COMMONWEALTH OF AUSTRALIA.
DEPARTMENT OF SUPPLY AND SHIPPING.
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MINERAL RESOURCES SURVEY.
H. G. RAGGATT, *Director*.

MINERAL RESOURCES OF AUSTRALIA.

SUMMARY REPORT No. 17.

ASBESTOS

Compiled in association with
The Controller of Minerals Production
and the Mines Departments of the States and Territories.

Compiled December, 1945, by L. C. NOAKES.
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SUMMARY REPORT No. 17.

ASBESTOS.

1. INTRODUCTION.

The term "asbestos" is a commercial rather than a mineralogical one and embraces the fibrous varieties of several minerals of the serpentine and the amphibole groups, which are characterized by highly developed prismatic cleavage allowing them to be readily separated into fibres or filaments.

TABLE I.

LIST OF ASBESTOS MINERALS.

Mineral Group.	Mineral.	Chemical Formula.	Composition.
Serpentine	Chrysotile ..	$3MgO.2SiO_2.2H_2O$ ..	Hydrated magnesium silicate
Amphibole	Crocidolite ..	$2NaFe(SiO_3)FeSiO_3$	Sodium-iron silicate
	Amosite ..	$(MgFe)O.SiO_2$ ..	Magnesium-iron silicate
	Anthophyllite	$(MgFe)O.SiO_2$ ..	Magnesium-iron silicate
	Tremolite ..	$CaO.3MgO.4SiO_2$ ..	Calcium-magnesium silicate
	Actinolite ..	$CaO.3(MgFe)O.4SiO_2$	Calcium-magnesium-iron silicate

The asbestos minerals are commonly found in narrow veins and occur usually in one of the following three forms:—

Cross fibre—the fibres are arranged at right angles to the vein walls; the fibre length is thereby limited to the vein width and is often less, due to a break, or parting, in the vein.

Slip fibre—the fibres lie in the same plane as the vein or slippage plane in which it is formed.

Mass fibre—formed as an aggregate of interlaced unoriented fibres, or as stellate groups of radiating fibres.

The commercial suitability of these minerals depends almost entirely on the length, tensile strength and flexibility of the fibres, although colour, impurities and degree of resistance to heat or acids are sometimes important. The fibrous minerals have a fairly wide distribution, but deposits containing fibre suitable for use in industry are comparatively rare.

Chrysotile is the most important of the asbestos minerals and is generally referred to commercially as "white" asbestos. It usually occurs in veins, ranging from a fraction of an inch to several inches in width, in serpentine—an alteration product of basic igneous rocks such as gabbro and peridotite or of sedimentary rocks rich in magnesium such as dolomite. The veins of chrysotile are generally short and may intersect one another at various angles to form a network, or lie in closely spaced parallel zones forming "ribbon structure". Chrysotile usually occurs as cross fibre, although slip fibre and mass fibre are also found. Massive chrysotile is usually some shade of green, but, when separated, the fibres are white. The better grades of chrysotile fibre are extremely fine and "silky" with high tensile strength and are particularly suitable for spinning.

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Crocidolite and Amosite are the most important of the amphibole asbestos minerals. Both are commonly found as interbedded cross-fibre veins in ferruginous slate or quartzite associated with dolomite.

Crocidolite is commercially the more important of the two, and is commonly known as "blue" asbestos from the blue colour, which is retained in the separated fibres. The fibres are, as a rule, of good length and flexibility, and the tensile strength is comparable with that of chrysotile.

Amosite is usually ash-grey in colour. The fibres are white on separation, pliable and often exceptionally long, though rather coarse in texture.

Anthophyllite is similar in chemical composition to amosite, but with less iron, and commonly occurs as slip or mass fibre. The colour is usually greyish white, but the fibres are white after separation. The fibres are generally brittle and weak, although deposits are known from which fibres possessing considerable strength and toughness have been produced.

Tremolite occurs in white to dark grey columnar crystals. The fibres are usually brittle and weak, but are highly resistant to acids.

Actinolite is similar in chemical composition to tremolite, but with iron replacing portion of the magnesium content. It is usually bright green or greyish-green in colour. The fibres are brittle, but have high heat resistance.

Anthophyllite, tremolite and actinolite commonly occur as slip fibre along foliation zones or shears in metamorphic rocks, although veins of cross-fibre tremolite or actinolite occur in serpentine. Anthophyllite also occurs as fibrous lenticular masses in gneissic or schistose rocks.

Asbestos is important in international trade, because, with the exception of Russia, the major consumers such as England and the United States of America, have very inadequate domestic supplies. With the exception of those in Russia, most of the other large producing deposits lie within the British Empire. Recent world production figures are not available, but the following tonnages* are given for recent years. Australian production for 1944 is added for comparison :—

TABLE II.

ASBESTOS PRODUCTION BY COUNTRIES.

Country.	Production of Asbestos, All Types.
	Tons.
Canada (1944)	333,009
Union of Soviet Socialist Republics (1938)	84,641
Southern Rhodesia (1939)	52,064
Union of South Africa (1940)	24,456
United States of America (1941) ..	21,777
Swaziland (1940)	18,575
Cyprus (1940)	9,499
Italy (1938)	6,752
Japan (1940)	984
Australia (1944)	764

* All tonnages given in this report are expressed as long tons (2,240 lb.).

2. U

The unique variety of properti
make it an essential raw material
Asbestos withstands fire and insulate
in weight and can be made into pli
by soil and the attack of vermin.
are developed varies considerably
and also according to the grade,
specific applications in industry.

Chrysotile has by far the wide
about 90 per cent. of the asbestos
chrysotile is spun into yarn from wh
are woven for use in the manufactur
curtains, insulating mats, fire-proof s
is also manufactured into asbestos
longer fibre is used in the manufac
fillings for mattresses and for magnes
85 per cent. magnesia and 15 per cent

Medium-length fibre is extensively
agent in cement products, in plaster
articles. The major consumption of
industry in the manufacture of wal
asbestos products for building, and i
cement pipes are extensively used for
of their superior resistance to corrosi
processed with rubber to make sheet
linings. Similar length fibres are us
lagging and pipe coverings.

Shorter fibres are utilized in the
which is used in the production of boi
switchboard materials, &c. The devel
and clutch facing made from heavy p
created additional demands for the sh

Waste, "shorts" and plaster grad
of asbestos lagging which is widely
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moulded synthetic resin products and

Crocidolite also has a wide range o
used as chrysotile, due largely to i
spinning qualities. On the other ha
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has its own specific uses such as in
coverings for mercantile use, in acid res
military equipment. The use of crocid
in Australia at least, is increasing.

South African crocidolite has fou
been used in the manufacture of asb
packings and millboard; in preparatio
in asbestos products for building.

Amosite fibre is inferior in strength
crocidolite but commonly occurs in very
use in industry, mainly in the manuf
weight insulation and in asbestos-ce

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2. USES.

The unique variety of properties possessed by asbestos combine to make it an essential raw material in certain branches of industry. Asbestos withstands fire and insulates against heat and sound; it is light in weight and can be made into pliable fabrics and it resists corrosion by soil and the attack of vermin. The degree to which these properties are developed varies considerably with the various types of asbestos and also according to the grade, so that each type and grade has specific applications in industry.

Chrysotile has by far the widest range of uses and constitutes about 90 per cent. of the asbestos consumed. Much of the long-fibre chrysotile is spun into yarn from which fabrics such as cloth and tape are woven for use in the manufacture of brake linings, gaskets, theatre curtains, insulating mats, fire-proof suits, aprons and gloves, &c. Yarn is also manufactured into asbestos thread and rope. Portion of the longer fibre is used in the manufacture of wick and rope packings, fillings for mattresses and for magnesia block insulation, which contains 85 per cent. magnesia and 15 per cent. asbestos.

Medium-length fibre is extensively used as a binding and reinforcing agent in cement products, in plasters and in asphaltic and moulded articles. The major consumption of chrysotile is in the asbestos-cement industry in the manufacture of wallboards, shingles, tiles and other asbestos products for building, and in piping and conduit. Asbestos-cement pipes are extensively used for gas and water mains on account of their superior resistance to corrosion. Medium-length fibre is also processed with rubber to make sheet packings, jointing and some brake linings. Similar length fibres are used in the manufacture of boiler lagging and pipe coverings.

Shorter fibres are utilized in the manufacture of asbestos paper which is used in the production of boiler and pipe coverings, insulating switchboard materials, &c. The development of moulded brake lining and clutch facing made from heavy paper of the millboard variety has created additional demands for the shorter fibres.

Waste, "shorts" and plaster grades are used in the manufacture of asbestos lagging which is widely used for boiler insulation, as a filler in paints and greases and in other compositions such as cold-moulded synthetic resin products and types of flooring material.

Crocidolite also has a wide range of uses, but it is not as extensively used as chrysotile, due largely to its colour and slightly inferior spinning qualities. On the other hand, it is held to be superior to chrysotile in resistance to acids, alkalies and sea-water and, therefore, has its own specific uses such as in flexible boiler and steam pipe coverings for mercantile use, in acid resistant packings and in specialized military equipment. The use of crocidolite in asbestos-cement products, in Australia at least, is increasing.

South African crocidolite has found a wide application and has been used in the manufacture of asbestos cloth, rope and yarn; in packings and millboard; in preparations for electrical insulation; and in asbestos products for building.

Amosite fibre is inferior in strength and flexibility to chrysotile and crocidolite but commonly occurs in very long fibres. It has a restricted use in industry, mainly in the manufacture of special types of light-weight insulation and in asbestos-cement products in which it is

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olended with chrysotile. However, the producers of amosite in South Africa, which is the only known source of the mineral, have demonstrated that amosite can be used satisfactorily in the manufacture of a wide range of asbestos products.

Anthophyllite has a very restricted use in industry, because the fibres are brittle and weak. It is used to some extent in the manufacture of paints, cements and boiler lagging, and has recently been used in America in welding rod coatings.

Tremolite and Actinolite fibres are weak and have few industrial uses. Both types have been used as filler in paints and in the manufacture of filter pads for the liquor industry.

3. INDUSTRY IN AUSTRALIA.

The principal producers of chrysotile asbestos in Australia are Asbestos Mines Pty. Ltd., operating at Baryulgil, New South Wales, and Tasmanian Asbestos Pty. Ltd., at Zeehan, Tasmania. The principal producers of crocidolite are Australian Blue Asbestos Ltd. and West Australian Blue Asbestos Fibres Co. Ltd., both of which operate in the Hamersley Ranges, Western Australia. Tasmanian Asbestos Pty. Ltd. and Australian Blue Asbestos Ltd. are both subsidiaries of the Colonial Sugar Refining Co. Ltd. Asbestos Mines Pty. Ltd. is a subsidiary of both James Hardie and Co. Pty. Ltd., and Messrs. Wunderlich Ltd. of Sydney.

In addition to the above, chrysotile is produced by syndicates operating on the Pilbara Goldfield, Western Australia, and amphibole asbestos by individual producers in several States.

Where production is large, asbestos is usually mined, cleaned and graded at the mine. Long fibres, usually ¾ in. or longer, are treated by hand-dressing or cobbing, a process in which the fibre is flattened out and freed from the rock by means of a hammer. If the fibre so obtained conforms to standard lengths, it is sold as crude, but, if ungraded, it is sold as run-of-mine crude.

Asbestos ore not dealt with by hand-dressing is treated in a mill which involves, in general, preliminary crushing in jaw breakers and rolls, followed by treatment in a succession of mills and screens which separate the fibres into various lengths. The final separation of the shortest fibres from waste is usually carried out in a trommel.

The grading of asbestos in Australia has not been standardized, with the result that care must be exercised in comparing graded products from different sources. Comparison by grade of Australian with imported asbestos is even more confusing, as both Canada and South Africa, the two principal suppliers, have their own grading systems.

The standard method of classifying fibre adopted in Canada is given hereunder (Ross, 1931). The equipment used to grade asbestos is known as the standard testing machine. It consists of a nest of four boxes placed one above the other, three of which contain metal screens. The uppermost box, No. 1, carries a screen with half-inch openings, No. 2 box carries a four-mesh screen, No. 3 box a ten-mesh screen and No. 4 box, at the bottom, serves as a tray. The nest of boxes is attached to a machine which induces horizontal shaking at a uniform rate by means of an eccentric drive.

The grade of milled fibre is determined by placing a 16-oz. sample of the fibre in the uppermost box and shaking the boxes at a uniform speed for exactly two minutes. The fibre remaining in each box is then weighed and

the grade expressed by the four fi
0–5–10–1 contains 5/16 or 31 per c
in length, 10/16 or 62 per cent. of fib
and 1/16 or 7 per cent. of fibre less th

These grades are arranged into
adopted by Rhodesia, South Africa, R
the Canadian grading system shown h

TABL

GRADING OF CRUDE

Class.	Standard Designation of Grade.
Group No. 1	Crude No. 1 .. ..
Group No. 2	Crude No. 2 .. ..
	Crude Run-of-Mine ..
	Crudes sundry .. ..
Group No. 3	Spinning or textile fibre ..
Group No. 4	Shingle fibre .. ..
Group No. 5	Paper fibre .. ..
Group No. 6	Waste, stucco or plaster ..
Group No. 7	Refuse or shorts ..
Group No. 8	Sand .. .. ..
Group No. 9	Gravel and stone ..

Each of the groups 3 to 9 in the first colu
Groups 3 to 5 are divided into grades D, F
fibre length. Group 6 is divided into g
divided into grades D, F, H, K, M, and for
weight in *lb. per cubic foot* (e.g. 7–20).
also expressed in the latter way. Exam
commonly imported into Australia, namely

4K which contains fibre testing not
7D which contains fibre testing not
7F which contains fibre testing not

Chrysotile produced by syndicates
field in Western Australia is graded a

Tops — ¼ inch and upwards
Seconds — ½ inch to ¾ inch.
Thirds — ¼ inch to ½ inch.
Fourths — ⅛ inch to ¼ inch.

Crocidolite is graded *differently*, m
a greater proportion of long fibre. C
Blue Asbestos Ltd. in the Hamersley
distributed in the following grades:—

No. 1 Grade—Average 1½ inch a
No. 2 Grade—Average ¾ inch.
No. 3 Grade—Average ⅜ inch.
No. 4 Grade—Below ⅜ inch.

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the grade expressed by the four figures so obtained. Thus, fibre grading 0–5–10–1 contains 5/16 or 31 per cent. of fibre between ¼ inch and ½ inch in length, 10/16 or 62 per cent. of fibre between 1/16 inch and ¼ inch in length and 1/16 or 7 per cent. of fibre less than 1/16 inch long.

These grades are arranged into nine groups which conform with those adopted by Rhodesia, South Africa, Russia and Italy. These groups appear in the Canadian grading system shown below—

TABLE III.

GRADING OF CRUDE ASBESTOS IN CANADA.

Class.	Standard Designation of Grade.	Description.
Group No. 1	Crude No. 1	Crude fibre ¾ inch and longer
Group No. 2	Crude No. 2	Crude fibre ¼ inch up to ¾ inch
	Crude Run-of-Mine ..	Unsorted crudes
	Crudes sundry	Crudes other than above
Group No. 3	Spinning or textile fibre ..	Fibres testing 0–8–6–2 and over
Group No. 4	Shingle fibre	Fibre testing below 0–8–6–2 to and including 0–1¼–9½–5
Group No. 5	Paper fibre	Fibre testing below 0–1¼–9½–5 to and including 0–0–8–8
Group No. 6	Waste, stucco or plaster ..	Material testing below 0–0–8–8 to and including 0–0–5–11
Group No. 7	Refuse or shorts ..	Material testing 0–0–5–11 and below and including material weighing 35 lb. or less per cubic foot loose measure
Group No. 8	Sand	Mill products weighing 35–75 lb. per cubic foot loose measure with preponderance of rock
Group No. 9	Gravel and stone ..	Mill products weighing 75 lb. and over per cubic foot loose measure

Each of the groups 3 to 9 in the first column of Table III. is divided into grades. Groups 3 to 5 are divided into grades D, F, K, M, R, T, Z in order of decreasing fibre length. Group 6 is divided into grades GD and GF only. Group 7 is divided into grades D, F, H, K, M, and for shorter lengths into grades expressing weight in lb. per cubic foot (e.g. 7–20). The grades in groups 8 and 9 are also expressed in the latter way. Examples of the grading given are those commonly imported into Australia, namely—

4K which contains fibre testing not lower than 0–4–9–3.
7D which contains fibre testing not lower than 0–0–5–11.
7F which contains fibre testing not lower than 0–0–4–12.

Chrysotile produced by syndicates operating on the Pilbara Goldfield in Western Australia is graded as follows:—

Tops — ¾ inch and upwards.
Seconds — ½ inch to ¾ inch.
Thirds — ¼ inch to ½ inch.
Fourths — ⅛ inch to ¼ inch.

Crocidolite is graded differently, mainly because the deposits yield a greater proportion of long fibre. Crocidolite milled by Australian Blue Asbestos Ltd. in the Hamersley Ranges, Western Australia, is distributed in the following grades:—

No. 1 Grade—Average 1½ inch at least. All above 1 inch.
No. 2 Grade—Average ¾ inch. All above ½ inch.
No. 3 Grade—Average ⅜ inch. All above ¼ inch.
No. 4 Grade—Below ¼ inch.

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West Australian Blue Asbestos Fibres Co. Ltd. follows the same grading, but does not produce grade 4.

From the consumers' viewpoint, it is essential that fibre sold in grades be clean and conform to the specifications of the grade.

The principal users of chrysotile and crocidolite in Australia are the manufacturers of asbestos-cement products. The principal manufacturers, who are also producers of crude asbestos, are James Hardie and Co. Pty. Ltd., Messrs. Wunderlich Ltd. and Asbestos Products Pty. Ltd. (a subsidiary of the Colonial Sugar Refining Co. Ltd.). There are nine factories producing asbestos-cement products, three in New South Wales, two in Victoria, two in Queensland, one in South Australia and one in Western Australia.

In 1944, only 5 per cent. of the total asbestos consumed in Australia came from domestic sources, the remainder being supplied by imports. The position improved slightly in 1945, and further improvement is expected in 1946. Considerable investigation has been carried on by the principal manufacturers with the object of determining the practicability of using Australian crocidolite in the manufacture of asbestos-cement products required by the building trades. As a result, asbestos-cement products, which contain crocidolite, are being manufactured in Australia, and it is considered that both the range and number of products in which crocidolite is incorporated are likely to increase.

It appears that the use of crocidolite up to 20, or perhaps 25, per cent. of the total amount of asbestos fibre used in asbestos-cement products may be feasible. Some time must elapse before this opinion can be confirmed and of course the price of domestic versus imported fibre has always to be considered.

There are no known deposits of amosite in Australia. The small quantities imported from South Africa are used in insulating composition and in asbestos boiler compounds.

Australian Asbestos Pty. Ltd. is producing asbestos yarn in Australia, but no cloth is woven at present, although at least one firm has indicated its intention to produce asbestos cloth and woven products in the near future.

Twisted and plaited asbestos rope and twisted cord are produced by Australian Asbestos Pty. Ltd., Tucks Asbestos Ltd. and Biturine Lavers Ltd.

Australian Asbestos Pty. Ltd. and Tucks Asbestos Ltd. also manufacture asbestos blankets, suits, aprons and gloves, &c.

Asbestos packings, jointing, boiler lagging, insulation material and other asbestos products are manufactured by a number of firms.

A dissection of the Australian consumption of asbestos is given in Section 8 of this report.

4. BUYERS AND PRICES.

In 1944 the major consumers of asbestos in Australia produced approximately 75 per cent. of the total Australian production. The remaining 25 per cent. was distributed to firms using smaller quantities of asbestos by agents or by rock-milling firms such as McLeod and Co. Ltd., Sydney; Minerals Pty. Ltd., Sydney; Minerals (Vic.) Pty. Ltd., Melbourne; and S. N. Rodda P
the Pilbara Goldfield, Western A
and Co. of Roebourne, and cro
apart from that mined by Austr
and handled by West Australia
Perth.

The price of crude asbestos
general, price increases with fibre
to long spinning fibre. Present
higher than those ruling befor
recently, it may be as well for pr

The following are the approx
ton delivered to Australian ma

Chrysotile.—The cost of Can
approximately £29 10s. per ton at
grade 7D, from the same source,
Rhodesian chrysotile cost £51 per
grade 4. In 1939, however, the
was approximately £23 12s. per t
3 and 4, cost approximately £35 a

The cost of Australian chryso
in 1943-1945 ranged from approxi
or short fibre, to £238 per ton for
difference in grading, it is difficul
and domestic asbestos, but there a
the cost of imported and domestic

Crocidolite.—The price of No. 3
at £45 c.i.f. Melbourne or Sydney
f.o.b. Fremantle.

Amosite.—The cost of South A
in 1943, was quoted as £39 per to
Amosite of the same grade cost app

Other Amphiboles.—The price
varies with type and quality. Figur
State Mines Departments indicate th
asbestos, principally anthophyllite f
at £9 to £12 per ton.

5. AUSTRALIA

In this section the asbestos mine
as chrysotile, crocidolite and amphib

The most important deposits of cl
Wales, Tasmania and Western Au
production from 1899 to 1944 inclusi

Deposits of crocidolite occur in S
tralia, but those in Western Australi
The total Australian production fr
1,736 tons.

Amphibole asbestos has been pr
ticularly in New South Wales, but the
1880 to 1944 inclusive was only 32

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Melbourne; and S. N. Rodda Pty. Ltd., Melbourne. Chrysotile from the Pilbara Goldfield, Western Australia, is handled by L. G. Hancock and Co. of Roebourne, and crocidolite from the Hamersley Ranges, apart from that mined by Australian Blue Asbestos Ltd., is produced and handled by West Australian Blue Asbestos Fibres Co. Ltd. of Perth.

The price of crude asbestos varies with the type and grade. In general, price increases with fibre length from waste and plaster grades to long spinning fibre. Present prices of imported asbestos fibre are higher than those ruling before the war. As prices have fallen recently, it may be as well for producers to keep 1939 figures in mind.

The following are the approximate costs of asbestos fibre per long ton delivered to Australian manufacturing plants:—

Chrysotile.—The cost of Canadian shingle fibre, grade 4K, was approximately £29 10s. per ton at the end of 1945 and refuse or shorts, grade 7D, from the same source, cost £17 10s. per ton. At this time, Rhodesian chrysotile cost £51 per ton for grade 3, and £36 per ton for grade 4. In 1939, however, the cost of Canadian shingle grade 4K was approximately £23 12s. per ton and Rhodesian chrysotile, grades 3 and 4, cost approximately £35 and £23 per ton respectively.

The cost of Australian chrysotile delivered to Australian plants in 1943-1945 ranged from approximately £30 per ton for fourth grade, or short fibre, to £238 per ton for first-grade long fibre. Owing to the difference in grading, it is difficult to compare the prices of imported and domestic asbestos, but there appears to be little difference between the cost of imported and domestic short and shingle grades.

Crocidolite.—The price of No. 3 grade (Australian origin) is quoted at £45 c.i.f. Melbourne or Sydney and of No. 1 grade £80 per ton f.o.b. Fremantle.

Amosite.—The cost of South African amosite, landed in Australia in 1943, was quoted as £39 per ton for the highest grade imported. Amosite of the same grade cost approximately £29 per ton in 1939.

Other Amphiboles.—The price of Australian amphibole asbestos varies with type and quality. Figures given in the annual reports of the State Mines Departments indicate that during 1942 and 1943 amphibole asbestos, principally anthophyllite from Western Australia, was valued at £9 to £12 per ton.

5. AUSTRALIAN SOURCES.

In this section the asbestos minerals will be treated in three groups as chrysotile, crocidolite and amphibole asbestos.

The most important deposits of chrysotile asbestos are in New South Wales, Tasmania and Western Australia, and the total Australian production from 1899 to 1944 inclusive was 6,380 tons.

Deposits of crocidolite occur in South Australia and Western Australia, but those in Western Australia are by far the more important. The total Australian production from 1915 to 1944 inclusive was 1,736 tons.

Amphibole asbestos has been produced in every State and particularly in New South Wales, but the total Australian production from 1890 to 1944 inclusive was only 329 tons.

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A. Queensland.

Asbestos minerals have been recorded from numerous localities, but no deposits of commercial significance have been discovered. Most of the occurrences are associated with serpentine which occurs at intervals near the coast from Brisbane to Bowen.

The most important belt lies in the *Rockhampton* district and extends from Keppel Bay north-west to Marlborough. Both chrysotile and amphibole asbestos have been recorded, but the chrysotile fibre so far examined is very short and the amphibole asbestos (anthophyllite) is relatively deficient in tensile strength and flexibility. Anthophyllite has been found in serpentine at Canoona, 40 miles north of Rockhampton, but tests by consumers indicate that the fibre is too weak for industrial use.

Chrysotile and amphibole asbestos (anthophyllite) have been found in the *Kilkivan* serpentine belt, which, though of less extent than that of Rockhampton, is considered to be not without promise.

Chrysotile has also been reported in serpentine in the *Clermont* district.

B. New South Wales.

Both chrysotile and amphibole asbestos have been produced in New South Wales.

(i) Chrysotile.

Chrysotile was first produced in 1918, but production ceased in 1923, to be revived in 1931 and again in 1942. Production totalled 3,343 tons to the end of 1944.

The commercial deposits and numerous other occurrences are associated with serpentine or ultrabasic rocks. These rocks occur in three main groups and comprise the Gordonbrook belt on the Clarence River, north-eastern New South Wales; the Great Serpentine belt, which runs through Barraba, about 200 miles north-north-west of Newcastle; and the Gundagai-Wallendbeen belt, 200 miles west-south-west of Sydney. In addition, serpentine outcrops in the Orange district and near Broken Hill.

Baryulgil.—Baryulgil is a small village situated 52 miles by road north-west from Grafton. The chrysotile deposit occurs in serpentine, which is part of the Gordonbrook belt, half a mile north-west of Baryulgil Post Office. It was first developed during the 1914-1918 war, but there is no record of production from this centre prior to 1942. In 1940, Messrs. Wunderlich Ltd. commenced further development of the deposit and in 1942 produced 105 tons of fibre. Milling plant was installed in 1943 and production of fibre was increased to 405 tons in 1943, 347 tons in 1944, and 254 tons in 1945. In 1944, Messrs. Wunderlich Ltd. and Messrs. James Hardie and Co. Pty. Ltd. formed a new company to work this deposit (Asbestos Mines Pty. Ltd.) and a development programme is now being carried on.

The chrysotile occurs in a stockwork of veins up to 1 inch or more in width and is mined by opencut. In 1943, the maximum depth reached in the workings was approximately 45 feet.

Chrysotile has also been reported 2 miles south of Baryulgil.

Wood's Reef.—Wood's Reef is in the Great Serpentine belt, but after 2,478 tons of chrysoti as the cost of production was too imported from South Africa.

Chrysotile occurs in steeply i derived from peridotite. Vein 1½ inches, and the bulk of fibre Milling rock was extracted fro 70 feet, and constituted slightly l tion of fibre from milling rock milled and graded on the propert for the manufacture of buildin fibre remaining is, however, rep for the manufacture of asbestos-c

Broken Hill.—Red Hill is a district and lies ½ mile south o of Broken Hill. Chrysotile was d towards the end of last century, b same serpentine, proved more attr asbestos were produced, but no fi chrysotile occurs in veins near the Red Hill is formed, but the fibre by metamorphism.

Serpentine occurs in other loca small masses, sills or dykes—the l by 200 feet wide. Chrysotile is localities, namely, Rockwell Pad Broken Hill, where a little prospec

The information available sug such as were produced in 1931, co favorable exposures, large commerc

(ii) Amphibole.

Production of amphibole asbest mittent, and only 203 tons have beer

Orange.—In the Orange dist asbestos (probably tremolite) have south-east of Orange, and from Lev town. Production commenced in 1 with a total production of 131 tons production of 213 tons of tremolite s in 1942.

Rockley.—At Rockley, 18 mil asbestos was produced in 1942, but tremolite variety and is found in ass has low tensile strength and has litt although a small amount of fibre of in the production of powder for use

Gundagai.—Amphibole asbestos Jones Creek, 3 miles north-west of G 1918, this deposit was the only sou was worked intermittently between

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Wood's Reef.—Wood's Reef is situated 12 miles east of Barraba and is in the Great Serpentine belt. Production was commenced in 1918, but after 2,478 tons of chrysotile had been extracted, ceased in 1923, as the cost of production was too high, compared with the price of fibre imported from South Africa.

Chrysotile occurs in steeply inclined cross-fibre veins in serpentine derived from peridotite. Vein width was recorded as not more than 1½ inches, and the bulk of fibre treated as not more than ¾ inch long. Milling rock was extracted from quarries, to a maximum depth of 70 feet, and constituted slightly less than half the rock mined. Extraction of fibre from milling rock averaged 5 per cent. The fibre was milled and graded on the property and, for the most part, was suitable for the manufacture of building materials (Raggatt, 1924). The fibre remaining is, however, reported to be below the grade desired for the manufacture of asbestos-cement products.

Broken Hill.—Red Hill is a prominent feature in the Broken Hill district and lies ½ mile south of the Menindie Road, 10 miles east of Broken Hill. Chrysotile was discovered and prospected at Red Hill towards the end of last century, but deposits of platinum, found in the same serpentine, proved more attractive. In 1931, 8 tons of chrysotile asbestos were produced, but no further production has resulted. The chrysotile occurs in veins near the edges of the serpentine boss of which Red Hill is formed, but the fibre has been rendered strong and hard by metamorphism.

Serpentine occurs in other localities in the Broken Hill district as small masses, sills or dykes—the largest not exceeding 2,640 feet long by 200 feet wide. Chrysotile is recorded from at least one of these localities, namely, Rockwell Paddock, about 15 miles south-west of Broken Hill, where a little prospecting was done prior to 1914.

The information available suggests that although small tonnages, such as were produced in 1931, could probably be won from the most favorable exposures, large commercial production is not likely to result.

(ii) Amphibole.

Production of amphibole asbestos began in 1880 but has been intermittent, and only 203 tons have been produced to the end of 1944.

Orange.—In the Orange district, small amounts of amphibole asbestos (probably tremolite) have been produced from Byng, 10 miles south-east of Orange, and from Lewis Ponds, 9 miles east of the same town. Production commenced in 1919 and has continued sporadically, with a total production of 131 tons to the end of 1942. In addition, the production of 213 tons of tremolite schist was recorded from this locality in 1942.

Rockley.—At Rockley, 18 miles south of Bathurst, amphibole asbestos was produced in 1942, but was not sold. The asbestos is the tremolite variety and is found in association with serpentine. The fibre has low tensile strength and has little, if any, application in industry, although a small amount of fibre of similar quality was used in 1943 in the production of powder for use in munitions work.

Gundagai.—Amphibole asbestos (actinolite) occurs in serpentine at Jones Creek, 3 miles north-west of Gundagai railway station. Prior to 1918, this deposit was the only source of asbestos in the State, and was worked intermittently between 1880 and 1921, when production

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ceased, for a total of 72.4 tons of fibre. At Jones Creek, the asbestos occurs as cross- and slip-fibre veins and pockets in serpentine derived from peridotite. The mineral varies in colour from white to pale or bluish green, some fibres being vitreous and brittle, others soft like felt. The white variety is noted as generally superior to other varieties, but all have little tensile strength and are probably suitable only for such uses as the manufacture of boiler lagging. A maximum fibre length of over 2 feet has been recorded from this locality.

Major production from this area is unlikely, although small amounts of actinolite could probably be won. Prospecting might reveal other types of asbestos.

C. Victoria.

No asbestos has been produced in Victoria, and no deposit of commercial importance is known.

D. Tasmania.

Both chrysotile and amphibole asbestos have been produced in Tasmania where both varieties are everywhere associated with serpentine.

Asbestos production in Tasmania prior to 1918, is recorded as the quantity of crude ore and not as the quantity of fibre produced. To obtain the complete figures given below, the quantity of fibre produced prior to 1918 has been estimated as 10 per cent. of the ore treated.

(i) Chrysotile.

Chrysotile has been produced during the periods 1899-1901, 1916-1919, and again since 1941. The total production to the end of 1944 was 534 tons. Of this, 365 tons were produced between 1916 and 1919 when Australian asbestos was in high demand. Deposits are associated with serpentinized ultrabasic rocks in three localities: Anderson's Creek in the Beaconsfield district, the Zeehan-Renison Bell area, and at Asbestos Point in Macquarie Harbour.

Anderson's Creek.—This locality, 2.5 miles west of Beaconsfield and 25 miles north-west of Launceston, has been the principal producing centre for chrysotile, with a total of 402 tons. Chrysotile was first worked in 1899, but major production commenced in 1917 when the first asbestos mill in Australia was erected in the area. Production proved too costly, however, and ceased in 1919, when the mill was removed to Barraba, New South Wales. Attempts have since been made to revive the industry, but the deposits apparently afford insufficient concentration of fibre.

Chrysotile occurs in a belt of serpentinized peridotite and pyroxenite about 5 miles long by a mile wide, into which small dykes of granitized rock have been intruded (Reid, 1919). Veins of chrysotile occur throughout the serpentine, but show preference for those areas where alteration of the peridotite is most complete, and for those in proximity to granitoid dykes.

The mineral usually occurs as white or pale-green cross fibre, $\frac{1}{8}$ inch to $\frac{3}{4}$ inch long, and grades from stiff vitreous material to fine silky fibre. Veins vary in width from threads to several inches and do not usually show parting, so that vein width equals fibre length. Slip fibre is also found, but is commonly associated with quantities of magnetite. The bulk of fibre produced was $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in length and was reported

to have satisfactory strength and
a variety of serpentine with inc
cipal minerals associated with the

Production figures from the
indicate that of all rock quarried,
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Although small parcels of hig
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examined.

Zeehan-Renison Bell Area.—
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The main group of deposits is
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Production in 1944 was 103 tons of

The other chrysotile-bearing loc
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Asbestos Point.—Asbestos Poi
south-western shore of Macquarie H
Strahan. A long narrow dyke of
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small area half a mile to the south.

Chrysotile occurs mainly in cros
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solid material is pale yellow, but
quality white fibre. Long slip fibre
the quantity available is relatively sm
possibly 20 tons, was extracted by

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to have satisfactory strength and flexibility. Magnesite and picrolite, a variety of serpentine with incipient fibrous structure, are the principal minerals associated with the chrysotile.

Production figures from the principal workings during 1917-1919 indicate that of all rock quarried, only 8.15 per cent. was milled, and it yielded 10 per cent. of fibre. Thus recoverable fibre constituted only 0.82 per cent. of rock mined, with a correspondingly high cost of production.

Although small parcels of high-grade fibre may be produced from this area, it does not seem likely that large-scale production could be profitably resumed. Available records suggest that areas of unprospected serpentine exist, but any new deposits would need to have a considerably higher content of chrysotile than those which have been examined.

Zeehan-Renison Bell Area.—Deposits of chrysotile are known to occur at two localities within a belt of serpentine situated about 5 miles east of Zeehan. Both areas are held by Tasmanian Asbestos Pty. Ltd.

The main group of deposits is situated about 5 miles north-east of Zeehan near the southern end of the Renison Bell tunnel on the Emu Bay railway line. A fibre-extraction plant was installed here in 1942 and to the end of September, 1945, a total of 363 tons of fibre had been produced. The asbestos is associated with pyroxenite which forms dyke-like bodies within the main serpentine mass. Chrysotile mineralization in the pyroxenite bodies and in the adjacent serpentine is irregular, and in some places is limited to the walls or is lacking altogether. Several of these pyroxenite bodies outcrop on the lease. Four of the most promising deposits have been developed by underground openings and by opencuts; surface indications elsewhere on the lease are poor. Ore has been won from several opencuts and from the underground developmental openings. Barren and low-grade material is rejected at the mine. The overall grade of the ore bodies is low. Production in 1944 was 103 tons of fibre, and in 1945, 276 tons.

The other chrysotile-bearing locality is situated 2 miles east of the above group on a northerly spur of Mount Razorback. The same association of fibre with pyroxenite is apparent. An adit has been driven across the fibre-bearing zone and the grade of the ore appears to be low.

Asbestos Point.—Asbestos Point lies west of Birch Inlet on the south-western shore of Macquarie Harbour, and is reached by boat from Strahan. A long narrow dyke of partly serpentinized pyroxenite, up to 300 feet wide, forms Asbestos Point itself and can be traced along a southerly strike for at least half a mile. Veins of chrysotile have been prospected in pits and costeans along the exposed length of the dyke, but the best concentrations of fibre occur on Asbestos Point and over a small area half a mile to the south.

Chrysotile occurs mainly in cross-fibre veins ranging from $\frac{1}{8}$ to $1\frac{1}{4}$ inches in width—the average being less than $\frac{3}{4}$ inch. The colour of the solid material is pale yellow, but teasing produces a mass of good quality white fibre. Long slip fibre is also found in the deposits, but the quantity available is relatively small. A small amount of chrysotile, possibly 20 tons, was extracted by hand cobbing prior to 1929. The

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proportion of fibre in the rock broken appeared sufficiently high for economic mining, but the limited development did not establish reserves of profitable ore.

Further development was carried out in 1941 by Minerals (Vic.) Pty. Ltd., and in 1942 by the Colonial Sugar Refining Co. Ltd., and trial samples of 4.3 and 7 tons respectively were extracted. The grade of the fibre was reported to be good, but prospecting in the Zeehan district proved more encouraging and development at Asbestos Point was suspended.

Spero River.—Chrysotile has also been reported in serpentine at the mouth of the Spero River, approximately 20 miles south of Asbestos Point, but has not been considered sufficiently promising to warrant development.

(ii) Amphibole.

Amphibole asbestos occurs in serpentine of the Beaconsfield area, but the only production recorded is 6¾ tons extracted during 1937-1938. The occurrence of amphibole asbestos at Spero River offers definite prospecting possibilities, but, in other localities, prospecting has yet failed to reveal a concentration of veins sufficiently large for commercial purposes.

Anderson's Creek.—A total of 6.25 tons of amphibole asbestos was produced in 1937-1938 from a quarry in serpentine towards the north-western end of the outcrop at Anderson's Creek (*see* page 14 for other details). The fibre is recorded as white, though much is discoloured, and, in general, is similar to the actinolite asbestos produced at Gundagai, New South Wales. Both cross- and slip-fibre types are reported to occur in steeply inclined veins which show a degree of structural regularity unusual in asbestos deposits (Reid, 1919). Some of the fibre shows considerable length (6 inches to 12 inches), others range from ¼ inch to ¾ inch, but all lack strength and flexibility. Talc, pierolite and a hard felspathic rock are associated with the asbestos. The extent of the deposit is not known but, as already stated in this report, the demand for this grade of fibre is very limited.

E. South Australia.

The total amount of asbestos produced in South Australia to the end of 1944 was 756 tons. Production has fallen sharply since 1941, and only 6 tons were produced in 1944. Future production will probably be small and dependent on individual producers or small syndicates. Crocidolite has been the most important variety mined, although small quantities of both chrysotile and amphibole asbestos have been produced.

(i) Chrysotile.

Cowell.—Chrysotile asbestos has been found in an area of Pre-Cambrian metamorphics in the vicinity of Cowell, 6 miles north-west of Franklin Harbour on the eastern side of Eyre Peninsula. The deposits are all within 15 miles of Cowell, and have many features in common. The country rock which is white, crystalline, magnesian marble, has been serpentinized in patches and along crush zones, and veins of cross-fibre chrysotile occur in the serpentine, particularly where alteration is most complete. Extensive surface prospecting has taken place in four localities since 1929, but a total of only 15 tons of fibre has been produced. This was us
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(ii) Crocidolite.

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Oraparinna.—At Oraparinna
54 tons of crocidolite were produc
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has been produced. This was used locally in the manufacture of electrical equipment. The working of these deposits has been unremunerative and the erratic distribution of the fibre does not encourage the hope that deposits of commercial value may be found.

Chrysotile occurs on Section 1*b*, Hundred of Minbrie, 6.5 miles west of Cowell, but it is reported that fibre would constitute only 0.25 per cent. and milling rock only 15 to 20 per cent. of all rock broken (Jack, 1919). It has been suggested that the marble with which the deposits are associated may have commercial value as a building stone and that small quantities of asbestos could be produced as a by-product (Jack, 1923).

(ii) Crocidolite.

Crocidolite occurs over a wide area within a belt of Pre-Cambrian metamorphics which extends north from Encounter Bay for about 400 miles. Deposits have been prospected in many localities between Truro, 47 miles north-east of Adelaide, and Blinman, 220 miles farther north. Fibre has been produced from only two localities, namely, Robertstown and from Oraparinna Station, near Blinman.

Robertstown.—Crocidolite has been found over an area of about 400 acres in the Hundred of Bright, 9 miles north of Robertstown, 83 miles north-north-east of Adelaide. It occurs in masses and in slip-fibre veins in altered magnesian limestone and in decomposed slate, in a narrow belt conforming to the strike of the metamorphics. A total of 628 tons of asbestos has been produced in the area to the end of 1944.

The fibre is usually fine and silky, up to 4 inches long and French grey in colour (Jack, 1921). A series of tests conducted in Adelaide showed the fibre to be well suited for use as a heat insulator. The chemical constitution differs from that of normal crocidolite by having a considerably higher alumina content, at the expense of iron and magnesia.

The best concentration of fibre was reported to occur in a band of micaceous schist along a fault zone in the limestone, 2 feet wide and 50 feet long, but, in general, the deposits consist of scattered masses of 5 per cent. ore (Dickinson, 1943).

About 41 tons of fibre were extracted by small producers prior to 1932. Amalgamated Asbestos Industries, N.L., installed a treatment plant in 1940 and extended the workings. The total rock mined was reported to contain 1.5 per cent. fibre and 25 per cent. milling rock, indicating that 75 per cent. of all rock broken was waste. Production between 1935 and the end of 1943 was 581 tons, but the cost was considerably higher than the value of the fibre recovered. If special uses are developed for this asbestos at a price commensurate with its cost of mining, there is a chance of further production of limited quantities.

In 1943, only 11 tons were produced from the area, 9 by the company before operations ceased, and two by an individual producer. Only 6 tons of fibre were produced in 1944.

Oraparinna.—At Oraparinna Station, 18 miles south of Blinman, 54 tons of crocidolite were produced in 1941 from veins and pockets in altered magnesian limestone associated with slate, but no further production has been recorded. The vein fibre was usually short and silky,

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but fibre up to 4 inches long was reported from the pockets (Cornelius, 1941). The grade of the asbestos was high, but the deposit was too small to justify development.

(iii) Amphibole.

Deposits of amphibole asbestos have been opened up in two localities near Adelaide within a small belt of Lower Pre-Cambrian metamorphics. A total of 59 tons of fibre was produced between 1935 and 1940, but production was not continued.

Kenton Valley.—At Kenton Valley, Hundred of Talunga, about 20 miles east-north-east of Adelaide, 27 tons of asbestos were produced between 1937 and 1939. The fibre occurred in lenticular veins and masses in the metamorphics and was probably the anthophyllite variety (Ward, 1937*a*). A definite ore zone was discernible in the workings, but asbestos-bearing rock constituted only about 5 per cent. of all rock mined.

Lyndoch.—Amphibole asbestos has been worked on the banks of the North Para River, at Lyndoch, 28 miles north-north-east of Adelaide. The asbestos occurs in well defined cross-fibre veins in a talc schist formed by alteration of an impure magnesian limestone. Vein fibre up to 6 inches in length has been noted. Asbestos was also found widely disseminated in the talc schist as well as in adjacent mica schists. The variety of the asbestiform amphibole is not stated, but may have been actinolite, since the later mineral was found in some places associated with asbestos in the talc schist (Ward, 1937*b*). The deposit was worked in 1936-37 and again in 1940 for a total production of 32 tons of fibre.

F. Western Australia.

Three kinds of commercial asbestos are produced in Western Australia. In the past, chrysotile has been the most important with a total production of 2,488 tons from 1908 to 1944, but future production will be very small compared with that of crocidolite, of which large deposits are now being developed. Crocidolite was first mined in 1937 and a total of 1,054 tons has been produced to the end of 1944. Deposits of anthophyllite and fibrous actinolite have been found at several localities in the Central and South-Western Divisions of the State, but, in general, the quality of the fibre is poor and the only production recorded is a total of 61 tons of anthophyllite between 1939 and 1944.

(i) Chrysotile.

Pilbara Goldfield.—Numerous deposits of chrysotile asbestos occur in the area between Roebourne and Nullagine which are in the Pilbara Goldfield and 200 miles apart. The deposits occur in serpentine and are usually in the form of lodes developed in shear zones or adjoining the walls of a dyke. They show more definition and structural regularity than is usual in deposits of chrysotile and many have provided milling rock averaging 20 to 50 per cent. fibre.

Intermittent production from about 10 small deposits between 1908 and 1944 amounted to approximately 2,488 tons of chrysotile. Only 12 tons were produced in 1944, however, and future production will probably be of this order since the deposits are small and most of

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In the vicinity of *Lionel*,
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The Soanesville deposits were
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the easily accessible high-grade material has been removed. The cost of production is high, due to the remoteness of the areas, and much of the past production has not been profitable.

After a comprehensive investigation in 1943, C. F. Adams, Inspector of Mines, Western Australia, formed the opinion that the production of chrysotile might be re-organized on a considerably larger scale than heretofore, provided labour and funds were available, and a guaranteed market existed for all grades of fibre produced. He considered that the mines most likely to repay further development were Nunyerri, Marshall's (Roebourne), Piesse's Luck and Fibre Queen, but estimated that the total outlay on the project, including the cost of mill equipment, would be in the vicinity of £25,000 (Adams, 1943).

In the vicinity of *Lionel*, 60 miles by road south-east of Marble Bar in the Pilbara Gold-field, high-grade chrysotile has been produced from shear zones in serpentine. Closely spaced parallel or anastomosing veins formed lodes up to 6 feet wide, striking north-west and varying in dip from 35 degrees to vertical. Fibre content varied widely, but averaged 20 to 50 per cent. The fibre was yellowish-green or olive-green, much of it fine and flexible, and occurred in cross-fibre veins varying from ¼ inch to 4 inches wide (Wilson, 1922).

About 1,000 tons of fibre have been produced from the *Lionel* area by mining and milling in the periods 1919 to 1928, 1937 and 1938, and 1943. Only 12.25 tons were produced in 1943, and future production is likely to be small since most of the easily accessible high-grade ore has been removed.

Chrysotile of a very high grade has been produced from *Soanesville*, 35 miles west-south-west of Marble Bar, where it is associated with dykes of dolerite intruded into serpentine. The two principal lodes occur on the sides of a dolerite dyke, about 100 feet wide, striking north-east and dipping south-east at approximately 70 degrees. The lodes are parallel to the dyke walls and consist of closely spaced veins of cross-fibre chrysotile forming a banded formation a few feet wide. No. 1 Lode, lying on the hanging wall side of the dyke, proved the richer deposit and by 1938 had been mined at intervals over a length of 1,300 feet. Good fibre was reported to be still available on some of the lower levels, then under water, but it was not profitable to mine. Most of the fibre exposed in accessible workings at this time was reported to be brittle. No. 2 Lode proved poorer and little development was carried out. About 2 miles south-west of these workings a third lode, ranging from 2 to 8 feet in width and carrying 5 to 30 per cent. fibre, has been traced for 800 feet. In the exposures, the fibre was weathered and ranged from ½ to ½ inch in length (Finucane and others, 1939). Presumably surface exposures did not justify more extensive development.

The Soanesville deposits were worked intermittently from 1908 to 1943, and yielded 264 tons of fibre valued at approximately £17,000. The principal workings changed hands several times and available figures indicate that the total amount spent on the deposits greatly exceeded the value of all fibre produced.

Small quantities may be produced in the future, but readily accessible high-grade ore is virtually exhausted in the principal lodes, and high-grade material remaining on lower levels would probably be

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unprofitable to mine. The mine is situated in extremely rough country and the approach road is reported to be almost impassable (Adams, 1943).

At *Dead Bullock Well*, 10 miles south-west of Soanesville, about 20 tons of chrysotile have been produced from small lodes and patches of asbestos occurring in serpentine in three principal localities.

In the *Olivine* deposit, short lodes of chrysotile occur within a total length of 1,300 feet. They occur in serpentine a few hundred feet from the contact of a large intrusive body of granite and are usually associated with small dykes of the same rock. Most of the fibre produced came from one high-grade shoot, about 25 feet long, which was stoped out from the 50-ft. level to within 15 feet of the surface. The fibre was of excellent quality and ranged from ½ inch to 1½ inches long. Other exposures on the property showed fibre of fair quality ¼ to ½ inch long, but the supply was not large.

On the *Fibre Queen* property, deposits of chrysotile occur in serpentine associated with granite dykes, over a total length of 400 feet. Again, one high-grade shoot supplied all the fibre produced. These workings were not accessible in 1938. Other exposures on the property showed some veins of fair quality, but, in most, the fibre was brittle (Finucane and others, 1939).

At *Picsse's Quest*, a tongue of serpentine, 150 to 200 feet wide, intrudes talc schist, and deposits of chrysotile were found in the serpentine close to the contact. Short lodes averaging 18 to 24 inches were exposed over a total length of 800 feet, but the percentage of fibre present was described as "moderate". The fibre was usually short, though of good quality (Finucane and others, 1939). The roads providing access to the deposit are now in bad condition.

In the records of production, it is difficult to separate production at Dead Bullock Well from that at Soanesville, but the total from the former district is approximately 20 tons, produced in three years, 1931, 1933 and 1936. Near-surface ore from the small high-grade shoots has apparently been exhausted, and unless other similar shoots can be found, production will probably not be revived in the future.

Chrysotile deposits were also found near *Strelley Pool*, 28 miles north of Soanesville, and 40 miles west of Marble Bar. A lode 3 feet wide, carrying about 30 per cent. of fibre up to ¾ of an inch long, was reported in 1921 (Wilson, 1922). The deposit was considered very promising then, but apparently subsequent development has proved disappointing.

At *Roebourne*, approximately 9 tons of chrysotile have been produced from small lodes in serpentine within 5 or 6 miles of the township. Adams (1943) reports that a semi-circular belt of fibre-bearing country, several miles long, lies 5 miles from Roebourne township. Gouging has been carried out in this belt east, south-east and south-west of the township, largely on claims of which there is no record. Wilson (1922) reported that the two most important lodes occurred 6 miles south-east of Roebourne and lay on either side of a pegmatite dyke striking north-east. Asbestos veins extended over a total width of 25 feet in the eastern lode, although the length of fibre was only about ¼ inch. In 1921, the deposit was regarded as promising on account of its apparent

size and favorable location, bu
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Roebourne district is 0.85 tons in

A small syndicate worked *M*
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(Adams, 1943). The production
may have come from this property

At *Sherlock*, 35 miles east-sou
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A total of 814 tons of chrysotil
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was poor and the maximum length
the most important, with a length
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was mostly short and brittle, but pat
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Patches of good quality fibre we
exposures, but, in general, the fibre
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A total of 362 tons of chrysotile h
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Ranges. Production was resumed on a
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size and favorable location, but development is presumed to have been disappointing since the only production recorded from the Roebourne district is 0.85 tons in 1923 and 8 tons in 1942.

A small syndicate worked *Marshall's mine*, 6 miles south-west by road from Roebourne, with a reported small profit. Fibre occurred in two shoots about 12 feet apart, which were mined for lengths of 200 feet and 150 feet respectively to a maximum depth of 40 feet (Adams, 1943). The production of 8 tons of fibre recorded in 1942 may have come from this property.

At *Sherlock*, 35 miles east-south-east of Roebourne, asbestos lodes were found on a low hill of serpentine adjoining granite. The principal lodes occurred close to the granite contact or were associated with off-shoots from the main granite body. In general, most of the fibre was short and of poor quality, and production was limited to a small shoot of higher grade fibre in each of the three principal lodes (Finucane and others, 1939).

A total of 814 tons of chrysotile was produced at Sherlock between 1925 and 1935. A revival of production is unlikely since the grade and quality of the exposed deposits appear generally poor. The small higher grade shoots probably persist below the level of the old stopes, but mining would be too costly.

Approximately 362 tons of chrysotile have been produced from *Nunyerri*, 90 miles by road south-east of Roebourne, and mining on a small scale is still in progress. Several asbestos lodes were found on a narrow ridge of serpentine about 250 feet wide, trending east and west and bounded by granite to the north and south. Deposits were found over a total length of 2,500 feet, but the main workings consisted of three lodes striking approximately north-west. No. 1 Lode was tested over a length of 400 feet and showed an average width of 12 inches. Some good fibre up to 2½ inches long was reported, but, in general, the fibre was poor and brittle. No. 2 Lode was traced for 150 feet with an average width of 9 inches, but the quality of fibre was poor and the maximum length half an inch. No. 3 Lode proved the most important, with a length of 500 feet and a width ranging from 12 to 30 inches. The lode has been mined at intervals over its entire length by pits and shafts and developed by adits to a maximum depth of 130 feet. Fibre remaining in the surface exposures in 1938 was mostly short and brittle, but patches of good fibre, up to 2½ inches long, were present in some of the unstoped sections of the lode.

Patches of good quality fibre were noted in the other lodes and exposures, but, in general, the fibre was short and of poor quality (Finucane and others, 1939).

A total of 362 tons of chrysotile has been produced from Nunyerri, 338 tons of which were won between 1934 and 1937, when a small mill was in operation. The mines were closed in 1937, and the mill was subsequently transferred to Lionel and later to the Hamersley Ranges. Production was resumed on a much smaller scale in 1941 and rose to 29 tons in 1943. In 1943, No. 3 Lode was worked by two men, who extended previous workings by two winzes and a drive below the lower adit level to block out approximately 100 tons of ore (Adams,

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1943). The nucleus of a small treatment plant has been assembled and production is expected to continue, although only 2 tons of fibre were produced in 1944.

Ashburton Gold-field.—Deposits of chrysotile asbestos occur along dolerite dykes intruding dolomite near Meilga Station, 120 miles by road south-east of Onslow, in the Ashburton Goldfield. The principal deposit is known as the *Silver Sheen*, where asbestos veins occur along bedding or joint planes in the dolomite on either side of a dolerite dyke, 80 feet wide, striking north and dipping almost vertically. Veins extended about 17 feet from the contact, but the fibre tended to become more brittle with distance from the dyke wall.

The main workings extended for about 280 feet along the eastern side of the dyke and reached a maximum depth of 57 feet. The fibre ranged from ¼ to 4 inches long and was of excellent quality, but the main shoot was apparently exhausted, since the fibre remaining in 1938 was nearly all brittle. Patches of high-grade fibre were noted elsewhere in the eastern lode, but the asbestos veins are strictly limited to the extent of the dolomite, which here extends for only 500 feet along the strike of the dolerite and is only about 100 feet thick.

Exposures on the western side of the dyke were not encouraging, although a little stoping was done (Finucane and others, 1939).

Chrysotile was produced from the Silver Sheen deposits in 1933, 1936 and 1937, with a total production of about 16 tons. Small amounts of good quality fibre could doubtless be produced from the eastern lode, but its limited depth, as well as the high mining costs, preclude any significant production.

Another deposit of chrysotile occurs about 1 mile west of the Silver Sheen workings, on the western wall of a dolerite dyke, but little development had been done in 1938. The fibre showing was short, but of good quality.

(ii) Crocidolite.

Hamersley Ranges.—Crocidolite occurs in the Hamersley Ranges in the north-western part of the State. The fibre is found in beds of the Nullagine Series which form a belt 180 miles long and 20 to 30 miles wide, trending east-south-east from Millstream Station, approximately 45 miles south of Roebourne, to the Ophthalmia Ranges. The deposits are strikingly similar to those found in the Griqua Town Series in South Africa (Hall, 1930), from which the greater part of the world's crocidolite is obtained, although the Hamersley Range deposits appear to have a higher proportion of long fibre.

Seams of cross-fibre crocidolite are found in thin beds of ferruginous quartzite, in proximity to beds of dolomite in bluish riebeckite rock, and in the absence of igneous intrusions, are held to be metamorphic products induced by the pressure of overlying strata. The beds are horizontal or dip at low angles, and asbestos-bearing horizons with characteristic marker beds, are exposed for considerable distances in the walls of gorges cut by northerly flowing tributaries of the Fortescue River (Finucane, 1939*b*, Miles, 1942).

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are undoubtedly large.

The total recorded produc
Ranges to the end of 1944 is
produced prior to 1939, have c

The Asbestos, Molybdenum
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Ltd. took over the mill and
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the half-year ending 30th June,
total for the year is 1,117 tons.

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Seams of crocidolite have be
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Yampire Gorge lies 30 miles
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In *Wittenoom's Gorge*, 17 miles
asbestos seams occur 150 to 200 fee
horizon contains a prominent marke
overlain by 10 to 15 inches of dc
quartzite lies the Main Seam of c

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Since 1937, at least 1,054 tons of crocidolite have been produced by breaking out ore along benches in the cliff face with no systematic underground mining. The reserves of fibre, though not yet estimated, are undoubtedly large.

The total recorded production of crocidolite from the Hamersley Ranges to the end of 1944 is 1,054 tons, but several hundred tons, produced prior to 1939, have obviously not been recorded.

The Asbestos, Molybdenum and Tungsten Co. Ltd. installed a small mill in the vicinity of Yampire Gorge in 1939, and improved it in 1942. In 1943, Western Australian Blue Asbestos Fibres Co. Ltd. took over the mill and properties, and a considerable increase in production has resulted. A second company, Australian Blue Asbestos Ltd. is also mining in the area and the combined annual production of the two companies rose to 249 tons in 1944. Their production for the half-year ending 30th June, 1945, was 378 tons, and the estimated total for the year is 1,117 tons.

A detailed geological survey is needed to determine, so far as possible, the relationship of the various asbestos horizons, their extent and the probable reserves of ore. The development of markets is also of great importance. Most of the long fibre will have to be exported, but a local market will probably be available for a considerable quantity of short fibre (see page 10).

Seams of crocidolite have been worked in four principal localities, namely, *Yampire Gorge*, *Wittenoom's Gorge*, *Dales Gorge* and Marramamba.

Yampire Gorge lies 30 miles by road south-east of Mulga Downs Station, which is 180 miles by road south-east of Roebourne. Seams of crocidolite have been exposed in the gorge over a total length of 3 miles, and occur in two stratigraphical horizons 150 to 200 feet apart. The lower horizon has been benched intermittently for a mile in the upper, or southern, end of the gorge, and consists of two marker beds of riebeckite rock 4.5 feet apart with which are associated several seams of crocidolite ranging from $\frac{1}{4}$ inch to 2 inches wide. The beds dip gently to the north and the lower horizon passes under the floor of the gorge.

A little over three-quarters of a mile to the north, the upper horizon is exposed in the gorge and has been benched at intervals for nearly 2 miles. In most of these workings the horizon consists of a marker bed of riebeckite rock with one or two seams of fibre above and below it, the aggregate thickness of fibre being about 2 inches over a vertical interval of 2 to 4 feet. The length of fibre varies from $\frac{1}{4}$ to $2\frac{1}{4}$ inches (Finucane, 1939). The production from individual localities is not shown in the records, but Yampire Gorge has probably been the most important centre, particularly since 1939, when a mill was installed in the area.

In *Wittenoom's Gorge*, 17 miles by road south-west of Mulga Station, asbestos seams occur 150 to 200 feet above the floor of the gorge. The horizon contains a prominent marker, consisting of 6 inches of quartzite overlain by 10 to 15 inches of dolomite and immediately below the quartzite lies the Main Seam of crocidolite. This has been exposed

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in benches for 1,400 feet and occurs in flat attenuated lenses, 400 to 500 feet long with the maximum development of fibre, up to 2 inches long, in the central portion of each lens.

About 4.5 feet above the Main Seam lies the Lower Ribbon, consisting of four to seven seams over a thickness of 18 inches, carrying fibre ¾ to ⅞ inch long. Twenty to thirty feet above the marker an Upper Ribbon, 18 inches thick, is found, consisting of 8 to 10 seams carrying fibre ¼ to 1¾ inches long.

It may be possible to mine the Main Seam and the Lower Ribbon together in a 6 to 7 foot face in several places in Wittenoom's Gorge, with a possible fibre recovery of 4 to 5 per cent. of all rock mined (Finucane, 1939).

In *Dale's Gorge*, 9 miles east of Yampire Gorge, crocidolite seams have been worked intermittently over a distance of 1¼ miles. The asbestos horizon consists of several seams associated with two marker beds of dolomite over a vertical interval of 50 feet. The dolomite beds are 6 to 10 inches thick and 20 feet apart. The persistant seams are—

(i) The Top Seam, 10 feet above the upper dolomite marker.
(ii) Malberg's Seam, 15 feet below the upper dolomite marker.
(iii) A small seam of asbestos, usually known as "The Stringer", 7.5 feet below the lower dolomite marker.
(iv) The Main Bottom Seam, 10 feet below the lower dolomite marker (Finucane, 1939).

Small seams are also found over an interval of 10 feet below the Main Bottom Seam.

Malberg's Seam has been worked at intervals for over 2,000 feet. The fibre length ranges from ½ to 2½ inches. The Main Bottom Seam has been benched at intervals for over 1,200 feet and has yielded fibre ranging from ½ to 1½ inches in length. A little benching on the Top Seam showed fibre length between 1¼ and 1½ inches (Finucane, 1939).

Dale's Gorge was not regarded as favorably as Yampire or Wittenoom's Gorge in 1942 on account of the difficulty of access and the smaller aggregate length of fibre exposed (Foxall, 1942).

Seams of crocidolite have been found over a distance of 9.5 miles in low hills which trend east and west, about 2 miles south of *Marramamba Homestead*, 65 miles west of Wittenoom's Gorge. The Nullagine beds in which the seams occur are considerably more disturbed than those in which deposits occur to the east, and show easterly or north-easterly dips ranging from 15 to 20 degrees. The structure has not been elucidated, but the absence of reversals of dip suggests that asbestos occurs on several distinct horizons.

Seams had been exposed on several prospecting areas in 1942, the best of which showed an aggregate of 9 to 10½ inches of fibre over a vertical interval of 8 to 8.5 feet. In some of the exposures the fibre was weathered and discoloured, but, in general, the quality and length appeared satisfactory. The deposits, as a whole, were regarded more favorably than those exposed in Yampire, Wittenoom's and Dale's Gorges to the east, since they appeared to offer a better concentration

of fibre, easier mining and m
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(iii)- Amphibole.

South-West Division.—An
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altered bands of amphibolite sc
in place, the fibrous structure of
appears rather as a striated grey
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Asbestos has been prospected b
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of slip fibre can probably be won
production of mass fibre would req
rock. A total of 56 tons of fibre
24 tons in 1942, 9 tons in 1943,
is now held under sub-lease by a
small scale is expected to continue.

At *Goomalling*, 76 miles north-
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cuts, but much of the fibre was of
or partial alteration to talc. Th
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deposits, which suggests that the qua
is only small.

Other Localities.—Anthophyllit
at *Mount Magnet*, 200 miles east-nor
of the occurrence are available.

Deposits of fibrous actinolite a
localities near *Yerilla*, 75 miles nor
long slip fibre and shorter cross fi
brittle and silicified form.

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of fibre, easier mining and much easier access. Another advantage lay in the fact that the distance by road from Roebourne could possibly be reduced to about 100 miles by following a new route (Foxall, 1942).

(iii) Amphibole.

South-West Division.—Anthophyllite deposits are found in granite gneiss, 2.5 miles north of the *Bindi Bindi* railway siding, which is 135 miles by rail north-north-east from Perth. The following description is taken from an unpublished report on the deposits by H. G. Raggatt (1943). "Asbestos occurs both as slip fibre and mass fibre. The former type is found in gently inclined, but warped and somewhat irregular, zones of a soapy rock which are believed to represent highly altered bands of amphibolite schist in acid granite gneiss. As it lies in place, the fibrous structure of the mineral is not very apparent. It appears rather as a striated grey to very pale green rock with a faint sheen. However, the fibre may be readily teased out with the fingers. The asbestos rock occurs in lengths of several feet, but jointing normal to the fibres determines the lengths of individual groups of fibre available. There would be no difficulty in selecting fibres between 2 and 3 inches long.

The mode of occurrence of the mass fibre is not as clear as that of the slip fibre, but the rock matrix in which it is found appears similar to that in which the slip fibre occurs".

Asbestos has been prospected by shafts over a total length of a mile, but development is limited to shallow shafts and open cuts. Much of the fibre is of poor quality, but in at least one section it has unusual tensile strength and can be used commercially. A considerable amount of slip fibre can probably be won by mining and hand-picking, but the production of mass fibre would require machinery to separate fibre from rock. A total of 56 tons of fibre has been produced from Bindi Bindi; 24 tons in 1942, 9 tons in 1943, and 23 tons in 1944. The property is now held under sub-lease by a new operator and production on a small scale is expected to continue.

At *Goomalling*, 76 miles north-east of Perth, anthophyllite deposits occur in a narrow belt of talc rock, probably altered serpentine, which trends in a north-westerly direction and crosses the railway line near Goomalling Station. The dominant country rock is granite. Asbestos-bearing zones up to 3 feet wide were reported in small shafts and open cuts, but much of the fibre was of inferior quality due to weathering or partial alteration to talc. The best fibre was reported to have sufficient tensile strength and flexibility for use as an insulator or in the manufacture of fibro-cement articles (Wilson, 1923). According to the records, however, no asbestos has been produced from the deposits, which suggests that the quantity of higher-grade fibre available is only small.

Other Localities.—Anthophyllite has been reported in serpentine at *Mount Magnet*, 200 miles east-north-east of Geraldton, but no details of the occurrence are available.

Deposits of fibrous actinolite are known in serpentine at several localities near *Yerilla*, 75 miles north-north-east of Kalgoorlie. Both long slip fibre and shorter cross fibre are reported, but mostly in a brittle and silicified form.

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Fibrous actinolite, associated with magnesite and dolomite, occurs in serpentine, 2 miles north of *Goongarrie*, 50 miles north-north-west from Kalgoorlie. A lode 18 inches wide was exposed in an open cut in 1921, but the grade of fibre was not specified. Some fibre may have been produced and sold, but there is no record of the amount.

The occurrence of fibrous actinolite in serpentine has also been reported from *Bulong*, 20 miles east of Kalgoorlie, where 5 tons of fibre were produced in 1939, and from *Hannan's Lake* and other localities in the Coolgardie district.

G. Northern Territory.

Anthophyllite occurs in association with serpentine at *Hart's Range*, approximately 130 miles north-east of Alice Springs. At one locality 3 miles north-north-east from Mount Palmer, anthophyllite is showing freely throughout a serpentine body 500 feet long by 60 feet wide. The anthophyllite occurs in narrow ramifying veins of cross fibre and in wider veins (6 inches to 2 feet) of slip and mass fibre.

Veins have been exposed in a number of costeans and pits to a maximum depth of 7 feet, but all the asbestos showing is weak and brittle. No attempt has been made to produce fibre from the deposit.

H. Papua and New Guinea.

Ultrabasic rocks are known to occur in both Papua and New Guinea, but as yet there is no reliable evidence that they contain desposits of asbestos.

6. AUSTRALIAN PRODUCTION.

The total production of crude asbestos in Australia from 1880 to the end of 1944 is 8,445 tons, consisting of 6,380 tons of chrysotile, 1,736 tons of crocidolite and 329 tons of amphibole asbestos. Peak production was in 1921, when 1,182 tons of fibre were produced, of which 915 tons came from chrysotile deposits at Barraba, New South Wales.

Production fell sharply when mining at Barraba ceased in 1923, and for the next sixteen years, i.e., to the end of 1939, the average annual production of fibre was 132 tons.

During the Second World War, production increased from 78 tons in 1939 to 764 tons in 1944, and in 1945 the production was approximately 1,700 tons. A further increase is expected in 1946. The production of asbestos since 1939 is summarised in Table IV. (For details of the production of crude asbestos in Australia from 1880 to 1944 *see* Tables XI.–XXIV.)

TABLE IV.

Production of Crude Asbestos 1939 to 1945.

Year.	Tons.
1939	78
1940	489
1941	252
1942	331
1943	678
1944	764
1945 (estimated in part)	1,700

It is worthy of note that the crocidolite in the Australian pr 1935 in that crocidolite has beco with chrysotile in the total produ

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Australian Production

Type.	
Chrysotile	
Crocidolite	
Other Amphibole	
Total	

Production in the immediate still further the relative importance output. In 1945 crocidolite consti the total production and this percen

7. OVERSE

The following information on been obtained from the Comm Statistics:—

Exports.

Australia's export trade in bot is small, and has shown a marked de the export of asbestos goods may of recent exports of crude asbesto Tables VI. and VII.

TABL

Australian Exports of Asbestos

Year ending 30th June.	Total Cru
	Tons.
1941	284
1942	102
1943	27
1944	87
1945	202

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It is worthy of note that the relative importance of chrysotile and crocidolite in the Australian production of asbestos has altered since 1935 in that crocidolite has become of approximately equal importance with chrysotile in the total production. This is illustrated in Table V.

TABLE V.

AUSTRALIAN PRODUCTION OF CRUDE ASBESTOS, BY TYPES.

Type.	1916–35.		1936–44.	
	Tons.	Per cent.	Tons.	Per cent.
Chrysotile	4,939	96.6	1,341	42.2
Crocidolite	109	2.1	1,627	51.2
Other Amphibole	65	1.3	208	6.6
Total	5,113	100.0	3,176	100.0

Production in the immediate future seems certain to emphasize still further the relative importance of crocidolite in the total Australian output. In 1945 crocidolite constituted approximately 66 per cent. of the total production and this percentage is likely to increase in 1946.

7. OVERSEA TRADE.

The following information on exports and imports of asbestos has been obtained from the Commonwealth Bureau of Census and Statistics:—

Exports.

Australia's export trade in both crude asbestos and asbestos goods is small, and has shown a marked decline since 1939. In post-war years, the export of asbestos goods may show an upward trend. Figures of recent exports of crude asbestos and asbestos goods are given in Tables VI. and VII.

TABLE VI.

AUSTRALIAN EXPORTS OF ASBESTOS AND ASBESTOS GOODS, 1941 TO 1945.

Year ending 30th June.	Total Crude Asbestos.		Total Value of Asbestos Goods.	Total Value of Exports.
	Tons.	Value £A.	Value £A.	Value £A.
1941	284	10,692	68,501	79,193
1942	102	4,104	108,987	113,091
1943	27	617	29,929	30,576
1944	87	2,455	26,881	29,336
1945	202	7,843	26,208	34,051

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Exports of crude asbestos were not recorded as a separate item prior to 1st July, 1937.

The value of exported asbestos goods was £A.2,124 in 1929-30 and £A.1,437 in 1938-39. The average for the ten-year period was £A.1,478.

TABLE VII.

AUSTRALIAN EXPORTS OF ASBESTOS AND ASBESTOS GOODS, 1943 AND 1944, AND COUNTRIES TO WHICH EXPORTED.

Country to which Exported.	Calendar Year 1943.		Calendar Year 1944.	
	Tons.	Value £A.	Tons.	Value £A.
Crude Asbestos.				
United Kingdom	28.8	1,330	68.3	4,293
United States of America ..	0.1	6	3.35	362
New Zealand	13.9	187	99.5	1,419
Total	42.8	1,523	171.15	6,074
Total value of exported Asbestos goods	..	24,759	..	18,285
Total value of exports ..	..	26,282	..	24,359

Imports.

Imports into Australia both of crude asbestos and asbestos goods have increased markedly since 1932, and in the year ended 30th June, 1945, reached a maximum value of £795,787 sterling. Imports, particularly of crude asbestos, are expected to remain at a high level especially until the immediate post-war housing programme has been completed. Tables VIII. and IX. summarize the available information on imports of crude asbestos and of asbestos goods.

TABLE VIII.

AUSTRALIAN IMPORTS OF ASBESTOS AND ASBESTOS GOODS, 1930 TO 1945.

Year ending 30th June.	Total Crude Asbestos.		Total Value of Imported Asbestos Goods.	Total Value of Imports.
	Tons.	Value £ Stg.	Value £ Stg.	Value £ Stg.
1930	2,523	60,428	77,955	138,383
1939	9,217	178,494	93,233	271,727
Annual average—				
1930-39..	4,091	71,150	68,484	139,604
1940	13,254	263,191	130,473	393,604
1941	15,231	411,994	121,928	533,922
1942	12,135	357,946	153,377	511,323
1943	18,714	564,305	171,758	736,063
1944	12,229	344,448	139,585	484,033
1945	16,809	569,267	226,520	795,787

T.

AUSTRALIAN IMPORTS OF ASBESTOS AND COUNTRIES

Country of Origin.	Ca.
	Ton
Crude Asbestos.	
Canada	5,450
New Zealand	..
Rhodesia (Southern) ..	8,118
Union of South Africa ..	818
United Kingdom	7.
United States of America ..	1.
Total	14,397
Value of imported Asbestos goods	..
Total value imports ..	..

.8. AUSTRALIAN

Consumption for 1944 and of crude asbestos, of which 96 per in Australia during 1944. This in the stocks held between the be "apparent consumption" obtaine the figure for imports and subtra fore, approximately 95 per cent. Australia was provided by import production. Some amosite was i other amphibole used was produced

According to reports by the pa in 1945 was approximately 18,00 was satisfied by production from of consumption met from Australi increase in 1946 (*see* page 10).

An analysis of Australian cons is given in the following table:—

TABI

CONSUMPTION OF ASBESTO

Use.
Asbestos-cement products, buildi pipes, &c. .. ..
Millboard .. ..
Boiler lagging, packings, insulatic
Brake linings .. ..
Plastic asphalt, asbestos-cement,
Rope yarn, gaskets, asbestos clo

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TABLE IX.

AUSTRALIAN IMPORTS OF ASBESTOS AND ASBESTOS GOODS IN 1943 AND 1944 AND COUNTRIES OF ORIGIN OF ASBESTOS.

Country of Origin.	Calendar Year 1943.		Calendar Year 1944.	
	Tons.	Value £ Stg.	Tons.	Value £ Stg.
Crude Asbestos.				
Canada	5,450	102,399	6,044.5	150,317
New Zealand	..	..	2.15	25
Rhodesia (Southern) ..	8,118.3	320,336	5,232.95	226,463
Union of South Africa ..	818.9	24,206	1,781.2	60,255
United Kingdom	7.95	667	24.4	1,091
United States of America ..	1.85	260	6.15	808
Total	14,397	447,868	14,091.35	438,958
Value of imported Asbestos goods	..	137,877	..	184,418
Total value imports ..	..	585,745	..	623,376

8. AUSTRALIAN CONSUMPTION.

Consumption for 1944 and 1945.—Approximately 14,800 tons of crude asbestos, of which 96 per cent. was chrysotile, were consumed in Australia during 1944. This figure does not allow for variations in the stocks held between the beginning and end of 1944 and is the "apparent consumption" obtained by adding domestic production to the figure for imports and subtracting the exports. In 1944, therefore, approximately 95 per cent. of the crude asbestos consumed in Australia was provided by imports and only 5 per cent. by domestic production. Some amosite was imported, but all the crocidolite and other amphibole used was produced in Australia.

According to reports by the principal users of asbestos, consumption in 1945 was approximately 18,000 tons, of which about 7 per cent. was satisfied by production from domestic sources. The percentage of consumption met from Australian sources of supply is expected to increase in 1946 (*see* page 10).

An analysis of Australian consumption of crude asbestos by uses is given in the following table:—

TABLE X.

CONSUMPTION OF ASBESTOS IN AUSTRALIA BY USES.

Use.	Approximate Percentage of Total Consumption.
Asbestos-cement products, building material, pipes, &c.	95.0
Millboard	2.0
Boiler lagging, packings, insulation material	1.6
Brake linings	1.0
Plastic asphalt, asbestos-cement, &c. ..	0.3
Rope yarn, gaskets, asbestos clothing, &c.	0.1
	100.0

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Anticipated Future Consumption.—The apparent consumption of crude asbestos in 1939 was approximately 9,000 tons, against 14,800 tons in 1944, and 18,000 tons in 1945. It is likely that consumption will remain at the 1945 level in the immediate post-war period rather than decline to the pre-war level. However, a fall in consumption may be anticipated when post-war housing requirements have been largely satisfied.

9. GENERAL SUMMARY.

Asbestos occurs in every State of the Commonwealth, but with the exception of the crocidolite deposits in the Hamersley ranges, Western Australia, which are very large, available reserves are believed to be relatively small.

Consumption of asbestos in Australia has increased markedly since 1931, and reached approximately 18,000 tons in 1945. Consumption is likely to continue at this level for several years.

Production of asbestos from domestic sources prior to 1943 rarely exceeded a few hundred tons, except in 1920-22, when it averaged approximately 1,000 tons per annum. In 1943, production amounted to 678 tons, and in 1944 to 764 tons. Production in 1945 was approximately 1,700 tons and a further increase is expected in 1946.

A recent development in the industry is the use of crocidolite from the Hamersley Ranges in asbestos-cement products manufactured in Australia. This use appears likely to become general—up to 20 or perhaps 25 per cent. of the quantity used in asbestos-cement products subject to the products so manufactured standing the test of time and provided the crocidolite can be produced at a price comparable with that paid for imported chrysotile.

Assuming the above usage becomes general, Australia will still need to import chrysotile to the extent of at least 70 per cent. of the total annual consumption of asbestos. Australian production of chrysotile is not likely to amount to more than 5 per cent. of the requirements of Australian industry. All the short-fibre crocidolite and other amphibole asbestos required can be supplied from domestic sources, but oversea markets will have to be found for most of the Australian production of long-fibre crocidolite, which may eventually reach 2,000 to 3,000 tons per annum.

10. REFERENCES.

In addition to the references listed below, information on the deposits has been drawn from unpublished reports by officers of Mineral Resources Survey. Information has also been taken from reports prepared by officers of the Mines Departments of the States and Territories, and of mining companies, which have been made available by courtesy of the various departments and organizations concerned. The annual reports and other publications of the State Mines Departments and current mining literature have also been freely consulted.

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TABLE XI.

Asbestos Production—New South Wales.

Year.	Gundagai District. (Jones Creek.)		Orange District. (Hyng and Lewis Ponds.)		Barraba District. (Woods Reef.)		Cowamumurst District. (Barrafell.)		Total.				Grand Total.	
	Amphibole.		Amphibole.		Chrysotile.		Chrysotile.		Amphibole.		Chrysotile.			
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1880	12.4	323	..	..	..	..	..	..	12.4	323	..	..	12.4	323
1881	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1882	7.5	75	..	..	..	..	..	..	7.5	75	..	..	7.5	75
1883-84 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1885	6.0	90	..	..	..	..	..	..	6.0	90	..	..	6.0	90
1886-06 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1907	5.0	50*	..	..	..	..	..	..	5.0	50*	..	..	5.0	50*
1908	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1909	15.0	150*	..	..	..	..	..	..	15.0	150	..	..	15.0	150
1910-11 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1915	0.5	5	..	..	..	..	..	..	0.5	5	..	..	0.5	5
1916	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1917	10.0	100*	..	..	..	..	..	..	10.0	100*	..	..	10.0	100*
1918	..	..	..	..	9*	122	..	..	..	..	9*	122	9.0	122
1919	..	..	12.0	48	143	1,938	..	..	12.0	48	143	1,938	155.0	1,986
1920	..	..	8.0	64	656	7,340	..	..	8.0	64	656	7,340	664.0	7,404
1921	10.0	100	24.0	116	905	23,440	..	..	40.0	276	905	23,440	945.0	23,716
1922	..	..	..	..	561	11,418	..	..	..	..	561	11,418	561.0	11,418
1923	..	..	..	..	204	4,267	..	..	..	..	204	4,267	204.0	4,267
1924-25 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1926	..	..	4.5	20	..	..	..	..	4.5	20	..	..	4.5	20
1927-30 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1931	..	..	..	..	..	..	..	..	..	..	8‡	64	8.0	64
1932-39 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1940	..	..	8.0	80	..	..	..	..	8.0	80	..	..	8.0	80
1941	..	..	37.0	370	..	..	..	..	37.0	370	..	..	37.0	370
1942	..	..	37.0†	340	..	..	105	4,200*	37.0	340	105	4,200*	142.0	4,540
1943	..	..	..	..	..	..	405	16,200*	..	..	405	16,200*	415.0	16,200
1944	..	..	..	..	..	..	347	13,880*	..	..	347	13,880†	347.0	13,880
Total ..	72.4	953	130.5	1,038	2,478	48,525	857	34,280	202.9	1,991	3,343	82,869	3,545.9	84,860

* Estimated. † 213 tons of tremolite schist valued at £369 recorded in 1942, in addition to above. ‡ Broken Hill district.

TABLE XII.

Asbestos Production—Tasmania.

Year.	Beaconsfield District. (Anderson's Creek.)		Zeehan District and Asbestos Point, &c.		Beaconsfield District. (Anderson's Creek.)		Total.					
	Chrysotile.		Chrysotile.		Amphibole.		Chrysotile.		Amphibole.		Grand Total.	
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1899 ..	20.00	363	..	..	..	..	20.00	363	..	..	20.00	363
1900 ..	12.80	113	..	..	..	..	12.80	113	..	..	12.80	113
1901 ..	4.05	45	..	..	..	..	4.05	45	..	..		
1902-15 ..	..	..	..	..	..	..						
1910 ..	1.50	30	..	..	..	..						

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1911 ..	..	..	..	37.01	340	..	..	405	16,200*	..	..	347	13,880†	347.0	13,880
1912 ..	..	..	..	..	..	..	..	347	13,880*	..	..				
1913 ..	..	..	..	..	..	..	..								
1914 ..	..	..	..	..	..	..	..								
Total ..		72.4	953	130.5	1,038	2,478	48,525	857	34,260	202.9	1,991	3,343	82,800	3,645.9	84,5

* Estimated. † 347 tons of tremolite schist valued at £360 recorded in 1912, in addition to above. ‡ Broken Hill district.

TABLE XII.

Asbestos Production—Tasmania.

Year.	Beaconsfield District. (Anderson's Creek.)		Zeehan District and Asbestos Point, &c.		Beaconsfield District. (Anderson's Creek.)		Total.					
	Chrysotile.		Chrysotile.		Amphibole.		Chrysotile.		Amphibole.		Grand Total.	
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1899 ..	20.00	363	..	..	..	..	20.00	363	..	..	20.00	363
1900 ..	12.80	113	..	..	..	..	12.80	113	..	..	12.80	113
1901 ..	4.05	45	..	..	..	..	4.05	45	..	..	4.05	45
1902-15..	..	..	..	..	..	..	..	..	..	..	..	..
1916 ..	1.50	30	..	..	..	..	1.50	30	..	..	1.50	30
1917 ..	27.10	271	..	..	..	..	27.10	271	..	..	27.10	271
1918 ..	285.40	5,008	..	..	..	..	285.40	5,008	..	..	285.40	5,008
1919 ..	51.00	1,275	..	..	..	..	51.00	1,275	..	..	51.00	1,275
1920-36..	..	..	..	..	..	..	..	..	..	..	..	..
1937 ..	..	..	..	..	2.00	29	..	..	2.00	29	2.00	29
1938 ..	..	..	..	..	4.25	68	..	..	4.25	68	4.25	68
1939-40..	..	..	..	..	..	..	..	..	..	..	..	..
1941 ..	..	..	3.50*	120	..	..	3.50	120	..	..	3.50	120
1942 ..	..	..	7.00*†	20	..	..	7.00	20	..	..	7.00	20
1943 ..	..	..	18.25	365	..	..	18.25	365	..	..	18.25	365
1944 ..	..	..	102.99	2,242	..	..	102.99	2,242	..	..	102.99	2,242
Total	402.45‡	7,105	131.74	2,747	6.25	97	534.19	9,852	6.25	97	540.44	9,949

* From Asbestos Point. † Trial parcel of ore; asbestos content not stated. ‡ Quantity of asbestos produced 1899–1918 estimated as 10 per cent. of rock milled.

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TABLE XIII.

ASBESTOS PRODUCTION—SOUTH AUSTRALIA.

Year.	Robertstown.		Cowell.		Lyndoch and Kenton Valley.		Total.						Grand Total.	
	Crocidolite.		Chrysotile.		Amphibole.		Crocidolite.		Chrysotile.		Amphibole.			
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1915	0.35	5	..	..	..	..	0.35	5	..	..	..	..	0.35	5
1916	21.00	210	..	..	..	..	21.00	210	..	..	..	..	21.00	210
1917-19 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1920	5.00	90	..	..	..	..	5.00	90	..	..	..	..	5.00	90
1921	2.00	71	..	..	..	..	2.00	71	..	..	..	..	2.00	71
1922	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1923	7.35	161	..	..	..	..	7.35	161	..	..	..	..	7.35	161
1924	4.00	80	..	..	..	..	4.00	80	..	..	..	..	4.00	80
1925-28 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1929	..	..	1†	40	..	..	..	..	1	40	..	..	1.00	40
1930	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1931	1.00	18	5‡	82	..	..	1.00	18	5	82	..	..	6.00	100
1932	20.00	130	..	..	..	..	20.00	130	..	..	..	..	20.00	130
1933	13.00	113	..	..	..	..	13.00	113	..	..	..	..	13.00	113
1934	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1935	35.00	359	..	..	..	..	35.00	359	..	..	..	..	35.00	359
1936	76.00	678	..	..	4¶	36	76.00	678	..	..	4	36	80.00	714
1937	97.00	1,014	..	..	24**	163	97.00	1,014	..	..	24	163	121.00	1,177
1938	38.00	511	1§	10	9††	78	38.00	511	1	10	9	78	48.00	599
1939	40.00	515	3§	30	2††	20	40.00	515	3	30	2	20	45.00	565
1940	97.00	1,302	..	..	20¶	160	97.00	1,302	..	..	20	160	117.00	1,462
1941	98.00	2,381	..	..	..	..	150.00*	3,336	..	..	..	..	150.00	3,336
1942	58.00	883	5‖	60	..	..	58.00	883	5	60	..	..	63.00	943
1943	11.00	245	..	..	..	..	11.00	245	..	..	..	..	11.00	245
1944	6.00	78	..	..	..	..	6.00	78	..	..	..	..	6.00	78
Total ..	627.70	8,644	15	167	59	457	681.70	9,709	15	222	59	457	755.70	10,478

* Including 54 tons value £955 from Oraparinna Station. † Rd. Mittalie. ‡ 4 tons value £74 Rd. Mittalie, 1 ton value £8 Rd. Minbrie. § Rd. Minbrie.
‖ Rd. Hawker. ¶ Lyndoch. ** 16 Kenton Valley, 8 Lyndoch. †† Kenton Valley.

TABLE XIV.

ASBESTOS PRODUCTION—WESTERN AUSTRALIA.

Year.	Pilbara Goldfield.						Total Chrysotile.		Total Amphibole.		Total Crocidolite.		Grand Total.	
	Lionel.		Soanesville and Dead Bullock Well.		Sherlock and Nunyerri.				Bindi Bindi.		Hamersley Ranges.			
	Chrysotile.		Chrysotile.		Chrysotile.									
	Tons.	£A.	Tons.	£A.	Tons	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1908	..	..	40.00	1,600	..	..	40.00	1,600	..	..	..	..	40.00	1,600
1909	..	..	2.83	154	..	..	2.83	154	..	..	..	..	2.83	154
1910-18 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1919	53.00	1,443	..	..	..	..	53.00	1,443	..	..	..	..	53.00	1,443
1920	124.50	5,330	32.00	1,000	..	..	156.50	7,280	..	..	..	..	156.50	7,280
1921	202.75	12,221	32.60	1,360	..	..	235.35	13,581	..	..	..	..	235.35	13,581
1922	170.18	7,330	2.50	250	..	..	187.68	7,600	..	..	..	..	181.68	7,600
1923	111.00	3,805	3.00	150	..	..	114.85	4,033	..	..	..	..	114.85†	4,032
1924	73.58	2,200	..	..	..	..	73.58	2,200	..	..	..	..	73.58	2,200
1925	50.00	1,610	..	..	0.74	22	50.74	1,611	..	..	..	..	50.74	1,611
1926	91.45	2,436	..	..	13.89	202	105.34	2,728	..	..	..	..	105.34	2,728
1927	10.80	304	..	..	..	..	10.80	304	..	..	..	..	10.80	304
1928	6.00	182	5.70	600	..	..	..	..	..	..	..	..	..	..
1929	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE XIV.

Asbestos Production—Western Australia.

Year.	Pilbara Goldfield.						Total Chrysotile.		Total Amphibole.		Total Crocidolite.		Grand Total.	
	Lionel.		Soanesville and Dead Bullock Well.		Sherlock and Sonyerri.				Bindi Bindi.		Hamersley Ranges.			
	Chrysotile.		Chrysotile.		Chrysotile.									
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1908	..	..	40.00	1,600	..	..	40.00	1,600	..	..	..	..	40.00	1,600
1909	..	..	2.83	154	..	..	2.83	154	..	..	..	..	2.83	154
1910–18 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1919	53.00	1,443	..	..	..	..	53.00	1,443	..	..	..	..	53.00	1,443
1920	124.50	5,386	32.00	1,900	..	..	156.50	7,286	..	..	..	..	156.50	7,286
1921	202.75	12,221	32.60	1,300	..	..	235.35	13,581	..	..	..	..	235.35	13,581
1922	170.18	7,350	2.50	250	..	..	187.68	7,600	..	..	..	..	191.68	7,600
1923	111.00	3,865	3.00	160	..	..	114.85	4,032	..	..	..	..	114.85†	4,032
1924	73.68	2,206	..	..	..	..	73.68	2,206	..	..	..	..	73.68	2,206
1925	50.00	1,619	..	..	0.74	22	50.74	1,641	..	..	..	..	50.74	1,041
1926	91.45	2,436	..	..	13.89	292	105.34	2,728	..	..	..	..	105.34	2,728
1927	10.80	304	..	..	..	..	10.80	304	..	..	..	..	10.80	304
1928	6.00	182	5.70	600	..	..	11.70	782	..	..	..	..	11.70	782
1929	..	..	63.70	6,113	191.25	8,568	254.95	14,681	..	..	..	..	254.95	14,681
1930	..	..	65.30	4,228	17.00	500	82.30	4,728	..	..	..	..	82.30	4,728
1931	..	..	2.57	36	105.50	1.410	108.07	1,446	..	..	..	..	108.07	1,446
1932	..	..	..	..	109.05	1,762	109.05	1,762	..	..	..	..	109.05	1,762
1933	..	..	7.00	230	254.00	4,100	260.00**	4,917	..	..	..	..	260.00	4,017
1934	..	..	..	..	155.00	2,975	155.00	2,975	..	..	..	..	155.00	2,975
1935	..	..	..	..	141.00	2,880	141.00	2,889	..	..	..	..	141.00	2,889
1936	..	..	11.10	310	144.90	3,160	158.00**	3,479	..	..	..	..	158.00	3,479
1937	20.00	1,180	..	..	..	..	28.00**	1,050	..	..	14.00	..	42.00	1,050*
1938	66.00	2,700	1.00	75	..	..	67.00	2,871	..	..	54.00	2,443	121.00	5,314
1939	..	..	1.00	202	..	..	1.00	202	5.00††	20	27.00	1,098	33.00	1,320
1940	..	..	..	..	..	..	..	..	..	..	304.00	14,534	304.00	14,534
1941	..	..	..	..	5.00	175	5.00	175	..	..	56.00	2,703	61.00	2,068
1942	..	..	..	..	11.00	550	11.00	550	24.00	289	84.00	4,949	119.00	5,788
1943	12.25	456	..	..	40.60‡	550	52.85	2,708	8.08	87	181.55	10,090	243.60	12,075
1944	..	..	..	..	12.04	656	12.04	656	23.00	226	273.40	9,074	308.53	10,856
Total (quantities to nearest ton)	1000.00	41,444*	270.00†	17,209	1,202.00§	20,800	2,488.00	89,625	61.00	622	1,054.00‖	45,681	3,602.53	136,030

* Incomplete. † Approximately 20 tons from Dead Bullock Well. ‡ Includes 8.75 tons purchased from various producers in Marble Bar district. § Approximately 814 tons from Sherlock. ‖ Probably greatly understated. ¶ Including .85 tons chrysotile valued at £17 from Rocbourne. ** Including Silver Sheen production: 1933, 5 tons value £197; 1936, 2.35 tons value £180; 1937, 8 tons value £700. †† From Bulong, East Coolgardie Goldfield.

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TABLE XV.

ASBESTOS PRODUCTION—AUSTRALIA.

Year.	Crocidolite.		Chrysotile.		Amphibole.		Total.	
	Tons.	£A.	Tons.	£A.	Tons.	£A.	Tons.	£A.
1880 ..	..	..	..	..	12.40	323	12.40	323
1881 ..	..	..	..	..	..	..	..	..
1882 ..	..	..	..	..	7.50	75	7.50	75
1883–84	..	..	..	..	..	..	..	..
1885 ..	..	..	..	..	6.00	90	6.00	90
1886–89	..	..	..	..	..	..	..	..
1890 ..	..	..	20.00	363	..	..	20.00	363
1900 ..	..	..	12.80	113	..	..	12.80	113
1901 ..	..	..	4.65	45	..	..	4.65	45
1902–06	..	..	..	..	..	..	..	..
1907 ..	..	..	..	..	5.00	50	5.00	50
1908 ..	..	..	40.00	1,600	..	..	40.00	1,600
1909 ..	..	..	2.83	154	15.00	150	17.83	304
1910–14	..	..	..	..	..	..	..	..
1915 ..	0.35	5	..	..	0.50	5	0.85	10
1916 ..	21.00	210	1.50	30	..	..	22.50	240
1917 ..	..	..	27.10	271	10.00	100	37.10	371
1918 ..	..	..	294.40	5,130	..	..	294.40	5,130
1919 ..	..	..	247.00	4,656	12.00	48	259.00	4,704
1920 ..	5.00	90	812.50	14,626	8.00	64	825.50	14,780
1921 ..	2.00	71	1,140.35	37,021	40.00	276	1,182.35	37,368
1922 ..	..	..	742.68	19,018	..	..	742.68	19,018
1923 ..	7.35	161	318.85	8,299	..	..	326.20	8,460
1924 ..	4.00	80	73.58	2,206	..	..	77.58	2,286
1925 ..	..	..	50.74	1,641	..	..	50.74	1,641
1926 ..	..	..	105.34	2,728	4.50	20	109.84	2,748
1927 ..	..	..	10.80	304	..	..	10.80	304
1928 ..	..	..	11.70	782	..	..	11.70	782
1929 ..	..	..	255.95	14,721	..	..	255.95	14,721
1930 ..	..	..	82.30	4,728	..	..	82.30	4,728
1931 ..	1.00	18	121.07	1,592	..	..	122.07	1,610
1932 ..	20.00	130	109.95	1,762	..	..	129.95	1,892
1933 ..	13.00	113	266.00	4,917	..	..	279.00	5,030
1934 ..	..	..	155.00	2,075	..	..	155.00	2,075
1935 ..	35.00	309	141.00	2,889	..	..	176.00	3,248
1936 ..	76.00	678	158.00	3,668	4.00	36	238.00	4,382
1937 ..	111.00	1,014*	28.00	1,950	26.00	192	165.00	3,156
1938 ..	92.00	2,954	68.00	2,881	13.25	146	173.25	5,981
1939 ..	67.00	1,613	4.00	232	7.00	40	78.00	1,885
1940 ..	461.00	15,836	..	..	28.00	240	489.00	16,076
1941 ..	206.00	6,129	8.50	295	37.00	370	251.50	6,794
1942 ..	142.00	5,832	128.00	4,830	61.00	629	331.00	11,291
1943 ..	193.00	10,335	476.25	19,363	9.00	87	678.25	29,785
1944 ..	279.00	16,052	461.99	16,778	23.00	226	763.99	27,056
Total ..	1,736.00	55,686	6,380.00	182,568	329.00	3,167	8,445.00	241,415

* Incomplete.

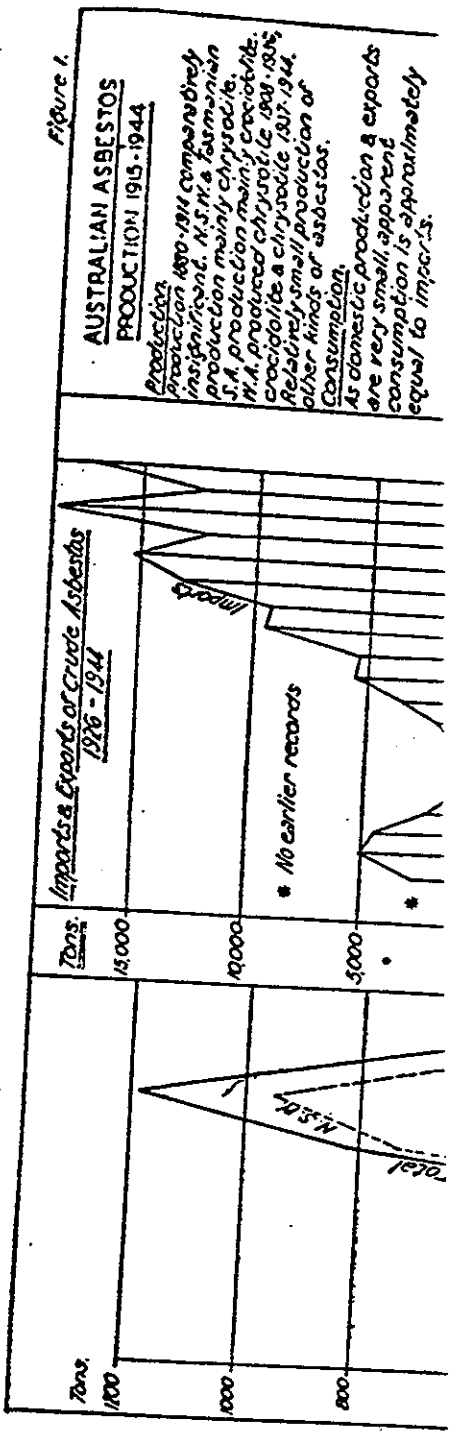

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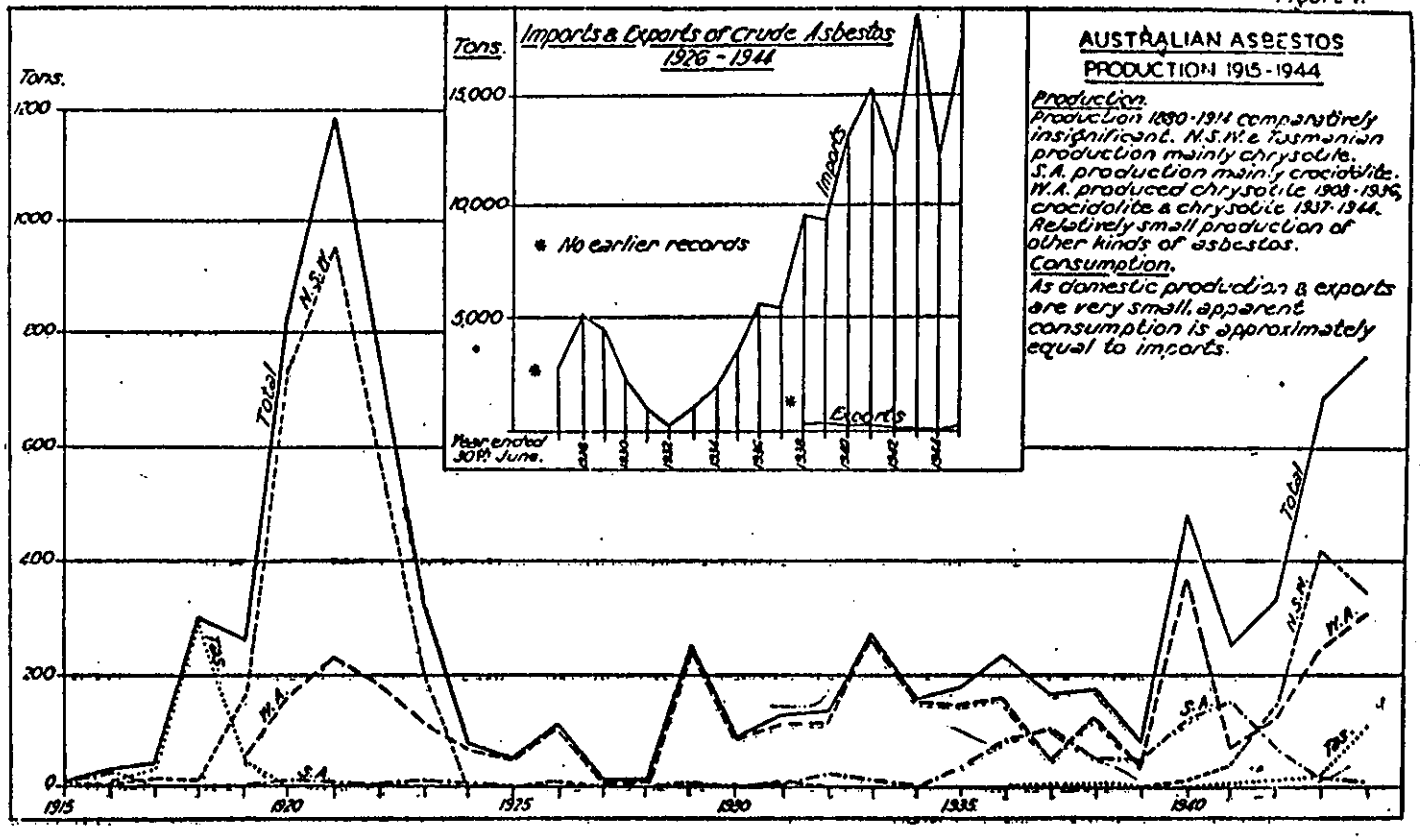
Figure 1.



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