Potential and Outlook

Phosphatic material, such as cave earth or guano, was extracted on a small scale in the past from caves in Palaeozoic limestone at several localities in New South Wales. Known phosphate occurrences are small and of low grade.

There is some potential for the discovery of economic phosphate rock deposits in the southern Eromanga Basin (Great Australian Basin) where thin, mostly low-grade phosphatic siltstones were intersected in drillholes during exploration undertaken in the early 1980s.

Nature and Occurrence

Phosphorus occurs in many minerals, of which apatite. $Ca_5(F,Cl,OH)(PO_4)_3$, is the most abundant and by far the most important group (Bartels & Gurr 1994). Characteristic minerals of the apatite group are shown in Table 30.

Table 30. Main apatite minerals

Mineral	Description
Collophane	Cryptocrystalline apatite
Francolite	Carbonate fluorapatite with 5% carbonate and 1% fluorine
Dahlite	Carbonate hydroxyapatite with 5% carbonate and 2% hydroxide

Source: Wallis (2004)

Other phosphate-bearing minerals of potential economic significance include:

- monazite, $(Ce,La,Nd,Th)PO_4$
- turquoise, $CuAl_6(PO_4)_4(OH)_8.4H_2O$
- pyromorphite, $Pb_5(PO_4)_3Cl$.

The term ‘phosphate rock’ refers to rocks containing phosphate minerals, usually apatite, which can be commercially exploited, either directly or after processing, for commercial applications (Bartels & Gurr 1994).

World production of phosphate rock in 2004 was 138 Mt (Jasinski 2005). The USA, China and Morocco/western Sahara, North Africa, are the major producers and are the source of about 60% of total global production.

Deposit Types

Sedimentary phosphate deposits occur on every continent and range in age from Precambrian to Recent, although almost all exploited deposits are Phanerozoic in age (Bartels & Gurr 1994). About 80% of phosphate rock used commercially is obtained from marine sedimentary deposits (phosphorites) (Harben & Kužvart 1996).

Large resources of phosphates occur on the continental shelves and on seamounts in the Atlantic and Pacific Oceans. They cannot be commercially mined, however, with current technology (Jasinski 2005).

Igneous intrusive alkali rocks, particularly carbonatite complexes, and associated contact metamorphic rocks, provide about 15–20% of the world’s phosphate, usually as fluorapatite (Bartels & Gurr 1994). Phosphate rocks of sedimentary origin typically have 30–35% P_2O_5 whereas those of igneous origin contain marginally higher P_2O_5, typically 35–40% (Schorr & Lin 1997).

Phosphorite beds consist of grains, pellets or fragments of cryptocrystalline apatite (collophane) and are typically a few centimetres to tens of metres thick (McHaffie & Buckley 1995). These deposits typically show extensive reworking, secondary enrichment and replacement. Shallow oceanic areas and continental shelves commonly have thick accumulations of phosphorus-rich organic debris, mainly derived from deep oceanic sources associated with upwelling currents of cold, nutrient-rich water. Sedimentary deposition of phosphate has occurred throughout much of the Earth’s history and continues today (Bartels & Gurr 1994).

Accumulations of bird and mammal excrement have also provided important sources of phosphate rock (McHaffie & Buckley 1995). Guano deposits on small oceanic islands, for example, Nauru and Christmas Island, were once major sources of phosphate but are now declining in importance or have ceased production. At these localities, bird excrement has formed thick accumulations of calcium phosphate, or guano, due to reaction of the organic waste with underlying limestone rocks.

Main Australian Deposits

Australia's total production of rock phosphate in 2004 was 2.3 Mt (Jasinski 2005), mainly from Phosphate Hill, which is situated 135 km southeast of Mount Isa in northern Queensland. The remainder of Australian production is from Christmas Island in the Indian Ocean. Very large phosphorite resources occur in the Early Middle Cambrian Beetle Creek Formation in northwestern Queensland and the Northern Territory (Wallis 2004).

The Phosphate Hill deposit is the only commercial phosphate rock mine in Australia. In 2003, this deposit contained Proved and Probable Resources of 89.9 Mt (24.3% P_2O_5) (WMC Resources pers. comm. 2004) (plus stockpiles). Phosphate Hill has sufficient resources to last for about 35 years. Significant deposits are also located at Ardmore, 70 km west of Phosphate Hill, and Lady Annie–Lady Jane, 120 km west-northwest of Mount Isa.

In 2003, the Phosphate Hill operation produced 760 000 tonnes of di-ammonium phosphate and 162 000 tonnes of mono-ammonium phosphate (WMC Resources pers. comm. 2004). The project has several major commercial advantages, including locally available supplies of natural gas, phosphate rock and sulphuric acid (obtained by processing of sulphur-bearing gases from copper-smelting operations at Mount Isa). The project also has a distinct transport advantage to Southeast Asia and China, which account for about 65% of the world's di-ammonium phosphate fertiliser market.

Production from Phosphate Hill is expected to replace much of Australia's fertiliser imports, which, before this project commenced operations, were about 1.2 Mt a year (Wallis 2004). About 70% of the production from Phosphate Hill is sold in Australia and the remainder exported, mainly to New Zealand and Southeast Asia.

New South Wales Occurrences

Phosphate deposits in New South Wales occur in diverse geological settings but typically they are small and of low grade (Herbert 1975). There has been minor production of phosphatic material, such as cave earth or guano from caves in Palaeozoic limestones — as at Ashford Caves; Wellington Caves; and Willi Willi Caves (near Kempsey). No production of phosphate rock has been recorded in the state for many years.

The southern Eromanga Basin (Great Australian Basin) may have potential for economic phosphate rock deposits. Phosphorite chips have been recorded in spoil from water bores and thin, mostly low-grade calcareous phosphatic siltstone beds were found during limited exploration undertaken in the early 1980s (Western Mining Corporation Limited 1981; Dominion Mining and Oil NL 1982). Best drilling intersections included 0.12 m at 13% P_2O_5 at a depth of 145 m in thinly bedded Cretaceous limestone and calcareous siltstone beds.

Turquoise and phosphate rock have been recorded in deformed Ordovician sedimentary rocks of the Wagonga Group on the far south coast of New South Wales (Herbert 1975). Minor amounts of bird guano occur on Lord Howe Island and on the Tollgate Islands near Batemans Bay (Holmes et al. 1982). Phosphate-bearing alluvium and soils occur between Molong and Wellington (Holmes et al. 1982). Near Canowindra, for example, phosphate rock and clay occur in an old weathering profile developed on Early Ordovician limestones and in overlying Tertiary alluvium (Herbert 1975). That locality of high-grade phosphate rock (as veins and lumps with up to 32% P_2O_5) reportedly occurs in soil and alluvium over 10 m thick.

Offshore exploration on the continental shelf and on seamounts in the Tasman Sea found only minor occurrences of marine phosphates, typically developed as concretions and nodules of Miocene age (Herbert 1975).

A recent reappraisal of the mineral resource potential of the continental shelf (Whitehouse 2006) indicates that although marine phosphates are comparatively widespread, they have generally low phosphate content and are unlikely to be economically viable.

Applications

About 90% of the phosphate produced is used in the manufacture of fertilisers, which are available as a wide range of products. There are no known substitutes for the use of phosphates as fertilisers. The remainder of world phosphate production is used in the manufacture of phosphoric acid, phosphorus-based industrial chemicals and phosphorus (Harben 1999). These are mainly used in detergents, animal feed supplements and food products.

Most fertiliser manufacturing processes use sulphuric acid, although some, mostly in Europe, use nitric acid (Bartels & Gurr 1994). Specifications for phosphate rock vary widely and were summarised by Harben (1999). Chemical grade phosphate rock should contain at least 24% P_2O_5, less than 3% Fe_2O_3 and have a CaO to P_2O_5 ratio between 3.3:1 and 3.6:1 (Holmes et al. 1982). By-products from the use of phosphate rock include gypsum, uranium, vanadium and fluorides (Bartels & Gurr 1994). Much of the fluorine is evolved as gaseous by-products during the manufacture of fertiliser. The world's phosphate rock deposits represent the largest known resources of fluorine and could become an increasingly important source of fluorine.

Economic Factors

Phosphate is a relatively low unit-value commodity. Therefore, most phosphate rock extraction operations tend to involve surface mining, large-volume extraction and reasonably low transport distances to major markets (Bartels & Gurr 1994).

In comparison to many other mineral commodities, the demand for phosphate rock appears relatively predictable and stable (Jasinski 2005). World fertiliser consumption was predicted by the International Fertilizer Industry Association to grow by 2.1% a year between 2003 and 2008, with phosphate consumption growing at a rate of 2.7% a year over the same period (Jasinski 2005). The highest growth rates are likely to be in developing countries, particularly in Asia and South America.

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