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THE OPAL INDUSTRY IN AUSTRALIA

by

I.C.H. Croll

BUREAU OF MINERAL RESOURCES.

(MINERAL ECONOMICS SECTION).

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SUMMARY.

A report on the Opal Industry in Australia has been prepared in the Mineral Economics Section of the Bureau of Mineral Resources. Part 1 deals with the production of opal and includes sections on the history and present operations in the industry (page 4), production and oversea trade statistics (page 9 and tables 1 and 2), and the types of mining tenures at present available to opal miners (page 7). The fields at present being worked are described (page 11) and the factors which affect production are discussed (page 25).

Part 2 deals with the marketing of opal and includes sections on the cutting and preparation of the stone (page 28), markets at home and abroad (page 30), and the various factors affecting trade (page 31). A number of proposals for improving trade and trading conditions generally are discussed (page 33), and the report concludes with a list of references in literature (page 40), two graphs showing the value of opal produced in each State and the whole of Australia, from 1890 to 1947, and a map of Australia showing localities mentioned in the text.

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(17) It is suggested that a Committee of Control representing all sections of the industry be set up to safeguard and promote its economic welfare; to conduct publicity and marketing campaigns in Australia and abroad; to advise on prices, markets, training of lapidaries etc; to arbitrate in any dispute concerning valuation; and any other functions designed to promote greater stability in the industry .. page 38

(18) Statements in the press regarding the value of the opal industry are exaggerated. Statistics show that it is a small non-essential industry; if the recorded value of production represents only one tenth of the actual value, the industry would still be small and would have no claims to preferential treatment on the sentimental or economic grounds .. page 39.

THE OPAL INDUSTRY IN AUSTRALIA.

The compilation of this report has only been made possible by the co-operation of Commonwealth and State Government Departments and of numerous individuals concerned with the mining, cutting and marketing of opal. This assistance is gratefully acknowledged.

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INTRODUCTION.

The opal industry in Australia has experienced a marked revival during the past few years, and the value of production during 1946 was the highest recorded for forty years. It is believed that the more buoyant conditions are due primarily to the purchases made by American troops when they were stationed in this country during the war, and the publicity given to the gems when the troops were repatriated and dispersed to their homes. Apart from the direct effect of this publicity on the demand for the gem, the discovery of good stone in a hitherto unprospected portion of the principal field led to considerable improvement in recorded production.

American interest in opals has become a little more discriminating but is being well maintained, and it has been suggested in the press and elsewhere that the export trade could and should be expanded as a means of improving dollar earnings. It is frequently pointed out that Australia is the principal opal producing country in the world, and that this pre-eminence should enable us to exercise what virtually amounts to international control of the industry. Whilst there are cogent arguments against any attempt to establish world control, a good case may be made in favour of some method by which a greater degree of economic stability could be achieved in the industry within Australia. The possibility of devising a method which would be in the best interest of all sections of the industry was investigated by the Bureau of Mineral Resources, and the results of the enquiry form the subject of this report.

At the outset of the investigation it was obvious that it would be impossible to obtain the opinions of every individual in the industry, which includes miners, lapidaries, buyers, gem merchants, and jewellers in all States, and an endeavour was therefore made to obtain information from what might be fairly regarded as representative cross section. Visits were made to the two principal fields (in South Australia), and discussions were held with interested parties in Adelaide, Melbourne, Sydney and Brisbane. As may be expected there was a wide diversity in the opinions expressed, but it is pleasing to record appreciation of the assistance rendered by everyone concerned. Special reference may be made to the co-operation extended by officials of the Mines Departments in South Australia, New South Wales and Queensland, and of the helpful views and criticism expressed by members of the Progress Committee, Andamooka, and the Gemmological Association of Australia, Sydney.

It is appropriate at this stage to emphasise several points which must be kept constantly in mind if the opal industry is to be considered in its proper perspective. As far as can be ascertained there is no commercial use for opal other than as a gemstone, and it must therefore be regarded as a non-essential luxury item. Although opal may have a considerable value as an export commodity, the industry is subject to vagaries of fashion and other unpredictable factors which make stabilisation extremely difficult. Besides this disability is the relative insignificance of opal production compared with that of other minerals - on the basis of recorded value it constitutes approximately .02% of the total mineral production in Australia. It must be clearly understood, therefore, that a small non-essential industry is under review - any departure from this perspective will lead to misunderstanding of the views expressed in this report.

Statistics relating to opal production are by no means complete, and the difficulties of obtaining correct figures or even reliable estimates are almost insuperable. The reasons may be summarised as follows:-

(i) The reticence of the miners regarding their discoveries and production. Through bitter experience they have learned to distrust each other, and consciously or otherwise they have become secretive or give misleading information. As the fields are situated in regions where police supervision is necessarily nominal, reticence amongst individuals is probably a good policy to follow, but there is little to be gained by withholding correct information from government authorities who are bound by law to treat it as confidential.

Another reason for the miners' diffidence is the firmly held belief that production figures will be used as a check against taxation returns, or to determine the earnings of pensioners. The isolation of the fields is an inducement to evade the law relating to taxation and pensions, and it would be difficult to eliminate a practice which can be followed with such relatively small risk of detection.

(ii) The reluctance of miners to register claims. It is argued that an opal gouger has little to gain by registering a claim, as it imposes upon him certain obligations which nullify the nominal protection given to his rights. The obligations most irksome from the miner's point of view are the labour covenants and the necessity of making returns. The former is a genuine difficulty; the latter is too often regarded as an unnecessary infringement of personal liberties. The result is that comparatively few miners register claims, and as there is no authority to compel the others to make returns the statistics are incomplete.

(iii) The difficulty in valuing opal in the rough state. Most of the stone leaves the field in the rough state, and its value can only be estimated. In some cases - probably in a majority - the price paid represents a fair value of the stone in the rough, but in others there is a large divergence between price and value. If the price paid to the miner is accepted as the value of production the latter will be under-estimated, and unless some other basis of valuation could be devised the statistics will be unsatisfactory.

For these and other reasons it will be understood that values of production quoted in this report must be regarded as comparative rather than absolute, and it may be safely assumed that they are all under-estimated.

The remainder of this report is divided into two major parts - the first dealing with the production of the raw material, the second dealing with the marketing aspects and a discussion of the various methods which have been suggested for stabilisation of the industry. Emphasis throughout is on the present rather than the past, although some historical data are included as essential to a proper appreciation of the present circumstances in the industry.

PART I - PRODUCTION OF OPAL.

1. THE CHARACTERISTICS OF OPAL.

The mineral opal is an amorphous form of silica containing variable amounts of water, usually between 3 and 9 percent. It is softer than quartz and has a lower specific gravity, but both hardness and specific gravity vary with the quantity of contained water. The mineral occurs in a wide variety of forms and colours of which the following are the most common:

(i) Precious Opal. Characterised by vitreous, pearly or resinous lustre and a play of colours which give it a distinctive appearance when cut and polished as a gem stone. The value of a stone depends largely on the intensity and pattern of the colours and vivid reds, yellows and green are more highly prized than duller blues and pinks. (See a later section of this report).

Two main varieties are recognised in Australia - the white opal in which the stone is translucent and milky, and black opal which is dark grey or black and almost opaque. The latter variety is not recorded outside Australia, but white opals have been obtained in other countries, notably Hungary and the U.S.A.

Minor varieties which have been used for gem purposes are fire opal, which has a vivid colour but lacks the play of colours of white or black opal, and water opal which is almost transparent and has a play of colours simulating drops of iridescent water. The latter variety has been obtained in Mexico, but is not as popular as other opals.

(ii) Common Opal. Probably the most common form of opal in Australia is wood-opal in which the structure and appearance of wood have been preserved by replacement with opal. The colour varies but is dominantly brown, cream or variegated. Another form which may be as common as wood opal is that to which the miners refer as opal potch. This is identical with the precious opal except that it lacks the play of colours and is consequently valueless as a gemstone. In any field a large quantity of potch has to be mined and closely inspected for the small amount of gem-quality material it may contain. Opal-agate is a form with banded structure due to deposition of opal of different shades of colour. Hydrophane is a variety which displays opalescence only when immersed in water.

Authorities are not agreed as to the cause of the distinctive play of colours in precious opal, but it is probably related to the presence of microscopic cavities and fissures in the stone. These minute cavities have an important significance in the utilisation of the material, as they allow it to flaw very readily during cutting, and they also provide conditions favouring rapid disintegration of the stone when it is exposed to atmospheric weathering or extremes of pressure and temperature. For the latter reason, opal found at or near the surface is useless for gem purposes, and as a general rule an outcrop is useful only as an indication of the existence of a seam which may be worth prospecting underground.

The conditions favourable to the occurrence of opal may be briefly stated since they have a direct bearing on the distribution of the mineral in Australia. The essential conditions are -

(i) The presence of silica - a constituent of such rocks as sandstone, or provided by decomposition of silicates in other rock types.

(ii) Presence of a solvent, either as circulating ground water, or magmatic water associated with vulcanism.

(iii) Suitable conditions of temperature and pressure which will enable the silica to go into solution, probably as a colloid.

(iv) Migration to a region or zone in which the temperature and pressure favour precipitation.

(v) Suitable cavities or fissures in which deposition may take place. These may be cracks or other channels in sandstone or shales, the interstices in a coarse conglomerate, or vesicles in igneous rocks. Deposition may also take place by replacement, as in the case of wood-opal or replacement of fossil shells.

The application of these general conditions to particular fields in Australia will be referred to in a later section of this report.

As far as is known, attempts to produce synthetic opals have been entirely unsuccessful, although it is the opinion of some gemmologists that doublets should be regarded as synthetic. This will also be discussed later.

2. INDUSTRY IN AUSTRALIA.

a) Historical Details.

There is indirect evidence that the earliest discovery of opal in Australia was at a locality near Angaston, South Australia, by a German geologist named Mingaye (or Menge). In the discussion which followed presentation of a paper to the Australian Institute of Mining Engineers in 1894 (Gipps 1894) a member named Serjeant stated that in 1849 he had been shown the site at which Mingaye had found opal near "Tarrawilla", the head station of Mr. Angas, M.L.C. He did not state that it was the precious variety, but as some opal from Angaston was sent to the London Mining Exhibition in 1890 it may be fairly assumed that it was precious opal and that it was obtained at or near the locality discovered by Mingaye. If this assumption is correct, the existence of precious opal in Australia was known before 1849.

The first precisely recorded discovery of precious opal was at two localities in Queensland - at Listowel Downs N.E. of Adavale, and at Springsure - in 1872, but there are no regular records of any commercial production prior to 1890. (Dunstan, 1913) The Listowel Downs discovery was the forerunner of many others in a region about 250 miles wide and 550 miles long, extending from Hungerford in the south to Kynuna in the north (Cribb 1948). The earliest discovery in N.S.W. was on the Abercrombie River, in the Lismore district, some time prior to 1877 (Pittman 1901), but the most significant finds were made in the 1880's when opal was recorded at Lightning Ridge and White Cliffs. The establishment of a township at White Cliffs about 1890 marks the start of opal production as an industry, and the White Cliffs area is the oldest of the recognised fields in Australia. The Opalton field in Queensland was proclaimed in 1896 and the Paroo field in 1897, but neither

of these achieved the economic importance of White Cliffs or Lightning Ridge. Some precious opal was produced at Tintenbar, near Lismore, N.S.W. following the discovery at that locality in 1901, and good quality stones were found at Coolgardie, Western Australia, in 1904. There is no record of the quantity produced at this or other localities in Western Australia, but it is believed to be small. Commercial production was commenced at Lightning Ridge, N.S.W. about 1905.

The next important discovery was in 1915 when opal was found at Stuarts Range in northern South Australia. The field developed from this discovery was called Coober Pedy and production of opal has been variable but continuous until the present time. The Grawin, portion of the Lightning Ridge field in N.S.W. was opened in 1926. The most recent discovery which has led to the establishment of a field was in 1930, when opal was found at Andamooka Station to the west of Lake Torrens, South Australia. A marked revival was experienced at Coober Pedy following the discovery in 1946 of a rich patch of opal in a hitherto unprospected area about 8 miles from the centre of the field.

In 60 years of opal production there has been no advance in mining technique, and the miners of today follow the same procedure, with the same type of equipment, as the miners followed in the early days of the industry. Only one attempt at operation by a Company is recorded, when in 1898-1900 the White Cliffs Opal Mining Company worked an area of about 300 acres by employing tributers or by means of day labour. The unsatisfactory outcome of the experiment led to the appointment of a Royal Commission N.S.W. to enquire into the industry at White Cliffs and the mining and sale of opal in general. The Commission's report (1901) deals at length with the problems of company control of opal mining and concludes with the following recommendations.

"To summarise the result of our investigation, and the opinions which, after careful deliberation, we have formed on the several questions dealt with in the foregoing report, your Commissioners respectfully submit the following recommendations:-

(1) That the Government should offer to redeem the unexpired portion of the leases now held by the White Cliffs Opal Mines, Limited (300 acres in all), at the price mentioned herein, the estimated capitalised value of the shares being represented by a cash payment of £8,400.

(2) That if this be effected the land be revested in the Crown, and thrown open for mining in small areas under Miner's Right or Mineral License.

(3) That in the event of the said Company not coming to terms with the Government it be a recommendation to the Company that in lieu of the tribute system a small weekly rental should be charged for the privilege of working on their blocks under agreement, which agreement should not be made for a shorter term than three months.

(4) That a rigid system of registration of all opal buyers, cutters, and polishers, be enforced under conditions outlined in our report, page 7, and that the fee for registration should be small.

(5) That provision be made in the new Mining Bill for the proper registration of all business or residence areas, claims, or shares in claims upon the White Cliffs

Field, at a nominal fee, say 1/-, and within two months of possession.

(6) That no opal buyers, cutters, or polishers be allowed to hold claims or interest in claims on the field.

(7) That prospecting under Government aid should be encouraged in the district; and that the whole question as to the manner in which such aid shall be given be referred to the Prospecting Board for consideration.

(8) That no more mineral leases be under any circumstances issued in the White Cliffs opal-bearing district, and that no claim be allowed in excess of 100 feet square."

Appointment of this Royal Commission was significant, as it was the first attempt to find a means of stabilising and improving the status and condition of the industry. Although the enquiry was conducted by a State Government authority, it covered the greater part of the producing side of the whole industry since more than 90% of all opals produced in Australia as that time came from N.S.W. The Government gave effect to some of the recommendations, but no action was taken on those relating to registration of opal buyers, cutters etc. Suggestions similar to those advanced by the Royal Commission will be mentioned in a later section of this present report.

In 1920 the South Australian Government commissioned Mr. M. Schlank to enquire into the sale of opals in England and elsewhere, and his report (1921) emphasised the difficulties of overcoming the superstitious prejudice against opal and of devising a suitable basis for trading. He gave serious consideration to the possibility of adopting a trade name which would overcome the prejudice against opal, but there is no record that the suggested term "Iridos" was ever adopted.

b) Present operations.

It is estimated that nearly 98% of opal produced in Australia during 1947 came from Coober Pedy and Andamooka in South Australia. The remaining 2% were produced at White Cliffs, Lightning Ridge and Grawin, in N.S.W. and near Quilpie in Queensland. The relative superiority of the South Australian fields over all others has been maintained since 1936, and they will probably occupy this favourable position for some time to come. The number of miners is approximately 150 of whom about 100 are in South Australia.

The present demand for good quality opal is said to be keen, but buyers claim that very little is offering and that the bulk of the material they purchase is of inferior grade. High prices and a buoyant market are apparently insufficient inducement for miners to engage in organised prospecting, and the boom production of 1946 - 1947 was the outcome of an accidental discovery (the "eight mile" at Coober Pedy) rather than the normal expansion of supply to meet a rising demand. The physical hazards of prospecting in dry and inhospitable areas are very real and prospectors must be well equipped to remain away from a supply base for more than a few days. Men who are in a financial position to purchase good equipment naturally prefer to remain near the centre where they have made the money, or to give up opal mining altogether, whereas others who would be prepared to go prospecting cannot afford the necessary equipment. Thus, very little of the money earned during a boom period is used in developmental work (exploration), and as soon as a rich patch is worked out there is a recession in the general level of production until another fortuitous discovery is made. The indications are that production is falling at the present

time, and it appears to be inevitable that the decline will continue until the next accidental discovery is made.

A few men on the fields are engaged in cutting and polishing stones and making doublets, principally for the tourist trade, but the greater part of the rough stone is sold to buyers who visit the fields from time to time, or to resident agents who act on behalf of city buyers. Business is transacted on a cash basis and a certain amount of secrecy is observed for reasons already stated. Sydney is the centre of the cutting and polishing section of the industry but lapidaries are also established in Melbourne, Brisbane and Adelaide.

c) Mining Tenures.

The following notes refer to the types of mining tenures available to opal miners and the conditions under which they are held in each State. Reference should be made to State Mining Acts and Regulations for more detailed information.

(i) South Australia.

Precious Stones Claim. Any holder of a miner's right may peg out and register one precious stones claim, which shall not exceed 150 feet square. This confers the right of residence on the claim, to mine for precious stones, and ownership of those found. At least one man must be constantly employed on the claim, the registration of which remains in force during the currency of the miner's right. Returns showing quantity of precious stones produced and other particulars must be lodged during January and July. With permission of a warden, not more than four adjoining claims may be amalgamated and worked as one, in which case the number of men employed must not be less than the number of claims amalgamated. The labour conditions shall not apply on public holidays or for one calendar month commencing on the 15th. December each year. A warden may suspend the labour conditions after 3 months work has been performed, for any period not exceeding 3 months.

Fees: Miner's Right 5/- per annum.
Registration of claim 2/6.
Amalgamation of claims 5/6.
Suspension of labour conditions 6/-.

Search Licence. Any holder of a miner's right may be granted a licence to search for precious stones over an area not exceeding 5 square miles, the licence remaining in force for twelve months. The licensee must employ at least one man for each square mile of the licence area, work to commence not more than 3 months from the granting of the licence and to be constant for the remainder of the licence term. Exemption or partial exemption of the labour condition may be granted in certain circumstances. Licensee must report any discoveries made, and has preferential right to a precious stones claim. No person may directly or indirectly hold more than 5 square miles under licence at any time.

Fees: Miner's Right 5/- per annum.
Licence £1 per square mile.
Exemption from labour conditions -
10/- for one month. £1 up to 3 months.

(ii) New South Wales.

Mineral Claim. Any holder of a miner's right may register a mineral claim, which shall not exceed 100 feet square for opal.

Registration of a claim is effective until the end of the year in which it is made, and may be renewed for each calendar year thereafter. Application for renewal must be made during December or January and no fee is required. Returns showing quantity of mineral produced during the calendar year must be lodged in the succeeding January. At least one man must be constantly employed on each claim except on certain public holidays and from 20th. December to 7th. January inclusive. Two or more adjoining claims may be amalgamated with consent of the warden.

Fees: Miner's Right 5/- per annum.
Application for registration of claim 2/-.
Registration of claim 2/6.
Application for amalgamation 1/-.
Certificate of amalgamation 1/-.

Mineral Prospecting Area. Any holder of a miner's right is entitled to take possession of a prospecting area not exceeding 400 feet square (in case of opal) and at least one miner must be efficiently employed on the area until it is abandoned or payable quantities of mineral (opal) are discovered. Registration may be effected but is not compulsory. Discovery of payable stone must be notified within 7 days and a lease or mineral reward claim must be applied for within 28 days.

Fees: Miner's Right 5/- per annum.
Application for registration (if desired) 2/-.
Registration 2/6.

Mineral reward claim. Any holder of a mineral prospecting area is entitled to mark off and occupy a mineral reward claim not exceeding 150 feet square (for opal). Conditions of tenure, fees etc. are the same as for mineral claims.

Lease. An opal mining lease may be granted, the maximum area being one half acre. At least one miner must be employed. The area has to be surveyed and the applicant must pay the survey fees. Royalty is payable at the rate of 1% of the value of the opal won from the lease. The lease may be issued for any period up to twenty years and the lessee has certain rights of renewal. Two or more adjoining leases may be amalgamated with consent of the Minister. Production returns for the preceding calendar year must be forwarded during the month of January.

Fees: Miner's Right 5/- per annum.
Survey £1.5.0.
Registration 10/-.
Rental 2/- per annum (Crown Lands)
" £1 " " (private lands)
Amalgamation of leases £1 per lease.

(iii) Queensland.

Prospecting Area. Any holder of a miner's right may be granted an area in which to prospect. In the case of minerals other than gold or coal, the maximum area is 160 acres if it is outside the limits of a proclaimed mineral field, and from 10 to 40 acres if within the limits of a mineral field, according to the distance from the nearest mine. Registration must be effected, and must be renewed monthly, provided that the Warden may exempt a prospecting area from the necessity for renewal for an additional period up to 30 days. At least one man must be employed, and any discovery must be reported within 14 days.

Fees: Miner's Right 5/- per annum.

Claim. The holder of a miner's right may take up any number of claims, provided that each claim is worked by the prescribed number of men. In ordinary reef or lode ground, for minerals other than gold, the dimensions are 200 feet in length by 350 feet in width for each holder of a miner's right, and up to ten such claims may be taken up conjointly. The labour conditions, which are one man for every 200 feet in length along reef, commence not later than 7 clear days after the claim has been marked off. Contiguous mineral claims may be amalgamated with the consent of at least a two-thirds majority in interest of the shareholders in each claim provided that the total length does not exceed 4,000 feet. Registration of a claim is effected by application to the nearest Warden within 7 days after pegging. A claim is held by virtue of a miner's right and remains in existence indefinitely provided the miner's right is kept in force and the labour conditions are observed or exemption is obtained. Returns of production must be forwarded to the Warden at the end of each month.

Fees: Miner's Right 5/- per annum.
Transfer of claim - 5/- plus stamp duty on consideration.
Amalgamation of claims 5/-.
Labour exemption 10/-.

Mineral Lease. Any person or persons (other than an Asiatic, African or Polynesian alien) or any registered Company may be granted a mineral lease of an area not exceeding 320 acres for a period of not more than 21 years but with certain rights of renewal. Leases for opal mining do not customarily exceed 20 acres. Two or more leases may be amalgamated with permission, but the total area of the amalgamated leases may not exceed 320 acres. The applicant for the lease must lodge a survey fee and the first year's rental with the application. The labour condition is one man for every 10 acres of the lease, but there is an alternative expenditure condition, and exemption for periods up to 6 months may be granted by the Minister. Monthly production returns are required.

Fees: Rental 10/- per acre per annum.
Survey: Ranging from £2 for 1 acre to £17.10.0 for 320 acres.
Transfer of lease: £1 plus stamp duty on consideration.
Amalgamation of leases: £10.
Labour exemption: £1.1.0. for periods not exceeding 1 month, or £3.3.0. for period over 1 month and up to 6 months.

(d) Production and Overseas Trade.

The estimated value of opals produced in Australia from 1890 to 1947 is shown in Table 1 and the trend of production is graphically illustrated in Figs. 1 and 2. The table and graphs have been compiled from published records of the Mines Departments in the three producing States; for reasons already stated the values shown must be regarded as comparative only.

The profile in Fig. 2 indicates a period of "boom" production from about 1896 to 1903, with an all-time maximum in 1902. The temporary recession in 1900 was probably due to severe drought conditions which prevailed in N.S.W. and Queensland at that time. The level of production fell in 1904 but then remained fairly steady until 1911, the main fluctuations being due to increased activity at Lightning Ridge during 1907 and a decline caused by a fall in overseas prices during 1908. From

1912 until 1915 there was a fairly sharp slump in production, and with the exception of a temporary revival in the post-war years (1919-1920) the general level remained very low until the present revival was initiated in 1946. The lowest production was recorded in 1932, during the worst of the depression, when the effect on any luxury industry was particularly evident. The causes of the spectacular rise in production in 1946-1947 have already been referred to, but it should also be mentioned that the increase indicated by statistics is partly attributable to improved methods of collecting the figures. The South Australian Mines Department has made a determined effort to close the gaps in the statistical returns furnished by the opal miners, and it is probable that the 1946-1947 figures are more nearly complete than those for preceding years. The extent to which this is the case cannot even be estimated, but this factor must be regarded when production trends are under consideration.

It would be very difficult, if not altogether impossible, to trace the cause of each fluctuation in production, which is subject to so many variable influences. The demand for the gem fluctuates according to prevailing fashions or the prosperity of the community, and the ability of the miners to follow these variations in demand or to exercise some control over them is very limited. The climatic conditions on each field have a marked effect on production insofar as they determine the number of men working during a particular season and the length of time they remain on the field. Reliance on fortuitous discoveries to offset depletion of known supplies is another factor which militates against foresight in production, and until some means are devised of overcoming this undesirable feature it is unlikely that production and demand will be properly related. Some of the climatic, economic and other conditions which may have lead to the sharp fluctuations in the recorded production of opal are noted in Fig. 1.

It will be observed that there are three fairly distinct periods during which one State predominated over the others in opal production. From 1890 to 1895, more than half of the Australian output came from Queensland, from 1896 to 1927 the N.S.W. fields were in the lead, whilst from 1936 to the present time the South Australian fields have supplied the greater part of the production. The inference that the Queensland and New South Wales fields were successively worked out or depleted would not be entirely correct. Decline of production in Queensland was due to the persistent drought conditions from 1897 to 1901 (Jackson, 1901), which induced prospectors to transfer to other fields, and was unrelated to the possible exhaustion of opal. The dominance of one State over the others is not necessarily due to the quantity of opal available in any particular area, but is more closely allied to conditions under which the miners must live and work in order to procure the stone. The field with the most easily won opal will inevitably attract the strongest labour force, regardless of the continuity of supplies.

The value of opal exported during the past twenty years is shown in Table 2, which has been compiled from the Overseas Trade Bulletins of the Commonwealth Bureau of Census and Statistics. The figures need little comment, but for statistical purposes, no distinction is made between cut and uncut stone, and the table therefore shows the total value of all stone exported, irrespective of condition. The value quoted for exports is therefore not on the same basis as that quoted for production and might lead to the mistaken impression that more opal was exported than has been produced for many years.

The statistics show that the U.S.A. have been Australia's best overseas market, with the U.K., Germany & Ceylon following in

that order. At current rates of exchange the sales to America during the financial years 1942 to 1947 inclusive represent an income of 335,000 dollars.

3. AUSTRALIAN OPAL FIELDS.

The following notes refer only to those fields from which opals are being produced at the present time, and no attempt is made to describe the abandoned fields in detail or to discuss the causes of their decline. All producing fields have the following features in common:

(i) The opal seams occur in beds of sandstone and clay, with some coarse conglomerates and glacial erratics.

(ii) The fields are situated in arid or semi-arid regions with low rainfall. Arid conditions favour the upward movement of siliceous solutions and the subsequent deposition of silica, either as a siliceous capping (duricrust) at the surface or as seams of opal in suitable channels at shallow depths.

(iii) Known opal seams occur at shallow depths rarely exceeding about 100 feet from the top of the duricrust. Where the duricrust has been eroded and removed, the opal seams are correspondingly nearer the present surface.

(iv) Peneplanation has reached an advanced stage and the regions in which opal is produced have very low topographic relief and comparatively poorly defined physical features.

Ward (1916) has pointed out that with one exception the precious opal fields lie in a region with an annual rainfall of less than 15", and the 15" isohyet may be regarded as indicating the geographical limit of the opal bearing area in Australia. The exception mentioned by Ward is the Lightning Ridge Field, which has a rainfall of about 16½" per annum, a difference of only minor significance.

The only deposits of any importance outside these limits were those at Tintenbar, N.S.W. where the opal was deposited in amygdaloidal cavities in basalt, and was presumably derived from magmatic solutions instead of by leaching from siliceous beds, as is the common method in Australia. The position in which the opal was found was due to conditions other than climatic and the field does not constitute an exception to the general rule that any area of Cretaceous beds (or similar lithological types) occurring in the semi arid region of Australia within the 15" isohyet is worth prospecting for precious opal, and that discovery of commercial quantities of precious opal is unlikely in regions where the rainfall is substantially higher than 15" per year

a) Coober Pedy, South Australia.

(i) Historical. The discovery of precious opal at Coober Pedy was noted in the S.A. Mining Review for the first half of 1915 (No. 22) in the following terms.

> "A prospecting party sent out by the New Colorado Prospecting Syndicate to prospect some of the Far North-Western country between Lake Phillipson and the railway made a discovery of opal, which proved to be of the precious variety and similar in character to that

found at White Cliffs. The locality is at Stuart's Range, about 70 miles west of Anna Creek Station. Very little work has been done so far, the country is destitute of water, and on account of the war the market is disorganised."

Little mining was carried on during 1916 and 1917, but the post-war years of 1919 and 1920 were marked by an influx of miners and sudden rise in the estimated value of output from £7,000 in 1918 to £20,000 in 1919 and £24,000 in 1920. Under the combined effects of an acute drought and a depressed market the production fell during the next four years, but a recovery was noted from 1925 to 1929. A large water storage tank, which has been constructed at Government expense, was filled to capacity by good rains in 1926 and since then the field has always had some water available. The population of the field has fluctuated according to the variations in demand for opal, market conditions and other factors, but the maximum number of men employed in mining did not exceed about 300 in any year. The aggregate value of production from 1916 to 1946 is estimated to be £222,000 (Parkin 1946), and the annual production varied from as little as £500 in 1917 to £55,000 in 1946. A spectacular rise of £54,000 in value of production occurred in 1946, following the discovery of good opal at the "eight mile".

The original name of "Stuarts Range Opal Field" was officially abandoned in favour of the aboriginal name "Coober Pedy" which is said to mean "white man in a hole" - an illusion to the fact that almost everyone on the field lives by choice in underground dugouts. These have the advantage of being cool in summer, comparatively fly-proof, easy and cheap to construct, and do not require the use of timber, which is scarce and has to be carted long distances.

Reports on the field and notes on the current operations have been published in various numbers of the Mining Review, issued by the Department of Mines, South Australia, the principal geological statement being by Ward (1916)

(ii) Geographical features. Coober Pedy is situated at latitude 29°2' south, longitude 134°48' east, approximately 125 miles north of Tarcoola on the trans-Continental line and 96 miles westerly of William Creek railway station on the Alice Springs line. Access is normally by rail from Adelaide to Kingoonya via Port Pirie and thence by road transport, 163 miles, to the field. Alternative routes are from Tarcoola (147 miles), or William Creek (98 miles) the latter route involving a train journey nearly 100 miles longer than for the former.

Stuarts Range is the name given to the insignificant topographic feature which constitutes the divide between two drainage systems - the basin of Lake Cadibarrawirracanna to the north-east and Lakes Woorong, Phillipson and Wirrida to the south-west. The lakes and drainage channels are dry for the greater part of the year and only contain water for short periods after heavy rain. The average rainfall is about 6" per year and the climate is mild during the winter but very hot during the summer months, when many miners and their families temporarily leave the field.

The divide consists of an open plateau with a very gentle slope to the south and a fairly abrupt deeply embayed scarp on the northern and north-eastern flank. The embayment of the scarp has left numerous spurs and flat topped outliers which indicate the former northward extension of the plateau. The height of the scarp would be about 65 feet and the slope is about 15°. The field extends about 40 miles in a N.W.-S.E.

direction and has a width of about 6 to 8 miles. Most of the opal mining has taken place adjacent to the north-eastern flank of the plateau, either at the scarp or in the broad flats between the outliers and spurs. The most intensively worked area is the Big Flat, which lies to the west of the present post office and store.

(iii) Geological Features. The following sequence may be regarded as typical of the field:-

Superficial layer of smooth rounded "gibbers". These are very hard silicous and ferruginous boulders ranging in size from less than one inch to a foot or more diameter, and they form an almost continuous but thin mantle over the tableland surface.

Approximately 15 feet of grey or brown quartzite with some conglomerate and porcellanite. This represents a zone of surface silicification (duricrust) due to the deposition of silica leached from underlying beds by ascending solutions, and is characteristic of arid climatic conditions. The quartzites etc. are very hard and form a protective covering which has slowed up the process of erosion in the comparatively soft beds on which they rest. Wherever the siliceous capping is intact the outliers have the form of a typical flat topped mesa, but where it has been removed by erosion the outliers are merely low rounded hillocks.

A zone of pink and cream mottled clay with scattered flakes of selenite. This may not be continuous over the whole field but is a distinct feature in the dugouts near the present post office and store, where it is not less than 8 feet thick.

White, cream, or pale pink siliceous claystone with one or more horizontal seams of fibrous gypsum up to eighteen inches thick. The claystone is very porous and it has been suggested by Crespin (1948) that the minute rounded cavities are the result of dissolution of radiolarian tests, which may have provided the siliceous content of the claystones and of the overlying quartzites. Poorly preserved foraminifera and radiolaria have been identified as of Lower Cretaceous age (Crespin, 1948)

Pink or brown ferruginous sandstone associated with veinlets of precious opal or pelecypod shells replaced by opal. This sandstone is a variant of the overlying claystones, and probably represents the original form of the material before the silica and iron were removed by leaching. The change from one to the other is almost imperceptible. The sandstone with opal is the lowest horizon exposed in the mining shafts and the thickness cannot be determined, but the total thickness of the beds below the quartzites (including the mottled clay) exceeds 60 feet. Jack (1931) and others have recorded the occurrence of glacial erratics in the Lower Cretaceous beds.

(iv) Occurrence of Opal. The seams of opal vary in thickness from about 2 inches to a fraction of an inch and they are irregular in their occurrence. Some are vertical, but the majority are horizontal or nearly so. Many of the veins are not continuous and are more in the nature of lenticles occuring in a series of fissures or joints. Ward (1916) records one vein or seam which was traced horizontally for more than 50 feet, but this is exceptional and the majority appear to pinch out in a comparatively short distance.

It is generally believed that there is only one opal "level" on the field, although some individual miners claim that there is at least one other below the main one. The main

level is at a depth of about 70 feet below the top of the plateau, and it may therefore be reached within a few feet of the surface on the flats formed by the embayment of the scarp. This has led to concentration of activity on the flats, where a minimum amount of shaft sinking is required.

There are few surface indications to guide miners in selecting sites to prospect, since the opaliferous horizon is relatively flat and is not normally more than a few feet below the surface. Scattered fragments of weathered opal lying at the surface have been regarded as indicating the proximity of a seam which is worth prospecting, but the selection of a site for a shaft is usually quite fortuitous.

(v) General Remarks. Despite the isolation of the field and the inhospitable nature of the country, living conditions during most of the year are not unduly severe. There is a general store and post office, meat supplies are available and the large storage tank ensures continuity of water supplies. The water is sold at the rate of 5/- per 100 gallons at the tank, cartage to camp sites being extra. A mail delivery is made from Kingoonya once a week, and telegraphic communication is maintained by pedal radio on the Alice Springs network. A serviceable landing strip is available for light aircraft and the Flying Doctor provides emergency medical services. Standing timber is entirely absent, and firewood has to be carted about 12 miles.

Most of the dugouts are provided with cooking stoves and are quite comfortable. Electric lighting in some is from storage batteries charged by wind driven generators, and a few are equipped with kerosene refrigerators. Some miners have brought their families to live on the field, but those with children endeavour to move away during the worst of the summer.

Living conditions at the "eight mile" are not quite as good as in the central part of Coober Pedy. The opal is won a few feet below the surface of a low lying area and there is no convenient scarp or outliers in which dugouts may be constructed. The men must therefore live in tents or huts, neither of which are suited to the climate, but some protection from the wind is obtained by erecting them in excavations made for the purpose, so that only the roofs project above ground level. Wood, water and stores have to be carted greater distances.

Several buyers are in more or less permanent residence and others from Sydney, Adelaide, and elsewhere visit the field from time to time. A few men have facilities for cutting and polishing stones and doublets which are sold to tourists visiting the field or passing through on the road to Alice Springs. Most of the opal, however, leaves the field in the rough (uncut) condition.

A few precious stones claims have been registered, but for reasons mentioned earlier they are not regarded by the miners as essential and most men are prepared to accept any risks incurred by not registering.

b) Andamooka, South Australia.

(i) Historical. The discovery of opal at Andamooka was made in 1930 by two boundary riders, Messrs. Brooks and Shepherd. The first miners were Messrs. Treloar and Evans, who are stated to have worked a claim for several months for a return of £1500 (Segnit, 1935). The first officially recorded production was valued at £962 and was obtained during 1933. In 1934 the value

fell to £656, the lowest in the fifteen years for which records are available (Parkin, 1947). From 1939 to 1945 - the war years - the value of production at Andamooka was consistently higher than that for Coober Pedy, which apparently suffered more from withdrawal of manpower. The highest value of production was £17,292 in 1946, and the aggregate to the end of that year £36,088.

The geology of the field was described by Segnit (1935); it should be noted that in a later paper (1939) he published, without discussion, an amended geological map of the area.

(ii) Geographical features. The Andamooka field is situated at latitude 30°26' south, longitude 137°10' east, approximately 18 miles in a direct line and 30 miles by road north-north-east of Andamooka homestead, and about 8 miles west of Lake Torrens near the northern end. Access to the field is by rail from Adelaide to Pimba, and thence about 85 miles by road via Arcoona and Andamooka homesteads.

The region is essentially a dissected tableland with gently undulating hills and low topographic relief. The surface of the tableland is about 600 feet above sea level near Andamooka homestead and there appears to be a gradual downward slope of about 300 feet in 40 miles in a northerly direction. The average rainfall is less than 6 inches per annum and the drainage channels flow only for short periods after heavy rains. Surface water is virtually absent and the opal miners and station population rely entirely on supplies obtained from bores, wells and tanks. Numerous small clay pans, cane grass swamps and dry lagoons are scattered over the region and there are a very few permanent lakes (e.g. Arcoona Lake). Low sandridges are a feature; although they are fixed by vegetation they are responsible for the devious tracks which have to be followed by cars to avoid being bogged. A few inches of sand is just as effective as a few feet in delaying a car with conventional drive, and the four-wheel drive vehicles made available from war disposal stocks are proving much more efficient in the sandhill country.

The field itself is of comparatively small extent and mining has been carried on at eight or nine separate localities on the broad flat spurs formed by Opal Creek and its tributaries. Opal Creek is itself a tributary of Teatree Creek, which runs into Lake Torrens. The full extent of the field is not known, but according to the map prepared by Segnit (1938) it would be at least 4½ miles long in an east-west direction and approximately 3 miles wide. These may be regarded as the potential limits only, as actual operations have been carried out in less than half that area. /1939

(iii) Geological Features. Precious opal occurs at Andamooka in a faulted outlier of Lower Cretaceous beds resting unconformably on quartzites, sandstones and shales of Upper Pre-Cambrian age. The following sequence may be regarded as typical in the immediate vicinity of the field.

Superficial mantle of ferruginous and siliceous "gibbers"
Approximately 15 feet of dense quartzite and sandstone (duricrust). This has been removed by erosion in most of the area but occurs as a capping on a small rise east-south-easterly of the German Gully Workings.
Zone of cream siliceous shale with limonitic veins; thickness not known.
Cream or pale pink siliceous clay and porous sandstone with gypsum in disseminated flakes or in horizontal seams. Foraminifera have been recorded in the lower part (Crespin, 1948) and glacial erratics are said to occur.

Total thickness is approximately 55 feet, including the zone immediately below the duricrust.

(a) "Hard-band" of brown sandstone.
(b) Seam of massive gypsum
(c) Band of coarse conglomerate and boulders up to 9" diameter.
(d) White micaceous clay.

Opal occurs in the interstices of the conglomerate and as a surface film or layer on the boulders, and it also occurs as seams within the clay which underlies the conglomerate band. The conglomerate and clay constitute the opal horizon, and the "hard band" and gypsum (when present) serve to indicate the proximity of the horizon. The sequence described above may be regarded as typical, but is not necessarily continuous throughout the field. The total thickness of this zone may be 5 feet but is variable.

A second boulder band is said to occur below the opal-bearing clay (d)

Approximately 20-25 feet of sandstone, clays and conglomerates with seams of gypsum and glacial erratics.

(?) Jurassic micaceous sandstone.

Upper Pre-Cambrian quartzite, sandstone and shale exposed in the bed of Opal Creek.

The beds above the (?) Jurassic micaceous sandstone are of Lower Cretaceous age and have a total thickness of about 85 feet. They are undisturbed by faulting except along the southern edge of the outlier, where they have been faulted against the Upper Pre-Cambrian quartzites and sandstone. The opal workings near the fault are said to reveal some minor disturbance in the Cretaceous beds, which are otherwise horizontally bedded.

(iv) Occurrence of Opal. The opal bearing horizon already described is at a level approximately 70 feet below the surface of the duricrust, and is therefore exposed on the hillsides where the streams have cut below that level. The bed of Opal Creek in the centre of the field is about 100 feet below the surface of the duricrust and the lowest workings are about 30 feet above the creek bed at this point. A little work was done from adits, but the miners have a preference for shaft sinking and this method of mining is used to the exclusion of others at the present time.

The veins of opal may traverse the clay below the conglomerate at any angle from horizontal to vertical, but flat veins predominate. It is recorded (Segnit, 1935) that the occurrence of opal in the Stevens Gully workings is somewhat different from that in other parts of the field. Here the opal occurs as fine veins in the large angular blocks of quartzite, and the conglomerate and water worn boulders are very scarce or absent altogether. This is probably connected with the proximity of the Stevens Gully workings to the fault which marks the southern limit of the Cretaceous beds.

Andamooka opal varies in colour and is generally darker than that obtained at Coober Pedy or White Cliffs. Some specimens are dark enough to compare favourably with the Lightning Ridge black opal.

(v) General Remarks. Living conditions at Andamooka are considerably less attractive than at Coober Pedy, although the miners are making a corporate attempt to overcome this disability. Water supplies are drawn from wells, one of which is fitted with a windmill and small tank, but the supply is very limited and barely sufficient for essential needs. Postal facilities

are available, the mail being delivered once a week from Pimba, but telegraphic communication via Andamooka homestead is subject to frequent interruptions. It is understood that approval has been given for installation of a pedal wireless transceiver, which will keep the field in touch with medical and other amenities. A general store and a butchers shop are established.

Dwellings are varied in design, some being conventional timber frames with weatherboard, sheet iron, hessian, or other material for walls, and galvanised iron roofs, but the majority are a type of semi dugout. These are constructed by digging an excavation into a hillside, constructing the front wall and portions of the side walls from the blocks of stone dug out, and using rough timber, cane grass and clay to frame and thatch the roof. These dwellings have the advantage of being cooler than iron roofed houses, but offer less resistance to the high winds. Stone, brushwood, or canegrass windbreaks are common where the surface buildings have been erected in exposed positions.

The local Progress Committee is active in improving the social conditions of the field. A small school building has been erected as a community effort and a resident teacher has been provided by the Education Department. First aid facilities are available and the Committee is endeavouring to have a landing strip constructed so that the services of a Flying Doctor may be called on in an emergency.

A few men on the field are engaged solely on cutting and polishing stones and manufacturing doublets, but the bulk of the opal won leaves the field in the rough condition. Buyers visit the field from time to time and some of the residents also buy small quantities of opal for cutting locally or exporting. One experienced miner is recognised as an expert valuer and his services in this capacity are freely used by the other miners.

There appears to be scope for exploratory prospecting within easy reach of the main camp, particularly to the east of the German Gully workings and to the west of the Stevens Gully and Boundary Riders Hill workings. The tendency of the miners to crowd together in areas which have been closely worked is particularly marked at Andamooka, as also is the failure to make the best use of the work involved in shaft sinking; the miners commonly do not open out from the shaft to test the ground in the vicinity.

(c) White Cliffs, N.S.W.

(i) Historical. Opal was discovered at White Cliffs (60 miles by road north-north-westerly of Wilcannia and approximately 120 miles north-east of Broken Hill) in 1884, but it was not until about 1890 that a township was established and production was undertaken on a large scale. Nine years later the population has risen to 2,500 persons, the field was flourishing, but the population had fallen to about 1,600 persons at the time of the Royal Commission in 1901. The highest recorded value of production was £140,000 in 1902, although Murphy (1948) states that the value of production during the boom years of 1897 and 1899 averaged £200,000 per year. At that time the ground was held under mining lease by companies and syndicates who let small areas out to individual miners on tribute. The rate of tribute was at first 50% and later 25% of the opal won, but the system proved entirely unsatisfactory and was abandoned on the recommendation of the Royal Commission.

From 1903 to 1914 there was a sharp decline in value of production regarding which Murphy (1948) makes the following comment:

"By degrees and in various ways, the miners' morals became undermined. They began to sell the best of their opal direct to certain buyers instead of putting it through the office, and without the knowledge of lease-holders. Even brothers and working mates were known, in some cases, to take each other down. One parcel of fine opal, which I bought at £35 per ounce, I found later to have been part of a large haul from Block 1 - just inside my own open cut. All of which - with dozens of other cases - was exposed eventually by the Royal Commission on Opal at White Cliffs, and was my main reason for recommending the registration of buyers and the total abolition of tribute.

Needless to say, illicit or stolen opal meant cheap opal - and when some thousands of pounds' worth, for which the market price at the time was £45 per ounce, was placed on the London market at £25 per ounce the opal market suffered its first severe setback. The large quantity and low price scared London buyers and they stopped purchasing for a time.

Then came a Mr. Rosanove's activities along a new line, known as "potch-box" or "candle-box" trade. For years we had kept the very low-grade opal, called "potch- and-colour", off the market so as to enhance the value of the better qualities. Rosanove started buying up the accumulations, and others followed suit. Tons of candle-boxes of this class were shipped to Germany, their usual price on the field being 5s. per box, that in Germany up to £3. This was the beginning of the end of the White Cliffs opal market, and the outbreak of war in 1914 finished it, since Germany had been chief buyer"

In 1916 only £663 worth of opal was produced, and the field has never resumed the large-scale production of the first few years of the present century. Kenny (1934) quotes the aggregate value of opal produced at White Cliffs to the end of 1933 as £1,167,761, and the value of output since that date would amount to only a few thousand pounds. A very little sporadic work is being done at the present time. The remaining notes on this field are quoted verbation from the report by Kenny (1934).

(ii) Geological features. "A typical sequence embracing the whole of the beds in an opal-bearing area from the surface downwards would be somewhat as follows:-

(a) Siliceous material, secondary quartzite or "Grey Billy". Maximum thickness, 20 feet. A description of this material will be found under "Siliceous Cappings, etc." (pp. 89-93)

(b) Clays, in part sandy, usually reddish in colour with nodules of "Grey Billy" in the upper portions. As much as 10 to 12 feet in thickness where best developed, but may be absent in some places. (a) resting directly upon (c). (a) and (b) are of Tertiary Age.

(c) "Geyser" or "Geaser" - Siliceous material of pisolitic nature closely resembling "Grey Billy." May represent an older development upon the surface of the Cretaceous rocks prior.

(d) Fine-grained sandstone, thinly-bedded and shaley in structure, with a clayey matrix. Probably felspathic sandstones originally. The beds contain abundant marine fossils, silicified wood, and erratic boulders of quartzite considered to be of glacial

origin. Precious opal in places.

(e) "Bandstone", a rock of indefinite composition, but suggestive of a fine-grained sandstone hardened somewhat by silicification of the matrix. Thin beds only.

(f) Beds similar to (d) with precious opal in places.

(d), (e) and (f) are undoubtedly of Lower Cretaceous Age. Thickness not known.

The "Bandstone" is apparently a very important horizon to the opal miner as the gem is developed typically in the ground immediately beneath this bed. Furthermore, it would appear to indicate the downward limits of opal-bearing rock except in those instances mentioned later. The depth from the surface to the bandstone ranges from 25 to 40 feet according to topography.

(iii) Occurrence of Opal. Usually the gemstone is found in minute veinlets of common or potch opal arranged within bedding planes of the Cretaceous sediments - (d) and (f) above, as many as five or six horizons being recorded in the one locality. More commonly, however, it would appear that the main supplies have been won from a "level" immediately beneath the "bandstone". Typically the opal is developed very irregularly on any one horizon, and no seam or vein can be followed for any distance. Furthermore, the gem variety is equally irregular in its occurrence in any seam of common or potch opal worked.

The mineral is found also in vertical or sub-vertical joints and cracks, and, in rare instances, these features, known locally as "verticals" have been followed considerably below the "bandstone". Examples have been reported in which opal has been won from verticals as much as 52 feet from the surface.

In addition opal has been found re-placing fossil remains, mostly shells and wood, as well as portions of erratic boulders of quartzite.

The usual practice adopted in prospecting is to sink a shaft, at the same time keeping a careful watch for favourable indicators, such as veins or streaks of potch opal. Where found these are followed laterally in the hope of obtaining the previous variety. In this quest a most remarkable number of shafts have been sunk at White Cliffs and Gemville, many of which are connected by drives. In fact so close have the shafts been sunk, in many places, that it was found necessary to fill in a pre-existent hole in order to find surface room for dump material from the newer sinking. Very little ground has remained untouched on the known areas, and the small production in recent years has been derived principally from the prospecting of pillars left in old workings.

The capping of dense siliceous material ("Grey Billy") by reason of its hardness has added to the cost and difficulties of prospecting work in many places, but such conditions have been avoided largely by driving adits or tunnels into the hillsides beneath the capping, as at Turley's Hill and Sullivan's Hill, near White Cliffs. However, the prospector prefers a shaft as he is enabled to test a greater thickness of beds with the possibility of the presence of more than one "level" of opal.

(d) Lightning Ridge & Grawin, N.S.W.

(i) Historical. It is recorded that opal was discovered in the Lightning Ridge district as far back as 1880 (Andrews, 1924) but that commerical production did not commence until about 1905 or 1906. The estimated value of production to the end of 1923 (based on Mines Department records) was £359,196, and since that date it is possible that another £80,000 worth has been produced bringing the aggregate value to approximately £430,000. For reasons already mentioned it is certain that this represents an under-estimation and the actual value of production would be considerably higher.

The stone obtained at Lightning Ridge is the black opal which is characteristic of the field and does not occur at any other locality in the world. Murphy (1948) records that it was difficult to sell black opal at first, but as soon as the beauty and distinctive character of the variety was recognised by the public it soon commanded better prices than white opal. During 1908 and 1909, when the average price of opal dropped by about 50% or more, the price for Lightning Ridge black opal remained fairly steady and the field probably helped to keep the industry active.

At the present time there are a few miners working at Lightning Ridge and Grawin, the latter being approximately 20 miles south-westerly of the former and constituting part of the same field. The opal obtained at the Grawin area is good quality but not quite up to Lightning Ridge standard.

(ii) Geographical Features. The Lightning Ridge field is reached by rail from Sydney to Walgett, a distance of 460 miles, thence about 60 miles by road in a north-north-easterly direction. The following notes on the field are quoted verbatim from the report by Andrews (1924):

> "From Narrabri to Lightning Ridge, a distance of 150 miles, the Black Soil Plains extend almost uninterruptedly being broken here and there only by an imperceptible rise of red soil marking the positions of the district not covered by water during the periods of flood. Walgett is situated on the Namoi, immediately above its junction with the Darling or Barwon River. Lightning Ridge and Angledool are situated on the Narran, which is a distributary of the Balonne and which discharges into Narran Lake, only reaching the main river in time for heavy flood.
>
> At Lightning Ridge itself the even skyline of the black soil is broken by long, low, sub-horizontal ridges, rising about 40 to 50 feet above the black soil and reaching an extreme height above the general level of 100 feet approximately. These ridges are not readily perceived from the Black Soil Plain because of the dense cover of box-tree growth on the latter. Black soil plains surround the ridges on all sides.
>
> The individual ridges may be many miles in length, and they form an even skyline, but not so continuous nor extensive as that of the Black Soil Plain. The ridges are usually in the form of low plateaus and join the plain from which they rise almost insensibly by gentle slopes somewhat resembling the gentle fold of the chocolate soil of the wheat belt rising from the surrounding black soil as in Forbes.

Ridges and slopes alike are covered with loose pebbles of quartz and ironstone gravel. In some places pudding stone or conglomerate outcrops, as also a hard rock known as Grey Billy, in loose or continuous masses both on the plateau tops and on the slopes. The weathered forms of the Grey Billy are known as Shin Cracker. This conglomerate with the Grey Billy, covers ridges, slopes and flats alike between Weetaliba and Angledool and thence to the Queensland border to the north. In other places the puddingstone and the Grey Billy have been worn from the summits and the slopes, leaving only a loose cover of gravel, pebbles, and soil overlying a light and porous sandstone.

Black opal in New South Wales is found in the sandstone (and opal dirt) underlying the Shin Cracker or Grey Billy, from the Three Miles to Queensland, a distance of 40 miles.

(iii) Geological Features.

Loose quartz pebbles and soil overlie gravel mainly or iron-stained boulders and nodules. The quartz pebbles are small and well rounded, and of transparent, translucent, and milky types. A reddish colour or varnish may be seen on many of the pebbles. The gravel underlying the shallow covering off iron-stained masses of quartzite, secondary in nature, composed of angular grains of transparent silica, giving a general grey appearance to the mass. The small nodules and ellipsoidal forms of ironstained gravel are composed merely of weathered quartzite showing the desert varnish.

These all represent merely peculiar products of weathering of the relatively thin compound skin or layer of secondary conglomerate and quartzite, the conglomerate generally overlying the quartzite or "Grey Billy". Both the conglomerate or puddingstone and the quartzite differ only in the fact that the one is a secondary quartzite and the other is a mass of pebbles cemented by this secondary quartzite. The combined depth of the conglomerate and the quartzite is variable, but at most it is only a skin or covering of desert weathering to the underlying sandstones. Both types have been worn away completely in many places along the lower slopes of the ridges, but on the summits and upper slopes they vary in thickness from 1 foot to 15 feet, as observed by myself. The quartzite has a sub-conchoidal fracture, and resists the action of weathering in a much less pronounced manner than the quartz pebbles, the latter standing out boldly from the weathered quartzite cement.

At Angledool and Weetaliba the quartzite and conglomerate cap is a pronounced and persistent feature; nevertheless on the richer portions of the opal fields as worked these hard types have been denuded in great measure and the Grey Billy reduced in hardness. Beneath the weathered quartzite or Shin Cracker layers of soft, porous sandstone, somewhat resembling biscuitware, are commonly found. This biscuit sandstone occurs in beds which are relatively thin and are of sub-horizontal disposition. The specific gravity of this porous sandstone is remarkably light, and is said by miners to be less than 15 cwt. per cubic yard. It represents sandstone, a greater portion of whose silica has been attracted to the surface by capillarity and there deposited.

(iv) Occurrence of Opal.

"At Lightning Ridge the holes or shafts sunk in the sub-horizontal summits generally reach the upper opal layer at a depth of 40 to 50 feet, whereas on the slopes of the ridges the opal layer or layers may outcrop or they may have been removed by erosion. At Bald Hill, about 1½ miles north of Lightning Ridge township, the upper level occurs at a depth of 40 to 50 feet below the surface pebbles; a second and sub-parallel layer occurs at a depth of 60 feet; while a third and fourth occur between the depths of 60 and 100 feet from the surface. These levels are not at all persistent, nor are they necessarily horizontal. Moreover there is a general lack of surface indication to guide the miner in his search for the opal. In many places the first or upper level is indicated by the presence of a very thin and hard band of siliceous sandstone known as the Steel Band. Below this occurs a layer of soft material resembling clay or sandy clay. This is know as the Opal Dirt, and is of variable thickness, but rarely exceeds 3 feet. Both in the Steel Band and just below it, and in the Opal Dirt, opal may be found. It may occur in thin seams, but generally occurs as nodules. The latter are tested carefully by snips or pliers to test the quality of the stone inside. Opal may also occur along inclined joints or slight faults in the soft sandstone or Opal Dirt.

Beneath the Opal Dirt layer other beds of a light biscuit sandstone occur, and these in turn terminate downward in places against a lower or second level, with opal Dirt containing opal.

The existence of opal at any particular place appears to depend upon the general character of the sandstone and sandy clay bands with which it is associated, and it may be seen thus that prospecting for the opal is a very difficult process, inasmuch as the sandstone and clay bands vary considerably from point to point within relatively short distances, and such variations are not necessarily indicated at the surface.

The Cretaceous sand-stone covered with the "Grey-Billy" in various stages of preservation or dismantlement admits generally of a threefold division, namely:-

(1) A very dense capping of secondary puddingstone and quartzite. This occupies by far the greater portion of the area.

(2) An area covered with weathered quartzite or "Shin Cracker" not nearly so expensive to prospect at No. 1. This is underlain by discontinuous opal levels. This area is also of considerable extent.

(3) An area, also considerable, from which the secondary quartzite capping has been removed by denudation, and from which also the upper opal level has been removed in great measure.

Of these, the first may contain opal, but the cost of prospecting under present conditions is practically prohibitive. This forms only a very small proportion of the area which may be considered as "likely" ground.

No. 2 is well worth prospecting as a whole.

No. 3 may contain deeper opal levels, but is not so promising as the area covered by the weathered "Shin Cracker".

Smith (1924) records that the opal occurs at the Grawin area in four "levels" to a depth of 90 feet and in this respect as in others, the features at Grawin are similar to those at Lightning Ridge.

(c) Hayricks Mine, Queensland.

The extent of the portion of western Queensland which was worked for opal has already been mentioned, but as operations are at present confined to only one mine - the Hayricks, near Quilpie - there is little point in giving a detailed description of the whole area. The following excerpts from a report by Cribb (1948) will adequately describe the Hayricks Mine and the nature of the opal occurrence at that locality:-

"The workings are situated in the southern face of Mount Canaway, the largest of an isolated group of mesas which, because of their striking outline, are named locally the "Hayricks." These mesas, which rise to a height of approximately 200 ft. above the surrounding plain country, are, together with the Grey Range, the dissected remnants of a once extensive sedimentary series. Owing to the softness of the lower strata of this series, erosion has been rapid and preservation of the residuals is due to the protective cover afforded by the more resistant upper beds. Under such conditions the characteristic form developed is that of a flat-topped plateau bounded by a vertical escarpment for the thickness of the capping, succeeded by a more gentle slope composed of the underlying softer beds gradually merging into the surrounding plain. The slopes are frequently strewn with blocks of the upper layer, which, due to under-mining break away from the edges of the cliffs along vertical joints.

The shales, sandstones, and clays forming these residual masses belong to the Eyrian Series of Early Tertiary age, which overlies the Cretaceous rocks of the Great Artesian Basin. The beds have been recognised as the product of laterisation with a number of well-defined horizons. These have been described fully by F.W. Whitehouse (1940).

The uppermost "ferruginous zone" described by him is represented on Mount Canaway by a thin screen of limonitic pebbles and occasional small boulders of dense siliceous iron-stone lying on the level surface of the plateau.

An upper cliff section some 35 ft. thick, locally termed "caprock" consists near the surface of hard, highly ferruginous material uniform in colour, which grades into the "mottled zone" whose ferruginous and kaolinic constituents are scattered in irregular patches. With increasing kaolinic content towards the bottom, the lowest 3 ft. consists of whitish soft sandy material showing traces of stratification. Weathering of this layer is responsible for the breaking away along vertical joints or large blocks of the overlying caprock, which are strewn as talus on the lower slopes.

Below this horizon the beds retain the structure of the original rock, but have been leached of most of the iron and any lime originally present. These strata, corresponding to the "pallid zone" are horizontally disposed and show the following section:-

Pinkish clay shales with conchoidal fracture	4 ft.
Fine-grained, buff sandstone	8 ft.

Alternating light-coloured fine-grained sand-stones and porcellanised shales	60 ft.
Clay shales	4 ft.
Sandstones with boulders	16 ft.

Infrequent exposures on the slopes below this level suggest a minimum thickness of 120 ft. for this zone.

The opal deposits worked in the Hayricks mine is of the "sandstone boulder" type, the boulders occurring irregularly in a bed of light-coloured kaolinic sandstone some 120 ft. below the top of the mesa. Mining operations by means of tunnels and drives have been confined largely to a horizon some 8 ft. thick.

In the workings, the fresh-sandstone is light-coloured soft, porous and clayey and marked by numerous curved lines of brown iron-staining, in general appearance not unlike false bedding, but due entirely to solution and subsequent deposition of ferruginous matter. Much of the silica of the original rock has been removed by leaching, leaving a porous, clayey framework of low density.

The Boulders occur irregularly distributed as elongated concretions, somewhat flattened and often with acutely rounded ends. Their length varies between 2 and 10 ft. and their width from 1 to 4 ft. The majority are disposed with their axes lying in directions approximating north-south and tilted slightly downwards to the south.

On removal from the sandstone they are seen to be bounded by a relatively thin casing of sandstone, the surface of which is grooved, polished, and striated in a longitudinal direction.

In section, concentric deposition of iron oxides is apparent at the ends of the boulders, but is somewhat obscured in the central portions, where the upper half is hard and heavily impregnated while the lower portion is softer and granular in texture.

Contraction has resulted in the development of numerous short, thin, radial and concentric cracks, particularly in the lower peripheral area. Frequently concentric iron-staining has developed independently in the separated fragments. Larger, predominantly vertical fractures have been formed in the central portion by crushing.

Opal, in part precious, has been deposited as an infilling of these cracks and fractures and forms the source of the gem material. The extent to which infilling has taken place varies. Boulders have been mined in which none is found, and when little is present the opal is usually inferior in quality. Invariably it occurs in the lower portion of the boulders and extends upwards for varying distances. While that deposited in peripheral cracks is mostly of the precious variety, the proportion present in the central fractures varies. Usually it is small and much of the mineral present consists of semi-opal, milk-opal, and colourless and blue glassy varieties. The different forms are arranged in successive horizontal layers which in veins approaching the vertical produce a banded structure. The lowest portion of the fracture is usually occupied by the blue, glassy form passing upwards into precious opal and succeeded by semi-opal, colourless and common varieties in the wider part of the fracture. Above the filled

portions the walls are coated with a veneer of glassy opal, giving place in the upper half of the boulder to a white amorphous siliceous powder.

Banding may be perfectly straight or may exhibit undulations, reflecting irregularities in the lower layers and increasing in degree in the uppermost layers. Variation in structure and fire is seen in adjoining layers of precious opal which may also alternate with a common variety. Such variations are not so apparent in horizontal veins since they lie parallel with the plane of lamination. It is thus possible to determine the position in a boulder originally occupied by a vein.

Experience has shown that the better quality opal occurs at the lower ends of the boulders as they lie in a slightly tilted position in the sandstone.

A great variety of precious opal is present in the boulders. Much of that from the centres has a transparent or translucent body, so that the attached matrix plays an important part in the quality and brilliance of the stone. Some carry numerous inclusions of "sand" or opaline impurities. In others the body is smoky and the fire less intense. Pattern varies from flash to harlequin and pinfire, while stellate, arborescent, banded and other fanciful forms are found in the vertical veins. Smaller stones showing the much-prized red fire are obtained, mostly from short radial and concentric cracks near the outer margin. Much of the opal in the vertical veins is banded to such a degree as to render it valueless as a gem, so that horizontal veins provide most of the larger size pieces of value."

It will be noted that this is the only locality at present being worked in Australia in which the opal occurs in beds younger than Lower Cretaceous, and emphasises the point that age of the beds is of relatively minor importance compared with the lithology and type of weathering to which they have been subjected. Woolnough (1928) has drawn attention to the fact that the presence of the "Duricrust" is indicative of conditions favouring the occurrence of opal. Whitehouse (1940) has gone further in describing a number of zones or horizons which have formed under conditions which also favour deposition of opal, and it appears that application of either of these criteria would place the work of prospecting for opal on a sounder basis.

4. FACTORS AFFECTING PRODUCTION

(a) Climatic Conditions.

In all probability the most important single factor which affects production is the weather. The principal fields are situated in comparatively isolated arid regions, and even under the most favourable seasonal conditions the intense heat and associated difficulties of the summer months induce many miners and their families to move nearer the coast for that period. If drought and other abnormal circumstances are superimposed on the naturally adverse conditions, the number of men leaving a field and the period of their absence will increase, and the production will show a marked decline. The effects of one or two drought years may extend over a much longer period, as some of the men will find other employment and will

not return to opal mining. This point was well illustrated in Queensland, when a severe drought from 1897 to 1902 caused a drop in production which has never since reached pre-drought levels.

The effects of the climatic conditions can be reduced to a certain extent by provision of water storage facilities as has been done at Coober Pedy, or ensuring that underground water supplies (which are less likely to be interrupted by drought) are made available, as is being done at Andamooka. Any improvements which can be made in living conditions and social amenities will also have a favourable effect in retaining the population on a field for longer periods

The seasonal migration from the fields has a bearing on the reluctance of miners to register claims or other mining tenures. It is contended that there is comparatively little need for protection of legal rights while a man is on the field, and that if he leaves the field in the summer he must pay an additional fee for suspension of the labour covenants without obtaining any real security of his rights during his absence. It will be understood that legal security may not imply actual security in areas in which police control is nominal. (Further comment on this point is made by Idriess (1947, Chap.15) Many miners therefore hold the view that registration of claims and other holdings is an unnecessary waste of money, and whether this view is correct or not, it must be conceded that many miners leave the fields in the summer through physical necessity, not as an evasion of their obligations under a Mining Act. Some consideration might be given to a review of the labour covenants and terms of opal mining tenures in an effort to meet the particular circumstances imposed by the climatic conditions at the principal fields.

(b) Mining Methods.

There is room for improvement in the mining methods favoured by some men on the fields. The ultimate aim in opal mining is to gouge and examine as much stone as possible so that the small amount of precious opal which may be present is not overlooked. This aim cannot be achieved by shaft sinking alone, and it should be realised that sinking is a means of obtaining access to the opal level, not a means of testing it. To sink a shaft and then to abandon it because the limited area of the opal horizon thus exposed proves disappointing is a wasteful but common procedure, and it cannot be too strongly emphasised that systematic underground development is essential. Assuming that the opaliferous horizon is continuous, a precious stones claim 150 feet square has an area of 22,500 square feet to be tested. Two shafts with a connecting drive and crosscuts would give adequate access and air circulation and nearly the whole of the opal horizon could be thoroughly tested with a minimum of unnecessary labour. The argument that underground work is more arduous and slower than shaft sinking is only valid if the objective is rather to keep men occupied than to win as much opal as possible from a particular area.

It is recognised that on each field there are pensioners and others to whom the winning of opal is a secondary consideration, but the miners who depends on the production of opal for a livelihood might reasonably be expected to adopt, in their own interests, such methods as will produce the greatest return for the labour expended. No person could positively guarantee increased production by the introduction of more systematic mining methods, but the odds are very heavily in favour of a better output following improvements in method.

It is understood that some mining interests have investigated the possibility of using modern earth moving equipment to strip overburden from opal levels at shallow depth, as, for example on the Big Flat and "eight mile" at Coober Pedy. This would enable the miner to concentrate on the fundamental work of testing the opal horizon, but it would not relieve him of the tedious and painstaking manual work necessary in gouging opal. Any attempt to mechanise the actual gouging will result in damage to the thin seams and loss of good opal, and mechanisation would have to be confined to overburden removal. This would undoubtedly assist the miner, but the cost may be out of proportion to the advantages.

(c) Government Assistance.

It is commonly contended that public funds should be used to subsidise opal production or to encourage prospecting, but it is not always recognised that Governments have already provided indirect assistance. The provision of water storage facilities and other community amenities is of material benefit since they enable men to remain on the field for longer periods and under better conditions. Technical services are provided by the Mines Department in each State, and it cannot be fairly claimed that they are ineffective if the advice of mining and geological experts has not been sought or has been disregarded.

In broad principal the expenditure of public funds to provide direct assistance in the form of grants and subisides to individuals within an industry is justified only if the commodity produced is of strategic or commercial importance to the community, or may be regarded as essential to the prosperity of the whole community. In other words, the public is entitled to expect re-imbursement of some kind in return for financial aid extended to a few individuals. The re-imbursement may not be commensurate with the outlay and it may be in a comparatively intangible form (e.g. enchanced security where strategic minerals are concerned) but there should be some advantage over and above that gained by individuals. The opal industry is concerned with a non-essential luxury item with relatively low value as an export commodity, and every endeavour should be made to keep the economy of the industry independent of outside assistance. During times when the community level of prosperity is high, the buoyant markets and other favourable circumstances should provide sufficient incentive to raise production to meet the demand, whilst in times of depression there would be little justification for bolstering production of an item for which there would be little or no demand. For these reasons it is believed that the case for direct financial aid as a stimulus to production in the opal industry is extremely weak, and it appears inappropriate to consider the possibility at the present time. There may be a better case for the granting of loans from public funds, but considerable difficulties may be anticipated in finding adequate securities and safeguards.

(d) Taxation.

It has been stated that the present level of taxation is proving a restrictive factor, insofar as it induces the miners to limit their production so that they remain in a lower income group. It would be virtually impossible to determine whether this contention is correct, but without entering into detailed discussion it may be stated that there are good grounds for believing that there are extremely few cases, if any at all, in which miners have deliberately restricted operations for this reason.

PART 2 - MARKETING.

1. CUTTING & PREPARATION.

Between the production of the rough opal at the field and the sale of the finished product to the public there is an intermediate stage in which the skill of the lapidary is of dominant importance. His skill must be both mechanical and aesthetic, as the production of good quality gem requires recognition of properties which are almost entirely latent while the stone is rough, and no amount of manual dexterity will compensate for poor selection of material. Almost anyone with mechanical ability and some training can cut and polish a piece of opal, but it requires long experience and an almost intuitive artistic sense if a craftsman is to be consistent in making the best use of every piece of raw material he uses. Each piece of stone requires individual treatment, and any standardisation of methods or specifications inevitably lowers the overall quality of the gems produced.

Opals are usualy cut en cabochon, that is, in a circular or oval shape with curved top and flat base (simple cabochon) or with upper and lower portions curved (double cabochon). Stones for special purposes such as drop ear rings, pendants etc. are cut pear shaped with either circular or flattened oval cross section, whilst occasionally a stone is cut in an irregular shape to emphasis some peculiarity of shape, colour, or pattern. In much of the jewellery in which opal is used the solid gemstone has been displaced by a two piece stone known as the "doublet" which is essentially a fragment of common material (potch, coloured glass, etc.) on which a veneer of opal has been mounted. After the base material has been smoothed on one face a thin wafer of precious stone is cemented to it with shellac, and the stone is then shaped and polished in the normal manner. The effect is pleasing and many people claim that the doublet is preferable to the solid stone because the depth of colour seems to be improved by the base material, which is usually dark and tends to provide a reflecting surface at the interface. On the other hand there are many who claim that a doublet should not be regarded as an opal, and throw doubts on the ethics or advisability of the common practice of using the terms as synonymous. Some persons prefer to use the term "two piece opal" when the backing is opal potch, and reserve the term "doublet" for gems in which material other than opal is used as a base. There does not appear to be any need for a hard and fast ruling on this point, but it is desirable in the interests of the industry that no confusion should exist in the mind of a purchaser regarding the nature of a gem being bought. It is difficult to distinguish between solid stones and doublets when the gems are mounted in jewellery so that only the face is visible. The advantage of the doublet is the low cost compared with that of a solid stone, but it may be less durable owing to the danger of parting at the interface; any attempt to sell a doublet at the price commanded by a solid stone of similar weight is obviously fraudulent practic which should be subject to heavy penalties.

Another form is matrix opal, in which opal occurs as such a thin film that it cannot be separated from the enclosing rock or matrix, and gems are cut so that the matrix forms a backing to a thin layer of opal. The finished article is in reality, a natural doublet.

The cost of cutting and polishing solid stone varies within wide limits according to the size and shape of the finished article, but it would be unlikely to exceed 10/- per stone of normal dimensions and the average is probably in the vicinity of 7/6 per stone. The cost of finishing doublets

has been stated to range from 4/- to 7/6. It is difficult to gain any idea of what proportion of the purchase price of a gem stone is represented by the return to the miner who won the raw material. A hazardous guess may be based on the assumption that wastage during cutting may amount of 50% and that rough stone purchased at £30 per ounce eventually reaches the public as solid gems sold at £3 per carat. The 75 carats obtained from one ounce of this stone would return £225 to the retailer, representing an appreciation of £195 an ounce in value since the stone left the field. Assuming further that in the interval the stone has passed through the hands of a buyer, a lapidary, and a retailer, these three parties have shared an amount of £195 from which must be deducted the following charges: expenses in visiting fields (or agent's commission if the buyer operates through a resident agent), proportion of overhead expenses of buyer, profit made by the buyer (which must be high enough to offset the risk involved in buying rough stone), costs of cutting and polishing, proportion of lapidary's overhead expenses, lapidary's profits (which must also include allowance for risks, involved in buying rough stone), proportion of overhead, profit of retailer and sales tax. If the functions of these three parties are combined, as is frequently the case, the charges are correspondingly reduced without a commensurate decrease in the price placed on the finished article.

These figures, relating to a purely hypothetical case, merely serve to illustrate the fact that in the opal industry the return to the primary producer (in this case the miner) seems disproportionate to the value of the finished article.

The value of a finished gem depends on the following characteristics:-

(i) Colour should show a perfect blending and no shade should predominate. It should be "true", that is, it should not be streaked with patches of colourless material.

(ii) Pattern of the colours. "Harlequin" and "pinfire" patterns are most highly prized - in the former the colours are arranged in small squares, in the latter it resembles pin points.

(iii) Fire or flash. Red or combinations of red with yellow, blue, or green are best. Plain blue is of very low value and plain green needs to be very vivid and have a good pattern if it is to be of value.

(iv) Soundness or freedom from cracks and flaws.

The personal element must also be taken into account in assessing the value to be placed on a particular gem. One individual may have a marked preference for a colour which is not highly regarded by others, and will be prepared to pay a higher price for a gem of that colour.

With these fixed characteristics and the personal element to be considered it is not surprising that the price of finished gems ranges from as little as 5/- per carat to £10 per carat or even higher in exceptional cases, and that their valuation cannot be a matter of mathematical precision. It will be appreciated that there is also room for considerable divergence of opinion between individual valuers, and it would be virtually impossible to relate all the variable factors in a single schedule of prices.

2. MARKETS.

Finished opals (including doublets) reach the domestic market either unmounted, in which form they are in demand either as souvenirs or for those who wish to have them set up in mounts of their own design or choice, or mounted in rings, brooches, pendants and other forms of jewellery. Most articles of jewellery containing opal are of the type used for occasional wear (brooches, earrings etc.) as the stone does not stand up to the constant use usually given to rings. With reasonable care an opal ring will give good service, but the stone needs to be repolished from time to time if the original beauty is to be retained. Some gemmologists claim that an opal has a limited "life", but there is no reason why a stone should not give long service if it is treated with the normal care due to a comparatively soft gemstone. Badly made doublets will tend to split and badly mounted stones may crack or chip at the edges, but these defects cannot be blamed on the stones themselves.

As the statistics are unsatisfactory it is impossible even to estimate the value of opal sold within Australia at the present time. Jewellery containing opal is displayed in almost every jeweller's shop in the capital cities, and superficially there appears to a buoyant market for these articles. If this is the case it does not necessarily represent a high value to the opal industry, since the gems used in this type of jewellery are of very poor quality and each stone would have only a minor fraction of the value of the article in which it is sold.

It is possible that more stones are sold unmounted as in this form they have greater appeal to tourists and those with a more discriminating taste in jewellery than is served by the manufactured articles normally on sale, but here again it is impossible to make any estimate of the value of turnover. The sales tax on finished gemstones is 25%, but there is no sales tax on uncut stone.

The export market is firm at the present time, but is tending to slump with a falling off in demand in the U.S.A., our best overseas customer. Optimistic and at times extravagant claims are made regarding the potential market in the U.S.A., but these should be treated with some reserve and intending exporters to that country should base their judgment of the possibilities on personal enquiries or firm orders. Reports from Australian trade representatives in the U.S.A. suggest that American buyers are becoming more exacting in their requirements and are allowing less latitude in selection of material. Most of the trade is done on a consignment basis, which, for reason discussed in a later section of this report, is believed to react unfavourably on the Australian exporter.

Opal doublets are said to be very popular in the U.S.A. for costume jewellery, for which they are cut to standard dimensions to facilitate mass production methods. Solid stones are preferred for rings. The 9 carat gold mounts so common in Australia do not appeal to the American trade, which prefers 14 carat settings.

According to the statistics in Table 2, our next best customer was formerly the United Kingdom, but there has been no trade since the outbreak of war in 1939. With the British export drive in full operation it seems improbable that any Australian opal will find its way to the U.K. unless it is for the purpose of cutting and sale to countries within the dollar bloc. It is understood that some Australian gem

merchants have investigated this possibility, but the result of their enquiries is not known.

Germany and Ceylon purchased a fair amount of opal prior to 1939, and the latter country resumed trading during 1946-47 at approximately the pre-war level. New Zealand, Japan, India, Holland, N.E.I. Hawaii, Spain and China have bought Australian opals at various times during the last twenty years, but the value of sales to these and some unspecified British and Foreign countries has averaged only about £A1,500 per year. Canada and South Africa has a complete embargo on the importation of opals, and the possibility of the embargo being lifted is believed to be very remote.

Import duties imposed in the principal countries to which Australian opal has been exported are listed in Table 3 hereunder.

TABLE 3.

IMPORT DUTIES ON OPALS IN VARIOUS COUNTRIES.

(Figures supplied by Dept. of Commerce & Agriculture)

COUNTRY.	UNCUT STONE	CUT STONE	MOUNTED STONES	REMARKS.
United Kingdom	Free	Free	Free	Entry of mounted stones not likely to be permitted.
New Zealand	5%	5%	25%	
India	Free	30%	60%	
Pakistan	Free	30%	60%	Entry of cut stone not permitted.
Ceylon	10%	30%	40%	
U.S.A.	Free	5%	55%	
South Africa	-	-	-	) Complete embargo
Canada	-	-	-	) on the importation of opals.

3. FACTORS AFFECTING TRADE.

The market for opal is as sensitive as that of any other luxury commodity to the fluctuations in the prosperity of the community, but as this aspect is beyond the control of the opal industry and is so intimately linked with world-wide economic stability it is outside the scope of this report. The factors mentioned in this section are those which are of domestic origin or which the industry itself can attend to.

(a) Prejudice.

First amongst the factors which have had and continue to have a powerful influence on the market for opal is the widespread superstitious prejudice against the gem as an omen of bad fortune. However absurd such a belief may be, it cannot be denied that it is long standing and is still current

in the minds of many people; there are many who regard it as anathema to have anything whatever to do with opals. It is irrelevant to attempt to trace the cause of this popular superstition, but it does exist and the industry continues to suffer as a result. The difficulty of overcoming such a deep rooted objection is recognised, and it cannot be too strongly emphasised that the industry itself should embark on a publicity and educational campaign with the object of removing the prejudice.

(b) Fashion.

The vagaries of fashion have a very decisive effect on the market for any item of dress or dress accessories, and opal is no exception to this general rule. The influence of fashion seems to be inevitable, but it is suggested that a publicity campaign would help to keep opal in the public mind at times when fashion may place emphasis on some other gem.

(c) Taxation.

Some gem merchants have said that they do not propose to attempt expansion of business until rates of income tax are reduced. The statements are made with considerable emphasis, but it would be very difficult to determine their reliability. It is unnecessary to comment on this attitude, since the trading policy of any individual or company is not a matter for public concern, but it should be remarked that any self-imposed restriction of trading at a time when the market is buoyant may react unfavourably when the market is less buoyant, and the policy may ultimately prove to be very short sighted indeed.

(d) Controls.

Compliance with the regulations for export and currency control is said to involve a considerable expenditure of time and money, and some merchants claim that the procedure is so complex as to make small transactions unprofitable. At the present time a person wishing to export a parcel of opals to the U.S.A. must approach at least four separate authorities for the necessary permits - one for an export licence, another for financial sponsorship, a third to comply with currency regulations, the fourth to obtain a consular invoice. Other authorities have to be approached if the parcel is to be sent by air, or if an agent is employed to make the necessary applications. As in the case of taxation, it would be difficult to prove that the system of control is, in fact, more of a restrictive factor in opal trading than in any other commodity, since the system is the same for all export items.

(e) Trading methods.

A large proportion of the export trade is done on a consignment basis, and cases have recently occurred in which the consignee has declined to accept delivery of parcels sent to his order. Whilst appreciating the need for adequate safeguards in negotiations involving a commodity which is so difficult to value, it should be obvious that a method by which one party carries the whole risk will ultimately react against both parties. An exporter who incurs expense in selecting stone to a buyer's specifications and in complying with the export and currency regulations does not wish to be out of pocket to that extent if the parcel is rejected and returned by the consignee. His reaction will be to abandon that type of trading; the consignee's reaction might well be that as he cannot draw on the source of supply on his own terms he will cease trading in opals and campaign to popularise some other gem.

Schlank (1921) mentions a case in which an order valued at approximately £2,000 was declined because the exporters were not prepared to operate on a consignment basis, and there is no doubt that this is not an isolated instance of the loss of trade for this reason.

(f) Quality of gems.

With comparatively few exceptions the opals displayed in jeweller's windows are of inferior quality, set in 9 carat mounts of mediocre design, and it is unfortunate that these are frequently the only examples of Australian opals seen by the general public. They do not do justice to the gems, and they pay a very poor compliment to the taste of prospective buyers. It is not suggested that these are the only stones available to the general public, but they have such a dominating influence in forming public opinion that efforts should be made by the opal industry to improve the quality of the material displayed. The stone will not be really popular while it is regarded, consciously or otherwise, as a second-rate or "cheap" gem.

Many gemmologists hold the view that the introduction of the doublet has had an adverse affect on the trade by lowering values and flooding the market with material of doubtful quality. The position has a complete analogy in the furniture trade, where veneers have replaced the use of solid wood to a large extent, and in each case it is a matter of personal opinion whether the solid is better than the veneer. There is little doubt, however, that badly made doublets which chip or crack impair development of the opal market, and it is in the interests of the industry to discourage the manufacture of doublets except by well trained and well equipped operators.

4. PROPOSALS FOR IMPROVING TRADE, AND CONDITIONS GENERALLY.

In the course of the investigation of which this report is the subject, a number of individuals expressed views regarding improvement of trade and stability of the opal industry in general. Some of these views are of greater interest than others; some are frankly partisan; others are too absurd to be given any consideration; they all have in common the sincere belief of their originator that introduction of the particular course of action would solve all present and future difficulties in the industry. Some of the ideas are noted and briefly discussed hereunder, but it is pertinent to refer to two points mentioned in earlier sections - firstly, that opal is a non-essential luxury item, and, secondly, that only under exceptional circumstances should public funds be applied in giving direct assistance to individuals in the industry. It will be readily understood that any improvement in the volume of trade, trading conditions, or stability of the industry will prove the most effective incentive to stimulate production. That, in itself, will benefit the miners, but they are also entitled to expect a better financial return for their work as the prosperity of the industry increases. Any proposal which will enable one section of the industry to make larger profits, without a corresponding benefit to miners, is fundamentally unsound.

(a) Embargo on export of rough stone.

The proposal to place a complete embargo on the export of rough stone is supported by some members of the industry who believe that it would have the following effects:

(i) It would increase the value of the export trade and ensure a higher dollar return.

(ii) It would stimulate employment amongst lapidaries.

(iii) As valuation of cut stone is more precise, it would be easier to ensure that the financial return to the country is in keeping with the true value of the commodity sold.

(iv) Profits at present being made by lapidaries in importing countries would be made and retained in Australia.

These advantages are claimed on the assumption that such an embargo would not affect the demand in importing countries and that the buyers and lapidaries in those countries will not apply retaliatory measures in an attempt to maintain the status quo. It also assumes that lapidaries in Australia would be able to cope with a very large expansion of business, but neither of these assumptions is entirely correct. However desirable an embargo may be from the Australian point of view, it would materially affect the markets from the point of view of the importing countries, and the proposal would receive a cold welcome from those who would be deprived of the substantial profits being made under the present system. Some form of retaliation would be inevitable; it may be applied by adjusting tariffs, or, more effectively, by influencing public opinion in favour of some other gemstone to the detriment of opal. The least that would be expected would be a reduction in the volume of export trade.

At the Australian end there are two main objections to the proposal. In the first case, it is believed that lapidaries at present in business are fairly fully employed, and that it would not be possible to increase the output of cut stones to any great extent. Even if the value of the export trade expanded as a result of the embargo, it would be at least eighteen months to two years before newly trained lapidaries would be available to meet the additional demand. Secondly, since the best overseas customer is the U.S.A., it would be necessary to produce cut stones to that country's specifications, and these are not at all popular with Australian lapidaries since they involve the production of small stones cut to exact sizes, suitable for stamping into mass produced jewellery. Only one lapidary of about a dozen interviewed in the course of the enquiries expressed himself as remotely interested in cutting to American specifications, and then only at a premium to offset the high wastage and additional labour costs.

Hence there is reason to believe that an embargo on the export of rough stone might have an undesirable sequel as far as the opal industry in Australia is concerned.

(b) Partial embargo or export quota.

Closely allied with the previous proposal is one to impose a partial embargo on the export of uncut stone or to introduce some form of quota system to ensure that a proportion of the opal exported shall be cut and polished in Australia. It is claimed that this would overcome some of the objections to the complete embargo whilst preserving the advantage of raising the value of the exports. Theoretically it would provide the overseas markets with sufficient uncut stone required for mass production jewellery, work which local lapidaries are reluctant to undertake, and would force

buyers of opals for other purposes to purchase finished stones. It is extremely doubtful, however, if the suggestion would be satisfactory in practice, as it is unlikely that importers would be prepared to buy finished stones merely as a means of qualifying for a quota of uncut stone. From the overseas buyer's point of view the objections to this proposal would be much the same as for the previous proposal, and it could easily prove to be detrimental to Australian interests.

(c) Export Duty.

Imposition of an export duty on uncut stone would be of some assistance in encouraging sales of finished gems, and if the duty is not unreasonably large there should not be any material reduction in the volume of trade in uncut stone. The nett effect would therefore be a tendency to enhance the value of exports, and there is much to commend the proposal. To American buyers, the imposition of an Australian export duty of (say) 5% would place the uncut stone on a par with cut stone as far as duty is concerned, and remove the financial advantage at present gained by importing uncut opal. The effect on the New Zealand market might also favour purchases of finished stones, but the reaction in Ceylon may be less favourable since uncut stone is already subject to a higher import duty than in other countries, and the duty on cut stones is fairly substantial.

(d) Government Valuer.

The appointment of a Government Valuer has been suggested as a means of ensuring that the best value is obtained for stones sent overseas, whether sold uncut or finished. His functions would be to check, and, if necessary, adjust the valuation placed on each outgoing parcel, to act as arbitrator in disputes concerning valuation, to act as an assessor and technical adviser in any matter relating to opals, and generally to ensure that miners and other obtain a return in keeping with the value of any material sold.

The satisfactory performance of these functions would be an unenviable task, and the powers and duties of the appointee would have to be very clearly defined. In addition to a very wide knowledge and experience of the opal industry, the man would have to be of undoubted integrity and to have no direct or indirect interests in the trade. To obtain a person with these qualifications it would be necessary to pay him such a large salary or retaining fee that the question might well be raised whether the advantages of his appointment would be in keeping with the costs involved.

The administration of the scheme would be costly, and this added to the difficulties which may be anticipated in selecting a suitable appointee puts the scheme beyond the bounds of possibility where the comparatively small opal industry is concerned. More serious consideration might be given to the suggestion if the functions outlined above could be discharged in conjunction with similar functions in another industry, or if the valuer's services could be extended in some way so that the whole of the cost is not borne by the opal industry.

The following excerpt from the report of the Royal Commission of 1901 is of interest in connection with this proposal.

"Another suggestion was that the Government should appoint an expert at £3,000 per annum to class and value the opal for the miners; the act of valuation in this case meaning that the value named would be the amount at which the Government would be prepared to purchase the opal, or to advance upon it, in the event of the finder not being able to obtain a higher offer from outside buyers. The evidence adduced goes clearly to show that it would be unadvisable on the part of the Government to entertain any such proposal. The officer appointed could not be expected to give satisfaction to everyone and we feel persuaded that the position would not be very long in existence before an agitation would be started to get rid of him. Even if successful for a short time, assuredly he would not be able to please everyone for long, and instead of creating a sense of trust and security among the miners it is likely his appointment would have the opposite effect. Moreover there seems every probability that sooner or later it would be found that the Government was left sole purchaser of the opal on the Field, as all the private buyers would be driven out of it. The suggestion altogether is one that does not commend itself to your Commissioners."

(e) Licensing Buyers and Valuers.

The suggestion was revived during the enquiries that buyers and valuers of opal should be licensed, principally as a means of protecting the miners against unscrupulous operators and dishonest practices. The proposal is by no means new, as it was one of the controversial matters which led to the appointment of the Royal Commission in N.S.W. in 1901. A Consolidated Mining Bill presented to the N.S.W. Parliament in 1900 incorporated a clause providing for the registration of buyers of gold, diamonds, opals, and other precious stones, but the opposition to this proposal was so vigorous and insistent that the Royal Commission was appointed to enquire into the desirability of proceeding with that portion of the Bill. The following excerpts from the Commission's report set out the considered views of the members and their reasons for recommending that registration should be made conpulsory.

"1. That licenses to persons desirous of carrying on the trade of opal buyer be granted by two Justices of the Peace sitting in Petty Sessions.

2. That the applicant must be of good reputation, and produce two certificates of character from reputable citizens.

3. That the fee for such license shall be £1 per annum, which shall include registration of same.

4. That all opal buyers have a registered office or place of business in which all purchases be made, the address of such place to be registered at the time of taking out the license, and any change of address to be immediately registered.

5. That no sales of, or transactions in, opal shall take place between the hours of sunset and sunrise.

6. That all registered opal buyers keep a book, correctly recording all sales or transactions, such book to show the date, place, time, name of seller, name of buyer, weight and description of opal bought, price paid, and

generally the nature of the transaction; both buyers and seller to certify by their signature to the correctness of the entry of each transaction at the time it is made.

7. That such book of record shall be open at all times to the inspection of any Government officer appointed for that purpose.

8. That no holder of an opal claim or lease, or interest in same, be eligible for registration.

9. The above conditions to apply to opal cutters and polishers as well as buyers.

10. That no person shall sell opal in an unmanufactured state, or have same cut or polished, unless the buyer or cutter and polisher is duly registered.

11. That any person convicted before two Justices of the Peace sitting in Petty Sessions of having violated any of the aforesaid conditions, to be liable to a severe penalty; and if such person be a registered opal buyer, cutter, or polisher, his license to be cancelled."

As far as it can be ascertained, the Commission's recommendation was not put into effect.

Circumstances have changed in the industry since the Commission made its enquiries - at that time the population of the White Cliffs field alone was about 1,600 persons; the total population of all fields in Australia at the present time would not exceed 300 - but it is considered that the scheme envisaged by the Commission could be put into operation now, with only minor modifications. It is conceded that it would not be easy to police the scheme, but the attempt would be well worth while if it did nothing more than to improve the statistics relating to the primary production of opal.

The idea would be opposed in principle by a section of the industry, but it is difficult to see what valid objections could be raised by buyers whose business is conducted on an ethical basis.

(f) Establishment of a Pool.

Some miners are of the opinion that it would be in their interests to establish a pool to which all opal must be sold, and from which all purchases must be made. It is contended that this would protect the miners from exploitation by buyers and ensure that a fair value is placed on parcels of uncut stone. In discussing this idea it is usually implied that it should be administered and financed by the Government, in which case it would closely resemble the scheme operated some time ago by the Queensland Government in connection with sapphires, or the present arrangements for the control of mica. Opponents of Government control cite the Queensland sapphire experiment as the best argument against a similar scheme for opals; they point out that sapphire control cost the Queensland Government a large amount of money to administer and was wound up with a deficit of £67,000. There are no official details of the operation of the sapphire pool, but it is believed that it failed because too much was expected of it by the people to whom it was of greatest value. No such scheme can ensure a permanently high level of prosperity within an industry, regardless of economic conditions generally, and the best that should be expected of it is to lessen the impact of sudden changes in conditions so that the small

operators in the industry may have a greater degree of economic security. The control being exercised over mica is in a different category, since it is an essential commodity of strategic importance, and there cannot be any real analogy between that mineral and opal.

Establishment of an opal pool through which all miners, buyers, lapidaries and exporters would be compelled to operate would be attended by all the disadvantages mentioned in paragraph (d) above (Government Valuer), and it is considered that these would outweigh the advantages of the scheme. Added to these disadvantages there is the expressed hostility of a majority of the miners and, it may be surmised, of the buyers. The Andamooka Progress Association invited miners on other fields to state their views on the suggestion that the Federal Government be asked to establish some system of control, and the replies received left no doubt that the suggestion was not popular.

There is some merit in the idea of establishing a voluntary pool or co-operative selling arrangement amongst miners themselves, but it would have to be confined to individual fields and it would tend to break down if even a few men remained aloof.

(g) Committee of Control.

The proposal which has most to commend it is the establishment of a committee, from within the industry, to discharge the following functions:

To conduct publicity, educational, and marketing campgains in Australia and elsewhere.

To be the accredited mouthpiece of the industry in Australia and to act as a liaison between the industry and the Governments.

To initiate and direct a policy which will safeguard the interests of all sections of the industry and which will tend to greater overall stability.

To advise on prices, standards, markets, training of lapidaries and all other matters which bear directly or indirectly on the welfare of the industry.

To arbitrate in any dispute concerning valuation or other matters.

To carry out any other functions which are designed to promote the best interest of the industry.

To perform these duties effectively the Committee would have to be composed of representatives of each section of the industry, and to have the goodwill of a large majority of those directly interested in the trade. Therein lies the principal obstacle to its formation - the mutual distrust of individuals and their reluctance to contribute anything to the common good of the industry. It is considered, however, that the industry can and should take the initiative to help itself rather than wait until others offer assistance in forms which may not be acceptable, and the creation of the Committee would be a step in the right direction. If it was demonstrated that the industry is prepared to do this much to sink sectional differences and help itself, it would have a much stronger case to present for financial assistance from public funds in the form of a grant to meet administrative expenses or to carry out a particular phase of a publicity campaign.

CONCLUSION.

T he purpose of this report has been to describe the opal industry in Australia with a view to placing it in proper perspective in relation to other industries, and to discuss means by which the industry might be stabilised. Press statements have given an exaggerated impression of the importance of opal as an export commodity, and of the value of the industry in general, but the conclusion is reached that these claims have a more sentimental than economic basis.

Recorded statistics show that the average value of production for 58 years is only £38,000 per year; even if this represents only one-tenth of the actual production the industry would be small, and would have no claim to preferential treatment over any other non-essential industry.

It is considered that the onus is on the members themselves to take steps which will safeguard and promote the welfare and stability of the industry, and a willingness to initiate co-operative action is regarded as fundamental to improving conditions generally.

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TABLE 1.

ESTIMATED VALUE OF ROUGH OPAL PRODUCTION IN AUSTRALIA.

(Compiled from Mines Department Records.)

YEAR	QUEENSLAND	N.S.W.	STH. AUST.	TOTAL	YEAR
1890	3,000	15,600	-	18,600	1890
1891	10,000	-	-	10,000	1891
1892	10,000	2,000	-	12,000	1892
1893	-	12,315	-	12,315	1893
1894	12,000	5,684	-	17,684	1894
1895	32,750	6,000	-	38,750	1895
1896	23,300	45,000	-	68,300	1896
1897	10,250	75,000	-	85,250	1897
1898	6,645	80,000	-	86,645	1898
1899	9,000	135,000	-	144,000	1899
1900	7,500	80,000	-	87,500	1900
1901	7,400	120,000	-	127,400	1901
1902	7,000	140,000	-	147,000	1902
1903	7,300	100,000	-	107,300	1903
1904	3,550	57,000	-	60,550	1904
1905	3,000	59,000	-	62,000	1905
1906	3,000	56,500	-	59,500	1906
1907	3,000	79,000	-	82,000	1907
1908	2,500	41,800	-	44,300	1908
1909	2,000	61,800	-	63,800	1909
1910	3,000	66,200	-	69,200	1910
1911	3,000	57,300	-	60,300	1911
1912	3,000	35,008	-	38,008	1912
1913	3,000	29,493	-	32,493	1913
1914	2,000	26,534	-	28,534	1914
1915	500	6,403	-	6,903	1915
1916	500	21,273	750	22,523	1916
1917	100	12,522	500	13,122	1917
1918	300	20,600	7,175	28,075	1918
1919	600	27,552	20,000	48,152	1919
1920	500	23,600	24,000	48,100	1920
1921	500	13,020	7,000	20,520	1921
1922	500	15,150	5,500	21,150	1922
1923	500	3,040	3,500	7,040	1923
1924	300	10,500	4,000	14,800	1924
1925	1,000	10,030	9,070	20,100	1925
1926	600	11,485	10,330	22,415	1926
1927	400	13,353	9,157	22,910	1927
1928	600	11,000	11,540	23,140	1928
1929	600	6,071	11,056	17,727	1929
1930	800	5,500	1,142	7,442	1930
1931	600	2,178	3,127	5,905	1931
1932	500	1,233	3,060	4,793	1932
1933	400	4,231	3,256	7,887	1933
1934	300	3,283	1,517	5,100	1934
1935	200	5,070	3,228	8,498	1935
1936	150	6,110	9,363	15,623	1936
1937	100	3,357	11,887	15,344	1937
1938	80	4,226	4,570	8,876	1938
1939	50	1,020	6,020	7,090	1939
1940	-	1,002	11,664	12,666	1940
1941	-	825	11,568	12,393	1941
1942	-	800	5,976	6,776	1942
1943	-	2,288	13,881	16,169	1943
1944	200	3,020	9,872	13,092	1944
1945		3,000	12,284	15,284	1945
1946	1,075	3,500	72,089	76,664	1946
1947	307	1,000	61,569	62,876	1947
TOTAL	189,457	1,643,476	369,651	2,202,584	

TABLE 2.

EXPORT OF OPALS - YEARS ENDING 30TH. JUNE 1928-1947.

VALUE IN £A.

YEAR	U.K.	N.Z.	INDIA	CEYLON	OTHER BRITISH COUNTRIES	U.S.A.	NETHERLANDS & N.E. INDIES	GERMANY	JAPAN	OTHER FOREIGN COUNTRIES	TOTAL	YEAR
1928	3,938	294	161	796	186	1,043		2,401	116	227(d)	9,162	1928
1929	1,342	1,745		2,220	327	368		7,038		334	13,374	1929
1930	27,152	2,466		4,300	565	2,103		11,618		385	48,589	1930
1931	5,972	91		2,025	863	2,210	1,014.	3,229		717	16,121	1931
1932	3,636		506	3,335	982	8,981		3,170		644	21,254	1932
1933	6,280			3,472	412	1,293	1,417(a)	2,313		178	15,365	1933
1934	8,699			2,589	941	1,774		1,281		231	15,515	1934
1935	5,908			2,303	481	2,497		835		346	12,370	1935
1936	8,814			2,684	731	2,704		1,551	1,398	79	17,961	1936
1937	5,932			2,873	573	2,929		1,988	916	569	16,552	1937
1938	3,582			2,958	597	2,490		1,749	570	175	12,121	1938
1939	1,366			528	316	1,866		2,148	268	845	7,337	1939
1940	420			1,026	425	5,894		55		252	8,072	1940
1941	-			1,441	165	7,488				42	9,136	1941
1942					620	11,341					11,961	1942
1943					152	6,776					€,928	1943
1944					228	10,149				8(b)	10,385	1944
1945			1,035		59	7,628				8(e)	8,730	1945
1946					1,966	9,278				100(c)	11,344	1946
1947		1,198	1,414.	1,626	189	58,756.				19	63,202	1947
TOTAL	83,041	6,566	3,116	34,176	10,778	147,568	2,431	39,376	3,268	5,159	335,479	

(a) Netherlands East Indies.
(b) Hawaii.
(c) Spain
(d) China
(e) Pacific Islands, possibly Hawaii.

ESTIMATED VALUE OF ROUGH OPAL PRODUCTION IN AUSTRALIA

(Compiled from Mines Department Records)

FIG. 1

1899 - £144,000 (N.S.W. £135,000)
1901 - £127,000 (N.S.W. £120,000)
1902 - £147,000 (N.S.W. £140,000)
1903 - £107,300 (N.S.W. £100,000)

Thousands of £

90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5

Severe drought in Queensland
Lightning Ridge, N.S.W.
Coober Pedy, S.A.
World War I
Inverell, N.S.W.
Severe drought, N.S.W.
New Growth, N.S.W.
Andamooka, S.A.
Economic Depression
World War II
8 mile, Coober Pedy, S.A.

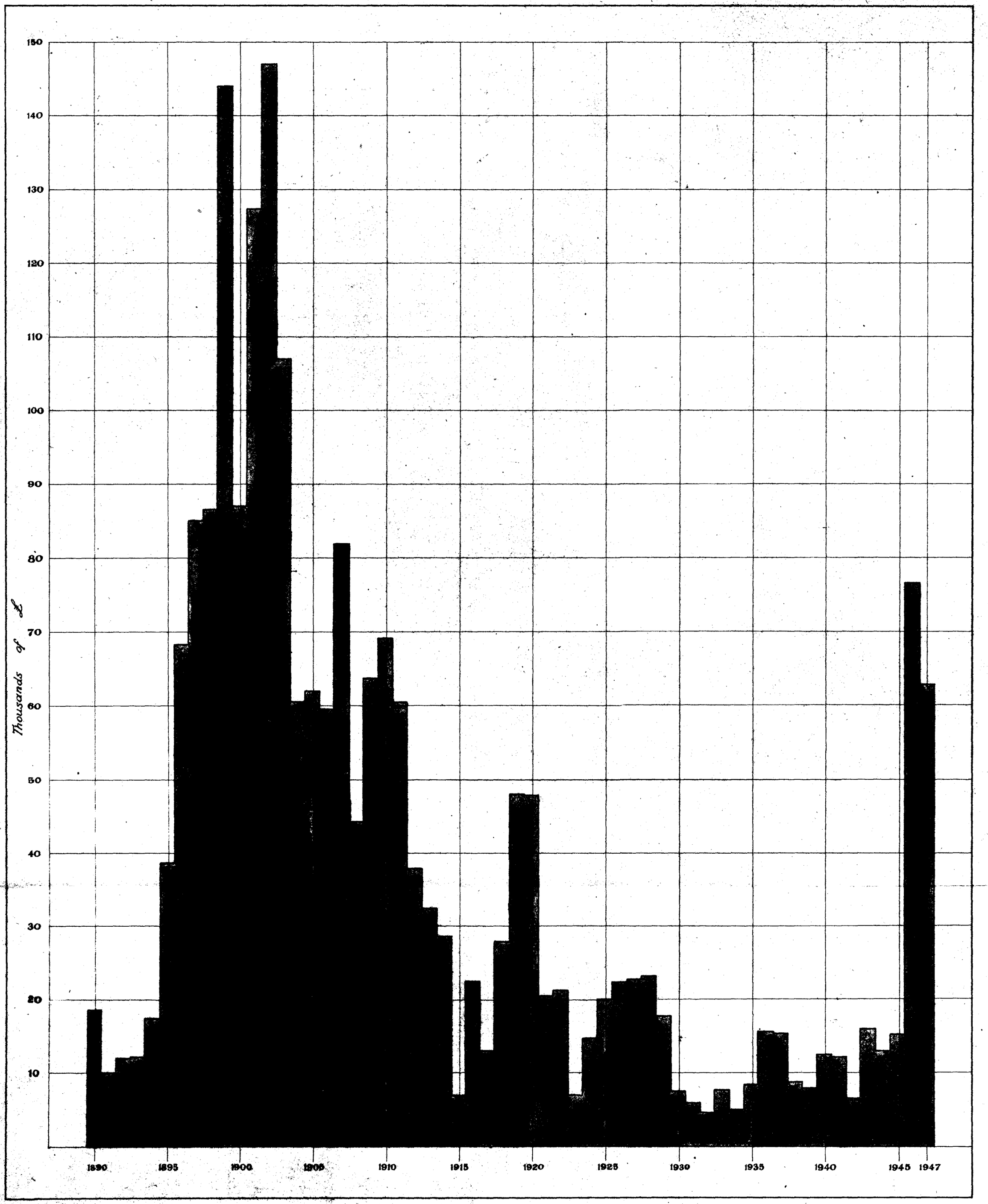
AUSTRALIA
N.S.W.
QUEENSLAND
S. AUST.

1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1947

Mineral Economics Section, Bureau of Mineral Resources, Geology and Geophysics.

M 1-2

FIG. 2



Mineral Economics Section, Bureau of Mineral Resources, Geology and Geophysics.

PRODUCTION OF OPAL IN AUSTRALIA, 1890 - 1947.

Estimated values compiled from Mines Department Records.

M 1-1

n by Geophysical Drafting Section, 1-12-48.

FIG. 3

Mineral Economics Section, Bureau of Mineral Resources, Geology and Geophysics.

MAP SHOWING TOWNS AND LOCALITIES MENTIONED IN REPORT ON THE OPAL INDUSTRY IN AUSTRALIA

Names of localities at which opal has been recorded are underlined.

M 1-3

wn by Geophysical Drafting Section, 3-12-48.