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#### Key information

Market: Private/pre-IPO  
Sector: Mining

This report is an investigation into the growing kaolin potential at Mining Licence ML 100008 at InterGroup's Brilliant Brumby Project.

#### Business

Gold mining and exploration in Queensland, Australia. The Company has a 100% stake in the Brilliant Brumby Project which is a fast-expanding major gold project in Northern Queensland. The Brumby Project covers more than 100km<sup>2</sup> of highly prospective ground in an underexplored gold district lying within the Charters Towers Gold Province.

#### InterGroup Mining

**Limited** is an unlisted Australian Public Company registered in Queensland under ACN 163 989 553.

#### Website

[www.igmining.com](http://www.igmining.com)

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## Increasing kaolin potential at Brumby

### Test results and market analysis point to multiple uses suggesting that kaolin could cover the cost of gold mining

- ❖ **Potential Tier 1 gold asset with growing evidence of valuable kaolin resources.** InterGroup Mining's (IGM) Brilliant Brumby Project covers a large area of highly prospective ground in the legendary Charters Towers Gold Province in NE Queensland, Australia, where more than 20Moz of high-grade gold has been mined. The Company's exploration work continues to unveil an expanding near surface gold deposit which combined with straight forward mineral processing is fast suggesting a large low-cost operation. Now there is the additional potential of kaolin which is the host rock for the gold-bearing quartz lodes and needs to be mined in any case which has the potential to pay for the cost of mining the gold. All of which points to attractively low production costs.
- ❖ **Kaolin has wide-ranging industrial uses and is an important EV battery material.** Major markets for kaolin are paper and ceramics but the growing use in new age industries is the big news. Kaolin is now heralded as "white gold" as it can be transformed into High Purity Alumina (HPA) which is highly versatile and used in LEDs, coating cathode and anode electrode separator sheets in the lithium-ion battery for EVs and energy storage. Improving on the whiteness and metallurgy of kaolin could attract a selling price of up to some US\$2,000 per tonne as an HPA precursor. Increasing purity of HPA from 99.9% to 99.9999% Al<sub>2</sub>O<sub>3</sub> creates 3N-6N priced at around US\$6,000 to 35,000/t when aluminium was at US\$2,200/t.
- ❖ **Brumby kaolin has come through initial lab tests with flying colours.** Kaolin samples were tested by a respected mineral technology company with proven expertise in processing/developing Australian kaolin deposits. Key findings were that the resource contained significant, high quality minerals including high purity silicas and highest quality kaolins. These kaolin experts were at pains to point out that this kaolinized saprolite contained some of the highest quality minerals, in sufficient ratio volumes, and represented a high value product. This opens the door to numerous potential product options spanning applications like as HPA precursors, pigments, fillers and pozzolans. High praise indeed.
- ❖ **Potentially ultra-low gold production costs per ounce subsidised by kaolin.** There is thought to be a global 29Mtpa market for kaolin and 200,000tpa domestic market in Australia. A leading commodity research house believes that the major opportunities open to IGM's kaolin could attract prices of US\$10-20/t in bulk or US\$100-350/t after passing through a basic washing plant. With further processing to create aluminium, HPA precursors and HPA generating anywhere between US\$2,000 – 15,000/t. IGM has a large resource with 100Mt estimated across the project area. However far the processing of IGM's kaolin is taken, there is clearly rapidly growing potential for ultra-low gold production costs on a global scale at Brumby moving forward.

## INTRODUCTION

InterGroup Mining's (IGM) 100%-owned Brilliant Brumby Project is a rapidly expanding major gold project in NE Queensland. This project covers more than 100km<sup>2</sup> of highly prospective ground in an underexplored gold district of the legendary Charters Towers Gold Province where more than 20 million ounces (Moz) of gold has been mined.

Detailed exploration and drilling continue to highlight growing potential of the Brumby Project. IGM began its initial gold mining activity at ML 100008 in 2018 and good progress has been made since then with processing. Such a strategy allows for early stage revenue generation as well as gaining a better understanding of future milling requirements. Processing of the gold ore has been found to be fairly straightforward using gravity separation. Growing stockpiles of mined product are now being processed to generate a high-grade gold concentrate and free gold.

## KAOLIN OPPORTUNITY

The management's interest in kaolin dates back to 2018 when the first kaolin assays were taken from the Surprise Prospect on ML 100008. However, due to the difficulty of sampling the dry powdery upper material, kaolinitic specimens from the lower levels of the initial Surprise excavation were sent to be analysed by the well-known supplier of industrial materials Sibelco at its operation in Adelaide. Sibelco's analysis was able to highlight that the material was extremely hard and assayed approximately 75% SiO<sub>2</sub>, 16% Al<sub>2</sub>O<sub>3</sub> and 6% Loss on Ignition (LOI). In contrast, the clay then mined was approximately 52% SiO<sub>2</sub>, 33% Al<sub>2</sub>O<sub>3</sub> and 10% LOI. At that time, Sibelco advised that it would be difficult to process commercially. It can be clearly seen that these deeper samples from Surprise were only partly kaolinized and so represented just half the story; and what a big story it is quite quickly turning out to be.



***Brumby Project and mining at the Surprise Prospect – a location of part of the kaolin potential***

The renewed interest in the kaolin potential has been sparked off by a review of the detailed drilling logs of 36 of the RC holes from the 2018 drilling programme in the Surprise area. Analysis of these drilling logs demonstrated that 30% of the holes were logged as having grey or white cuttings. On top of that, an additional 16% of the holes which were drilled in or near the gold bearing quartz lodes showed up pale cuttings with sericite alteration caused by hydrothermal activity which is how kaolin is formed. The remaining drill holes contained some pink or brown hues in the weathered profile.

The white coloured material begins 2 - 6m below the surface and extends to depth of 6 - 14m. Intervals of material logged with grey to white colours have a thickness of 1m - 16m (with 25m shown in one hole). Based on just the area of Tertiary cover mapped by the Geological Survey of Queensland (GSQ), a 6m average thickness of weathered material and a kaolin deposit density of 1.7 t/m<sup>3</sup> (as at Poochera Hallosyite-Kaolin Project, South Australia), IGM's consultants made an order-of-magnitude estimate of maybe 35Mt of kaolinitic material on the Brilliant Brumby EPM 18419.

## INCREASING SCALE OF THE KAOLIN POTENTIAL

Certainly, that was a good start. However, subsequent work on the ground has demonstrated that there is potentially approximately 100Mt of kaolin available to mine across the various EPMs that make up the Brumby Project. Testing has now begun on further kaolin samples to ascertain purity and brightness to determine whether a potential saleable product can be mined at Brumby. This material is excavated along with the gold-bearing quartz veins and therefore could represent additional revenue if the product has the right characteristics.



Preliminary tests on Surprise mine kaolin indicated that it can be on-processed for the manufacturing of lower to medium quality industrial usage kaolin and also as value-added kaolin clays including feed stock for the manufacture of HPA. So, testing was designed to characterise kaolin samples from the Brumby Project as a precursor for the extraction of aluminium. Initial results for the laboratory test work seem to have been highly impressive and testing has confirmed that IGM's kaolin meets the specifications to be good for use in both the regular kaolin market as well as the HPA market. Improving on whiteness and metallurgy of kaolin could attract a selling price of up to some US\$2,000 per tonne as an HPA precursor.

## USES & OUTLOOK FOR KAOLIN

There is a 29Mtpa international market for kaolin which has a range of industrial applications led by paper, ceramics and other speciality uses. Demand is dominated by the paper industry which accounts for more than 40% of market share in terms of volume where kaolin acts as both as a filler to reduce costs as well as improving printing characteristics which is important in the manufacturing of high-quality paper for promotional material. Lightweight coated papers can contain up to 35-40% kaolin.

The second biggest market is for use in the manufacture of whiteware ceramics where kaolin makes ceramics whiter in anything from vitreous-china sanitary ware to tableware and wall tiles. Specialty applications include the use of kaolin as a filler in paint as well as being used in rubber, plastics, adhesives, sealants, pharmaceuticals, animal feed, white cement and glass fibre. Although, the associated minerals in kaolin do determine the suitability for a particular use.

However, it is the growing use by a myriad of new age industries which has got people talking. Kaolin is now being heralded as "white gold" as it can be transformed into HPA which is a key ingredient of the modern world as it is highly versatile with many uses including LEDs, coating cathode and anode electrode separator sheets in the lithium-ion battery for electric vehicles and energy storage. HPA produced from kaolin is less expensive as its less energy intensive than the traditional processing route which uses bauxite as the feedstock material.

Moving ahead, India and US based market researcher Grand View Research believes that the global kaolin market was worth US\$4.36 billion in 2019 and expects it to grow at a compound annual growth rate (CAGR) of 3.3% from 2020 – 27. The key driving factor is expected to continue to be the increasing demand for ceramics in the construction industry as kaolin is the major raw material used in manufacturing ceramic tiles. Grand View has also pointed out that increasing construction activities in developing economies (China, Brazil and India) resulting from rapid urbanization and industrialisation combined with greater migration of the rural population to urban centres which is projected to drive the demand for new housing units resulting in a positive influence on ceramic tile demand. A leading commodity research house in its market research report on the Surprise Kaolin Project highlighted the outlook for kaolin usage in the paint, plastics, rubber, refractories and fibreglass industries which is outlined in the table overleaf.

Industry	Comments
Paint	Increased consumption of paint is forecast driven primarily by Asian demand. North American growth in previous years is expected to continue to outperform weaker forecasts. Overall, the industry is expected to continue growing at a steady pace of 2.0% CAGR.
Plastics	Total demand for plastics is expected to grow by around 2.75% per annum. Increased consumption is forecast to be driven primarily by Asian demand. Growth in Europe and North America seem to be fairly static.
Rubber	Overall growth in demand for kaolin in rubber is forecast to average approximately 1% per annum.
Refractories	Long term trend towards using higher performance refractories which is reducing the specific consumption of refractory material per tonne of product. Production forecast for refractories to grow by 0.5 – 1.0% per annum until 2030 and kaolin consumption has been adjusted accordingly.
Fiberglass	Forecast to grow on average by 3% per annum. Much of this increase is expected to be in Asia, especially China.

***Outlook for world kaolin demand in certain industries.***

**WORLD KAOLIN PRICES**

In this market research report on the Surprise kaolin, export values into China from Indonesia and Malaysia were reported to be US\$50.3/t cost, insurance and freight (CIF) and US\$47/t CIF respectively in 2019, - more indicative of contract prices rather than spot prices. The material exported from these two countries into China is likely to be comparable low brightness fillers grades. Higher specification material exported into China from the USA and Brazil averaged US\$229/t CIF and US\$203/t CIF respectively which is thought most likely to be material for the clay coated paper market.

Industry	Price US\$/t	Moisture & product form
Ceramic tiles	100	10% moisture lump or noodle kaolinite in bag or Big Bags
Sanitaryware	150	10% moisture lump or noodle kaolinite in bag or Big Bags
Paper filler	150	10% moisture lump or noodle kaolinite, in bag or Big Bags
Paint (low-end emulsion grades)	175 – 225	1% powder in 20 or 25kg or Big Bags



***Kaolin estimated price and product forms.***

***Noodle kaolinite. Source: Indiamart***

China’s production of high-quality kaolin clays is apparently frustrated by technological limitations. Despite its huge scale of kaolin clay production, China also imports significant quantities of this raw material as Chinese suppliers cannot meet the technological requirements.

Increasing purity of HPA from 99.9% to 99.9999% purity  $Al_2O_3$  generates a large and fast expanding premium to the current LME cash price of US\$1,738 for aluminium. As with other battery minerals, new markets are rapidly opening for industrial minerals such as HPA propelled by the influx of high-tech industries emerging on the world stage. HPA prices are truly stratospheric with 3N-6N fetching around US\$6,000 to 35,000/t when aluminium was at US\$2,200/t.

**AUSTRALIAN KAOLIN MARKET**

Australian exports are currently at US\$300 – 450/t to the major markets. The consultants have suggested that to achieve such a price, the kaolin must be high quality clays with surface modification. Basically, surface modification of kaolin uses physical, chemical and mechanical methods to change the surface properties of kaolin (i.e. surface functional groups, crystal structure and surface adsorption and surface electrical) to meet the requirements of the industrial application.

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Kaolin production (kt)	105	80	205	169	254	244	218	208	205
Kaolin and other kaolinic clays exports (kt)	9.5	10.2	10.2	8.5	8.4	10	10.8	9.9	9.3
Kaolin and other kaolinic clays imports (kt)	9.4	6.7	9.6	15.2	5.3	12.9	9.6	7.1	6.4
Apparent kaolin consumption (kt)	86.1	63.1	185.2	145.3	240.3	221.1	197.6	191	189.3

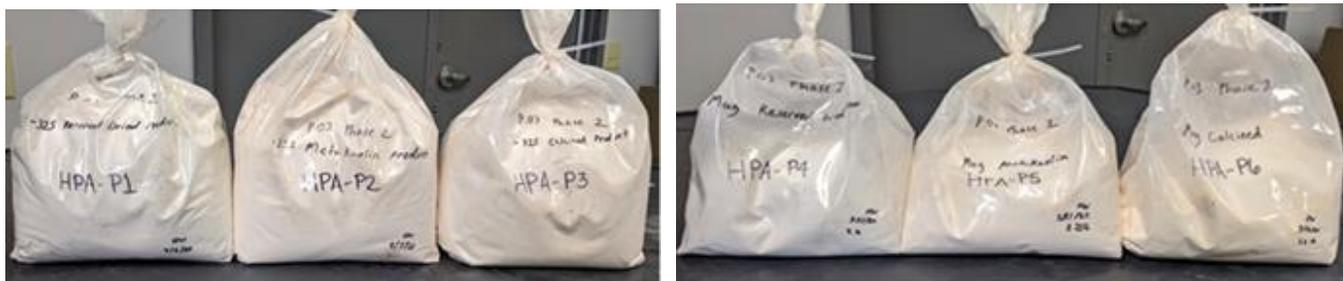
***Australian kaolin market statistics***

## REALLY IMPRESSIVE RESULTS FROM INITIAL LAB TESTS

Highly kaolinized saprolite samples from Surprise were sent to a respected mineral technology company with proven expertise in processing and developing Australian kaolin deposits. Results look particularly good with Brumby kaolin scoring very well on a variety of important factors. Firstly, brightness where reading in the high 80's was recorded which is very high for a non-processed clay. Secondly, potassium levels are low indicating that there is less, if any mica/illite in the samples which is an important consideration. Thirdly, kaolin passing through the 325-mesh yielded 40-50%. Lastly, the particle-size distribution (PSD) of the kaolin was found to be coarse to medium which is apparently very good for a range of applications. Kaolin samples were evaluated as a precursor for the extraction of aluminium to produce HPA.

Laboratory test work confirmed that IGM's kaolin meets the specifications to be good for use in both the regular kaolin market as well as the HPA market. The laboratory work was focused on the HPA potential and results here seem to have been impressive as the consultants commented that the process produced a highly reactive dry metakaolin product that could be a good resource for HPA. There appears to be significant potential for HPA development using the Brumby kaolin resource provided  $Al_2O_3$  concentration is achieved and reactivity creation justifies the refined resource as a commercial HPA precursor (HPAP). The key findings of the research work are outlined below.

Mineral characteristics		HPA processing potential
<p>IGM's samples were saprolitic composite included quartz, feldspars and micas as the primary minerals (mineral formed during the original crystallization process of the host igneous primary rock) and kaolinite and illite/degraded mica as the secondary minerals (formed by the alteration of the primary mineral in an igneous rock).</p> <p>The samples were initially separated at 44 microns (<math>\mu m</math>) by being passed through a 325-mesh screen giving 32% silt and sand (<math>&gt; 44\mu m</math>) and 62% clay-size fraction (<math>\leq 44\mu m</math>).</p>	<p>The clay-size fraction consisted of kaolinite and potassium clay minerals such as, illite and fine, degraded mica.</p> <p>82% of the clay-size fraction was kaolinite and 18% was potassium-bearing clay minerals.</p> <p>Of the total - 51% was kaolinite and importantly for HPA manufacturing the aluminium content was an ~19%.</p>	<p>Dry and wet processing techniques both beneficiated and refined the samples into HPA precursor candidates.</p> <p>Advanced processing such as classification and magnetic separation concentrated the aluminium and significantly reduced the non-kaolinite impurities such as illite and iron oxides/hydroxides.</p> <p>Thermal processing of both the dry and wet processing products significantly increased the reactivity of the metakaolin-type products that will be more conducive for HPA manufacturing.</p>



*IGM's kaolin samples were successfully processed into HPA-P1 to P6 (project specific terms)*

### A high value product

The expert mineral tech company chosen to perform this analysis was a good choice as this business not only has experience in processing/developing Australian kaolin deposits but also in the development of commercial products including highly reactive meta-kaolin products which are used as precursors for advanced mineral/metal products, pozzolans (added to concrete to increase strength, impermeability and sulphate resistance) and pigments/fillers.

**The key findings were that the resource composite contained significant, high quality minerals including high purity silicas and highest quality kaolins. The mineral tech consultants reckoned that this kaolinized saprolite contained some of the highest quality minerals, in sufficient ratio volumes, and represents a high value product. Numerous product options have potential, spanning applications such as HPA precursors, pigments, fillers and pozzolans. High praise indeed from such acknowledged kaolin industry experts.**

## ANALYSIS OF POTENTIAL MARKETS

Analysis of the potential of Brumby's kaolin by the leading commodity research house highlighted major opportunities for basic filler grade in two broad markets. Firstly, the basic filler grade from the white matrix could be used in ceramic tiles, sanitaryware and earthenware as the product lies within the required specifications. However, the Fe<sub>2</sub>O<sub>3</sub> content is too high for higher price applications such as porcelain, hotel ware and glazes. Secondly, the basic filler grade material could also be used in paint (low emulsion grades only), flame-resistant plasterboard, polymers and rubber.

The consultants also confirmed that the material could also be used as a source of Al<sub>2</sub>O<sub>3</sub> which is high at almost 37% due to the high kaolinite content and free quartz is low at only 1% which means that manufacture to HPA to 4N grade is highly feasible. Some these markets plus other opportunities are discussed below.

**Direct shipped ore** – ROM material crushed and dry screened to < 2mm without further refining might be suitable for the brick making industry due to Brumby's kaolin product having high plasticity (demonstrated by test results) and high flux potential during firing (derived from high K<sub>2</sub>O content provided by muscovite and illite). The chemistry is not dissimilar to some fireclays that are used for this purpose. Sales would be to local brick making companies in Queensland to minimise transport costs. Price would be low compared to refined kaolin at US\$15 – 20/t ex works.

**Ceramic tiles** – Lower quality raw material is required by ceramic tile manufacturers and there may be some limited opportunities here. The process applies 2 or 3 layers of glaze to tiles prior to firing and so the fired brightness of the base tile is not critical and kaolin with higher levels of Fe<sub>2</sub>O<sub>3</sub> can be used. There is a better opportunity in floor tiles as the feldspar content in the mix could be reduced to accommodate high K<sub>2</sub>O in the Brumby kaolin. Floor tiles have less stringent technical requirements (particle size, plasticity, chemistry and other properties) and so price paid for kaolin is lower than most other applications. Chinese prices for floor-grade kaolin average US\$100/t ex works (10% moisture content).

Floor tiles	Wall tiles	Plasterboard <sup>1</sup>		Leather <sup>2</sup>	
Raw materials	Raw materials	Chemical & physical properties	Chemical analysis by XRF	Properties	Properties
Soda feldspar 25%	Ball clay 35%	Moisture 0.5%	SiO <sub>2</sub> 46.5%	SiO <sub>2</sub> 50%	Surface are 8m <sup>2</sup> /g
Potash feldspar 20%	Kaolin 15%	Residue (+300#) 0.06%	Al <sub>2</sub> O <sub>3</sub> 33.2%	Al <sub>2</sub> O <sub>3</sub> 35%	Oil absorption 33g/100g
Ball clay 30%	Limestone 10%	Particle size distribution	Fe <sub>2</sub> O <sub>3</sub> 0.85%	ISO Brightness 78.5%	
Kaolin 10%	Quartz 25%	<20µm 100%	CaO 0.08%	Yellowness 7%	
Quartz 15%	Pitchers 15%	<10µm 89%	MgO 0.3%	>53µm 0.05% max	
		<2µm 30%	K <sub>2</sub> O 3%	>10µm 35%	
		<1µm 18%	ISO Brightness 79.5%	<2µm 25%	
			Yellowness 5.7%	pH 5	

<sup>1</sup> - Polwhite E (Imerys) <sup>2</sup> Polwhite (Imerys)

### Composition, chemical and physical properties for the key products

**Plasterboard** – Kaolin is used at a rate of 1kg/m<sup>2</sup> of plasterboard to enhance the flame-retardant properties by ensuring that the board does not shrink too much when high temperatures are applied. The colour of kaolin is not important as the plaster is laminated with paper. Knowledge of the medium to large plasterboard manufacturing sites in Europe suggests that they each consume 300 – 700t per annum. There is potential here for Brumby kaolin although prices are comparatively low at approximately US\$150 – 185/tonne ex-works in powder form.

**Leather** – Australia's leather industry has a revenue of almost US\$ 1 billion from tanning cattle, kangaroo and sheepskins. Some US\$700 million of this total comes from the export of pre-tanned or rawhides. Although it should be pointed out that not all leather producing companies use kaolin in their refining process. Kaolin can be used to improve suspension and rheology (the science of deformation) at the liming stage, improve the application of enzymes (acting as a carrier), improve the finish by filling voids and improve the colour control by pre-mixing with dyes. Apart from being free of grits, technical requirements are less stringent as particle sizing can be relatively coarse and high brightness not required. Brumby refined kaolin might prove to be suitable for leather processing. Approximate prices are US\$125 – 145/t in bulk ex-works at 10% moisture of US\$216/t in powder from ex works at 1% moisture, bagged and on a pallet.

## KAOLIN COULD COVER THE COST OF GOLD MINING

IGM is a successful junior miner which is continuing to make high-grade gold discoveries across its vast licence area which is rapidly suggesting that all the parameters are in place to establish a viable mining operation based on the gold veins of the Mt Stewart region. Drilling later this year should help to test the growing possibility that all the isolated gold targets discovered so far may well connect underground. Whilst gold exploration and analysis seems to point to an ever-increasing large-scale gold mining opportunity. The host rock containing the gold-bearing quartz lodes is kaolin which has to be mined in any case and it is fast becoming obvious that the kaolin could cover for the cost of mining the gold.

Impressive results were received from the initial laboratory tests on kaolin samples from Brumby to ascertain purity and brightness to determine whether a potential saleable product can be mined here. Brightness was very high for a non-processed clay combined with low impurities and a decent grade. Kaolin samples were also evaluated to concentrate the purest Al<sub>2</sub>O<sub>3</sub> minerals as well as create the most reactive product for HPA processing. All of which has confirmed that IGM's kaolin meets the specifications to be good for use in both the regular kaolin market as well as the HPA market. Further positive test results could easily open the door to opportunities stemming from IGM's own kaolin production with value-adding processes coupled with off-take deals agreed with leading distributors.

Based on those initial successful test results, the leading commodity researcher house has assessed the market opportunities open to IGM. These consultants reckon that Brumby kaolin could attract prices of US\$10-20/t in bulk as is or US\$100-350/t after going through a basic washing plant. The research house was also quick to point out that IGM's kaolin could also be used as a source of Al<sub>2</sub>O<sub>3</sub> due to the high kaolinite/low quartz content and free quartz which means that manufacturing HPA to 4N grade is highly feasible. So proper confirmation that with further processing IGM's kaolin could be used to create aluminium, HPA precursors and HPA generating anywhere between US\$2,000 – 15,000/t.

Developments surrounding IGM's kaolin seem to be quickly coming together. Based on work on the ground, the Company has already delineated that potentially approximately 100Mt of kaolin is available to mine across the Brumby Project. Once determined to JORC-compliant standards could easily be a world class kaolin project on its own merits. However, the scenario which is rapidly developing following the excellent results from the lab tests coupled with the expert market analysis is that mining of the host kaolin could well cover for the cost of mining gold. The end result in that the important metric for comparing costs per payable's metal unit for gold mining companies of all-in sustaining cost (AISC) per ounce could be globally very low for IGM's gold production as it would be heavily subsidised by kaolin production. The Brumby project looks like it will be attracting growing interest given the powerful combination of its genuinely large scale coupled with such potentially low gold mining costs.

### About the author

Dr Michael Green is an independent analyst specialising in growth and resources companies. He gained a BSc Honours degree in Mining Engineering from Nottingham University, UK and PhD for a thesis that looked at the economic analysis of mining projects. Having been involved in consultancy work, Michael began working in the City in the 1980s as a Mining Analyst with stockbrokers Buckmaster & Moore and then HSBC-owned Greenwell Montagu Securities. Subsequently, he was involved in analysing a wide range of growth companies and became Head of Research at stockbroker Everett Financial which specialised in the small cap market. Since, 2006 Michael has been an independent analyst specialising in analysing companies in the resources sector and providing research for mining companies, stockbrokers, corporate finance houses, advisers and independent research firms. He was formerly a Non-Executive Director of Ascot Mining PLC, a quoted Central American gold mining company. In addition, Michael has also worked closely with resources companies on IR.

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