Alkalinity Generating Cover Materials for Sustainably Lowering Acidity Loads from Waste Rock Piles – Field Demonstration¹

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ABSTRACT

A new acid and metalliferous drainage (AMD) avoidance / minimisation technique has been developed. It involves the strategic placement of selected alkalinity producing materials on top of sulfidic waste rock materials. This technique relies on the passive but sustained addition of soluble alkalinity to sulfidic waste materials from specialised amendments within cover materials. The amendments are placed above sulfidic materials to prevent surface passivation and blinding. Suitable amendments need to demonstrate elevated solubility values and relatively rapid dissolution rates compared to typical carbonate minerals.

As the alkaline amendments dissolve during rainfall infiltration, sulfide grains and preferential pathways in the waste materials are coated with inert precipitates when acid salts are encountered. This coating process results in the minimisation of water–acid salt interaction, thereby lowering the acidity load emerging from sulfidic mine wastes. If the coating of sulfidic materials and lining of fluid flow pathways can be achieved from the top to the base of a waste rock pile, there is no reason why this methodology cannot provide sustainable reduction in AMD generation. This approach is predicted to be very cost effective as very small masses of amendment should be capable of passivating entire fluid flow networks in waste rock piles. Hence there is no requirement for the mass of alkaline amendment to match the mass of potential acidity with mine wastes.

The performance of two alkalinity producing cover materials is being tested at the former Brukunga Pyrite Mine in South Australia. Preliminary results presented here indicate that alkalinity producing covers have significant potential to provide cost effective and sustainable reduction in acidity load discharges from sulfidic waste rock piles.

Additional Key Words: preferential fluid flow pathways, passivation, lining, coating, acidity load, alkaline covers, caustic magnesia, carbonate.

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INTRODUCTION

Acid and Metalliferous Drainage (AMD) is the single biggest environmental challenge facing the mining industry. While the last 30 years have seen a significant improvement in our understanding of AMD, a comprehensive source control technique capable of long-term prevention / suppression of AMD from sulfidic mine wastes remains elusive.

Leading practice soil cover systems cannot always be relied upon to provide a long-term solution to AMD discharges from sulfidic mine wastes. In addition, attempts to ameliorate AMD generation by blending alkaline materials (eg. limestone, dolomite) with sulfidic wastes is rarely successful in the long-term due to the surface passivation of alkaline amendments and the development of preferential fluid flow pathways within waste rock piles. In combination, these factors tend to isolate large quantities of alkaline amendment from interaction with water. As a result, the mining industry has few tools that are effective in preventing or significantly minimising AMD from many sulfidic wastes.

A new technique has been developed with the aim of providing sustainable AMD avoidance / suppression from sulfidic waste rock material. This new technology involves the placement of specialised alkalinity producing materials within soil cover systems over sulfidic waste rock piles. Unlike carbonate blending techniques, the specialised alkalinity producing materials are placed strategically above sulfidic materials, and hence are never in contact with them. This placement avoids surface passivation of the alkaline amendment. As rainwater infiltrates through the cover materials, it interacts with the alkaline amendment and transports soluble alkalinity into the waste rock pile. Alkalinity-rich water reacts with acidic salts that it encounters, resulting in acid neutralisation and metal hydroxide and oxy-hydroxide precipitation within the wastes.

The purpose of the alkaline amendment is not to treat all of the acid salts that develop within the waste rock pile, but to coat reactive sulfide grains and line preferential flow pathways with the inert neutralisation precipitates. In effect, the technique is designed to surface passivate sulfide grains and flow pathways in order to retard sulfide oxidation and minimise the ongoing dissolution of stored acid salts. If the surface passivation of sulfide grains and flow paths is as effective as the surface passivation of carbonate grains during limestone blending, then this technique has an excellent chance of success.

In order for the technique to be effective and sustainable, it is not necessary for the mass of alkaline amendment to provide sufficient neutralising capacity to deal with the mass of acid salts that will develop over time within a waste rock pile (ie. this is not a passive treatment technique). Ideally, the mass of alkaline amendment merely needs to provide sufficient alkalinity to coat sulfide grains and flow pathways with inert precipitates from the top of the pile to its base. Hence, theoretically, only a minute proportion of the total potential acidity load within a waste rock pile needs to be matched with an equivalent alkalinity to provide a major and sustained reduction in acidity discharge. Indeed, once the exposed sulfide grains and preferential fluid pathways are coated with inert precipitates, concern over depletion of the alkaline amendment is no longer relevant, as effective and sustainable reduction in acidity discharges will have been achieved.

A key factor controlling the ability of alkaline capping materials to successfully minimise acidity generation is the rate at which sulfide minerals or fluid pathways can be coated. This in turn is controlled by the solubility and dissolution rates of the alkaline material used. As naturally occurring alkaline materials (eg. limestone, dolomite) are characterised by low solubility and dissolution rates, the slow kinetics of the dissolution reactions tends to limit the effectiveness of capping waste rocks with such materials, unless exceptional climatic and geological circumstances are invoked (Miller et al., 2003).

Taylor et al., (2006) circumvented this problem by introducing an enhanced form of caustic magnesia (EMgO) to be used as a capping material. Enhanced caustic magnesia is an engineered amendment characterised by high surface area, high solubility and fast dissolution rates. Laboratory tests have shown that this material can reach solubilities in excess of 200 mg/L CaCO₃ (compared with 10-15 mg/L CaCO₃ for limestone over the same time period) and very fast dissolution rates. For example, in an area that receives an annual rainfall of 1,000 mm/year, a 2 mm thick layer of EMgO could potentially deliver all of its alkalinity within 30 years, while a limestone cover of equal thickness would take more than 200 years to dissolve completely (Taylor et al. 2006).

Alkaline cover technology is currently being field-tested at the former Brukunga Pyrite Mine in South Australia. This paper presents the results obtained during the first twelve months of a two year demonstration commissioned by the Department of Primary Industries and Resources South Australia (PIRSA), to assess the most effective long-term strategy for minimisation / suppression of AMD generation from waste rock material. Alkaline covers, which include EMgO and ultra-fine grained limestone covers, are among several AMD management options being tested at Brukunga.

Site Background

The Brukunga Mine site is located in the Mt. Lofty ranges to the east of Adelaide, South Australia (Figure 1).



Figure 1. Location plan and site layout for the Brukunga pyrite mine.

Pyrite and pyrrhotite were mined from 1955 to 1972 to supply feedstock for sulfuric acid production for the South Australian fertiliser industry. The mining legacy at the site includes two large waste rock piles containing approximately 8 Mt of sulfidic waste rock material (approximately 2-3 wt% S), a tailings storing facility (TSF) containing approximately 3.5 Mt of sulfidic sand-tails (1.7 wt% S), mine benches and a highwall. Both (1990) reported that pyrite and pyrrhotite are the major sulfide minerals within the waste rock at Brukunga, representing approximately 0-2% and 10% by volume, respectively. Minor amounts of sphalerite, chalcopyrite, galena and arsenopyrite are also present within the waste rock (Both, 1990)

Generation of AMD due to the oxidation of pyrite and pyrrhotite from the waste rock, tailings and open cuts has been a significant issue at the Brukunga site. As a result of sulfide oxidation, untreated drainage from the waste rock piles, TSF and open cut at Brukunga is typically characterised by a pH of 2.5-3.0, sulfate concentrations of 6,000-10,000 mg/L, iron concentrations of 200-4,000 mg/L (Cox et al., 2006) and acidity concentrations of 8,000-15,000 mg/L CaCO₃. In addition, leachate typically contains elevated concentrations of metals such as aluminium, cadmium, chromium, copper, lead, manganese, nickel and zinc (Cox, 2006).

At present, approximately 90-100% of affected runoff and seepage from the Brukunga mine site is being pumped to a central water treatment facility where it is being treated prior to release into Dawesley Creek.

The results presented here represent the first 12 month phase of a 24 month demonstration commissioned by the Department of Primary Industries and Resources South Australia (PIRSA), to assess the most effective long-term strategy for minimisation / suppression of AMD generation from waste rock materials.

METHODOLOGY

Construction of test piles

The demonstration involved the construction of seven (7) one-thousand (1,000) tonne waste rock test piles (TP1-TP7). Of these test piles, TP1 was capped with EMgO, TP2 was capped with ultra-fine grained limestone, and TP4 comprised unamended waste (ie. providing baseline conditions). Waste rock was sourced from the site and carefully mixed prior to emplacement to ensure compositional homogeneity between each test pile (Figure).

The base of each test pile consisted of an inward draining, square clay pad, fitted with a narrow linear trench to facilitate drainage collection. The clay was covered with a thin layer (10-15 mm) of clean, coarse, quartz sand and subsequently overlain by a 2 mm thick liner of high density polyethylene (HDPE). A polyethylene pipe was welded into the HDPE liner to collect drainage from above the liner, via the drainage trench, and enable sampling from the pipe outlet. An additional layer (10-30 cm) of clean, coarse, quartz sand was placed on top of the HDPE liner and drainage pipe to prevent damage from overlying rock (Figure 2).

One thousand tonnes of homogenised waste rock was placed onto the protective sand layer to produce a truncated pyramid with a footprint of 17×17 m, a core height of approximately 3 m, and an upper surface area of 9.5 x 9.5 m (refer to Figures 2 and 3).



Figure 2: left to right: Waste rock selected for test pile construction prior to mixing; Mixing of waste rock with D9 bulldozer; Reworking of homogenised waste rock prior to emplacement onto test piles – note uniform colour of the final mixed platform.



Figure 3: from left to right: Sump and trench in inward draining basal clay pad; Installation of HDPE liner over basal pad. Emplacement of primary and contingency drainage pipes onto HDPE liner prior to final sand layer and subsequent waste rock emplacement.

Seepage from each test pile was captured by the HPDE liner, collected in the central sump area and drained by gravity via a perforated polyethylene pipe connected to a non-perforated polyethylene pipe extension. The drainage pipe emerged from the test piles to permit free flow of drainage and water monitoring and sampling. In addition to the main seepage collection and drainage pipes, the system was fitted with contingency drainage pipes (Figure).

Test pile capping

The top surface of each test pile was levelled but not compacted, to facilitate percolation of water, and TP1 and TP2 were capped with a thin surficial layer of alkaline material. TP1 was capped with enhanced EMgO while TP2 was capped with ultra-fine grained limestone ($<5 \mu m$ grain size). Only the top surface area of TP1 and TP2 was capped with alkaline material – this area represents approximately 40% of the total surface area of the test pile – while the remaining 60% was uncapped and therefore exposed to direct interaction with incident rainfall. The low proportion of the total surface area capped (40%) was associated with the small scale of the test piles (high ratio of batter surface area to top surface area) relative to typical large scale waste rock piles at mine sites. The alkaline capping material was excluded from the batter surfaces, to minimise the generation of highly alkaline leachate (that would result from limited interaction between infiltrating water and acid salts in the test pile) and prevent alkaline material from reporting directly to the HDPE liner.

TP1, TP2 and TP4 (baseline) were then covered with a layer of sand and fitted with an irrigation system, as shown in Figure 4.

Irrigation system

Due to the limited duration of the demonstration (24 months), the low average annual rainfall (approximately 573 mm) and the seasonal nature of rainfall at Brukunga, each test pile was fitted with an irrigation system to augment natural precipitation, and provide constant leachate production during the drier months. An irrigation protocol was designed to encourage regular wet-dry cycles, therefore optimising the potential for acidity generation and flushing, as well as enhancing alkalinity infiltration. An irrigation system comprising multiple lines of porous hose was installed across the surficial sand layer on each test pile. The sand layer was designed to facilitate the uniform distribution of irrigation water (Figure 3). Each irrigation system was fitted with an in-line flow meter for accurate monitoring of irrigation volumes.



Figure 4: from left to right: Construction of test pile; Capping of TP1 with EMgO; Irrigation system installed on top of a test pile.

Infiltration volumes

In the context of this paper, the term "infiltration volume" refers to the amount of water received by each test pile via irrigation and rainfall. This assumption presumes that the plastic liner captures runoff from the piles and that there is no loss of water through evaporation. In addition, the daily infiltration volume is assumed to equal the daily leachate volume production.

Geochemical characterisation of the test pile material

Grab samples of waste rock from each test pile were collected for geochemical characterisation. Geochemical analyses for all test piles included:

- Al₂O₃, BaO, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, P₂O₅, SiO₂, TiO₂, S, Ag, As, Cd, Co, Cu, Mo, Ni, Pb, Sb, Zn, Bi, Hg, Se, Sn, Te, Tl.
- Total C, organic C, and total S.
- Loss on Ignition (LOI).

Leachate quality – field monitoring

Leachate generated by each test pile was regularly collected throughout the demonstration for field monitoring of general water quality parameters and laboratory analysis of detailed water chemistry. Leachate was monitored in situ, on a weekly basis for pH and temperature.

Leachate quality – laboratory sampling

Leachate samples from the test piles, including a blind sample, were collected on a monthly basis for 12 months and analysed for pH, total alkalinity, bicarbonate, acidity, TDS, EC

(electrical conductivity), Na, K, Ca, Mg, sulfate, chloride, phosphate, fluoride, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Al and Fe.

Leachate data assessment

Monthly acidity and monthly alkalinity loads were calculated as follows:

- Monthly Acidity Load (kg / unit time) = 30 x acidity (mg/L) x <u>daily infiltration</u> volume (L / unit time) x 10⁻⁶
- Monthly Alkalinity Load (kg / unit time) = 30 x alkalinity (mg/L) x <u>daily infiltration</u> volume (L / unit time) x 10^{-6} .

Daily acidity values were calculated by linear interpolation of monthly acidity values determined by laboratory analysis. Alkalinity values of $200 \text{ mg/L} \text{ CaCO}_3$ and $15 \text{ mg/L} \text{ CaCO}_3$ were used for the saturated solubility of EMgO and ultra-fine grained limestone, respectively (Taylor et al. 2006).

RESULTS

Waste rock geochemistry

The bulk geochemical composition of all test piles showed a high degree of homogeneity, with major and minor element concentration variation contained within one standard deviation. In particular, sulfur contents varied from 2.98 wt% (TP4) to 3.15 wt% (TP1), with an intermediate value of 3.02 wt% in TP2. The average sulfur content of 3.05 wt% is approximately 1 wt% higher than the average value reported by Blesing et al. (1974) for the entire volume of waste rock at Brukunga.

Infiltration volume

The total infiltration volume (rainfall plus irrigation) for each test pile was approximately 368 kL for the initial 12 months of the demonstration. This value corresponds to approximately 2.2 years of average annual rainfall (Table 1).

Parameter	Unit	Test Pile ID and Material			
		TP1 - EMgO Cap	TP2 - Limestone Cap	TP4 - Baseline	
Rainfall	mm / test period	434	434	434	
Rainfall volume	L / test period	125,426	125,426	125,426	
Irrigation volume	L / test period	242,030	241,638	243,128	
Infiltration volume (rainfall and irrigation combined)	L / test period	367,456	367,064	368,554	
Infiltration volume – equivalent years of rainfall	years	2.21	2.21	2.22	

Table 1: Rainfall and irrigation data for the test piles 1, 2 and 4.

Leachate chemistry

Acidity

Baseline acidity values (TP4) ranged from $9,900 \text{ mg/L CaCO}_3$ in December 2007 to $17,600 \text{ mg/L CaCO}_3$ in March 2008 (Table 2, Figure 5) with an average acidity value of approximately $13,000 \text{ mg/L CaCO}_3$ equivalent.

Parameter	Unit	Sampling event (d/m/yy)	Test Pile ID and Waste Amendment		
			TP1 - EMgO Cap	TP2 - Limestone Cap	TP4 - Baseline
Acidity as Calcium Carbonate	mg/L	13/7/07	13,700	13,400	15,100
		20/8/07	16,100	15,200	13,200
		13/9/07	8,570	16,300	12,900
		15/10/07	7,510	11,300	10,300
		19/11/07	17,800	15,200	12,600
		14/12/07	11,500	13,200	9,990
		15/1/08	11,800	15,200	11,300
		13/2/08	9,560	14,200	13,500
		17/3/08	9,240	17,600	17,600
		16/4/08	9,200	15,200	13,500
		16/5/08	16,000	16,200	11,400
		16/6/08	14,600	17,100	13,700

Table 2: Acidity data for leachate from test piles 1, 2 and 4 over the 12 month period of the demonstration program.



Figure 5: Variation in leachate Acidity (as CaCO₃) over time for TP1, 2 and 4.

TP1 (EMgO cap) acidity values ranged from a minimum of 7,510 mg/L CaCO₃ in October 2007 to a maximum of 17,800 mg/L CaCO₃ in November 2007 (Table 2, Figure 5). Acidity values for TP1 were 30% lower than those of the baseline test pile in September 2007 and October 2007 (ie. 8,579 mg/L CaCO₃ vs 12,900 mg/L CaCO₃ respectively, September 2007) and as much as 47% lower than the baseline test pile from January 2008 to April 2008 (eg. 9,240 mg/L CaCO₃ vs 17,600 mg/L CaCO₃ respectively, March 2008).

Acidity levels peaked for TP1 in November 2007 and May 2008. The acidity trend line for TP1 shows a correlation with the rainfall to irrigation ratio, with upward trends in acidity generally corresponding to high rainfall to irrigation ratios (ie. following significant rainfall events). Acidity values decreased promptly in response to low rainfall to irrigation ratios (Figure 6).

Acidity values for TP2 (limestone cap) ranged from $11,300 \text{ mg/L CaCO}_3$ in October 2007 to $17,100 \text{ mg/L CaCO}_3$ in May 2008. In general, acidity values for TP2 slightly increased throughout the first 12 months of the demonstration and maintained values at or slightly above those observed for the baseline test pile (Table 2, Figure 5).



Figure 6: Relationship between Acidity trend for TP1 and rainfall to irrigation ratio.

Alkalinity Load Inputs for TP1 and TP2

The alkalinity released by the EMgO cap (TP1) from 6 June 2007 to 16 June 2008 is estimated to be equivalent to 48 kg $CaCO_3$ / year (ie. approximately 3.8 kg $CaCO_3$ / month). This is sufficient to neutralise a total of 47 kg H_2SO_4 equivalent / year, or 3.8 kg H_2SO_4 equivalent / month (Table 3).

The alkalinity released by the limestone cap (TP2) from 6 June 2007 to 16 June 2008 is estimated to be equivalent to 3.6 kg CaCO_3 / year (ie. approximately 0.3 kg CaCO_3 / month). This is sufficient to neutralise a total of $3.5 \text{ kg H}_2\text{SO}_4$ equivalent / year, or $0.3 \text{ kg H}_2\text{SO}_4$ equivalent / month (Table 3).

Parameter	Unit	Test Pile ID and Alkaline Amendment		
		TP1 - EMgO Cap	TP2 - Limestone Cap	
Alkalinity Load	kg H_2SO_4 equivalent / month	3.8	0.3	
Cumulative Alkalinity Load	kg H ₂ SO ₄ equivalent / Test Period (June 2007 to June 2008)	47.4	3.6	

Table 3: Cumulative Alkalinity Loads in kg H₂SO₄ equivalent for TP1 (EMgO cap) and TP2 (limestone cap).

DISCUSSION

EMgO Alkaline Cap

- TP1 showed distinct improvements in leachate quality relative to TP4 (baseline pile) during two sampling intervals, with marked decreases in acidity, sulfate and all soluble metals. These periods were interrupted by strong rainfall events that caused a surge of poor quality leachate to discharge from TP1.
- Monthly Acidity Loads for TP1 (EMgO) were lower than the baseline test pile (TP4) for the sampling interval September 2007 to October 2007 (average difference of 105 kg H₂SO₄ equivalent / month) and from February 2008 to May 2008 (average difference of 100 kg H₂SO₄ equivalent / month) as shown in Figure 7. For these sampling intervals, monthly acidity loads for TP1 were as much as 30% and 40% lower than the corresponding values for the baseline test pile.
- For the sampling interval November 2007 to January 2008 and the June 2008 sampling event, monthly acidity loads for TP1 were higher than the baseline test pile. These events appear to be a consequence of test pile design and do not reflect poor performance of the alkaline cap. Acidity values (and acidity loads) for TP1 correlate with the ratio of rainfall to irrigation volume. During rainfall events, alkalinity is being added to the test pile only from approximately 40% of the surface area (alkaline amendment is present only on top surface) while the remaining 60% of the surface produces untreated leachate that reports to the sump. The surge of untreated leachate produced by 60% of the surface area of the test pile overpowers the positive effect on leachate quality generated by the limited alkaline cap area. When the rainfall to irrigation volume decreases, leachate quality improves with acidity loads decreasing again compared to the baseline test pile.
- Although the EMgO amendment covers only 40% of the test pile surface area, the cumulative acidity load production for TP1 has always been lower than that of the baseline test pile. Starting in January 2008, the difference between the cumulative acidity loads from TP4 (baseline) and TP1 has substantially increased, with the baseline test pile producing consistently higher acidity loads than TP1 (Figure 8). In typical waste rock piles, significantly greater coverage could be achieved by an alkaline cover due to the smaller contribution of batter surface area to the total waste rock pile surface area. Furthermore, alkaline capping materials could be applied to batter surfaces in real waste rock piles, which would enable significantly better coverage of sulfidic waste material than was achieved in this demonstration work.

- From June 2007 to June 2008, the acidity load discharged from TP1 (EMgO cap) was approximately 460 kg H₂SO₄ less than from the baseline test pile. During the May 2008 sampling event this value was as high as 505 kg H₂SO₄. This significant decrease in acidity load generated by TP1 was achieved despite the fact that during the same period (June 2007 to June 2008) the alkalinity released by the EMgO cap was only sufficient to neutralise approximately 47 kg H₂SO₄ equivalent. This comparison between acidity load reduction and alkalinity load release highlights the potential for alkalinity generating covers to sustainably and cost effectively lower acidity discharges from sulfidic wastes.
- The average weekly trends in acidity load from TP1 and TP4 show similar behaviour. In the course of the demonstration, the weekly acidity load from TP1 never exceeded that of the baseline test pile (Figure 9). In particular, during the months of January 2008 to April 2008, average weekly acidity loads from TP1 decreased while those from the baseline test pile increased sharply, with this trend being interrupted by the onset of the wet season (Figure 9). Until the April 2008 sampling event, the average monthly acidity load from TP1 was approximately 45 kg H₂SO₄ equivalent / month lower than for TP4, while during the same timeframe the EMgO cap released enough alkalinity to neutralise approximately 3.8 kg H₂SO₄ equivalent / month (Table 3).
- The disproportionate decrease in acidity load from TP1, relative to the alkalinity addition from the cap (observed in both monthly and total Acidity Loads), can be explained by the coating of sulfide grains and the lining of preferential fluid flow pathways with inert neutralisation precipitates, thus minimising the interaction between infiltrating water and acid salts.

Limestone Alkaline Cap

• From June 2007 to June 2008, leachate quality from TP2 showed only very marginal and recent improvements by the addition of alkalinity released from the limestone cap. This is believed to be due to the lower solubility of limestone compared to enhanced EMgO (Table 1) as applied to TP1. Over time, TP2 is expected to show similar improvements in leachate quality to those achieved in TP1.



Figure 7: Monthly Acidity Loads for TP1, 2 and 4 (kg H_2SO_4 equivalent / month). On the horizontal axis, a star indicates the months for which the acidity load for TP1 was lower than for TP4.



Figure 8: Cumulative difference in acidity load production between TP4 and TP1 (kg H_2SO_4 equivalent). For reference, the Cumulative Alkalinity addition produced by the EMgO cap (kg H_2SO_4 equivalent) is also shown.



Figure 9: Variation in acidity load calculated on a weekly basis for TP1 and TP4 (kg H_2SO_4 / week).

CONCLUSIONS

Since the process of surface passivation (via secondary mineral precipitation) can be very effective at retarding carbonate dissolution in sulfidic waste rock piles, it is reasonable to assume that it offers a similar potential to retard acidity release rates if sulfide grains and reactive fluid pathways can be coated with inert materials.

The first 12 months of this field demonstration have confirmed the significant potential of alkalinity producing covers to be an effective and sustainable AMD minimisation strategy. This has important implications for the pro-active or retrospective management of waste rock piles at mine sites throughout the world.

In spite of the short timeframe of the demonstration and the fact that only 40% of the available surface area of TP1 and TP2 was covered with alkaline amendment, acidity loads from the test pile capped with EMgO decreased considerably during the course of the demonstration relative to the baseline test pile. The fact that the difference in acidity load generation between the TP1 and TP4 was sustained, and indeed increased over time, is consistent with the hypothesis that fluid pathways in TP1 are being sustainably coated with inert precipitates. The disproportionate decrease in acidity load compared to the alkalinity addition from the EMgO cap also supports this mechanism.

Based on the performance of alkaline covers to date, it is predicted that, given sufficient time, the entire fluid-flow network within alkaline capped waste rock piles could become coated with inert precipitates, thus dramatically minimising or even avoiding the requirement for downstream leachate treatment.

The difference in performance between the EMgO and limestone covered test piles indicates that specialised alkaline material such as EMgO, characterised by relatively high solubilities and rapid dissolution rates, can be expected to provide far more rapid control of acidity release rates from sulfidic mine wastes via reactive mineral and pathway passivation.

Monitoring of TP1 and TP2 (alkaline covers) and TP4 (baseline) will continue for a further 12 months. At the end of the initial 12 month monitoring period, TP1 and TP2 had their batters capped with HDPE to ensure that all rainfall (and irrigation water) passes through the alkaline amendment. This modification is expected to provide a more rapid and unequivocal assessment of the benefit of alkalinity producing cover materials in the management of sulfidic mine wastes.

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