POTASSIUM MINERALS

Potential and Outlook

New South Wales has good potential for commercial potassium deposits. Saline groundwater in the Murray Basin, southwestern New South Wales (Figure 1), has significant potential for the recovery of a diverse range of industrial minerals. Currently, a total of about 30 000–50 000 tpa of sodium chloride and magnesium chloride are extracted annually from solar evaporation basins near Wentworth for various industrial applications. The potential for the commercial recovery of potassium compounds appears possible but would require additional investigation.

Opportunities for development of potassium resources elsewhere in New South Wales are restricted owing to the relatively small size of known alunite deposits (Alum Mountain, near Bulahdelah) and because evaporite deposits in the western part of the state tend to be dominated by gypsum and other minerals.

Nature and Occurrence

Potassium is the seventh most-abundant element in the continental crust and a major element in oceanic waters, a minor element in oceanic crust and a trace element in mantle rocks (Hem 1985). Potassium is readily soluble, so it is easily transported in surface waters and tends to concentrate in seawater, where it is the sixth most-abundant element. That tendency for potassium to concentrate in seawater is moderated by its propensity to be fixed by clay minerals (particularly illite) and zeolites in marine sediments. Potassium can also form up to 20% by mass of feldspar and mica minerals. Leaching of rocks containing these minerals can form surface and subsurface brines (highly saline groundwaters).

In 2004 world production of potassium minerals was 30 Mt (Searls 2005). Commercial potassium-bearing ores are generically known as potash (Harben & Kužvart 1996). Potash production is largely confined to 13 countries, of which seven account for 90% of world production. Canada produces approximately 31% of world production and the Saskatchewan Basin alone has sufficient reserves to maintain world production for about 5000 years. Many of these basinal deposits are very large, some being hundreds or thousands of kilometres long and hundreds of metres to several kilometres thick. Brines represent an additional source of potash, as do the world's oceans.

World resources of potassium are estimated at approximately 250 billion tonnes (Searls 2005). Large deposits of carnallite occur in Russia and Thailand. However, it is not certain if those deposits could be profitably mined.

Deposit Types

The major economic occurrences of potassium are soluble minerals in evaporites. The principal potassium minerals are:

- sylvite (KCl)
- carnallite ($KCl.MgCl_2.6H_2O$)
- kainite ($4KCl.4MgSO_4.11H_2O$)
- langbeinite ($K_2SO_4.2MgSO_4$).

These minerals occur with sodium, calcium and magnesium minerals, such as halite, anhydrite and epsomite, respectively (Harben & Kužvart 1996). High-grade potassium deposits contain more than 25% K_2O equivalent, but may be economic with as little as 1% KCl.

Potassium becomes saturated late in evaporating brines, and therefore generally forms thin beds near the tops of halite beds, unless concentrated by various depositional processes. In such circumstances, sylvite tends to be concentrated on the side of a basin or around its edges, with concentrated potassium-rich brines descending to deeper parts of the basin only to precipitate later when significantly further concentrated. Some potassium deposits are magnesium-rich (requiring similar degrees of concentration to saturate), and contain polyhalite, hexahydrite, kieserite and epsomite. Others are magnesium-poor and include halite and carnallite, as well as primary minerals probably precipitated from brines rich in calcium.

Major evaporitic deposits range in age from Proterozoic to Recent and occur in various geological settings. However, nearly all formed in Palaeozoic epicontinental seas, mostly now preserved in Europe and North America (Harben 1999).

Non-evaporitic minerals containing potassium include:

- alunite $KAl_3(OH)_6(SO_4)_2$ and its ferruginous equivalent
- jarosite $KFe_3(OH)_6(SO_4)_2$
- leucite $K(AlSi_2O_6)$
- glauconite $K_2(Mg,Fe)_2Al_6(Si_4O_{10})_3(OH)_{12}$.

These minerals are considered to have relatively low economic potential.

Main Australian Deposits

Australia has several large basins with evaporitic sequences, including the Carnarvon and Adavale Basins, where sylvite has been recorded (Williams-Stroud et al. 1994). To date, no economic occurrences of potash have been found.

New South Wales Occurrences

Alum Mountain, near Bulahdelah, is the only known deposit of potassium minerals in New South Wales (Jenkins & Nethery 1992).

The Early Permian Alum Mountain Volcanics (mainly the basal Sams Road Rhyolite Member of welded ignimbrite and lesser crystal tuff, epiclastic deposits, lava, autobreccia and polymictic breccia) are intensely altered in a north–south trending, stratabound zone centered on Alum Mountain. That zone is over 5 km long, typically 400 m to 600 m wide, and exhibits alteration ranging from phyllic to advanced argillic. Massive alunite occurs in numerous bedding-parallel lenses up to 30 m by 20 m by 10 m. The main zones of alunite development are at the Tunnel Quarry, Big Quarry and Myall Quarry, where alunite contents range up to 89% (Booker 1950). Mining occurred from 1890 to 1926 and from 1935 to 1952. Total recorded production of alunite was 70 065 t of hand-picked ore (Booker 1950; Uren 1976; Holmes et al. 1982).

Applications

Potassium is a primary plant nutrient, increasing disease resistance and adding flavour and colour. Adequate supplies, along with nitrogen and phosphorus, are necessary for virtually every aspect of plant growth (Hem 1985). Some potassium products and their applications are listed in Table 31.

Potash is also used as a feedstock for the manufacture of a variety of potassium chemicals used either as fertiliser or for industrial applications. About 95% of potash production goes into fertilisers.

Potassium chloride for fertiliser is sold as muriate of potash (MOP), with at least 60% KCl. Alternatively, sulphuric acid treatment produces potassium sulphate with at least 50% K_2SO_4 for use in specialised fertiliser, medicine or glass manufacture, or as an accelerator for gypsum products (Harben & Kužvart 1996).

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Table 31. Selected potassium products and their applications

Chemical	Formula	Use
Potassium persulphate	KSO_4	Bleaching agent, photography, polymerisation initiator
Potassium nitrate (saltpetre)	KNO_3	Fertiliser and explosives, pyrotechnics, glass and ceramics, plastics, drugs and tobacco products
Caustic potash	KOH	Liquid fertiliser, oil and gas production, metal treatment, batteries, soaps, textile bleaching, water treatment
Potassium iodide	KI	Medicine, photography, salt additive
Potassium permanganate	$KMnO_4$	Saccharine manufacture, zinc refining, welding rod coating, water treatment
Potassium carbonate	K_2CO_3	Speciality glass

Source: Harben (1999)