## Potential and Outlook

There is moderate potential for lithium-bearing pegmatite deposits in New South Wales. The most likely host to lithium-rich pegmatite are Mesoproterozoic rocks of the Broken Hill region, particularly amblygonite-pegmatites near Byjerkerno, in the Euriowie tin field.

The potential for economic concentrations of lithium in brines in New South Wales has yet to be systematically tested. Although salt lakes are widely developed in western New South Wales, most appear unlikely to contain economic concentrations of lithium.

## Nature and Occurrence

The distribution of lithium in igneous rocks is controlled by its charge, and by the $(MgO+FeO)/LiO_2$ ratio (Kunasz 1994). This ratio is very large during early magmatic differentiation, but as the manganese and iron are removed the lithium content increases, thus resulting in enrichment of lithium in silicic rocks and pegmatites. Many of the pegmatites develop an arrangement of zones, each of which has a specific suite of minerals.

### Deposit Types

The major commercial sources of lithium are granitic pegmatites, and brines associated with volcanic/geothermal areas or petroleum occurrences (Kunasz 1994; Harben & Kužvart 1996).

#### *Pegmatites*

- Principal lithium minerals in pegmatites

  ***Major***

  Spodumene $LiAl[Si_2O_6]$
  Petalite $Li[AlSi_4O_{10}]$

  ***Minor***

  Amblygonite $LiAl(PO_4)(F,OH)$
  Lepidolite $K_2(Li,Al)_{5-6}[Si_{6-7}Al_{2-1}O_{20}](OH,F)_4$
  Eucryptite $LiAl(SiO_4)$

#### *Brines*

- Enrichment of lithium (and other elements, such as boron) in some geothermal waters and petroleum brines
- Concentration of lithium-bearing brines, primarily as lithium carbonate, in saline lakes in desert environments within enclosed basins near Tertiary or Recent volcanoes. A prolonged period of enrichment and concentration is required. Lithium concentrations in salt lakes in parts of Chile and Argentina can attain concentrations exceeding 1000 ppm. These lakes are also sources of boron, sodium bicarbonate and sodium sulphate.

Worldwide resources of lithium exceed 12 Mt (Harben 1999). In 2004, world production of lithium compounds, most of which come from brine processing, was 15 500 t (Ober 2005). The overall production of lithium could be higher, however, owing to the non-reporting of such data by several major producers.

Australia, Canada and Zimbabwe are major producers of lithium ore concentrates, Chile is the largest lithium chemical producer, followed by Argentina, China, Russia and the USA.

## Main Australian Deposits

The foremost world producer of lithium ore concentrates (excluding brines) is the Greenbushes Mine in Western Australia, where spodumene is mined from a pegmatite dyke swarm. In 2004, the mine produced almost 4000 t of lithium oxide (Western Australian Department of Industry and Resources 2004). A lithium carbonate plant was closed in 1996–1997, shortly after completion, because the product was not competitive against brine-derived lithium carbonate (Fetherston 2002).

## New South Wales Occurrences

The only significant lithium occurrences in New South Wales are near Byjerkerno, which is northeast of Broken Hill (Lishmund 1982). There, amblygonite occurs in tin-bearing pegmatite deposits in the Euriowie tin field. Small amounts of amblygonite were produced from the Trident Mine and possibly also from the Sceptre and Lady Don Mines.

## Applications

Applications for lithium have traditionally been in the glass and ceramic industries, where it is mainly used as a flux and to improve the brilliance of frits and glazes (Harben 1999). The low thermal expansion properties and favourable fluidities of lithium oxide also enable it to impart heat-resistant qualities to flameproof ware

and for use in shock-resistant glass ceramics. Lithium minerals and chemicals are widely used in container and safety glass, fibreglass, rubber, plastics, TV tubes, pharmaceutical products and pyroceramics.

Minerals such as spodumene can be used as feedstock for the manufacture of lithium carbonate and other lithium compounds. Spodumene is also a source of lithium metal which is used to produce lithium–aluminium and lithium–magnesium alloys, in catalysts, electrodes and aerospace applications. Lithium minerals and chemicals are steadily replacing other less environmentally acceptable chemicals in glass manufacture and are also being used at an increasing rate in electrovoltaic cells in video cameras and electric cars.

Lithium mineral concentrates are graded according to their lithium oxide (lithia) content. (Pure spodumene contains 8% $Li_2O$ and petalite contains 4.9% $Li_2O$.) Lithium carbonate competes with spodumene and petalite concentrates in glass and ceramics applications, although lithium minerals are generally considered to be more effective fluxes (Crossley 2003). Lithium carbonate is also used as a feedstock for the manufacture of a wide range of other lithium compounds, including lithium hydroxide, lithium chloride, butylithium and lithium bromide (Anon 2003).

## Economic Factors

Production of lithium compounds in the USA, based on spodumene extraction, has declined and been replaced by lithium derived from brines produced domestically and imported from Chile and Argentina. Brines have become the major source of lithium carbonate worldwide because of their lower production costs compared with the costs of processing hard-rock ores, and their extremely large resources (Ober 2005).

Demand for lithium for use in the manufacture of batteries, particularly for mobile phones, lap-top and palm computers, should continue to increase.

## References


Anon 2003 Mineral Spotlight: lithium industrial minerals. *Industrial Minerals* **424**, 51.

Crossley P. 2003. Living the high life. *Industrial Minerals* **430**, 46–53.

Fetherston J.M. 2002. Industrial minerals in Western Australia: the situation in 2002. *Geological Survey of Western Australia, Record* **2002/12**.

Harben P.W. 1999. *The industrial minerals handybook,* 3rd edition. Industrial Minerals Information Ltd, London.

Harben P.W. & Kužvart M. 1996. *Industrial minerals: a global geology.* Industrial Minerals Information Ltd, London.

Kunasz I.A. 1994. Lithium resources. *In:* Carr D.D. ed. *Industrial minerals and rocks,* 6th edition, pp. 631–642. Society for Mining, Metallurgy, and Exploration, Inc. Littleton, Colorado.

Lishmund S.R. 1982. Non-metallic and tin deposits of the Broken Hill district. *Geological Survey of New South Wales, Bulletin* **28**.

Ober J.A. 2005. Lithium. *In* United States Geological Survey. compiler. *Mineral Commodity Summaries 2005,* pp. 98–99. United States Department of the Interior.

Western Australian Department of Industry and Resources. 2004. *Western Australia Mineral and Petroleum Statistics Digest 2004.* Government of Western Australia.