



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Photograph 6. Ceramic whiteware products emerging from a kiln, Caroma Industries ceramics plant, Sydney. Raw materials most commonly used in porcelain manufacture are feldspar, as a flux, and kaolin, as the clay or plastic fraction. Slow heating of the material in a kiln (depicted) produces a solid, strong and non-porous structure with a permanent glassy surface. (Photographer D. Barnes)

Potential and Outlook

Coarse-grained granitic rocks, such as leucocratic granite, aplite, alaskite and albitised granites (granites in which more-calcic feldspars have been replaced by albite), are the main commercial sources of feldspar. The Lachlan and New England orogens of eastern New South Wales contain large areas dominated by granitic rocks. The most significant in terms of the feldspar potential are the 'Oberon Alaskite deposit' (in the Rossdhu Granite), near Oberon, and at Goombargana near Walbundry, northwest of Albury (Figure 9). There has been little systematic exploration for feldspar within the Lachlan and New England orogens and there is moderate potential for further large deposits.

There are more than 50 plutons in the Lachlan Orogen with chemical characteristics favourable for the development of economic deposits of feldspar (that is, total iron less than 1.5% and alkalis over 8%).

Specific details of these plutons, however, have yet to be documented.

The 'Oberon Alaskite deposit' (Rossdhu Granite) consists of quartz, alkali feldspar, albite, muscovite mica and accessory garnet. It contains on average 0.5–0.9% iron ($\text{FeO}+\text{Fe}_2\text{O}_3$) and 8.0–8.5% alkalis ($\text{K}_2\text{O}+\text{Na}_2\text{O}$). The intrusion has a surface area of about four square kilometres and contains an identified resource in the order of several million tonnes of high-quality feldspar, although potential resources would be far greater. The quartz and mica contained in the rock are potential by-products.

Goombargana is a part of the Jindera Granite west of Walbundry. The granite at Goombargana is very coarse-grained, with aplite dykes and minor pegmatite. A potentially large resource of feldspar suited for industrial use may be present.

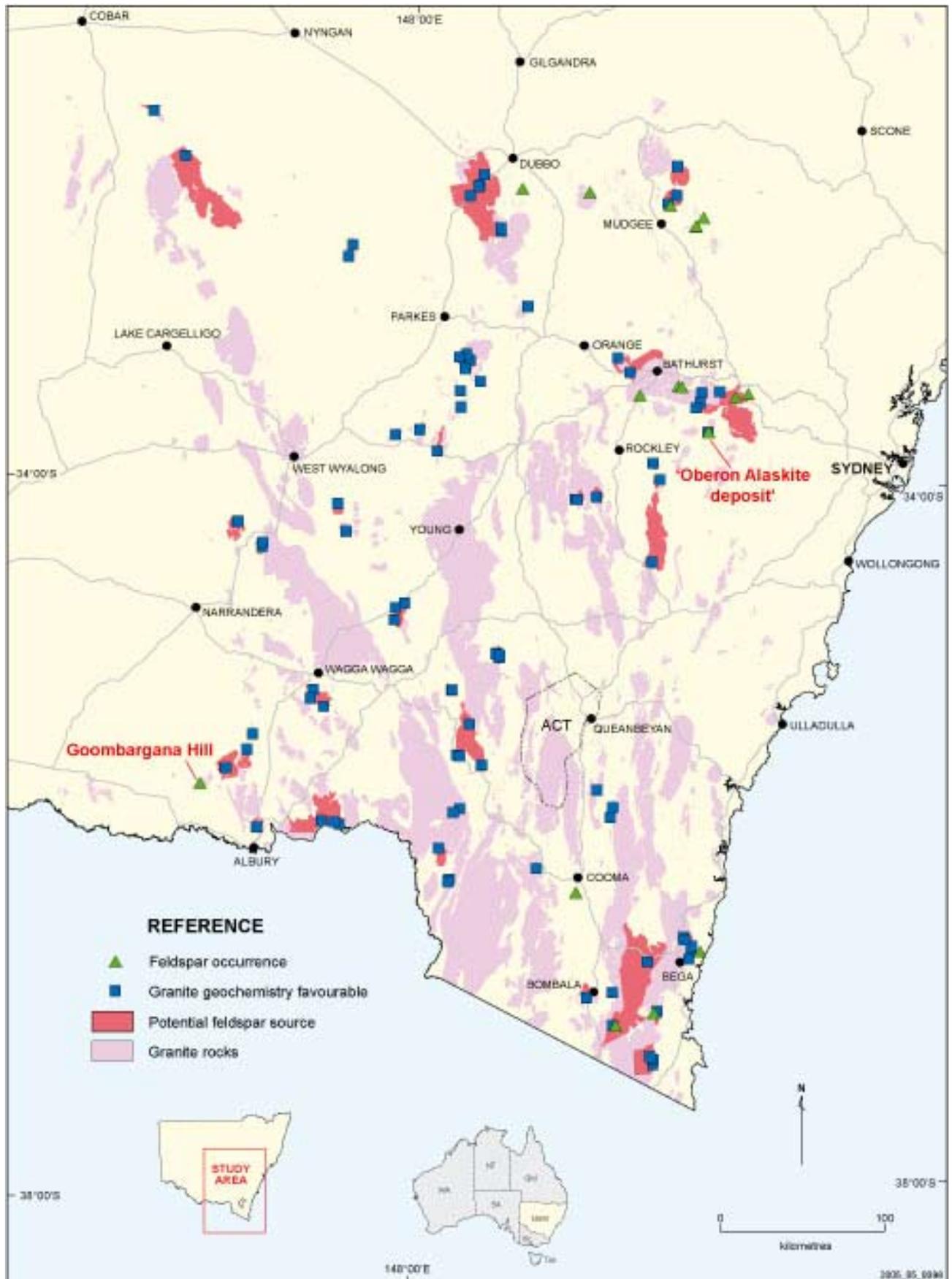


Figure 9. Feldspar occurrences, granitic rocks and favourable granite geochemistry, eastern Lachlan Orogen, New South Wales

A number of granitic intrusions in the Bathurst area are considered to be moderately to highly prospective for feldspar on the basis of their geochemistry. The Gumble Granite, north west of Orange and Burruga Granite south of Rockley, are intrusions with surface areas of about 50 km² and 25 km², respectively. Both are leucocratic in part and whole-rock analyses show that they have iron contents of less than 1% and alkali contents exceeding 8%.

Southeast of Bathurst, the Tarana Granite, which forms a part of the Bathurst Batholith, is a multiphase intrusion that becomes progressively more felsic towards the east. It contains leucogranitic and rhyolitic phases with similar chemical characteristics to the Gumble and Burruga Granites.

Pegmatitic deposits in the Broken Hill Block (Lishmund 1982) have been the major source of feldspar in New South Wales to date and are the main current source. There is potential for further development of pegmatites in that region, which include some large bodies of intermixed pegmatite and leucocratic quartzofeldspathic rock that may have potential as a source of mixed soda–potash feldspar. The Broken Hill region also contains extensive albite-rich rocks, that are a potential source of sodium feldspar, if the iron content can be economically reduced to acceptable levels (Lishmund 1982).

Nature and Occurrence

Feldspars are some of the most abundant minerals in the Earth's crust and occur in many rock types. Feldspar minerals are aluminosilicates containing varying amounts of sodium, potassium and calcium. Feldspars are divided into two groups, alkali feldspars and plagioclases, each of which is a continuous solid solution series between end-member compositions.

- *Alkali feldspars* range in composition from albite (NaAlSi₃O₈) to microcline and orthoclase (KAlSi₃O₈).
- *Plagioclases* range in composition from anorthite (CaAl₂SiO₈) to albite (NaAlSi₃O₈).

Deposit Types

The commercial potential of source rocks is enhanced by a high proportion of feldspar and a low proportion of easily separated ferromagnesian minerals.

Feldspar was first produced from granite pegmatites, mainly because the constituent minerals quartz, feldspar and mica are segregated in zones. Also, the feldspar in these deposits is generally coarse- to very coarse-grained, making selective extraction and hand-

sorting relatively easy. The main disadvantage of these deposits is their typically small size. In addition, pegmatite bodies almost invariably have steep dips and are vertically extensive but rarely more than a few tens of metres wide, making large-scale extraction difficult and costly.

World production of feldspar in 2004 was 11 Mt (Table 9) (Potter 2005). Coarse-grained granitoid intrusions are the main source of feldspar in the major producing countries (USA, Turkey, Germany and Italy).

Table 9. World feldspar production 2004

Country	Production (tonnes)
Italy	2 500 000
Turkey	1 900 000
USA	790 000
Thailand	780 000
France	670 000
Germany	500 000
Spain	500 000
Czech Republic	400 000
Republic of Korea	400 000
Egypt	350 000
Mexico	330 000
Poland	250 000
Other countries (including Australia)	1 599 000
Total	10 969 000

Source: Potter (2005)

These granitoids include: granite; leucocratic granite; aplite, alaskite; and albitised (Na-altered) granite.

Gravels and sands derived from granitic source areas can contain up to 35% feldspathic material. Deposits of this type occur in Italy, Spain, California and the Czech Republic (Harben & Kuřvart 1996).

Main Australian Deposits

Pegmatite deposits in Western Australia and New South Wales were the main source of feldspar in Australia until 1998, when Australian Consolidated Industries (ACI) opened a mine (now operated by Unimin Australia Ltd) in felsic granite near Beechworth in Victoria. Western Australia accounted

for over 90% of feldspar production until the Beechworth mine was opened (1998).

Production of feldspar in Australia has increased from just over 20 000 tpa in the early 1990s to approximately 50 000 tonnes in 2004 (Potter 2005).

New South Wales Occurrences

There are 154 recorded feldspar deposits in New South Wales (Ray et al. 2003). The state's production of feldspar comes primarily from pegmatite deposits in the Broken Hill area. New South Wales production in 2004 was about 4000 tonnes.

In the Broken Hill area, Unimin mines feldspar from the Lady Beryl mine and the dumps at the Triple Chance mine (formerly operated by Minerals Corporation Ltd). All of the ore is processed in a plant at the Triple Chance mine (Alexander 1997).

Pegmatite deposits are widespread within the Broken Hill Block (Lishmund 1982). These include some large deposits of intermixed pegmatite and leucocratic quartzofeldspathic rock up to 10 km long, several kilometres wide and containing, on average, approximately 60% feldspar (microcline and albite), and about 40% quartz, with a variety of accessory minerals, including tourmaline, garnet and muscovite.

There are also extensive albite-rich rocks (consisting essentially of sodium feldspar and quartz) within the Broken Hill Block. These rocks are a potential source of sodium feldspar, if the iron content, which is present mainly as pyrite and biotite, and averages about 0.3%, can be economically reduced to acceptable levels.

Small amounts of altered rhyolite are produced from a deposit at Lue, near Mudgee, for use as a feldspathic material in ceramic manufacture.

Feldspar has also been mined in the past from leucocratic granites at Brewongle (west of Bathurst), Hartley and Mount Blaxland (both near Lithgow); and aplitic/pegmatitic rocks, near Bombala, and at Bayly, northeast of Mudgee. Production from these deposits was small scale, sporadic and mostly occurred before the 1960s. Large deposits of feldspar have been identified near Oberon and at Goombargana, near Walbundry, northwest of Albury.

East of Oberon large resources of feldspar occur in the Rossdhu Granite, which has the composition of an 'alaskite', i.e. granite composed primarily of quartz and alkali feldspar. The Rossdhu Granite consists of quartz, feldspar and muscovite mica, with accessory garnet, magnetite, apatite, pyrite and zircon. The average total iron (FeO+Fe₂O₃) content of the rock is low (0.5–0.9%) and the total alkali (K₂O+Na₂O) content

is high (8.0–8.5%). The rock is similar in composition and mineralogy to the alaskite deposits mined in the Spruce Pine district of North Carolina, the largest single source of feldspar in the USA. Treatment studies have shown that in addition to yielding a feldspar product with an iron content of 0.05%, the Oberon deposit can yield flake muscovite and high-grade silica.

Goombargana west of Walbundry is an outcrop of Jindera Granite where a small feldspar quarry operated prior to 1949. The rock is very coarse-grained, with aplite dykes and minor pegmatite. The rock contains 70–75% feldspar, 15–25% quartz, 5–10% muscovite and up to 3% biotite. The average total iron (FeO+Fe₂O₃) and alkali (K₂O+Na₂O) contents of the granite are 1.57% and 9.1%, respectively. It is estimated that a potential resource in excess of 100 Mt of material suitable for production of glass- and ceramic-grade feldspar exists (Wallarrah Minerals Pty Ltd 1999).

Numerous granitic plutons with low iron and moderately high alkali contents that may contain economic deposits of feldspar occur in the Lachlan and New England orogens.

Applications

Feldspars and feldspathic materials are used as a source of alumina and alkalis in glass and ceramic manufacture (Photograph 6). The alumina retards devitrification of the finished product in glassmaking. In ceramics it provides durability and inertness. In both processes the alkalis act as a flux. Depending on the type of product, glass requires 8–18 % feldspar. Manufacture of ceramics requires significantly higher amounts, 25–35% for sanitary ware (bathroom fittings) and 10–55% for wall and floor tiles.

Glassmaking consumes about 60% of world feldspar production and about 30% is used in ceramics. Small amounts of feldspar are used as filler materials in paint, plastics and rubber; as additives in sealants and adhesives; and as mild abrasives.

Commercial feldspar for glassmaking should contain 5–7% Na₂O; 4–6% K₂O; about 19% Al₂O₃ with maximum 0.08% Fe₂O₃ and a grainsize of 0.5–1.0 mm (Harben 1999). Potassium feldspar is preferred for ceramic manufacture; and should contain: 5–14% K₂O; a maximum 0.07% Fe₂O₃; and have a grainsize less than 75 μm.

Economic Factors

The demand for feldspar is driven by the glass and ceramics industries, which in turn are linked to construction activity. Increasing living standards in developing countries, e.g. eastern Europe and China, are expected to increase the demand for sanitary ware,

whiteware, floor and wall tiles and flat glass (windows and windscreens for motor vehicles), and therefore increase the demand for feldspar. In contrast, demand for container glass is expected to decrease owing to increased use of PET, aluminium and paper containers and increased rates of glass recycling.

The ceramic tile plant at Rutherford, near Maitland, operated by National Ceramic Industries Australia, should provide opportunities for the further development of feldspar resources in New South Wales.

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