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Ok Tedi Mining Limited

**WASTE GEOCHEMISTRY AND IMPLICATIONS
FOR BIGE DREDGE OPERATIONS**

PROGRESS REPORT

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Executive Summary

The sediments being dredged and stockpiled at Bige are comprised predominantly of tailings and waste rock with tailings contributing the bulk of the sulphide and waste rock contributing the bulk of the limestone (or acid neutralising capacity, ANC). The trend in the acid-base balance of the dredged sediments is influenced by the acid-base balance of the waste rock and tailings placed into the river system and segregation of sulphide and carbonate minerals along the river reach above the dredge slot. This report provides an update on the current level of understanding of the factors influencing the acid-base characteristics of the dredged sands and provides an assessment of the ARD risk associated with the current and future dredge sands. Recommendations for continued operation of the dredging operation are also provided.

The current understanding of the Bige dredge sediment geochemistry is as follows:

- The acid-base balance of the stockpiled dredge sediments varies widely and approximately 15% of the monitoring samples tested to-date are confirmed as potentially acid forming (PAF). The current factor of safety (average ANC/MPA ratio of 1.4) is at the lower limit of typical industry values for non-acid forming (NAF) tailings and process waste.
- The current stockpiled PAF sediments have a significant lag period and would require a long period of exposure before acid conditions were developed (years). Due to the relatively small proportion of PAF material within the current stockpile and the long lag period of the PAF material the risk of significant ARD from the current stockpiled sediments is low.
- As mining continues the ANC load will decrease, therefore the factor of safety will continue to decrease and is expected to be less than 1 within the next few years. Under the NAPP minus 150 plan the annual average NAPP of dredged sediments is expected to be positive within the next few years and PAF sands are likely to occur more than 50% of the time.
- The risk of ARD from future stockpiled sediments is high.
- The potential ARD impact on the Ok Tedi and Fly River system is predicted to be negligible under normal flow conditions. Under low flow conditions there is a low risk of localised impact from ARD and under El Nino conditions the impact is predicted to be moderate to high within the Ok Tedi but expected to low in the Fly.

Based on the current understanding the most geochemically secure option and therefore lowest ARD risk for management of PAF mine derived sediments is to discontinue dredging and allow the sediments to be transported down-stream where deposition in more geochemically stable (i.e. less oxidising) areas is likely to occur.

However, if dredging is to be continued to provide downstream physical benefits then the following are recommended to reduce the ARD risk from the dredge operation at Bige:

- An ANC/MPA ratio of 2 in dredge discharge sediments is recommended to achieve a NAF stockpile for control of ARD and copper leaching. Reducing the sulphide load or increasing the ANC load will increase the ANC/MPA ratio.
- Removal of sulphide from the dredge discharge is an option for achieving an ANC/MPA ratio of 2. OkARD modelling indicates that removal of 30 to 50% of the sulphur during years 2001 to 2004 and 70 to 80% during years 2005 to 2010 would meet this target.
- Because of the pending shortfall in ANC over the next year, ongoing operation of the stockpile must include a diligent operational monitoring program with fast turn around so that placement decisions can be made on the basis of the anticipated trend in sediment characteristics. This should be linked to monitoring outflow from the mill as well as material leaving the Ok Mani and entering the Ok Tedi.
- PAF material must be placed low in the stockpile profile and covered with NAF material. Where possible the PAF material should be located so that it will be permanently under water. No PAF material should be placed within the outer walls or bunds.
- It is recommended that the current stockpile is designed and configured so that zones for placement of PAF and NAF sands can be carefully managed. Sealing below the base of PAF cells is unlikely to be necessary provided the cells can be covered and the PAF material isolated from atmospheric oxygen. The long geochemical lag identified in the current dredge sediments means that acid generation is unlikely to occur while PAF cells are open and hence basal sealing will not be necessary. Monitoring is recommended to identify if the lag period is likely to be affected by changing material characteristics.
- Removal of sulphur from the dredge discharge or avoiding high sulphur material within the slot are options that need urgent attention. Without the removal of sulphur to maintain a factor of safety (ANC/MPA) near 2, the current physical benefits of the dredging operation are likely to be jeopardised by a significant ARD liability that will require on-going treatment and maintenance.
- Preliminary results from the dredge slot sediment investigations indicate that sulphides are preferentially deposited on the eastern side of the slot. If selective dredging within the slot is likely to be a viable method for controlling the sulphur load in the dredge sediments, it is recommended that an investigation be performed to confirm and refine this distribution.

- Recent investigations have shown that sulphides (framboidal pyrite) are actually forming in the lower Ok Tedi. Hence sulphides removed at the dredge could be safely placed back into the river and transported down stream where deposition in geochemically stable areas is likely to occur. Alternatively, the sulphides could be placed in cells within the dredge stockpile and isolated from atmospheric oxygen. The quantity of sulphur removed would range from 0.2 to 0.35 million tonnes per year which is equivalent to about 0.4 to 0.7 million tonnes of pyrite.

The outstanding results from the current intensive sampling and testing program at Bige and the results of the Harvey Creek and Ok Mani program will be available within the next 6 to 8 weeks. These data will help to confirm the trends and issues raised in this report. It is also important that the waste rock production inventory is reviewed and confirmed and if possible, the sulphur grade of waste rock types mined in 1995, 1996 and 1997 confirmed.

1.0 Introduction

The sands dredged from the Ok Tedi and stockpiled at Bige are a combination of natural sediments, valley wall eroded materials, waste rock and tailings. The contribution from each of these source is not yet known but is likely to be predominantly tailings and waste rock with tailings contributing the bulk of the sulphide and waste rock contributing the bulk of the limestone (or acid neutralising capacity, ANC).

To date more than 500 samples have been collected from the dredge discharge and the deposited sands. The average sulphur content of the samples is 2.3%S and the average ANC is 92 kgH₂SO₄/t. The acid base balance indicates, on average, an excess of ANC over the potential acidity that could be generated by the contained sulphide. The average net acid producing potential (NAPP) is -24 kgH₂SO₄/t (a negative NAPP indicates an excess of ANC and a positive NAPP indicates a deficiency of ANC over the inherent acid potential). However, the ANC and sulphur content of the samples does vary and overall about 28% of the samples report a positive NAPP.

The trend in the acid-base balance of the dredged sediments is an important consideration for the design, operation and closure of the dredging operation. This balance is influenced by the acid-base balance of the waste rock and tailings placed into the river system and segregation of sulphide and carbonate minerals along the river reach above the dredge slot. This report provides an update on the current level of understanding of the factors influencing the acid-base characteristics of the dredged sands and provides an assessment of the ARD risk associated with the current and future dredge sands.

2.0 Geochemical Characterisation of Bige Dredge Sediments

This section provides an outline and summary of the results to-date from monitoring and investigation programs being conducted at the Bige Dredging Operation.

2.1 Monitoring Programs

A number of monitoring programs were implemented at the Dredge Site during 2000 to determine the acid forming characteristics of the dredged sediments. These include routine deposited sediment and dredge discharge programs and a grid survey program carried out over the dredge stockpiles at discrete points in time.

2.1.1 Routine Dredge Discharge Program

A routine program to characterise the daily dredge discharge material was initiated in May 2000. This program utilises samples collected by site personnel for Particle Size Distribution (PSD) determination. The samples are collected daily and provided to the Environmental Department for geochemical characterisation. To-date a total of 171 samples have been collected and analysed and a summary of the results are presented below.

<i>Parameter</i>	<i>Mean</i>	<i>Range</i>	<i>% NAPP +ve</i>
Total S (%S)	2.41	0.01 to 5.81	
ANC (kg H ₂ SO ₄ /t)	91	0 to 157	
NAPP (kg H ₂ SO ₄ /t)	-14	-84 to +90	33

2.1.2 Routine Deposited Sediment Program

A routine deposited sediment program was initiated in March 2000. This program utilises samples collected by site personnel from newly deposited material. A number of samples (approx. 20) are collected from the deposition areas after the surface has dried sufficiently to allow access. The samples are analysed for their PSD and acid forming characteristics. The results from this program provide information on the acid forming characteristics of the dredged material after being deposited on the stockpiles. Field observations indicate that heavy mineral segregation is an active depositional process on the stockpiles. To-date a total of 236 samples have been collected and analysed and a summary of the results are provided below.

<i>Parameter</i>	<i>Mean</i>	<i>Range</i>	<i>% NAPP +ve</i>
Total S (%S)	2.45	0.08 to 5.89	
ANC (kg H ₂ SO ₄ /t)	88	7 to 172	
NAPP (kg H ₂ SO ₄ /t)	-17	-162 to +96	30

2.1.3 Grid Survey Program

The grid survey program involves collecting surface grab samples (0 to 0.2 m) from grid intersections at approximately 100m intervals over the stockpile area. To-date 2 sampling events have been carried out, in December 2000 and in March 2001, and a total of 169 samples have been analysed. This program is designed to monitor the distribution of potentially acid forming (PAF) and non-acid forming material (NAF) material on the surface of the stockpile over time. A summary of the results from this program is provided below.

Parameter	December 2000 Samples			March 2001 Samples		
	Mean	Range	% NAPP +ve	Mean	Range	% NAPP +ve
Total S (%S)	1.93	0.44 to 5.26		2.15	0.01 to 4.04	
ANC (kg H ₂ SO ₄ /t)	103	62 to 161		82	56 to 146	
NAPP (kg H ₂ SO ₄ /t)	-44	-127 to +61	8.5	-16	-117 to +57	39

The S contents are plotted against the ANC's for the two sampling events on Figure 1. These results indicate that the ANC of the sediments being dredged decreased significantly from December 2000 to March 2001. This along with a slight increase in the average S content has caused an increase in the average NAPP from -44 to -16 kg H₂SO₄/t and a dramatic increase in the proportion of NAPP positive samples. Figure 1 shows that the level of safety, indicated by the ANC/MPA ratio, has also decreased significantly. These samples are currently being evaluated to determine the proportion of PAF samples and the spatial distribution of PAF material on the dredge stockpile.

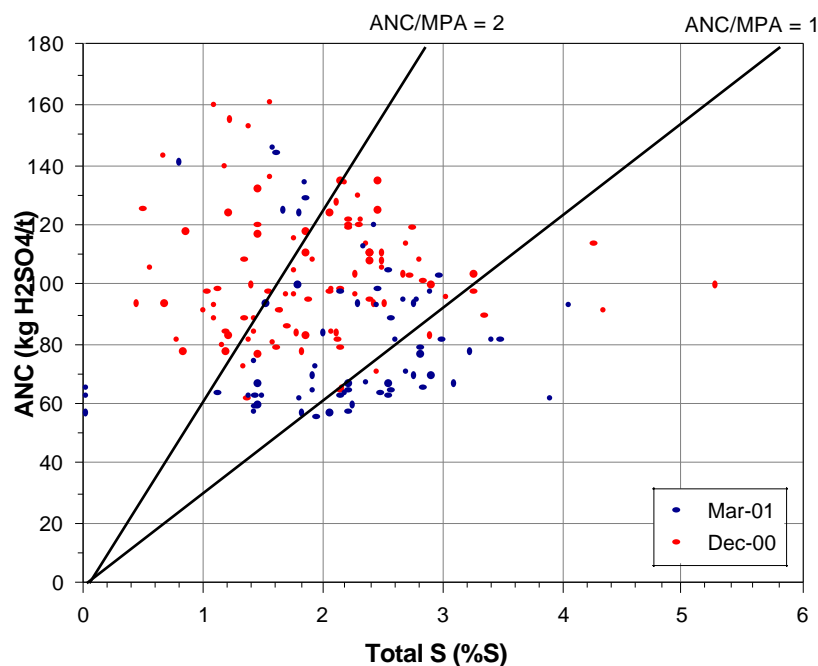


Figure 1: Total S plotted against ANC for the grid survey samples.

2.1.4 Evaluation of Monitoring Results

Combining the results of the dredge discharge and dredge stockpile monitoring programs (including routine and grid programs) indicates that approximately 28% of the 576 samples tested to date are NAPP positive. Figure 2 is a plot of the NAPP against the NAGpH (where available) for these two monitoring data. Data points that fall in the top left quadrante represent samples that are confirmed as non-acid forming (NAF), and those that fall in the lower right quadrante represent samples that are confirmed as potentially acid forming (PAF). Data points that fall in the other quadrates represent samples that have an uncertain (UC) classification based on the NAPP and NAG test results. Subsequent sequential NAG testing is used to confirm the classification of the majority of the uncertain samples. The results of testing to date indicate that approximately 15% of the samples are confirmed as PAF.

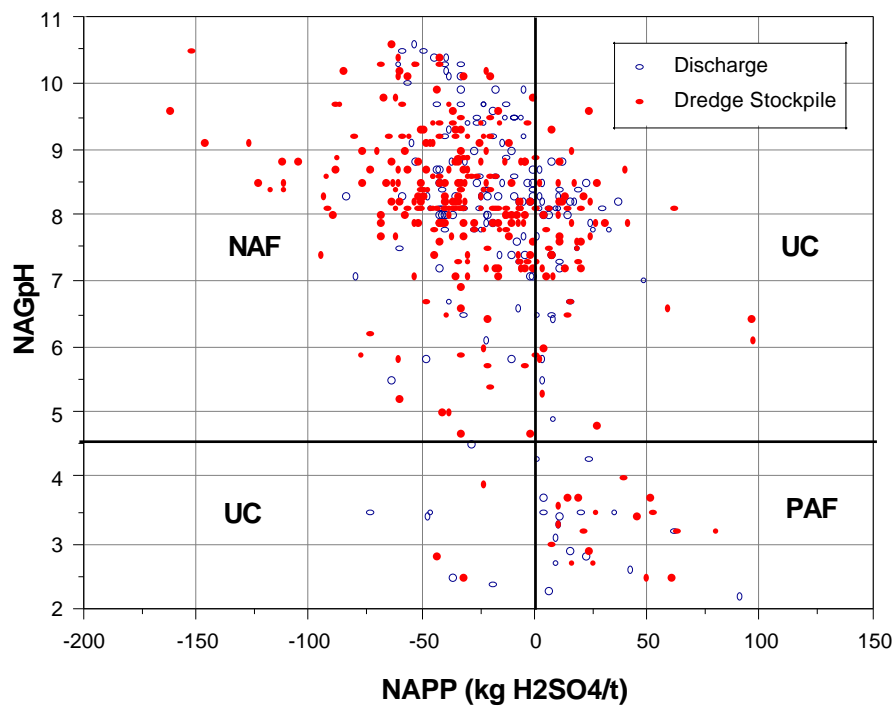


Figure 2: NAPP plotted against NAGpH for the combined monitoring data.

As the results of the sequential NAG testing become available, the percentage PAF is likely to increase. However, samples, which require sequential additions of hydrogen peroxide to be confirmed as PAF, are also likely to have a very long lag period and hence are unlikely to be a concern if left exposed for long periods during construction of the stockpile.

2.2 Specific Geochemical Investigations

A number of geochemical investigation programs have been performed to address specific issues in regard to the management of ARD at the dredging operation. These

include a drill-hole program through the sediment stockpile, and specific event sampling programs of the dredge slot and surrounding river sediments.

2.2.1 Drill-Hole Program

The drill-hole program was carried out to determine the acid forming characteristics of dredge sediments within the current stockpile. A total of 12 drill-holes were positioned over the stockpile area and drilled through to the base of the stockpile. Samples were collected at approximately 0.5m intervals and a total of 188 samples were obtained. A summary of the results from this program is provided below.

<i>Parameter</i>	<i>Mean</i>	<i>Range</i>
Total S (%S)	1.69	0.14 to 8.25
ANC (kg H ₂ SO ₄ /t)	89	7 to 164
NAPP (kg H ₂ SO ₄ /t)	-37	-146 to +164

These results indicate a large range in S and ANC through the stockpiled material. Figure 3 shows the down-hole MPA (Maximum Potential Acidity), ANC and NAPP profiles for 3 selected drill-holes (BDH 06, 07 and 11). The MPA is calculated from the sulphur content of the sample and is reported in the same units (i.e. kgH₂SO₄/t) as the ANC and NAPP. An increase in the sulphur content of a sample is reflected by an increase in the MPA.

These plots show that the MPA (or percent S) increases upwards in each profile and the ANC is higher deeper in the profile than at the surface. These trends result in a significant increase in the NAPP towards the surface. Figure 3 shows that at holes BDH06 and BDH07 the MPA exceeds the ANC at the surface resulting in positive NAPP values. The surface sands at 7 of the 12 holes investigated have positive NAPP values ranging up to 40 kgH₂SO₄/t.

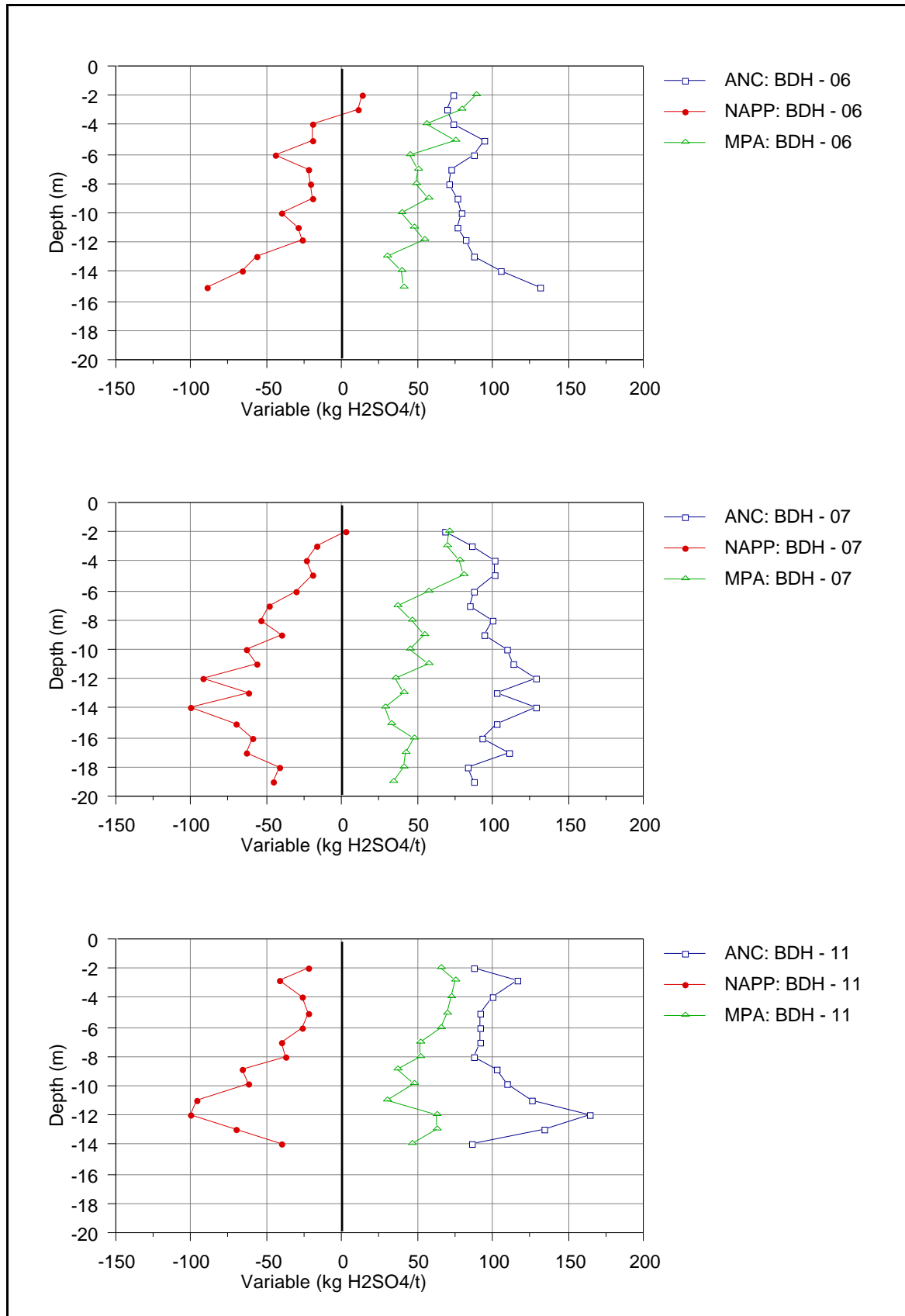


Figure 3: MPA, ANC and NAPP trends with depth for BDH 06, BDH 07 and BDH 11.

2.2.2 Dredge Slot Program

During December 2000 the dredge slot was emptied and a program was implemented to geochemically characterise sediments as it filled in order to identify any S or ANC distribution trends within the slot. A total of 63 samples were collected on a grid pattern. The results indicate that generally the sediments deposited in the western side of the slot have lower S (average 1.61%S) and higher ANC's (102 kg H₂SO₄/t) compared to sediments deposited in the eastern side (average S of 2.47%S, ANC of 88 kg H₂SO₄/t). These preliminary results indicate that it may be possible to selectively dredge material for placement in specific zones within the stockpiles. However, additional surveys would be required to confirm the occurrence and persistence of this distribution.

2.2.3 Partial Mill Shutdown Program

During March 2001 a partial mill shutdown provided the opportunity to characterise sediment within, upstream and downstream of the dredge slot in order to gain a better understand of the impact of tailings on dredge sediment geochemistry. The sampling program was carried out from 6 to 29 March overlapping the shutdown period. A total of 690 bedload and suspended load samples were collected from 3 transects (above, at and below slot). Along each transect five sampling locations were selected and the sampling was carried out twice a day. At the time of writing this report, only a small proportion of these samples had been prepared and analysed. The results and findings from this program will be reported when available.

3.0 Acid-Base Characteristics of River Sediments

The acid-base characteristics of the river sediments which report to the dredge slot at Bige are controlled by the tailings and waste rock contributions. In year 2000, the sulphur load from waste rock and tailings were estimated to be about 310 and 615 kt S, respectively. Hence the load from the tailings was approximately twice the load from the waste rock. Modelling indicates that the relative sulphur loads from these sources is likely to continue for the majority of the current planned mine life.

The ANC loads from the tailings and waste rock are significantly different. In year 2000, the ANC load from waste rock and tailings were estimated to be 12,500 and 250 kt CaCO₃, respectively. The ANC load from the waste rock was 50 times the input from tailings. Hence, the major influence on the acid-base balance of the bulk mine derived sediment leaving the mine has been and will continue to be the ANC content of the bulk waste rock. The ANC content is directly related to limestone production.

3.1 Waste Rock Production (1995 to February 2001).

Figure 4 is a plot of the monthly production data provided by OTML¹ for each waste rock type (in tonnes) for the period October 1995 to February 2001 and Figure 5 shows the limestone fraction of the total waste rock production.

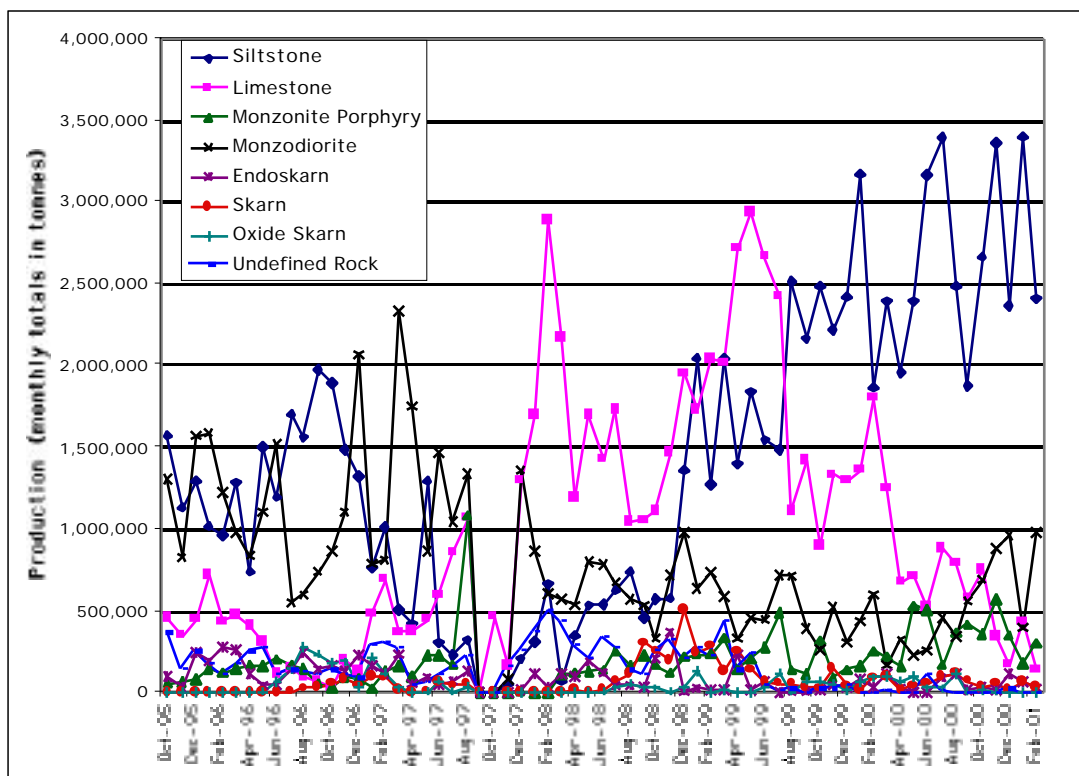


Figure 4: Waste rock production from October 1995 to February 2001 (monthly tonnes).

¹ The waste rock production inventory is from OTML excel file WASTER~5.XLS.

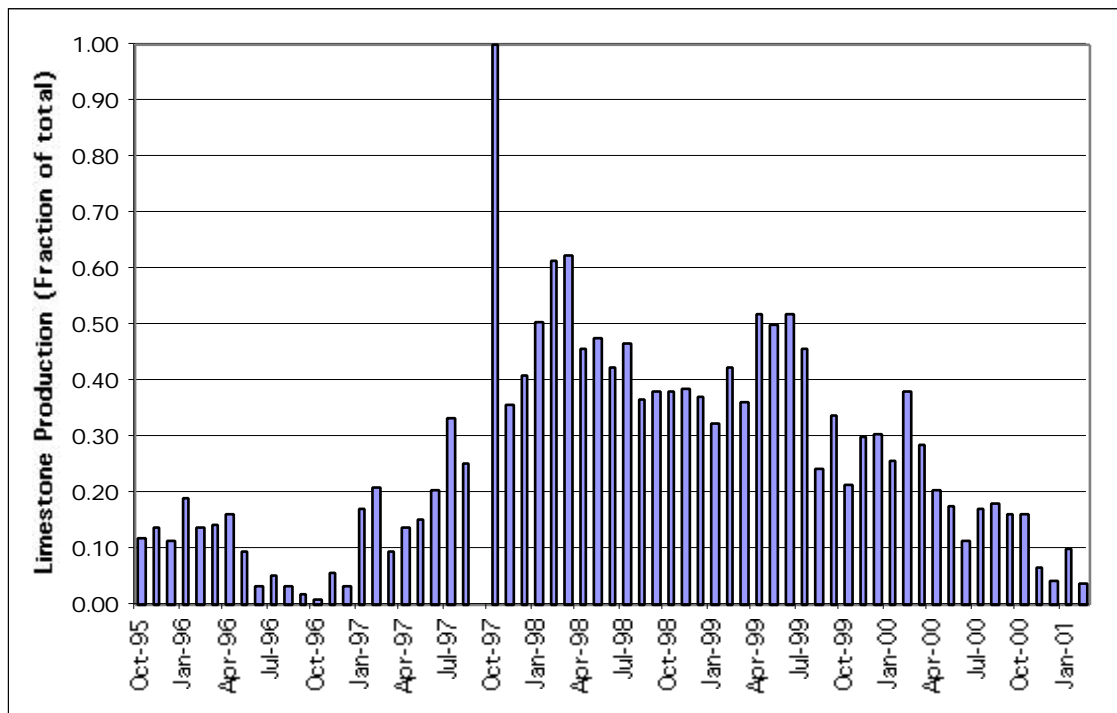


Figure 5: Limestone production as a fraction of total waste rock production.

These figures identify 3 main production periods that influence waste rock geochemistry as follows:

- Siltstone/monzodiorite dominant period: October 1995 to October 1997;
- Limestone dominant period: November 1997 to June 1999; and
- Siltstone dominant period (with decreasing limestone): July 1999 to February 2001.

3.2 Monthly and Annual NAPP Trends

Figure 6 shows the monthly NAPP values calculated from the waste rock type production and the 3 monthly moving average trend line. Also shown at the top of this figure are the average annual NAPP values for the bulk waste rock.

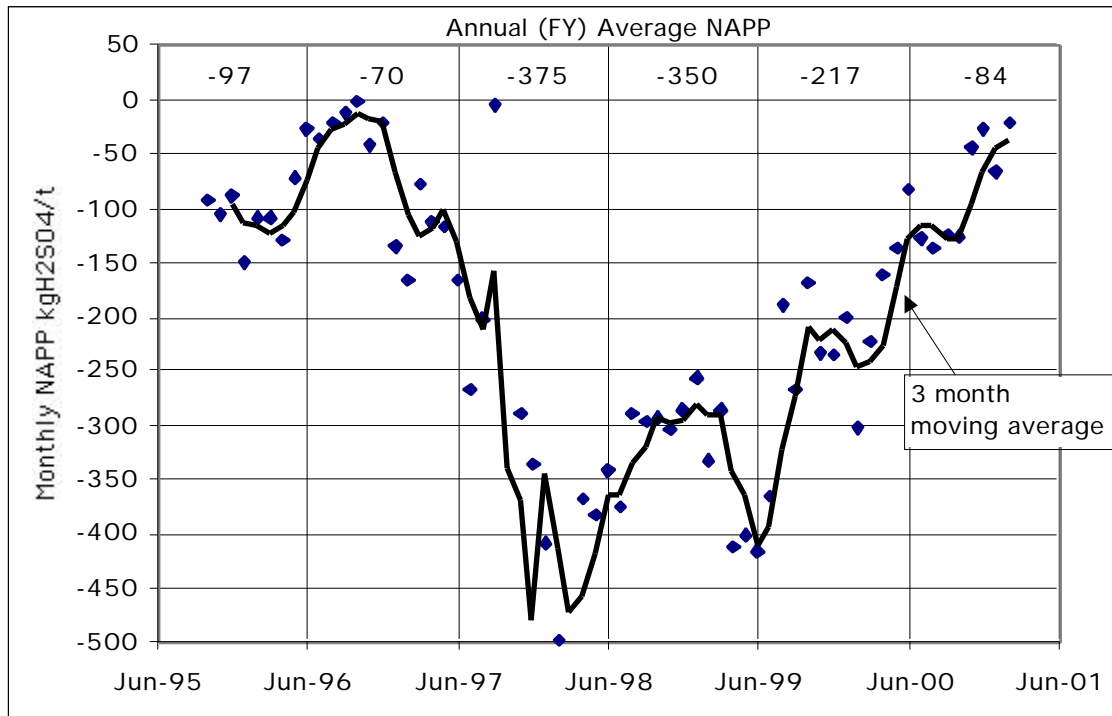


Figure 6: Waste Rock Monthly NAPP Trends and Annual Average Values

In the absence of historical sulphur and ANC data, it has been necessary to assume that the sulphur grade and ANC content of rock types have remained constant for the period modelled. Based on this assumption, Figure 6 shows that the NAPP of the waste rock during FY's 1996 and 1997 was consistently greater than $-150 \text{ kgH}_2\text{SO}_4/\text{t}$ and the annual averages were -97 and $-70 \text{ kgH}_2\text{SO}_4/\text{t}$, respectively². The data also show that during FY 1998 and 1999 the NAPP ranged from about -300 to $-450 \text{ kgH}_2\text{SO}_4/\text{t}$. However, since the start of FY 2000, the NAPP has increased significantly and in February 2001 was only $-21 \text{ kgH}_2\text{SO}_4/\text{t}$ (average from Nov 2000 to Feb 2001 was $-40 \text{ kgH}_2\text{SO}_4/\text{t}$).

These trends and values are consistent with the results for the bulk samples collected to date from Harvey Creek. Two bulk samples were collected in August 1999 and had NAPP values of -318 and $-430 \text{ kgH}_2\text{SO}_4/\text{t}$. In the current program 16 bulk samples have been collected to date and the NAPP values range from -44 to $-324 \text{ kgH}_2\text{SO}_4/\text{t}$. The average for the 16 samples is $-131 \text{ kgH}_2\text{SO}_4/\text{t}$ with 9 of the 16 samples having NAPP values greater than $-100 \text{ kgH}_2\text{SO}_4/\text{t}$.

² Average for FY1996 is for the 9 month period from October 1995 to end June 1996.

4.0 Implications for River Deposited and Bige Dredge Sediments

4.1 River Deposited Sediments

The trends shown on Figures 5 and 6 identified 1996 and 1997 as years of low limestone production and high NAPP. It is possible that significant areas of PAF sediments were deposited in the Ok Tedi during this period. There is evidence of past deposition of PAF material that had oxidised and then subsequently been overlain by high ANC non-acid forming (NAF) sediments. An example of this is shown on Photograph 1.



Photograph 1: Previously oxidised PAF layer within deposited sediments in the braided reach of the Ok Tedi

The NAPP trend suggests that similar conditions are likely to develop at the present time given the similar NAPP of the waste rock. Also, the NAPP of the tailings is currently higher than in 1997/98 and hence the occurrence of PAF sediments may be more significant at the present time.

4.2 Dredge Sediments

Table 1 shows the predicted sulphur, ANC, NAPP and ANC/MPA ratio of dredge sediments for FY 2001 to end-of-mine life using the ARD model with the NAPP minus

150 plan (OkARD v3.4³). A lag of 1 year is assumed to account for the delay associated with waste rock dumped in Harvey Creek influencing the geochemistry of the load leaving Ok Mani and entering the Ok Tedi. There is uncertainty in the predicted values because of this lag⁴ and contributions from waste rock of previous years to the load leaving Ok Mani. However, the predicted trend is likely to be appropriate.

Table 1: Predicted annual average sulphur grade, ANC, NAPP and ANC/MPA of dredge sediments at Bige (with NAPP-150 plan)

Year	%S	ANC (kg H ₂ SO ₄ /t)	NAPP (kg H ₂ SO ₄ /t)	ANC/MPA
2001	2.15	90	-25	1.4
2002	1.96	71	-11	1.2
2003	1.99	68	-7	1.1
2004	2.36	68	5	0.9
2005	3.28	66	34	0.7
2006	3.27	66	35	0.7
2007	2.24	61	7	0.9
2008	2.35	53	19	0.7
2009	2.74	52	32	0.6
2010	3.04	40	53	0.4

The predicted average NAPP for FY 2001 of -25 kgH₂SO₄/t is consistent with the average of -24 kg kgH₂SO₄/t for the 576 monitoring samples assayed to-date. A total sulphur grade of 2.15%S and an ANC of 90 kg kgH₂SO₄/t are also consistent with the monitoring data. Based on the current production schedule, the OkARD model predicts that the average NAPP of dredge sediments will increase to about -11 kgH₂SO₄/t next year and by FY2004 the average NAPP will be positive. At an average annual NAPP of 5 kgH₂SO₄/t it is estimated that about 40% of the time the dredged sands will be potentially acid forming (PAF).

Table 1 also shows the predicted ANC/MPA ratio. This ratio indicates the level of safety in relation to the amount of excess ANC. A value of at least 1.5 is typically recommended for mine tailings to prevent long term ARD⁵. Table 1 shows that the ratio is predicted to be 1.4 in FY 2001 and to drop below 1 from 2004. These results

³ OkARDv3.4 using S and ANC production schedules and including limestone from the Geneva quarry according to the current mine plan.

⁴ Data from the current Harvey Creek and Ok Mani bulk sampling program will be compared with the past production figures to help define this lag period.

⁵ The NAPP and NAG data at OTML suggests that a ratio of 1.5 should be appropriate for Bige but because of S and ANC segregation during stacking, a ratio of 2 is recommended.

suggest a high risk of ARD from dredge sands that are located above permanent water and exposed to atmospheric oxygen.

Figure 7 shows the predicted NAPP trends of dredge sands for the NAPP minus 150 target and NAPP minus 100 target. The preliminary results of the current Harvey Creek investigations indicates that a NAPP of minus 100 may control ARD in the waste rock dumps (Harvey Creek, Taranaki and Ok Mani). However, the reduced ANC load under this option will significantly influence the NAPP of the river deposited and dredged sediments unless action is take to remove sulphide from the tailings or dredge discharge streams or provide additional limestone. Figure 7 indicates that under a NAPP minus 100 plan, the average annual NAPP of the dredge sands during FY 2002 could be +10 kgH₂SO₄/t. At this average NAPP, PAF sands are likely to occur about 45% of the time. In addition, the ANC/MPA factor of safety falls below 1 in FY2002. Operating at a NAPP minus 100 plan will therefore further increase the ARD risk at Bige.

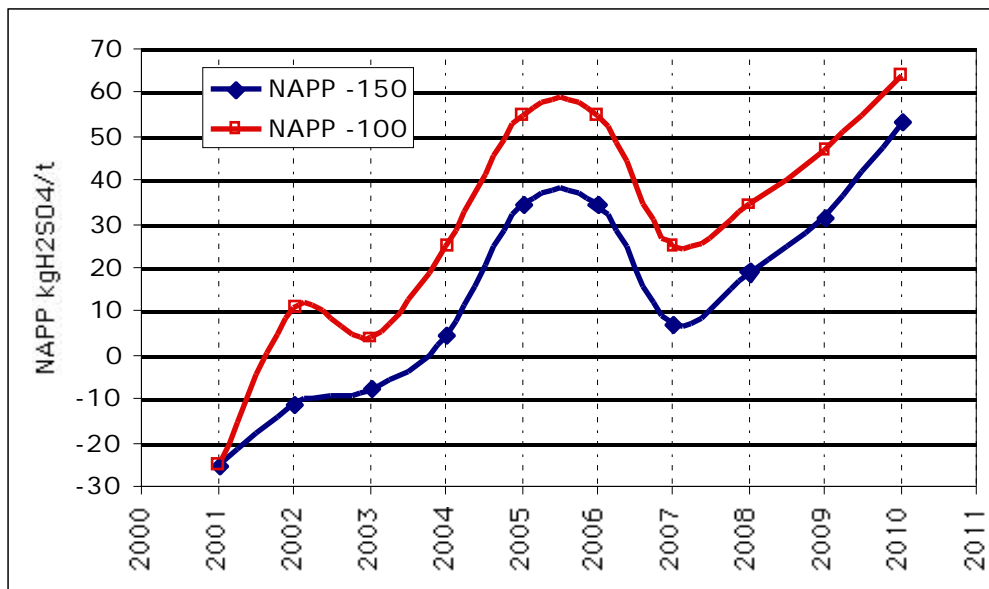


Figure 7: Predicted NAPP of dredge sands for NAPP -150 and NAPP -100 targets.

Although there are a number of assumptions associated with the inputs for the OkARD model, it is clear that an ANC deficit is likely to develop within the dredge sands in the short term. The timing will depend on the lag within the Harvey Creek/Ok Mani system but is likely to occur within the next few years. Monitoring dredge sands at Bige and waste rock leaving Ok Mani will give an early warning and hence these programs should be given high priority⁶.

⁶ A program for effectively monitoring waste rock geochemistry leaving the Ok Mani storage is yet to be developed.

The ongoing results of the net acid generation (NAG) tests and column leach program continue to confirm the significant geochemical lag in many of the NAPP positive river deposited materials and dredge sands. These samples, although NAPP positive, have a moderate to high ANC which delays the development of acid conditions. The indicated lag period for samples could be more than two years which will significantly aid the management of PAF exposed river deposits and stockpiled dredge sands. However, with the indicated reduction in the overall ANC input, the lag period for future PAF sediments are likely to be reduced.

5.0 Summary and Recommendations for Bige Dredge Operation

The following points summarise the current understanding of the Bige dredge sediment geochemistry:

- The acid-base balance of the stockpiled dredge sediments is variable. Results from the monitoring programs indicate the following 10th, 50th and 90th percentiles for S, ANC and NAPP:

Total Sulphur (%S): 1.28, 2.27, 3.30

ANC (kgH₂SO₄/t): 63, 92, 120

NAPP (kgH₂SO₄/t): -64, -24, +16

- Approximately 28% of the 576 monitoring samples tested to-date are NAPP positive and 15% have been confirmed as potentially acid forming (PAF). A number of programs have now been implemented to determine the distribution of the PAF materials occurring within the stockpile. These data will be evaluated when available.
- The current factor of safety (average ANC/MPA ratio of 1.4) for the dredge sediments is at the lower limit of typical industry values for non-acid forming tailings and process waste.
- The current stockpiled PAF sediments have a significant lag period and would require a long period of exposure before acid conditions were developed (possibly a number of years). Due to the relatively small proportion of PAF material within the current stockpile (estimated to be <15%) and the long lag period of the PAF material the risk of significant ARD from the current stockpiled sediments is low.
- As mining and milling continue the ANC load will decrease, sulphur will remain high and the NAPP will progressively increase. Therefore the factor of safety will continue to decrease and will be less than 1 within the next few years. Under the NAPP minus 150 plan the annual average NAPP of dredged sands is expected to be positive within the next few years and PAF sands are likely to occur more than 50% of the time.
- The risk of ARD from future stockpiled sediments is high but the potential ARD impact on the Ok Tedi and Fly River system is predicted to be negligible under normal flow conditions. Under low flow conditions there is a low risk of localised impact from ARD and under El Nino conditions the impact is predicted to be moderate to high within the Ok Tedi but expected to remain low in the Fly.

Based on the current understanding the most geochemically secure option and therefore lowest ARD risk for management of PAF mine derived sediments is to discontinue

dredging and allow the sediments to be transported down-stream where deposition in more geochemically stable (i.e. less oxidising) areas is likely to occur.

However, if dredging is to be continued to provide downstream physical benefits then the following are recommended to reduce the ARD risk from the dredge operation at Bige:

- An ANC/MPA ratio of 2 in dredge discharge sediments is recommended to achieve a NAF stockpile for control of ARD and copper leaching. Reducing the sulphide load or increasing the ANC load will increase the ANC/MPA ratio.
- Removal of sulphide from the dredge discharge is an option for achieving an ANC/MPA ratio of 2. OkARD modelling indicates that removal of 30 to 50% of the sulphur during years 2001 to 2004 and 70 to 80% during years 2005 to 2010 would meet this target.
- Because of the pending shortfall in ANC over the next year, ongoing operation of the stockpile must include a diligent operational monitoring program with fast turn around so that placement decisions can be made on the basis of the anticipated trend in sediment characteristics. This should be linked to monitoring outflow from the mill as well as material leaving the Ok Mani and entering the Ok Tedi.
- PAF material must be placed low in the stockpile profile and covered with NAF material. Where possible the PAF material should be located so that it will be permanently under water. No PAF material should be placed within the outer walls or bunds.
- It is recommended that the current stockpile be designed and configured so that zones for placement of PAF and NAF sands can be carefully managed. Sealing below the base of PAF cells is unlikely to be necessary provided the cells can be covered and the PAF material isolated from atmospheric oxygen. The long geochemical lag identified in the current dredge sediments means that acid generation is unlikely to occur while PAF cells are open and hence basal sealing will not be necessary. Monitoring is recommended to identify if the lag period is likely to be affected by changing material characteristics.
- Removal of sulphur from the dredge discharge or avoiding high sulphur material within the slot are options that need urgent attention. Without the removal of sulphur to maintain a factor of safety (ANC/MPA) near 2, the current physical benefits of the dredging operation are likely to be jeopardised by a significant ARD liability that will require on-going treatment and maintenance.
- Preliminary results from the dredge slot sediment investigations indicate that sulphides are preferentially deposited on the eastern side of the slot. If selective dredging within the slot is likely to be a viable method for controlling the sulphur

load in the dredge sediments, it is recommended that an investigation be performed to confirm and refine this distribution.

- Recent investigations have shown that sulphides (framboidal pyrite) are actually forming in the lower Ok Tedi. Hence sulphides removed at the dredge could be safely placed back into the river and transported down stream where deposition in geochemically stable areas is likely to occur. Alternatively, the sulphides could be placed in cells within the dredge stockpile and isolated from atmospheric oxygen. The quantity of sulphur removed would range from 0.2 to 0.35 million tonnes per year which is equivalent to about 0.4 to 0.7 million tonnes of pyrite.

The outstanding results from the current intensive sampling and testing program at Bige and the results of the Harvey Creek and Ok Mani program will be available within the next 6 to 8 weeks. These data will help to confirm the trends and issues raised in this report. It is also important that the waste rock production inventory is reviewed and confirmed and if possible, the sulphur grade of waste rock types mined in 1995, 1996 and 1997 confirmed.