

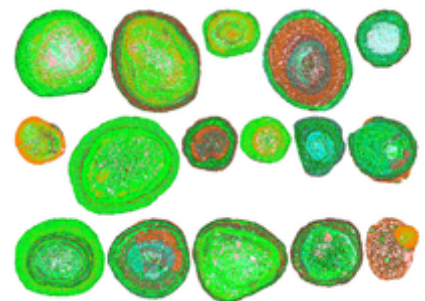
Bauxite

Bauxite is a sedimentary rock with a relatively high aluminium content. It is the world's main source of aluminium. Bauxite consists mostly of the aluminium minerals gibbsite ($\text{Al}(\text{OH})_3$), boehmite ($\gamma\text{-AlO}(\text{OH})$) and diaspore ($\alpha\text{-AlO}(\text{OH})$), mixed with the two iron oxides goethite and haematite, the aluminium clay mineral kaolinite and small amounts of anatase (TiO_2) and ilmenite (FeTiO_3 or $\text{FeO}\cdot\text{TiO}_2$).^{[1][2]}

In 1821 the French geologist Pierre Berthier discovered bauxite near the village of Les Baux in Provence, southern France.^[3] In 1861, French chemist Henri Sainte-Claire Deville named the substance "bauxite".^[4]



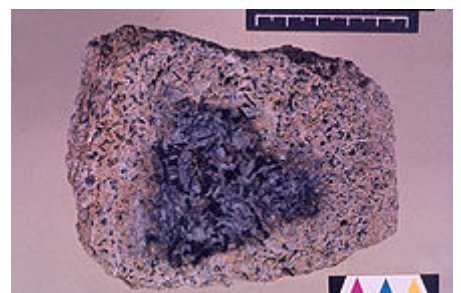
Bauxite with US penny for comparison



QEMSCAN mineral maps of bauxite ore-forming pisoliths



Bauxite in Les Baux-de-Provence, France



Bauxite with core of unweathered rock

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Formation

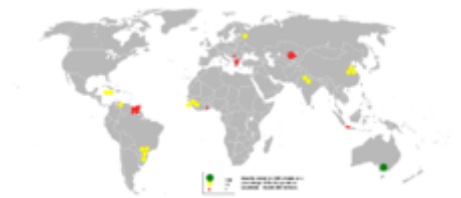
Lateritic bauxites (silicate bauxites) are distinguished from karst bauxite ores (carbonate bauxites). The carbonate bauxites occur predominantly in Europe, Guyana, and Jamaica above carbonate rocks (limestone and dolomite), where they were formed by lateritic weathering and residual accumulation of intercalated clay layers – dispersed clays which were concentrated as the enclosing limestones gradually dissolved during chemical weathering

The lateritic bauxites are found mostly in the countries of the tropics. They were formed by lateritization of various silicate rocks such as granite, gneiss, basalt, syenite, and shale. In comparison with the iron-rich laterites, the formation of bauxites depends even more on intense weathering conditions in a location with very good drainage. This enables the dissolution of the kaolinite and the precipitation of the gibbsite. Zones with highest aluminium content are frequently located below a ferruginous surface layer. The aluminium hydroxide in the lateritic bauxite deposits is almost exclusively gibbsite.

In the case of Jamaica, recent analysis of the soils showed elevated levels of cadmium, suggesting that the bauxite originates from recent Miocene ash deposits from episodes of significant volcanism in Central America.

Production trends

In 2009, Australia was the top producer of bauxite with almost one-third of the world's production, followed by China, Brazil, India, and Guinea. Although aluminium demand is rapidly increasing, known reserves of its bauxite ore are sufficient to meet the worldwide demands for aluminium for many centuries.^[5] Increased aluminium recycling, which has the advantage of lowering the cost in electric power in producing aluminium, will considerably extend the world's bauxite reserves.



Bauxite output in 2005

Numbers for 2010's total proven bauxite reserves x1,000Mg^[6]

Country	Mine production		Reserves	Reserve base
	2010	2011 (est.)		
 <u>Guinea</u>	17,400	18,000	7,400,000	8,600,000
 <u>Australia</u>	68,400	67,000	6,200,000	7,900,000
 <u>Vietnam</u>	80	80	2,100,000	5,400,000
 <u>Jamaica</u>	8,540	10,200	2,000,000	2,500,000
 <u>Brazil</u>	28,100	31,000	3,600,000	2,500,000
 <u>Guyana</u>	1,760	2,000	850,000	900,000
 <u>India</u>	18,000	20,000	900,000	1,400,000
 <u>China</u>	44,000	46,000	830,000	2,300,000
 <u>Greece</u>	2,100	2,100	600,000	650,000
 <u>Iran</u>	—	500 ^[7]	—	—
 <u>Suriname</u>	4,000	5,000	580,000	600,000
 <u>Sierra Leone</u>	1,090	1,700	180,000	?
 <u>Kazakhstan</u>	5,310	5,400	160,000	450,000
 <u>Venezuela</u>	2,500	4,500	320,000	350,000
 <u>Russia</u>	5,480	5,800	200,000	250,000
 <u>United States</u>	30 ^[7]	N/A	20,000	40,000
Other countries	2,630	2,600	3,300,000	3,800,000
World total (rounded)	209,000	220,000	29,000,000	38,000,000



One of the world's largest bauxite mines in Weipa, Australia

In November 2010, Nguyen Tan Dung, the prime minister of Vietnam, announced that Vietnam's bauxite reserves might total 11,000 Mt; this would be the largest in the world.^[8]

Processing

Bauxite is usually strip mined because it is almost always found near the surface of the terrain, with little or no overburden. As of 2010, approximately 70% to 80% of the world's dry bauxite production is processed first into alumina and then into aluminium by electrolysis.^[9] Bauxite rocks are typically classified according to their intended commercial application: metallurgical, abrasive, cement, chemical, and refractory

Usually, bauxite ore is heated in a pressure vessel along with a sodium hydroxide solution at a temperature of 150 to 200 °C. At these temperatures, the aluminium is dissolved as sodium aluminate (the Bayer process). The aluminium compounds in the bauxite may be present as gibbsite($\text{Al}(\text{OH})_3$), boehmite(AlOOH) or diaspore(AlOOH); the different forms of the aluminium component will dictate the extraction conditions. The undissolved waste, bauxite tailings, after the aluminium compounds are extracted contains iron oxides, silica, calcia, titania and some un-reacted alumina. After separation of the residue by filtering, pure gibbsite is precipitated when the liquid is cooled, and then seeded with fine-grained aluminium hydroxide. The gibbsite is usually converted into aluminium oxide, Al_2O_3 , by heating in rotary kilns or fluid flash calciners to a temperature in excess of 1000°C. This aluminium oxide is dissolved at a temperature of about 960 °C (1,760 °F) in molten cryolite. Next, this molten substance can yield metallic aluminium by passing an electric current through it in the process of electrolysis, which is called the Hall–Héroult process, named after its American and French discoverers.

Prior to the invention of this process, and prior to the Deville process, aluminium ore was refined by heating ore along with elemental sodium or potassium in a vacuum. The method was complicated and consumed materials that were themselves expensive at that time. This made early elemental aluminium more expensive than gold.^[10]



Bauxite being loaded at Cabo Rojo, Dominican Republic, to be shipped elsewhere for processing; 2007



Play media

Bauxite being digested by washing with a hot solution of sodium hydroxide at 175 °C (347 °F) under pressure at National Aluminium Company, Nalconagar, India.

Source of gallium

Bauxite is the main source of the rare metal gallium.^[11]

During the processing of bauxite to alumina in the Bayer process, gallium accumulates in the sodium hydroxide liquor. From this it can be extracted by a variety of methods. The most recent is the use of ion-exchange resin.^[12] Achievable extraction efficiencies critically depend on the original concentration in the feed bauxite. At a typical feed concentration of 50 ppm, about 15 % of the contained gallium is extractable^[12]. The remainder reports to the red mud and aluminium hydroxide streams.^[13]

See also

- Alcoa
- Bauxite, Arkansas
- Rio Tinto Alcan
- United Company RUSAL

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4. Notes:

- In 1847, in the cumulative index of volume 3 of his series *Traité de minéralogie*, French mineralogist **Armand Dufrénoy** listed the hydrated alumina from Les Beaux as "beauxite". (See: A. Dufrénoy *Traité de minéralogie*, volume 3 (Paris, France: Carilian-Goeury et J. B. Baillière, 1847), p. 799. (<https://books.google.be/books?hl=en&id=XxwOAAAAQAAJ&pg=FA799#v=onepage&q&f=false>))
 - In 1861, H. Sainte-Claire Deville named "bauxite" on p. 309, "Chapitre 1. Minerais alumineux ou bauxite" of: H. Sainte-Claire Deville (1861) *"De la présence du vanadium dans un minerai alumineux du midi de la France. Études analytiques sur les matières alumineuses."* (<http://babel.hathitrust.org/cgi/pt?id=hvd.hx3dz6;view=1up;seq=321>) (On the presence of vanadium in an alumina mineral from the Midi of France. Analytical studies of aluminous substances.), *Annales de Chimie et de Physique* 3rd series, **61** : 309-342.
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External links

- [USGS Minerals Information: Bauxite](#)
- [Mineral Information Institute](#)
-  ["Bauxite". *New International Encyclopedia* 1905.](#)

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