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La Oficina de Patentes y Marcas de los Estados Unidos

10 de julio de 2019

EL PRESENTE DOCUMENTO CERTIFICA QUE ADJUNTO AL MISMO SE ENCUENTRA UNA COPIA FIEL DE LOS REGISTROS DE LA OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS UNIDOS DE LOS DOCUMENTOS DE LA SOLICITUD DE PATENTE IDENTIFICADA A CONTINUACIÓN QUE CUMPLIERON CON LOS REQUERIMIENTOS PARA OTORGAMIENTO DE UNA FECHA DE PRESENTACIÓN BAJO EL CÓDIGO DE ESTADOS UNIDOS 35 USC 111.

NÚMERO DE SOLICITUD: 62/688,610
FECHA DE PRESENTACIÓN: 22 de junio de 2018

EL SIGUIENTE ES EL CÓDIGO Y NÚMERO DE SU SOLICITUD DE PRIORIDAD, A SER USADO EN LA PRESENTACIÓN EN EL EXTRANJERO BAJO LA CONVENCIÓN DE PARIS: US62/688,610

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JOHN A BURSON
Funcionario que certifica

Estados Unidos de América. A quien corresponda. Departamento de Comercio de los Estados Unidos. Oficina de Patentes y Marcas de los Estados Unidos.

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Por la presente se certifica que la que se adjunta es copia fiel de los registros que obran en la Oficina de Patentes y Marcas de los Estados Unidos de la solicitud de patente identificada a continuación, que cumple con los requisitos para que se le otorgue una fecha de presentación en virtud de lo estipulado en el artículo 111, Título 35, del Código de los Estados Unidos.

Número de solicitud: 62/688.610

Fecha de presentación: *22 de junio de 2018*

El código de país y el número de su solicitud de prioridad, para ser usados en presentaciones en el exterior bajo la Convención de París, son *US62/688.610*.

Por facultad del Subsecretario de Comercio para la Propiedad Intelectual y Director de la Oficina de Patentes y Marcas de los Estados Unidos

[Aparece una firma ilegible]

JOHN A. BURSON – Funcionario Certificante

[Aparece una estampilla que reza:] Oficina de Patentes y Marcas de los Estados Unidos. Departamento de Comercio.

Acuse de recibo electrónico

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Título de la invención: PROCESAMIENTO DE MENAS DE LATERITA

Inventor nombrado en primer lugar/Nombre del solicitante: Anthony Owen
FILMER

Número de cliente: 22204

Presentada por: Jeffrey Costellia / Donald Sias

Persona autorizada por: Jeffrey Costellia

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Cuenta de depósito: [En blanco]

Usuario autorizado: [En blanco]

[N. de la T.: Se tradujeron solo las partes pertinentes de los formularios.]

PROCESAMIENTO DE MENAS DE LATERITA

Antecedentes de la invención

La ley de níquel en las menas de laterita es muy heterogénea, pero esto
5 generalmente no es uniforme en todo el cuerpo de la mena en cualquier
dimensión. Las costuras de alto grado están intercaladas con zonas de bajo
grado, y no se concentran uniformemente en la superficie o la base del cuerpo de
mena.

La estimación de un bloque de mena establece todos los procesos
10 posteriores (extracción, mezcla y procesamiento) tal como se ilustra en la Figura
1.

La heterogeneidad espacial puede ilustrarse en forma de curva de tonelaje
de ley. En la Figura 2, la curva de tonelaje de ley de un cuerpo de mena brasileño
se ilustra en términos de la relación entre ley y tonelaje para bloques discretos de
15 mena de 50 toneladas, con una ley de corte de 0,9% de níquel.

Debido a que la naturaleza de la heterogeneidad no es uniforme, no puede
utilizarse minería selectiva para separar la mena de menor ley que está
intercalada con la mena de alta ley, sin un programa de muestreo excesivo, y el
uso de equipos de carga muy pequeños. Este enfoque minero altamente selectivo
20 es antieconómico.

Por esta razón, un recurso de níquel laterítico debe tener, en promedio,
una ley media lo suficientemente alta como para justificar su procesamiento para
convertir la mena en una forma utilizable. Esto elimina el atractivo económico de
los recursos de níquel, a pesar de su ubicación en lugares que de otro modo
25 serían favorables para la minería y el procesamiento.

Las lateritas de níquel son típicamente fundidas o lixiviadas a alta
temperatura.

En ambos casos, el costo de procesamiento es muy superior al costo de extraer la mena. Por lo tanto, la ley de alimentación de la laterita es el determinante principal del costo unitario de producción de níquel (\$/t de níquel).

5 Los elementos de impureza también son muy importantes en el procesamiento. Por ejemplo, la relación de sílice a magnesia es muy importante para lograr temperaturas de operación satisfactorias en la fundición en horno eléctrico de lateritas de níquel. Y el contenido de magnesio soluble del mineral de laterita en la lixiviación a alta temperatura afecta en gran medida el consumo de ácido por tonelada de níquel.

10 Estos componentes de ganga son lo suficientemente importantes como para que, aunque la ley de níquel sea aceptable para el procesamiento, el mineral no sea económicamente viable o deba mezclarse con otro mineral en otro lugar del depósito para producir un flujo de alimentación dentro de las especificaciones aceptables.

15 Los componentes de ganga también son heterogéneos en el cuerpo de mena, por lo que la extracción selectiva nuevamente no es posible, excepto en circunstancias limitadas.

La mejora del contenido de níquel de la mena laterítica antes del procesamiento a altas temperaturas ha sido desde hace tiempo un deseo del mundo metalúrgico, pero a diferencia de los sulfuros, no existe un método fácil de beneficiación. Esto se debe a la incorporación del níquel en grandes proporciones de la matriz de ganga, a diferencia de muchos otros metales que existen como partículas minerales discretas de alta ley en la mayor parte de la ganga. La única técnica de beneficiación que ha obtenido éxito comercial es la detección. Esto a veces se puede utilizar para eliminar el sobredimensionado rico en sílice del resto de la laterita de níquel y, por lo tanto, aumentar ligeramente la ley de níquel.

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Durante la última década, el equipo de detección para la aplicación de clasificación a granel está cada vez más disponible comercialmente. Los sensores se han desarrollado para el análisis multielemento de menas en transportadores que funcionan a velocidad normal. Cuando se integra con derivadores, las mediciones se pueden utilizar para controlar los flujos de material a granel. Estos sensores se han utilizado típicamente para mezclar pilas de reservas para cumplir con las especificaciones del cliente, y han encontrado aplicación comercial principalmente en las industrias del mineral de hierro y carbón.

Este sistema de sensores y derivadores también se ha propuesto recientemente para la clasificación a granel de menas de cobre, a fin de permitir el rechazo de las fracciones de mena ricas en gangas. El sensor mide el cobre presente en la mena triturada y, en función de la ley, rechaza el material para desecharlo, o lo almacena en reserva de baja ley, o lo envía al molino para la molienda fina de la mena de mayor ley. El concepto se denomina clasificación a granel.

SÍNTESIS DE LA INVENCION

De acuerdo con la invención, se proporciona un método para procesar menas de laterita que incluye los pasos de:

obtener mena de laterita heterogénea extraída;
someter la mena heterogénea a trituración; y
clasificar a granel la mena triturada heterogénea para obtener una ganga y una mena de laterita clasificada que sea adecuada para su posterior procesamiento.

De acuerdo con la invención, se evita la homogeneización de la mena durante la extracción, la carga y el transporte de la mena, para mantener la integridad espacial del cuerpo de mena natural. La mena extraída puede cargarse

en un camión y entregarse en una trituradora fija para su trituración, o triturarse directamente en una trituradora móvil.

Preferiblemente, la mena no se mezcla, por ejemplo, por almacenamiento en pilas antes de la molienda.

- 5 Preferiblemente, la mena triturada no se mezcla, por ejemplo, por almacenamiento en pilas antes de la clasificación a granel.

En la etapa de clasificación a granel, la mena es clasificada por un clasificador a granel que comprende un sensor, un derivador y un transportador, en donde:

- 10 el sensor determina la ley promedio que pasa a lo largo de un transportador desde la trituradora hasta el derivador;

el derivador es controlado para dirigir paquetes seleccionados de mena en el transportador a diferentes destinos, por ejemplo, ganga que se puede desechar o almacenar en pilas y clasificar la mena de laterita para su posterior procesamiento.

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BREVE DESCRIPCIÓN DE LOS DIBUJOS

La **Figura 1** es un diagrama de bloques que muestra las implicancias de la heterogeneidad en todas las lateritas de níquel en relación con una industria minera típica;

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La **Figura 2** es una curva de tonelaje de ley de un cuerpo de mena brasileño; y

La **Figura 3** es un diagrama de bloques que muestra las implicancias del análisis y la separación después de extraer una mena de laterita de níquel mediante clasificación a granel.

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DESCRIPCIÓN DE LAS FORMAS DE REALIZACIÓN PREFERIDAS

La presente invención es una configuración de extracción, trituración y análisis de mena de laterita de níquel en un proceso de beneficiación que permite el rechazo eficiente de mena de baja ley para desecho o para pila de reserva de baja ley, y combina la fracción de mena de alta ley para cumplir con las especificaciones del procesamiento posterior, ilustrado en la Figura 3.

Mediante el uso de beneficiación basada en la heterogeneidad espacial, denominada clasificación a granel,

- La extracción de la mena de laterita se lleva a cabo normalmente con equipos dimensionados para optimizar el proceso de extracción. La carga puede ser a un camión, a una trituradora fija o directamente a una trituradora móvil.
- La mena se vierte directamente en una trituradora sin una pila de reserva intermedia, manteniendo así su heterogeneidad, para reducir el tamaño adecuado para su presentación al sensor elemental.
- El sensor determina la ley promedio que pasa a lo largo de un transportador desde la trituradora hasta un sistema derivador, que se controla para dirigir los 'paquetes' de mena en el transportador a diferentes destinos, dependiendo de su composición.
- Los parches de mena de níquel de bajo grado o aquellos con proporciones inaceptables de ganga se separan y descartan si no son económicos para su procesamiento, o se almacenan en pilas si son potencialmente atractivos económicamente pero están fuera de la ley preferida para el procesamiento inmediato.
- La mena de níquel de mayor ley puede estar dentro de las especificaciones para un procesamiento adicional, en cuyo caso se puede dirigir al flujo de alimentación del proceso.

- Sin embargo, si la laterita de alta ley está fuera de especificación, se asigna a una pila de reserva. Aquí se usa para mezclar con otras menas de alta ley con componentes de ganga compensados, por lo que el compuesto combinado de mena de alta ley cumple con las especificaciones para el procesamiento.

Los elementos importantes del éxito de la invención son los siguientes:

- Evitar la homogeneización tanto como sea posible durante la extracción, la carga y el transporte de mena, a fin de mantener la integridad espacial del cuerpo de mena natural.
- Evitar las pilas de reserva antes de la clasificación, mediante la alimentación directa del flujo de mena de mina a la trituradora y el posterior proceso de clasificación a granel.
- Ajustar el plan de la mina para garantizar un equilibrio aproximado de elementos de ganga, para evitar la necesidad de un almacenamiento a gran escala después de la clasificación a granel.

Mediante la integración del proceso de extracción, clasificación y mezcla en la presente invención, es posible aumentar la ley para una amplia gama de leyes de alimentación de mineral de laterita, aunque con un rendimiento variable.

Por lo tanto, es posible ajustar la alimentación de procesamiento a un valor económico óptimo para el yacimiento. Cualquiera que sea la ley de mena extraída que se suministra al clasificador, el producto para el procesamiento se optimiza. Esto aumenta la flexibilidad en la selección de minerales a extraer.

Esto permite una secuencia de extracción eficiente, en lugar de las actividades actuales en la extracción de laterita de níquel de extracción selectiva

de bolsones de mineral de mayor ley. Se puede aumentar la escala del equipo y reducir la cantidad de remanipulación en la mina.

El espaciado de las perforaciones de control de ley también se puede aumentar, ya que la sensibilidad a los parches de mineral de baja ley en el
5 procesamiento se elimina mediante la clasificación a granel. Los costos del control de ley se reducen.

Y dado que el clasificador a granel puede eliminar parches ocasionales de dilución de minas, es posible incrementar la recuperación de la mina, sin preocuparse por la incorporación accidental de algún mineral marginal.

10 En una característica útil adicional de la invención, la trituración y la clasificación se pueden combinar en un sistema móvil, adecuado para carga directa o transporte muy corto. La corriente de rechazo de baja ley desde el clasificador se vuelve a depositar en la zona minera, lo que permite transportar una mejor ley del mineral a la instalación de procesamiento.

15 El sensor utilizado para medir el contenido de níquel del mineral de laterita, tal como un sensor PGNAAs, también puede medir otros elementos en el mineral. Esto permite un monitoreo de la composición del producto y una mayor separación del mineral en base a estos elementos menores.

Dado este mejor conocimiento de los elementos de ganga, estos pueden
20 equilibrarse en el proceso de minería para proporcionar una mezcla aproximada en el flujo de alimentación al procesamiento. Las fracciones del mineral que cumplen con la ley de níquel, pero no con las especificaciones de gangas, pueden almacenarse. Las reservas de tamaño modesto y composición conocida luego pueden ser recuperadas y mezcladas nuevamente en el flujo de alimentación de
25 procesamiento, cuando existe la oportunidad.

Esto permite la máxima cantidad de alimentación directa del mineral al procesamiento, en lugar de separar las reservas en espera de una mezcla

posterior, reduciendo así el capital de trabajo y el costo de manipulación de materiales.

Por ejemplo, en la fundición de ferroníquel, es esencial alimentar el horno con una proporción adecuada de sílice a magnesia. Típicamente, las lateritas de níquel están formadas por zonas ácidas y básicas, las cuales están fuera de una proporción aceptable de magnesia a sílice. Sin embargo, en la mezcla, la mezcla resultante está dentro de las especificaciones. Es normal asignar cada fracción a una pila de reserva separada, luego mezclar en peso basado en la composición promedio de la reserva, para alimentar el horno y, en última instancia, el horno eléctrico. Utilizando la invención, se analiza la composición del mineral, y los totales acumulados de los contenidos de sílice y magnesia permiten la mezcla directa desde el clasificador al horno. Solo cuando las tasas de extracción de componentes ácidos y básicos no se pueden equilibrar, se requiere un almacenamiento adicional.

La capacidad de establecer el contenido de níquel del flujo de alimentación mediante la clasificación a granel también permite ajustar la ley del mineral en respuesta a los cambios en el precio del níquel.

Áreas de generación de valor

1. Un proceso en el cual el níquel laterítico se extrae, tritura, clasifica y mezcla para producir una fracción con mayor ley de níquel adecuado para el procesamiento, al rechazar una fracción de menor ley del mineral.
2. En el cual el recurso de laterita de níquel anteriormente antieconómico se actualiza para permitir que la fracción de alto ley de ese recurso se procese económicamente.

3. En el cual la eficiencia de la minería y el manejo de materiales también se mejora como consecuencia del impacto reducido de la dilución de la mina en los costos de procesamiento.
4. En el cual la homogeneización del mineral se minimiza durante la extracción, y
5 el mineral extraído se carga directamente para enviarlo a trituración y clasificación.
5. En el cual el clasificador reduce la dilución de la mina al separar los desechos contenidos del mineral extraído restante.
6. En el cual la alimentación al clasificador separa una fracción de alta ley para
10 procesar ahora, y una fracción de ley intermedia para almacenar y procesar más adelante en la vida útil de la mina.
7. En el cual la alimentación al clasificador separa una fracción de alta ley para el procesamiento ahora, una fracción de ley intermedia para almacenar y procesar más adelante en la vida útil de la mina, y una fracción de desechos para la
15 eliminación permanente.
8. En el cual la trituradora y el clasificador a granel se encuentran en el área de minería, para minimizar el costo de manejo de la fracción de baja ley del mineral, y aumentar la ley del mineral transportado a la planta de proceso.
9. En el cual el rechazo de baja ley se vuelve a depositar en el área previamente
20 explotada.
10. En el cual el costo de la perforación y el análisis de control de ley se reduce mediante el uso de la clasificación a granel para controlar la ley de níquel.
11. En el cual se minimiza la doble manipulación de mineral y la reserva de mezcla, al integrar las actividades mineras con el monitoreo en tiempo real de los
25 elementos de ganga críticos, para alimentar directamente gran parte del mineral a la planta de procesamiento.

12. En el cual la ley de níquel se ajusta para optimizar el valor en el precio del día del níquel.

[N. de la T.: Del presente formulario solo se traducen las partes pertinentes.]

Información acerca del solicitante:

El proporcionar información acerca de la cesión en esta sección no sustituye el cumplimiento de cualquiera de los requisitos establecidos en la parte 3 del Título 37 del CFR que exige el registro de una cesión por parte de la Oficina.

Solicitante 1.

No deberá completarse esta sección si el solicitante es el inventor (o el/los inventor/es conjunto/s restante/s en virtud del art. 1.45 del Título 37 del CFR). La información que se ha de suministrar en esta sección es el nombre y el domicilio del representante legal que es el solicitante en virtud del art. 1.43 del Título 37 del CFR; o el nombre y el domicilio del cesionario, la persona a quien el inventor está obligado a efectuar una cesión de la invención, o la persona que demuestra derecho de propiedad suficiente en la materia que es la solicitante en virtud del art. 1.46 del Título 37 del CFR. Si el solicitante es un solicitante en virtud del art. 1.46 del Título 37 del CFR (cesionario, persona a quien el inventor está obligado a efectuar una cesión, o la persona que demuestra el derecho de propiedad suficiente) juntamente con uno o varios inventores conjuntos, entonces el/los inventor/es conjunto/s quienes también son el solicitante deberán identificarse en esta sección.

☒ Cesionario. ☐ [Sin marcar]. Representante legal en virtud del Art. 117, Título 35 del USC. ☐ [Sin marcar]. Inventor conjunto.

☐ [Sin marcar]. Persona a la cual el inventor está obligado a efectuar una cesión.

☐ [Sin marcar]. Persona que demuestra el derecho de propiedad suficiente.

Si el solicitante es el representante legal, indicar con qué facultad efectúa la presentación, el inventor es: [En blanco].

Nombre del inventor fallecido o legalmente incapacitado: [En blanco].

Si el solicitante es una Organización marcar este casillero: ☒

Nombre de la organización: ANGLO AMERICAN SERVICES (UK) LTD.

Información acerca del domicilio postal para el Solicitante:

Domicilio 1: 20 Carlton House Terrace

Domicilio 2: [en blanco]

Ciudad: London Estado/Provincia: [en blanco]

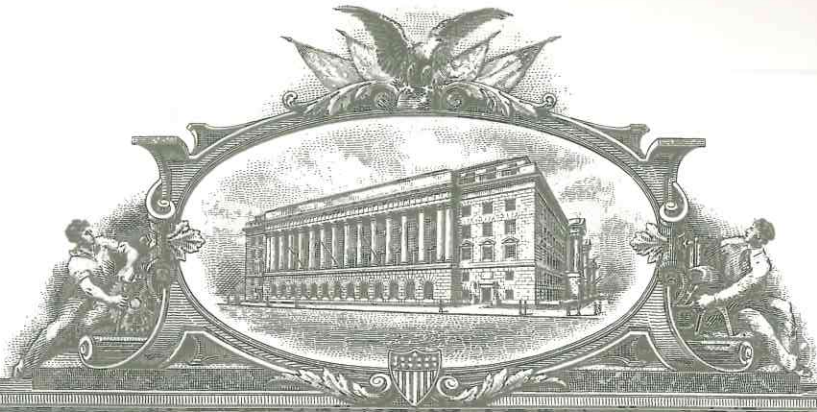
País: UK Código postal: SW1Y 5AN

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UNITED STATES DEPARTMENT OF COMMERCE

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July 10, 2019

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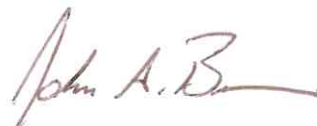
APPLICATION NUMBER: 62/688,610

FILING DATE: June 22, 2018

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US62/688,610

**By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office**





**JOHN A BURSON
Certifying Officer**

Electronic Acknowledgement Receipt

EFS ID:	32972911
Application Number:	62688610
International Application Number:	
Confirmation Number:	6795
Title of Invention:	PROCESSING OF LATERITE ORES
First Named Inventor/Applicant Name:	Anthony Owen FILMER
Customer Number:	22204
Filer:	Jeffrey Costellia/Donald Sias
Filer Authorized By:	Jeffrey Costellia
Attorney Docket Number:	742439-000112
Receipt Date:	22-JUN-2018
Filing Date:	
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Application Type:	Provisional

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Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 280
RAM confirmation Number	062518INTEFSW00000662192380
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		742439_000112_Provisional_Specification_and_Drawings.pdf	666681	yes	10
			8f2e97303c8e0452f2a092b9be95cedd287eaa3		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	8	
	Drawings-only black and white line drawings		9	10	
Warnings:					
Information:					
2	Application Data Sheet	742439_000112_Application_Data_Sheet.pdf	1276093	no	8
			580e02d6022069baf0c5bd6acfe5558dbcf0bc2		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	29761	no	2
			0b8a08564f0178bf0d079777b3e88db4a7e6364c		
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PROCESSING OF LATERITE ORES

BACKGROUND OF THE INVENTION

The nickel grade in laterite ores is very heterogeneous, but this is typically non-uniform across the orebody in any dimension. The high grade seams are interspersed with low grade zones, and are not uniformly concentrated at the surface or base of the orebody.

The estimation of a block of ore sets up all the subsequent processes (mining, blending and processing) as illustrated in Figure 1.

The spatial heterogeneity can be illustrated in the form of a grade tonnage curve. In Figure 2, the grade tonnage curve of a Brazilian orebody is illustrated in terms of the grade and tonnage relationship for 50 tonne discrete blocks of ore, with a cut-off-grade of 0.9% nickel.

Because the nature of the heterogeneity is non uniform, selective mining cannot be utilised to separate the lower grade ore that is interspersed with high grade ore, without an excessive sampling program, and use of very small loading equipment. This highly selective mining approach is uneconomic.

For this reason, a lateritic nickel resource must on average be high enough average grade to justify their processing to convert the ore into a usable form. This eliminates the economic attractiveness of nickel resources, despite their location in places otherwise favourable for mining and processing.

The nickel laterites are typically either smelted or leached at high temperature.

In both cases, the cost of processing is greatly in excess of the cost of mining the ore. Thus the feed grade of the laterite is the primary determinant of the unit cost of nickel production (\$/t nickel).

The impurity elements are also very important in the processing. For example, the silica to magnesia ratio is very important to achieve satisfactory operating temperatures in the electric furnace smelting of nickel laterites. And the soluble magnesium content of the laterite ore in high temperature leaching, greatly affects the acid consumption per tonne of nickel.

These gangue components are sufficiently important that even though the nickel grade may be acceptable for processing, the ore is either not economically viable, or needs to be blended with other ore elsewhere in the deposit, to produce a feed within acceptable specifications.

The gangue components are also heterogeneous in the orebody, thus selective mining is again not possible, except in limited circumstances.

Upgrading the nickel content of the lateritic ore prior to high temperature processing has long been a desire of the metallurgical world, but unlike sulphides, there is no easy method of beneficiating. This is due to the incorporation of the nickel into large proportions of the gangue matrix, unlike many other metals which exist as discrete high grade mineral particles in amongst the bulk of the gangue. The only beneficiating technique that has gained commercial success is screening. This can sometimes be used to remove silica rich oversize from the remainder of the nickel laterite, and hence modestly increasing the nickel grade.

Over the past decade, sensing equipment for application of bulk sorting is increasingly commercially available. The sensors have been developed for multi-element analysis of ores on conveyors running at normal speed. When integrated with diverters, the measurements can be used to control bulk material flows. These sensors have been typically utilised for blending

of stockpiles to meet customer specifications, and have found commercial application mainly in the iron ore and coal industries.

These system of sensors and diverters have also been recently proposed for bulk sorting of copper ores, to enable rejection of the gangue rich ore fractions. The sensor measures the copper present in the crushed ore, and based on grade, either rejects the material to waste, or to a low grade stockpile, or to the mill for fine grinding of the higher grade ore. The concept is termed bulk sorting.

SUMMARY OF THE INVENTION

According to the invention there is provided a method for processing of laterite ores including the steps of:

- obtaining mined heterogeneous ore laterite ore;
- subjecting the heterogeneous ore to crushing; and
- bulk sorting the heterogeneous crushed ore to obtain a gangue and a sorted laterite ore that is suitable for further processing.

According to the invention, homogenisation of the ore is avoided during mining, loading and haulage of the ore, to maintain the spatial integrity of the natural ore body. The mined ore may be loaded onto a truck and delivered to a fixed crusher for crushing, or crushed directly at a mobile crusher.

Preferably, the ore is not mixed, for example by stockpiling prior to crushing.

Preferably, the crushed ore is not mixed, for example by stockpiling prior to bulk sorting.

In the bulk sorting step, the ore is sorted by a bulk sorter comprising a sensor, diverter and a conveyor, wherein:

the sensor determines the average grade passing along a conveyor from the crusher to the diverter;
the diverter is controlled to direct selected packages of ore on the conveyor to different destinations, for example gangue which may be discarded or stockpiled and sorted laterite ore for further processing.

BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1** is a block diagram showing the implications of heterogeneity in all nickel laterites relative to a typical mining industry;
- Figure 2** is a grade tonnage curve of a Brazilian ore body; and
- Figure 3** is a block diagram showing the implications of analysis and separation after mining a nickel laterite ore using bulk sorting.

DESCRIPTION OF PREFERRED EMBODIMENTS

The current invention is a configuration of mining, crushing, and analysis of nickel laterite ore into a beneficiation process which enables efficient rejection of low grade ore to either waste or a low grade stockpile, and blends the high grade ore fraction to meet the specifications of the subsequent processing, illustrated in Figure 3.

Through use of beneficiation based on spatial heterogeneity, termed bulk sorting,

- Mining of the laterite ore proceeds as normal with equipment sized to optimise the mining process. Loading can be to a truck to a fixed crusher or directly to a mobile crusher.
- Ore is dumped directly to a crusher without an intervening stockpile, thus maintaining its heterogeneity, to reduce the size suitable for presentation to the elemental sensor.

- The sensor determines the average grade passing along a conveyor from the crusher to a diverter system, which is controlled to direct the 'packages' of ore on the conveyor to different destinations, depending on their composition.
- The low grade patches of nickel ores or those with unacceptable ratios of gangue are separated and either discarded if they are uneconomic to process, or stockpiled if they are potentially economically attractive but outside of the preferred grade for immediate processing
- The higher grade nickel ore may be within specification for further processing in which can it is directed to the process feed.
- However, if the high grade laterite is outside of specification it is assigned to a stockpile. Here it is used for blending with other high grade ores with offsetting gangue components, thus bring the combined high grade ore composite within specification for processing.

Important elements of success of the invention are:

- Avoiding homogenisation as much as possible during the mining, loading and haulage of ore, to maintain the spatial integrity of the natural orebody
- Avoiding stockpiles prior to sorting, by direct feeding the run of mine ore to the crusher and subsequent bulk sorting process
- Adjusting the mine plan to ensure an approximate balance of gangue elements, to avoid the need for large scale stockpiling after bulk sorting

Through integrating the mining, sorting and blending process in the current invention it is possible to increase the grade for a wide range of laterite ore feed grades, albeit with a variable yield.

Thus it becomes possible to adjust the processing feed to an economic optimum value for the orebody. Whatever the grade of run-of-mine ore fed to the sorter, the product for processing is optimised. This increases the flexibility in the selection of ores to be mined.

This allows an efficient mining sequence, rather than the current activities in nickel laterite mining of selectively mining pockets of higher grade ore. The scale of equipment can be increased, and the amount of re-handling in the mine reduced.

The spacing of grade control drilling can also be increased, as the sensitivity to patches of low grade ore in the processing is eliminated by bulk sorting. Grade control costs are decreased.

And since the bulk sorter can remove occasional patches of mine dilution, it is possible to increase the mine recovery, without concern about accidental incorporation of some marginal ore.

In a useful added feature to the invention, the crushing and sorting can be combined into a mobile system, suited for direct loading or very short haulage. The low grade reject stream from the sorter is then redeposited in the mining zone, allowing a better grade of ore to be hauled to the processing facility.

The sensor used for measuring nickel content of the laterite ore, such as a PGNAA sensor, can also measure other elements in the ore. This allows a monitoring of the composition of the product, and further separation of ore on the basis of these minor elements.

Given this improved knowledge of the gangue elements, these can be balanced in the mining process to provide an approximate blend in the feed to processing. Those fractions of the ore that meet nickel grade but not the gangue specifications, can be stockpiled. The modest sized stockpiles of known composition, can then be reclaimed and blended back into the processing feed, when the opportunity exists.

This allows the maximum amount of direct feed of the ore to the processing, rather than to separate stockpiles awaiting subsequent blending, thus reducing working capital and cost of materials handling.

For example, in the smelting of ferronickel, it is essential to feed the furnace with an appropriate silica to magnesia ratio. Typically nickel laterites are made up of acid and basic zones, both of which are outside of an acceptable magnesia to silica ratio. However on blending, the resultant mix is within specifications. It is normal to allocate each fraction to a separate stockpile, then blend by weight based on the average composition of the stockpile, to feed the kiln, and ultimately the electric furnace. Using the invention, the composition of the ore is analysed, and cumulative totals of the silica and magnesia contents enable blending direct from the sorter into the kiln. It is only when the acid and basic component mining rates cannot be balanced, that additional stockpiling is required.

The ability to set the nickel content of the feed using bulk sorting, also allows the grade of ore to be adjusted in response to changes in the nickel price.

Areas of Generating Value

1. A process in which lateritic nickel is mined, crushed, sorted, and blended to produce a fraction with increased nickel grade suitable for processing, by rejecting a lower grade fraction of the ore.
2. In which previously uneconomic nickel laterite resource is upgraded to enable the high grade fraction of that resource to be processed economically.
3. In which the efficiency of mining and materials handling is also enhanced as a consequence of reduced impact of mine dilution on processing costs.

4. In which homogenisation of the ore is minimised during mining, and run-of mine ore is directly loaded to crushing and sorting.
5. In which the sorter reduces mine dilution by separating contained waste from the remaining run-of-mine ore.
6. In which the feed to the sorter separates a high grade fraction for processing now, an intermediate grade fraction for stockpiling and processing later in the mine life.
7. In which the feed to the sorter separates a high grade fraction for processing now, an intermediate grade fraction for stockpiling and processing later in the mine life, and a waste fraction for permanent disposal.
8. In which crusher and bulk sorter is located in the mining area, to minimise the cost of handling low grade fraction of the ore, and increase the grade of ore transported to the process plant.
9. In which the low grade reject is redeposited in the area previously mined.
10. In which the cost of grade control drilling and analysis is reduced through use of bulk sorting to control nickel grade.
11. In which double handling of ore and blending stockpiles are minimised, by integrating the mining activities with real time monitoring of the critical gangue elements, to directly feed much of the ore to the processing plant.
12. In which the nickel grade is adjusted to optimise value at the nickel price of the day.

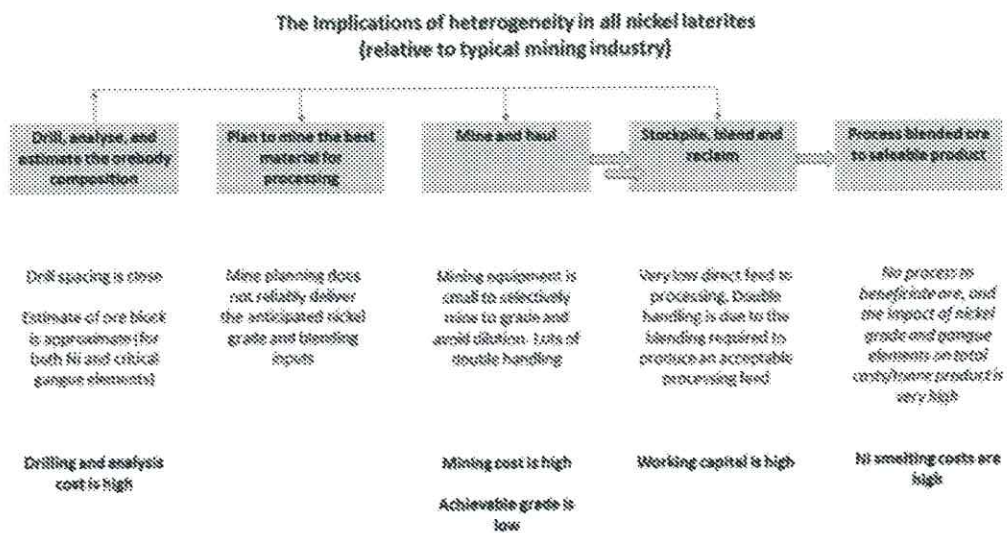


Fig 1

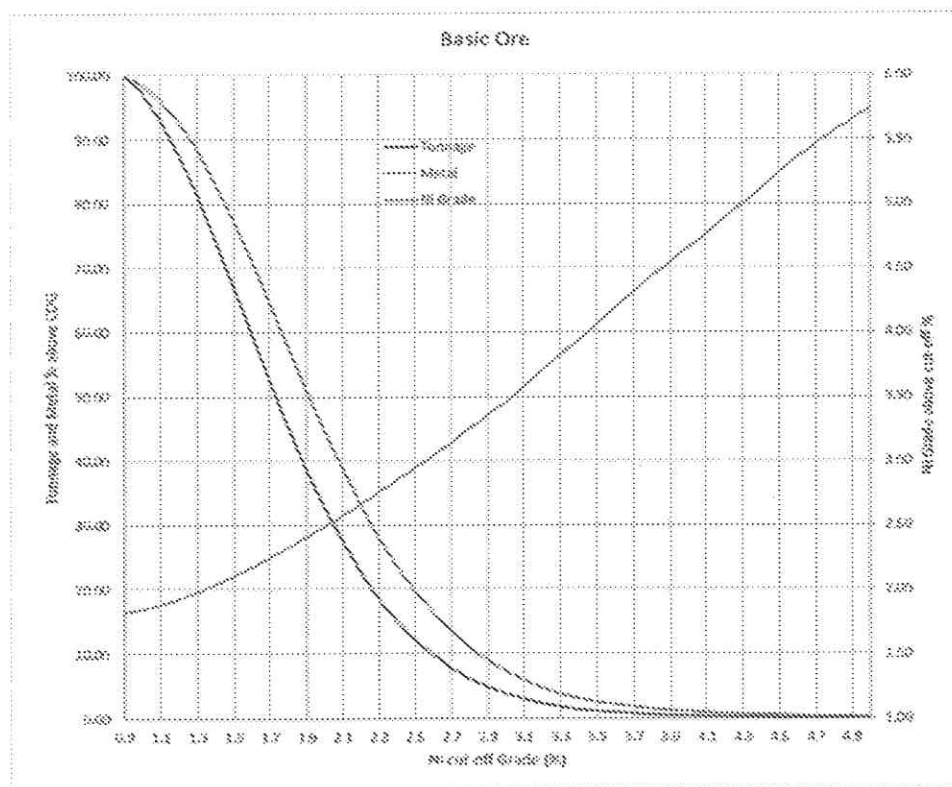


Fig 2

The Implications of analysis and separation after mining
(the concept of bulk sorting)

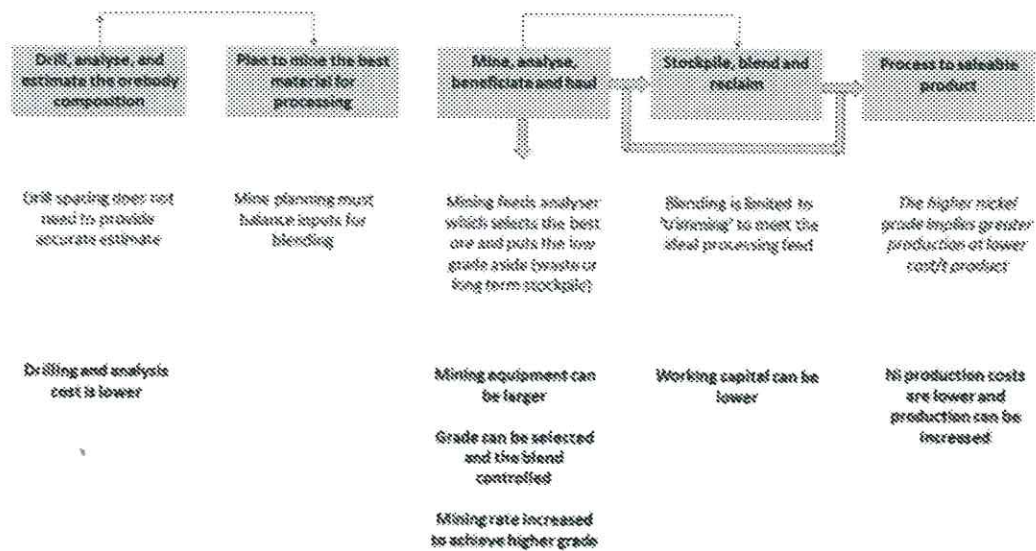


Fig 3

Application Data Sheet 37 CFR 1.76

Attorney Docket Number 742439-000112
Application Number

Title of Invention PROCESSING OF LATERITE ORES

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

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☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

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Inventor	1			
Legal Name	Remove			
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Residence Information (Select One)				
☐ US Residency ☒ Non US Residency ☐ Active US Military Service				
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Inventor	2			
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Application Data Sheet 37 CFR 1.76

Attorney Docket Number 742439-000112

Application Number

Title of Invention PROCESSING OF LATERITE ORES

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence information of this application.

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Application Information:

Title of the Invention PROCESSING OF LATERITE ORES

Attorney Docket Number 742439-000112

Small Entity Status Claimed ☐

Application Type Provisional

Subject Matter Utility

Total Number of Drawing Sheets (if any)

Suggested Figure for Publication (if any)

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application

Filing date (YYYY-MM-DD)

Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	742439-000112
		Application Number	
Title of Invention	PROCESSING OF LATERITE ORES		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78. When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
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Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Remove
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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

- ☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
- NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76

Attorney Docket Number

742439-000112

Application Number

Title of Invention

PROCESSING OF LATERITE ORES

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

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1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

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☐ **B.** Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	742439-000112
	Application Number	
Title of Invention	PROCESSING OF LATERITE ORES	

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Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1	Remove	
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.		
Clear		
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Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest
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Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name

ANGLO AMERICAN SERVICES (UK) LTD.

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Address 2			
City	London	State/Province	
Country	UK	Postal Code	SW1Y 5AN
Phone Number		Fax Number	
Email Address			

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Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	742439-000112
	Application Number	
Title of Invention	PROCESSING OF LATERITE ORES	

Assignee 1

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Prefix	Given Name	Middle Name	Family Name	Suffix

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Signature:

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See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Jeffrey L. Costellia, Reg. No. 35,483/		Date (YYYY-MM-DD)	2018-06-22	
First Name	Jeffrey L.	Last Name	Costellia	Registration Number	35483

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	742439-000112
		Application Number	
Title of Invention	PROCESSING OF LATERITE ORES		

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