

## ILUKA CERAMICS TILE STUDY

7 March 2014

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### OVERVIEW

In 2013 Iluka conducted its second annual ceramics tile study, following up from the original study conducted in 2012.

The 2013 study collected and analysed zircon content from a large sample of tiles from eight major tile producing countries. Input to the analysis of the results was complemented by information received from tile manufacturers, retail tile outlets, industry consultants and Iluka's customers. The 2013 study builds on the 2012 study that focussed on analysing tiles produced in China, the largest global tile producer. The tile analysis survey, which forms the key part of the study, is a component of Iluka's broader market and product development work.

The two years of China tile data now facilitates year-on-year comparisons of zircon usage in various ceramic tile types, as well as trends in production and consumption patterns. This form of analysis will be continued and extended.

The large and broad sample collected in 2013 provides Iluka with a comprehensive data set from which to generate insights into tile preferences (refer to the Appendix for a description of various tile types) and zircon usage trends. The main high level conclusions from the 2013 study include the following (it should be noted for commercial and proprietary reasons, Iluka does not disclose specific data related to its survey results):

- year-on-year, the zircon content of Chinese tiles increased across all tile segments, with some increases statistically significant, some not;
- high technology tile manufacturing processes, specifically digital printing on both glazed ceramic and glazed and rustic porcelain, are growing in popularity and are associated with higher zircon content;
- on average, across all countries sampled, polished porcelain tiles (polycrystalline) contain the highest level of zircon. The trend previously observed by Iluka (refer Iluka's Briefing Paper, *Modernisation, Thrifting and Substitution*, December 2012) was of a reduction in zircon content in polished porcelain tiles in China through the application of tile manufacturing technology, known as double charging which had been in existence in other regions. Iluka's analysis suggests that this structural change in zircon intensity has occurred in China. In other regions sampled (Italy, United Arab Emirates, India and Malaysia) zircon content of polished porcelain tiles can vary and be higher than China, reflecting quality and style and other manufacturing considerations;
- crystal jade porcelain tiles, a variant of glazed porcelain tiles, had the highest zircon content in China. While a small segment of the market, these are an increasingly popular tile type, marketed to higher end markets; and reduced demand was observed in China for lower end, low cost soluble salt polished porcelain tiles that tend to contain minimal to nil zircon.

The median values of tile zircon intensity from the China tile sampling study imply that zircon contributions to finished tile production costs were less than 2 per cent of final costs. The results also support information gained by Iluka from customers, tile producers and industry participants over the course of late 2013, that a number of practices relating to thrifting, changes in tile formulations and in some limited cases, outright substitution, have or may be reversing.

## 2013 TILE STUDY - HIGH LEVEL FINDINGS

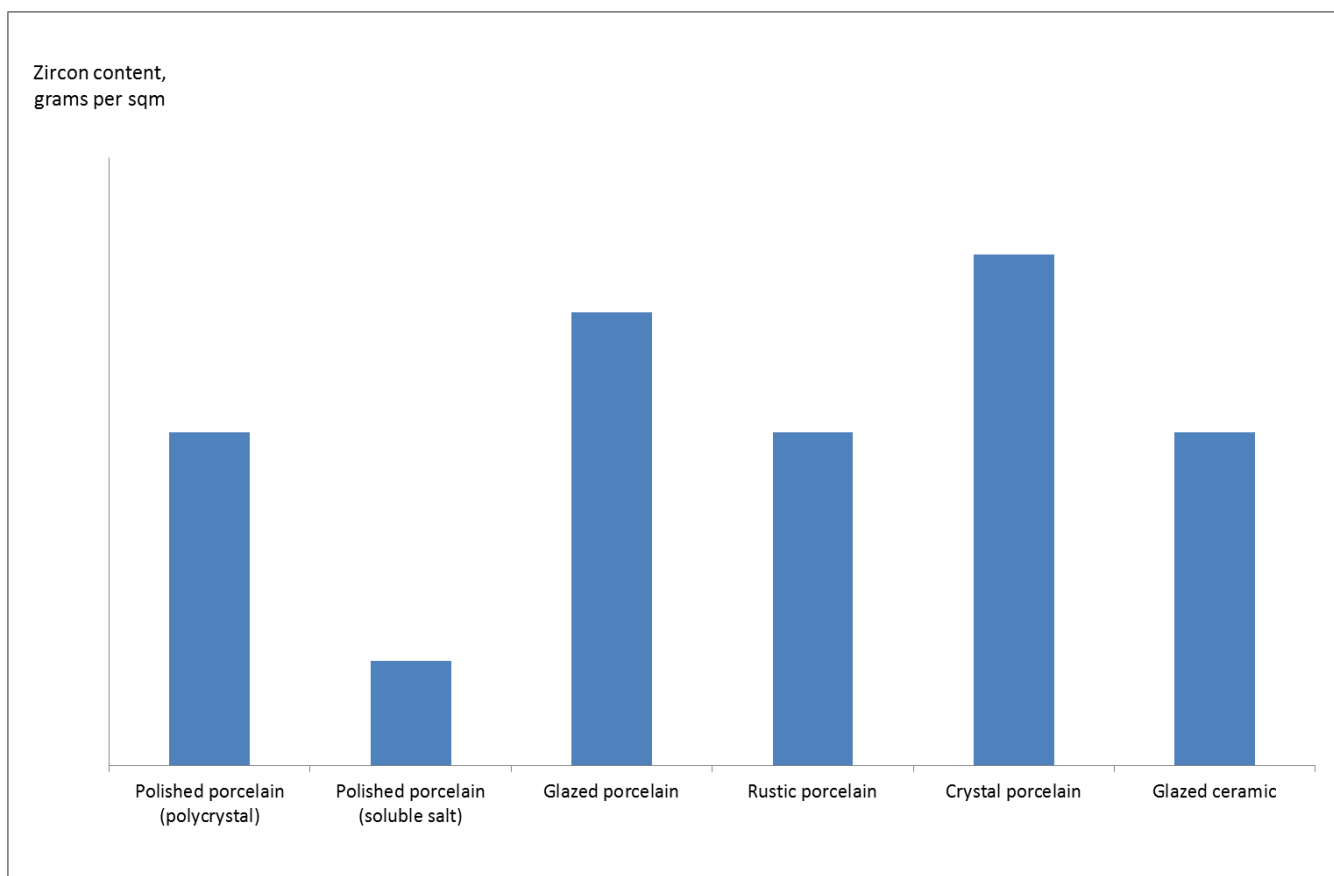
### Zircon content and tile type

Across tile types, crystal porcelain tiles exhibited the highest median zircon content. This increasingly popular product type is typically decorated in high-definition using digital printing and requires good white background for the desired effects to be achieved. Zircon is used either in an engobe layer or in a white body layer on top of the body, serving as the decorative canvas for the intended design.

Glazed porcelain have the next highest median zircon content, driven by the same factors mentioned above for crystal porcelain tiles due to growing adoption of digital printing. Polycrystalline polished porcelain, rustic porcelain and glazed ceramic tiles show similar average zircon loadings. The zircon in polished (non-glazed) porcelain tiles is contained largely in body layer and the rustic porcelain and glazed ceramic tile in the engobe (layer between tile body and glaze) and glazed layers with typically minimal zircon in the main tile body.

The technology of digitally printing tiles has been growing in popularity, with digitally printed effects applied to glazed tiles (porcelain and ceramic). In Iluka's sample, and supported by industry feedback, digitally printed tiles have a higher zircon content than non-digitally printed tiles (discussed further below). It is not possible for Iluka to estimate at this stage the market share of digitally printed tiles or production growth, although it appears to be increasing rapidly, while installation of digital printers in tile manufacturing in China has shown a rapid increase (refer Figure 4).

Figure 1: Median zircon content by tile type



Source: Iluka

### Zircon content of Chinese made tiles

China was, as in 2012, a key focus of Iluka's 2013 study given its importance as a tile producer globally and as Iluka's main zircon sales region. Over half the tiles sampled in the 2013 study were from China, taken from a range of provinces and of varying type, price and quality. Sampling was aimed to reflect the tile type proportions of the overall market and hence some categories grew in sample size from 2012 while new tile making provinces were also part of the sampling.

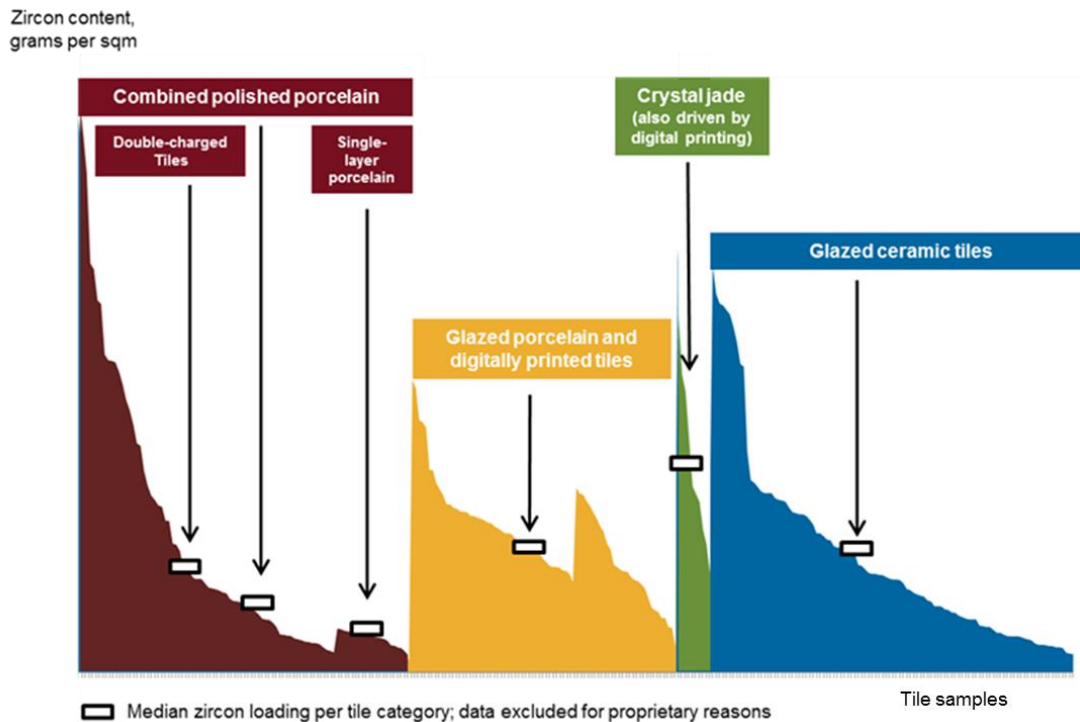
In 2013, crystal jade porcelain tiles contained the highest median zircon content. This was also the case in 2012 with a small increase in zircon content over the two years (though not statistically significant). These tiles are produced in several provinces and target higher end consumers.

Glazed porcelain and glazed ceramic tiles both showed similar median zircon contents in 2013 to the previous survey. The zircon content of both tile types increased from 2012, being statistically significant for glazed ceramic tiles. Production of these tile types has grown strongly, likely due to increased demand for higher quality tiles and the emerging trend of more complex, vivid designs achieved through advanced digital printing techniques.

In 2013, glazed porcelain and glazed ceramic tiles from China had higher median zircon content than polished porcelain. In addition, there was a tighter range of loadings and a higher minimum zircon content. This is often a result of optimizing tile properties for printing technologies that need a good white engobe layer, even for darker tile designs (discussed further below). This new trend appears to be an important driver of zircon demand.

Zircon content of polished porcelain tiles increased marginally, likely due to a drop off in demand for, and production of, lower quality soluble salt polished porcelain tiles within this category. Industry feedback and Iluka's analysis suggests demand is shifting to higher quality polished porcelain tiles.

**Figure 2: Zircon content of Chinese tiles, 2013**



Source: Iluka

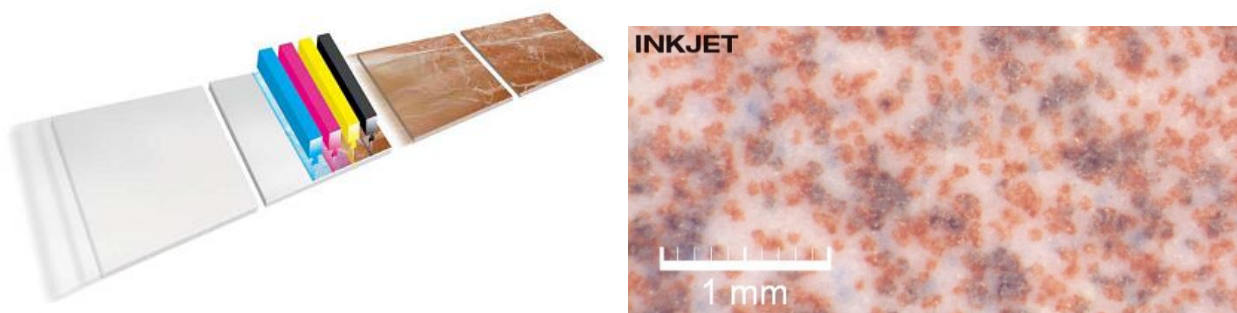
Note: The above chart shows the median zircon content of each tile sampled in China, grouped by their tile type. As such it is a geographic subset of the complete survey. The horizontal axis represents the sample universe.

### Digital printing and zircon content

Designer tile manufacturing, facilitated by new technologies like digital printing, is a growing global trend, and especially marked in China. This technology allows designs printed on tiles to be highly varied, for instance to include stone and marble-like features, wood-like grains, graphic prints and many other features. Increasingly, many ceramic industry participants rely on the aesthetic attractiveness of ceramic tile products as their source of competitive advantage. Tile design, innovation and product appeal are seen as crucial success factors.

Digital printing is superior to conventional printing techniques (rota and screen printing) as it offers greater versatility in designs, allows optimisation of pigment, requires significantly less manpower and factory footprint, allows printing on uneven surfaces and value-adding special effects, enables on-the-run changes to printed tile designs and prevents unnecessary accumulation of slow-moving tile inventory, among other benefits.

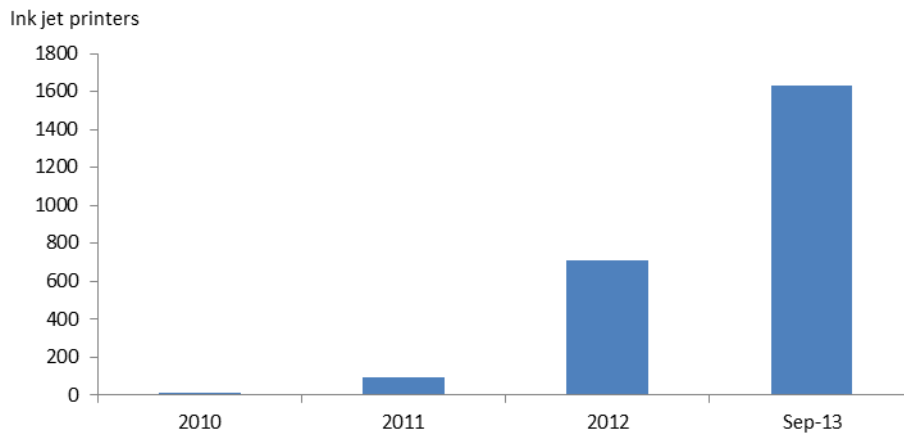
**Figure 3: Example of digitally printed tiles, in production and magnified**



Source: Digitalfire and ACIMAC

The image on the right shows a close up digital ink droplets on a white tile.

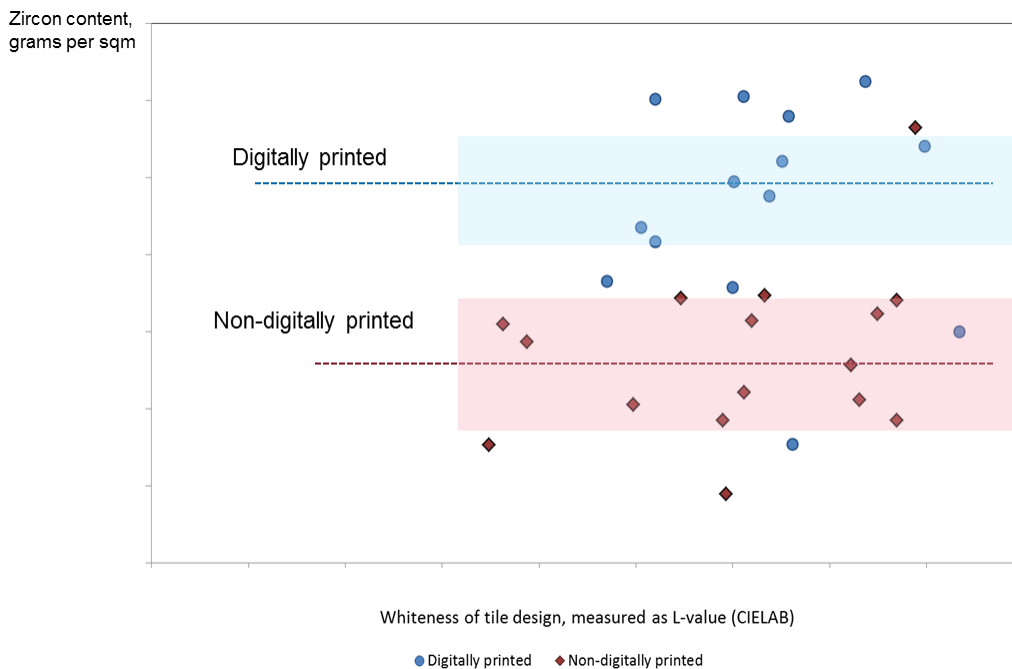
**Figure 4: Digital tile inkjet printers in China, to September 2013**



Source: Lee, X. Ceramic Town Weekly, 2014

Digitally printed tiles, based on Iluka's analysis and supported by industry feedback, have significantly higher zircon content relative to non-printed tiles and tiles printed with conventional techniques (refer Figure 5). Higher zircon content is recorded regardless of the colour of the tile design with dark and light coloured printed tiles having higher zircon content than similar coloured conventionally decorated tiles.

**Figure 5: Zircon content of digitally printed and non-digitally printed tiles**



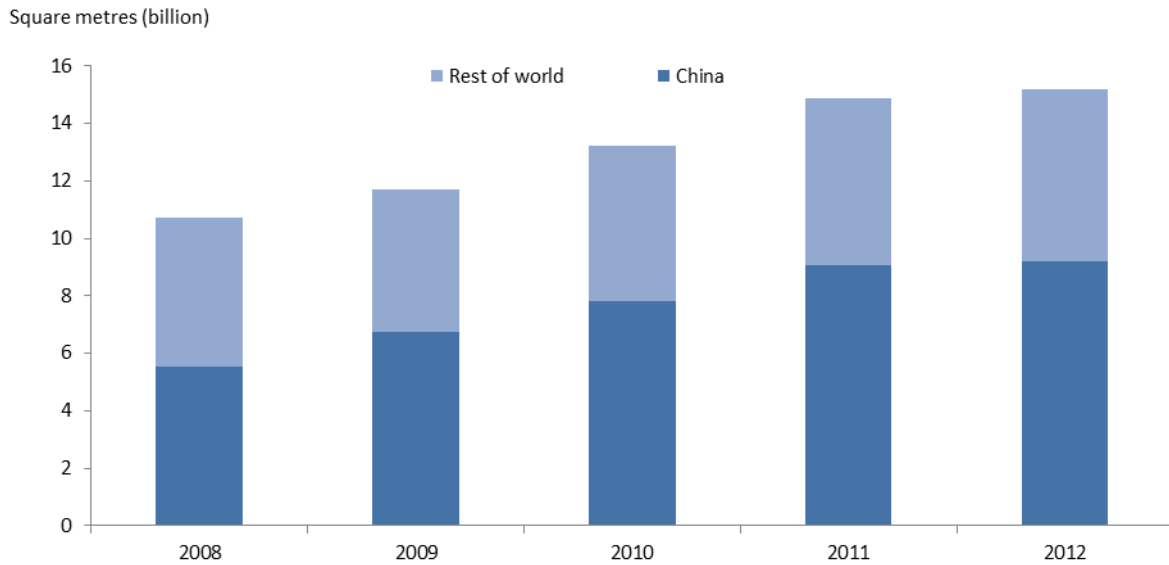
Source: Iluka

Higher zircon content is needed not only to impart greater aesthetic appeal but also to optimize the cost of expensive digital inks and other inputs. Digital printing inks are more expensive, finer and applied thinner than conventional inks so the background engobe must be sufficiently white for the colours to be displayed in the most effective and economical manner.

**CONTEXTUAL INFORMATION - GLOBAL TILE PRODUCTION**

In 2012 over 15 billion square metres of tiles were estimated to have been produced globally. China is the world’s largest tile producer, accounting for around 60 per cent of global production. The top ten tile producers also include Brazil, India, Iran, Spain, Italy, Indonesia, Vietnam, Turkey and Mexico. Tile manufacturing has recorded strong growth in recent years and industry estimates show a rebound in 2013 after slowing in 2012. In China, average annual growth in tile output over the past five years has been around 14 per cent.

**Figure 6: Global Tile Output**

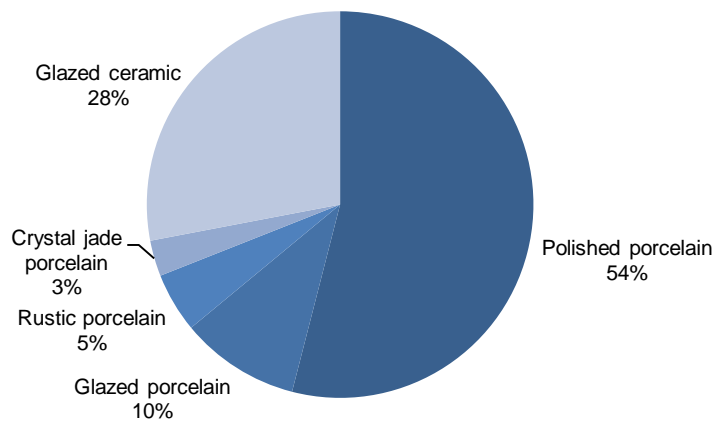


Source: Ceramic World Review (2013) and Asian Ceramics (2014)

Note: China tile output estimates from Asian Ceramics, rest of world from Ceramic World Review. Published tile output estimates can vary significantly. Iluka believes this methodology to produce the best estimate based on currently available data.

Globally, porcelain tiles dominate, accounting for around 60 per cent of total ceramic tile production (the other main component being glazed ceramic tiles). This is also the case in China where around 70 per cent of ceramic tiles produced are porcelain (refer diagram below). This is also the strongest growth market.

**Figure 7: 2013 China Tile Output, by Tile Type**



Source: Iluka

Note: Digitally printed tiles are sub-components of glazed, rustic and crystal jade porcelain tiles and glazed ceramic tiles.

## APPENDIX: TILE TYPES AND ZIRCON CONTENT

There are two main types of ceramic tiles, porcelain and non-porcelain. Porcelain tiles include full body porcelain, glazed and rustic porcelain, and crystal jade porcelain. Non-porcelain tiles include glazed ceramic, stoneware and earthenware tiles. Zircon use in ceramics typically constitutes about 55 per cent of global demand for zircon, of which about 85% of zircon use in ceramics is applied in tiles and about 15% in sanitary and table ware.

**Table 1: Summary of selected Tile Types**

Tile Type	Description
Polished porcelain (unglazed)	<p>A high density, wear resistant and water impervious (vitreous) tile body without any glazing applied on the surface that is typically polished to provide the aesthetic quality.</p> <p>There are a number of variants in this category depending on the manufacturing and decorative process used. For instance, in manufacture, the polished porcelain tile could be produced with single composition across the tile depth (full-body) or with two layers of different compositions (either produced with double-charging using a single press or with double-pressing using two subsequent presses). In decoration, the polished porcelain could be decorated using soluble salts (older method) or with dry crystalline granules. In China, typically the soluble salt decorated tiles are produced as full-body tiles, whereas the polycrystalline decorated tiles are produced as double-charged tiles.</p>
Glazed porcelain	<p>Similar to porcelain but glazed to enhance the aesthetic appeal and allow cheaper materials to be used in the body.</p> <p>Typically, a white engobe layer between the body and the glaze is needed to serve as the intermediate layer to ensure good attachment of the glaze layer onto the body, prevent cracking of glazes during the manufacture and, aesthetically, fully mask the colour of the body and serve as a white canvass for the decoration.</p> <p>Normally, glazed porcelain tiles are not polished and left either as matte or glossy surface. For high-end glazed tiles, since the glaze layer is thicker, polishing may be necessary to achieve good flatness and glossiness of the glaze layer.</p> <p>Glazed porcelain tiles are used for both floors and walls.</p>
Crystal jade porcelain	<p>A high-quality glazed porcelain tile with thick crystal glaze on top, typically 15 – 30 per cent of the tile thickness. The thick crystal applied on the surface emulate the natural effects of crystal stones and allows the decoration (typically applied through digital inkjet printing) to become highly enhanced.</p>
Rustic porcelain (glazed)	<p>A type of glazed porcelain tile with designs that utilize earth colours (darker) and use rough or uneven surfaces for enhanced effects. Glazing methods and effects employed vary depending on the desired designs.</p>
Unglazed ceramic	<p>Tile body made from clay or a mixture of clays and other materials. Body is porous. Limited decorative effects, usually achieved by adding colorants to the tile body.</p>
Glazed ceramic	<p>As above but with glaze applied resulting in harder wearing, non-porous surface. Decorative effects that can be applied are numerous, from plain white glossy surfaces for instance as bathroom tiles, to digitally-printed glazed surfaces for wide range of applications, such as living room walls.</p> <p>White engobe layer play an important role, similar to that in the glazed porcelain. Typically, thicker layers of engobe are required in darker-coloured ceramic bodies to fully mask the body colour and provide good white background for the decorative pigments.</p>

\* Glaze: glassy opaque or transparent coating fired or fused onto tile body, creating smooth, impermeable surface.

Zircon is used in tiles for its opacifying (whiteness), hardness (abrasion resistance) and chemical resistance properties. It can also be used in ceramic pigments for colouring tiles. Zircon content (grams per square metre) is influenced by several factors including type of tile; production region; and production process.

## Production regions

Average zircon content for a given tile type varies across regions. This could be due to production process adopted in these countries and regional preferences for colour, quality and other factors.

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