	-	-	-
Minimum		0.02	0.02	0.6	1.0	0.1	-0.4	0.3	4.6		<0.5				0.0			
Average		0.06	0.03	1.7	1.0	0.1	0.7	0.9	6.0		0.6				0.0			
Median		0.04	0.02	1.2	1.0	0.1	0.2	0.8	6.6		<0.5				0.0			
Maximum		0.11	0.04	3.4	1.0	0.1	2.4	1.6	6.8		1.4				0.0			
TOTAL (127 Samples)																		
n=	-	127	127	127	127	127	127	108	127	-	127	-	-	-	127	-	-	-
Minimum		<0.01	<0.01	0.0	-3.0	-0.3	-32.5	0.0	2.4		<0.5				<0.01			
Average		0.66	0.54	20.3	9.4	0.0	10.9	2.5	5.2		8.6				0.5			
Median		0.46	0.24	14.1	7.0	0.7	2.4	0.6	5.3		1.0				0.2			
Maximum		5.20	5.20	159.1	61.0	6.2	131.1	19.6	9.1		89.0				5.2			

Table F-1: Summary statistics for selected static geochemical parameters. Statistics are shown for all samples and also for sample subsets. Refer to the Glossary of Terms for a description of each static geochemical parameter.

Generated using: AMDact v.5.2.8.2

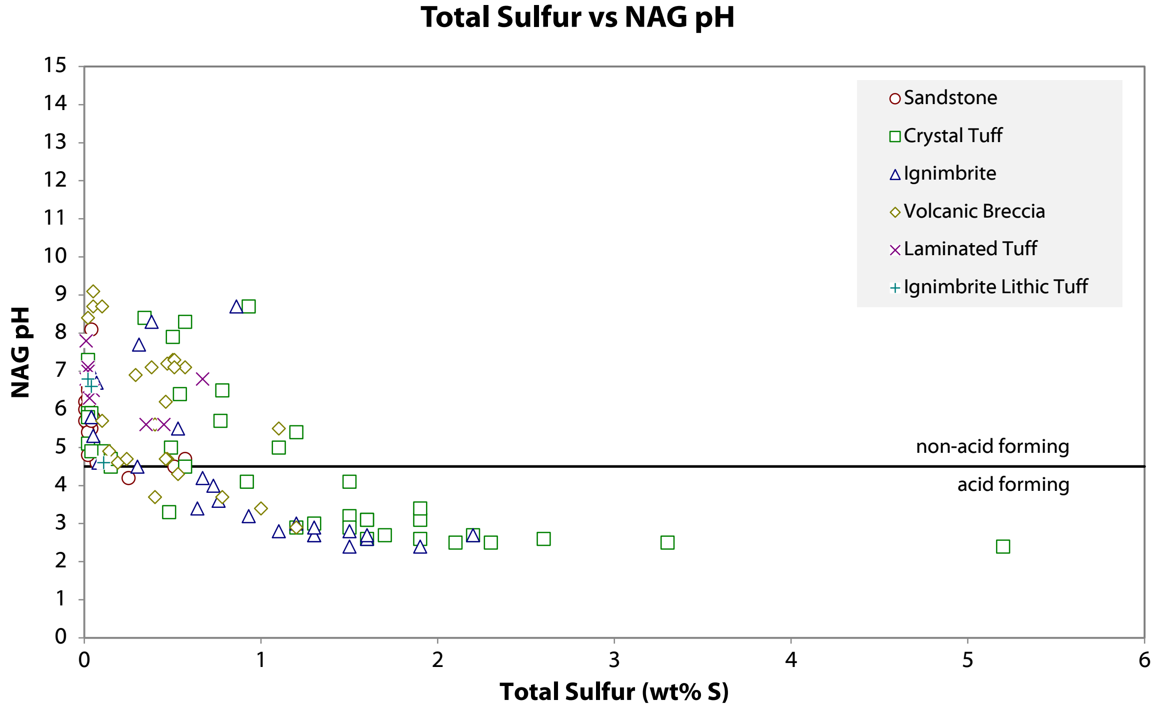

Figure G1: Total sulfur versus Net Acid Generation (NAG) pH after oxidation for all samples. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

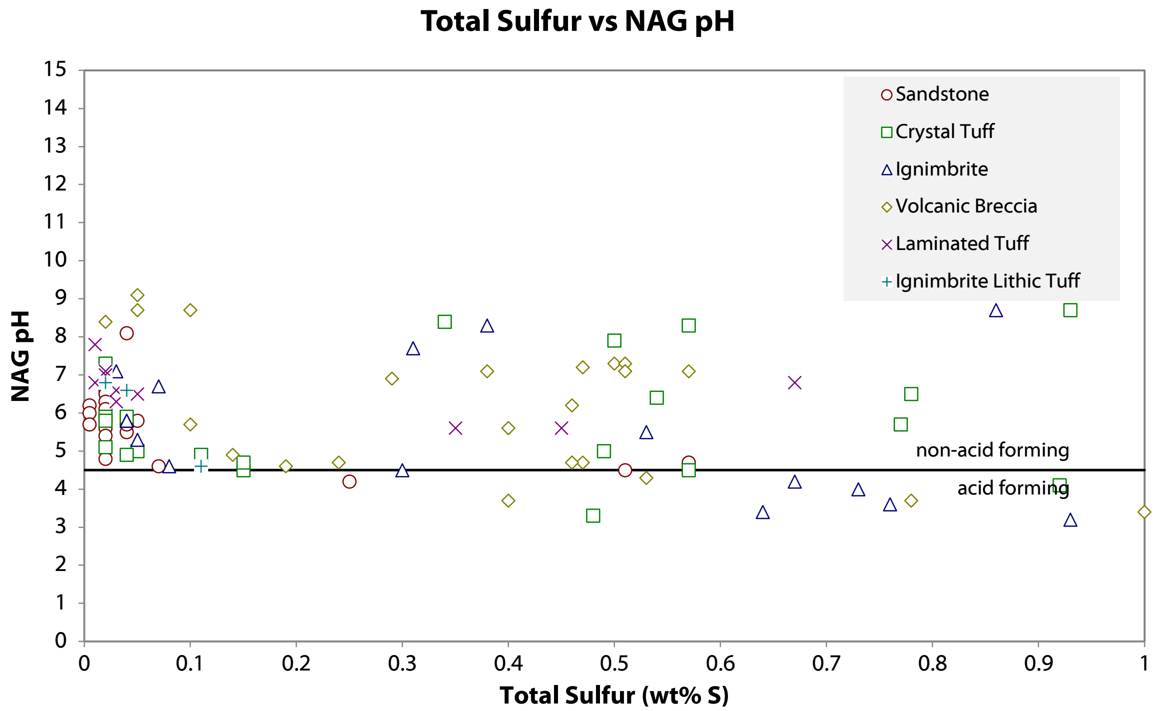

Figure G2: Total sulfur versus Net Acid Generation (NAG) pH after oxidation for samples with Total sulfur values less than 1 wt%. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

Generated using: AMDactv.5.2.8.2

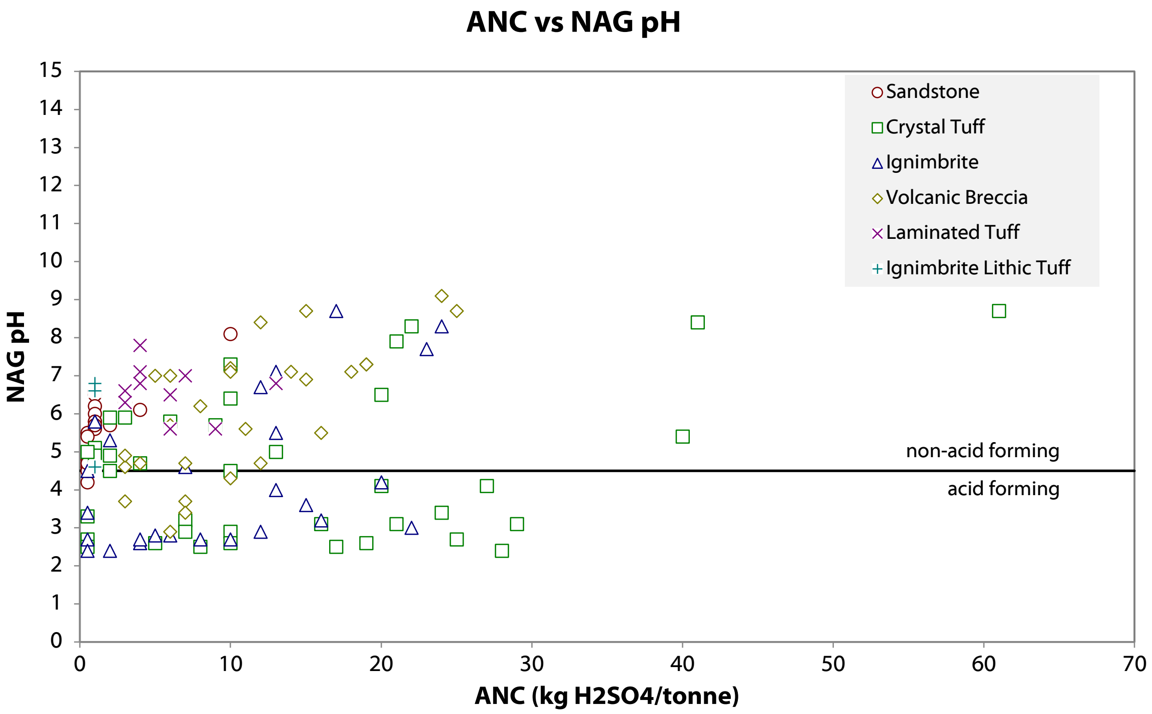

Figure G3: Acid Neutralising Capacity (ANC) versus Net Acid Generation (NAG) pH after oxidation. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

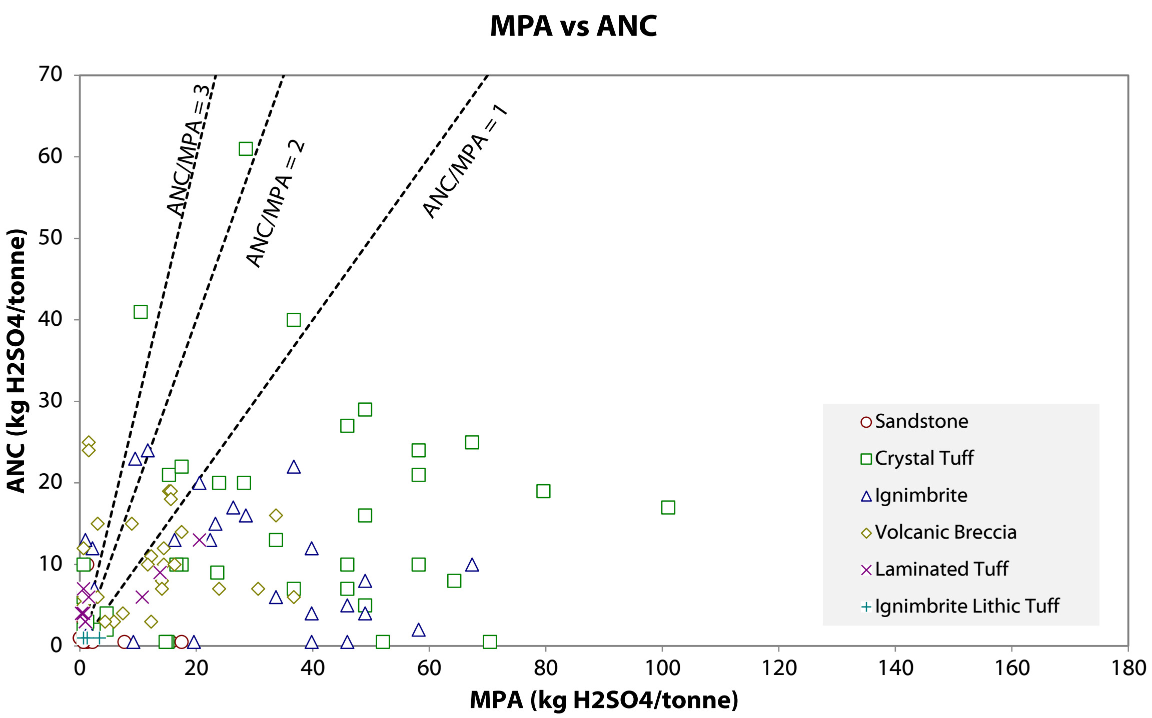

Figure G4: Maximum Potential Acidity (MPA) versus Acid Neutralising Capacity (ANC).

Generated using: AMDactv.5.2.8.2

Total Sulfur vs ANC

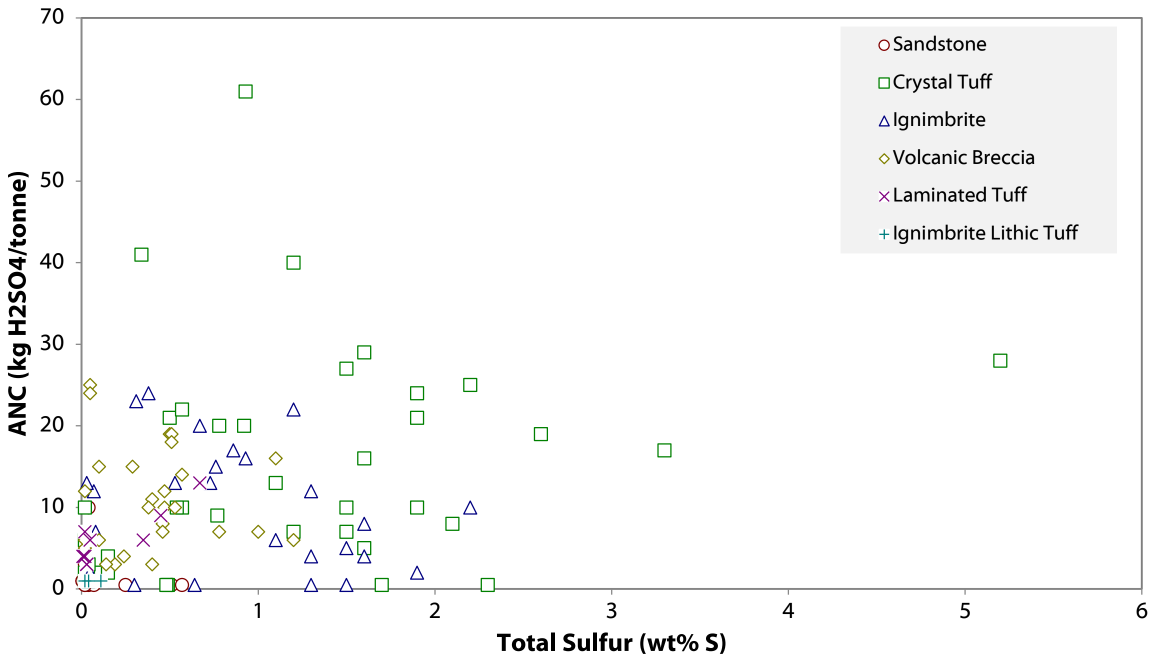

Figure G5: Total sulfur versus Acid Neutralising Capacity (ANC).

Total Sulfur vs NAPP

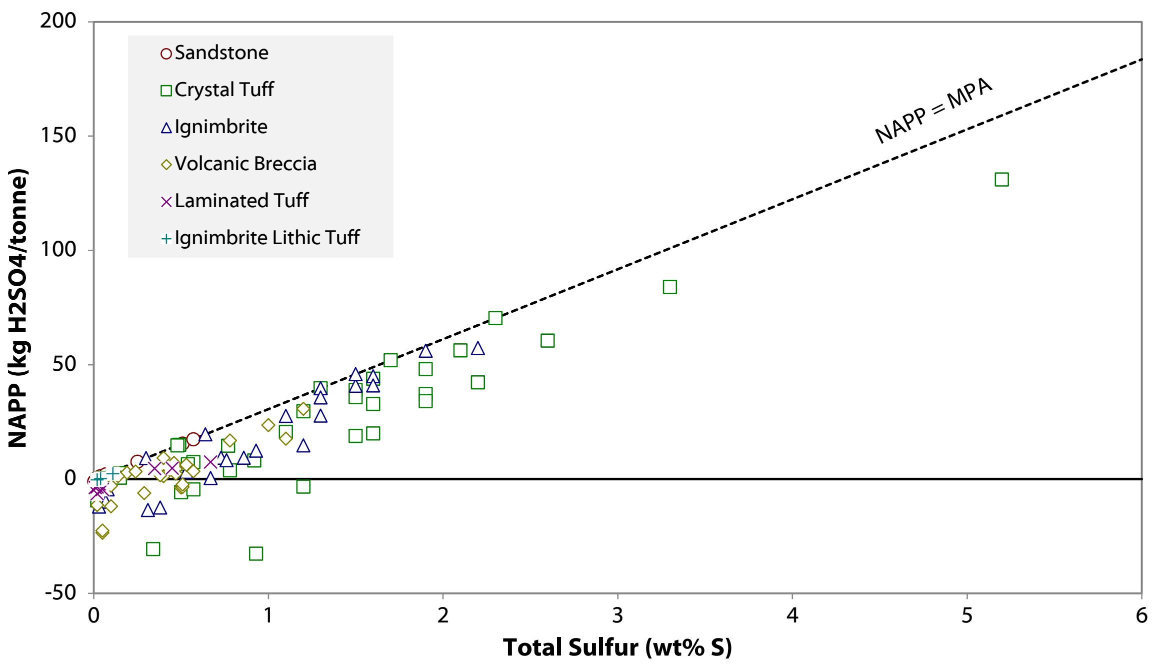

Figure G6: Total sulfur versus Net Acid Producing Potential (NAPP). The line shown at NAPP = 0 separates samples with an excess of Maximum Potential Acidity (MPA) from those with an excess of acid neutralising capacity (ANC). The dashed line identifies where the NAPP = MPA. Samples falling close to this line contain essentially no acid neutralising capacity.

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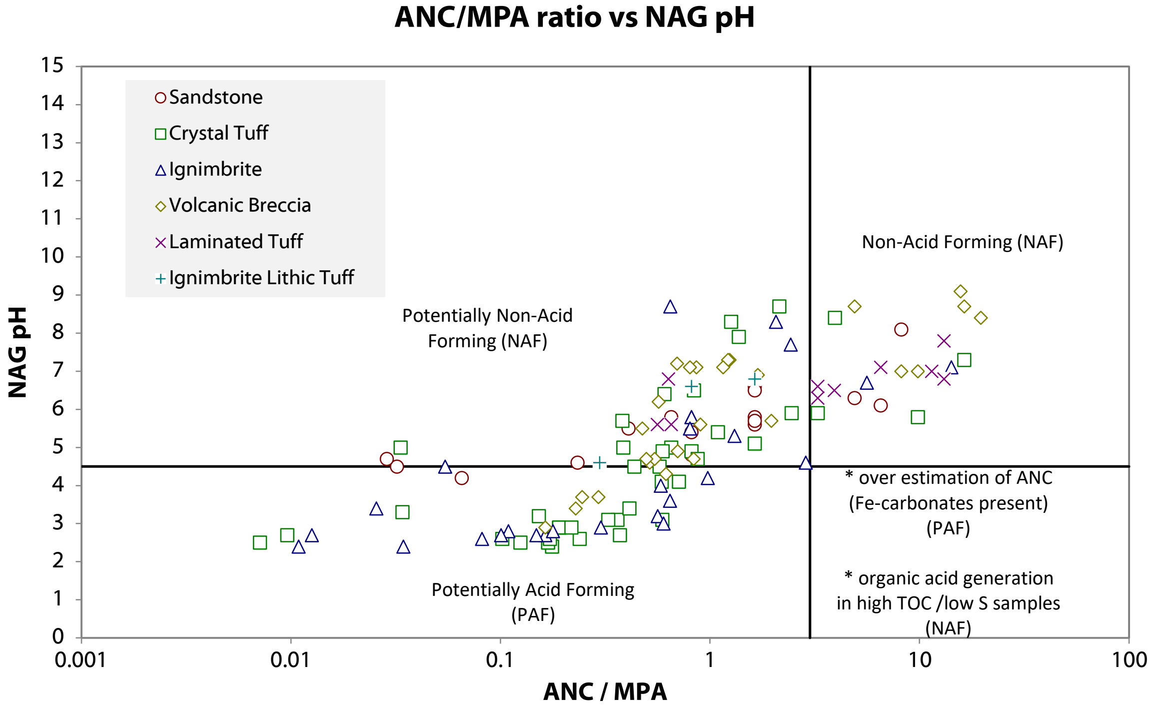

Figure G7: The ratio of Acid Neutralising Capacity to Maximum Potential Acidity (ANC/MPA) versus Net Acid Generation (NAG) pH after oxidation. The vertical line shows where ANC/MPA = 3. ANC/MPA ratios above this will be NAF. The line shown at a NAG pH of 4.5 is the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

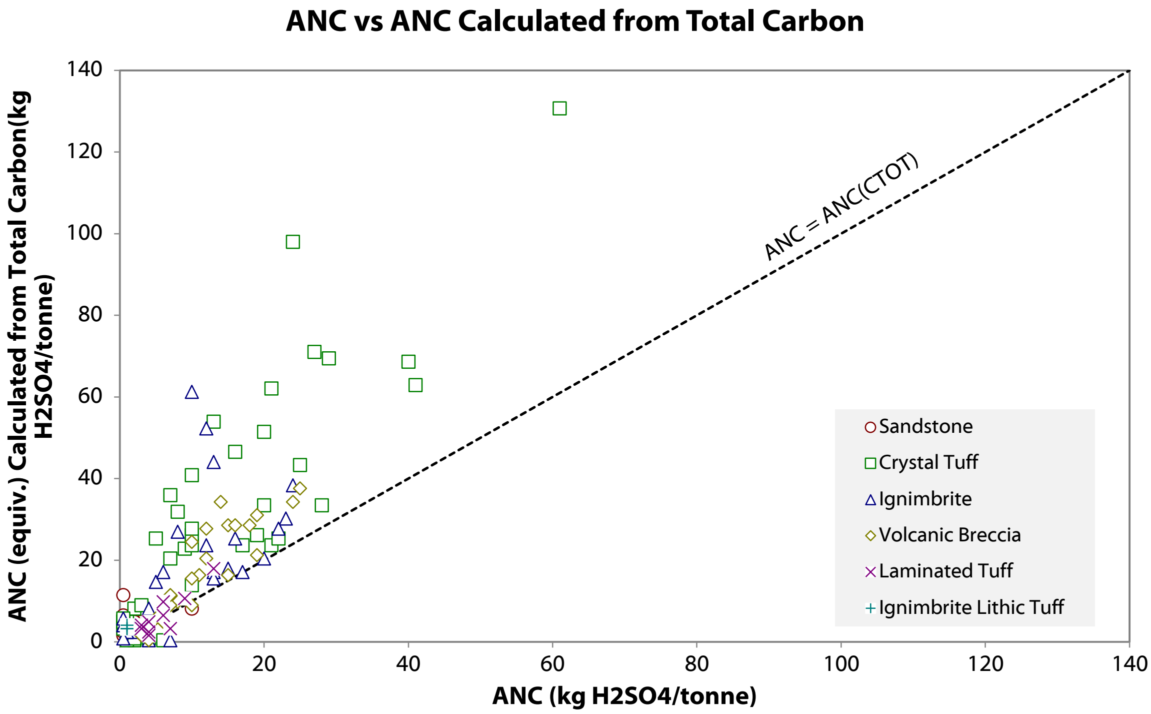

Figure G8: Laboratory measured Acid Neutralising Capacity (ANC) versus calculated ANC based on the laboratory measured Total Carbon. Samples falling above the dotted line suggest the presence of non-carbonate carbon or non-neutralising carbonates in the samples (eg. graphite). Samples falling below the dotted line suggest the presence of non-carbonate neutralising minerals.

Generated using: AMDactv.5.2.8.2

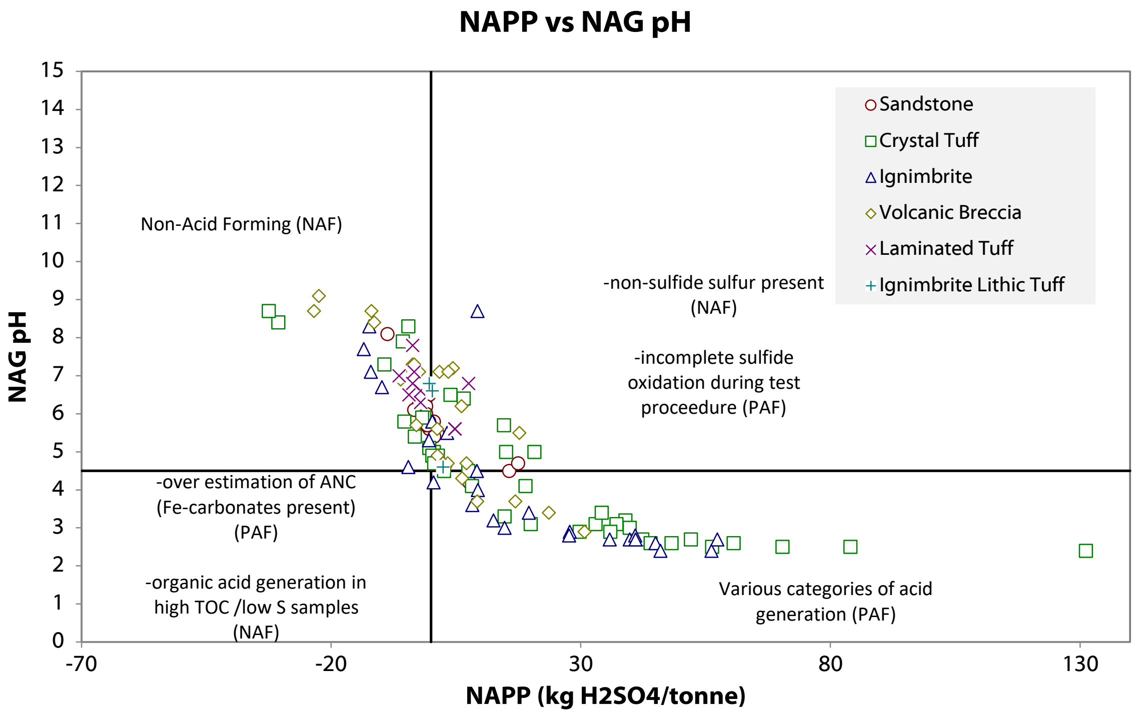

Figure G9: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) pH after oxidation. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials. Risk classification fields are shown.

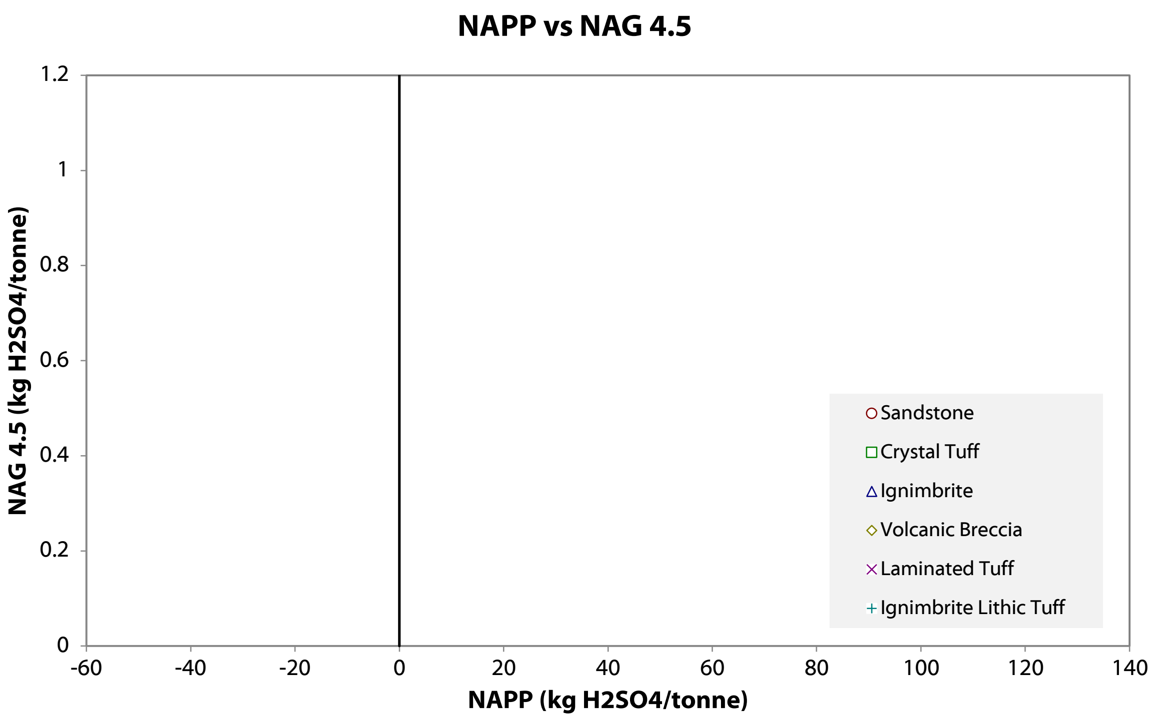

Figure G10: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) to pH 4.5. The line shown at NAPP = 0 separates samples with an excess of Maximum Potential Acidity (MPA) from those with an excess of acid neutralising capacity (ANC). NAG4.5 values >0 indicate an acid generating capacity.

Generated using: AMDactv.5.2.8.2

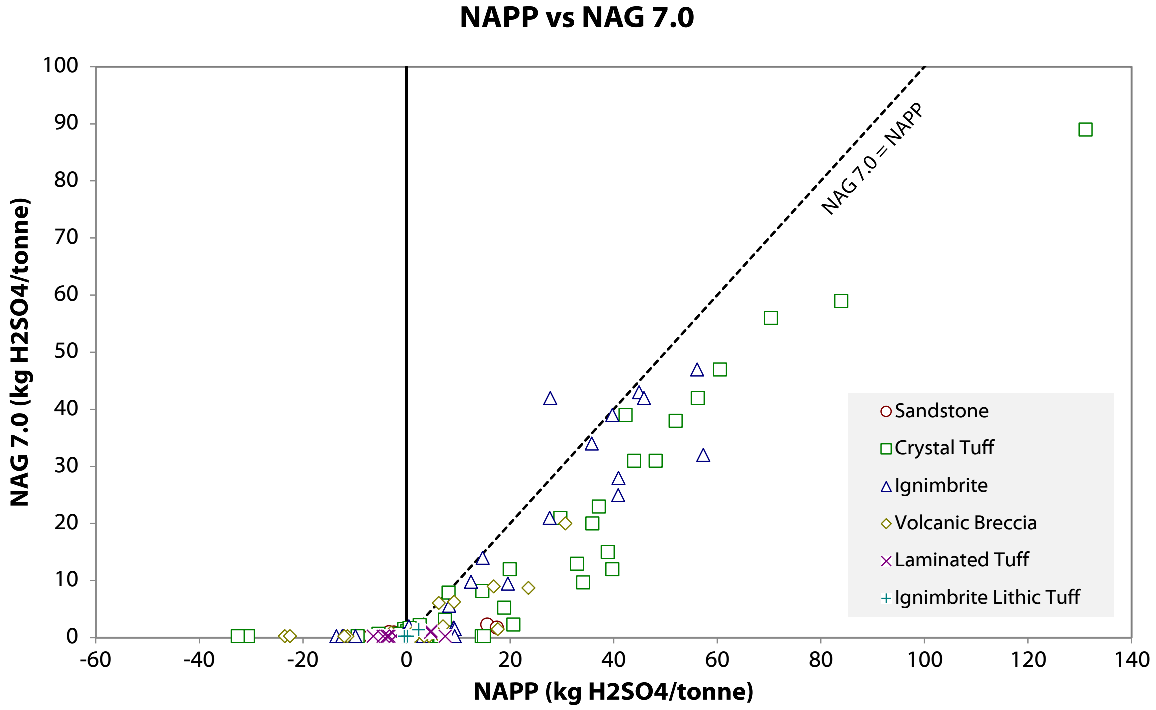

Figure G11: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) to pH 7.0. The line shown at NAPP = 0 separates samples with an excess of MPA from those with an excess of ANC. NAG7.0 values >0 generally indicate an acid generating capacity. Samples below the dashed line could indicate non-acid forming sulfur is present in samples.

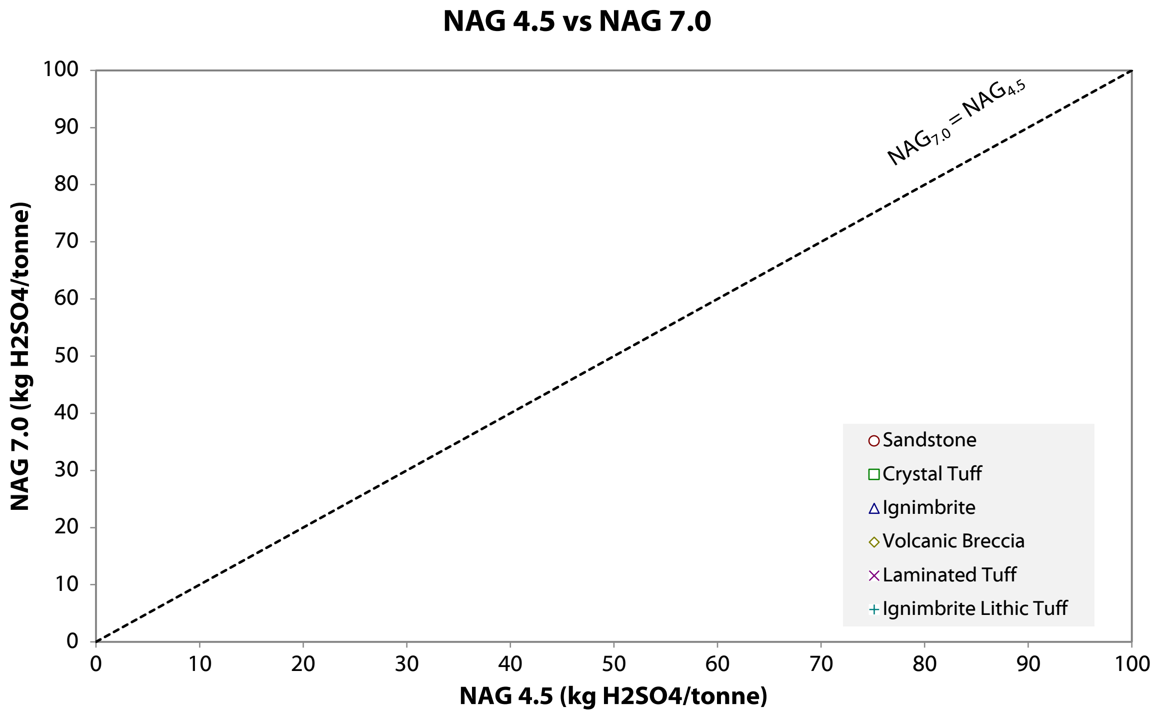

Figure G12: NAG 4.5 versus NAG 7.0. Samples with NAG 4.5 and NAG 7.0 >0 are likely to produce acid and metalliferous drainage. Samples with NAG 4.5 =0 but NAG 7.0 >0 are likely to produce neutral metalliferous drainage. Samples should not fall below the line.

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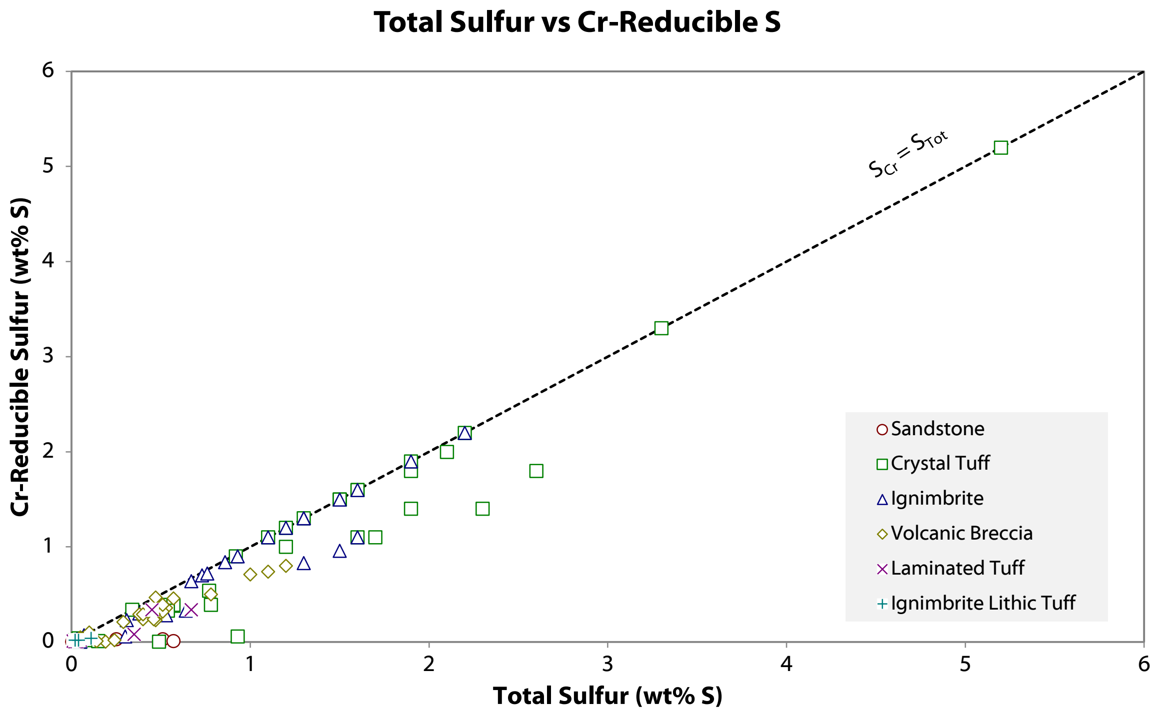

Figure G13: Total Sulfur versus chromium reducible sulfur (S-Cr). S-Cr is a laboratory measure of the sulfur within a sample that is present in sulfide minerals. The dashed line on the plot represents the case where the sulfide sulfur (S-Cr) is equal to the total sulfur in the sample. Samples plotting below the line contain at least some sulfur not in the form of sulfide minerals.

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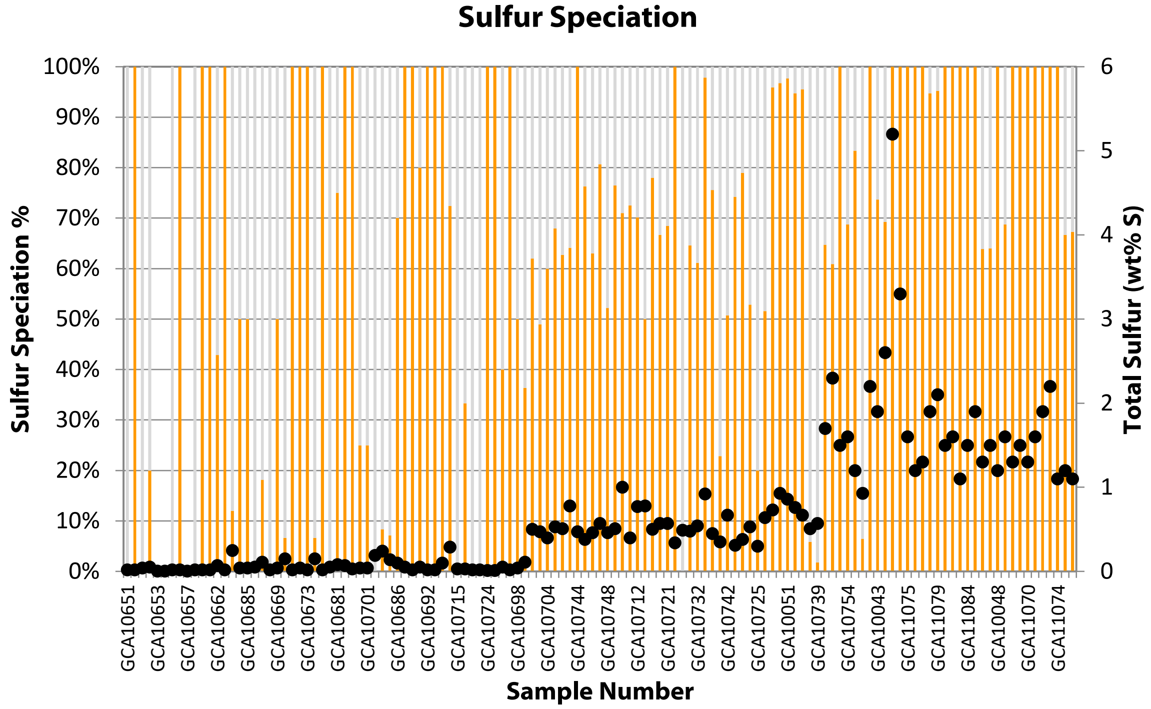

Figure H1: Chart showing the relative proportion of the various forms of sulfur within each sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Legend for ALL Sulfur Speciation charts

- Non-sulfide sulfur (undifferentiated)
- Readily soluble non-acid storing sulfate sulfur
- Readily soluble acid storing sulfate sulfur
- Sparingly soluble acid storing sulfate sulfur
- Sulfide sulfur
- Total sulfur (wt %)

Generated using: AMDactv.5.2.8.2

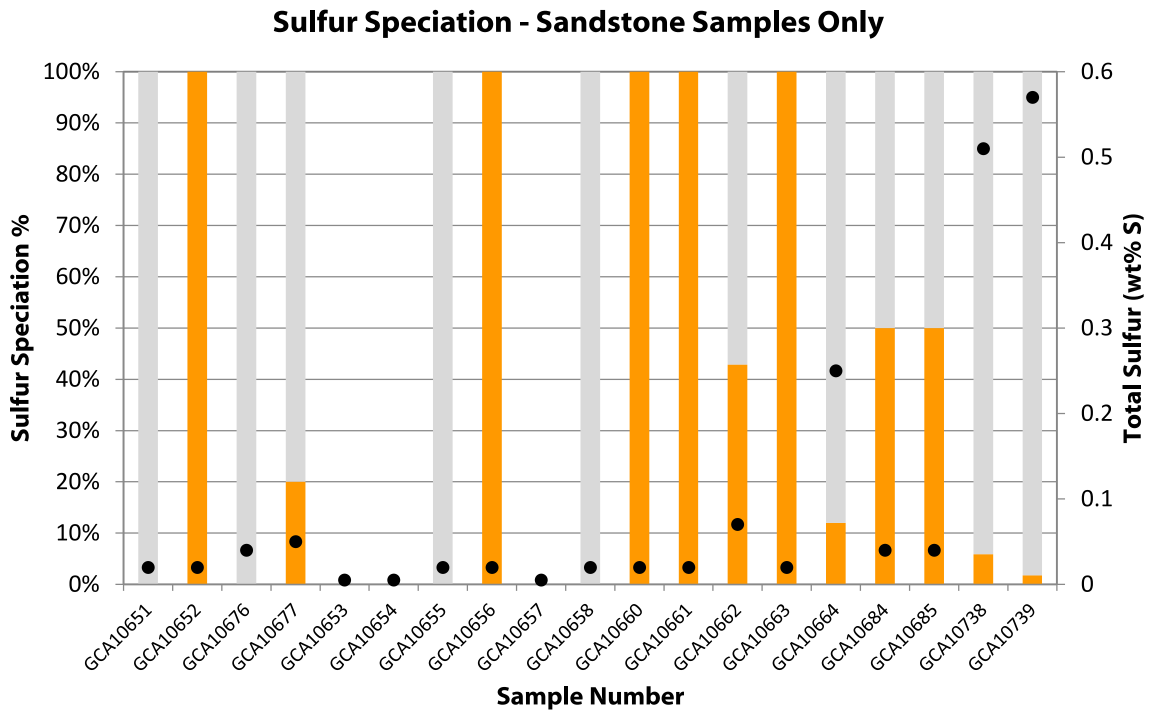

Figure H2: Chart showing the relative proportion of the various forms of sulfur within each Sandstone sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

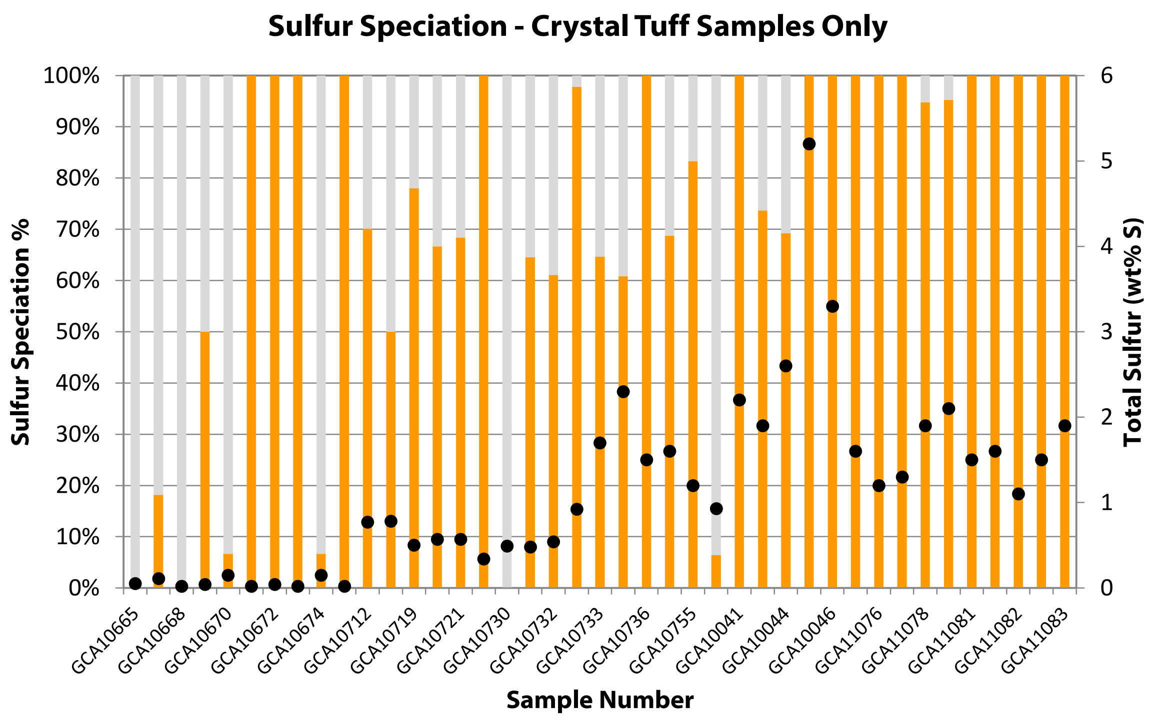

Figure H3: Chart showing the relative proportion of the various forms of sulfur within each Crystal Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

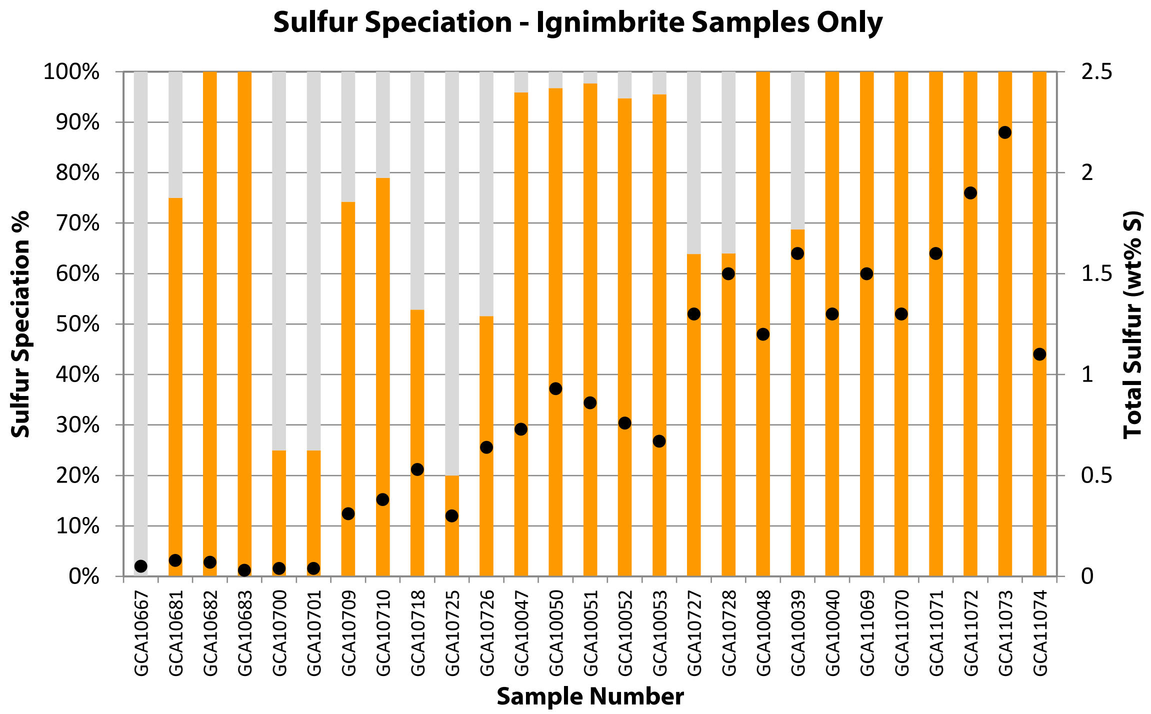

Figure H4: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

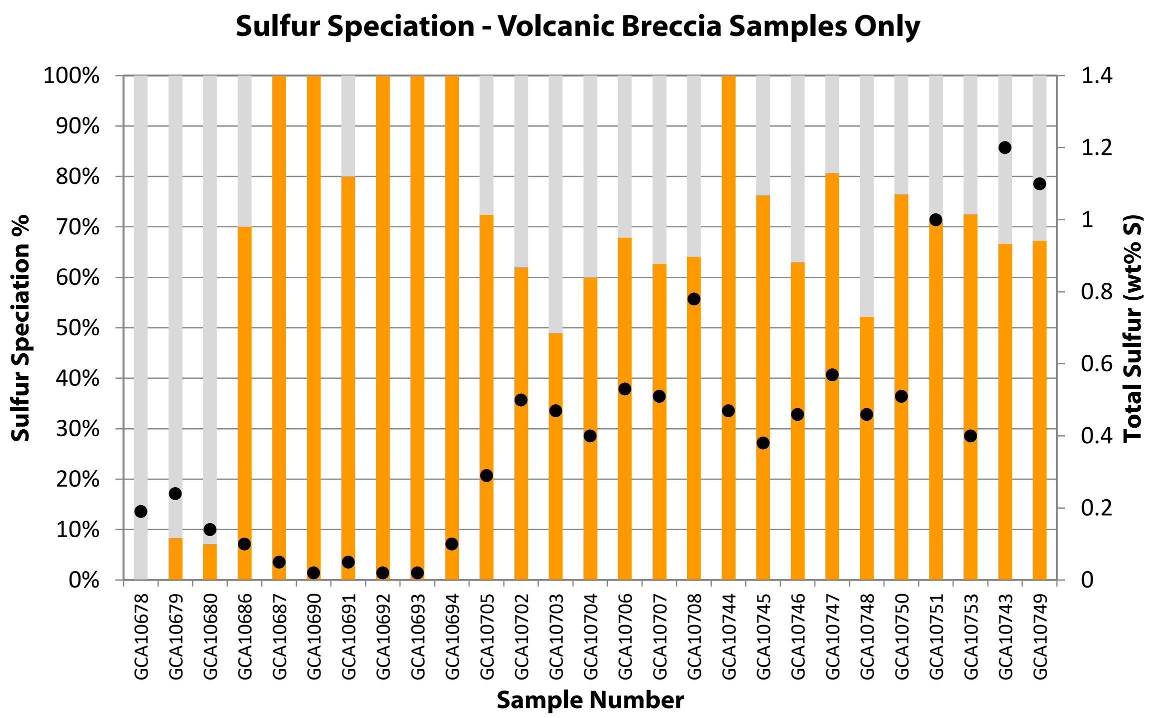

Figure H5: Chart showing the relative proportion of the various forms of sulfur within each Volcanic Breccia sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

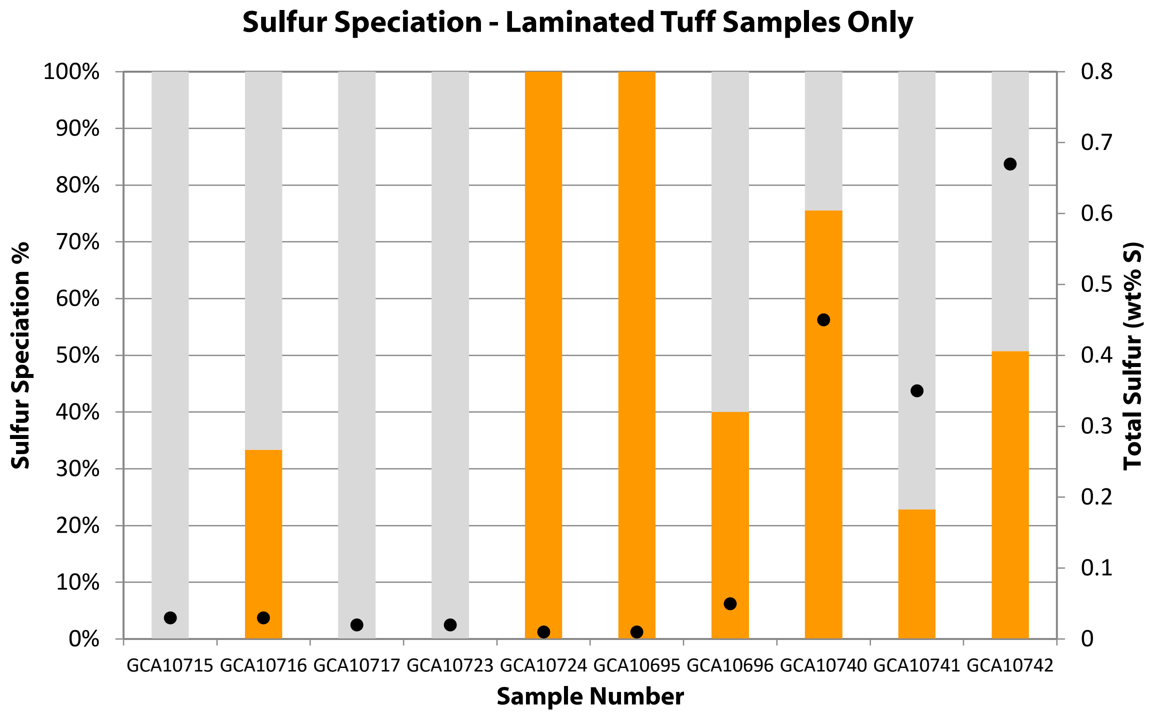

Figure H6: Chart showing the relative proportion of the various forms of sulfur within each Laminated Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

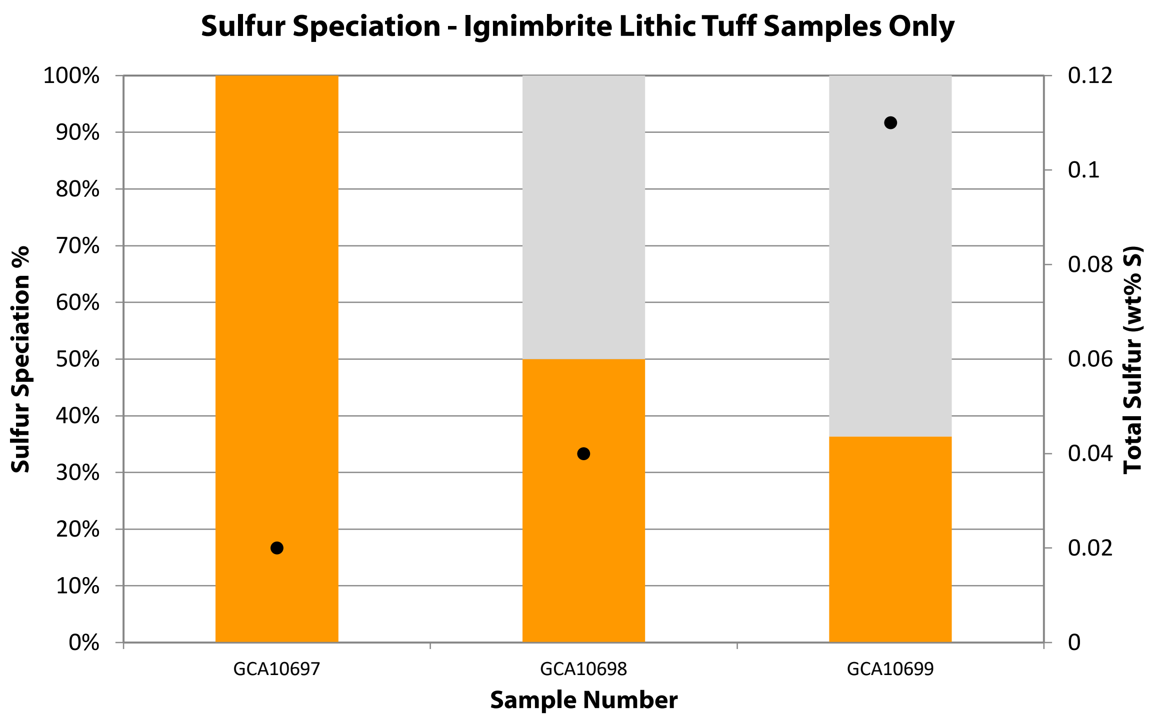

Figure H7: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite Lithic Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

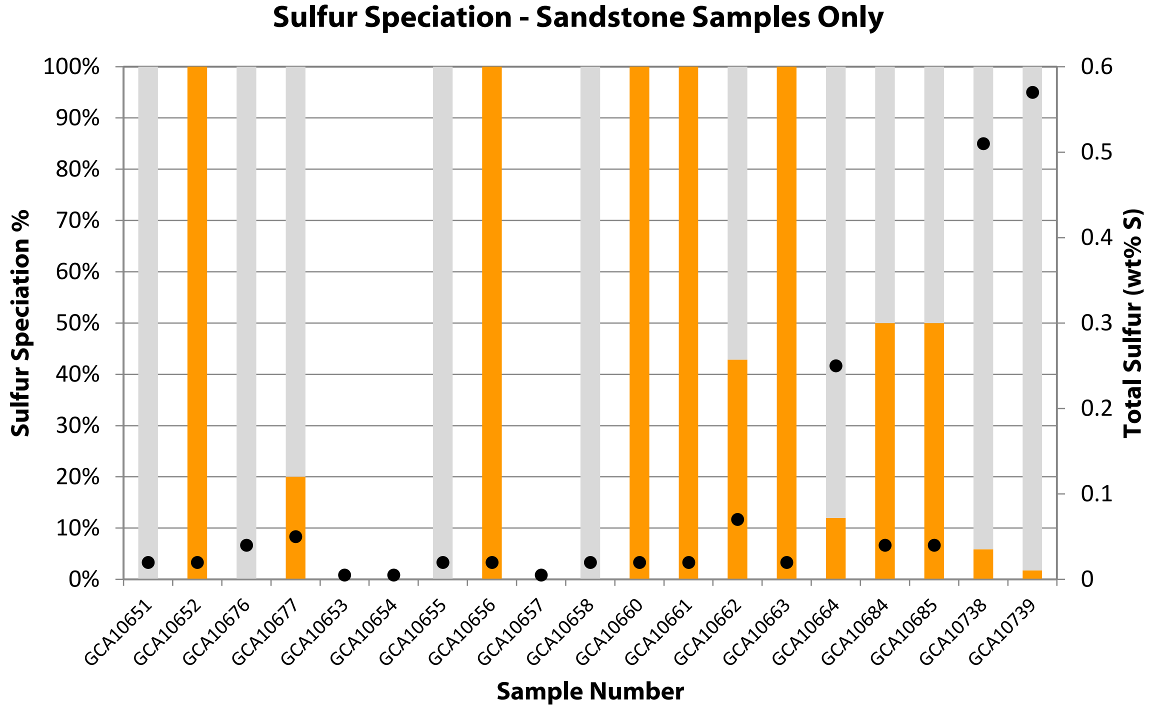

Figure H8: Chart showing the relative proportion of the various forms of sulfur within each Sandstone sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

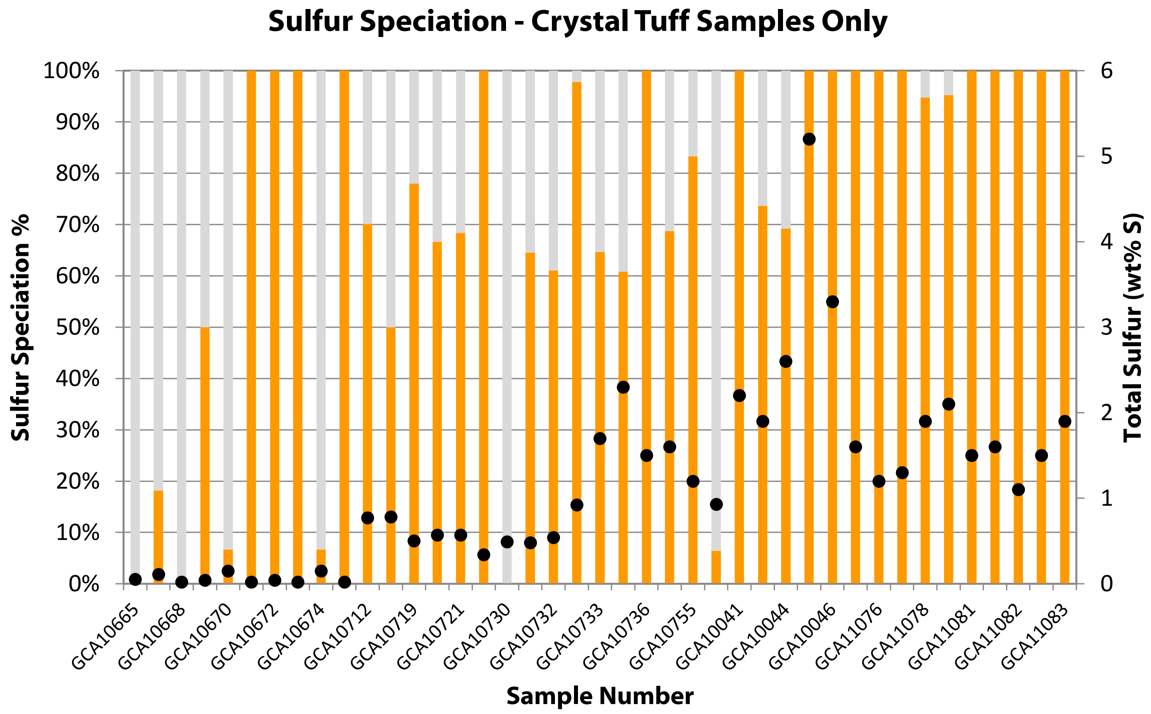

Figure H9: Chart showing the relative proportion of the various forms of sulfur within each Crystal Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

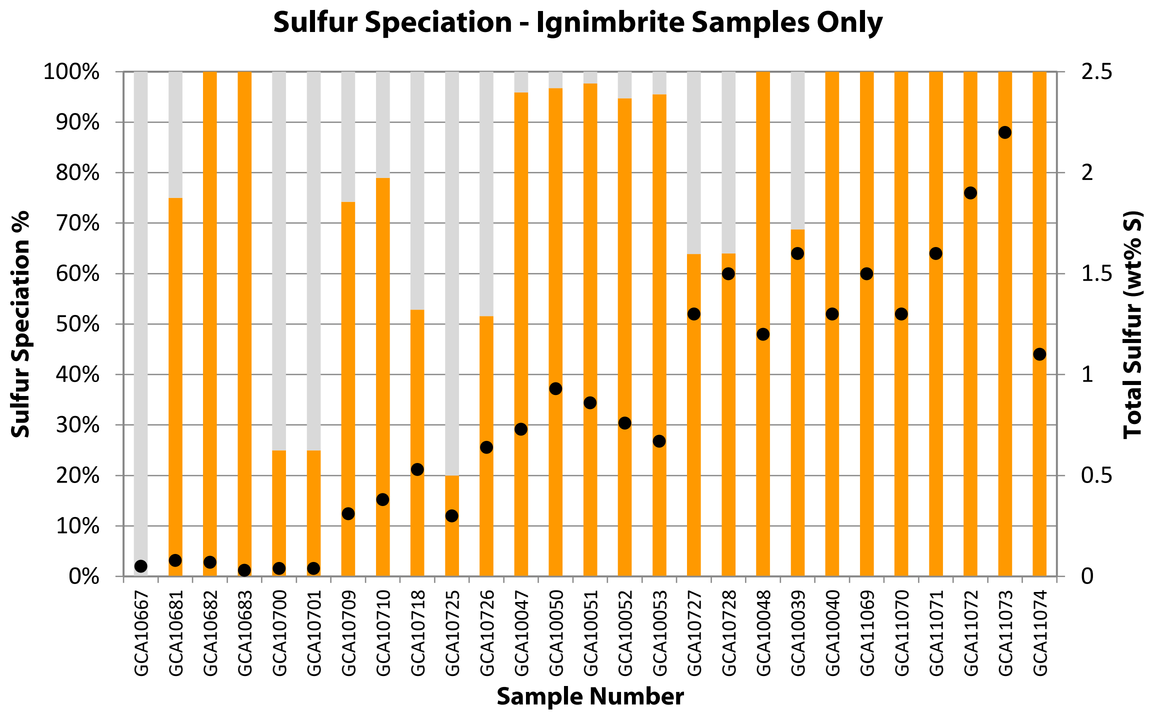

Figure H10: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

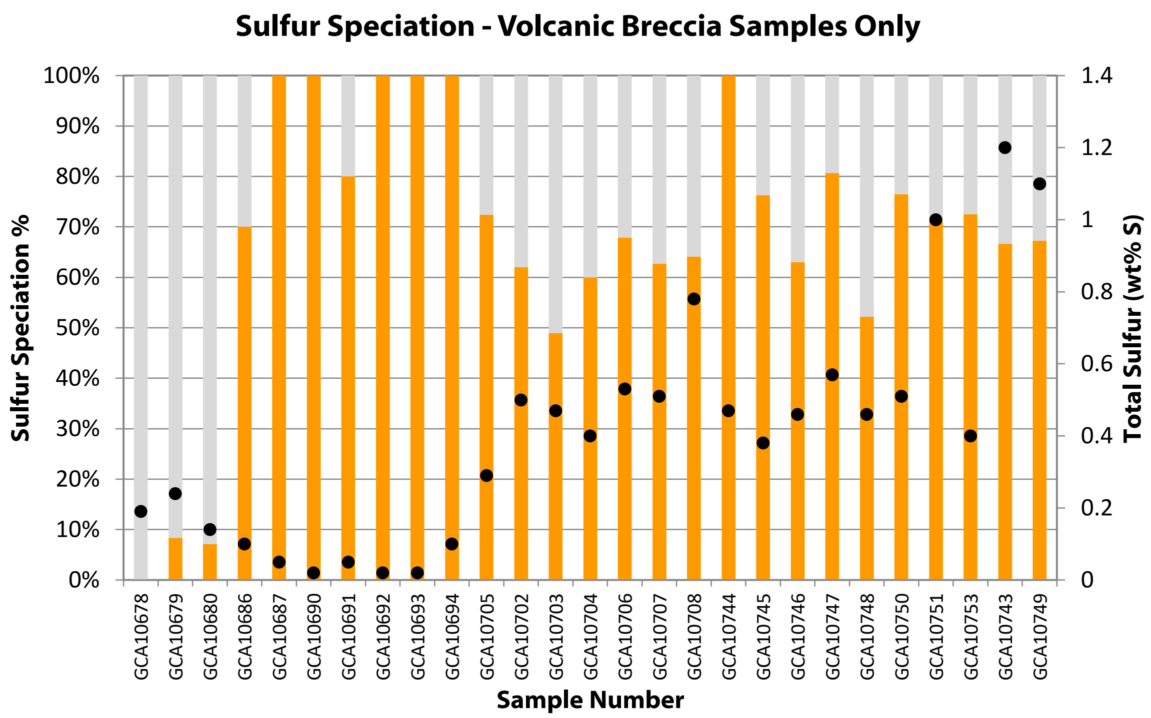

Figure H11: Chart showing the relative proportion of the various forms of sulfur within each Volcanic Breccia sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

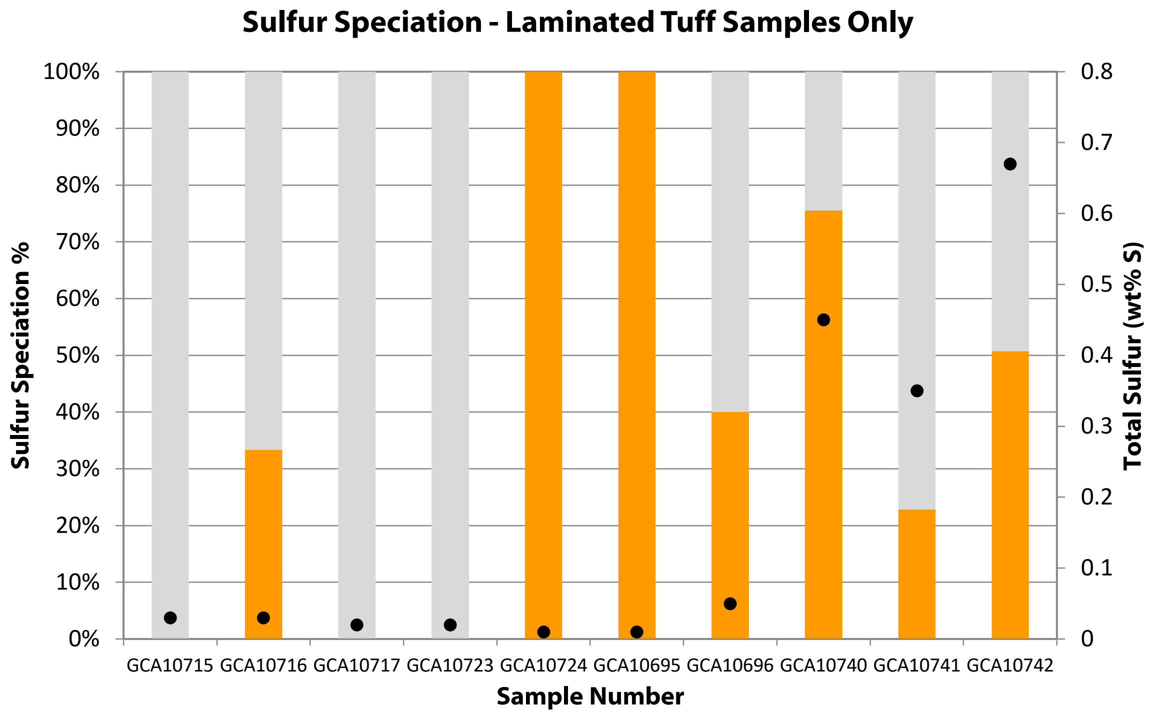

Figure H12: Chart showing the relative proportion of the various forms of sulfur within each Laminated Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

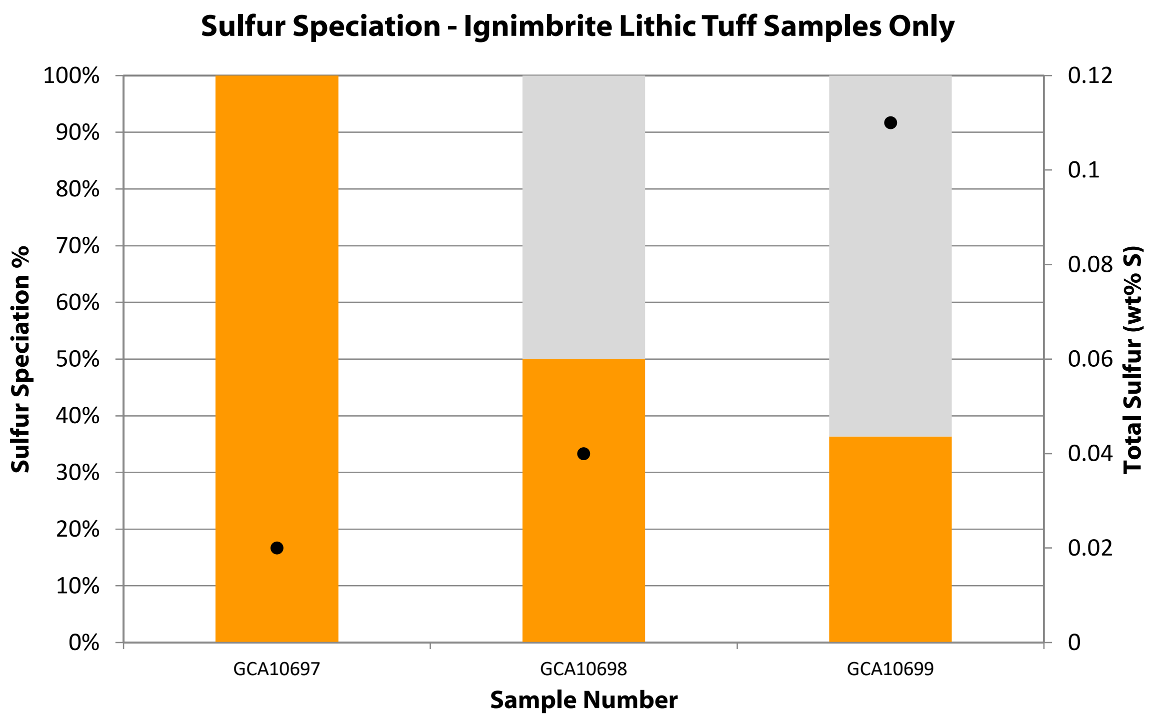

Figure H13: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite Lithic Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

ASSESSMENT COMMENTS

CODE	EXPLANATION
	Drainage Characteristics
1	Material expected to produce Acid & Metalliferous Drainage
2	Material may potentially produce Acid & Metalliferous Drainage
3	Material unlikely to produce Acid & Metalliferous Drainage
4	Material NOT expected produce Acid & Metalliferous Drainage
5	Material expected to produce metalliferous, near neutral pH drainage
6	Material expected to produce alkaline, non-metalliferous drainage
7	Material expected to produce acid drainage
8	Material expected to produce drainage with low pH
9	Material expected to produce drainage with low to near neutral pH (slightly acidic)
10	Material expected to produce drainage with near neutral pH
11	Material expected to produce drainage with alkaline pH (may need confirmation)
12	Material unlikely to produce acid drainage
13	Material NOT expected to produce acid drainage
14	Material expected to produce drainage containing dissolved metals
15	Material expected to produce drainage with high levels of dissolved metals
16	Material expected to produce drainage with moderate levels of dissolved metals
17	Material expected to produce drainage with low levels of dissolved metals
18	Material may produce drainage with low levels of dissolved metals
19	Material expected to produce drainage with no or low levels of dissolved metals
20	Metalliferous drainage cannot be excluded
21	Material NOT expected to produce drainage with metal acidity
22	For high S and high ANC / NP, drainage might contain high level of Mn and other metals (depending on mineralisation)
23	Leachate characteristics need to be confirmed
24	Leachate composition unknown
	Management Options
41	Material likely to require special AMD management & handling to limit oxidation
42	Material may require special AMD management & handling to limit oxidation
43	Material unlikely to require special AMD management & handling
	NAPP / NNP Characteristics
60	NAPP / NNP results indicate net acid producing potential
61	NAPP / NNP results indicate net acid consumption
62	NAPP / NNP possibly overestimated
63	NAPP / NNP possibly be overestimated (sulphides other than pyrite present, or non sulphide sulphur e.g. gypsum or other sulphates)
64	MPA / AP could be overestimated (pyrite is not the main sulphide)
65	NAPP / NNP likely to be underestimated (ANC / NP overestimated or not readily available for neutralisation)

ASSESSMENT COMMENTS

CODE	EXPLANATION
66	NAPP / NNP potentially underestimated (ANC / NP potentially overestimated, or not readily available for neutralisation)
67	NAPP / NNP suggests excess acid neutralising capacity; NAG suggest net acid generating capacity
68	NAPP / NNP suggests net acid generation but NAGpH suggests no acid production
69	NAPP / NNP suggests net acid generation but NAGpH suggests potentially no acid production
70	NAPP / NNP indicates excess acid neutralising capacity; NAGpH indicates high acid generation capacity
71	NAPP / NNP indicates excess acid neutralising capacity; NAGpH indicates net acid generating capacity
72	NAPP / NNP indicates likelihood of excess acid neutralisation capacity; NAGpH indicates net acid generation capacity
73	Inconsistency between NAPP / NNP and NAG results
74	Inconsistency between NAPP / NNP and NAGpH results
75	NAPP / NNP to be confirmed with further test work
	NAG Characteristics
90	Net acid generation capacity needs to be quantified
91	NAG results lower than expected based on NAPP / NNP value
92	NAG underestimated (incomplete oxidation of sample during test)
93	NAG value might be overestimated (e.g. excess organic C)
94	NAGpH needed
95	NAGpH results too high to be reliable / representative
96	NAGpH higher than expected based on NAPP / NNP value
97	NAGpH higher than expected (possible incomplete oxidation of sample during test, for S > 1 wt %)
98	NAGpH lower than expected based on NAPP / NNP results
99	NAGpH likely to reflect potential drainage pH
100	NAGpH unlikely to reflect potential drainage pH
101	NAG4.5 value higher than expected based on NAPP / NNP results
102	NAG7 value higher than expected based on NAPP / NNP results
103	NAG7 value lower than expected based on NAPP / NNP results
104	Net acid generation potential at pH 7 (NAG7.0), unknown
105	Net acid generating capacity at pH 7 (NAG7.0) potentially underestimated
106	NAGpH and NAG4.5 might reflect contribution of organic acids (e.g. excess organic C)
107	NAGpH and NAG7 might reflect contribution of organic acids (e.g. excess organic C)
108	NAGpH and NAG values might reflect contribution of organic acids (e.g. excess organic C)
109	NAG results indicate contribution of metal acidity to total acid load
110	NAGpH and NAG7 indicate possible effects of metal acidity
111	If Sulphur > 1 wt%, NAGpH likely to be overestimated (incomplete oxidation of sulphides)
112	If Sulphur > 1 wt%, NAG likely to be underestimated (incomplete oxidation of sulphides)

ASSESSMENT COMMENTS

CODE	EXPLANATION
140	Possible contribution of metals other than Fe to total acidity
141	Non-pyritic sulphide minerals might be important
142	Specific metal acidity issues likely
	ANC / NP Characteristics
150	ANC / NP required to evaluate acid consuming potential
151	ANC / NP insufficient to neutralise acid generated
152	ANC / NP likely to be insufficient to neutralise acid generated
153	ANC / NP may be available for acid neutralisation
154	Excess ANC / NP available
155	Material could potentially be used for acid neutralisation
	Additional Test work Requirements
170	Further test work required
171	Further test work required to clarify NAG_{pH}
172	Further tests needed to clarify discrepancy between NAPP / NNP and NAGpH results
173	High S content requires further tests to confirm NAPP / NNP prediction of net acid consumption
	Other
200	Insufficient data to classify sample
201	Insufficient data to further classify sample
202	Classification is tentative and needs to be confirmed
203	Classification needs further confirmation
204	Data can have multiple interpretations
205	Rate of acid generation (Oxidation rate) unknown
206	Rate of acid generation (Oxidation rate) and neutralisation rate unknown
207	Amount of acid likely to be generated, unknown

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
1	AMD potential should be considered in mine planning
2	AMD potential might need to be considered in mine planning
3	AMD potential unlikely to be a concern
10	Select a sample suite representative of waste rock / tailings (on same samples as NAPP / NNP test work):
10.1	Determine ANC / NP
10.2	Calculate NAPP / NNP
10.3	Conduct NAGpH test (same samples as NAPP / NNP)
10.4	Conduct NAG4.5 test (same samples as NAPP / NNP)
10.5	Conduct NAG7.0 test (same samples as NAPP / NNP)
10.6	Determine Total Sulfur / MPA / AP
11	Repeat ANC / NP test using modified protocol to ensure full oxidation of Fe^{2+}
12	On same samples as NAG tests:
12.1	Determine ANC / NP
12.2	Calculate NAPP / NNP
12.3	Determine NAGpH
12.4	Determine Total Sulfur / MPA / AP
13	On same samples as NAGpH test:
13.1	Determine ANC / NP
13.2	Calculate NAPP / NNP
13.3	Determine Total Sulfur / MPA / AP
14	On same samples as NAG4.5 tests:
14.1	Determine ANC / NP
14.2	Calculate NAPP / NNP
14.3	Conduct NAGpH test
14.4	Determine Total Sulfur / MPA / AP
15	If NAGpH < 5, Kinetic testwork (eg. oxygen consumption test) should be established to:
15.1	Define leachate composition
15.2	Evaluate oxidation and neutralisation rates
15.3	Constrain sample behaviour under normal weathering conditions
16	If NAGpH < 6, Kinetic testwork (eg. oxygen consumption tests) should be established to:
16.1	Define leachate composition
16.2	Evaluate oxidation and neutralisation rates
16.3	Constrain sample behaviour under normal weathering conditions
17	If NAGpH < 7 use the same sample to:
17.1	Conduct a NAG4.5 test
17.2	Conduct a NAG7.0 test
17.3	Conduct a NAG9.5 test
18	If NAGpH < 9.5 use the same sample to:
18.1	Conduct a NAG4.5 test
18.2	Conduct a NAG7.0 test
18.3	Conduct a NAG9.5 test
20	If NAG tests is repeated, ensure H_2O_2 is not all consumed before end of oxidation
21	Analyse NAG liquor to determine metal concentrations
22	Analyse NAGpH liquor for presence of Mn and main metals
23	If majority of samples show similar high NAGpH values, sequential NAG tests are recommended
24	Consider conducting sequential NAG tests
25	Sequential NAG tests might be needed to confirm NAGpH
26	If NAPP / NNP result is confirmed, consider kinetic testwork (eg. oxygen consumption tests)

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
30	Kinetic testwork (eg. Oxygen consumption tests) should be established to:
30.1	Define leachate composition
30.2	Quantify metal acidity contribution to drainage acidity
30.3	Evaluate oxidation and neutralisation rates
30.4	Constrain sample behaviour under normal weathering conditions
35	Define Acid Buffering Characteristic curve
40	Evaluate TOC content.
40.1	If TOC < 7%, repeat ANC / NP test using modified protocol to ensure full oxidation of Fe^{2+}
40.2	If TOC < 7%, conduct NAGpH tests (same NAPP / NNP samples)
40.3	If TOC < 7%, conduct NAG7.0 tests (same NAPP / NNP samples)
50	Use lithological and mineralogical data to interpret results
51	Use lithological and mineralogical data to support results
52	Refer to lithological and mineralogical data to assist with sample classification
53	Use mineralogical data to confirm MPA / AP
54	Use mineralogical data to interpret NAPP / NNP results
55	Use mineralogical / lithological data to interpret NAPP / NNP results and identify likely metals in drainage
56	Use sulphide mineralogy to establish identity of potential metals in leachate
57	Use sulphide mineralogy to assist interpretation of results
58	Define sulphide mineralogy
58.1	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
59	Use mineralogy to assist interpretation of results (sulphides and sulphate)
60	Quantify presence of sulphates
61	Define carbonate mineralogy
62	Carbonate and sulphide mineralogy should be used to support tests results
63	Define carbonate mineralogy to confirm NAPP / NNP results
64	Use carbonate mineralogy to assist interpretation of results
65	Define distribution of carbonate within lithology (e.g. veins, pockets, disseminated)
66	Evaluate distribution of carbonate within lithology (e.g. veins, pockets, disseminated)
67	Reclassify samples using new data
68	Use NAPP / NNP value to classify sample
69	Use NAPP / NNP value to reclassify sample
70	Use NAPP / NNP classification for indicative characterisation
71	Calculate NAPP / NNP using mineralogical data (ABATES)
72	Use NAPP / NNP value to classify sample, NAGpH too high to be representative
73	Unless majority of samples show similar NAGpH values, disregard data
74	If only few samples show similar high NAGpH values, use NAPP / NNP value to classify sample
75	NAGpH value is unlikely to be reliable
80	Confirm NAPP / NNP result:
80.1	Determine NAGpH
80.2	If NAPP / NNP value is confirmed, conduct sequential NAG tests
80.3	Define sulphide mineralogy
80.4	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
80.5	Confirm absence of gypsum or other sulphates in sample
80.6	Analyse for S from Sulphide minerals only
80.7	Recalculate NAPP / NNP using Sulphur from Sulphide value
80.8	Define carbonate mineralogy

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
82	Resolve discrepancy between NAG and NAPP / NNP values:
82.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
82.2	Define sulphide mineralogy
82.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
82.4	Confirm absence of gypsum or other sulphates in sample
82.5	Analyse for S from Sulphide minerals only
82.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
83	Confirm NAG and NAPP / NNP values
83.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
83.2	Define sulphide mineralogy
83.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
83.4	Confirm absence of gypsum or other sulphates in sample
83.5	Analyse for S from Sulphide minerals only
83.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
83.7	Determine NAGpH
84	Confirm NAGpH and NAPP / NNP values:
84.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
84.2	Define sulphide mineralogy
84.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
84.4	Confirm absence of gypsum or other sulphates in sample
84.5	Analyse for S from Sulphide minerals only
84.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
84.7	Define carbonate mineralogy
86	Resolve discrepancy between NAGpH and NAPP / NNP value:
86.1	Determine NAGpH
86.2	If NAPP / NNP value is confirmed, conduct sequential NAG tests
86.3	Define sulphide mineralogy
86.4	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
86.5	Confirm absence of gypsum or other sulphates in sample
86.6	Analyse for S from Sulphide minerals only
86.7	Recalculate NAPP / NNP using Sulphur from Sulphide value
88	If classification is confirmed, UAG samples most likely will not require special handling
90	If material is to be used as a neutralising agent:
90.1	Determine carbonate dissolution rates
90.2	Determine leachate composition
100	No further action required

GLOSSARY

SAMPLE DETAILS

Sample type: This represents the primary sample type desired by the client, generally representing various mine materials (eg. ore, waste rock and tailings). This term may also represent any differentiating characteristic of the rock that may be provided by the client (including lithology).
Sample sub-type: Generally, this represents the sample lithology provided. This term may also represent any differentiating characteristic of the rock that may be provided by the client (eg. deposit name, mine zone / spatial delineation, flood plain sample, location etc.).
General classification: The simplified classification of a sample's potential AMD risk, based on the static geochemical parameters provided. PAF samples represent the total number of samples classified as potentially acid generating. NAF samples represent the total number of samples classified as non-acid forming.
Detailed classification: The classification of a sample's potential AMD risk, based on the static geochemical parameters provided. Detailed classification categories from highest to lowest acid generating risk are High Potential for Acid generation; Moderate / High Potential for Acid Generation; Moderate Potential for Acid Generation; Low Potential for Acid Generation; Unlikely to be Acid Generating; Likely to be Acid Consuming. Samples with insufficient data or have data providing conflicting risk classifications are not classified.

STATIC GEOCHEMISTRY

PAF : Samples that are classified as Potentially Acid Forming based on the static geochemical parameters provided.
NAF : Samples that are classificated as likely to be Non-Acid Forming based on the static geochemical parameters provided.
Maximum Potential Acidity (MPA) : A calculation of the maximum amount of sulfuric acid (H2SO4) that could be produced if all reactive sulfide in the sample is oxidised (wt%S x 30.6). This is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Maximum potential acidity based on S-Cr ($MPA_{(SCr)}$) : A calculation of the maximum amount of sulfuric acid (H_2SO_4) that could be produced assuming that the chromium reducible sulfur represents the sulfide sulfur within the sample, and all of the sulfide sulfur is oxidised. This is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Acid Neutralising Capacity (ANC) : A measure of the potential acid neutralising capacity of the sample, typically due to the presence of calcium- and/or magnesium-bearing carbonate minerals. The ANC value assumes that all of the carbonate is available for acid neutralisation (kg H_2SO_4/tonne).
Net Acid Producing Potential (NAPP) : A measure of the overall acid-generating potential of the sample, calculated by subtracting the ANC value from MPA. The NAPP value is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Acid Generation Potential (AP) : Analogous to MPA. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
Acid Generation Potential based on S-Cr ($AP_{(SCr)}$) : Analogous to MPA(SCr).
Neutralization Potential (NP) : Analogous to ANC. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
Net Neutralization Potential (NNP) : Calculated. NNP=AP-NP. Analogous to NAPP. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
ANC/MPA Ratio : Represents a calculated ratio between the Acid Neutralising Capacity (ANC) and the Maximum Potential Acidity (MPA).
Neutralization Potential Ratio (NPR) : Represents a calculated ratio between the Neutralizing Potential (NP) and the Acid Generation Potential AP. NPR = NP/AP. Analogous to ANC/MPA ratio.
Pyrite equivalent based on Total Sulfur ($Pyrite_{(STOT)}$) : The pyrite mass equivalent of the total sulfur, assuming all sulfur is present as pyrite.
Pyrite equivalent based on S-Cr ($Pyrite_{(SCr)}$) : The pyrite mass equivalent of the sulfide sulfur, assuming the chromium reducible sulfur is representative of the sulfide sulfur.
Net Acid Generation pH after oxidation (NAG-pH) : The pH of a sample after oxidation with an excess of hydrogen peroxide.
Net Acid Generation to pH 4.5 ($NAG_{4.5}$) : The equivalent acidity of a peroxide-oxidised sample titrated to pH 4.5 (kg H_2SO_4/tonne).
Net Acid Generation to pH 7.0 ($NAG_{7.0}$) : The equivalent acidity of a peroxide-oxidised sample titrated to pH 7.0 (kg H_2SO_4/tonne).

SULFUR SPECIATION

Total sulfur (S-TOT) : Total sample sulfur determined by the Leco method.
Chromium reducible sulfur (S-Cr) : Laboratory method for estimating the sulfide forms of sulfur within a sample.
Peroxide Sulfur (S_P) : The sulfur present within the filtered leachate following TPA titration.
Potassium chloride extractable sulfur (S-KCl) : The sulfur measured from a filtered sample leachate following extraction with 1M KCl.
Hydrochloric acid extractable sulfur (S-HCl) : The sulfur measured from a filtered sample leachate following extraction with 4M HCl.
Total oxidisable sulfur (S-TOS) : Calculated. S-TOS = STOT – S-HCl
Net acid soluble sulfur (S-NAS): Calculated. S-NAS = S-HCl – S-KCl
Potential oxidisable sulfur (S-POS) : Calculated. S-POS = S_P – S-KCl
Residual acid soluble sulfur (S-RAS) : Sulfur measured in the filtered leachate following 4M HCl extraction of the residual solids from the TPA test.
Sulfide sulfur : Sulfur in the form of sulfide minerals (eg. pyrite, pyrrhotite, chalcopyrite).
Readily soluble non acid storing sulfate sulfur : A measure of sulfur present as relatively soluble minerals which do not contribute to acidity upon dissolution (eg. gypsum).
Gypsum (equivalent) : The calculated mass of gypsum equivalent (expressed in weight percent) based on the mass of readily soluble non acid storing sulfate sulfur.
Readily soluble acid storing sulfate sulfur : A measure of sulfur present as minerals with relatively high solubility formed by prior oxidation of sulfide minerals and which release acid upon dissolution and oxidation (eg. melanterite).
Melanterite (equivalent) : The calculated mass of melanterite equivalent (expressed in weight percent) based on the mass of readily soluble acid storing sulfate sulfur.
Sparingly soluble acid-forming sulfate sulfur : A measure of the low-solubility, acidity storing sulfate minerals (eg. jarosite, alunite) present within a sample.

GLOSSARY

Jarosite (equivalent) : The calculated mass of jarosite equivalent (expressed in weight percent) based on the mass of sparingly soluble acid storing sulfate sulfur.

ACIDITY

pH after potassium chloride extraction (pH_{KCl}) : The pH of a sample leachate after a 4 hour extraction with 1M KCl.
pH after hydrogen peroxide extraction (pH_{ox}) : The pH of a sample leachate after extraction with 30% hydrogen peroxide.
Titratable actual acidity (TAA) : The acidity titrated from a sample leachate after a 4 hour extraction with 1M KCl. The titration is stopped when the solution reaches pH 6.5.
Total Potential Acidity (TPA) : The acidity titrated from a sample leachate after extraction with 30% hydrogen peroxide. The titration is stopped when the solution reaches pH 6.5.
Total sulfide acidity (TSA) : Calculated. TSA = TPA - TAA
Potential acidity : Represents the net potential for acid generation from a sample, following oxidation of the sulfide minerals within the sample and neutralisation against any available neutralising minerals within the sample. Expressed in units of moles of H+ per tonne of material.
Actual acidity : The readily available / soluble acidity held within a sample. Expressed in units of Moles of H+ per tonne of material.
Retained acidity : The relatively insoluble stored acidity within a sample. Expressed in units of moles of H+ per tonne of material.
Existing acidity : Calculated. Existing acidity = Actual acidity + Retained acidity
Net acidity : Calculated. Net Acidity = Potential sulfidic acidity + Existing acidity - ANC

CARBON

Total carbon (C_{TOT}) : The total amount of carbon in a sample, representing all forms of carbon.
Total organic carbon (C_{TOC}) : The laboratory measured carbon in a sample that is present as organic forms. Also captures any graphite within the sample.

Total inorganic carbon (C_{TIC}) : The carbon in a sample that is present as inorganic forms. Calculated by subtracting CTOC from CTOT.

CALCIUM CARBONATE

Excess acid neutralising capacity (ANC_E) : Requires back titration with HCl to pH 4 followed by peroxide digestion and titration to pH 6.5 with NaOH. The NaOH titration result is subtracted from the HCl titration result to provide an indication of excess neutralising capacity.
Calcium carbonate equivalent based on ANC : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured ANC result.
Calcium carbonate equivalent based on C_{TOT} : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured total carbon result.
Calcium carbonate equivalent based on C_{TIC} : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured calculated inorganic carbon content.

Attachment D

AMD Assessment and Classification Tool (AMDact) Report on 2017-18 Static Geochemistry Data

CERTIFICATE OF ASSESSMENT

Client :	NSW Dept. of Planning and Environment	Pages :	30
Project :	Bowdens Silver	Project Code :	NSWDPE2396
Location :	Central NSW	Report No.:	NSWDPE2396.08.B
		Contact :	Sophie Pape
Client Order No.:		Address :	ES Analytical - Melbourne Unit 4, 290 Salmon Street, Port Melbourne Victoria 3207, AUSTRALIA.
Client Contact :	Rose-Anne Hawkeswood		
Client Email :	rose-anne.hawkeswood@planning.nsw.gov.a	Email :	lab@esanalytical.com
Client Phone :	02 9274 6324	Phone :	(61-3) 9810 7500
Data received :	21/11/2022	No. of samples received :	16
Date assessed :	21/11/2022	No. samples classified :	16

Notes

Where available, Chromium-(SCr) was entered into AMDACT. When it was NOT available a calculated (Total S - SO4-S) equivalent was used.

Report Approval

This report has been approved for distribution by:

Name :	Dr. Jeff Taylor
Position :	Senior Principal Environmental Geochemist
Date released:	21/11/2022

Client : NSW Dept. of Planning and Environment
Project : Bowdens Silver

DATA SUMMARY

	Units	Data	Source	Notes**
Net Acid Producing Potential				
Net Acid Producing Potential (NAPP) :	kg H_2SO_4 / tonne	✓*		* Calculated by AMDACT
Acid Neutralising Capacity				
ANC as H_2SO_4:	kg H_2SO_4 / tonne	✓		
ANC as $CaCO_3$:	% $CaCO_3$	×		not provided
ANC - Excess (ANC-E) :	% $CaCO_3$			
Net Acid Generation				
NAG pH :	pH units	✓		Incomplete Data
NAG 4.5 :	kg H_2SO_4 / tonne	✓		Incomplete Data
NAG 7.0 :	kg H_2SO_4 / tonne	✓		Incomplete Data
NAG 9.5 :	kg H_2SO_4 / tonne	×		not provided
Acidity				
Potassium Chloride pH (pH-KCl) :	pH units	×		not provided
Titratable Actual Acidity (TAA) :	mol H^+/ tonne	×		not provided
Peroxide oxidised pH (pH-ox) :	pH units	×		not provided
Titratable Peroxide Acidity (TPA) :	mol H^+/ tonne	×		not provided
Sulfur Speciation				
Total Sulfur (S-TOT):	% S	✓		
Cr-reducible Sulfur (S-Cr):	% S	✓		
Peroxide Sulfur (Sp) :	% S	×		not provided
1M KCl extractable sulfur (S-KCl) :	% S	×		not provided
4M HCl extractable sulfur (S-HCl) :	% S	×		not provided
Residual Acid soluble Sulfur (S-RAS) :	% S	×		not provided
Carbon Speciation				
Total Carbon (C-TOT) :	% C	✓		
Organic Carbon (C-Org) :	% C	×		not provided
Inorganic Carbon (C-In) :	% C	✓		

** Limited Data (<50% of samples), Incomplete Data (50% - 99% of Samples)

This report is not to be used for purposes other than those for which it was intended. The geochemical risk assessment and classification of Acid Generating Potential of the suite of samples provided is based on the parameters indicated above. All of the data has been provided by the CLIENT and sourced from third party laboratories unless otherwise stated.

The Acid Generating Potential may vary greatly from the actual Acid Generating Capacity due a number of factors and, as a result, some samples may require additional static and kinetic testwork. Where possible additional suggested testwork has been indicated. It is recommended that any additional work be discussed with a qualified professional environmental geochemist.

Where sample parameters are reported as less than ("<"), or below detection ("B.D.") one half the reported detection limit has been used for the statistical analysis.

This report has been automatically generated byAMDACTv.5.2.8 (release date 24/06/2019) using data indicated above and supersedes any previous report(s) issued under the same work order / report number.

Sample Details		AMD Risk Classification - No. of Samples										
		General Classification			Detailed Classification							Totals
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available	
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data	Sub-total
Laminated Tuff	No. Samples	0	3	0	0	0	0	0	3	0	0	3
	Proportion	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	-
Volcanic Breccia	No. Samples	1	11	0	0	0	0	0	9	1	2	12
	Proportion	8.3%	91.7%	0.0%	0.0%	0.0%	0.0%	0.0%	75.0%	8.3%	16.7%	-
Ignimbrite	No. Samples	0	1	0	0	0	0	0	1	0	0	1
	Proportion	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	-
All Samples	No. Samples	1	15	0	0	0	0	0	13	1	2	16
	Proportion	6.3%	93.8%	0.0%	0.0%	0.0%	0.0%	0.0%	81.3%	6.3%	12.5%	-

Table B-1: Summary of the relative proportions (in percentage) of primary sample types in each of the AMD Risk Classification categories, relative to the total number of samples assessed. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

Sample Details		AMD Risk Classification - No. of Samples											
		General Classification			Detailed Classification							Totals	
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available		
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data	Sub-total (lithology)	Sub-total (mine material type)
Laminated Tuff	Laminated Tuff	0	3	0	0	0	0	0	3	0	0	**3**	**3**
Volcanic Breccia	Volcanic Breccia	1	11	0	0	0	0	0	9	1	2	**12**	**12**
Ignimbrite	Ignimbrite	0	1	0	0	0	0	0	1	0	0	**1**	**1**
Sub-Total		1	15	0	0	0	0	0	13	1	2	**16**	**16**

Table B-2: Summary of the number of samples in each of the AMD Risk Classification categories. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

Sample Details		AMD Risk Classification - % of Samples									
		General Classification			Detailed Classification						
					Potential Acid Forming (PAF)				Non-Acid Forming (NAF)		Not Available
Sample Type	Sample Sub-Type	Potential Acid Forming (PAF)	Non-Acid Forming (NAF)	Unavailable	High Potential for Acid Generation	Moderate / High Potential for Acid Generation	Moderate Potential for Acid Generation	Low Potential for Acid Generation	Unlikely to be Acid Generating	Likely to be Acid Consuming	Insufficient, Inconsistent, Ambiguous Data
Laminated Tuff	Laminated Tuff	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Volcanic Breccia	Volcanic Breccia	8.3%	91.7%	0.0%	0.0%	0.0%	0.0%	0.0%	75.0%	8.3%	16.7%
Ignimbrite	Ignimbrite	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%

Table B-3: Summary of the relative proportions (in percentage) of samples in each of the AMD Risk Classification categories, relative to the total number of samples assessed. Sample numbers under the General Classification heading include samples in the appropriate Detailed Sample Classification categories.

Generated using: AMDact v.5.2.8.2

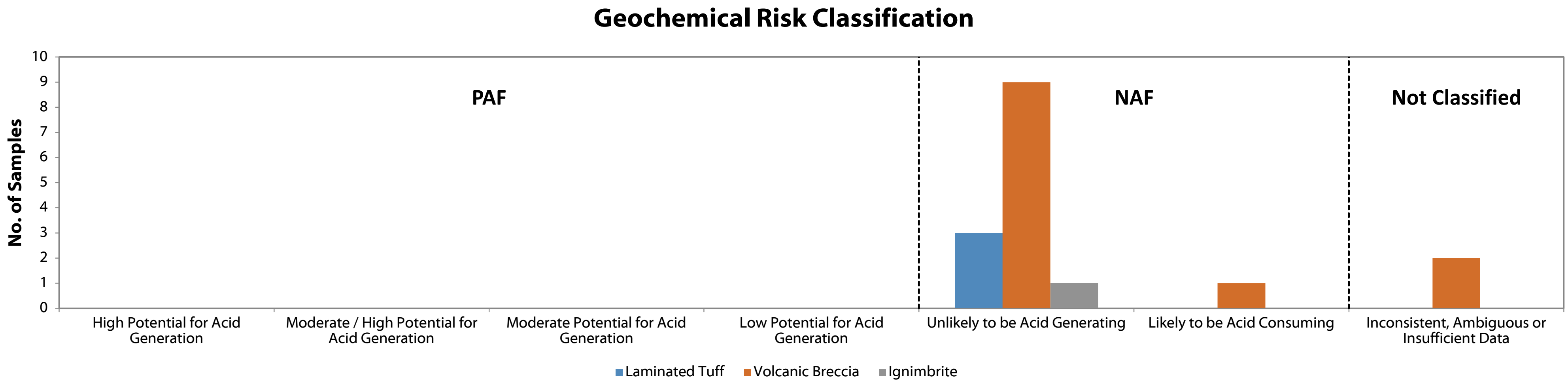

Figure C1: A chart showing the distribution of samples in each of the geochemical risk classification categories.

Generated using: AMDact v.5.2.8.2

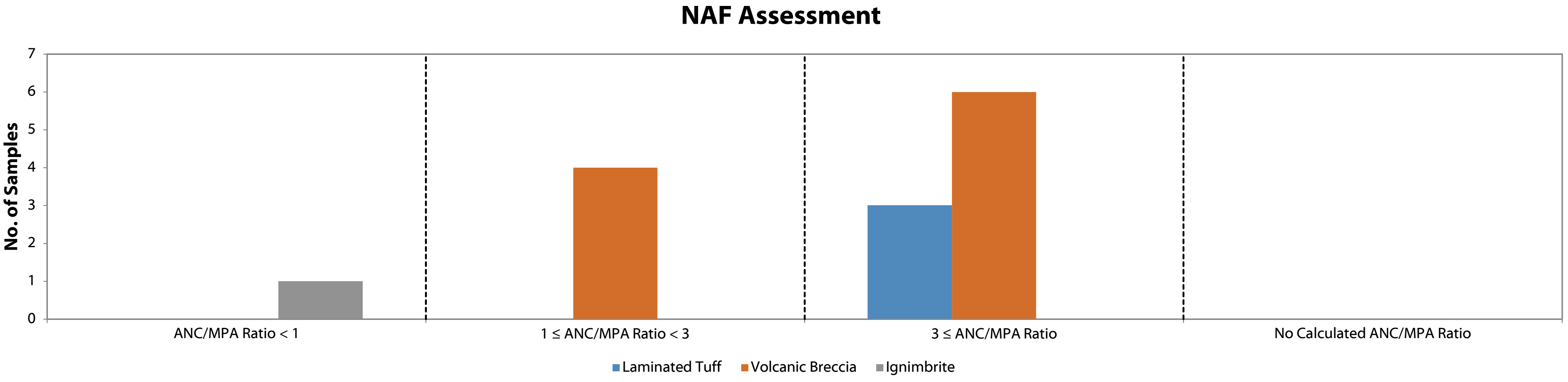

Figure C2: The distribution of NAF samples with various ANC/MPA ratios. Samples with no calculated ratio have Total Sulfur below detection and therefore an MPA of zero.

Generated using: AMDact v.5.2.8.2

Sample Details			Geochemical Risk Classification			
			AMD / ARD Risk Classification		Additional Risk Classification	
Sample ID	Sample Type	Sample Sub-Type	General Classification	Detailed Classification	Neutral Metalliferous Drainage (NMD/ML)	Saline Drainage (SD)
BD17016_35	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD16003_57	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD17007_53	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Unlikely to Generate NMD	Unlikely to Generate SD
BD17007_55	Volcanic Breccia	Volcanic Breccia	NAF*	Inconsistent Data*	Unlikely to Generate NMD	Unlikely to Generate SD
BD17007_65	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Unlikely to Generate NMD	Unlikely to Generate SD
BD17014_48	Volcanic Breccia	Volcanic Breccia	PAF*	WARNING: The NAG 4.5 is too low for the NAG pH.	Not assessed	Unlikely to Generate SD
BD17010_60	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Potential for NMD	Unlikely to Generate SD
BD17001_74	Volcanic Breccia	Volcanic Breccia	NAF	Likely to be Acid Consuming	Unlikely to Generate NMD	Unlikely to Generate SD
BD17001_76	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Unlikely to Generate NMD	Unlikely to Generate SD
BD17001_96	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Potential for NMD	Unlikely to Generate SD
BD16005_114	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD13128_73	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD16016_105	Volcanic Breccia	Volcanic Breccia	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD16016_67	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Potential for NMD	Unlikely to Generate SD
BD16016_69	Laminated Tuff	Laminated Tuff	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed
BD13128_111	Ignimbrite	Ignimbrite	NAF	Unlikely to be Acid Generating	Insufficient Data	Not assessed

NAF NAF Safety Factor Warning (ANC/MPA < 1)

NAF NAF Safety Factor Warning (1 < ANC/MPA < 3)

PAF* NAF* Where there is inconsistency between static data the PAF/NAF classification is based soley on NAGpH when available.

Generated using: AMDact v.5.2.8.2

Sample Details	Sample ID		BD17016_35	BD16003_57	BD17007_53	BD17007_55	BD17007_65	BD17014_48	BD17010_60	BD17001_74	BD17001_76	BD17001_96
	Sample Type		Laminated Tuff	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	Sample Sub-Type		Laminated Tuff	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Volcanic Breccia
	General Classification		NAF	NAF	NAF	NAF*	NAF	PAF*	NAF	NAF	NAF	NAF
	Detailed Classification		Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Inconsistent Data*	Unlikely to be Acid Generating	WARNING: The NAG 4.5 is too low for the NAG pH.	Unlikely to be Acid Generating	Likely to be Acid Consuming	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-33.4	-1.4	-24.2	6.5	-5.2	4.7	-3.6	-49.7	-31.3	-3.0
	NNP	kg $CaCO_3$ / tonne	34.1	1.4	24.7	-6.7	5.3	-4.8	3.6	50.8	32.0	3.0
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-34.0	-2.0	-29.7	-2.0	-10.7	0.4	-10.6	-53.1	-32.4	-3.9
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	34.7	2.0	30.3	2.1	10.9	-0.4	10.8	54.2	33.0	4.0
	MPA	kg H_2SO_4 / tonne	0.6	0.6	9.8	12.5	9.8	7.7	17.4	8.3	3.7	7.0
	AP	kg $CaCO_3$ / tonne	0.6	0.6	10.0	12.8	10.0	7.8	17.8	8.4	3.8	7.2
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	-	-	4.3	4.0	4.3	3.4	10.4	4.9	2.6	6.1
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	-	-	4.4	4.1	4.4	3.4	10.6	5.0	2.7	6.3
	ANC	kg H_2SO_4 / tonne	34.0	2.0	34.0	6.0	15.0	3.0	21.0	58.0	35.0	10.0
	NP	kg $CaCO_3$ / tonne	34.7	2.0	34.7	6.1	15.3	3.1	21.4	59.2	35.7	10.2
	ANC/MPA	-	55.6	3.3	3.5	0.5	1.5	0.4	1.2	7.0	9.5	1.4
	NPR (NP/AP)	-	55.5	3.3	3.5	0.5	1.5	0.4	1.2	7.0	9.5	1.4
	$Pyrite_{(STOT)}$	% Pyrite	0.0	0.0	0.6	0.8	0.6	0.5	1.1	0.5	0.2	0.4
	$Pyrite_{(SCr)}$	% Pyrite	-	-	0.3	0.2	0.3	0.2	0.6	0.3	0.2	0.4
	Paste pH	pH units										
	NAG_{pH}	pH units			8.5	4.7	5.9	4.0	8.0	8.9	9.1	7.3
	$NAG_{4.5}$	kg H_2SO_4 / tonne			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	$NAG_{7.0}$	kg H_2SO_4 / tonne			<0.5	1.10	0.60	2.90	<0.5	<0.5	<0.5	<0.5
	$NAG_{9.5}$	kg H_2SO_4 / tonne										
Sulfur Speciation	S_{TOT}	wt% S	0.02	0.02	0.32	0.41	0.32	0.25	0.57	0.27	0.12	0.23
	S_{Cr}	wt% S	<0.1	<0.1	0.14	0.13	0.14	0.11	0.34	0.16	0.09	0.20
	S_P	wt% S										
	S_{KCl}	wt% S										
	S_{HCl}	wt% S										
	S_{TOS}	wt% S										
	S_{NAS}	wt% S										
	S_{POS}	wt% S										
	S_{RAS}	wt% S										
	Sulfide Sulfur	wt% S	<0.1	<0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.2
	Pyrite (equiv.)	wt%	-	-	0.3	0.2	0.3	0.2	0.6	0.3	0.2	0.4
	Readily soluble non-acid storing Sulfate-S	wt% S										
	Gypsum (equiv.)	wt%										
	Readily soluble acid storing Sulfate-S	wt% S										
	Melanterite (equiv.)	wt%										
	Sparingly soluble acid storing Sulfate-S	wt% S										
	Jarosite (equiv.)	wt%										
Acidity	pH_{KCl}	pH units										
	pH_{ox}	pH units										
	TAA	mol H^+/ tonne										
	TPA	mol H^+/ tonne										
	TSA	mol H^+/ tonne										
	Potential Acidity	mol H^+/ tonne	0.0	0.0	87.3	81.1	87.3	68.6	212.1	99.8	53.6	124.7
	Actual Acidity	mol H^+/ tonne										
	Retained Acidity	mol H^+/ tonne										
	Net Acidity	mol H^+/ tonne										
Carbon	C_{TOT}	wt% C	0.6	0.0	0.6	0.1	0.4	0.2	0.4	1.1	1.0	0.2
	C_{TO}	wt% C										
	C_{IN}	wt% C	0.6	<0.01	0.6	0.1	0.4	0.0	0.4	1.1	1.0	0.2
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$										
	$CaCO_3$ based on ANC	% $CaCO_3$	3.5	0.2	3.5	0.6	1.5	0.3	2.1	5.9	3.6	1.0
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	4.9	0.2	4.8	1.2	3.4	2.0	3.7	9.0	8.5	2.0
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	4.7	0.0	4.6	0.8	3.2	0.3	3.3	8.7	8.2	1.7
Assessment	Additional Potential Risks		Not assessed	Not assessed	Unlikely to Generate NMD / Unlikely to Generate SD	Unlikely to Generate NMD / Unlikely to Generate SD	Unlikely to Generate NMD / Unlikely to Generate SD	Not assessed / Unlikely to Generate SD	Potential for NMD / Unlikely to Generate SD	Unlikely to Generate NMD / Unlikely to Generate SD	Unlikely to Generate NMD / Unlikely to Generate SD	Potential for NMD / Unlikely to Generate SD
	Details [a]		3, 10, 18, 23, 43, 75	3, 10, 18, 23, 43, 75	3, 9, 19,24, 43, 99, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]	7, 73, 96 (63, 97), 170, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]	3, 9, 19,24, 43, 99, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]		9, 17, 24, 43, 73 (64, 112), 203, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]	4, 13, 19, 23, 24, 43, 99, 155	3, 9, 19,24, 43, 99, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]	3, 9, 19,24, 43, 99, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]
	Recommendations [b]		3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	30, 30.1, 30.3, 30.4, 62	86, 86.2, 86.3, 86.4, 86.5, 86.6, 86.7	30, 30.1, 30.3, 30.4, 62		30, 84, 84.2, 84.3, 84.4, 84.5, 84.6	62, 90, 90.2	30, 30.1, 30.3, 30.4, 62	30, 30.1, 30.3, 30.4, 62

* Calculated values based on:

AMIRA (2002). ARD Test Handbook - Project P387A Prediction & Kinetic Control of Acid Mine Drainage. AMIRA International

Ahern CR, McElnea AE, Sullivan LA (2004). Acid Sulfate Soils Laboratory Methods Guidelines. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3
<0.1	SCr calculated from Total S - SO4-S
PAF* / NAF*	Where there is inconsistency between static data the PAF/NAF classification is based soley on NAGpH when available.

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Sample Details	Sample ID		BD16005_114	BD13128_73	BD16016_105	BD16016_67	BD16016_69	BD13128_111
	Sample Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Laminated Tuff	Laminated Tuff	Ignimbrite
	Sample Sub-Type		Volcanic Breccia	Volcanic Breccia	Volcanic Breccia	Laminated Tuff	Laminated Tuff	Ignimbrite
	General Classification		NAF	NAF	NAF	NAF	NAF	NAF
	Detailed Classification		Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating	Unlikely to be Acid Generating
Static Geochemistry	NAPP	kg H_2SO_4 / tonne	-8.6	-6.5	-3.6	-25.4	-39.5	0.4
	NNP	kg $CaCO_3$ / tonne	8.8	6.6	3.6	25.9	40.3	-0.5
	$NAPP_{(SCr)}$	kg H_2SO_4 / tonne	-9.9	-8.0	-6.0	-30.3	-41.0	-2.0
	$NNP_{(SCr)}$	kg $CaCO_3$ / tonne	10.1	8.2	6.1	30.9	41.8	2.0
	MPA	kg H_2SO_4 / tonne	3.4	1.5	2.4	11.6	1.5	2.4
	AP	kg $CaCO_3$ / tonne	3.4	1.6	2.5	11.9	1.6	2.5
	$MPA_{(SCr)}$	kg H_2SO_4 / tonne	2.1	-	-	6.7	-	-
	$AP_{(SCr)}$	kg $CaCO_3$ / tonne	2.1	-	-	6.9	-	-
	ANC	kg H_2SO_4 / tonne	12.0	8.0	6.0	37.0	41.0	2.0
	NP	kg $CaCO_3$ / tonne	12.2	8.2	6.1	37.8	41.8	2.0
	ANC/MPA	-	3.6	5.2	2.5	3.2	26.8	0.8
	NPR (NP/AP)	-	3.6	5.2	2.4	3.2	26.8	0.8
	$Pyrite_{(STOT)}$	% Pyrite	0.2	0.1	0.1	0.7	0.1	0.1
	$Pyrite_{(SCr)}$	% Pyrite	0.1	-	-	0.4	-	-
	Paste pH	pH units						
	NAG_{pH}	pH units				8.7		
	$NAG_{4.5}$	kg H_2SO_4 / tonne				<0.5		
	$NAG_{7.0}$	kg H_2SO_4 / tonne				<0.5		
	$NAG_{9.5}$	kg H_2SO_4 / tonne						
Sulfur Speciation	S_{TOT}	wt% S	0.11	0.05	0.08	0.38	0.05	0.08
	S_{Cr}	wt% S	0.07	<0.1	<0.1	0.22	<0.1	<0.1
	S_P	wt% S						
	S_{KCl}	wt% S						
	S_{HCl}	wt% S						
	S_{TOS}	wt% S						
	S_{NAS}	wt% S						
	S_{POS}	wt% S						
	S_{RAS}	wt% S						
	Sulfide Sulfur	wt% S	0.1	<0.1	<0.1	0.2	<0.1	<0.1
	Pyrite (equiv.)	wt%	0.1	-	-	0.4	-	-
	Readily soluble non-acid storing Sulfate-S	wt% S						
	Gypsum (equiv.)	wt%						
	Readily soluble acid storing Sulfate-S	wt% S						
	Melanterite (equiv.)	wt%						
	Sparingly soluble acid storing Sulfate-S	wt% S						
	Jarosite (equiv.)	wt%						
Acidity	pH_{KCl}	pH units						
	pH_{ox}	pH units						
	TAA	mol H^+ / tonne						
	TPA	mol H^+ / tonne						
	TSA	mol H^+ / tonne						
	Potential Acidity	mol H^+ / tonne	42.4	0.0	0.0	137.2	0.0	0.0
	Actual Acidity	mol H^+ / tonne						
	Retained Acidity	mol H^+ / tonne						
	Net Acidity	mol H^+ / tonne						
Carbon	C_{TOT}	wt% C	0.3	0.3	0.2	0.7	0.8	0.1
	C_{TO}	wt% C						
	C_{IN}	wt% C	0.3	0.2	0.1	0.7	0.7	0.0
Calcium Carbonate	ANC_E (SPOCAS)	% $CaCO_3$						
	$CaCO_3$ based on ANC	% $CaCO_3$	1.2	0.8	0.6	3.8	4.2	0.2
	$CaCO_3$ based on C_{TOT}	% $CaCO_3$	2.3	2.2	1.2	6.1	6.3	0.4
	$CaCO_3$ based on C_{IN}	% $CaCO_3$	2.3	1.8	1.0	5.8	6.1	0.2
Assessment	Additional Potential Risks		Not assessed	Not assessed	Not assessed	Potential for NMD / Unlikely to Generate SD	Not assessed	Not assessed
	Details [a]		3, 10, 18, 23, 43, 75	3, 10, 18, 23, 43, 75	3, 10, 18, 23, 43, 75	3, 9, 19,24, 43, 99, [IF NAG4.5 / NAG7.0 <<1 then see 140,141,142]	3, 10, 18, 23, 43, 75	3, 10, 18, 23, 43, 75
	Recommendations [b]		3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	30, 30.1, 30.3, 30.4, 62	3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88	3, 10, 10.3, 17, 17.7, 17.2, 54, 67, 88

[a,b] See Section-H for detailed descriptions of Classification and Assessment notes.

NAF / 0.5	NAF Safety Factor Warning ANC/MPA < 1
NAF / 2.1	NAF Safety Factor Warning 1 < ANC/MPA < 3

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Statistic	Paste pH	Total Sulfur	Chromium Reducible Sulfur	Max. Potential Acidity	Acid Neutralising Capacity		Net Acid Production Potential	ANC / MPA Ratio	Net Acid Generation				Neutral Meatlliferous Drainage / Metal Leachate Potential		Sulfide sulfur	Sparingly soluble acid forming sulfate sulfur	Readily soluble acid forming sulfate sulfur	Readily soluble non-acid forming sulfate sulfur
		S_{Total}	S_{Cr}	MPA	ANC		NAPP		pH (OX)	NAG (pH 4.5)	NAG (pH 7.0)	NAG (pH 9.5)	NAG7.0 - NAG4.5 [1]	NAG9.5 - NAG7.0 [2]				
	pH units	%	%	kg H_2SO_4/tonne	kg H_2SO_4 equiv./tonne	% $CaCO_3$	kg H_2SO_4/tonne	-	pH units	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	kg H_2SO_4/tonne	%	%	%	%
Laminated Tuff (3 Samples)																		
n=	-	3	3	3	3	3	3	3	1	1	1	-	1	-	3	-	-	-
Minimum		0.02	<0.1	0.6	34.0	3.5	-39.5	3.2	8.7	<0.5	<0.5				<0.1			
Average		0.15	0.11	4.6	37.3	3.8	-32.7	28.5	8.7	0.3	0.3				0.1			
Median		0.05	<0.1	1.5	37.0	3.8	-33.4	26.8	8.7	<0.5	<0.5				<0.1			
Maximum		0.38	0.22	11.6	41.0	4.2	-25.4	55.6	8.7						0.2			
Volcanic Breccia (12 Samples)																		
n=	-	12	12	12	12	12	12	12	8	8	8	-	8	-	12	-	-	-
Minimum		0.02	<0.1	0.6	2.0	0.2	-49.7	0.4	4.0	<0.5	<0.5		0.0		<0.1			
Average		0.23	0.13	7.0	17.5	1.8	-10.5	3.3	7.1	0.3	0.7		0.6		0.1			
Median		0.24	0.12	7.3	11.0	1.1	-4.4	2.9	7.7	<0.5	<0.5		0.0		0.1			
Maximum		0.57	0.34	17.4	58.0	5.9	6.5	9.5	9.1		2.9		2.9		0.3			
Ignimbrite (1 Sample)																		
n=	-	1	1	1	1	1	1	1	-	-	-	-	-	-	1	-	-	-
Minimum		0.08	<0.1	2.4	2.0	0.2	0.4	0.8							<0.1			
Average		0.08	0.05	2.4	2.0	0.2	0.4	0.8							<0.1			
Median		0.08	<0.1	2.4	2.0	0.2	0.4	0.8							<0.1			
Maximum		0.08	<0.1	2.4	2.0	0.2	0.4	0.8							<0.1			
TOTAL (16 Samples)																		
n=	-	16	16	16	16	16	16	16	9	9	9	-	9	-	16	-	-	-
Minimum		0.02	<0.1	0.6	2.0	0.2	-49.7	0.4	4.0	<0.5	<0.5		0.0		<0.1			
Average		0.21	0.12	6.3	20.3	0.0	-14.0	7.9	7.2	0.3	0.7		0.5		0.1			
Median		0.18	0.10	5.4	13.5	1.4	-5.8	3.2	4.4	<0.5	<0.5		0.0		0.1			
Maximum		0.57	0.34	17.4	58.0	5.9	6.5	55.6	9.1		2.9		2.9		0.3			

Table F-1: Summary statistics for selected static geochemical parameters. Statistics are shown for all samples and also for sample subsets. Refer to the Glossary of Terms for a description of each static geochemical parameter.

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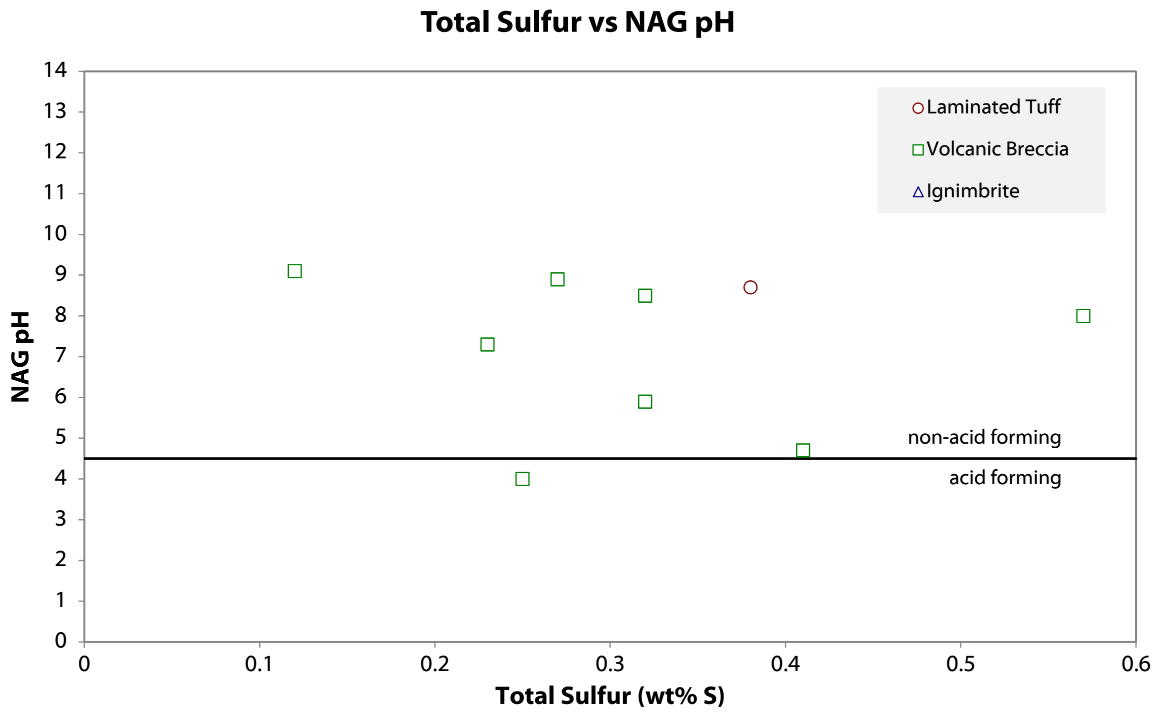

Figure G1: Total sulfur versus Net Acid Generation (NAG) pH after oxidation for all samples. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

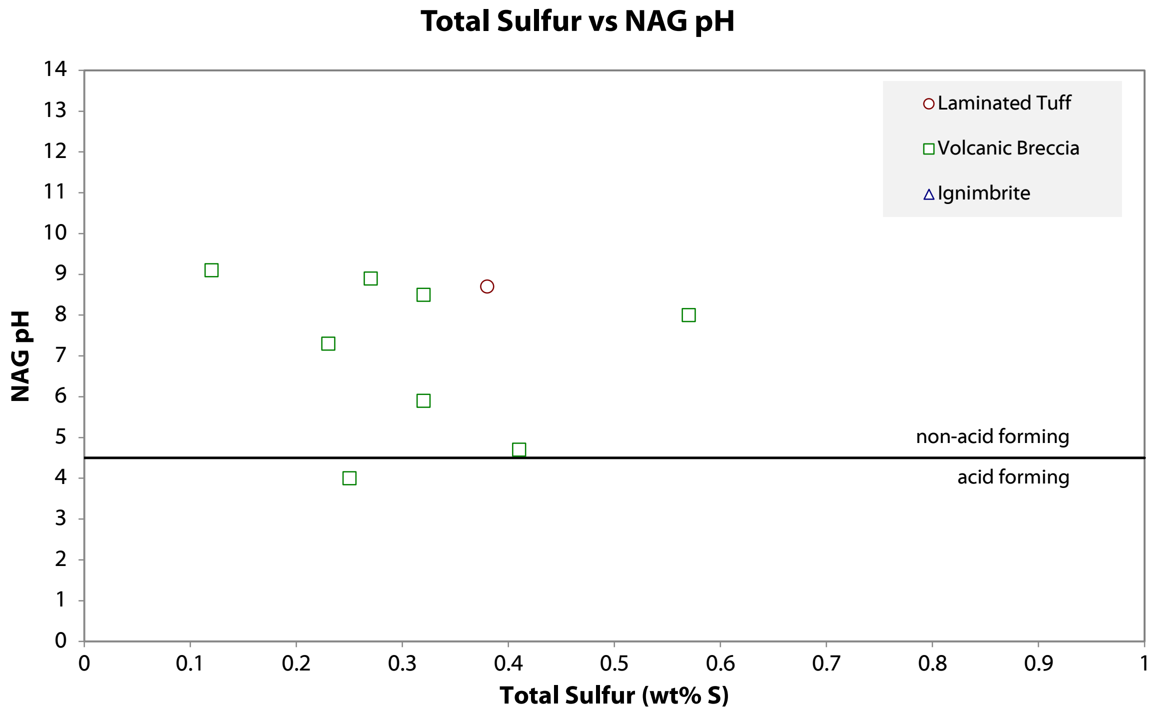

Figure G2: Total sulfur versus Net Acid Generation (NAG) pH after oxidation for samples with Total sulfur values less than 1 wt%. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

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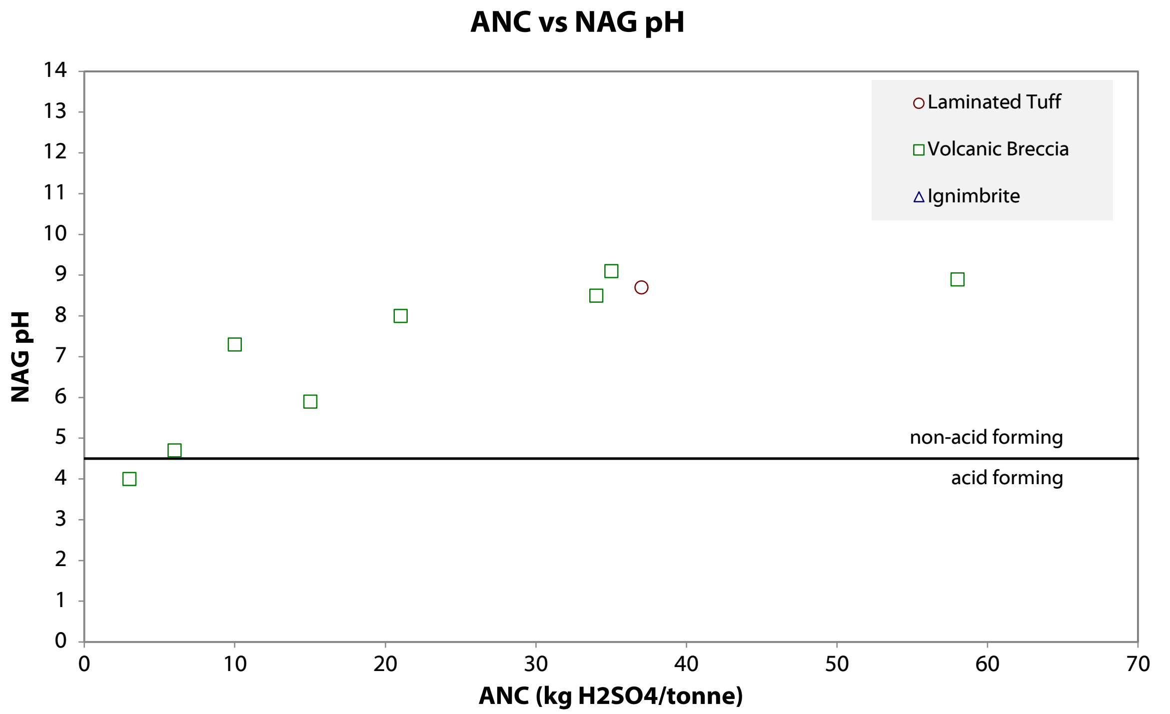

Figure G3: Acid Neutralising Capacity (ANC) versus Net Acid Generation (NAG) pH after oxidation. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

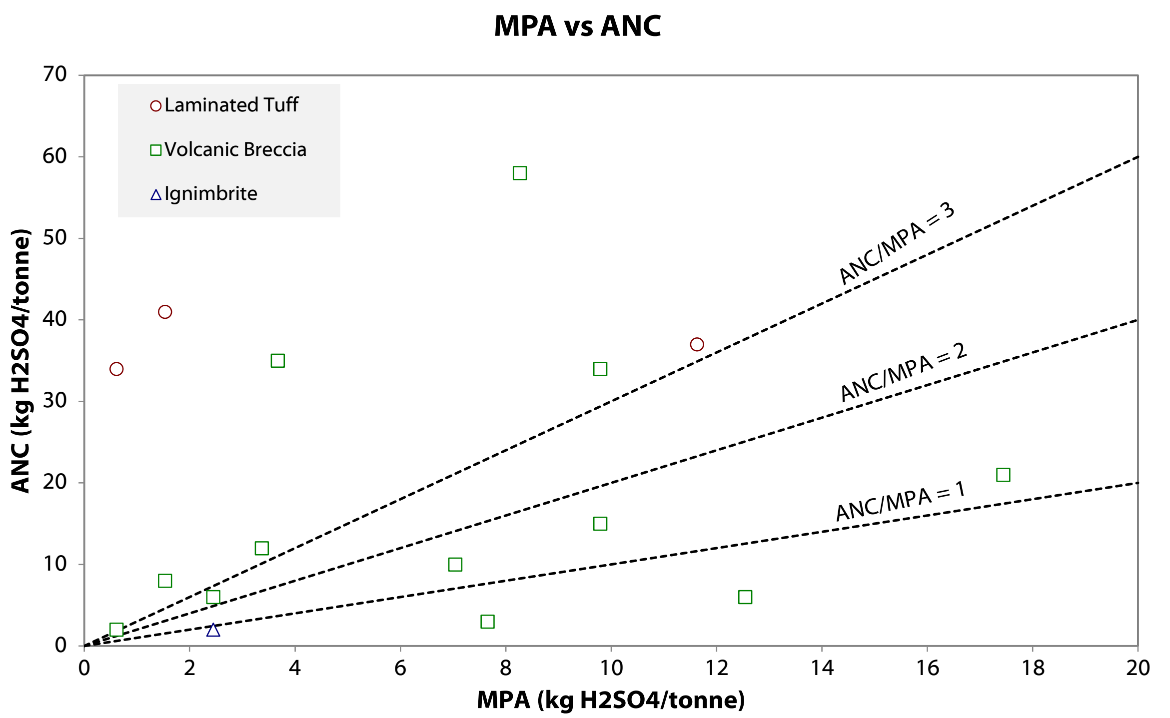

Figure G4: Maximum Potential Acidity (MPA) versus Acid Neutralising Capacity (ANC).

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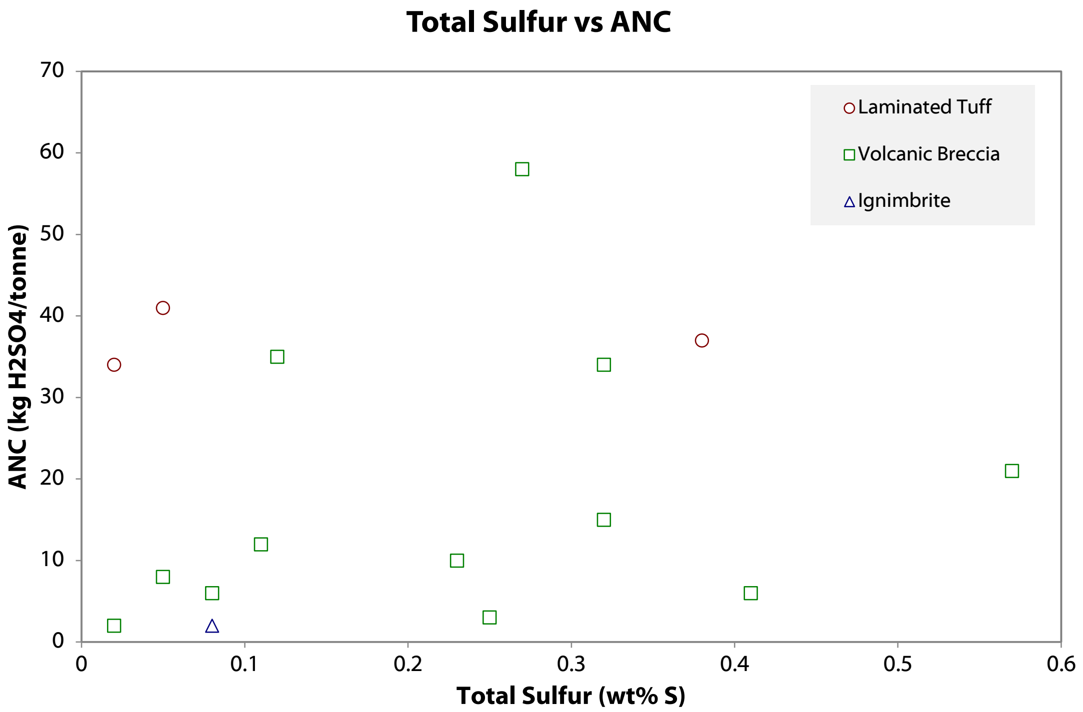

Figure G5: Total sulfur versus Acid Neutralising Capacity (ANC).

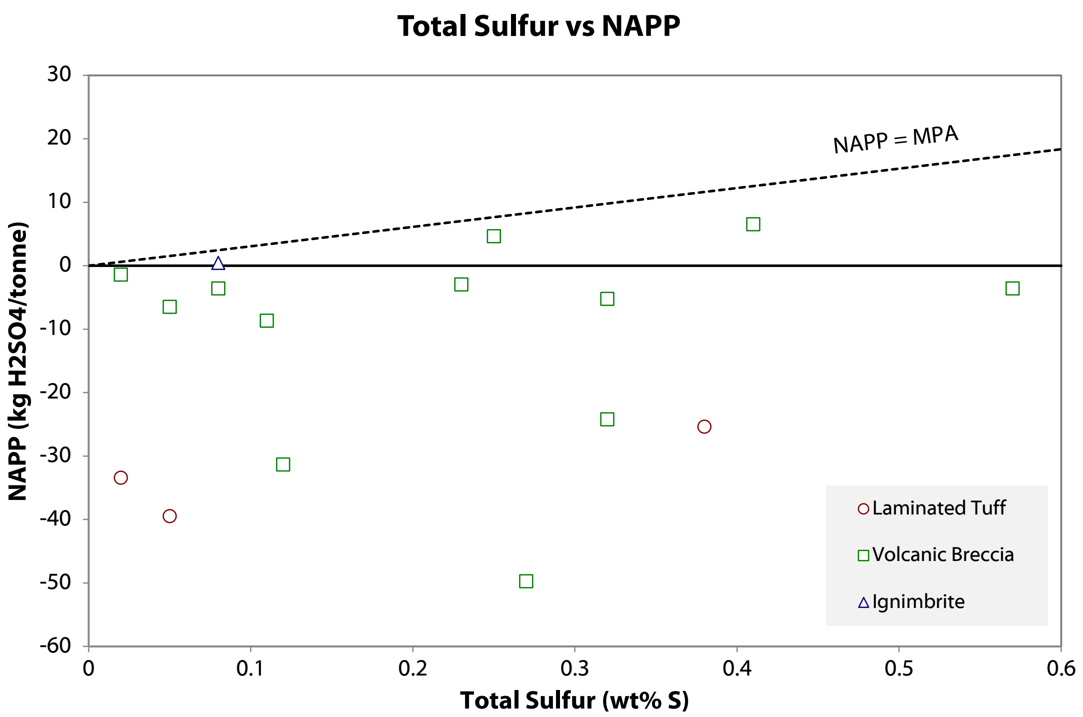

Figure G6: Total sulfur versus Net Acid Producing Potential (NAPP). The line shown at NAPP = 0 separates samples with an excess of Maximum Potential Acidity (MPA) from those with an excess of acid neutralising capacity (ANC). The dashed line identifies where the NAPP = MPA. Samples falling close to this line contain essentially no acid neutralising capacity.

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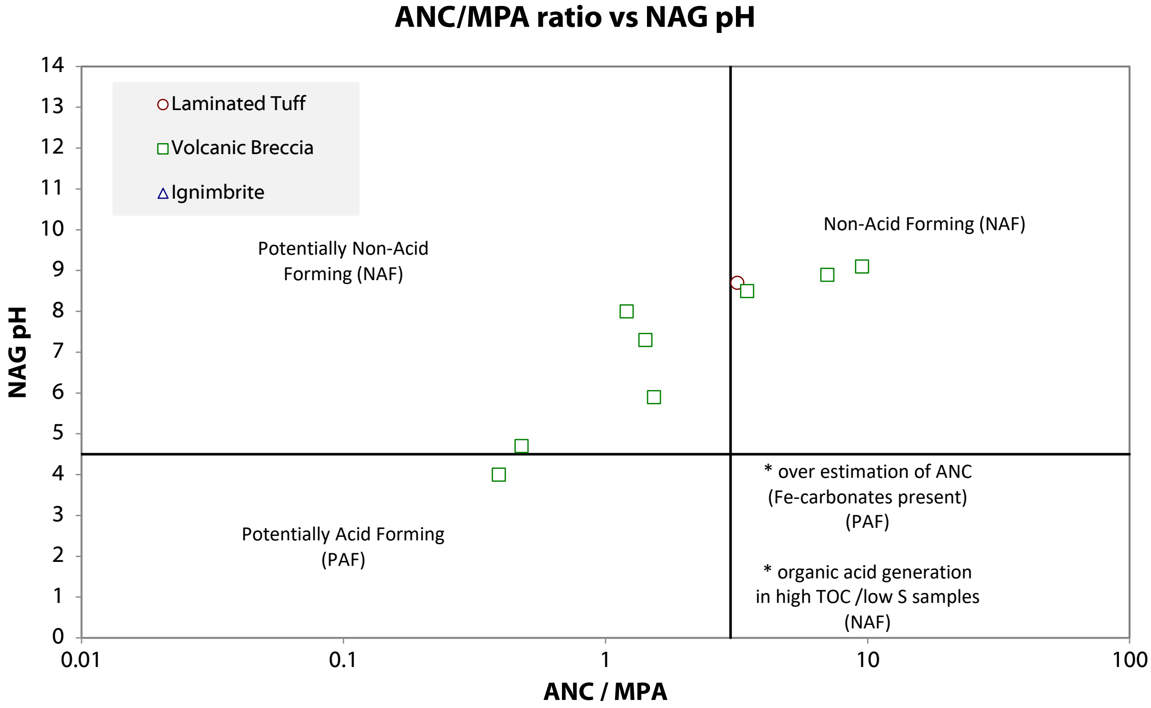


Figure G7: The ratio of Acid Neutralising Capacity to Maximum Potential Acidity (ANC/MPA) versus Net Acid Generation (NAG) pH after oxidation. The vertical line shows where ANC/MPA = 3. ANC/MPA ratios above this will be NAF. The line shown at a NAG pH of 4.5 is the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials.

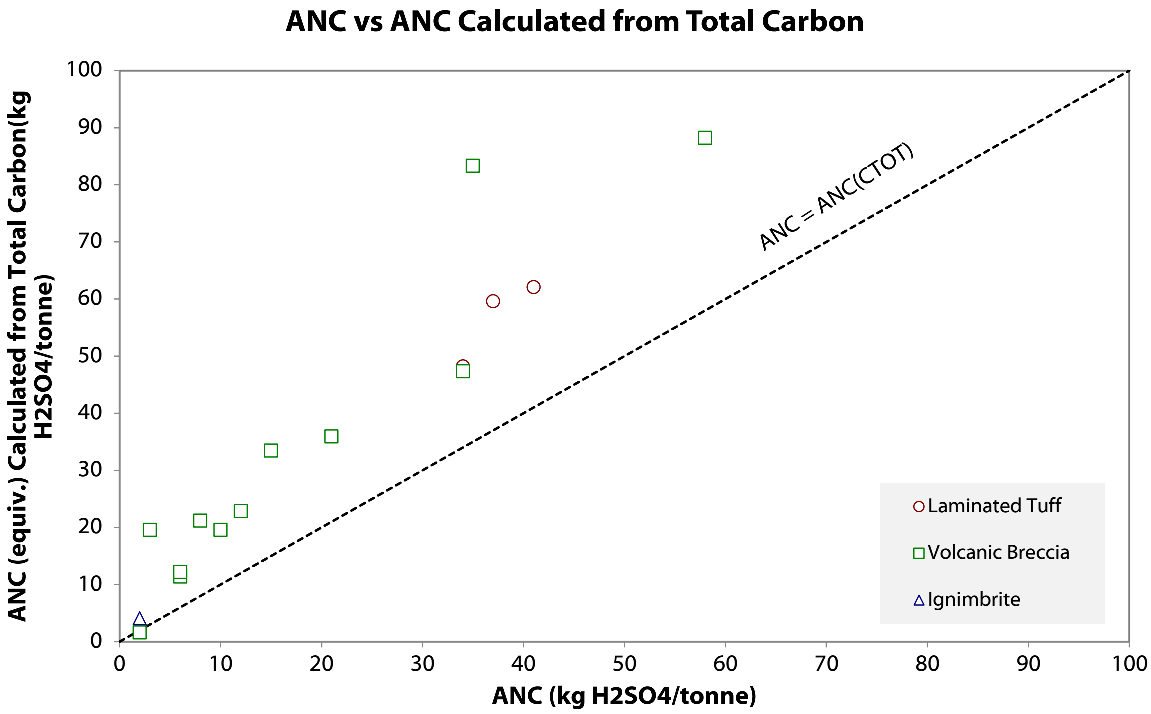


Figure G8: Laboratory measured Acid Neutralising Capacity (ANC) versus calculated ANC based on the laboratory measured Total Carbon. Samples falling above the dotted line suggest the presence of non-carbonate carbon or non-neutralising carbonates in the samples (eg. graphite). Samples falling below the dotted line suggest the presence of non-carbonate neutralising minerals.

Generated using: AMDactv.5.2.8.2

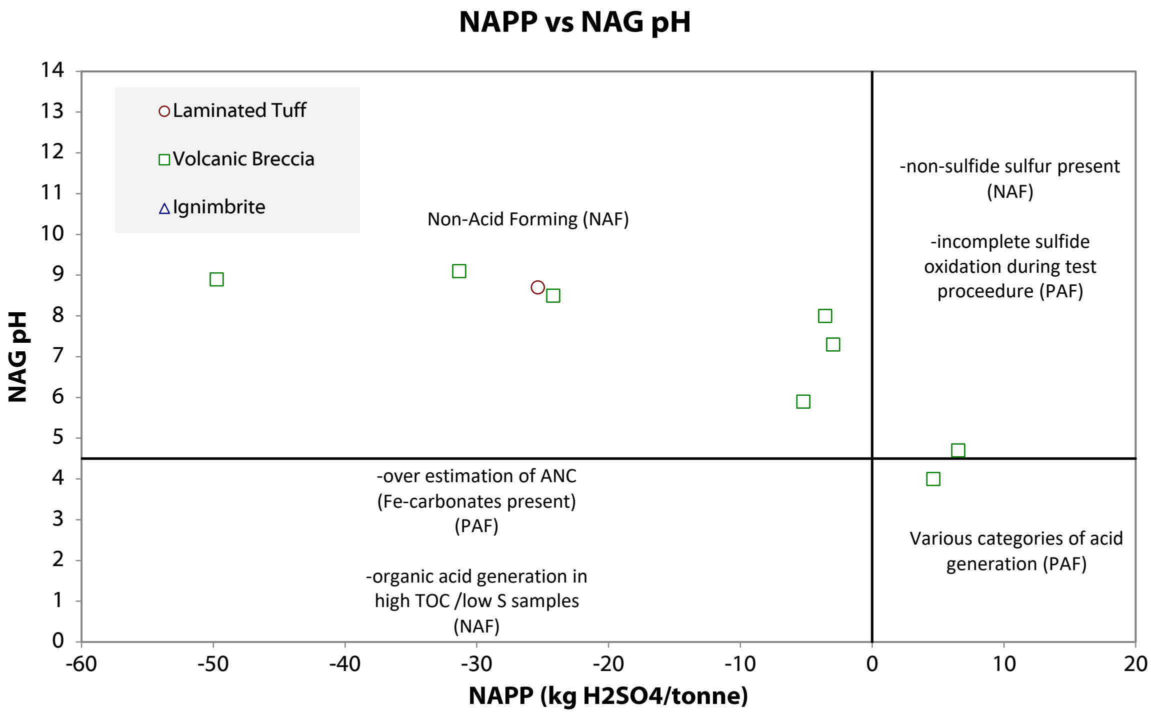


Figure G9: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) pH after oxidation. The line shown at NAG pH of 4.5 identifies the accepted boundary between acid forming materials (NAG pH ≤4.5) and non-acid forming (NAG pH >4.5) materials. Risk classification fields are shown.

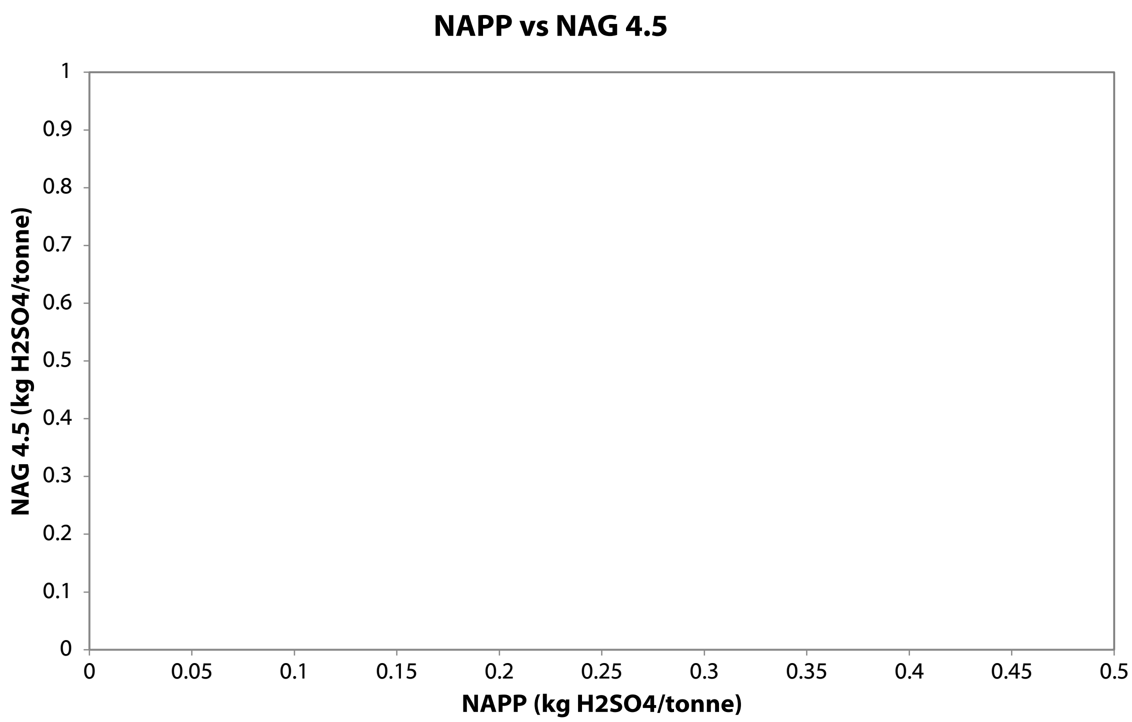


Figure G10: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) to pH 4.5. The line shown at NAPP = 0 separates samples with an excess of Maximum Potential Acidity (MPA) from those with an excess of acid neutralising capacity (ANC). NAG4.5 values >0 indicate an acid generating capacity.

Generated using: AMDactv.5.2.8.2

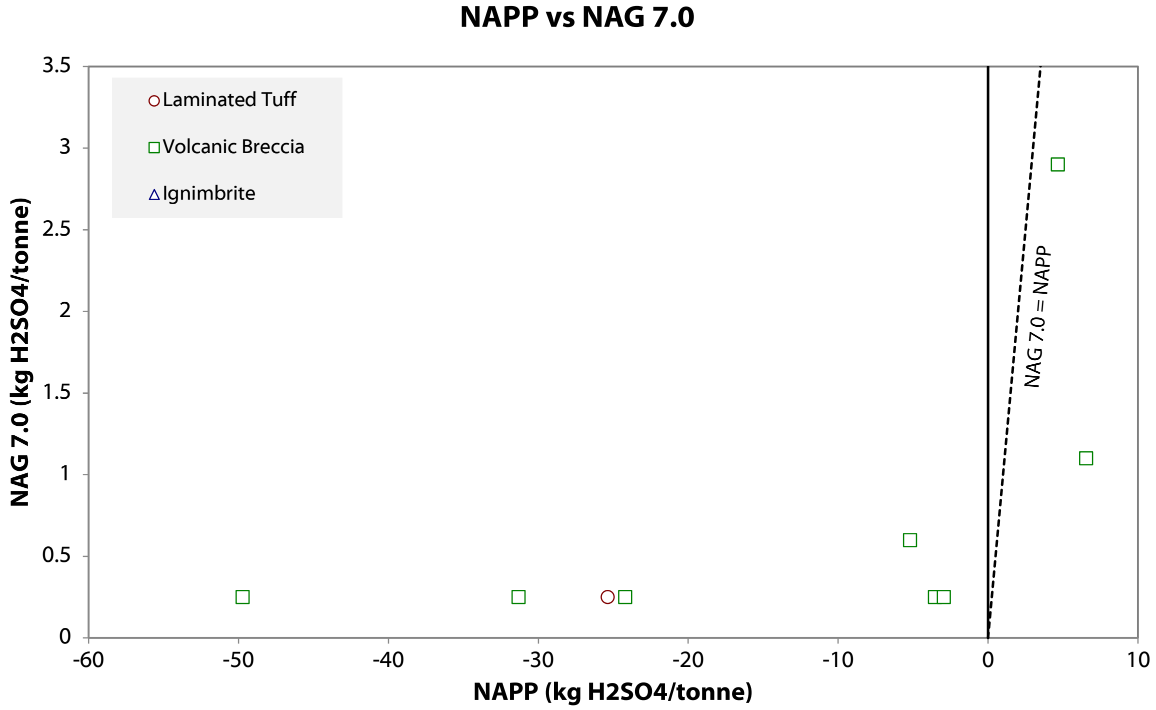


Figure G11: Net Acid Producing Potential (NAPP) versus Net Acid Generation (NAG) to pH 7.0. The line shown at NAPP = 0 separates samples with an excess of MPA from those with an excess of ANC. NAG7.0 values >0 generally indicate an acid generating capacity. Samples below the dashed line could indicate non-acid forming sulfur is present in samples.

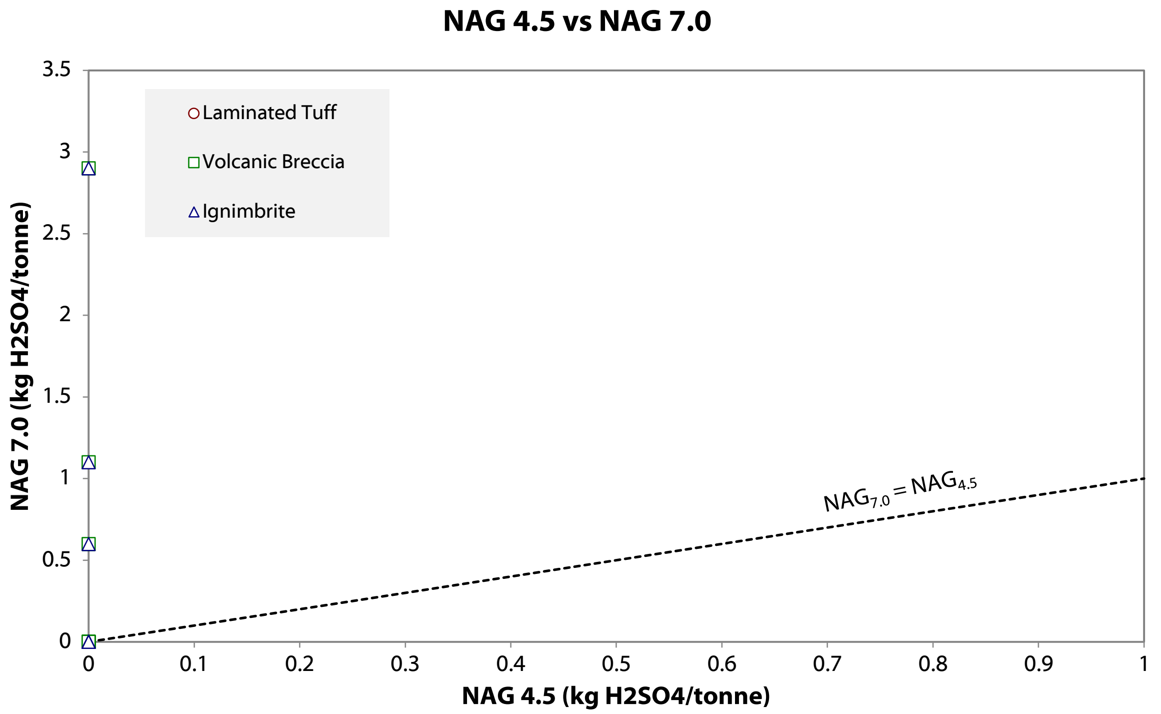


Figure G12: NAG 4.5 versus NAG 7.0. Samples with NAG 4.5 and NAG 7.0 >0 are likely to produce acid and metalliferous drainage. Samples with NAG 4.5 =0 but NAG 7.0 >0 are likely to produce neutral metalliferous drainage. Samples should not fall below the line.

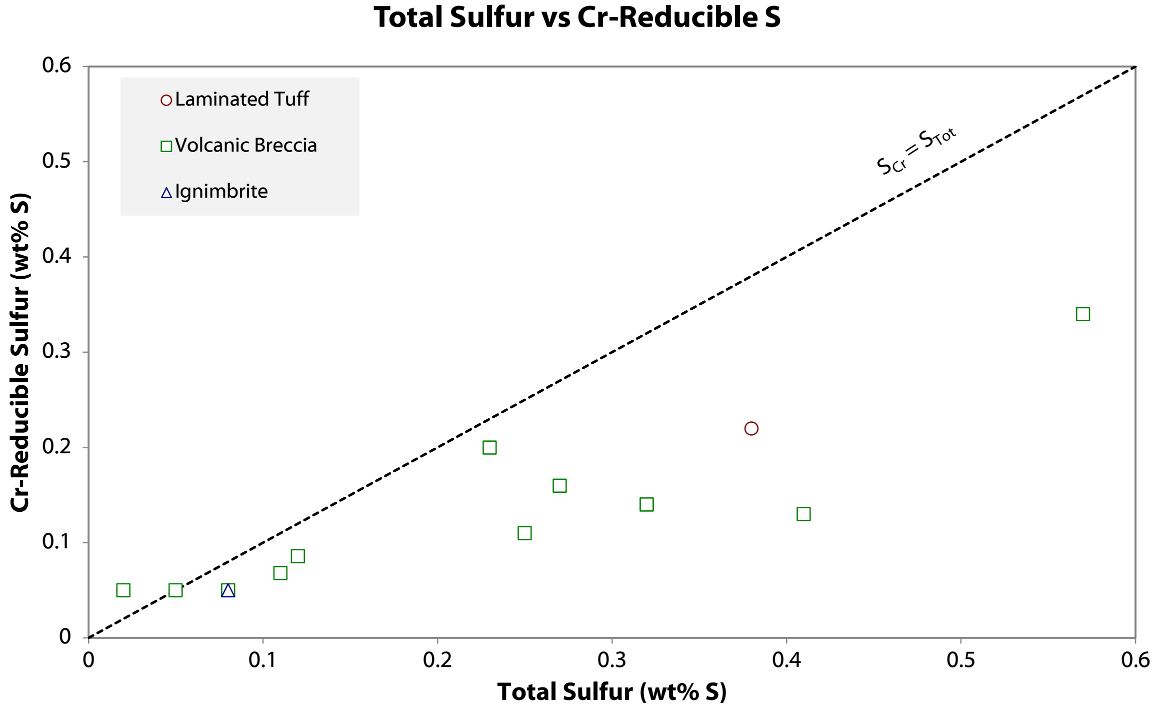


Figure G13: Total Sulfur versus chromium reducible sulfur (S-Cr). S-Cr is a laboratory measure of the sulfur within a sample that is present in sulfide minerals. The dashed line on the plot represents the case where the sulfide sulfur (S-Cr) is equal to the total sulfur in the sample. Samples plotting below the line contain at least some sulfur not in the form of sulfide minerals.

Generated using: AMDactv.5.2.8.2

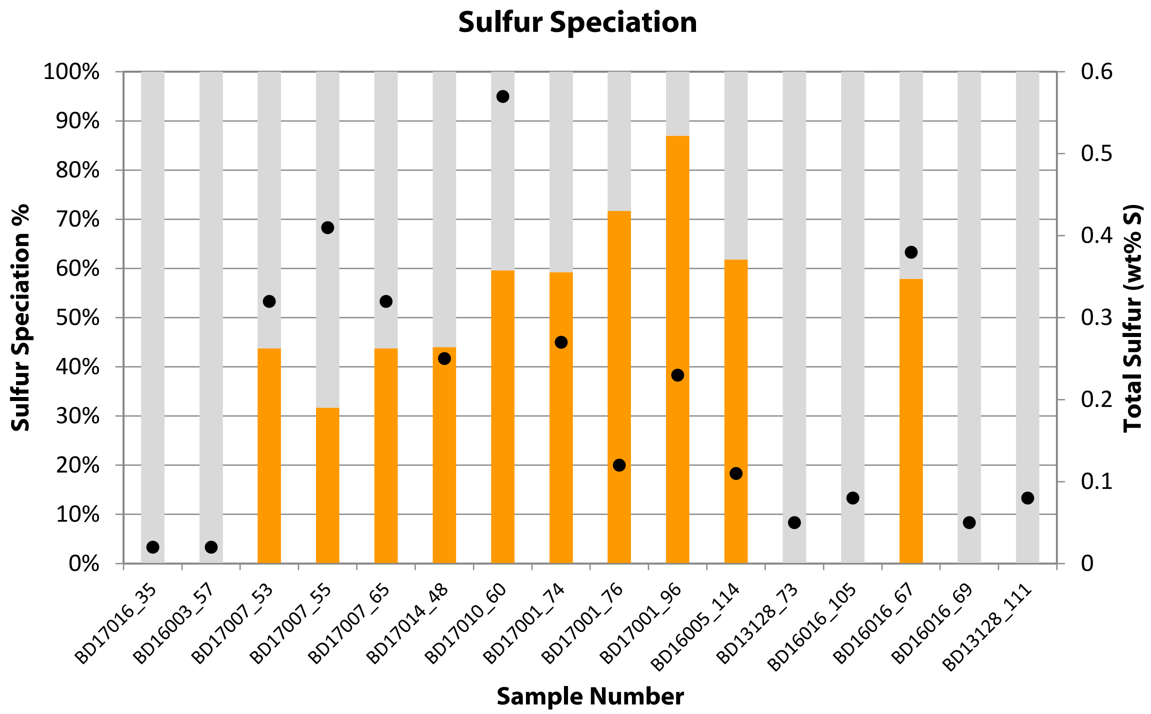
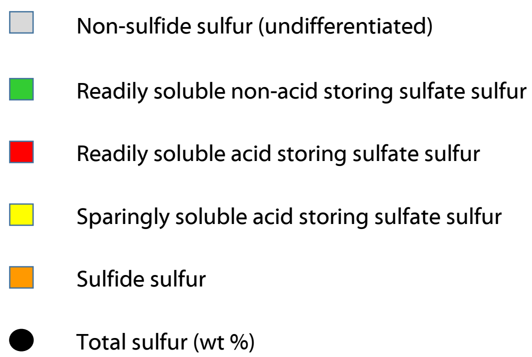


Figure H1: Chart showing the relative proportion of the various forms of sulfur within each sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Legend for ALL Sulfur Speciation charts



Generated using: AMDactv.5.2.8.2

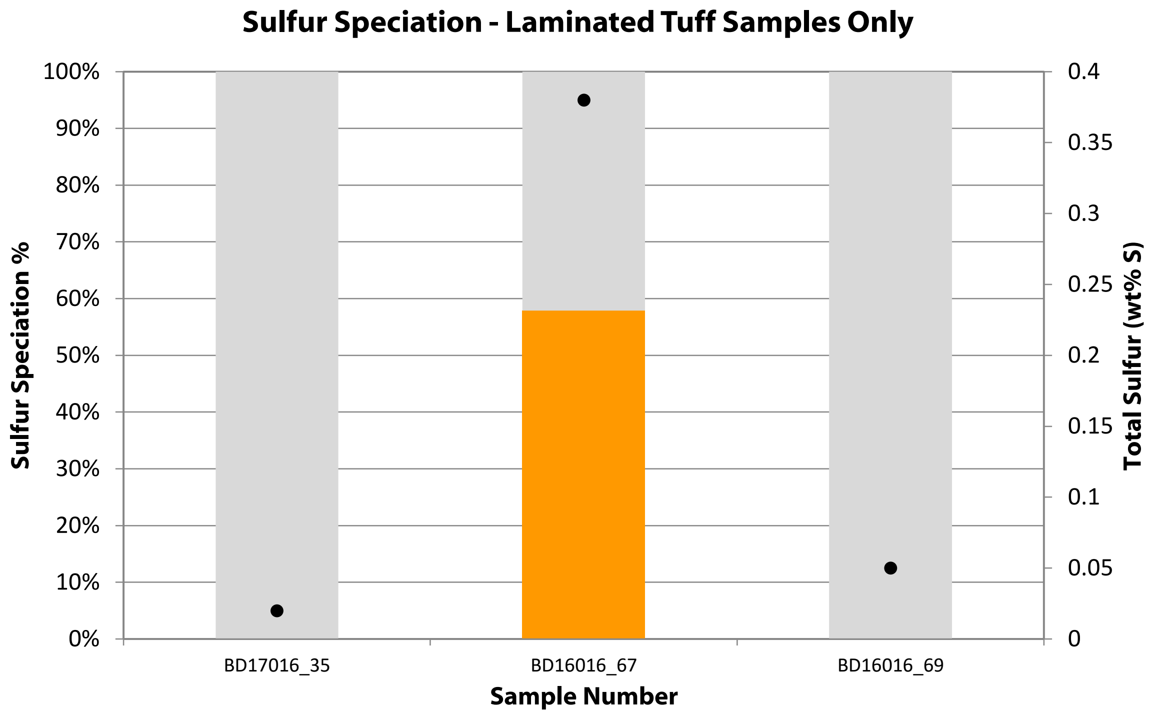


Figure H2: Chart showing the relative proportion of the various forms of sulfur within each Laminated Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

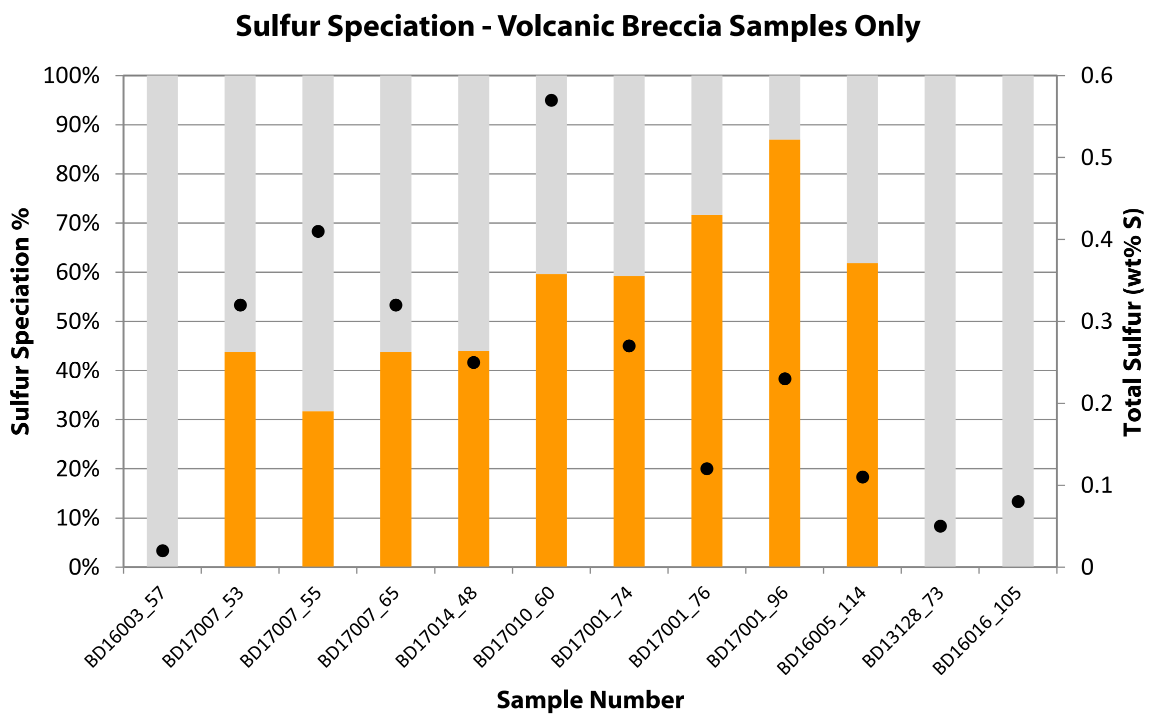


Figure H3: Chart showing the relative proportion of the various forms of sulfur within each Volcanic Breccia sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

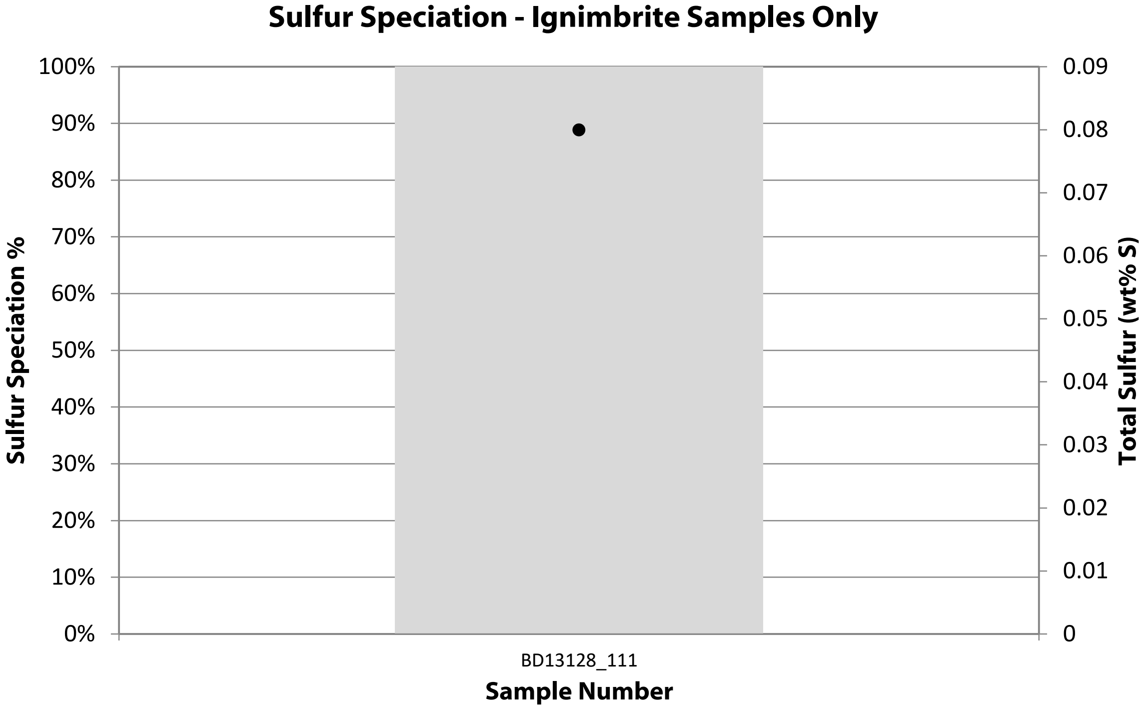


Figure H4: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

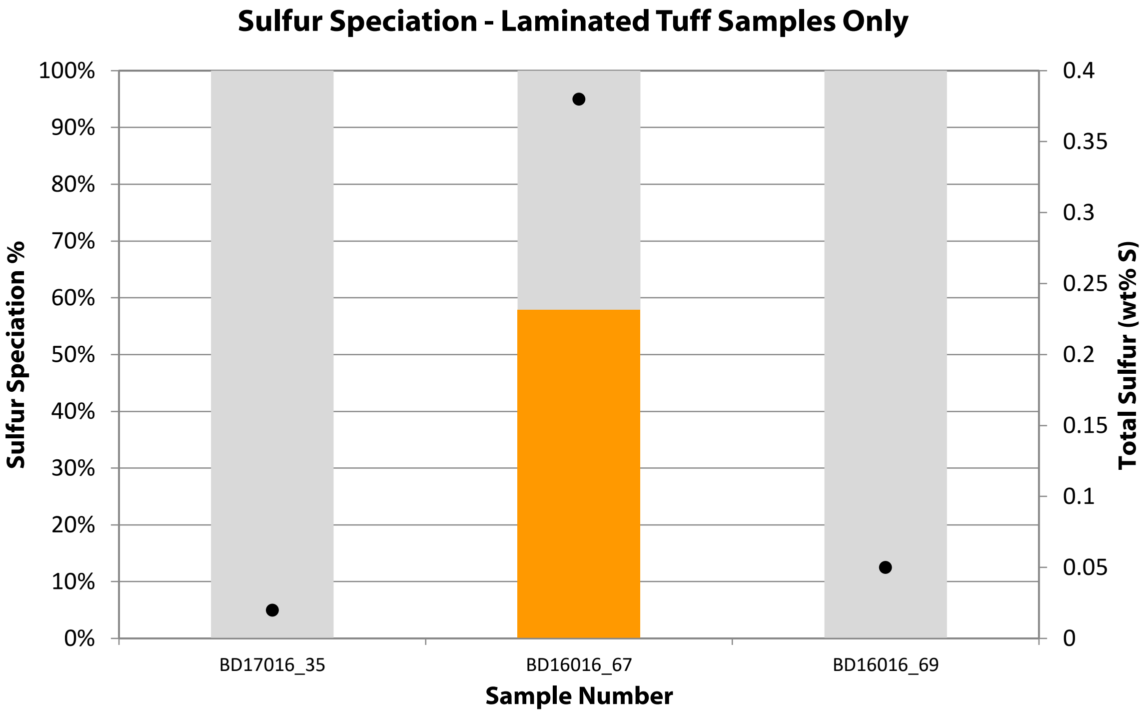


Figure H5: Chart showing the relative proportion of the various forms of sulfur within each Laminated Tuff sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

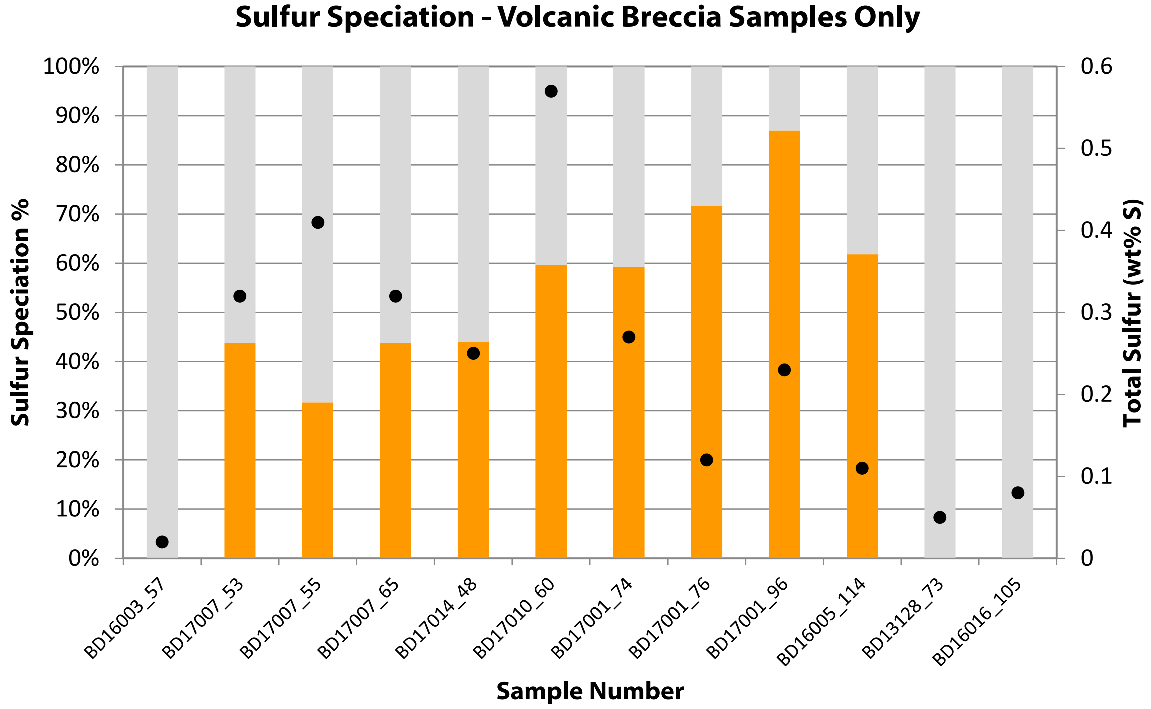


Figure H6: Chart showing the relative proportion of the various forms of sulfur within each Volcanic Breccia sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

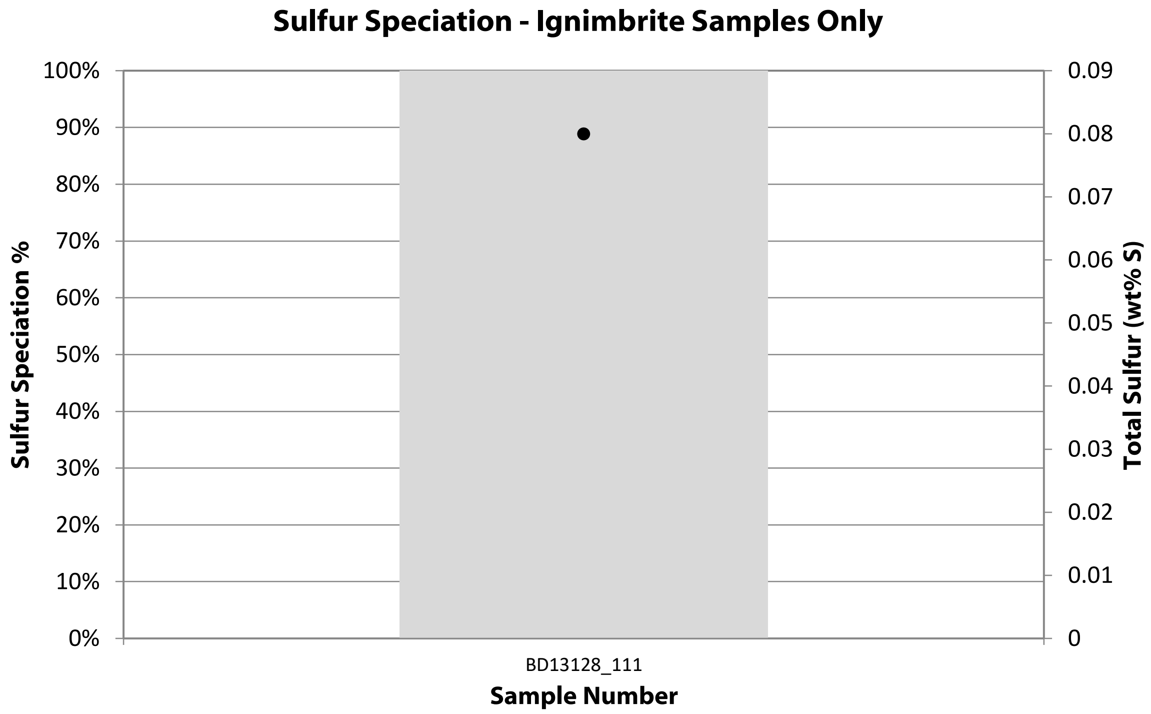


Figure H7: Chart showing the relative proportion of the various forms of sulfur within each Ignimbrite sample, normalised to the sample's total sulfur content (left axis). The corresponding total sulfur for each sample is shown as a black circle (right axis). The legend is shown below Figure H1.

Generated using: AMDactv.5.2.8.2

ASSESSMENT COMMENTS

CODE	EXPLANATION
	Drainage Characteristics
1	Material expected to produce Acid & Metalliferous Drainage
2	Material may potentially produce Acid & Metalliferous Drainage
3	Material unlikely to produce Acid & Metalliferous Drainage
4	Material NOT expected produce Acid & Metalliferous Drainage
5	Material expected to produce metalliferous, near neutral pH drainage
6	Material expected to produce alkaline, non-metalliferous drainage
7	Material expected to produce acid drainage
8	Material expected to produce drainage with low pH
9	Material expected to produce drainage with low to near neutral pH (slightly acidic)
10	Material expected to produce drainage with near neutral pH
11	Material expected to produce drainage with alkaline pH (may need confirmation)
12	Material unlikely to produce acid drainage
13	Material NOT expected to produce acid drainage
14	Material expected to produce drainage containing dissolved metals
15	Material expected to produce drainage with high levels of dissolved metals
16	Material expected to produce drainage with moderate levels of dissolved metals
17	Material expected to produce drainage with low levels of dissolved metals
18	Material may produce drainage with low levels of dissolved metals
19	Material expected to produce drainage with no or low levels of dissolved metals
20	Metalliferous drainage cannot be excluded
21	Material NOT expected to produce drainage with metal acidity
22	For high S and high ANC / NP, drainage might contain high level of Mn and other metals (depending on mineralisation)
23	Leachate characteristics need to be confirmed
24	Leachate composition unknown
	Management Options
41	Material likely to require special AMD management & handling to limit oxidation
42	Material may require special AMD management & handling to limit oxidation
43	Material unlikely to require special AMD management & handling
	NAPP / NNP Characteristics
60	NAPP / NNP results indicate net acid producing potential
61	NAPP / NNP results indicate net acid consumption
62	NAPP / NNP possibly overestimated
63	NAPP / NNP possibly be overestimated (sulphides other than pyrite present, or non sulphide sulphur e.g. gypsum or other sulphates)
64	MPA / AP could be overestimated (pyrite is not the main sulphide)
65	NAPP / NNP likely to be underestimated (ANC / NP overestimated or not readily available for neutralisation)

ASSESSMENT COMMENTS

CODE	EXPLANATION
66	NAPP / NNP potentially underestimated (ANC / NP potentially overestimated, or not readily available for neutralisation)
67	NAPP / NNP suggests excess acid neutralising capacity; NAG suggest net acid generating capacity
68	NAPP / NNP suggests net acid generation but NAGpH suggests no acid production
69	NAPP / NNP suggests net acid generation but NAGpH suggests potentially no acid production
70	NAPP / NNP indicates excess acid neutralising capacity; NAGpH indicates high acid generation capacity
71	NAPP / NNP indicates excess acid neutralising capacity; NAGpH indicates net acid generating capacity
72	NAPP / NNP indicates likelihood of excess acid neutralisation capacity; NAGpH indicates net acid generation capacity
73	Inconsistency between NAPP / NNP and NAG results
74	Inconsistency between NAPP / NNP and NAGpH results
75	NAPP / NNP to be confirmed with further test work
	NAG Characteristics
90	Net acid generation capacity needs to be quantified
91	NAG results lower than expected based on NAPP / NNP value
92	NAG underestimated (incomplete oxidation of sample during test)
93	NAG value might be overestimated (e.g. excess organic C)
94	NAGpH needed
95	NAGpH results too high to be reliable / representative
96	NAGpH higher than expected based on NAPP / NNP value
97	NAGpH higher than expected (possible incomplete oxidation of sample during test, for S > 1 wt %)
98	NAGpH lower than expected based on NAPP / NNP results
99	NAGpH likely to reflect potential drainage pH
100	NAGpH unlikely to reflect potential drainage pH
101	NAG4.5 value higher than expected based on NAPP / NNP results
102	NAG7 value higher than expected based on NAPP / NNP results
103	NAG7 value lower than expected based on NAPP / NNP results
104	Net acid generation potential at pH 7 (NAG7.0), unknown
105	Net acid generating capacity at pH 7 (NAG7.0) potentially underestimated
106	NAGpH and NAG4.5 might reflect contribution of organic acids (e.g. excess organic C)
107	NAGpH and NAG7 might reflect contribution of organic acids (e.g. excess organic C)
108	NAGpH and NAG values might reflect contribution of organic acids (e.g. excess organic C)
109	NAG results indicate contribution of metal acidity to total acid load
110	NAGpH and NAG7 indicate possible effects of metal acidity
111	If Sulphur > 1 wt%, NAGpH likely to be overestimated (incomplete oxidation of sulphides)
112	If Sulphur > 1 wt%, NAG likely to be underestimated (incomplete oxidation of sulphides)

ASSESSMENT COMMENTS

CODE	EXPLANATION
140	Possible contribution of metals other than Fe to total acidity
141	Non-pyritic sulphide minerals might be important
142	Specific metal acidity issues likely
	ANC / NP Characteristics
150	ANC / NP required to evaluate acid consuming potential
151	ANC / NP insufficient to neutralise acid generated
152	ANC / NP likely to be insufficient to neutralise acid generated
153	ANC / NP may be available for acid neutralisation
154	Excess ANC / NP available
155	Material could potentially be used for acid neutralisation
	Additional Test work Requirements
170	Further test work required
171	Further test work required to clarify NAG_{pH}
172	Further tests needed to clarify discrepancy between NAPP / NNP and NAGpH results
173	High S content requires further tests to confirm NAPP / NNP prediction of net acid consumption
	Other
200	Insufficient data to classify sample
201	Insufficient data to further classify sample
202	Classification is tentative and needs to be confirmed
203	Classification needs further confirmation
204	Data can have multiple interpretations
205	Rate of acid generation (Oxidation rate) unknown
206	Rate of acid generation (Oxidation rate) and neutralisation rate unknown
207	Amount of acid likely to be generated, unknown

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
1	AMD potential should be considered in mine planning
2	AMD potential might need to be considered in mine planning
3	AMD potential unlikely to be a concern
10	Select a sample suite representative of waste rock / tailings (on same samples as NAPP / NNP test work):
10.1	Determine ANC / NP
10.2	Calculate NAPP / NNP
10.3	Conduct NAGpH test (same samples as NAPP / NNP)
10.4	Conduct NAG4.5 test (same samples as NAPP / NNP)
10.5	Conduct NAG7.0 test (same samples as NAPP / NNP)
10.6	Determine Total Sulfur / MPA / AP
11	Repeat ANC / NP test using modified protocol to ensure full oxidation of Fe^{2+}
12	On same samples as NAG tests:
12.1	Determine ANC / NP
12.2	Calculate NAPP / NNP
12.3	Determine NAGpH
12.4	Determine Total Sulfur / MPA / AP
13	On same samples as NAGpH test:
13.1	Determine ANC / NP
13.2	Calculate NAPP / NNP
13.3	Determine Total Sulfur / MPA / AP
14	On same samples as NAG4.5 tests:
14.1	Determine ANC / NP
14.2	Calculate NAPP / NNP
14.3	Conduct NAGpH test
14.4	Determine Total Sulfur / MPA / AP
15	If NAGpH < 5, Kinetic testwork (eg. oxygen consumption test) should be established to:
15.1	Define leachate composition
15.2	Evaluate oxidation and neutralisation rates
15.3	Constrain sample behaviour under normal weathering conditions
16	If NAGpH < 6, Kinetic testwork (eg. oxygen consumption tests) should be established to:
16.1	Define leachate composition
16.2	Evaluate oxidation and neutralisation rates
16.3	Constrain sample behaviour under normal weathering conditions
17	If NAGpH < 7 use the same sample to:
17.1	Conduct a NAG4.5 test
17.2	Conduct a NAG7.0 test
17.3	Conduct a NAG9.5 test
18	If NAGpH < 9.5 use the same sample to:
18.1	Conduct a NAG4.5 test
18.2	Conduct a NAG7.0 test
18.3	Conduct a NAG9.5 test
20	If NAG tests is repeated, ensure H_2O_2 is not all consumed before end of oxidation
21	Analyse NAG liquor to determine metal concentrations
22	Analyse NAGpH liquor for presence of Mn and main metals
23	If majority of samples show similar high NAGpH values, sequential NAG tests are recommended
24	Consider conducting sequential NAG tests
25	Sequential NAG tests might be needed to confirm NAGpH
26	If NAPP / NNP result is confirmed, consider kinetic testwork (eg. oxygen consumption tests)

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
30	Kinetic testwork (eg. Oxygen consumption tests) should be established to:
30.1	Define leachate composition
30.2	Quantify metal acidity contribution to drainage acidity
30.3	Evaluate oxidation and neutralisation rates
30.4	Constrain sample behaviour under normal weathering conditions
35	Define Acid Buffering Characteristic curve
40	Evaluate TOC content.
40.1	If TOC < 7%, repeat ANC / NP test using modified protocol to ensure full oxidation of Fe^{2+}
40.2	If TOC < 7%, conduct NAGpH tests (same NAPP / NNP samples)
40.3	If TOC < 7%, conduct NAG7.0 tests (same NAPP / NNP samples)
50	Use lithological and mineralogical data to interpret results
51	Use lithological and mineralogical data to support results
52	Refer to lithological and mineralogical data to assist with sample classification
53	Use mineralogical data to confirm MPA / AP
54	Use mineralogical data to interpret NAPP / NNP results
55	Use mineralogical / lithological data to interpret NAPP / NNP results and identify likely metals in drainage
56	Use sulphide mineralogy to establish identity of potential metals in leachate
57	Use sulphide mineralogy to assist interpretation of results
58	Define sulphide mineralogy
58.1	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
59	Use mineralogy to assist interpretation of results (sulphides and sulphate)
60	Quantify presence of sulphates
61	Define carbonate mineralogy
62	Carbonate and sulphide mineralogy should be used to support tests results
63	Define carbonate mineralogy to confirm NAPP / NNP results
64	Use carbonate mineralogy to assist interpretation of results
65	Define distribution of carbonate within lithology (e.g. veins, pockets, disseminated)
66	Evaluate distribution of carbonate within lithology (e.g. veins, pockets, disseminated)
67	Reclassify samples using new data
68	Use NAPP / NNP value to classify sample
69	Use NAPP / NNP value to reclassify sample
70	Use NAPP / NNP classification for indicative characterisation
71	Calculate NAPP / NNP using mineralogical data (ABATES)
72	Use NAPP / NNP value to classify sample, NAGpH too high to be representative
73	Unless majority of samples show similar NAGpH values, disregard data
74	If only few samples show similar high NAGpH values, use NAPP / NNP value to classify sample
75	NAGpH value is unlikely to be reliable
80	Confirm NAPP / NNP result:
80.1	Determine NAGpH
80.2	If NAPP / NNP value is confirmed, conduct sequential NAG tests
80.3	Define sulphide mineralogy
80.4	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
80.5	Confirm absence of gypsum or other sulphates in sample
80.6	Analyse for S from Sulphide minerals only
80.7	Recalculate NAPP / NNP using Sulphur from Sulphide value
80.8	Define carbonate mineralogy

ASSESSMENT RECOMMENDATIONS

CODE	EXPLANATION
82	Resolve discrepancy between NAG and NAPP / NNP values:
82.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
82.2	Define sulphide mineralogy
82.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
82.4	Confirm absence of gypsum or other sulphates in sample
82.5	Analyse for S from Sulphide minerals only
82.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
83	Confirm NAG and NAPP / NNP values
83.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
83.2	Define sulphide mineralogy
83.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
83.4	Confirm absence of gypsum or other sulphates in sample
83.5	Analyse for S from Sulphide minerals only
83.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
83.7	Determine NAGpH
84	Confirm NAGpH and NAPP / NNP values:
84.1	If NAPP / NNP value is confirmed, conduct sequential NAG tests
84.2	Define sulphide mineralogy
84.3	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
84.4	Confirm absence of gypsum or other sulphates in sample
84.5	Analyse for S from Sulphide minerals only
84.6	Recalculate NAPP / NNP using Sulphur from Sulphide value
84.7	Define carbonate mineralogy
86	Resolve discrepancy between NAGpH and NAPP / NNP value:
86.1	Determine NAGpH
86.2	If NAPP / NNP value is confirmed, conduct sequential NAG tests
86.3	Define sulphide mineralogy
86.4	If main sulphide is not pyrite, revaluate MPA / AP using mineralogical data (ABATES)
86.5	Confirm absence of gypsum or other sulphates in sample
86.6	Analyse for S from Sulphide minerals only
86.7	Recalculate NAPP / NNP using Sulphur from Sulphide value
88	If classification is confirmed, UAG samples most likely will not require special handling
90	If material is to be used as a neutralising agent:
90.1	Determine carbonate dissolution rates
90.2	Determine leachate composition
100	No further action required

GLOSSARY

SAMPLE DETAILS

Sample type: This represents the primary sample type desired by the client, generally representing various mine materials (eg. ore, waste rock and tailings). This term may also represent any differentiating characteristic of the rock that may be provided by the client (including lithology).
Sample sub-type: Generally, this represents the sample lithology provided. This term may also represent any differentiating characteristic of the rock that may be provided by the client (eg. deposit name, mine zone / spatial delineation, flood plain sample, location etc.).
General classification: The simplified classification of a sample's potential AMD risk, based on the static geochemical parameters provided. PAF samples represent the total number of samples classified as potentially acid generating. NAF samples represent the total number of samples classified as non-acid forming.
Detailed classification: The classification of a sample's potential AMD risk, based on the static geochemical parameters provided. Detailed classification categories from highest to lowest acid generating risk are High Potential for Acid generation; Moderate / High Potential for Acid Generation; Moderate Potential for Acid Generation; Low Potential for Acid Generation; Unlikely to be Acid Generating; Likely to be Acid Consuming. Samples with insufficient data or have data providing conflicting risk classifications are not classified.

STATIC GEOCHEMISTRY

PAF : Samples that are classified as Potentially Acid Forming based on the static geochemical parameters provided.
NAF : Samples that are classificated as likely to be Non-Acid Forming based on the static geochemical parameters provided.
Maximum Potential Acidity (MPA) : A calculation of the maximum amount of sulfuric acid (H2SO4) that could be produced if all reactive sulfide in the sample is oxidised (wt%S x 30.6). This is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Maximum potential acidity based on S-Cr ($MPA_{(SCr)}$) : A calculation of the maximum amount of sulfuric acid (H_2SO_4) that could be produced assuming that the chromium reducible sulfur represents the sulfide sulfur within the sample, and all of the sulfide sulfur is oxidised. This is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Acid Neutralising Capacity (ANC) : A measure of the potential acid neutralising capacity of the sample, typically due to the presence of calcium- and/or magnesium-bearing carbonate minerals. The ANC value assumes that all of the carbonate is available for acid neutralisation (kg H_2SO_4/tonne).
Net Acid Producing Potential (NAPP) : A measure of the overall acid-generating potential of the sample, calculated by subtracting the ANC value from MPA. The NAPP value is expressed in units of kilograms of H_2SO_4 equivalent per tonne of sample (kg H_2SO_4/tonne).
Acid Generation Potential (AP) : Analogous to MPA. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
Acid Generation Potential based on S-Cr ($AP_{(SCr)}$) : Analogous to MPA(SCr).
Neutralization Potential (NP) : Analogous to ANC. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
Net Neutralization Potential (NNP) : Calculated. NNP=AP-NP. Analogous to NAPP. This is expressed in units of kilograms of $CaCO_3$ equivalent per tonne of sample (kg $CaCO_3$/tonne).
ANC/MPA Ratio : Represents a calculated ratio between the Acid Neutralising Capacity (ANC) and the Maximum Potential Acidity (MPA).
Neutralization Potential Ratio (NPR) : Represents a calculated ratio between the Neutralizing Potential (NP) and the Acid Generation Potential AP. NPR = NP/AP. Analogous to ANC/MPA ratio.
Pyrite equivalent based on Total Sulfur ($Pyrite_{(STOT)}$) : The pyrite mass equivalent of the total sulfur, assuming all sulfur is present as pyrite.
Pyrite equivalent based on S-Cr ($Pyrite_{(SCr)}$) : The pyrite mass equivalent of the sulfide sulfur, assuming the chromium reducible sulfur is representative of the sulfide sulfur.
Net Acid Generation pH after oxidation (NAG-pH) : The pH of a sample after oxidation with an excess of hydrogen peroxide.
Net Acid Generation to pH 4.5 ($NAG_{4.5}$) : The equivalent acidity of a peroxide-oxidised sample titrated to pH 4.5 (kg H_2SO_4/tonne).
Net Acid Generation to pH 7.0 ($NAG_{7.0}$) : The equivalent acidity of a peroxide-oxidised sample titrated to pH 7.0 (kg H_2SO_4/tonne).

SULFUR SPECIATION

Total sulfur (S-TOT) : Total sample sulfur determined by the Leco method.
Chromium reducible sulfur (S-Cr) : Laboratory method for estimating the sulfide forms of sulfur within a sample.
Peroxide Sulfur (S_P) : The sulfur present within the filtered leachate following TPA titration.
Potassium chloride extractable sulfur (S-KCl) : The sulfur measured from a filtered sample leachate following extraction with 1M KCl.
Hydrochloric acid extractable sulfur (S-HCl) : The sulfur measured from a filtered sample leachate following extraction with 4M HCl.
Total oxidisable sulfur (S-TOS) : Calculated. S-TOS = STOT – S-HCl
Net acid soluble sulfur (S-NAS): Calculated. S-NAS = S-HCl – S-KCl
Potential oxidisable sulfur (S-POS) : Calculated. S-POS = S_P – S-KCl
Residual acid soluble sulfur (S-RAS) : Sulfur measured in the filtered leachate following 4M HCl extraction of the residual solids from the TPA test.
Sulfide sulfur : Sulfur in the form of sulfide minerals (eg. pyrite, pyrrhotite, chalcopyrite).
Readily soluble non acid storing sulfate sulfur : A measure of sulfur present as relatively soluble minerals which do not contribute to acidity upon dissolution (eg. gypsum).
Gypsum (equivalent) : The calculated mass of gypsum equivalent (expressed in weight percent) based on the mass of readily soluble non acid storing sulfate sulfur.
Readily soluble acid storing sulfate sulfur : A measure of sulfur present as minerals with relatively high solubility formed by prior oxidation of sulfide minerals and which release acid upon dissolution and oxidation (eg. melanterite).
Melanterite (equivalent) : The calculated mass of melanterite equivalent (expressed in weight percent) based on the mass of readily soluble acid storing sulfate sulfur.
Sparingly soluble acid-forming sulfate sulfur : A measure of the low-solubility, acidity storing sulfate minerals (eg. jarosite, alunite) present within a sample.

GLOSSARY

Jarosite (equivalent) : The calculated mass of jarosite equivalent (expressed in weight percent) based on the mass of sparingly soluble acid storing sulfate sulfur.

ACIDITY

pH after potassium chloride extraction (pH_{KCl}) : The pH of a sample leachate after a 4 hour extraction with 1M KCl.
pH after hydrogen peroxide extraction (pH_{ox}) : The pH of a sample leachate after extraction with 30% hydrogen peroxide.
Titratable actual acidity (TAA) : The acidity titrated from a sample leachate after a 4 hour extraction with 1M KCl. The titration is stopped when the solution reaches pH 6.5.
Total Potential Acidity (TPA) : The acidity titrated from a sample leachate after extraction with 30% hydrogen peroxide. The titration is stopped when the solution reaches pH 6.5.
Total sulfide acidity (TSA) : Calculated. TSA = TPA - TAA
Potential acidity : Represents the net potential for acid generation from a sample, following oxidation of the sulfide minerals within the sample and neutralisation against any available neutralising minerals within the sample. Expressed in units of moles of H+ per tonne of material.
Actual acidity : The readily available / soluble acidity held within a sample. Expressed in units of Moles of H+ per tonne of material.
Retained acidity : The relatively insoluble stored acidity within a sample. Expressed in units of moles of H+ per tonne of material.
Existing acidity : Calculated. Existing acidity = Actual acidity + Retained acidity
Net acidity : Calculated. Net Acidity = Potential sulfidic acidity + Existing acidity - ANC

CARBON

Total carbon (C_{TOT}) : The total amount of carbon in a sample, representing all forms of carbon.
Total organic carbon (C_{TOC}) : The laboratory measured carbon in a sample that is present as organic forms. Also captures any graphite within the sample.

Total inorganic carbon (C_{TIC}) : The carbon in a sample that is present as inorganic forms. Calculated by subtracting CTOC from CTOT.

CALCIUM CARBONATE

Excess acid neutralising capacity (ANC_E) : Requires back titration with HCl to pH 4 followed by peroxide digestion and titration to pH 6.5 with NaOH. The NaOH titration result is subtracted from the HCl titration result to provide an indication of excess neutralising capacity.
Calcium carbonate equivalent based on ANC : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured ANC result.
Calcium carbonate equivalent based on C_{TOT} : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured total carbon result.
Calcium carbonate equivalent based on C_{TIC} : The percentage (by mass) of the sample that contains calcium carbonate (equivalent), calculated based on the measured calculated inorganic carbon content.