Photograph 25. Crushed zeolite from the Escott zeolite mine, Werris Creek. Zeolite applications include odour control, contaminated site remediation, fertilisers and sewage treatment. New South Wales zeolite deposits are typically high-grade, and much harder than overseas deposits, making them more suitable for such uses as water filtration. (Photographer D. Barnes)

Potential and Outlook

The zeolite industry in New South Wales, while still comparatively small, is now well-established and can be expected to grow at a steady rate. It is likely that markets in the wastewater treatment and other specialised areas will develop.

Natural zeolites are usually relatively high-volume, low-value materials so international trade is not large. As there are many competing materials for some markets, marketing and research on applications are major activities for zeolite producers.

The potential for zeolites in New South Wales is dependent not only on finding resources but also on developing markets and processing techniques for tailoring zeolites to those markets.

The main zone of resource potential lies within the Carboniferous volcanic rocks of the Tamworth Belt, where the existing deposits and prospects are located (Figure 31). Of particular importance is the Currabubula Formation, which consists of conglomerate, sandstones, mudstones, felsic ashflows and airfall tuffs (Roberts et al. 2004).

Other areas of investigation should include acid, alkaline and intermediate volcanic rocks of Carboniferous or younger age. As there are few acid to intermediate rocks of Tertiary age, the potential for significant zeolite resources in such rocks is not considered to be high. There is a remote potential for small volcaniclastic deposits in Tertiary basins, such as the Murray Basin (Figure 1). Carboniferous volcanic rocks remain the most promising target.

Figure 31. Zeolite occurrences and prospective rocks in New South Wales

Nature and Occurrence

Zeolites are aluminosilicates characterised by a porous framework structure occupied by loosely held cations and water molecules. There are about 45 naturally occurring zeolite minerals, of which mordenite, clinoptilolite, chabazite, erionite, phillipsite, laumontite, ferrierite and analcite are exploited commercially (Hanson 1995).

World production figures for natural zeolites are not published. However, reported production figures and estimates for various major producing countries suggest that world production is between 2.5 Mt per annum and 3 Mt per annum (Virta 2004). China is the major source, with estimated production of 2.0 Mt. Other significant producing countries include Japan (140 000 to 160 000 tpa), the USA (57 400 tpa), Cuba (37 500 tpa) and Hungary (30 000 tpa).

Deposit Types

Commercial deposits of natural zeolites are usually formed by the action of pore water on volcanic glass. Some of the major environments of zeolite formation, identified by Hay (1978, 1981), are summarised below.

- Saline alkaline lakes
- Weathered zone (saline, alkaline soils and land surfaces)
- Deep-sea sediments
- Open hydrologic systems
- Hydrothermal or hot springs
- Burial metamorphic settings

Most commercially exploited deposits of zeolites are of Cainozoic age (particularly Tertiary), with a few Mesozoic deposits. The Carboniferous zeolites in the New England area (Figure 31) are the oldest deposits to be commercially exploited.

The zeolite species formed in each deposit are dependent on the composition of the source materials, the fluids that react with them, and the temperature of formation.

The largest commercially exploited deposits include clinoptilolite-bearing tuffs of Miocene age in the Itaya area of Japan. They have formed from marine rhyolitic and dacitic ash that has undergone low-grade hydrous metamorphism.

In Arizona, USA, chabazite occurs with clinoptilolite in Pliocene–Holocene tuffs deposited in an intermontane saline alkaline lake environment.

Other significant producers include China, Cuba, Italy, Hungary (clinoptilolite in Tokay; mordenite in Harcsa) and New Zealand (Wairakei). Holmes (1994) reported that there are several newly developed resources and prospects in Indonesia — in Sumatra (high-quality clinoptilolite) and in Java (clinoptilolite and mordenite).

Main Australian Deposits

New South Wales has the only operating zeolite mines in Australia. Occurrences have been recorded in Queensland and Northern Territory (McHaffie & Buckley 1995).

New South Wales Occurrences

There are ten recorded zeolite occurrences in New South Wales (Ray et al. 2003). More detailed information on the nature and occurrence of zeolites in New South Wales is in Holmes & Pecover (1987) and New South Wales Department of Mineral Resources (1987).

There are two operating zeolite mines in the Currabubula Formation in the New England region. These are the Escott mine, near Werris Creek (Figure 31) and the more recently opened Bindawalla mine, near Quirindi (Figure 31). They are situated in acid to intermediate pyroclastic and epiclastic rocks in Late Carboniferous continental to shallow marine units of the Tamworth Belt. The zeolite species produced (Photograph 25) are dominantly clinoptilolite, with small amounts of laumontite and mordenite. These zeolites are relatively hard and siliceous and have a high cation exchange capacity. Although total production has been in the order of several thousand tonnes annually, from 2000 to 2003 (Table 45), production over the past few years has increased significantly to about 6000 tonnes annually (Zeolite Australia Pty Ltd pers. comm. 2006).

Table 45. New South Wales zeolite production 2000–2003

Year	Tonnes	Value A $
2000–01	3884	818 673
2001–02	406	85 682
2002–03	2114	446 135

Source: New South Wales Department of Mineral Resources (2003)

There are several other zeolite prospects in New South Wales, all in the Currabubula Formation. Zeolites have also been reported from a number of other locations, including intermediate to basic tuffs associated with lacustrine deposits in the Nandewar and Warrumbungle

Ranges, and basic tuffs and lavas associated with Triassic to Tertiary volcanic rocks in the Warrumbungle and Liverpool Ranges (Pecover 1987). These deposits are considered to have little economic potential.

Applications

Uses for zeolites, specifications and alternative materials depend on the characteristics of the material from each deposit and therefore vary widely. The most common applications are summarised below.

- Agriculture, as a soil additive, animal feed additives, moisture and odour absorption, filler or anti-caking agent, carrier for chemicals and pesticides
- Catalysts
- Industrial, nuclear and mine waste, for heavy metal ion removal
- Wastewater and sewage treatment, pet litter, aquaculture

The properties of zeolites are dependent on their molecular structure, especially the size of voids and channels within the structure and the cation exchange capacity. The properties of zeolites, particularly those from New South Wales deposits were outlined in Fredrickson (1987) and Slansky (1987).

In Australia and overseas the agricultural sector appears to be the largest consumer of natural zeolites. Zeolites from Australian producers are largely used in a range of agricultural and wastewater treatment applications.

Alternative Materials

Synthetic zeolites are higher-value materials having a wide range of uses and stringent specifications, particularly in detergent manufacture, catalysts and high-technology industries. Generally, natural and synthetic zeolites do not compete for the same markets. There are many other competing materials for natural zeolite applications. They include clays, talc and diatomite, and a range of fine-ground and absorbent minerals.

Health Issues

There are two fibrous zeolite minerals, mordenite and erionite. However, only erionite is classified as a carcinogen by the International Agency for Research on Cancer.

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