

“Industrial Waste Resources Will Become the New Normal”

In this Refractories Special Edition of *Interceram*, we turned to industrial minerals and markets specialist Mike O’Driscoll of IMFORMED – Industrial Mineral Forums & Research, to sound him out on refractory materials matters – particularly as they apply to the European industry. We were interested to interview him to see what he had to say about critical minerals, the supply chain, potential changes in the future, and the role of recycling. Read his perspective below.

Interceram: Which do you regard as the critical raw materials for today’s European refractories industry?

Mike O’Driscoll: Refractory minerals maybe termed the ‘DNA of refractories’, since without them refractories cannot be manufactured, nor perform to their desired requirements, thus directly impacting production of steel, non-ferrous metals, glass, cement, ceramics, lime, etc.

At least 25 different types of industrial minerals are used in refractory manufacture and some of the main types are listed in [Table 1](#). It has been estimated that some 35m tpa of refractory minerals are consumed worldwide, with the leading minerals (by volume consumed) being fireclay (46 %), magnesia (26 %), bauxite (4 %), speciality aluminas (4 %), brown fused alumina (3 %), and dolomite (3 %) (see [Figure 1](#)). Each refractory product can have its own ‘critical’ raw material, such as insulation refractories need perlite or vermiculite, while specialist high resistance components need zircon or silicon carbide.

However, in the main, for today’s European refractories industry, the classic refractory categories of acidic refractories require aluminas (fused, calcined, tabular), bauxite, andalusite, refractory clays (kaolins, chamotte) and silica; basic refractories require graphite, magnesia (fused, dead burned), dolomite, chromite, and spinel; speciality refractories require zircon, silicon carbide.

There is also increasing development and use of ‘synthetic’ refractory raw materials such as spinels, high purity sintered

bauxites and aluminas, and increasing use of lime- and silica- enriched formulas. The drivers for this trend include not only rising demand for higher purity and higher performance products (triggered by demand for high performance steels), but also to diversify refractory raw material consumption as sources and production of natural traditional refractory mineral grades either dwindle or become inconsistent in supply and quality availability. The criticality factor for refractory raw materials is very much influenced by their source, and recent events have now shaped changes in mineral sourcing and use.

Where are the main sources for these materials? Do you see any of the imports or sup-

ply lines being compromised in the short- to medium-term?

The table of refractory mineral types ([Table 1](#)) also indicates the primary source country for each mineral. With the exception of silica, and perhaps refractory clays to some extent, both of which can generally be sourced close to most refractory producing centers, all other refractory minerals are actually quite limited in their sources. Magnesias and aluminas are probably the most widely sourced, relative to the remainder. But even these are limited: high purity magnesias from Europe, Russia, Turkey, Brazil, Australia, Japan and China; aluminas from the USA, Europe, India, Japan and China.

Regarding primary world trade in the other minerals: chromite is sourced from mainly just South Africa; bauxite from

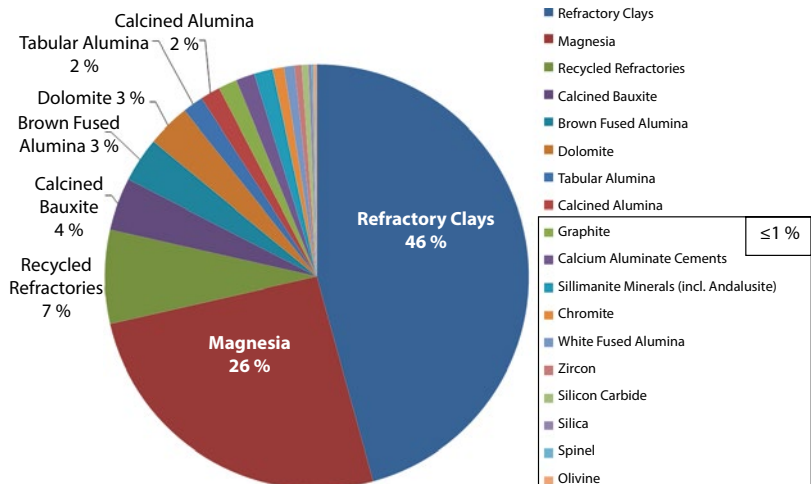


Figure 1 Estimated world consumption of refractory minerals: total ~35m tonnes (© Imformed)



Mike O'Driscoll

Mike O'Driscoll is Director and co-founder (with Ismene Clarke) of IMFORMED – Industrial Mineral Forums & Research Ltd, focused on specific industrial minerals research and conferences. He has over 30 years' experience specializing in industrial minerals and markets. Mike joined London-based Industrial Minerals (IM) magazine in 1987, was posted to New York as Associate American Editor 1988–90, before becoming IM's longest serving Editor 1995–2012. He became Global Head of Research IM in 2012 before leaving in July 2014 to pursue a career as an independent expert in industrial minerals. In 2011 he received the Hal Williams Hardinge Award, from the SME, for services to the industry, in particular owing to his coverage of China.

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Guyana and China; dolomite from the USA, Belgium, Spain, Italy, Austria and China; andalusite from South Africa, France and most recently Peru; pyrophyllite from South Korea, Japan, Canada, Turkey; zircon from the USA, Senegal, South Africa, and Australia; graphite from Canada, Brazil, Norway, Madagascar, Mozambique, India, and China; silicon carbide from the USA, Brazil, Netherlands, Norway, Spain, Germany, Romania, Russia, South Africa, Vietnam, Japan and China.

What stands out of course is just how prevalent China is in supplying refractory minerals to world markets. In fact, based on global exports, China dominates world refractory mineral supply in bauxite (almost 100 %), magnesias (57 %), natural graphite (60 %), fused alumina (58 %), silicon carbide (53 %), and for fireclay is second (11 %) after Ukraine (80 %).

The world's refractory bauxite supply is restricted to very few sources of economically developed deposits, and is pretty much run by Chinese companies in Shanxi, Guizhou, and Henan provinces in China, and in one operation in Guyana. A look at the charts of export markets for specific Chinese refractory exports (Figure 2) indicates that leading consuming markets are in the USA, Japan, India, South Korea, and the Netherlands (a conduit to European consumers) – all leading steelmaking countries. The USA, for example, relies on imports for > 50 % of its total demand for

bauxite, magnesias, graphite, fused alumina, and silicon carbide – with China as its leading source for each mineral.

As any mineral consumer knows, having all your mineral supply in one source basket – for example China – might be rather risky (and it is!). However, over the last 40 years plentiful Chinese mineral supply at low prices, albeit with some hiccups in 'exclusivity' from suppliers, quality issues, and price and export tax/quota unpredictability, has nevertheless been enjoyed and endured by refractory buyers in the West. Until now.

The last few years have witnessed a sea change in consumers' attitudes on this reliance on China. There were warning signs from 2000, during the SARS outbreak of 2003, the Beijing Olympics of 2008, and most recently and dramatically, the continuing anti-pollution drive from 2017; and now in 2020, the Covid-19 pandemic. All these events, almost immediately at their time of occurrence, negatively impacted refractory mineral supply from China, and at a stroke forcefully reminded consumers how dependent they were on Chinese sources and thus sensitive to any supply disruption.

For in the ensuing years since the late 1980s, western mineral producers, strangled by the flood of cheaper Chinese raw materials, either reduced capacities, were consolidated, or went out of business altogether – in other words, when the Chinese

mineral tap was turned off, there was not much around to take up the slack. SARS, the Olympics, and Covid-19 all impacted the Chinese mineral supply chain by paralyzing the logistics for getting the minerals to markets in the West: by security actions, quarantines, transport restrictions and bans, provincial border controls, and port shutdowns and congestion.

The anti-pollution crusade had deeper consequences. Initiated in late 2016, President Xi Jinping's ongoing mission to stamp out industrial pollution saw whole swathes of Chinese mineral production capacity wiped out during 2017–18 through temporary and permanent closures of operations as they were inspected for pollution. The situation was compounded by an intermittent dynamite ban (no mine blasting, so no primary ore), and tax evasion investigation (many companies had not kept their books well, leading to more closures).

The upshot is essentially less availability of minerals from China, a big reduction in the number of mineral suppliers, and uncertain pricing. Combine this with (last few Covid-19 impacted months aside) increasing growth of domestic manufacturing of added-value products, including refractories, demanding China's minerals, then suddenly exports are no longer as attractive as they once were for a mineral producer, and certainly not as a top priority. All this has naturally highlighted the refractory markets' high import reliance

TABLE 1 Industrial minerals consumed in refractories (© Imformed)

Refractory classification	Industrial mineral (incl. synthetic)	Main chemical component	Primary source country
Basic	Dead burned magnesia	85–99,8 % MgO	China
	Fused magnesia	97–99,8 % MgO	China
	Dead burned dolomite	56–62 % MgO, 36–49 % CaO	USA
	Chromite	> 46 % Cr ₂ O ₃	South Africa
	Sintered/fused spinel	66–80 % Al ₂ O ₃ , 21–33 % MgO	China
	Olivine	40–50 % MgO, 35–45 % SiO ₂	Norway
	Acidic	Calcined alumina	> 99,5 % Al ₂ O ₃
High alumina	Fused alumina	94–99,5 % Al ₂ O ₃	China
	Calcined bauxite	85–88% Al ₂ O ₃	China
	Sintered/fused mullite	40–75% Al ₂ O ₃	USA
Low alumina	Andalusite, sillimanite, kyanite	60–65% Al ₂ O ₃	South Africa
	Refractory clays	20–45% Al ₂ O ₃	China
	Pyrophyllite	20–30% Al ₂ O ₃	South Korea
Silica	Quartzite, silica sand	> 97 % SiO ₂	Regional
	Fused silica	> 99,8 % SiO ₂	USA
Specialized	Zircon	66 % ZrO ₂ + HfO ₂	Australia
	Zirconia	> 99 % ZrO ₂	China
	Silicon carbide	> 93 % SiC	China
	Graphite	75–99 % C	China
Insulating	Diatomite	> 75% SiO ₂	USA
	Perlite	65–80 % SiO ₂	China
	Vermiculite	45 % SiO ₂	South Africa

from China and revived the drive to seek alternative sources of supply elsewhere (at the time of writing of course, the Covid-19 impact has massively slowed down western manufacturing sectors, so mineral demand has declined thus easing the supply situation and mineral prices are plummeting – but, recovery will come, and consumers are seeking sources outside China).

There is much talk of an ‘economic decoupling of China’ from traditional supply chains by some developed countries and the next few years may see a major change in mineral sourcing options. There has already been some success in recent years in getting bauxite (e.g. First Bauxite, Guyana), magnesia (e.g. Ternamag, Greece), graphite (e.g. Syrah Resources, Mozambique) projects off the mark outside China, as well as ongoing interest in increasing vertical integration by western refractory producers (e.g. Refra acquisition of QMAG). These trends are

likely to continue. With this latest stimulus, the start of the 2020s may well herald another surge in global mineral project development in order to lessen markets’ reliance on China’s mineral resources.

What is the status and outlook for recycling refractories?

There is one other sector that has also received a boost from the above raw material situation, that of recycling refractories. This sector, while not new, has recently increased in size, and in attention to research and development. Recycling refractories is still not that widespread, led mostly in Europe, but is fast gaining traction in China, India, and South Korea. More processing companies, and a few refractory and steel companies, in Europe are dedicating investment and production lines to processing minerals from industrial waste – not only driven by demand for alternative

mineral sources and to cut costs (from waste disposal), but also the more widespread (and, crucially, EU-funded) move to develop a Circular Economy to protect our environment.

Advances in processing and above all, sorting technology, has already enabled a few companies in Europe to specialize in independent recycling of refractories – more will surely follow. The objective, which is slowly being realized, is to have recycled refractory minerals on the menu for refractory buyers side-by-side with primary raw materials, and at competitive prices. Not only will more refractory recycling processors emerge, but also we may begin to see more primary mineral mining producers involve themselves with recycling tailings and other waste sources to offer a wider range (including blends?) of products with a favorable ‘green’ tinge to their portfolio.

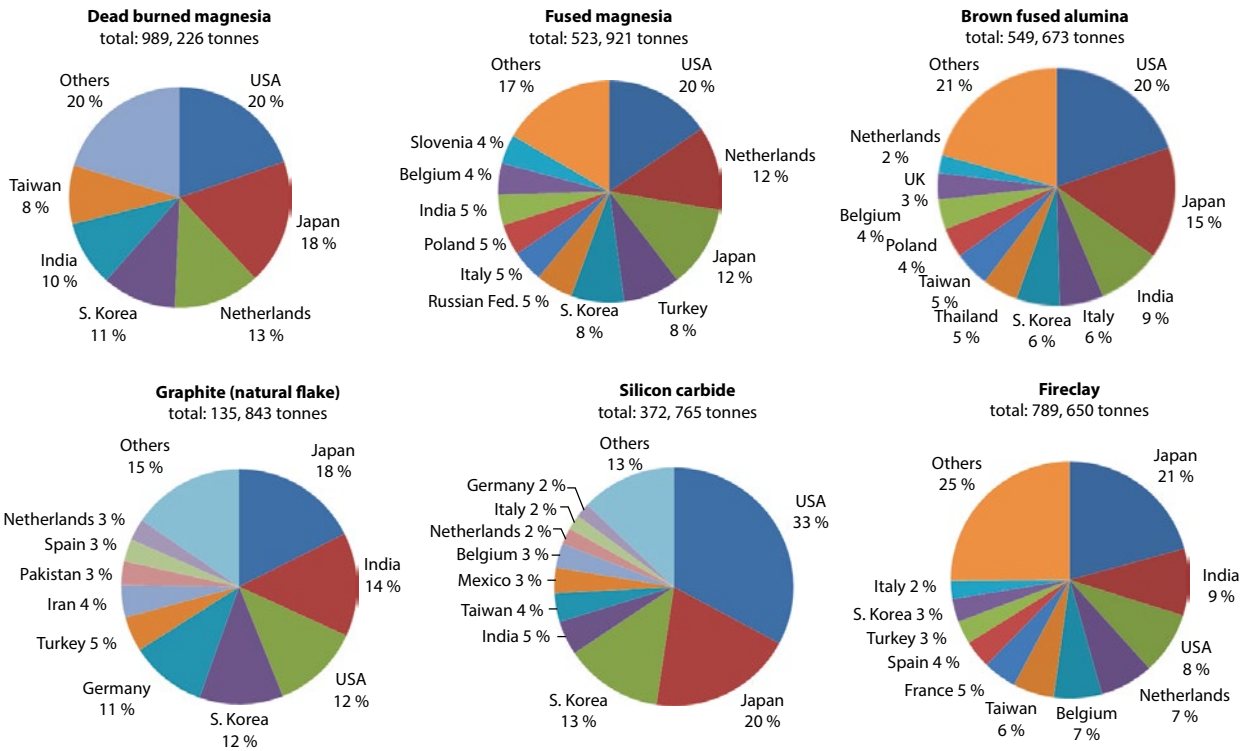


Figure 2 Countries importing Chinese refractory minerals (© Imformed)

Key to the evolving new mineral supply chain incorporating more recycling will be a drive to modify refractory product formulations to permit easier end of life recyclability. There will be increasing economic alliances between the waste sources (such as steel, cement and glass makers), the recyclers, and the refractory manufacturers, plus more investment in suitable processing and accurate sorting technology. Industrial waste resources such as refractories will emerge as the new alternative 'mineral resource' and eventually become the 'new normal' supply chain option for mineral consumers. ◀

Thank you for the interview.

Interview: Charlie Wallin (Editorial Consultant of Interceram)

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