Environmental Studies
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Bauxite

Bauxite is an example of an **ore** – a rock that contains economically important quantities of a mineral. Bauxite contains several **aluminium hydroxide minerals**, from which valuable aluminium can be processed, but the ore also contains some impurities and these need to be removed.

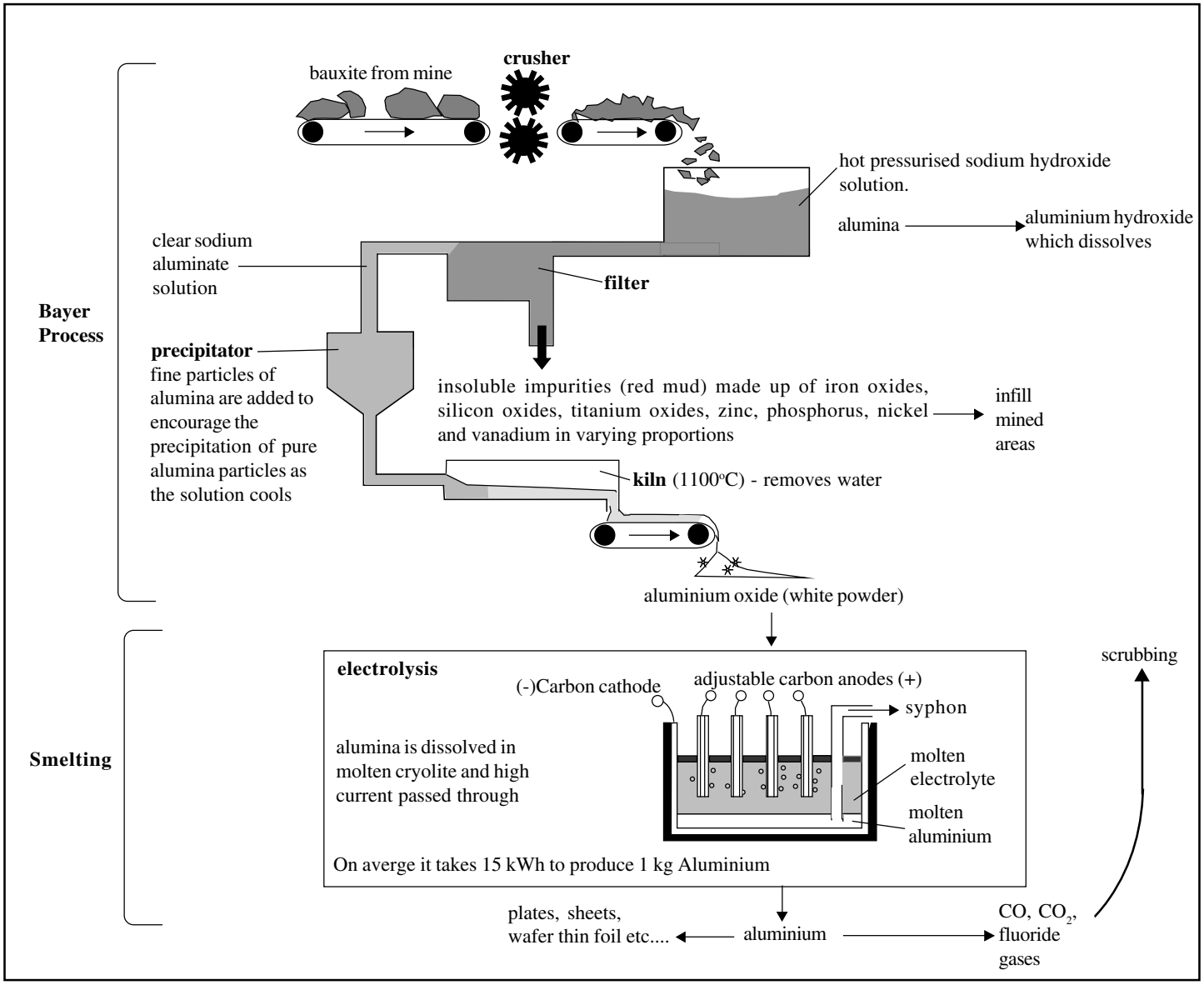
Bauxite occurs mainly in tropical and sub-tropical areas: Africa, S.America, Australia and the West Indies. In most of these areas it occurs in 4-6m thick layers, just beneath the soil surface, so it is usually mined using **opencast methods**.

The primary production of aluminium - ie smelting aluminium ores - requires a huge amount of energy. In contrast, making aluminium from recycling requires only 5% of this energy and this is why recycling aluminium - any form of aluminium, including foil - is environmentally sensible.

Because so much electricity is needed at the smelting stage, most smelters are sited close to abundant energy supplies – hydroelectric, gas, coal or nuclear. Once smelting has begun, it must continue for as long as possible – any break in the electricity supply will cause the aluminium to solidify in the smelting pots which would require an extremely expensive re-build of the pots. So not only does smelting need a lot of electricity, it needs a stable supply.

The main processes involved in the production of aluminium from bauxite are summarised in Fig 1.

Fig 1. Processing bauxite



Bauxite resources and reserves

Aluminium is the third most abundant element in the earth's crust, with an 8% crustal abundance (the amount that is estimated to exist within the entire earth's crust). Even though aluminium is present in many minerals, modern mining techniques only exploit aluminium which has become concentrated in a bauxite deposit. This is because a high concentration deposit is cheaper to exploit than a low concentration deposit due to the volume required for a given amount of mineral.

Bauxite is a **residual mineral deposit**, which means that the aluminium has been naturally concentrated through the removal of other substances. It is produced in a strip approximately 5 metres deep and 50cm below the surface, in tropical and sub-tropical regions where chemical weathering removes silica and other ions but not aluminium. This process, which is sometimes called 'bauxitisation' or 'laterisation', results in a laterite soil profile with an increased grade of aluminium (the grade is the concentration of a mineral within a rock). Due to this process, the grade may increase from only a few percent to around 40%, although most bauxite ores have a grade of 20-30%. 83% comes from bauxite deposits in laterite soil profiles. 14% comes from residual deposits in solution hollows that form in limestone regions (Karst areas) and the remaining production comes from clay deposits.

If a low grade ore is exploited, it means that for a given quantity of aluminium a larger amount needs to be removed. This results in a greater impact on the environment, the use of more energy and a lower profit.

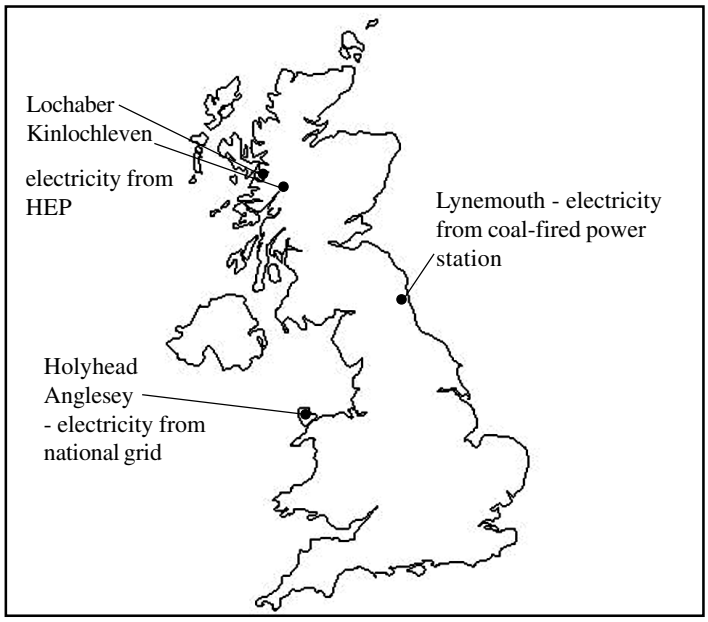
The **total resource** of a mineral is the volume within the earth's crust which is estimated to be economically exploitable, now or in the future. The total bauxite resource is estimated to be 22-23 $\times$ 10^3 Mt (million tonnes) and will supply world demand well into the twenty-first century. **A reserve** is that part of the resource base which is economically exploitable under the present socio-economic conditions. The largest single reserve is the Boké mine in the republic of Guinea (5.6×10^3Mt), although other large reserves are present in many other countries (e.g. Australia, Brazil, Greece, Guyana, Jamaica and Yugoslavia).

Environmental impacts

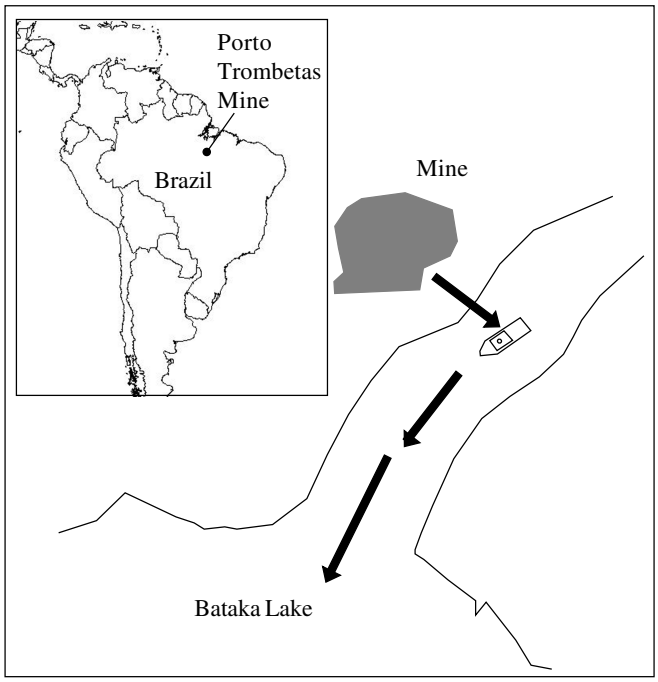
Stage	Impact
Mining	loss of habitat, dust, noise
Conversion of bauxite to aluminium oxide (Bayer process)	red mud – usually put back into hole where bauxite was removed but leaching may cause water pollution
Smelting (conversion of aluminium oxide into aluminium)	14kWh/kg of aluminium. The environmental impact of this depend on how the electricity was generated. 60% of world aluminium is produced using HEP electricity. Fluoride gases and carbon dioxide are released and act as greenhouse gases. Sulphur dioxide contributes to acid rain. Polyaromatic hydrocarbons(PAHs) are toxic to humans

In the UK, about 24,000t of aluminium are made by smelting aluminium oxide produced from bauxite mined in Australia and Jamaica. 275,000t is made from recycling old aluminium.

Aluminum smelters in the UK



Case Study - Reclamation of bauxite mine and aluminium smelter, Para State, Brazil



Mining began: 1979
Annual production : 16.7 Mt bauxite of which 35% is exported

1984 - present
red mud stockpiled and sprayed with seeds of leguminous shrubs & trees, nitrogen - fixing bacteria and fertilizer.

Some red mud mixed with other wastes and made into bricks for house buiding

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