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BAUXITE-ALUMINA INDUSTRY OF INDIA – SOME SUGGESTIONS FOR DEVELOPMENT AND IMPROVEMENT

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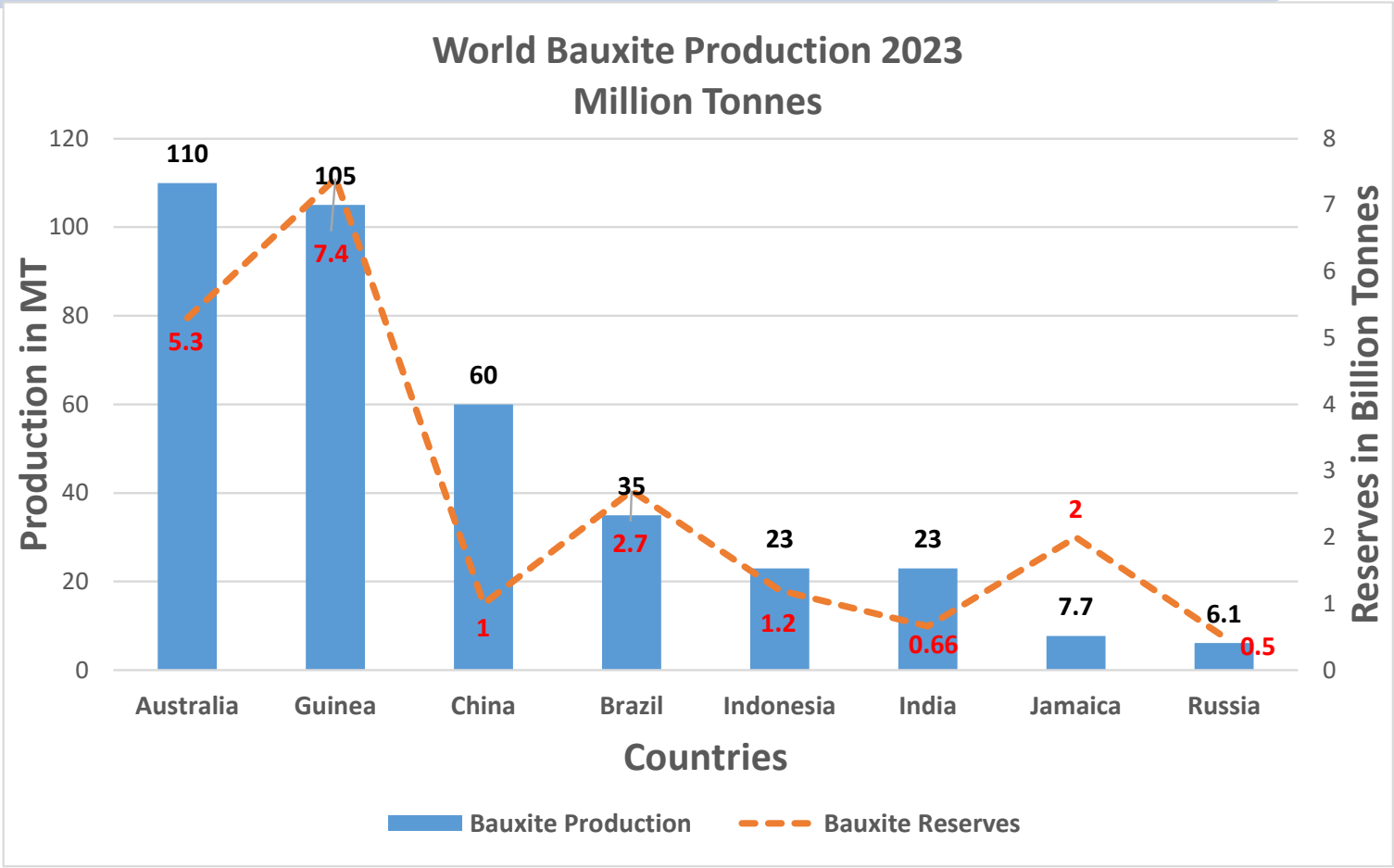
Introduction Bauxite Production

- At present about 393 million tonnes of bauxite is produced in the world dominated by Australia (110 MTPA) and Guinea (105 MTPA). Although Australian bauxite is high in silica, thanks to developed infrastructure and geographical location, this country also exports raw ore, apart from significant alumina production.
- About 130 million tonnes of alumina is produced in the world and China is undoubtedly leader with more than 60% of world production.

Bauxite Reserves/ Production in World

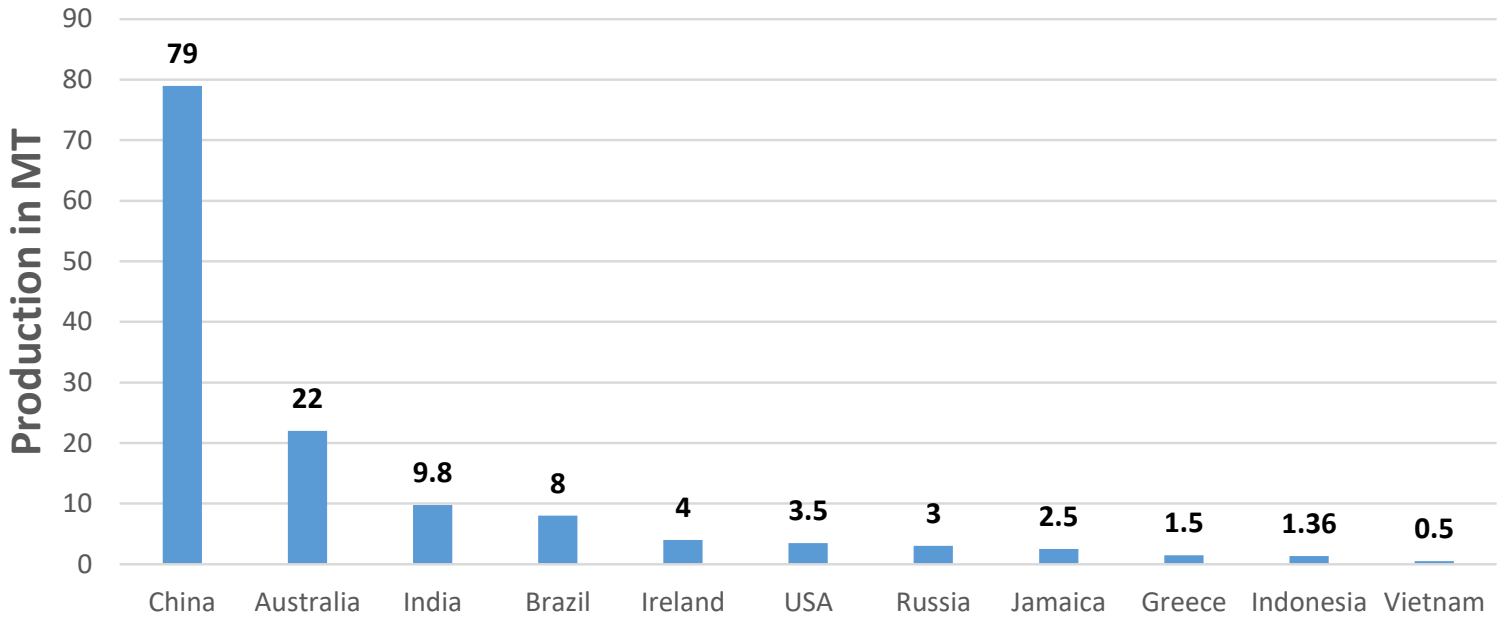


Sources: 1.Al Circle, 2. US Geological Survey, 3.IBM(Indian Bureau of Mines)

Introduction Alumina Production

- India distinctly occupies third position in alumina production with 9.8MTPA during 2023.
- Country has fairly good potential to increase the alumina production and surpass Australia by 2030.
- India has developed good expertise in alumina processing and concerted efforts by R&D institutes and engineering companies may provide base for developing indigenous technology. There are already small operating alumina plants in the country built by Indian engineers.

Alumina in World and Position of India

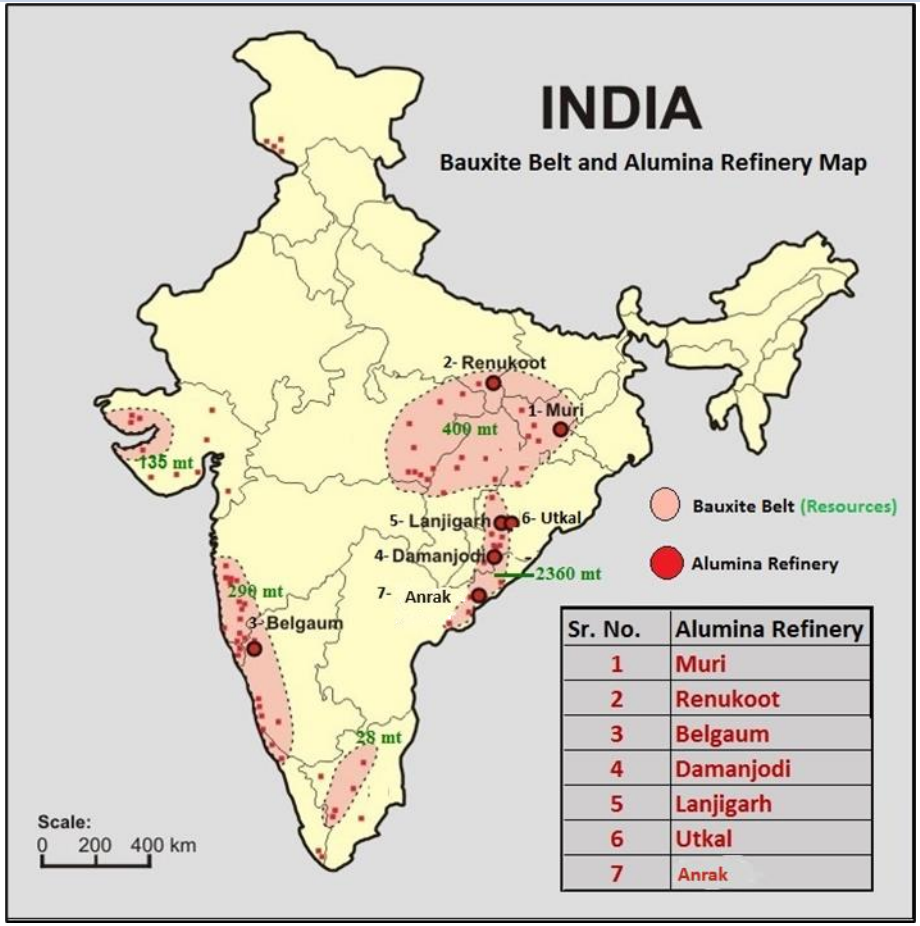


Sources: 1. Al Circle,
2. IAI

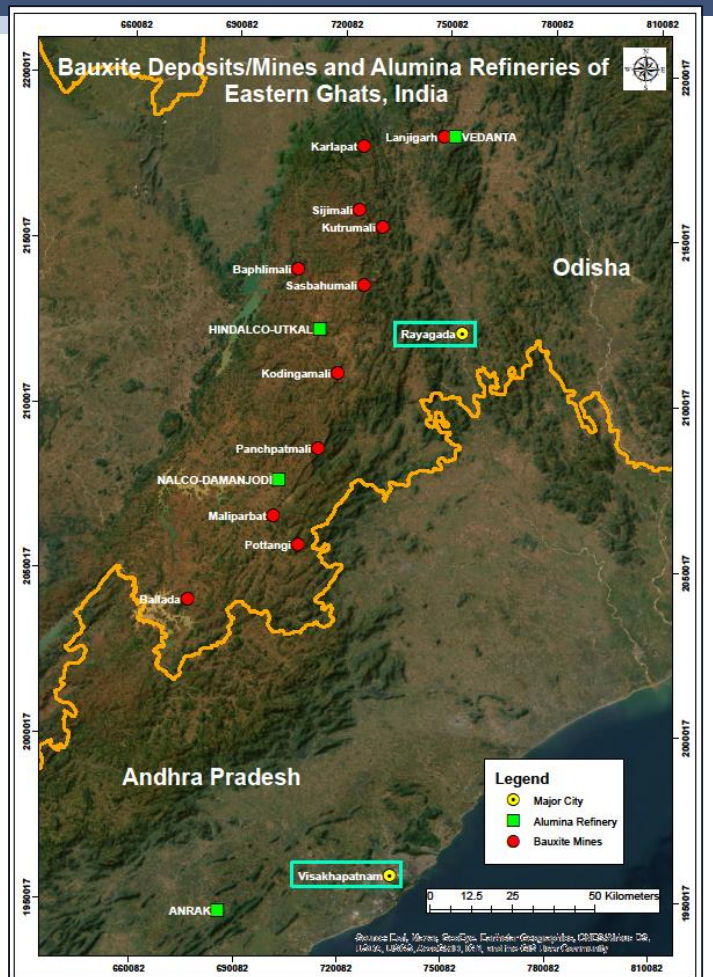
Bauxite Alumina Industry India

- Bauxite-Alumina Industry of India is undergoing rapid changes as several large bauxite deposits of Odisha are allotted to Vedanta and Adani Group.
- Two greenfield alumina plants are announced in state of Odisha. First one is Kalinga Alumina Limited (KAL) of Adani Group, which is planning to set up 4MTPA refinery. Second is announced by Hindalco (Aditya Alumina Refinery) of 2MTPA at Kansariguda with Odisha Mining Corporation (OMC).
- It is time for the country to develop technological and engineering capabilities to built greenfield alumina refinery.

Bauxite Mines and Alumina Plants INDIA



Sr. No.	Alumina Refinery
1	Muri
2	Renukoot
3	Belgaum
4	Damanjodi
5	Lanjigarh
6	Utkal
7	Anrak



Future Bauxite Forecast for India

- The present metallurgical bauxite production in the country is likely to increase significantly with starting of 3 new mines in Odisha namely Sijimali, Kutrumali and Ballada.
- It is expected that by 2030 India may produce about 59 MTPA bauxite, mainly from Odisha deposits. However, high grade bauxite import may continue.
- Except Odisha, bauxite production in other states may not increase significantly.
- It is unfortunate that large bauxite deposits of Andhra Pradesh are lying idle due to state Govt. policy.

Bauxite Scenario

S.No.	Name of Mine(s)/State	Resources (MT)	Owner	Production 2023 (MTPA)	Expected Production by 2030 (MTPA)	Comments
1	**Panchpatmali, Eastern Ghats (EG)**	314 and ~140 (Left Over)	Captive Mine of NALCO	**7.5**	**7.5**	Overburden rejected and high silica bauxite not mined
2	**Pottangi, EG**	76	NALCO	**0**	**3**	Likely to start in 2025
3	**Baphlimali, EG**	195 and ~150 leftover	Captive Mine of Utkal HINDALCO	**7.5**	**10**	Plant will expand to 3MTPA. Bauxite quality may deteriorate.
4	**Kodingamali, EG**	81 and ~60 leftover	Odisha Mining Corporation (OMC)	**3**	**6**	To be expanded, quality continuously deteriorating
5	**Kutrumali, EG**	~127	Alloted to Kalinga Alumina Limited (KAL) of Adani Group	**0**	**9**	Project development to start in 2024. It may take about 12 months for coming into operation.
6	**Sijimali, EG**	~311	Alloted to Vedanta Aluminium	**0**	**6**	Project Development started, may take about 12 months for full operation

Bauxite Scenario (Contd.)

7	**Karlapat, EG**	207	Auction Process stopped	**0**	**6**	Fresh auction likely to take place in 2024
8	**Ballada, EG**	~22	Alloted to KAL of Adani Group	**0**	**3**	Small deposit , expected to start Operations as early as III quarter 2024
9	**Small Mines of Central, Eastern & Western India**	650	HINDALCO, BALCO/ VEDANTA	**5**	**3**	Boehmitic Bauxite. Small scattered mines of varying quality
10	**Gujarat Bauxite**	~100 (Kutch & Jamnagar)	GMDC & Others	**0.5**	**1.5**	Includes low grades, calcined bauxite & Credo refinery
11	**Maharashtra Bauxite**	~60	Small Mine Owners	**0.2**	**1**	Metallurgical bauxite, being supplied to Belgavi plant
Total				**23.7**	**59**	Includes non-metallurgical

Future Alumina Forecast for India

- The present installed capacity of alumina in India is only about 10MTPA, however, there is an ambitious plan of Vedanta to increase the production to 6MTPA from the present 2.3 after getting ore from the captive mine (Sijimali).
- It is expected that by 2030, alumina production may go up to 23 MTPA and India may catch up or supersede Australia as one of the large Alcoa plant (Kwinana) may close down this year.
- Vedanta may be the largest single location alumina plant in the country.

Alumina Scenario

S.No.	Alumina Refinery	Installed Capacity 2023	Projected 2030	Comments
1	**Hindalco-Muri. Jharkhand**	**0.45**	**0.45**	Upgraded during 2008 and presently producing special alumina.
2	**Hindalco-Renukoot, UP**	**0.7**	**0.7**	Old integrated refinery with smelter and hence able to survive.
3	**Hindalco-Belgaum, Karnataka**	**0.38**	**0.38**	Produces special alumina; shortage of bauxite
4	**Hindalco- Utkal Alumina, Odisha**	**2.5**	**3.0**	Modern plant, likely to expand in phases.Lowest cost refinery in world.
5	**Nalco -Damanjodi, Odisha**	**2.3**	**3.3**	Expansion with Pottangi bauxite

Alumina Scenario (Contd.)

6	**Vedanta, Odisha**	**2.3**	**6.0**	Supply by Sijimali to start, augmented by OMC purchase
7	**Gujarat Credo**	**0.04**	**0.1**	Special alumina hydrates
8	**Anrak, Andhra Pradesh**	**1.5**	**3.0**	Started with 0.7 mtpa capacity mainly based on imported bauxite
9	**Kalinga Alumina Limited (KAL) of Adani, Odisha**	**0.0**	**4.0**	Project development initiated and this is in planning phase.
10	**Joint Hindalco-OMC (Aditya Alumina Refinery), Kansariguda, Odisha**	**0.0**	**2.0**	OMC may acquire 2-3 new deposits of Odisha, other than Kodingamali.
11	**Maa Kudargarhi Alumina, Chattisgarh**	**0.014**	**0.225**	Feasibility stage
	Total	**10.18**	**23.155**	

Some Observations Bauxite Mining in India

- Despite having more than 3 billion tons of bauxite resources, India is struggling to mine 24 million tons and country has to import ore from Guinea and Sierra Leone.
- The fluctuating bauxite quality and processing of different types of ore causes loss in productivity in refinery and it is better to process consistent low alumina and medium to high silica ore.
- Some of the large bauxite mines of Odisha are still rejecting high silica overburden laterites. Similarly high silica (>8%) ore with 38-40% alumina are left over in the deposit. These can be easily avoided by adopting simple beneficiation techniques.

Some Observations Bauxite Mining in India (Contd.)

- China with poor quality of bauxite is regularly beneficiating their ore by complex froth floatation techniques and bauxites of Brazil, Sierra Leone and Ghana are regularly washed and upgraded.
- There is scope to partly upgrade typical Eastern Ghats bauxite by crushing followed by screening out of fines, which not only decreases kaolinite and goethite contents but also reduces moisture and improves handling characteristics.
- A systematic mine plan, grade control drilling, generation of Internal Reference Materials (IRM), table-top XRF, use of stacker-reclaimer and online analyser can help in long term quality control and provide ore of consistent quality.

Some Observations Bauxite Mining in India (Contd.)

- Since bauxite mining & forest clearance are Center's subject, States must not have veto rights & stop approved projects, if the Bauxite Alumina Industry is to grow and compete with the best.
- Present methodology of calculating Average Sale Price (ASP) is flawed and rendering bauxite FOB cost at mines to be the highest in the world, which is also creating an unnecessary barrier in developing the Bauxite Alumina industry as a standalone one like Australia & Brazil.
- An average 45% alumina and 3% silica bauxite of Guinea have FOB price of about USD 20 per ton, whereas ASP of Odisha ore is higher than USD30 per ton.

Some Observations on Alumina Refining in India

- Alumina refineries should have more productive relationship with bauxite mines via regular dialogues and interactions. Alumina plant should understand the limitations of mine and its capabilities as these are natural ore.
- Every year bauxite mines should be evaluated for sustainable quality and reserves. A geo-metallurgist can play crucial role in suggesting appropriate grade for each year for the plant.
- With the depleting bauxite quality in the worldwide deposits and mines, local bauxite having around 35% available alumina and less than 5% reactive silica should be considered economically viable for low temperature alumina plants.

Some Observations on Alumina Refining in India (Contd.)

- Online bauxite analyzer can substantially improve the digestion efficiency. In one of the CHALCO plants, this is already installed and providing positive results.
- Similar to financial audit, there should be comprehensive technical audit of alumina production process in each refinery. For example, every 3 months the feed bauxite, blow off mud, last washer mud & mud to pond should be thoroughly analyzed including detail quantitative mineralogy to identify undigested phases. Scales in various pipelines should also be studied.
- Plants should explore digital technologies to monitor and control alumina production by:

❑ Digital Twins of production processes;
❑ Computational Fluid Dynamics;
❑ Machine Learning.

Some Observations on Alumina Refining in India (Contd.)

- As silica content is likely to increase in Indian bauxite deposits, it may be useful to consider the ILTD (improved low temperature digestion) process (Refer IBAAS proceedings 2022) or Sumitomo's differential extraction process.
- Over the years ILTD has been patented in 9 countries by Hungarian process engineers. The process concept has been validated in laboratory /batch experiments and now one of the Chinese alumina refineries has adopted this process.
- Red mud utilization must be time bound, maximum 5 years to start & minimum 80% utilization within 10 years.

Conclusions

- India occupies sixth position in bauxite production despite having 3 billion tonnes of resources. In alumina production India is third in the world after China and Australia.
- With the allocation of 3 large bauxite deposits of Odisha, there may be substantial increase in ore production in coming 1 to 2 years and overall quantity may go up to 59MTPA by 2030.
- The installed alumina capacity in the country may rise from present 10.18MTPA to the range of 23 MTPA, similar to present production of Australia.
- It is necessary to use all the sub-grade materials of existing bauxite mines by adopting various dry and wet beneficiation processes. All the overburden, inter-burdens and high silica ores should be used after upgradation or blended with higher grades.

Conclusions (Contd.)

- Alumina plants should have closer relationship with bauxite mines to understand their problems and every year a judicious feed grade should be decided, keeping in view the conservation and sustainability of mine.
- Online bauxite analyser and adoption of digital twins may significantly increase the production and productivity of alumina plant.
- As silica content of India bauxite feed is likely to increase, it is necessary to consider ILTD and / or Sumitomo differential process to bring down the caustic consumption and produce usable bauxite residue.
- Each alumina refinery should provide plan for the safe disposal and utilization of bauxite residue (red mud) & minimum 80% should be used within 10 years.

Thank You

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