Metallurgical Test Report – Leaching of Copper Ore

Borroloola Project

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CAUTIONARY STATEMENT

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1 SUMMARY

A series of metallurgical leach tests has been conducted on a sample of ore supplied by Pacifico Minerals Ltd from the Borroloola Project in the Northern Territory. The testing was a preliminary attempt to show whether the ore was amenable to copper extraction using the GlyLeach™ process. Table 1 and Figure 1 below summarise the findings:

Table 1: Summary of Test Conditions and Results

	Test:	1	2	3	4
	Method:	**GlyLeach™**	**Acid**	**GlyLeach™**	**Acid**
	Particle size:	**6 mm**	**6 mm**	**20 micron**	**20 micron**
Duration	h	48	48	48	48
Assay head grade (Cu)	%	1.03	1.03	1.03	1.03
Residue grade (Cu)	%	0.92	0.82	0.89	0.75
Copper extraction (of total Cu)	%	12.2	24.8	13.3	30.5

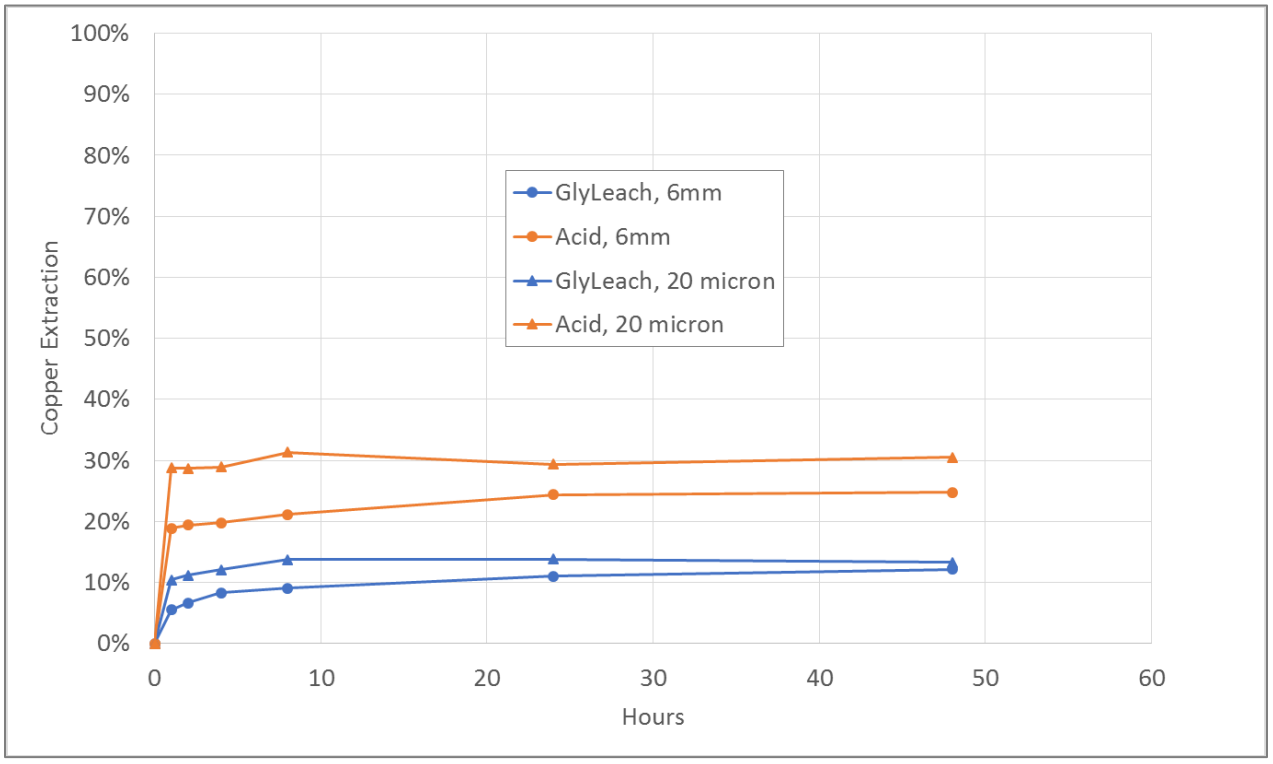

Figure 1 – Leach results

Results from the mineralogical examination, sequential assay and bottle roll tests all indicate that the ore is not amenable to leaching by either acid or alkaline glycine methods. It appears that most of the copper is locked in solid solution with iron oxides, and would require very intensive conditions to extract.

2 BACKGROUND

Pacifico Minerals Ltd is evaluating the Borroloola copper project in the Northern Territory. MPS have been approached to assess the heap leach potential of the ore, in particular using GlyLeach™ technology. The ore is high in carbonates so conventional acid leaching is expected to be difficult.

A series of sighter tests was carried out to assess the response of the ore to both conventional acid leaching and the GlyLeach™ process.

3 SAMPLES AND SAMPLE PREPARATION

Two bags of RC chips from a single drill hole at Coppermine Creek were received for testing. The two bags were combined and treated as a single sample. The sample preparation procedure is shown in the diagram below.

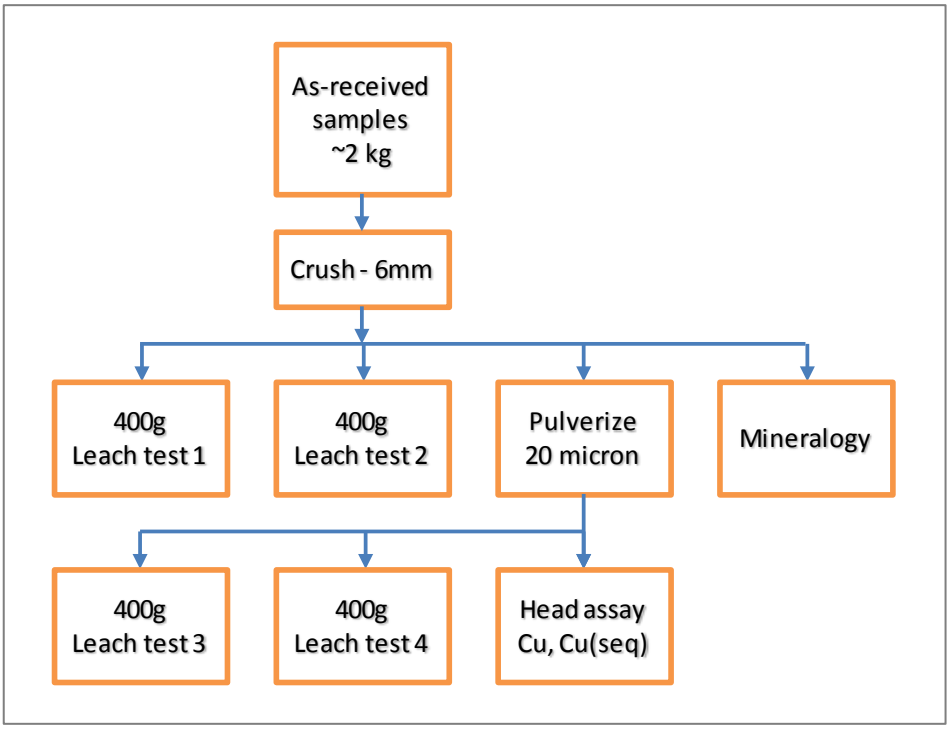

Figure 2 – Sample preparation

4 SAMPLE CHARACTERISATION

The sample was characterised by microscopic examination as follows:

> It is a lateritic soil with large iron (maghemite/goethite mixture) pisolites and irregular hard pan pieces. Dark brown to dark umber in colour. Visible copper is rare, perhaps representing 0.15 to 0.25 % Cu as large (1-4 mm) well-formed acicular prismatic crystals of pure malachite

enclosed within the precipitated iron oxide matrix. No other copper minerals were observed in the sample. More malachite can be found by breaking open large iron pieces.

Expected recovery by either dilute acid or GlyLeach™ would be no more than between 15 and 30% of the copper.

Head assay results are as follows:

Table 2: Head assay

	Copper				
	Total	Water sol.	Acid sol.	CN sol. (seq.)*	CN sol (head)*
Grade	1.03%	<10 ppm	0.36%	0.02%	0.20%
Distribution	100%	0%	35%	2%	19%

Note – CN sol (seq.) refers to the sequential cyanide soluble assay, performed on the residue of the acid soluble test. CN sol (head) refers to cyanide soluble assay performed directly on the head sample.

The sequential assay indicates that:

- 35% of the copper is in acid soluble minerals, such as oxides, carbonates, silicates
- 2% of the copper is in secondary sulphides, such as chalcocite and covellite
- 19% of the copper is in glycine soluble minerals (oxides, carbonates, secondary sulphides but not silicates)
- 63% of the copper is in refractory minerals such as chalcopyrite, or in this case most likely in solid solution with iron oxides

5 TEST PROGRAM

A total of 4 leach tests were carried out. Conditions are outlined in the table below.

Table 3: Test conditions

		Test:	1	2	3	4
		Method:	GlyLeach™	Acid	GlyLeach™	Acid
		Particle size:	6 mm	6 mm	20 micron	20 micron
Equipment			Bottle roll	Bottle roll	Bottle roll	Bottle roll
Glycine	g/L		20	-	20	-
pH target			11	1.5	11	1.5
Temperature	C		ambient	ambient	ambient	ambient
Solids content	%		16.7%	16.7%	16.7%	16.7%
Duration	h		48	48	48	48

In all cases, the lixiviant was added well in excess of the stoichiometric requirements for complete dissolution.

6 RESULTS

Summary results and leach curves are presented below.

6.1 Sulphuric acid leach

Table 4: Test results – Acid leach

Test		2	4
Particle size		6 mm	Pulverised
Assay head grade (Cu)	%	1.03	1.03
Calculated head grade (Cu) (residue + solution)	%	1.04	1.00
Residue grade (Cu)	%	0.82	0.75
Copper extraction (of total Cu)	%	24.8	30.5
Copper extraction (of acid sol Cu)	%	70.9	87.1

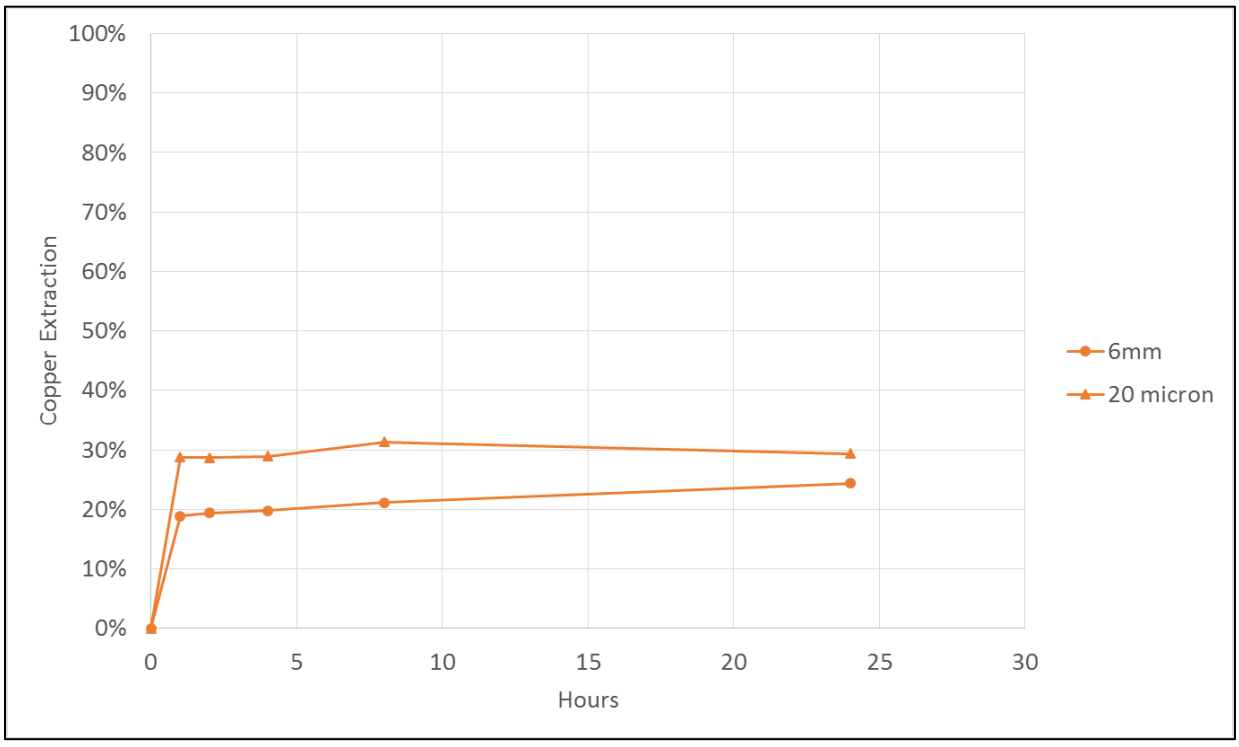

Figure 3 – Leach curves – Acid leach

6.2 GlyLeach™

Table 5: Test results – GlyLeach™

Test		1	3
Particle size		6 mm	Pulverised
Assay head grade (Cu)	%	1.03	1.03
Calculated head grade (Cu) (residue + solution)	%	1.05	1.01
Residue grade (Cu)	%	0.92	0.89
Copper extraction (of total Cu)	%	12.2	13.3
Copper extraction (of CN sol Cu*)	%	64.2	70.0

Note that copper extraction is here presented as a percentage of cyanide soluble copper in the head sample. GlyLeach™ can generally extract the same minerals as cyanide, so this standard assay provides a useful benchmark

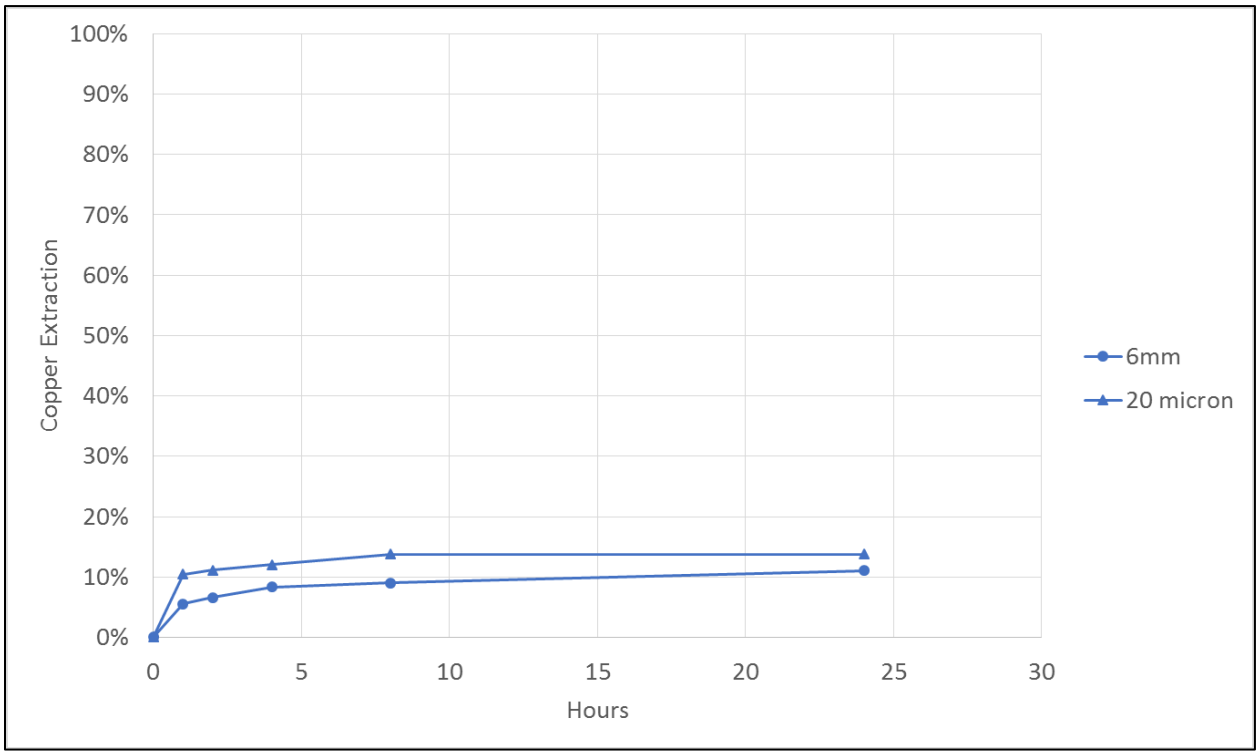

Figure 4 – Leach curves – GlyLeach™

7 CONCLUSIONS

- Mineralogical examination as well as sequential assays show that the copper is mostly present as minerals refractory to extraction by leaching, using either conventional sulphuric acid or alkaline glycine.
- The leach tests showed poor leaching in both acid and alkaline glycine, consistent with the findings of the sample characterisation.
- Fine grinding gave only a modest improvement in leaching compared to the crushed material. This shows that the poor extractions are not due to inadequate mineral liberation.

8 RECOMMENDATIONS

Based on the sample supplied, the material is not amenable to extraction by either GlyLeach™ or conventional means.

Most of the copper appears to be locked in solid solution with iron oxides, so an intensive digestion process would be required for leaching. This would involve a costly combination of temperature and reagents, and is unlikely to be economic.

No further tests are recommended on this sample. However, alternative ore domains from the same region may give a quite different response.

For any future targets, it is recommended to complete mineralogical examinations and sequential assays before starting metallurgical testing.

APPENDIX A: COMPANY INFORMATION

About Mining & Process Solutions (MPS)

Mining and Process Solutions (MPS) was established with a deliberate strategy to bring innovative thinking and technology to the mining and processing of deposits. Through strategic relationships nurtured over many years with selected global organisations, we have access to experience, innovative ideas, and technology that can provide a step change to any base or precious metals project.

Our collaboration includes:

- **A Collaboration agreement with CSIRO.** Positioned within the Australian Minerals Research Centre in Perth as part of a collaborative agreement with CSIRO (Commonwealth Scientific and Industrial Research Organisation), MPS has capacity to draw on world-class hydrometallurgical capabilities and facilities when needed.
- **Global network capability and access to low cost leaching systems.** MPS is a partner in a global agency with Innovat Mineral Processing Solutions (Canada) and Mineria & Technologias 2R (MinTec2R) in Chile. This agency provides MPS with exclusivity in the Australasian region to an emerging technology called Continuous Vat Leaching (www.vatleach.com).
- **Exclusive license holder for the Glycine leaching process developed by Curtin University.** MPS has an exclusive license and support from Curtin University for their Glycine Lixiviant for low cost leaching of base and precious metals.

About GlyLeach™

GlyLeach™ is an environmentally benign hydrometallurgical process that will leach copper from copper oxide, mixed oxide and supergene ores, and even primary copper ores.

Glycine is one of the simplest and cheapest amino acids, and is available in bulk. It has a number of attractive chemical and physical properties and it is the main reagent in the Glycine leaching process. Glycine has a number of advantages over any other copper lixiviants:

- It is an environmentally safe and stable reagent, and leaching is in an alkaline based circuit;
- It can enhance the solubility of copper ions in aqueous solutions and forms stable complexes with copper;
- It is easily recovered and recycled. Apart from normal process losses, the Glycine is recoverable.
- It is non-volatile (compared with HCN, NH_3, HCl), crystalline and highly soluble in water.

About GlyCat™

Small amounts cyanide used in conjunction with a glycine-dominant lixiviant has many beneficial properties, particularly for the leaching of precious metals with elevated copper content. These are:

- Overall reagent cost is greatly reduced. A small addition of glycine can cause a marked reduction in cyanide consumption. This is a consequence of copper preferentially bonding to glycine rather than cyanide, thus freeing the cyanide to leach gold.
- The cupric glycinate is an effective oxidation agent that will oxidize gold and replace the need for free oxygen in the reaction.
- Gold extraction is around four times faster than cyanide alone.
- After the duration of a gold-copper leach (typically 24-48 hours), the free and WAD cyanide falls comfortably within the limits of the ICMC code, whilst the main reagent (glycine) is recovered and recycled.

MPS has branded this catalytic process GlyCat™.