



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

This document is part of a larger publication and is subject to the disclaimers and copyright of the full version from which it was extracted. Information on purchasing the book, and details of other industrial minerals, as well as updates and copyright and other legal information can be found at:

<http://www.dpi.nsw.gov.au/minerals/geological/industrial-mineral-opportunities>

Potential and Outlook

The sillimanite group includes the metamorphic minerals sillimanite, kyanite and andalusite. Minimal exploration for sillimanite group minerals has been undertaken in New South Wales in recent years.

The Broken Hill and Euriowie Blocks (part of the Delamerian Orogen, Figure 1), in particular, are considered to have potential for large disseminated deposits of all three major sillimanite group minerals. Sillimanite group minerals are widespread in this area of high-grade metamorphic rocks (Figure 26). Detailed geological and metallogenic mapping of the Broken Hill Block and Euriowie Blocks (Barnes 1988; Burton 1994, 2000) and data produced in the *Discovery 2000* and *Exploration NSW* programs (Buckley et al. 2002) provide an essential basis for exploration. Historically, individual small pods of high-grade mineralisation were worked on a small scale in the Broken Hill region. Larger disseminated or possibly multi-commodity deposits may be viable in the future.

Other areas with the greatest potential for sillimanite group minerals of commercial interest are large thermal metamorphic aureoles developed in pelitic (high-alumina) rocks and areas of high-grade regional metamorphism of pelitic rocks. Areas suggested for examination are pelitic rocks around intrusions in the Lachlan Orogen (such as the Wuuluman Granite near Wellington, the Owendale Intrusive Complex and the Gulgong Granite) as well as metamorphic complexes (such as those near Cooma, Girilambone, Leadville and Captains Flat).

Nature and Occurrence

Sillimanite, kyanite and andalusite are polymorphs with the composition $Al_2O_3 \cdot SiO_2$. All three minerals are formed in metamorphic environments. They may be calcined to form mullite ($3Al_2O_3 \cdot 2SiO_2$), used mainly in the refractory industry.

Generally, sillimanite forms under high-temperature conditions, kyanite at high pressure, while andalusite develops in lower temperature and pressure environments.

World production of aluminosilicate ore (andalusite, sillimanite and kyanite) in 2004 was almost

350 000 tonnes (Table 37) (Potter 2005). South Africa has aluminosilicate ore reserves of 51 Mt and is the largest producer, with annual production of about 165 000 tonnes. Australian production, mainly from deposits in Western Australia, in 2004 was almost 1300 tonnes.

Table 37. World sillimanite group production 2004

Country	Mineral	Production (tonnes)
South Africa	Andalusite	165 000
	Sillimanite	
USA	Kyanite	90 000
France	Andalusite	65 000
India	Sillimanite	14 500
	Kyanite	
China	Unspecified	3 300
Spain	Andalusite	2 500
Australia (WA)	Kyanite	1 000
Zimbabwe	Kyanite	500
Australia (SA)	Sillimanite	300
Total		348 300

Source: adapted from Potter (2005)

Deposit Types

Harben and Kužvart (1996) have described the main environments of formation and major world occurrences of sillimanite group minerals, as follows:

1. Contact metamorphism, forming mainly andalusite and sillimanite

Andalusite

- Aktash, Uzbekistan
- White Mountain, USA
- Groot Marico district, South Africa.

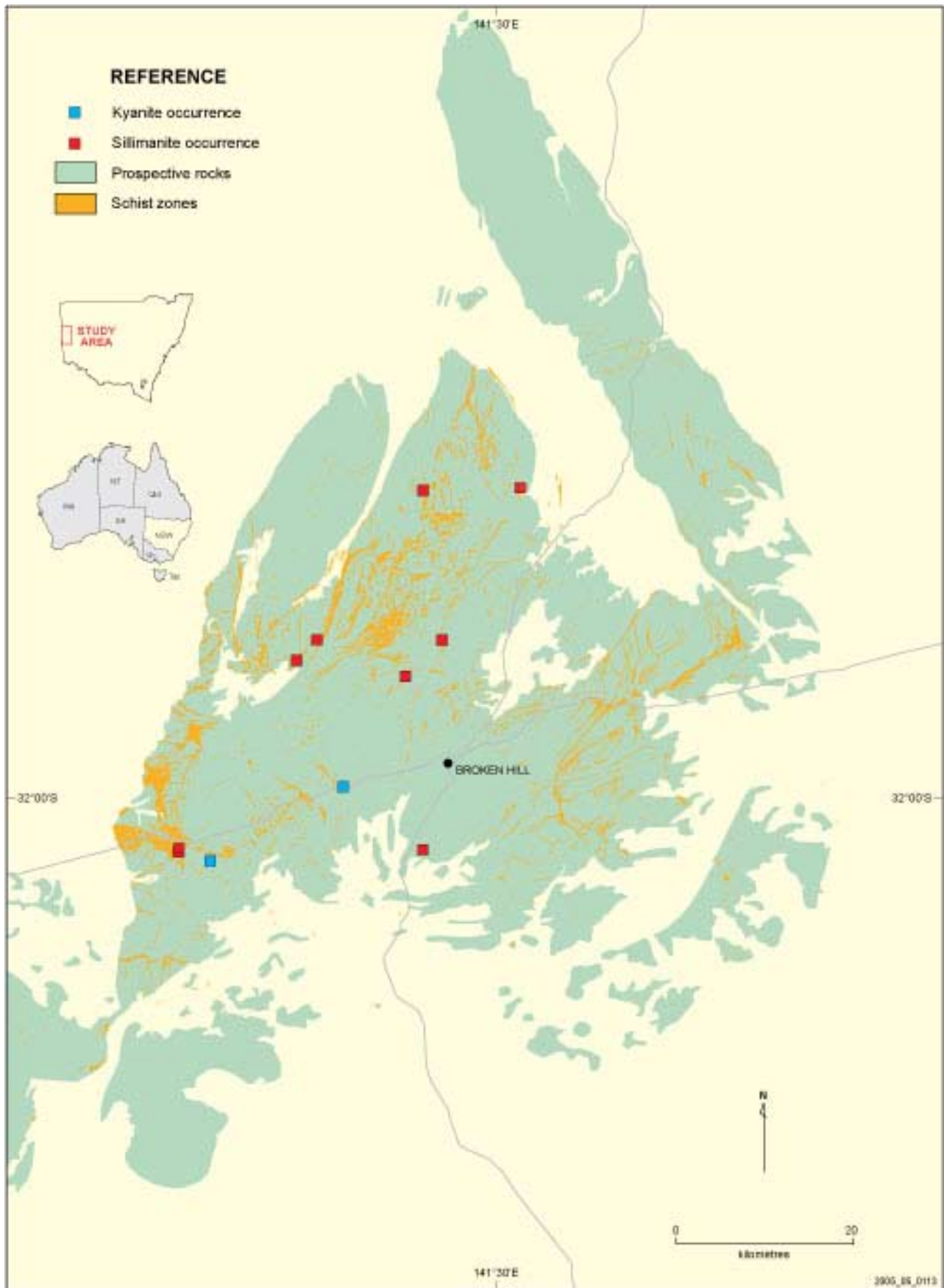


Figure 26. Sillimanite and kyanite occurrences in the Broken Hill area

Sillimanite

- Sonapahar, India
 - Cape Province, South Africa
 - Thackaringa, New South Wales
 - Mount Crawford, South Australia.
2. Regional metamorphism of alumina-rich clayey rocks, or bauxitic sedimentary rocks to form kyanite quartzite, kyanite schist and gneiss, massive kyanite, sillimanite schist or massive sillimanite

Kyanite

- Keiva, Kola Peninsula, Russia
- Baker Mountain, USA
- Lapsaburu, India
- Halfway Kop, Botswana; Liberia
- Uganda; Tanzania
- Angola.

Sillimanite

- Hart County, Georgia, USA
 - Bethanien district, Namibia.
3. Desilicified pegmatites, secondary quartzites or Al-metasomatites, quartz veins, and nearby metasomes

Andalusite, kyanite and dumortierite

- Semiz-Bugu deposit, Kazakhstan
 - Lapsaburu, India.
4. Placer or eluvial
- Boschland, Surinam
 - Andrelandia, Brazil
 - Eneabba, Western Australia.

Main Australian Deposits

The only operating sillimanite group deposit in Australia is the Mount Crawford mine in the Adelaidean Barossa Complex at Williamstown in South Australia. The deposit is composed of metasomatised muscovite and biotite–quartz schist, quartz–sillimanite gneiss, and sillimanite quartzite with accessory kyanite, rutile and garnet (Barnes 1990). Production from this mine has been around 70 tpa during the 1990s (Keeling 1999). Fine-grained kyanite has been produced as a by-product of mineral sands production at Eneabba in Western Australia (Harben & Kuřvart 1996).

New South Wales Occurrences

There are 10 recorded occurrences of sillimanite group minerals in the state. This includes eight sillimanite

occurrences and two kyanite occurrences. All are located in the Broken Hill area (Figure 26).

Sillimanite group minerals have been mined at several places in the Broken Hill Block (Stevens & Stroud 1983). These deposits have very small resources or are worked out. Sillimanite is widespread in middle to upper amphibolite and granulite facies pelitic rocks of the Palaeoproterozoic Willyama Supergroup. Six small sillimanite deposits have been worked, mainly in the 1960s and 1970s (Lishmund 1982). Kyanite occurs in retrograde metamorphic rocks usually associated with shear zones and derived mainly from sillimanite (Stevens & Stroud 1983). Only one kyanite deposit has been worked (Lishmund 1982). Andalusite usually occurs in lower-grade pelitic rocks in the northern part of the Broken Hill Block and the Euriowie Block.

Applications

About 90% of world consumption of sillimanite group minerals is used as refractory raw materials (Harben & Kuřvart 1996). When sillimanite group minerals are calcined they produce a mixture of highly refractory mullite ($3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$) and cristobalite. Sillimanite group refractories lie between the acid and basic refractory groups and are used in the metallurgical, particularly steel, industries and the glass industry (O'Driscoll 1999, 2002). Outside the refractory industry, applications include abrasives, ceramics and non-slip flooring.

Specifications for sillimanite group minerals relate largely to their refractory characteristics. The higher the alumina content, the higher their efficiency. Industry specifications generally refer to the alumina content, as well as impurities such as iron, titanium or alkalis. Grainsize specifications vary for different applications, the coarser grades for high-strength applications and finer-grade materials for refractory mortars and monolithics.

Economic Factors

In the refractories industry, the trend has been towards the use of higher-grade, longer-lasting refractories and the use of sillimanite group minerals in conjunction with such minerals as graphite, zircon and chromite. This trend has resulted in relatively steady production, influenced largely by the metallurgical industry and the general state of world economies.

References

- BARNES L.C. 1990. Williamstown kaolin–sillimanite–mica deposits. In: Knight C.L. ed. *Economic geology of Australia and Papua New Guinea*. 4. *Industrial minerals and rocks*, pp. 1163–1166. Australasian Institute of Mining and Metallurgy, Monograph 8.
- BARNES R.G. 1988. Metallogenic studies of the Broken Hill and Euriowie Blocks, New South Wales. Volume 1. Styles of mineralisation in the Broken Hill Block. Volume 2. Mineral deposits of the southwestern Broken Hill Block. *Geological Survey of New South Wales, Bulletin* 32 (1, 2).
- BUCKLEY P.M., MORIARTY T. & NEEDHAM J. (compilers) 2002. Broken Hill Geoscience Database. 2nd edition. Geological Survey of New South Wales, Sydney, CD-ROM.
- BURTON G.R. 1994. Metallogenic studies of the Broken Hill and Euriowie Blocks, New South Wales. Volume 3. Mineral deposits of the South-Eastern Broken Hill Block. *Geological Survey of New South Wales, Bulletin* 32 (3).
- BURTON G.R. 2000. Metallogenic studies of the Broken Hill and Euriowie Blocks, New South Wales. Mineral deposits of the Euriowie Block (including the northernmost Broken Hill Block and Poolamacca Inlier). *Geological Survey of New South Wales, Bulletin* 32 (4).
- HARBEN P.W. & KUŽVART M. 1996. *Industrial minerals: a global geology*. Industrial Minerals Information Ltd, London.
- KEELING J. 1999. Sillimanite, andalusite, kyanite. www.pir.sa.gov.au/pages/minerals/resources/commodity/sillimanite.htm
- LISHMUND S.R. 1982. Non-metallic and tin deposits of the Broken Hill district. *Geological Survey of New South Wales, Bulletin* 28.
- O'DRISCOLL M. 1999. Sillimanite minerals — refractory market slump takes its toll. *Industrial Minerals* 379, 89–95.
- O'DRISCOLL M. 2002. Irons in the fire — what's cooking with sillimanite minerals? *Industrial Minerals* 418, 37–45.
- POTTER M.J. 2005. Kyanite and related minerals. In: United States Geological Survey. compiler. *Mineral Commodity Summaries 2005*, pp. 92–93. United States Department of the Interior.
- STEVENS B.P.J. & STROUD W.J. eds. 1983. Rocks of the Broken Hill Block: their classification, nature, stratigraphic distribution and origin. *Geological Survey of New South Wales, Record* 21 (1).