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# 4N HPA successfully produced & 5N possible

## High purity 4N HPA achieved in lab tests on Surprise kaolin

- **Initial analysis of the HPA potential at a growing kaolin project.** A substantial kaolin resource has been discovered at the Surprise Prospect by InterGroup Mining (IGM) within its Brilliant Brumby Project, in NE Queensland, Australia. Kaolin is increasingly being seen as providing big advantages in the production of HPA which is highly versatile and a key ingredient for the modern world. With HPA generally commanding US$25,000 – 40,000/t on increasing purity, it is a highly important potential market that IGM would like to capitalise on.

- **Laboratory tests demonstrated that Surprise kaolin is a high value product.** The study to characterise and prepare HPA from IGM's kaolin material was undertaken by independent experts who have successfully produced 5N HPA from variety of kaolin clays and are now in the midst of designing a pilot plant to refine their bespoke process and IP ahead of the move into scaled commercial production. Importantly, IGM's kaolin was shown to be low in reactive impurity elements which is highly favourable for HPA production.

- **High purity 4N HPA produced comparable to commercial HPAs.** IGM's HPA sample was seen to be comparable to with Sumitomo's HPAs. Not only was it ≥99.99% $Al_2O_3$ , but like Sumitomo's HPAs, the Company's HPA also had similarly low levels of key impurities (Si, Fe, Na, Mg & Cu) as well as having an α crystal structure, no coloured impurities and a textured surface. Reassuringly, the results of these lab tests also suggested that IGM's kaolin should be able to meet the chemical purity specifications required for other kaolinite products such as meta-kaolin products, pozzolans and pigments/fillers after appropriate processing.

- **5N HPA is starting to look like a real possibility.** Due to the low level of containments, 5N increasing looks to be on the cards with further work. The move from 4N HPA to 5N greatly increases the potential selling price. Successfully producing 5N HPA in lab tests would be a quite a coup for IGM as achieving 5N HPA might be a lot rarer than some would have us believe. Truth is that a number of companies have reportedly produced 5N HPA to 99.999% purity, although it may be questionable. The experts undertaking these latest lab tests for IGM have reason to believe that the instruments and methods used by some parties to test 5N purity maybe potentially flawed.

- **Developments surrounding IGM's kaolin seem to be moving along swiftly.** Kaolin has been produced by the hydrothermal decomposition of the host rock granite that surrounds the gold bearing quartz lodes at the Brilliant Brumby Project. So, the kaolin will need to be mined to get to the gold. Work on the ground has led to around 100Mt of kaolin potentially being outlined across the licence area. Good feedback from both mineral technology consultants and a leading commodity market research house is pointing towards the real prospect that kaolin might help subsidise gold mining resulting in low costs per ounce on a global basis.

InterGroup Mining

**Key information**
Market: Private/pre-IPO
Sector: Mining

This report is an investigation into 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 100km² 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

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## GROWING KAOLIN POTENTIAL

InterGroup Mining's (IGM) 100%-owned Brilliant Brumby Project is a fast-growing gold project in NE Queensland which covers more than 100km² of highly prospective ground in an underexplored gold district of the Charters Towers Gold Province. Kaolin potential at the project was first investigated in 2018 with the assaying of kaolin samples from the Surprise area on mining licence ML 100008. This interest was renewed in 2020 following the examination of the detailed drilling logs of 36 of the reverse circulation (RC) holes from the 2018 drilling programme in the Surprise area.

***Some of the Kaolin potential at the Brilliant Brumby Project***

This last round of drilling revealed that white coloured material typically began at something like 2m - 6m below the surface and extended to a depth of 6m – 14m. The intervals of logged material with grey to white colours varied in thickness from 1m to 16m, although one hole intersected an interval which was 25m thick. An order-of-magnitude estimate from the geological consultants for the potential across EPM 18419 has suggests that there may be 35Mt of kaolinised granite. This estimate was solely based on the area of the Tertiary cover mapped by the Geological Society of Queensland (GSQ), a 6m average thickness of kaolinitic weathered material (as seen at Surprise) and an assumed kaolin deposit density of 1.7 t/m³ (based on the Poochera Hallosyite-Kaolin Project in South Australia). However subsequent work on the ground has demonstrated that there could potentially be approximately 100Mt of kaolin available to be mined.

## COMMERCIAL KAOLIN PRODUCTS

With such potential, IGM's management team has swiftly moved to bring in a number of specialist consultants in the kaolin space to begin to thoroughly analyse the resource as well as the available commercial opportunities. The Company contracted a leading US-based mineral technology consultancy to evaluate and characterise several highly kaolinized saprolite samples from the Brilliant Brumby Project. This consultant has experience and expertise in the processing and development of Australian kaolin deposits as well as in the development of commercial products including highly reactive meta-kaolin products used as precursors for advanced mineral/metal products, pozzolans and pigments/fillers.

The goal of this initial study was to determine if any valuable commercial products could be derived. A series of lab tests on samples from the Surprise area saw the material processed and refined using a variety of techniques. The report made for good reading as the mineral tech consultant was able to point out that the presence of high-purity minerals (kaolins and silicas) which opens the door to numerous potential commercial product options including HPA precursors, pigments, fillers and pozzolans (used as supplementary cementitious materials – SCMs - in the concrete industry).

These lab tests also resulted in adding high purity silica to the list of high-quality minerals that can be refined from Brumby kaolinized saprolite. Very uniformly sized silica resulted from wet screening where almost 100% $SiO_2$ was achieved. Such very high purity silica acts as the main filler in a lot of products including semiconductor moulding compounds, optical fibres, coating powders as well as being used in building materials, solar panels and high-performance ceramics.

Across this range of commercial kaolin products, a leading commodity research house believes that 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 – 40,000/t. Brumby kaolin seems to have significant commercial potential however the resource transformation requires a determination of the resource to optimise near-term marketing options. There certainly would seem to be a large market for kaolin as this commodity research house believes that there is a 29Mtpa global market with a 200,000tpa domestic market in Australia.

## KAOLIN TO HPA OPPORTUNITY

Global demand for kaolin is forecast to increase by a compound annualised growth rate (CAGR) of 4.4% to reach 43.1Mt by 2025 with the main use of kaolin continuing to be in manufacture of white paper. However, it is the big benefits provided by high purity $Al_2O_3$ (>99.99%) which are increasingly becoming better understood. HPA is highly versatile and seen to be a key ingredient for the modern world. 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$1,835 per tonne for aluminium. HPA is a processed premium high-purity form of aluminium oxide and generally commands prices of between US$25,000/t (4N HPA) to 40,000/t (5N HPA).

Technologies have emerged in recent times which produce HPA from kaolin that are less expensive and less energy intensive that traditional methods. 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. The move to electric vehicles and energy storage has all the makings of becoming one of the largest global trends of the 21st century.

A number of Australian companies are developing such white gold opportunities which has led to some chucky valuations being awarded by the stock market due to the highly attractive value-adding proposition that mastering such technology could bring. Certainly, HPA production is not easy. The final stages of HPA processing are more akin to pharmaceutical manufacturing rather than traditional mineral processing. Maintaining purity in the laboratory is relatively easy with clean equipment but there has been an issue on scale-up using industrial kilns.

## HPA PRODUCTION FROM IGM'S KAOLIN

IGM recently received the results from the first laboratory tests designed to produce HPA from Surprise kaolin clay. The test work was undertaken by independent experts using a bespoke process which successfully led to the production of HPA 4N.

The Surprise kaolin clay sample was termed ITK in the report. The kaolin sample was sandy and contained chucks of quartz. Ahead of any test work, the kaolin clay was sieved at 8mm to remove the oversized quartz to provide a more homogeneous sample. The -8mm fraction, which represented 90% of the original kaolin sample, was then characterised using a series of techniques.

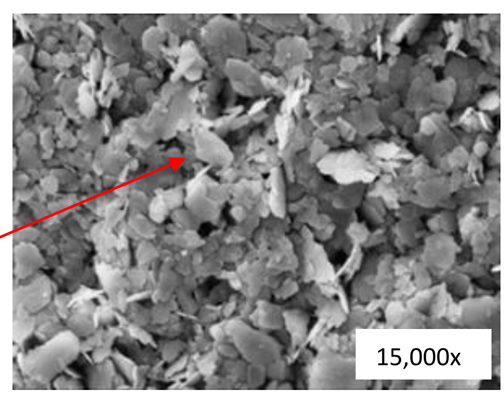

***Sieved fraction of ITK clay***

**Mineralogical analysis -** X-Ray Diffractometry (XRD) was used to identify the minerals/phases based on crystalline structural properties. The ITK sample had approximately 45% quartz, 48% kaolinite and 7% muscovite. The low level of reactive impurities in the sample was highly positive as this is favourable for HPA production. Further XRD analysis also demonstrated that kaolinite was the only clay phase present in the samples, so there was seen to be no smectite or halloysite.

| Phase | Formula | Weight % |
|---|---|---|
| Quartz | $SiO_2$ | 44.6 |
| Kaolinite | $Al_2Si_2O_5(OH)_4$ | 48.2 |
| Muscovite (mica) | $KAl_2(Si_3AlO_{10})(OH)_2$ | 6.9 |
| Amorphous/non-diffracting | n/a | 0.4 |

***Mineralogical analysis by quantitative XRD of the ITK***

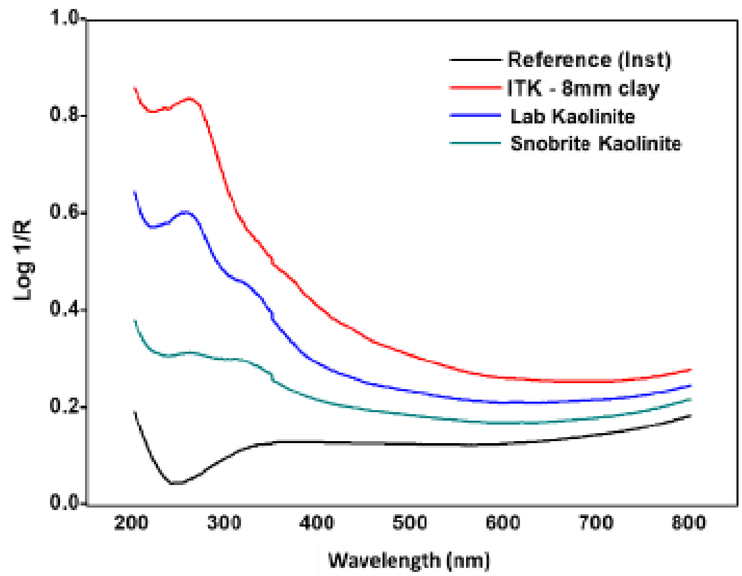
**Morphological analysis** – A Scanning Electron Microscope (SEM) was used to investigate the physical relationships of the size, crystallinity and juxtaposition of the phases present. The drop-cast method was used where the material was mixed with ethanol and then the liquid was sampled. A second sample using the clay fraction was prepared for the XRD where further disaggregation (dispersion) of clay particles was observed. The SEM image showed well-defined plate-like particles which are highly characteristic of kaolin with similar findings resulted from the XRD analysis.




***SEM image of the ITK for the disaggregated clay fraction***

**Thermal stability** - Thermogravimetric analysis (TGA) was used to investigate thermal stability. At a desired temperature range, a species is deemed to be thermally stable when there is no observed change in mass. The kaolin-metakaolin transition happened at around 482°C, and so 600°C was selected as the appropriate temperature for roasting the ITK sample. Further experimentation was then carried out using this roasted sample.

**Elemental analysis** - Energy-dispersive X-Ray Fluorescence (XRF) was employed for elemental analysis. XRF's unique capabilities include the highly accurate determination of the major elements as well as a broad elemental survey of the sample composition. XRF is used in the analysis of rocks/metals and has an accuracy of ~0.1% for the major elements. XRF analysis showed that the ITK sample was free of any major contaminants. The composition of the roasted clay for samples 1 & 2 showed that apart from silicon (72.99% & 73.02% $SiO_2$) and aluminium (23.38% & 23.47% $Al_2O_3$), the concentration of all other elements was below 1% - in line with the XRD data.




***UV-Vis spectra of ITK clay & other kaolin samples***

**Clay colour analysis** - Ultraviolet Visible Spectroscopy (UV-Vis) was used to compare the clay's 'whiteness' with that of commercial kaolins. UV-Vis looks at the absorption or reflectance in the visible range which directly affects the perceived colour of the chemicals involved. Facilities for a quantitative assessment of the clay colour were unavailable and so a qualitative comparison was made against two 'white' kaolin samples using UV-Vis. One of which was a commercially available Snobrite kaolinite (Sibelco), whilst the other sample was a white kaolinite available in the laboratory. The results of this comparative test suggested that the ITK does not have any coloured impurities, but this is not seen to be a definitive study.

## PREPARATION OF IGM'S HPA SAMPLE

Leachates were prepared using the bespoke process which included roasting the clays at 600°C ahead of leaching using an acid concentration of 20% hydrochloric acid (HCL). Where a leachate is basically any liquid that extracts soluble and suspended solids when passed through matter, or indeed any other component of the material through which it has passed. To create the aluminium chloride hexahydrate (ACH), the leachates were sparged (gas flushed) where an HCl gas stream was bubbled through until solid ACH was produced. Crystals of solid ACH were then dissolved in water for a second crystallisation. Alumina was prepared from aluminium chloride using a bespoke process.

The composition of the acidic leachate was analysed by Inductively Coupled Plasma Optical Emission (ICP-OES) which uses an inductively coupled plasma to ionize the sample which can then be detected. The high sand content in the ITK sample made it hard to stir in test 1 (2.0kg mass of clay) under the standard conditions of the process being employed. This was rectified in the test 2 (1.0kg mass of clay) where a higher stirring velocity was used resulting in an improved Al concentration (31,510mg/L). The highest concentrations of containments were iron, potassium and magnesium (at 973.3mg/L, 567.2mg/L & 83.61mg/L respectively in test 2). The concentration of all other containments was <50mg/L.

Despite the high proportion of Si in the roasted clay, the silicon content of the leachate was less than 10mg/L which shows that the silicon in the sample had low reactivity to acid leaching. Low levels of impurities in the ITK leachates do suggest that unprocessed clay could be used.

The two leachates were combined into a composite sample which was used as the first ACH crystallisation (RC1) feed solution. After ACH crystallisation the supernatant (the liquid that lies above a solid residue after crystallisation) had an aluminium concentration of 792.2mg/L which was much lower than that of the feed at 74,270mg/L. The level of contaminants in the reaction supernatant actually increased as water was consumed during the ACH crystallisation.

Next the ACH was dissolved in water and recrystalised in a second crystallisation (RC2). The supernatant aluminium concentration was 685.5mg/L which once again much lower than the feed at 75,150mg/L. The level of contaminants in the RC2 solution was much lower which clearly proved that ACH crystallisation was an effective method of purification.

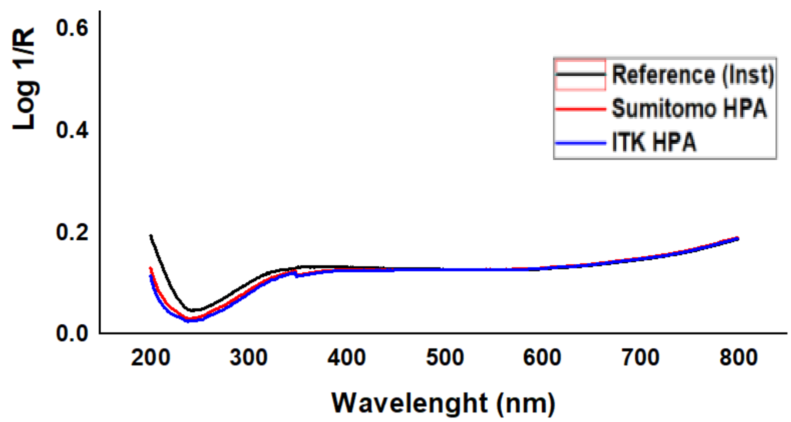
The composition of ACH in each crystallisation (RC1 and RC2) was assessed using ICP-OES which showed that contaminants (Fe, K & Mg) were present in higher concentrations in the ITK leachate, were also present in higher proportions in the RC1 ACH. Although the concentration of contaminants was much lower in the second crystallisation. Next, a bespoke process was used to prepare the final ITK HPA sample from ACH-RC2. At this stage, we already seem to be looking at high purity 4N HPA with the projected alumina purity of ACH-RC2 standing at 99.998%.

| Highlights of the composition of aluminium chloride hexahydrate (ACH) produced from ITK clay | | |
|---|---|---|
| | **ACH-RC1** | **ACH-RC2** |
| Aluminium | 93160 | 95260 |
| Sum of impurities | 59.61 | 3.614 |
| Projected alumina impurities | 282.5 | 17.13 |
| **Projected alumina purity** | **99.972** | **99.998** |

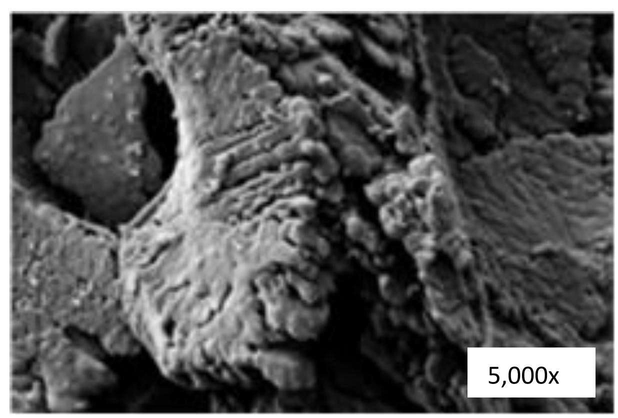
## PHYSICAL CHARACTERISTICS OF IGM'S HPA

XRD, UV-Vis and SEM techniques were used to assess the physical characteristics of the HPA samples. XRD results showed that the only crystalline phase present was corundum (α-alumina). To assess the colour of the products, the HPA samples were analysed by spectroscopy in the ultraviolet-visible range where the ITK HPA was compared to AKP3000 HPA (Sumitomo). From this analysis, it was clear to see that the UV-Vis spectra of ITK HPA matched the spectrum of a commercial Sumitomo HPA. Importantly, this means that as far as coloured impurities are concerned, the synthesised ITK HPA is comparable to a commercial HPA sample.

SEM images revealed that the HPA had a granular structure with a particle size in the 10-100µm range. On a microscale, the surface of these particles is textured due to the sample being heated to a temperature of more than 1,000°C to gain the alpha crystal structure. A similar structure is noted on Sumitomo's commercial HPA.




*UV-Vis spectra of ITK HPA*




*SEM image of ITK HPA*

## CHEMICAL ANALYSIS OF IGM'S HPA

ICP-MS and ICP-OES were used to determine the chemical composition of the synthesised ITK HPA which require a liquid sample. HPA is a solid material and so was prepared for analysis using the total digestion method (where a mixture of acids is used at a standardised digestion time and temperature). The method was tested on 3 commercial HPA samples ensuring the process did not introduce major contaminants.

| Composition (mg/kg) of ITK HPA determined by ICP-OES and ICP-MS | | | | |
|---|---|---|---|---|
| | Inductively Coupled Plasma Optical Emission (ICP-OES) | | Inductively Coupled Plasma Mass Spectrometry (ICP-MS) | |
| **Element** | **Sample 1** | **Sample 2** | **Sample 1** | **Sample 2** |
| **Boron (B)** | 1.524 | 1.525 | 1.088 | 0.936 |
| **Barium (Ba)** | 0.013 | 0.056 | 0.004 | 0.005 |
| **Calcium (Ca)** | 1.737 | 1.579 | 2.156 | 1.526 |
| **Chromium (Cr)** | 0.574 | 0.865 | 0.699 | 0.677 |
| **Copper (Cu)** | 0.060 | 0.037 | 0.042 | 0.050 |
| **Iron (Fe)** | 0.203 | 0.213 | 0.395 | 0.399 |
| **Potassium (K)** | 3.737 | 3.647 | 1.653 | 1.716 |
| **Lithium (Li)** | 0.077 | 0.183 | 0.167 | 0.151 |
| **Magnesium (Mg)** | 2.909 | 2.807 | 2.977 | 2.832 |
| **Manganese (Mn)** | 0.047 | 0.133 | 0.007 | 0.029 |
| **Sodium (Na)** | 3.770 | 3.771 | 2.797 | 2.164 |
| **Phosphorus (P)** | n/a[1] | n/a[1] | 3.210 | 3.019 |
| **Silicon (Si)** | 9.460 | 9.414 | 9.383 | 8.461 |
| **Strontium (Sr)** | 0.003 | 0.009 | 0.007 | 0.002 |
| **Titanium (Ti)** | 0.430 | 0.411 | 0.397 | 0.403 |
| **Vanadium (V)** | 0.389 | 0.299 | 0.206 | 0.199 |
| **Zinc (Zn)** | 0.410 | 0.279 | 0.657 | 0.653 |
| **Sum of impurities** | 25.34 | 25.23 | 25.85 | 23.22 |
| **Aluminium purity** | **99.9975%** | **99.9975%** | **99.9974%** | **99.9977%** |

[1] Potassium was not assessed by ICP-OES due to instrument interference with aluminium

Purity of the HPA samples was at least 99.997% with the concentration of the contaminants below 1mg/kg (i.e. 0.0001%) except for boron, calcium, potassium, magnesium, sodium, phosphorus and silicon. Further work on IGM's kaolin using this bespoke process is likely to focus on further reducing these elements to produce 5N HPA.

| Main findings of the study |
|---|
| ITK clay was low in reactive impurity elements and minerals, with the only crystalline phases attributed to the clay being quartz, kaolinite and muscovite. |
| TGA showed that the metakaolin transition of ITK occurred at 482°C. |
| Stirring during the leach was impacted by high proportion of quartz in the sample, which led to a leachate with a low concentration of aluminium. A second test was performed where stirring was improved. |
| XRD analysis showed that the ITK HPA sample was comprised of α-alumina. |
| UV-Vis of ITK HPA was similar to a commercially available HPA (Sumitomo AKP3000). |
| High 4N purity was achieved for the ITK HPA sample (99.997%). |
| All measured contaminants in the sample were below 1mg/kg except for boron, calcium, potassium, magnesium, sodium, phosphorus and silicon. |
| Reduction of these elements would be an avenue for future work toward higher grades of HPA. |

## SHAPING UP TO HAVE SERIOUS HPA POTENTIAL

Results from previous mineral tech lab tests combined with market research and the size of the kaolin resource has rapidly begun to suggest that the Brilliant Brumby Project had serious kaolin potential. Now with these latest findings, the project seems to be shaping up to also have serious HPA potential.

The message that has come out loud and clear from these latest tests is that Surprise kaolin looks to be favourable for HPA production**.** The crystalline phases in ITK samples were approximately 48% kaolinite, 45% quartz and 7% muscovite (mica) with just 0.4% of reactive impurity elements and minerals. Being low in reactive impurities is seen to be highly favourable for HPA production. At the same time, there was no smectite or halloysite in the sample SEM and XRD confirmed the presence of kaolinite as the only Al mineral.

**High Purity Alumina (HPA)**

| Typical Properties | | Product | AKX-5 | AKP-20 | AKP-30 | AKP-50 | AKP-53 | AKP-3000 |
|---|---|---|---|---|---|---|---|---|
| Crystal Structure | | | α | α | α | α | α | α |
| Purity(Al2O3) | | [%] | ≧ 99.99 | ≧ 99.99 | ≧ 99.99 | ≧ 99.99 | ≧ 99.99 | ≧ 99.99 |
| Mean Particle Size (MT3300) | | [μm] | - | 0.46 | 0.27 | 0.20 | 0.18 | 0.70 |
| Loose Bulk Density | | [g/cm3] | 2.2 | 0.9 | 0.9 | 0.9 | 1 | 0.41 |
| Tapped Bulk Density | | [g/cm3] | - | 1.4 | 1.3 | 1.3 | 1.4 | 0.80 |
| BET Surface Area | | [m2/g] | 0.3 | 4.3 | 6.7 | 10.3 | 11.7 | 4.5 |
| Impurity | Si | [ppm] | 6 | 16 | 14 | 11 | 33 | 4 |
| | Fe | [ppm] | 3 | 3 | 3 | 4 | 4 | 3 |
| | Na | [ppm] | 2 | 4 | 2 | 2 | 2 | 2 |
| | Mg | [ppm] | 1 | 3 | 3 | 2 | 5 | 1 |
| | Cu | [ppm] | 1 | 1 | 1 | 1 | 1 | 1 |
| Packing | PE Bag | | | 20kg | 20kg | 20kg | 20kg | 10kg |
| | Paper Drum | | 100kg | | | | | |
| Application | | | Single Crystal | High-strength and high-density Ceramics, Composite Materials, Additives for non-Oxide Ceramics, Abrasives, Plasma Spray, Ceramic Filter, etc. | | | | |
| | | | | | | | | Insulation layer of Li-ion Secondary Battery |

***Sumitomo's HPA. Source: Sumitomo Product Databook***

It was also demonstrated that IGM's HPA is comparable to commercial HPA such as Sumitomo's HPAs for a number of reasons. In addition to ≥ 99.99% $Al_2O_3$ purity, all the measured contaminants in the sample were below 1 mg/kg (1ppm) except for boron, calcium, potassium, magnesium, sodium, phosphorus, and silicon; and ITK HPA also had an α crystal structure. Judging by the results of UV-Vis spectroscopy, synthesised ITK HPA does not have any coloured impurities and is comparable to commercial HPAs such as Sibelco's Snobrite.

## PRE- CONCENTRATING KAOLINITE LOOKS BENEFICIAL

The composition of the roasted ITK clay material was around 73% $SiO_2$ and 23% $Al_2O_3$, but the high quartz content did not prove to be a problem. As mentioned earlier on, the sand made the mixture hard to stir in the leaching experiments which led to a low concentration of aluminium due to the high quartz content. A higher stirring velocity was used with a second sample to ensure that the sandy material was fully exposed to the acid, which slightly improved the Al recovery. However, the really important point here is that this did not result in an increase of silicon in solution. More good news as this basically has served to demonstrate that silica sand is not a troublesome contaminant.

Ahead of all these tests, the material was screen at 8mm which was just purely to remove the large pieces of quartz rather than to take out the sand. The plan was to see if this made any difference to the final outcome. In earlier tests carried out by the US-based mineral tech consultancy, their IGM sample was sieved at the outset with a large proportion of the +325 Mesh (+44µm) sand/silt fraction being uniformly-sized quartz/silica along with minor amounts of kaolinite, mica/illite and ancillary minerals. Additional screening at 30 mesh increased $SiO_2$ concentration to almost 99.7% which represents very high purity silica with potential uses in electronic and solar energy generation. In these latest tests by the independent experts, despite the high proportion of silicon in the roasted clays, the concentration in the leachate was under 10mg/L, all of which suggests that kaolinite pre-concentration by removing the sand would not need to be that precise.

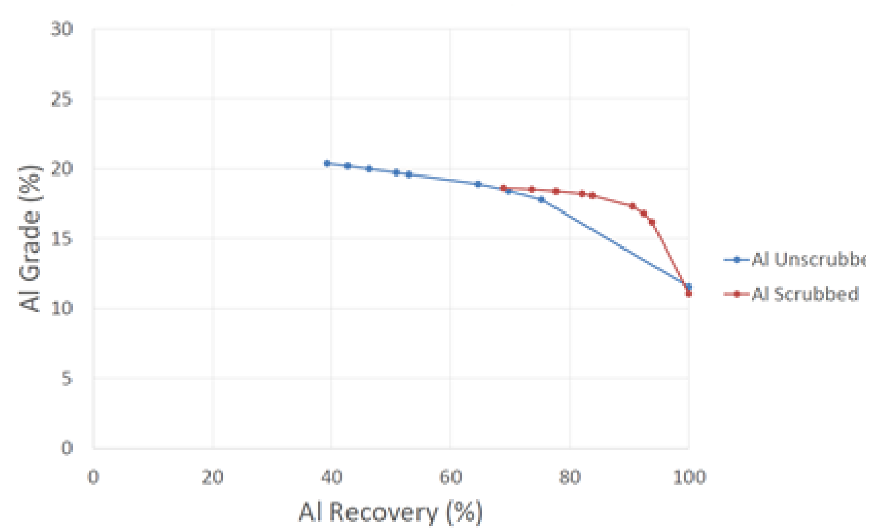
Others have been taking a good look at further samples of kaolin from the Brilliant Brumby Project. An independent mineral processing services group undertook a test work programme to characterise a kaolin sample from the project and to assess possible uses for the material. Beneficiation test work showed that the sample was amenable to aluminium upgrading using scrubbing and screening. In fact, some 50% of the silica and 36% of the mass can be very easily rejected which allows the aluminium to be upgraded from 10% to 16% with seemingly only minimal losses.

| Element | Application | | | Sample tested | | | |
|---|---|---|---|---|---|---|---|
| | White cement | Pigments/ Ceramics | HPA[1] | As received | As received -53µm | Scrubbed -53µm | Scrubbed -850µm |
| Si | 33-34 | 23-25 | 34.9 | 33.7 | 21.7 | 20.6 | 24.6 |
| Al | 9.5-10.5 | 23-35 | 12.4 | 10.3 | 20.4 | 18.6 | 16.2 |
| Fe | 0.3-0.7 | <0.3 | 0.7 | 0.79 | 0.86 | 0.78 | 0.83 |
| Ti | 0-0.8 | <1 | 0.6 | 0.10 | 0.21 | 0.16 | 0.16 |

[1] average of three samples previously tested, before beneficiation

***Comparison of IGM's sample tested against typical kaolins***

This study seemed to confirm the results from other lab tests that the sample of IGM's kaolin appears to be suitable for use as an additive to white cement or as a feed stock for HPA production; however it probably unlikely to be suitable for use as a pigment or ceramics. Certainly, the sample demonstrated amenability to beneficiation, which is an important factor as it would potentially allow for a smaller sized leaching circuit, necessary if the material were to be used for HPA production. To help in future projects developments, following these results, it was recommended that a scoping study be undertaken to assess the project economics of both HPA production and use as a cement additive.




***Grade vs recovery curves for Brilliant Brumby kaolin sample***

## 5N HPA SEEMS A REAL POSSIBILITY

5N does looks to be a real possibility with further purification stages. The second round of recrystallisation improved the Al concentration by 2.25% upgrading the product to 4N from 3N which resulted from the first recrystallisation. It is possible that the resulting product might be 5N if the sand had been removed before processing. However, 5N HPA has a maximum of only 10ppm (or mg/kg) of total impurities, whereas in this round of testing, the sum of impurities totalled 23 and 25ppm of which silicon accounted for 8.4 - 9.4ppm. Just removing/reducing the silicon content would not be sufficient to achieve 5N as a total of 15ppm of other contaminants would still need to be removed. This might be achieved more cheaply and simply with a third round of crystallisation rather than removing the sand ahead of processing.

The independent experts normally obtain a 10-12% mass recovery in achieving a 5N product, which gives an idea of the ultimate yield that may be expected and could suggest a high value for 5N feed material which meets the right specifications. Although these experts routinely work on other sources of kaolin, they have not completed the whole 5N process on many kaolins. Producing 5N HPA from Surprise kaolin could represent quite a coup because successful 5N HPA might be a lot rarer than some might believe. Interesting enough, a number of companies have announced 5N HPA production to 99.999% purity, although it may be questionable if it's really been achieved. It is the view of these independent experts that the instruments and methods used by some parties to test 5N purity are potentially flawed.

Obviously, it is still early days in IGM's appraisal of the kaolin potential at the Brilliant Brumby Project and the investigation into potential market opportunities across a range of commercial kaolin products. These latest test results should be seen as baseline values where improvements can be made in the future. Further laboratory test work is likely to focus on reducing contaminants with the goal of achieving higher grades of HPA. For this initial investigation into producing HPA from IGM's kaolin, the sample was selected from some of the best material from Surprise, whilst other material there has a higher level of contaminants like iron and sericite. Iron is relatively easy and if not removed in the leach quickly becomes ferrous chloride from the first phase of dissolution of the leachate, whilst the sericite (a fine-grained variety of the silicate mineral muscovite) is seen to be the more likely source of the silicon in solution rather than quartz. Moving ahead further testing is likely to involve a range of samples that may be more statistically representative of the kaolin resource at Brilliant Brumby to provide a true measure of the HPA potential.

Lab test result continue to provide good news beyond the HPA potential. The low level of contaminants does mean that chemical purity specifications required for other kaolinite products could be met, obviously following the appropriate processing. This is highly favourable for other markets such as meta-kaolin products and pozzolans along with new opportunities opening up for kaolin such as in thermal energy storage. However, the big message from all this work is the real prospect that kaolin might help subsidise gold mining resulting in lower cost per ounce on a global basis.

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 on 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 and independent research firms. He was formerly a Non-Executive Director at Ascot Mining PLC, a quoted Central American gold miner. Michael also continues to work closely with resources companies on IR.