BAUXITE ON THE MITCHELL PLATEAU

On 2 May 2007, Dr Ivor Roberts, Manager of Mineral Resources at the Geological Survey of Western Australia (GSWA), spoke to the Kimberley Society about the world-class bauxite deposits on the Mitchell Plateau. His summary of the talk, which he illustrated with plenty of PowerPoint slides, appears below.

What is Bauxite?

Berthier in 1821 introduced the term ‘bauxite’ for terra rosa soils rich in aluminium and overlie limestone at Les Baux in southern France. However, the Australian deposits, including the Mitchell Plateau, are not associated with limestone but laterite. It is estimated that 85% of the global bauxite resource are lateritic bauxite deposits. Aluminium-rich laterite becomes bauxite ore when certain criteria are met, including

- Available Al2O3 > 27.5%
- Reactive silica < 2.5%

Importance of aluminium

Abundance of Aluminium

- Aluminium is the third most abundant element in the Earth's crust after oxygen and silicon and accounts for 8% of its composition by weight.
- It is the second most common metal on earth; 800 times more common than copper, which has been used for thousands of years.
- Aluminium does not occur in its pure state in nature, but it is common in various compounds such as oxides, as well as in silicate minerals such as feldspar, micas and clays.

Aluminium - a precious metal?

British scientist Sir Humphry Davy discovered aluminium in 1808 and, due to the difficulty of separating it from other elements, it was considered “precious”. It was first shown publicly at the World Fair in Paris in 1855, where it kindled tremendous interest. Early applications of aluminium as a “precious” metal are as follows.

- The statue known as *Eros* in Piccadilly Circus London, was made in 1893 and is one of the first statues to be cast in aluminium.

- Aluminium was selected as the material to be used for the apex of the Washington Monument, at a time when one ounce cost twice the daily wages of a common worker in the project (monument completed in 1884).

Properties of Aluminium

1. strong, malleable and has a low density.
2. resistant to corrosion.
3. good conductor of heat and electricity.
4. can be polished to give a highly reflective surface.
5. very easy to recycle; one reason that it is environmentally friendly and is often called the "green" metal.
6. 100% dense and impervious to light, odour and taste – it has no effect on the taste or smell of food.
7. non-flammable substance.

Uses of Aluminium

1. Low density and strength make it ideal for construction of aircraft, lightweight vehicles, and ladders.
2. Easy shaping and corrosion resistance make it a good material for drink cans and roofing materials.
3. Corrosion resistance and low density leads to its use for window frames.
4. Good conduction of heat leads to its use for boilers, cookers and cookware.
5. Good conduction of electricity leads to its use for overhead power cables hung from pylons (low density gives it an advantage over copper).

Geological controls and formation of bauxite

The occurrence of bauxite on the Mitchell Plateau is controlled by the distribution of the Carson Volcanics and the present and past climate. The overlap of areas of high rainfall with the Carson Volcanics depicts the main distribution of bauxite.

Basalt to Bauxite

Bauxite is a naturally occurring material that is often derived from the weathering of basalt. Basalt typically contains plagioclase and clinopyroxene, while the principal minerals in bauxite are gibbsite ($Al_2O_3.3H_2O$), boehmite and diaspore($Al_2O_3.H_2O$).

Bauxite formation involves basalt with 14-19% Al_2O_3, containing primary silicate minerals, losing Na and Ca in the weathering process to form clay (secondary hydrated aluminium silicates) with 20-39% Al_2O_3. Further weathering results in the

loss of Si and the formation of bauxite (hydrated aluminium oxides) with 27.5-65% Al2O3. (gibbsite-rich rock). Electron micrographs of bauxite often depict well-formed crystals of gibbsite (Al2O3.3H2O).

Discovery and exploration of the Mitchell Plateau

Discovery:

In 1965 during regional reconnaissance by an AMAX (American Metal Climax Inc) field party led by D. K. Malcolm.

Exploration:

Five Temporary Reserves totalling 3,930 km2 over Mitchell Plateau and adjacent regions, as well as 135 Mineral Claims totalling 85 km2 over Cape Bougainville.

Bauxite Reserves:

	Mitchell Plateau	***Cape Bougainville***
Dry tonnes	230,000,000	980,000,000
Total alumina	47%	36%
Total silica	2.6%	1.9%
Area of laterite	120 km2	85 km2
Area of bauxite	40 km2	44 km2
Bauxite thickness	3.2 m	8.6 m

Land tenure of the region

The Mitchell Plateau is covered by a number of land tenures including State Agreement, exploration tenements, conservation lands and Aboriginal lands.

Alumina State Agreement:

The Alumina Refinery (Mitchell Plateau) Agreement Act 1971 is one of five State Agreements in Western Australia for bauxite and alumina.

Details about State Agreements are as follows

- An Agreement is between the State and a private sector company and gives a company exclusive right to develop a natural resource (owned by the

State) in return for the company undertaking to establish and operate a resource project.

- The resultant contract is presented, as a Schedule to a Bill, for approval ('ratification') by Parliament.
- Parliamentary ratification means that Agreement provisions, where they are inconsistent, may override the existing statutory laws of the State.
- Agreements commonly include obligations:
    - to develop the project within a reasonable timeframe
    - to support State economic growth and create jobs by maximising the use of local labour, services and materials
    - to establish further processing industries, if commercially viable
    - that the Agreement will not be subsequently amended by the State, without the concurrence of the company.

Exploration tenements:

Companies with tenements in the region include the following:

Mitchell Plateau Bauxite Co (Rio Tinto, Alcoa, AngloGold)

- *Mitchell Plateau (State Agreement)*
- *Cape Bougainville*

Bauxite Australia Pty Ltd / United Minerals Corporation

- *Mitchell Plateau South*
- *Couchman Range / Foster Range*

Australasian Mining & Exploration

- *West Kalumburu*

Ochre Resources Ltd

- *Mt Leeming*

Kimberley Bauxite Pty Ltd

- *Cape Bougainville*

Bauxite Resources Pty Ltd

- *West Kimberley*

Bauxite to alumina to aluminium – the processes

The processing of bauxite requires conversion to alumina and then to aluminium.

Alumina (Bayer process)

Karl Josef Bayer in Austria realized a method for processing alumina from bauxite in mid 1880s (Bayer process – still used today).

Aluminium (Electrolysis)

The Frenchman Paul Héroult and the American Charles Hall separately applied for aluminium production patents in 1886. Both used the method of dissolving alumina in molten cryolite before extracting the aluminium by electrolysis. The global ascent of aluminium had begun.

Comparison of bauxite deposits

Bauxite and Alumina and Aluminium in Australia

Australia's aluminium industry is a large integrated sector of mining, refining, smelting and semi-fabrication, and is economically important both nationally and globally. Important facts are as follows:

- The industry consists of
    - 5 bauxite mines,
    - 7 alumina refineries,
    - 6 primary aluminium smelters,
    - 12 extrusion mills, and
    - 2 rolled-product mills
- Australia is the World's largest producer of bauxite, producing 59.9 mt (34%) of world bauxite production in 2005 (WA share of Australia is 65%; Huntley mine is the largest bauxite operation in the world and has been for many years).
- Australia is the largest producer and exporter of alumina, producing 17.7 mt (30%) of world alumina production in 2005 (WA produced 11.5 mt valued at $4.1 billion)
- Australia is the fifth largest aluminium producer, with 1.9 mt (6%) of world aluminium production in 2005.

- In 2005-06, the Western Australian State Government collected $64 million in royalties, and the bauxite-alumina operations employed about 10,000 people.

Ivor completed the talk by giving geological maps to the first people in the audience to answer the following questions:

- How abundant is aluminium in the earth's crust – ranking and % ?
- How common is aluminium as a metal on earth?
- Who invented the Bayer process?
- In 2005-06 how many people did the bauxite/alumina industry employ in WA?