Guinea's Golden Decade of Bauxite Export Growth

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Abstract

Over the past decade, annual bauxite exports from Guinea have increased from 18.5 million tonnes (dry) in 2013 to 111 million tonnes (dry) in 2023, representing a compound annual growth rate (CAGR) of approximately 20 %. Almost all of the additional tonnes mined and exported from Guinea over the ten-year period have been destined for China, despite the enormous geographic distance between the two countries. Guinean bauxite is characterized by its high gibbsite content and low reactive silica content, which makes it highly desirable for alumina production, typically using low-temperature (LT) Bayer processing. Chinese domestic bauxite is characterized by its high diaspore content and high silica content, which requires high-temperature (HT) Bayer processing. This paper seeks to explore the drivers behind China's voracious appetite for imported bauxite, its ability to adapt existing refining capacity from HT to LT Bayer processing and how Guinea has managed to position itself as the country of choice for Chinese bauxite importers.

Keywords: Bauxite, Guinea, Bayer, Diaspore, Gibbsite.

1. Introduction

Guinea is home to the world's largest bauxite reserves. Prior to 2016 however, they remained largely untapped, with exports registering a modest 18 million tonnes (dry), or around 5 % of global supply (~350 million tonnes dry) in 2015. More recently, exports of bauxite from Guinea have surged, driven by the voracious appetite of China's alumina refining sector.

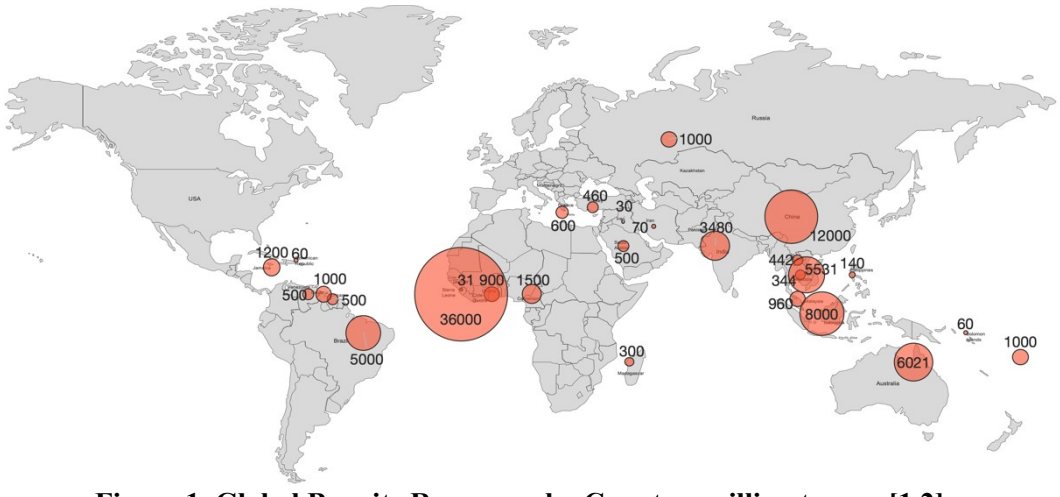

Figure 1. Global Bauxite Resources by Country, million tonnes [1,2].

Prior to 2015, Guinean bauxite was exported almost exclusively to countries where alumina refineries processed bauxite according to either vertical ownership arrangements (between Guinean miner and refiner) or long-term supply agreements, which typically stretched back decades.

Beginning in 2015, a new generation of bauxite miners emerged in Guinea, mostly backed by Chinese investment, which ushered in a new era for the country's bauxite mining sector and signalled the start of major upheaval in global bauxite consumption patterns.

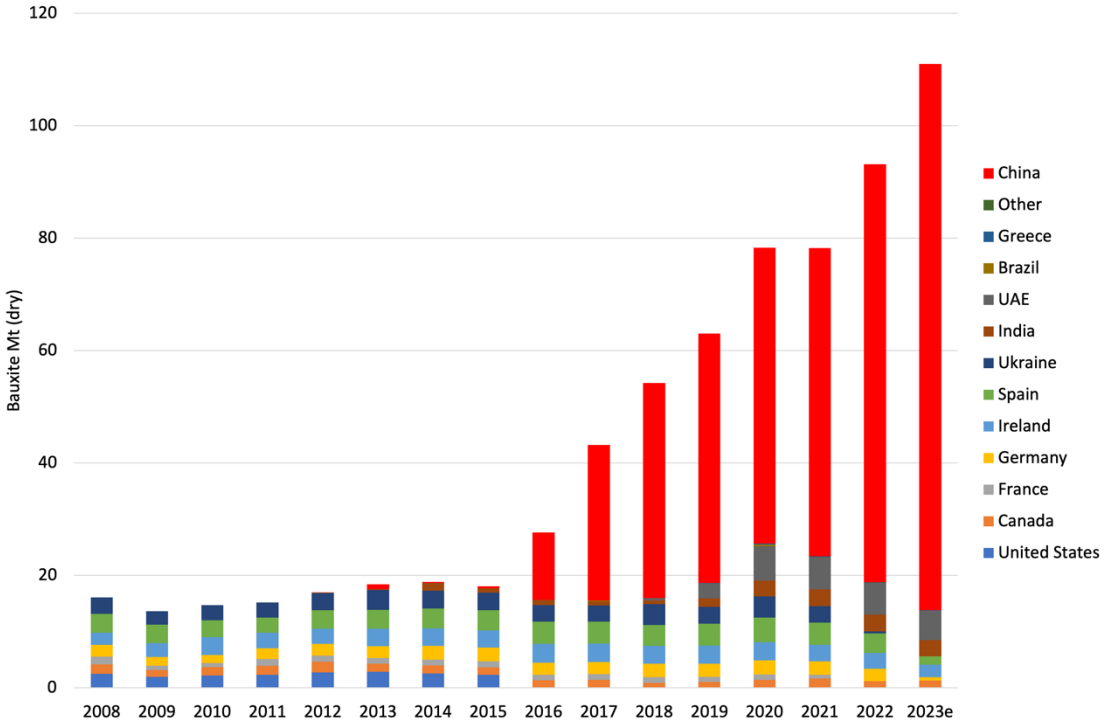

Figure 2. Guinean Bauxite Exports by Destination Country, 2008 to 2023 (tpy dry).

2. Demand for Imports from China

Ahead of the enormous growth surge in Guinean bauxite exports, Chinese refiners had embarked on a mission to develop high-volume, low-cost bauxite operations offshore to feed its growing demand for alumina and primary aluminium, both a consequence of China's rapid industrialisation program. Over time, strong demand growth collided with falling domestic grades, which added further demand for imports.

Indeed, over the period 2008 to 2014 alone, Chinese alumina refining capacity had grown at a compound annual growth rate (CAGR) of around 12 %, resulting in demand for an additional 55 tpy of bauxite by 2014. Chinese refiners initially sourced bauxite from Indonesia, a country geographically close and endowed with sufficient bauxite reserves to support China's growing demand for decades. However, in January 2014, Indonesia introduced a minerals export ban, which stopped all bauxite exports to encourage growth of its own domestic alumina refining sector.

Given the high costs associated with building alumina refineries in Indonesia relative to China (at the time), Chinese refiners looked elsewhere for imported bauxite, landing next in Malaysia. From the outset, however, Malaysian bauxite exports were challenging, given their inferior grade and quality, as well as the uncertainty surrounding the size of reserves, which fell well short of those in Indonesia.

Furthermore, Malaysian authorities had taken a dim view of the rapid expansion in bauxite mining and the practices miners were employing, particularly in the Kuantan prefecture. In 2016, Malaysia introduced a temporary bauxite mining ban, which was extended seven times between 2016 and 2019.

With hopes seemingly dashed in Indonesia and Malaysia and other regional options of significance, notably Australia and Vietnam, discounted by unsupportive policies, complex approvals processes and, at least in Australia's case, significantly higher capital costs, Chinese refiners cast their net further afield, finally arriving in Guinea in 2015.

3. The Rise of Guinea

Although home to the world's largest bauxite deposits, most of Guinea's high-grade reserves are located more than 100 km from its coastline. Furthermore, the coastline is relatively short, stretching for around 300 km along the Atlantic Ocean, and characterised by a series of estuaries, mangroves, small islands and low-lying swamps, making it difficult for the development of major port infrastructure.

The arrival of Chinese developers came with a commercially proven solution to the challenges posed by Guinea's coastline, in the form of barging and transloading, a simple, low-cost alternative to direct loading of ocean-going-vessels (OGVs) and one which circumvents the need for a deep-water port.

Figure 3. Barge Loading Facilities in Guinea.

Guinea's bauxite export industry found further support in the form of the country's 2011 mining code, framed in such a way as to encourage both mineral exports and value-added investments in alumina refining over the longer-term.

The key factors ultimately enabling Guinea's bauxite export industry to flourish were:

- Prolonged, double-digit growth in Chinese alumina demand and a rest of the world (ROW) alumina supply base incapable of responding
- The introduction of Indonesia's minerals export ban

- The existing minerals export ban in Vietnam
- Limitations imposed on bauxite mining in Malaysia and concerns around reserve life
- Complex compliance requirements and high capital costs in Australia
- A supportive mining code in Guinea, and
- Adoption of the barging and transloading model in Guinea

Combined, these factors enabled Guinea to enter into a golden age of double-digit bauxite export growth, a development which not only changed the structure of the global aluminium supply chain, but also took much of the industry by surprise.

4. Adapting the Bayer Process

Mineralogy refers to the chemical structure of minerals. For example, bauxites originating from, and commercially processed into alumina in Australia, can be gibbsitic or boehmitic, or a combination of both. They can vary in alumina content from 30 % to 55 %, while reactive silica levels can vary from 1 % to 13 %.

Guinean bauxites are mostly gibbsitic, although many contain boehmite. Available alumina content of Guinean bauxites are typically 35 % to 45 %, while reactive silica can vary from 1.2 % to 2.5 %. Figure 2 illustrates the differences in appearance between bauxites from different countries.

Figure 4. Bauxites Mined in Different Countries [3].

Due to the differences in grade, morphology and quality between bauxites, alumina refineries tend to be designed and operated to process a specific grade and quality of bauxite under very strict conditions. This means refineries are unlikely to be able to efficiently process other types of bauxite or can do so only if significant equipment modifications are made and operating parameters are changed. This is why, in the past, bauxite has not been freely traded.

- Most bauxite mined globally is processed into alumina on the basis of an integrated mine-mouth-to-refinery (MMTR) operating model. This means that bauxite of a specific grade and quality being mined is transported directly to an alumina refinery which has been designed and built specifically to process the bauxite from that mine i.e. the ‘design bauxite’, which is of a known grade and quality.
- Any major variation in grade and/or quality from the design bauxite can significantly impact the performance of the refinery and the stability of the refinery operation, resulting in higher costs, lower productivity, and, in some cases, potentially damaging equipment and stopping the operations altogether.
- Most bauxite is supplied to refineries on either (i) a vertically integrated ownership basis (integrated mine and refinery), meaning both the mine and refinery are owned by the same group or groups, or (ii) on a long-term contractual basis, where supply agreements can be greater than ten years in duration. The objective is always to minimise variations in grade

and quality on an operational basis, therefore promoting stable operation, maximising productivity, and minimising costs.
- If bauxite is sold on a 'spot' basis, then a suitable refinery capable of physically processing it with minimal disruption to performance must be identified. One way of treating 'non-design' bauxite is to blend it with existing bauxite at a blend rate sufficiently low so as not to destabilise the process or significantly increase production costs.

Processing imported bauxite through an existing alumina refinery therefore requires a different approach if processes are to be optimised and operating costs minimised.

Chinese refiners approached the problem on two fronts:

- Equipment modifications – to optimise refinery performance, a series of reversible modifications was developed for existing high temperature (HT) refineries, originally designed to process domestic diasporic bauxite, to process boehmitic or gibbsitic bauxites. The modifications included circumventing the digestion pre-heating stage, short-circuiting the digestion vessel's train to reduce overall digestion times, lowering caustic concentrations and lowering lime addition rates.

- Blending – another approach was to blend different bauxites to create a single, more consistent bauxite feed, which allowed refineries to operate more efficiently. Blend rates vary depending on the availability of different bauxites and the range of parameters under which these refineries can operate. Blending of imported ore with low-grade domestic diasporic ore was also used, to take advantage of low-cost local material.

Precipitation circuit parameters also require significant adjustment to cope with variable or blended bauxite feeds. Indeed, control of the precipitation circuit has been one of the greatest challenges for refineries switching to different bauxites. For example, refineries treating imported bauxites containing high organics levels have had to overcome this by taking remedial action in the precipitation train.

Existing materials handling and comminution circuits have also faced challenges for inland refineries switching to blended or imported ores. For example:

- High moisture content of imported ores can cause hang-ups in bins and feeders, as well as cause stockpiles to freeze during China's cold inland winter.
- Comminution circuits designed for hard, stony diaspore struggle to cope with softer imported ores, particularly in blends.
- Red mud separation is challenging for refineries unfamiliar with imported ores because they can cause high mud loads and slower settling times.

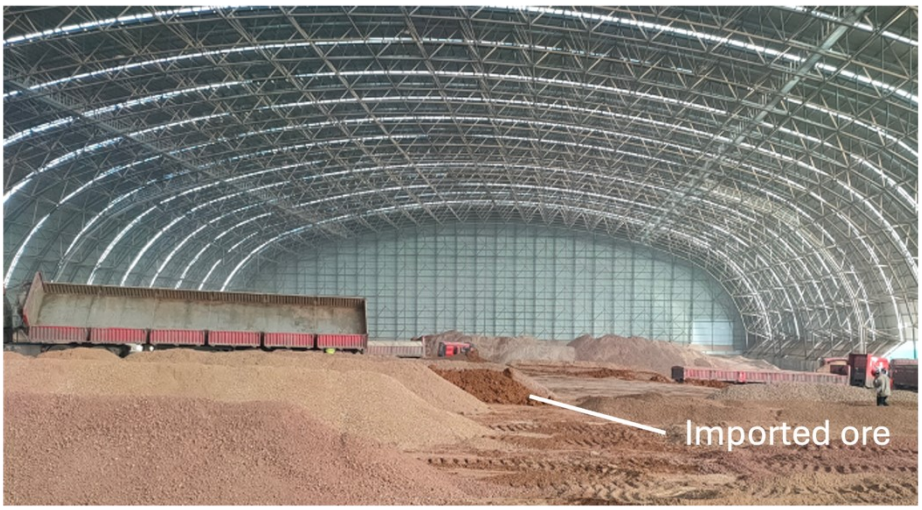

Figure 5. Imported Bauxite Storage and Mixing.

Despite the practical challenges presented by major changes in bauxite feed characteristics, many of China's older, existing inland refineries have adopted the necessary changes to commercially process imported bauxites.

5. Bauxite Market Evolution

Although the quantities of bauxite mined globally are large, bauxite is not considered a fungible commodity because grades and qualities vary substantially, both within and between deposits, including those in Guinea and China. Grades refer to the content and type of alumina containing minerals in the bauxite, while qualities refer to the level of undesirable impurities in the bauxite, typically silica, organic materials and moisture.

Despite the many factors working against bauxite being traded on a short-term contractual basis, the arrival of the merchant refining model in China fundamentally changed the nature in which bauxite was procured. As volumes of bauxite imported into China have subsequently grown, so too has the portion being bought and sold on a third-party contractual basis.

In the evolution of similar 'commodity' markets, pricing mechanisms have adapted to capture growing levels of market liquidity to provide the transparency necessary to make informed commercial decisions. The past five years have witnessed major changes to the bauxite market, which is now following a similar evolutionary pathway.

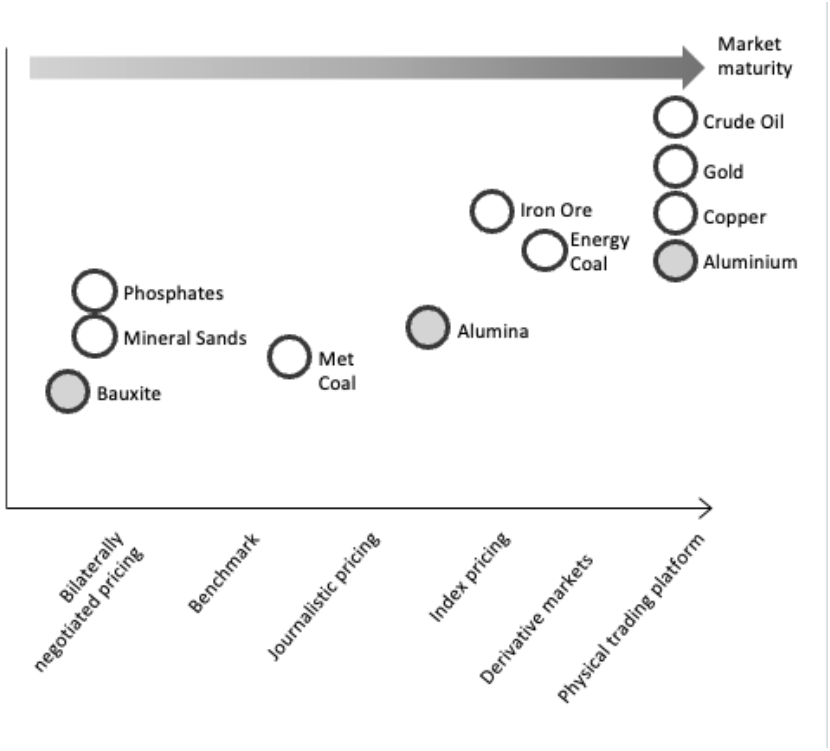

Figure 6. Evolution of Commodity Markets.

6. Conclusions

Over the past decade, global bauxite supply and demand fundamentals have undergone a seismic shift, driven by China's rapid industrialisation and on-going depletion of its domestic reserves. Combined, these two factors have driven double digit growth in bauxite imports.

Over the past five years, Guinea has emerged as the dominant bauxite supplier to China, with exports surging from 18.5 million tonnes (dry) in 2013 to 111 million tonnes (dry) in 2023, at a compound annual growth rate (CAGR) of around 20 %.

As China's domestic bauxite reserves have depleted, existing alumina refiners dependent on local supply have adapted to processing imported bauxite by making a series of process and equipment modifications, which have kept them commercially viable over the period.

Despite the significant variation in bauxite grades and qualities, growth in globally-traded bauxite volumes has led to an increase in market transparency, which is likely to result in pricing mechanisms evolving to become more reflective of a maturing commodity market.

7. References

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