Remining Bauxite Residue

Handling Practice and Valorisation research in Aluminium of Greece

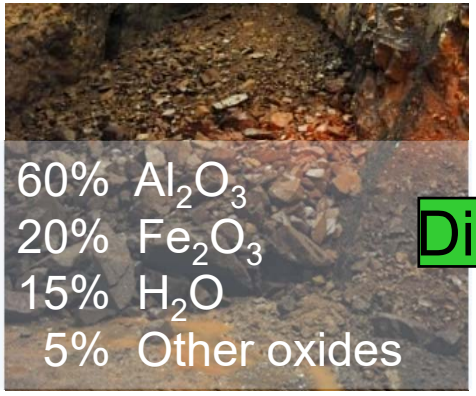
Efthymios Balomenos
Residue Valorization
Mytilineos S.A.- Metallurgy Business Unit

Aluminium of Greece

- **The leading industrial producer of alumina and aluminium** in S.E. Europe and the only vertically integrated bauxite, alumina and aluminium production plant in Europe
- Mining **650,000 tons** of Greek bauxite ore, processing each year more than **1.4 million tons** of Greek bauxite ore and **0.4 million tons** of tropical bauxite ore.
- Producing **820,000 tons** of alumina (out of which 480,000 tons are exported)
- Producing **185,000 tons** of aluminium (out of which 125,000 tons are exported)

The AoG Alumina Refinery

Bauxite Ore

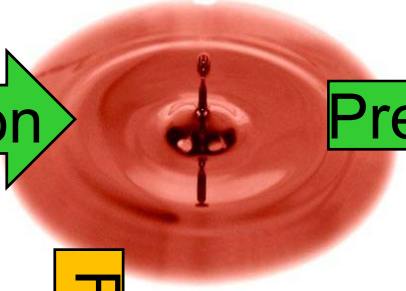


1,800,000 t/year

AoG processes (mainly) Greek Bauxite

Digestion

The ore is digested under high temperature and pressure in alkaline solution



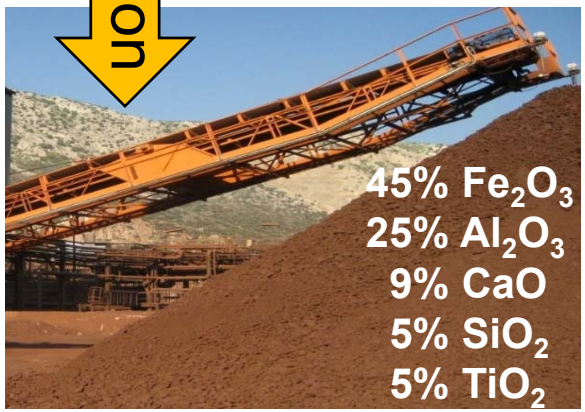
Precipitation

Alumina

800,000 t/year

Alumina precipitates from the alkaline "pregnant" solution

Filtration



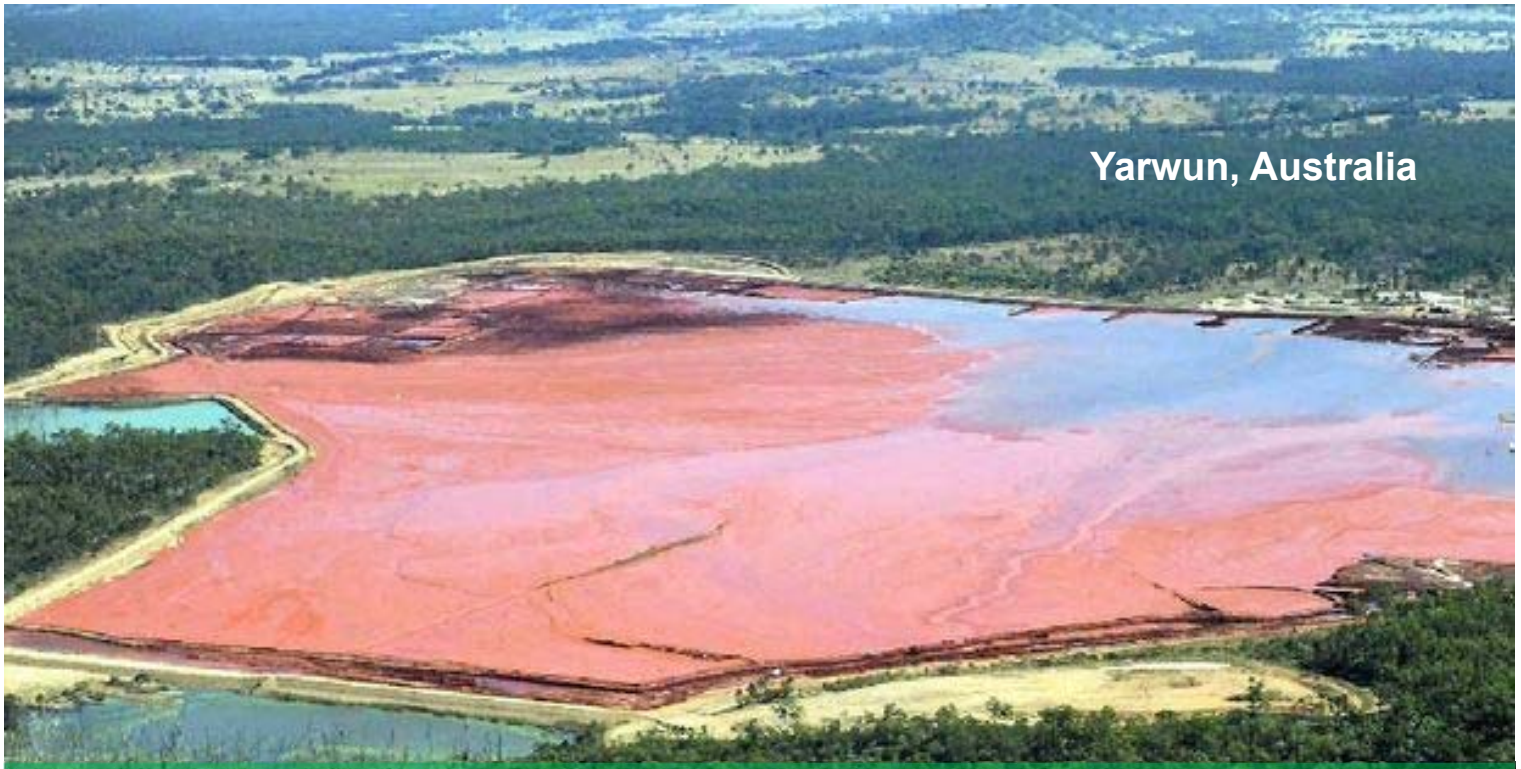
Bauxite Residue (BR)

750,000 t/year

The undissolved portion of the ore, forms the Bauxite Residue (BR) by-product

Activities for Residue Valorization

ALUMINIUM OF GREECE
METALLURGY BUSINESS UNIT



Worldwide only **3%** wt from the ***140,000,000 t of Bauxite Residue*** produced annually are utilized in cement and iron production

…and this takes place mainly in **China and India**

Activities for Residue Valorization

Slurry disposal

Activities for Residue Valorization

Tailing ponds

AoG Vision for Red Mud

To remove the water content from the slurry so:

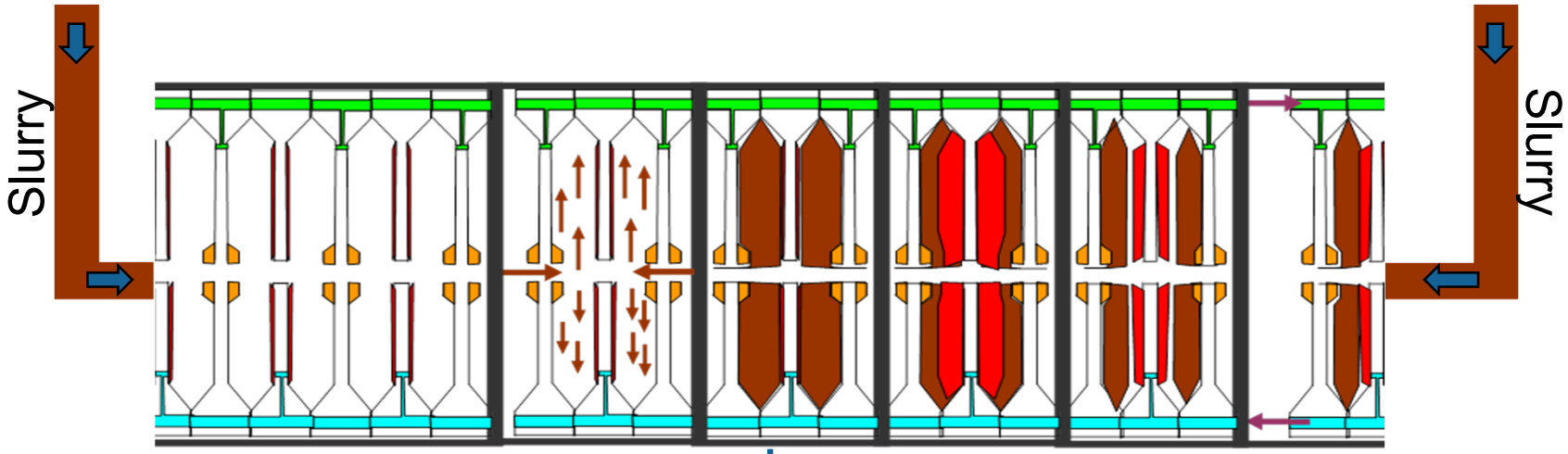
- It can be **safely deposited in-land** in full accordance with EC waste directives.
- It can be **easily transported** in other industrial facilities **for re-use.**

Filterpress is now a BAT

- 2006: Installation of 1st Filterpress .
- 2007: Pilot tests- Automation and improvements.
- 2008: Installation of 2nd Filterpress, storage site.
- 2009: Installation of 3rd and 4th Filterpress - gradual increase of operations.
- **2012 - today: 100% dry disposal of all bauxite residue produced from the alumina refinery.**

Activities for Residue Valorization

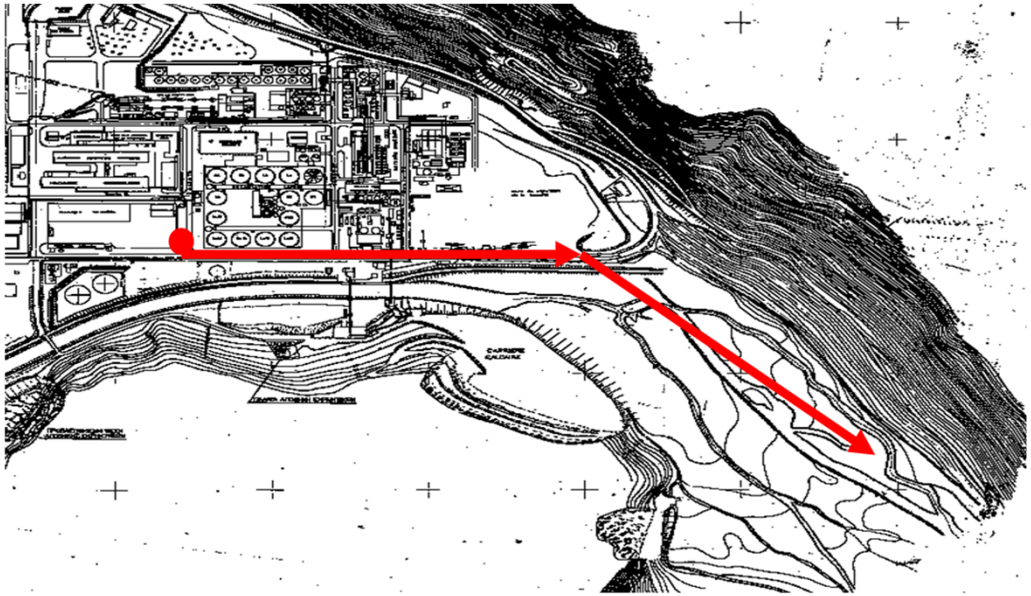
The Filter-Press Process



Bauxite Residue discharged with moisture between 26-28%

Filtrate is returned to washers, and re-introduced to the Bayer cycle

Activities for Residue Valorization



The BR storage site is located just behind the plant (St. Athanasios).

Storage takes place in accordance to obtained environmental permit and geotechnical study

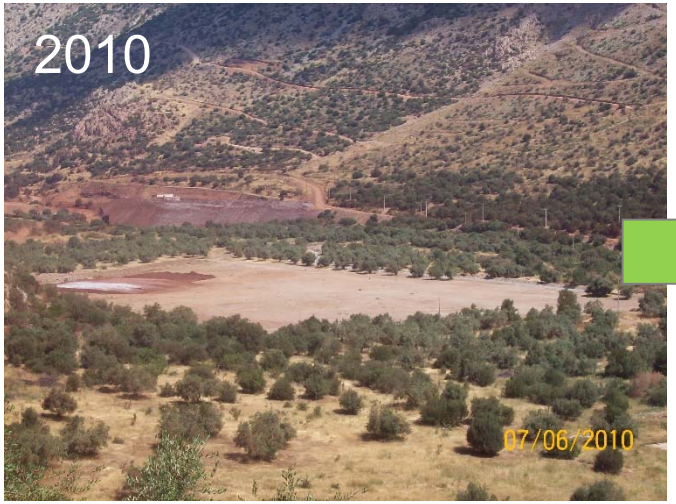
Activities for Residue Valorization

Central pipeline

Peripheral draining channels

Geofabric and gravel introduced at specific height intervals to enhance stability

Activities for Residue Valorization

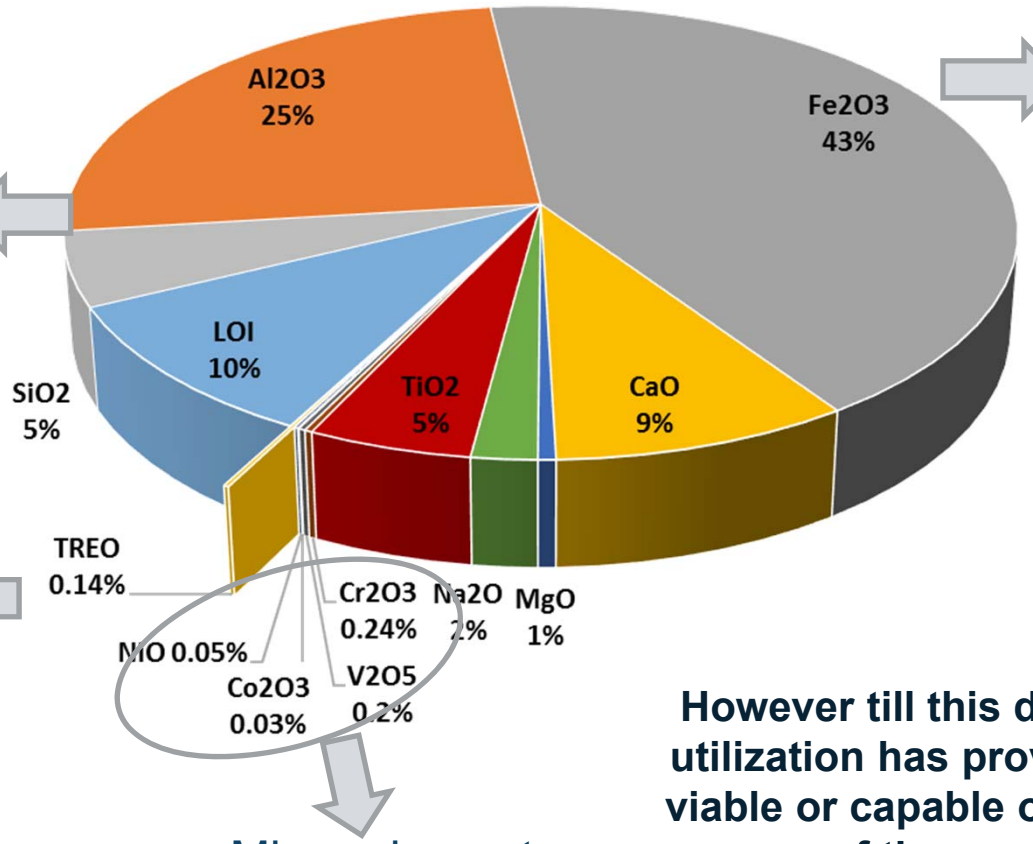


- Currently 7 plateau active with heights 9-15 m.
- The site contains over 4,5 million tons of BR already.
- Estimated to be in operation for another 20 years.


But our goal is not to make new mountains…

AoG BR filter cake (ferroalumina)

Utilize alumino-silicates as raw materials for building products (cement, insulation material, …)



Utilize as source for iron (iron industry or cement industry)

Utilize as alternative REE resource

Minor elements utilized in steel production

However till this day no single one utilization has proven economically viable or capable of valorizing 100% of the produced BR

Activities for Residue Valorization

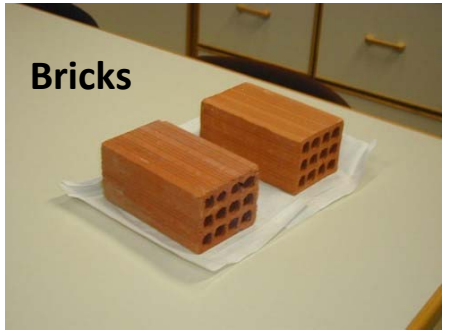
ALUMINIUM OF GREECE
METALLURGY BUSINESS UNIT

CEMENT

Pig-Iron

Since 1991, AoG BR was been tested for use in

- **Cement Industry** (iron/alumina source in clinker)
- Iron production
- Brick/Tile Industry (substitution of clay)
- Geopolymer bricks
- Soil Remediation/ Vegetation cover
- Road Base Construction
- Landfill barrier / cover
- Backfilling of closed Mines



Geopolymers

ALUMINIUM OF GREECE
METALLURGY BUSINESS UNIT

BR Utilization In Cement Production

- BR can substitute up to 5-10% of the cement raw material feed as iron and alumina sources.
- The installed production capacity of the Greek cement industry could utilize all 750,000 t of BR produced in AoG with a 5% substitution in the raw meal
- **Up till now AoG BR bas been used at rates of 1.5 - 3% substitution.**
- **The past 5 years, 10- 30 kt of BR were used in Greek cement plants annually.**

This year

- theTITAN plant in Patra,
- the AGET plant in Volos,
- the VASILIKO plant in Cyprus

will utilize in total **110,000 t of BR** ***or 15% of the annual BR produced in AoG***

Next year we will reach 20%

BR loading at AoG

Why not more ? – Key Barriers

Technical Barriers

Soda content, Cr content, moisture are the most common technical barriers**, yet none of them is crucial.**

Legislative Barriers

EWC code 01 03 09 = waste/non-hazardous

EC waste transport legislation is a complicated process requiring specific permits from all parties involved. Cross boarder transport even more complicated.
There is no classification for BR only for red mud.

Financial Barriers

Logistics is a key issue. Cement plants are willing to utilize BR only as long at is a cheaper alternative to other iron and alumina sources.

Social Barriers

Local Societies are always eager to protest against cement plants treating wastes ‘in their backyard’.
BR handling during unloading and mill feeding is the biggest issue as any potential dusting of the BR would create significant protests by local societies.

Why not more ? – Lifting Barriers

Technical Barriers	Air drying to further reduce moisture, De-alkalization of BR, …
Legislative Barriers **EWC code 01 03 09 = waste/non-hazardous**	Once there is an 'industrial- use' for a waste it could be classified as a by-product, simplifying the transfer process. **Waste Declassification is a central policy decision.**
Financial Barriers	**Incentives** should be provided to the cement and other plants for utilizing BR and similar wastes. **Gate fees do not promote industrial symbiosis.**
Social Barriers	More effort should be placed on increasing social awareness – reducing NIMBYSM. '**Popularizing science' through RTD projects** could be a key.

Activities for Residue Valorization

ALUMINIUM OF GREECE
METALLURGY BUSINESS UNIT

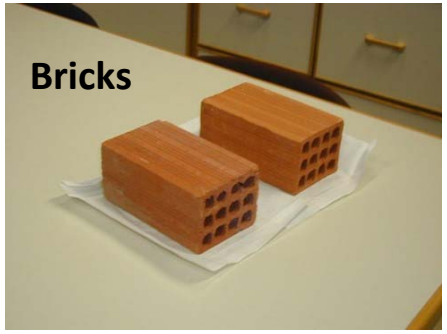
CEMENT

Pig-Iron

In all these cases BR:

- Are used as substitutes of cheap and available raw materials (soil, clay, iron oxide…)
- Are not the main component but ratter an additive in small amounts (1-30% wt)

There is need for new BR-centered processes that can be technically and financially viable



Geopolymers

Thank you for your attention

Activities for Residue Valorization