Title: IMPROVED LEACHING OF BASE METALS

Abstract: A method for the leaching of base metals from oxide ores, the method characterised by the method steps of: a) Separating the ore to be leached into fine and coarse fractions or streams; b) Leaching the coarse fraction of the ore in a leach solution with a suitable leach agent for the leaching of the contained metals; and Utilising the fine ore fraction or part thereof to neutralise or partially neutralise the leach agent contained in a pregnant leach solution produced in step b), prior to passing some or all of the pregnant leach solution on for further refinement or other treatment as required.
"Improved Leaching of Base Metals"

Field of the Invention

The present invention relates to the leaching of base metals from oxide ores. More particularly, the present invention is intended to have application in the recovery of nickel and cobalt from lateritic ores in the context of heap leaching.

Background Art

The application of heap leaching techniques in the recovery of base metals, for example copper, from oxide ore deposits is well established. For example, if copper is the base metal of interest and the host rock is sufficiently oxidised, the oxide ore can be crushed to a suitable size, stacked in heaps and leached with a sulphuric acid solution (SME Minerals Processing Handbook, Ed. NL Weiss, Society of Mineral Engineers ISBN 0-89520-433-6).

It is often the case that the ore, after crushing, will contain a significant level of fine particulate material, such as clay or clay-like material. This material, if preventative steps are not taken, can interfere with the permeability of the heap, and consequently reduce the efficiency of the heap leach process. In dealing with such ores, it is common practice to agglomerate the ore with water or process solution, and with cement. The agglomeration is conducted in an agglomeration drum, immediately prior to stacking of the heap.

In the agglomeration process the fine particles stick to the coarser particles and thereby make the subsequently formed heap more permeable to the leach process solution. The fines in the heap are immobilised during agglomeration and cannot then migrate and give rise to blinding of the heap, and/or channelling of leach solution, which may otherwise lead to long leach times and to incompletely leached pockets within the heap.

Where sulphuric acid is used to heap leach nickel from laterite ores, the leach kinetics can be very slow. High acid strength leach solutions may be utilised to
partially overcome this. In such a situation the rate of acid consumption as the solution passes through the heap will also be slow and the acid strength in the solution emanating from the base of the heap will not vary greatly from that in the solution being supplied to the top of the heap. This will result in a high acid concentration in the solution that is being bled from the leaching circuit into the metals recovery circuit. If it is not possible to recover this acid then this can become a major operating cost, which will be compounded by the need to add more chemicals, such as limestone, in order to neutralise the acid so that the base metals can be effectively recovered.

The present invention has as one object thereof to overcome the abovementioned problems associated with the prior art or to at least provide a useful alternative thereto.

The preceding discussion of the background art is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was part of the common general knowledge in Australia or any other country or region as at the priority date of the application.

Disclosure of the Invention

In accordance with the present invention there is provided a method for the leaching of base metals from oxide ores, the method characterised by the method steps of:

a) Separating the ore to be leached into fine and coarse fractions or streams;

b) Leaching the coarse fraction of the ore in a leach solution with a suitable leach agent for the leaching of the contained metals; and

c) Utilising the fine ore fraction or part thereof to neutralise or partially neutralise the leach agent contained in a pregnant leach solution
produced in step b), prior to passing some or all of the pregnant leach solution on for further refinement or other treatment as required.

Preferably, some or all of the neutralised or partially neutralised pregnant leach solution of step c) is passed to a base metal recovery circuit.

5 Still preferably, the ore is a laterite ore containing nickel and cobalt.

Still further preferably, the coarse ore fraction is leached in one or more heaps.

In one form of the invention, the ore may have been agglomerated with sulphuric acid prior to forming the or each heap.

In a further form of the invention sodium metabisulphite or sulphur dioxide is added to a sulphuric acid based leach solution.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to one embodiment of the present invention and the accompanying drawings, in which:-

15 Figure 1 is a diagrammatic representation of a simple leach circuit in accordance with the method of the present invention;

Best Mode(s) for Carrying Out the Invention

In Figure 1 there is shown a flow-sheet demonstrating one potential commercial application of a method in accordance with the present invention in use in a heap leach environment.

A laterite ore containing nickel and cobalt is mined and crushed to pass through a 12mm screen in a crushing and screening plant 10. During the crushing process, any particles of a size less than about 75 micrometers in diameter (<75μm), a fine fraction, are removed from the bulk of the ore and stored in a fines storage facility
12. A coarse ore heap 14 is stacked on an impermeable membrane 16 in known manner, utilising the coarse fraction of ore greater than 75 micrometers.

The coarse ore heap 14 has arranged thereon a reticulation system 18 to feed the heap 14 with a sulphuric acid based leach solution from a leach solution pond 20, via a pump 22. The leach solution pond 16 is maintained at a suitable acid strength or pH by the addition of sulphuric acid.

Piping 24 is provided to direct pregnant leach solution to a sump 26, from which the pregnant leach solution may flow by gravity through a line 28 to the leach solution pond 20, or may be bled through line 30 from the leaching process to a fines neutralisation circuit 32. The sump 26 contains a pump (not shown).

Fine ore from the fines storage facility 12 is utilised in the fines neutralisation circuit 32 to neutralise some or all of the sulphuric acid contained in the solution in the bleed from the heap 14. Some or all of this treated solution may then be passed on to a metals recovery circuit. Solids waste from the fines neutralisation circuit 32 can be discarded, as shown in Figure 1. Alternatively, in the event the solid waste contains high enough metal values, it may be recycled back into the leaching circuit and mixed back into the coarse ore.

The method of the present invention can be seen to offer efficiencies when compared with prior art processes, at least in part through the use of fines to neutralise pregnant leach solution prior to metal recover.

It is envisaged that an agglomeration step may be utilised prior to stacking of the heap 14 and that sodium metabisulphite or sulphur dioxide may be added to the sulphuric acid based leach solution.

It is further envisaged that the distinction between fine and coarse fraction may differ between applications. That is, the sizing of what constitutes a fine may change depending upon a variety of factors within the method, including the specific mineralogy of the ore.
Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.
Claims

1. A method for the leaching of base metals from oxide ores, the method characterised by the method steps of:

   a) Separating the ore to be leached into fine and coarse fractions or streams;

   b) Leaching the coarse fraction of the ore in a leach solution with a suitable leach agent for the leaching of the contained metals; and

   c) Utilising the fine ore fraction or part thereof to neutralise or partially neutralise the leach agent contained in a pregnant leach solution produced in step b), prior to passing some or all of the pregnant leach solution on for further refinement or other treatment as required.

2. A method according to claim 1, wherein some or all of the neutralised or partially neutralised pregnant leach solution of step c) is passed to a base metal recovery circuit.

3. A method according to claim 1 or 2, wherein the ore is a laterite ore containing nickel and cobalt.

4. A method according to any of claims 1 to 3, wherein the coarse ore faction is leached in one or more heaps.

5. A method according to claim 4, wherein the ore is agglomerated with sulphuric acid prior to forming the or each heap.

6. A method according to any one of claims 1 to 4, wherein the leach agent is or contains sulphuric acid.

7. A method according to claim 5, wherein sodium metabisulphite or sulphur dioxide is added to the sulphuric acid based leach solution.
8. A method according to any one of the preceding claims, wherein ore particles less than about 75μm constitute the fine fraction.

9. A method according to any one of the preceding claims, wherein ore particles greater than about 75μm constitute the coarse fraction.

10. A method for the heap leaching of nickel and/or cobalt from oxide ores, the method characterised by the method steps of:

   (a) Separating the ore to be leached into fine and coarse ore fractions or steams;

   (b) Leaching the coarse fraction of the ore in one or more heaps with a leach solution containing a sulfuric acid based leach agent; and

   (c) Utilising the fine ore fraction or part thereof to neutralise or partially neutralise the leach agent contained in a pregnant leach solution produced in step b), prior to passing at least a portion of the pregnant leach solution to a base metal recovery circuit.

11. A method for the leaching of base metals from oxide ores, the method substantially as hereinbefore described with reference to the accompanying figure.
# INTERNATIONAL SEARCH REPORT

**International application No.**

PCT/AU2005/000901

## A. CLASSIFICATION OF SUBJECT MATTER

**Int. Cl.**: C22B 3/03, 3/04, 23/04, 23/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC \* AS ABOVE

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Derwent WPI: IPC \* as above and (nickel or cobalt or leach+ or coars+ or fine+)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
<td>US 6319389 B1 (Fountain et al) 20 November 2001 Whole Document</td>
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<tr>
<td>A</td>
<td>US 5642863 A (Patzelt et al) 1 July 1997 Whole Document</td>
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X See patent family annex

Further documents are listed in the continuation of Box C

* Special categories of cited documents:
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document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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**Date of the actual completion of the international search**

22 July 2005

**Name and mailing address of the ISA/AU**

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**Date of mailing of the international search report**

28 JUL 2005

**Authorized officer**

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Form PCT/ISA/210 (second sheet) (January 2004)
INTERNATIONAL SEARCH REPORT
Information on patent family members

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX