COMMONWEALTH OF AUSTRALIA

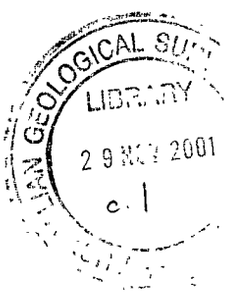
DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1941/1

Preliminary Statement on Australian Bauxite Resources



by

H. G. Raggatt

15928/65

DEPT. OF NATIONAL DEVELOPMENT CANBERRA
MINERAL RESOURCES.

INTRODUCTION.

Bauxite deposits are known to occur in Queensland, New South Wales, Victoria and Western Australia, but it is only in New South Wales that there has been any systematic attempt made to assess resources. Even here the final results of the most recent surveys are not yet available. Sufficient is known, however, to enable an authoritative statement on possibilities of development to be made.

The chemical symbols used in the report with their meanings are :

Al_2O_3 (Alumina) expressed as total, available (acid-soluble) or free (soda-soluble)
Fe_2O_3 Iron (ferric) oxide.
TiO_2 Titanium dioxide.
SiO_2 Silica.
H_2O Water. In some places "Loss on ignition" is given. As alkalis and related substances are virtually absent in the bauxites analysed, "loss on ignition" may be taken to represent "combined water".

QUEENSLAND.

The only deposits which have been prospected to any extent are those of the Tamborine Plateau, 6 miles from Tamborine Railway Station which is 33 miles southerly from Brisbane. (See Fig. 1). These deposits have been opened up in Geissmann's quarry (from which several thousand tons of ore have been removed for surfacing roads) and several shafts have also been sunk over a wide area under the supervision of Mr. W.H. Curteis of Sulphates Pty. Ltd.

It is not possible at present to give actual figures for proved reserves, but there is evidently a fairly large tonnage of ore available. Prospecting operations are still in progress.

The average analysis of a twelve foot face of ore in Geissmann's quarry is :-

Al_2O_3	Fe_2O_3	TiO_2	SiO_2	H_2O
42%	26%	4%	1%	27%

Many samples from other localities hereabouts have given comparable results and selected samples have given up to 55% Al_2O_3 and down to 0.3% SiO_2.

Bauxite is also reported from the Cairns hinterland.

It may be pointed out that many of the world's developed resources of bauxite occur within the monsoon belt and it is likely therefore that deposits of high grade bauxite will be found in North Queensland.

NEW SOUTH WALES.

There is considerable information available concerning the bauxite resources of New South Wales, due chiefly to recent activity by Sulphates Pty. Ltd., Broken Hill Pty. Co. Ltd. and to co-operation of these companies with the New South Wales and Commonwealth Governments.

The principal deposits occur in two groups (1) Emmaville-Inverell, (2) Bundanoon-Marulan-Crookwell. Bauxite has also been found near Trundle. These localities are shown on Fig. 1.

EMMAVILLE-INVERELL DISTRICT (See Fig. 2).

In the Emmaville district, as in the Bundanoon-Marulan-Crookwell area, the bauxites form mesa-like deposits and are easily mapped and

prospected, but near Inverell there is usually some difficulty in defining the deposits. It is especially difficult to draw the line in the field between "primary" bauxites and redistributed ones, but the latter are invariably found to be high in silica when analysed.

(1). Portions 34, 36, 37, 32, 31, 29 and 30 Parish of Lorne and Portions 10 and 11 Parish of Lockerby, County of Arrawatta, 28 miles by road, W.N.W. from Emmaville and 45 miles by road from Deepwater, the nearest Railway Station.

Prospecting operations by the Broken Hill Pty. Co. have proved a total tonnage of 1,700,000 tons of bauxite, much of which is of good quality.

The following table shows the tonnages and chemical composition of higher grade ore available in individual sections of the deposits arranged in order from north to south :-

	Average Thickness.		Analysis. SiO_2	Fe_2O_3	Al_2O_3 (available).
a.	700,000 tons	22 ft.	3.25	26.30	41.40.
b.	350,000 "	26 ft.	2.20	28.86	39.20
c.	160,000 "		See note.		
d.	100,000 "	16 ft.	5.05	33.41	42.96
TOTAL	1,310,000 Tons.				

(Note):- Section c. is joined to Section d. and is separated by three chains from b. No shaft has been sunk on it but its quality is likely to be at least as good as that of d.

(2.) Portions 2, 5, 6 and 11 Parish of Ashley, County of Arrawatta, 12 miles by road westerly from Emmaville and 28 miles from Deepwater Railway Station.

Some sections of this group of deposits have been prospected by the Broken Hill Pty. Co. A total tonnage in excess of 1,000,000 is available of which 412,000 have been proved by shaft sinking operations.

The following statement summarises the information available concerning this group of deposits :-

	Tons	Thickness in feet.	Analysis. SiO_2	Fe_2O_3	Al_2O_3 (available).
(a) 3 small deposits in Portions 5 & 6.	20,000	-	No shafts or samples.		
(b) Portion 11 (N.E. Section)	400,000	10 (Assumed)		ditto	
(c) Portion 11 (S.W. Section)	220,000	10 (Assumed)		ditto	
(d) M.L.1	400,000	19	2.16	27.60	39.60
(e) Portion 2.	120,000	34	1.76	26.24	43.15
(f) Portion 1.	58,000	19	4.10	31.14	39.13
TOTAL:	1,218,000				

(3.) Large deposits occur in and adjacent to Portions 512, 516 Parish of Scone and Portion 39 Parish of Strathbogie, County of Gough, about three miles southwest of the village of Emmaville, which is 16 miles westerly from Deepwater Railway Station. Reserves much exceed 3,000,000 tons, and although final results of prospecting are not yet available, it is apparent that there is a considerable tonnage of ore proved here with the following range in composition :-

			Total
SiO_2	Al_2O_3	Fe_2O_3	TiO_2
1.1-2.9%	34.5-43.4%	21.8-36.4%	2.0-4.2%

(4.) Emmaville Common. Results of sampling not yet available.

(5). Graveyard Creek. Results of sampling not yet available.

(6). Nullamanna. Only a reconnaissance examination has been made and samples have given very variable results.

(7). The Nine Mile, nine miles from Inverell on the road to Warialda.

A shaft was sunk on this deposit by the Broken Hill Pty. Co. which proved a thickness of 10'-6" with the following average composition:-

	SiO_2	Fe_2O_3	Avail Al_2O_3
5'-0" in quarry	5.96%	26.95%	39.47%
5'-6" at top of shaft on floor of quarry.	15.86%	27.41%	33.36%

The deposit is fairly large and there may be higher grade material in the untested portions.

(8). The Four Mile, four miles west of Inverell on the road to Warialda.

Samples taken from a quarry in Portion 358 Parish of Byron, County of Arrawatta averaged 27.33% soda-soluble Al_2O_3 over a 40 ft. face. The bottom 10 feet contained 30.2% Al_2O_3 and it is possible that shaft sinking would reveal higher grade material below the quarry floor.

(9). Bundarra Road, 10 miles southerly from Inverell Railway Station.

The deposits are situated along and adjacent to the Inverell-Bundarra Road, north and north-east of the road junction forming part of the boundary of Portion 406 Parish of Clive, County of Gough.

A large tonnage of ore is available, but most of it is low grade containing under 25% of caustic soda-soluble alumina. The highest soda-soluble alumina percentage noted in an extensive series of samples, is 33.5%.

Other deposits which occur between Bundarra Road and Topper's Mountain have also been sampled and found to be similar in alumina percentage to the foregoing.

(10). Topper's Mountain lead, 4 miles N.E. of the village of Tingha and 23 miles by road S.E. of Inverell Railway Station.

The highest grade deposits are in Portions 229 and 419, Portions 173 and 434 Parish of Herbert, County of Gough.

In these Portions shafts sunk by the Broken Hill Pty. Co. have revealed about 500,000 tons of ore with the following average composition :-

SiO_2	Fe_2O_3	Available Al_2O_3
4.37%	30.26%	39.57%

There is also a very large tonnage of ore containing about 20% soda-soluble alumina, but high in silica. Much of this silica is present in the form of sand grains and could be removed by washing.

BUNDANOON-MARULAN-CROOKWELL.

The deposits in this area fall into three groups; Bundanoon-Wingello; Marulan-Bungonia, and Crookwell.

The Crookwell deposits have not been examined and only a few of the Marulan-Bungonia group have been surveyed and sampled (see Fig.3) Results of survey of the latter group have been disappointing so far. Considerable tonnages of ore are available with relatively high alumina content, but also with high silica content.

The Bundanoon-Wingello group being the nearest to industrial centres, easily accessible and cheaply worked, have been extensively sampled. Detailed surveys were made of the principal deposits in 1940 and are being kept up-to-date as prospecting proceeds. (See Fig. 4).

The following table summarises the information available concerning the Bundanoon-Wingello group :-

No. of Deposit. (Fig.4)	Reserves Tons.	AVERAGE ANALYSIS. SiO_2	FeO	Fe_2O_3	Total Al_2O_3	Avail. Al_2O_3	Free. Al_2O_3	TiO_2	P_2O_5	Loss on ignition.
1.	3,500			Not	sampled.					
2.	1,625,000	5.37	0.97	31.12	39.28	35.76		5.17	.104	18.58
3.	50,000	3.87		34.42		31.01				
4.¢	170,000	4.17ø	1.74	35.88	36.84			4.16		18.73
5.	270,000	4.03	1.60	37.39	36.72x	31.59		4.98x		15.88x
6.	1,500,000	6.37	1.66x	32.37	34.99+		35.43+	4.86+		21.58
7.	Very small			Not	sampled.					
8.	175,000	7.52		30.21		35.18				
9.	10,000	5.47		34.64		34.00				
10.	6,000	7.36		32.64		32.49				
11.	Very small	Too low grade to warrant consideration.								

TOTAL: 3,809,500

ø Excluding surface sample. x Three samples only. + Four samples only. ¢ Western end only, see following note:-

NOTE:- In view of results of recent prospecting on the western end of Deposit 4, special mention is made of it. The deposit has been closely sampled by shafts, 21 of which have been sunk in an area of about 2 acres. This work has not only shown the deposit to be very much thicker than suggested by a study of the surface but has proved a noteworthy tonnage of high grade ore below the ferruginous capping. This work makes possible the following addition to reserves for this deposit :-

Tons.	Al_2O_3	Fe_2O_3	SiO_2
24,000	53.9%	5.7%	4.5%
73,000	43.2%	12.6%	6.5%
500,000	31.3%	28.8%	4.75%

The total reserves of bauxite proved in the Bundanoon-Wingello area are therefore in excess of 4,400,000 tons.

TRUNDLE.

Bauxite occurs nine miles S.E. of Trundle in the Parishes of Salisbury and Coradgery West, County of Kennedy and Parish of Plevo, County of Cunningham.

Some samples containing up to 47.8% soda-soluble Al_2O_3 have been collected, but a preliminary geological examination suggests that the bulk of the material available is of considerably lower grade.

However, several shafts have recently been sunk on the deposits which the New South Wales Department of Mines intends to sample in the near future.

VICTORIA.

The principal locality for bauxite is Boolarra, a township on the Morwell-Mirboo North branch railway. The deposits are within six miles of the railway.

The Geological Survey of Victoria has not examined the deposits since 1925 and the Director states that it is impossible on present information to give any idea of reserves.

The results obtained by W.H. Ferguson in 1925 are promising but unfortunately his report gives no indication of the thickness of section represented by the samples.

Sulphates Pty. report that the "run-of-mine" ore worked by them in this district has the following analysis :-

Al_2O_3	Fe_2O_3	TiO_2	SiO_2	H_2O
53%	6.5%	4.5%	5%	31%

and that this ore can be readily beneficiated to a standard approximating :-

60.76% Al_2O_3, 3.01% Fe_2O_3, 1.92% TiO_2, 3.03% SiO_2,

31.5% H_2O.

This company considers that there would be no difficulty in obtaining 50,000 to 60,000 tons in the Boolarra area.

WESTERN AUSTRALIA.

There are extensive areas of lateritic deposits in the Darling Ranges within 30 miles of Perth and close to the railway. No systematic geological examination has been made of the deposits and they have not been prospected to any extent.

CONSTITUTION OF THE ORES.

It will be seen by reference to the bauxite analyses (some of which are given in the preceeding pages) that the percentage of "free" alumina (soda-soluble) and "available" alumina (acid-soluble) in bauxites of adjacent deposits and of obviously similar composition are much the same and that the amount of total alumina present in these ores is not more than a few percent higher than alumina extracted by acid or alkalis. Further, in many instances the ratio of Al_2O_3 to loss on ignition (H_2O) in the ores approximates to the ratio of these constituents in pure gibbsite, despite the high Fe_2O_3 content.

In pure gibbsite the ratio is 1:1.88; the average ratio in 40 analyses from deposit 4 (Bundanoon-Wingello) is 1:1.77.

These facts show that the alumina is present predominantly as gibbsite ($Al_2O_3\ 3H_2O$). This deduction has been verified by Mr. H. F. Whitworth who has identified gibbsite in thin sections of bauxite from New South Wales.

In addition to gibbsite, the bauxites examined contain hematite, magnetite, and in some instances, limonite and quartz grains. Some of the titanium may be present as ilmenite, but this has not been proved beyond doubt.

The statement has been made that ores such as those at Wingello are refractory and the silica percentage is quoted as proof of this. This statement is clearly shown to be incorrect at least for those ores in which SiO_2 is about 8% or less by (1) the small amount by which the total Al_2O_3 exceeds the soda-soluble Al_2O_3 and (2) the fact that quartz grains can be seen in the ore either in the hand specimen or under the microscope. Clay minerals such as kaolinite are present in some ores, but usually in extremely small amounts.

The foregoing remarks are intended to stress the fact that the Australian ores are chemically and mineralogically closely similar to the gibbsite ores used in other countries for the manufacture of aluminium.

GENERAL STATEMENT ON GRADE OF ORES.

It is possible to quote analyses of high grade ores which are being used for the manufacture of aluminium, overlooking the fact that ores with a great range in chemical composition can be and are being used successfully for this purpose. It is also overlooked that in most countries, ores receive beneficiation treatment and many of the analyses quoted do not relate to "run-of mine" ores, but to beneficiated materials. Following are some notes on commercial ores in use in foreign countries:-

(1). U.S.A. The following statement by the United States Bureau of Mines is taken from Minerals Yearbook, 1937, p.667.

"IN MAKING ALUMINA IN THE U.S.A. BY THE BAYER PROCESS A SILICA CONTENT UP TO 7% IS PERMITTED. MOST OF THE ORES USED PROBABLY AVERAGE 5% TO 6% SiO_2."

(2). ROUMANIA. (Mineral Industry 1938)

"The ore contains 20% - 25% Fe_2O_3."

(5). U.S.S.R. (Minerals Yearbook 1937, pp.681-682; 1938 p.595).

"Ores worked in the Urals have the following composition:-

(a) Kamensk 36% Al_2O_3, 35% Fe_2O_3, 5.3% SiO_2.

(b) Vagran 50% " , 26% " , 3.17% "

The close resemblance of the Kamensk ore to the ferruginous ores so common in New South Wales will be apparent.

It should be noted that the Kamensk plant uses the Bayer process and that the electric current used at the plant is steam generated.

It is undeniable that Russia experienced early difficulties in ore treatment, but it is also a fact that in 1939 the production of aluminium in that country was 44,000 tons.

(4). HUNGARY. Fe_2O_3 ------ 15% to 30%
SiO_2 ------ 2% to 4%

These deposits have 15 to 65 feet of overburden. Very large tonnages of this ore have been used for the manufacture of aluminium.

TREATMENT.

The principal impurities in bauxite are iron minerals, titanium minerals, free silica (quartz) and clay minerals.

As already stated, some form of beneficiation, usually washing, is commonly applied to bauxites mined in other countries, and it has been demonstrated on a small scale that such methods are effective in improving the grade of local ores.

Gandrud and De Vaney (Bull. U.S. Bureau of Mines No. 312, 1929) state that, as a result of their experiments it appears feasible to produce iron ore concentrates by tabling and jigging from a bauxite containing more than 20% Fe_2O_3. It might be pointed out that if all the ferric oxide were removed from an ore of the following composition:- 42% Al_2O_3, 25% Fe_2O_3, 3% SiO_2, 21% H_2O, the resultant concentrate would contain:-

58.56% Al_2O_3, 4.16% SiO_2, 29.28% H_2O.

This would give a silica content within commercial limits even if no silica were removed with the iron. In all probability, however, tabling and jigging would remove some silica also.

CONCLUSIONS.

If attention be directed only to the higher grade deposits in New South Wales, all of which are readily accessible and could be worked at the shortest notice, we have the following material available:-

Deposit	Tonnage	Average analysis.		
		SiO_2	Fe_2O_3	Al_2O_3(Avail.)
Emmaville.				
2 d & 2 e.	520,000	2.06	27.29	40.42
1 a & 1 b.	1,050,000	2.90	27.15	40.67
Bundanoon.				
3.	50,000	3.87	38.42	31.01
4. (1)	24,000	4.50	5.70	53.90

Deposit.	Tonnage	Average analysis. SiO_2	Fe_2O_3	Al_2O_3 (Avail.)
(ii)	73,000	6.50	12.60	43.20
(iii)	500,000	4.50	28.80	31.30
5.	270,000	4.03	37.39	31.59

These figures give a total tonnage of 2¾ million. To them may be added say 50,000 tons of high grade ore from Victoria and a large quantity of relatively high grade ore from Tamborine Mountain, Queensland.

It is stated that Australian requirements of aluminium are about 4,000 tons per annum. It requires from 4 to 6 tons of ore to produce one ton of metal; hence the quantity of ore required annually is about 24,000 tons.

THERE IS OBVIOUSLY PLENTY OF ORE AVAILABLE OF HIGH ENOUGH GRADE UPON WHICH TO BASE THE MANUFACTURE OF ALUMINIUM METAL IN AUSTRALIA, THE ORE PROVED UNDER 4 (i)-(ii) ALONE BEING SUFFICIENT TO SATISFY AUSTRALIAN REQUIREMENTS FOR FOUR YEARS.

(SGD.) H.G. RAGGATT.
Deputy Chairman.

J. HORSBURGH.

M.J. MARTIN.

J.M. NEWMAN.

ADDENDUM BY A.J. KEAST.

In becoming a signatory to this report, I am not prepared, without qualification, to express the view contained in the last paragraph of the report marked ★ but prefer to state the case as follows -

"It is evident from this report that there is a large proven tonnage of bauxite in Australia which should be investigated as to its suitability both economically and physically for the manufacture of aluminium metal in Australia. If, on investigation, this ore and its treatment will meet these requirements, it is estimated that the proven ore under 4 (i)-(ii) alone would be sufficient to supply present-known Australian needs for approximately four years".

(SGD.) A.J. KEAST.

2nd August, 1941.

FIG.1.

QUEENSLAND

BRISBANE

TAMBORINE PLATEAU

EMMAVILLE

DEEPWATER

GLEN INNES

INVERELL

SEE FIG 2

TAMWORTH

NEW SOUTH WALES

OCEAN

TRUNDLE

PARKES

LITHGOW

NEWCASTLE

PACIFIC

SYDNEY

CROOKWELL

PORT KEMBLA

SEE FIG 3, 4, AND INSET

SOUTH

VICTORIA

ORBOST

from Melbourne

MORWELL

BOOLARRA

DEPOSITS SHOWN THUS:-

N

LOCALITY MAP

BAUXITE DEPOSITS

N.S.W., S.E. QUEENSLAND

-AND-

COUNTY OF BULN-BULN

-VICTORIA-

0 36 72

MILES

INSET

CROOKWELL

GOULBURN

MARULAN

BUNDANOON

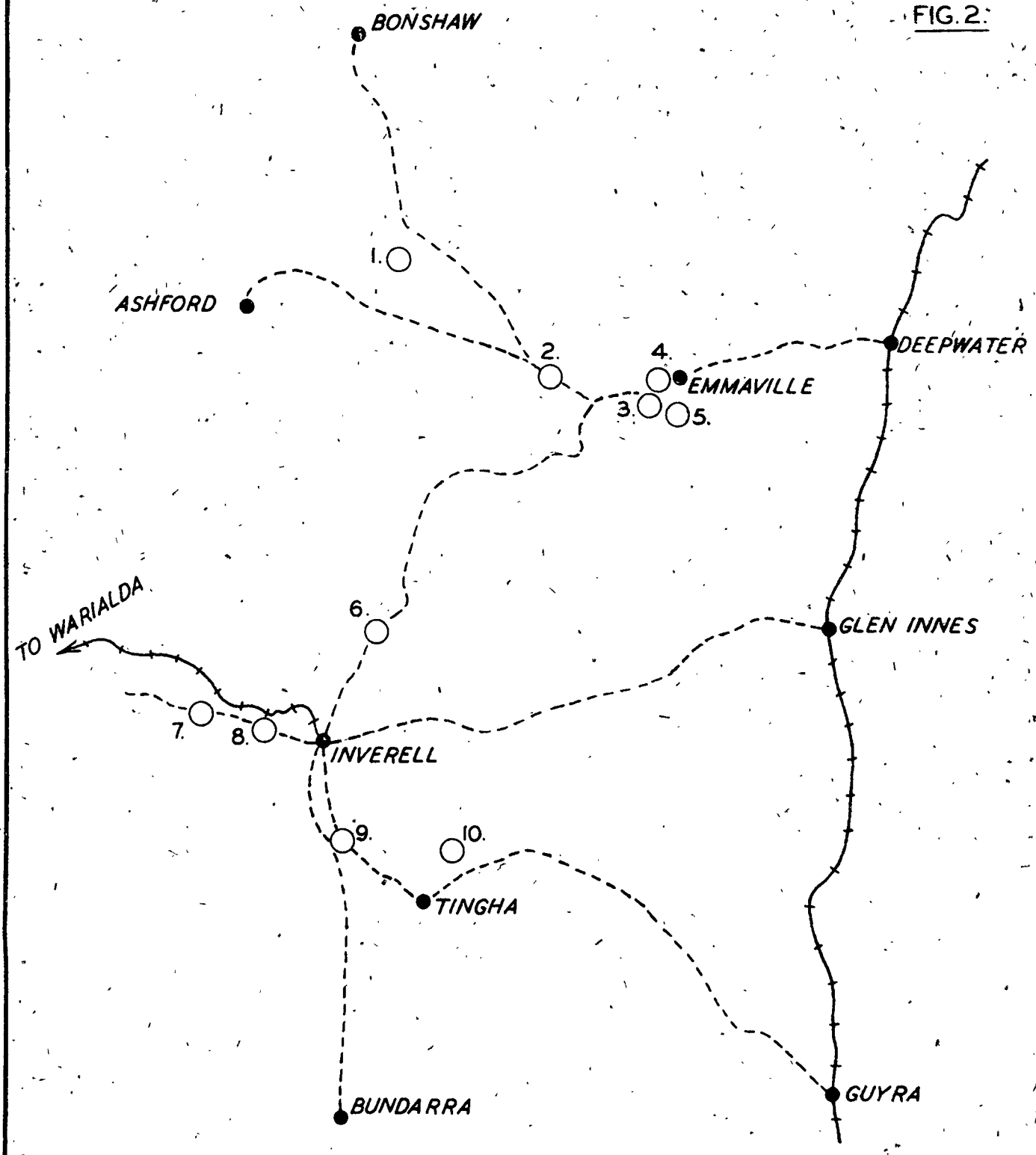
WINGELLO

BUNGONIA

0 12 24 48

MILES

FIG. 2.

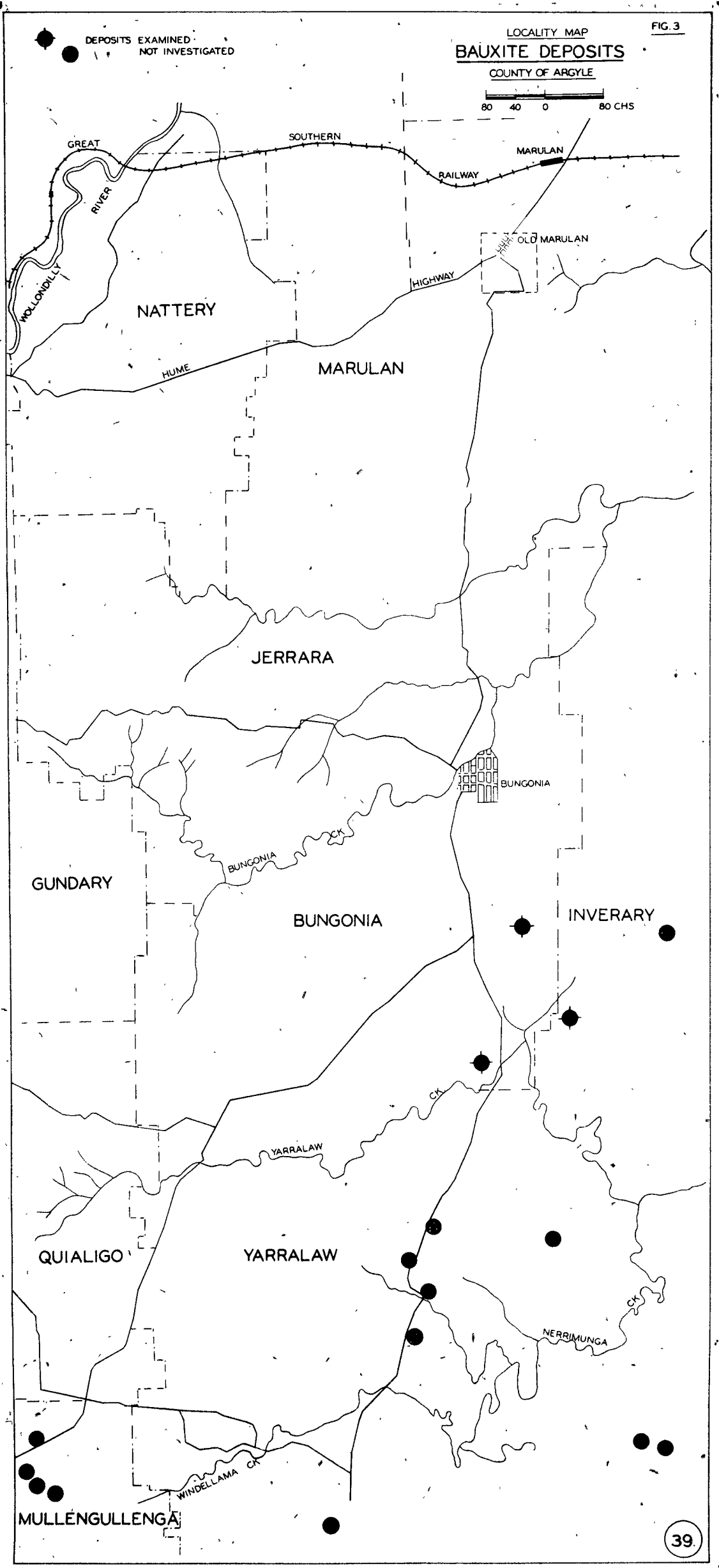


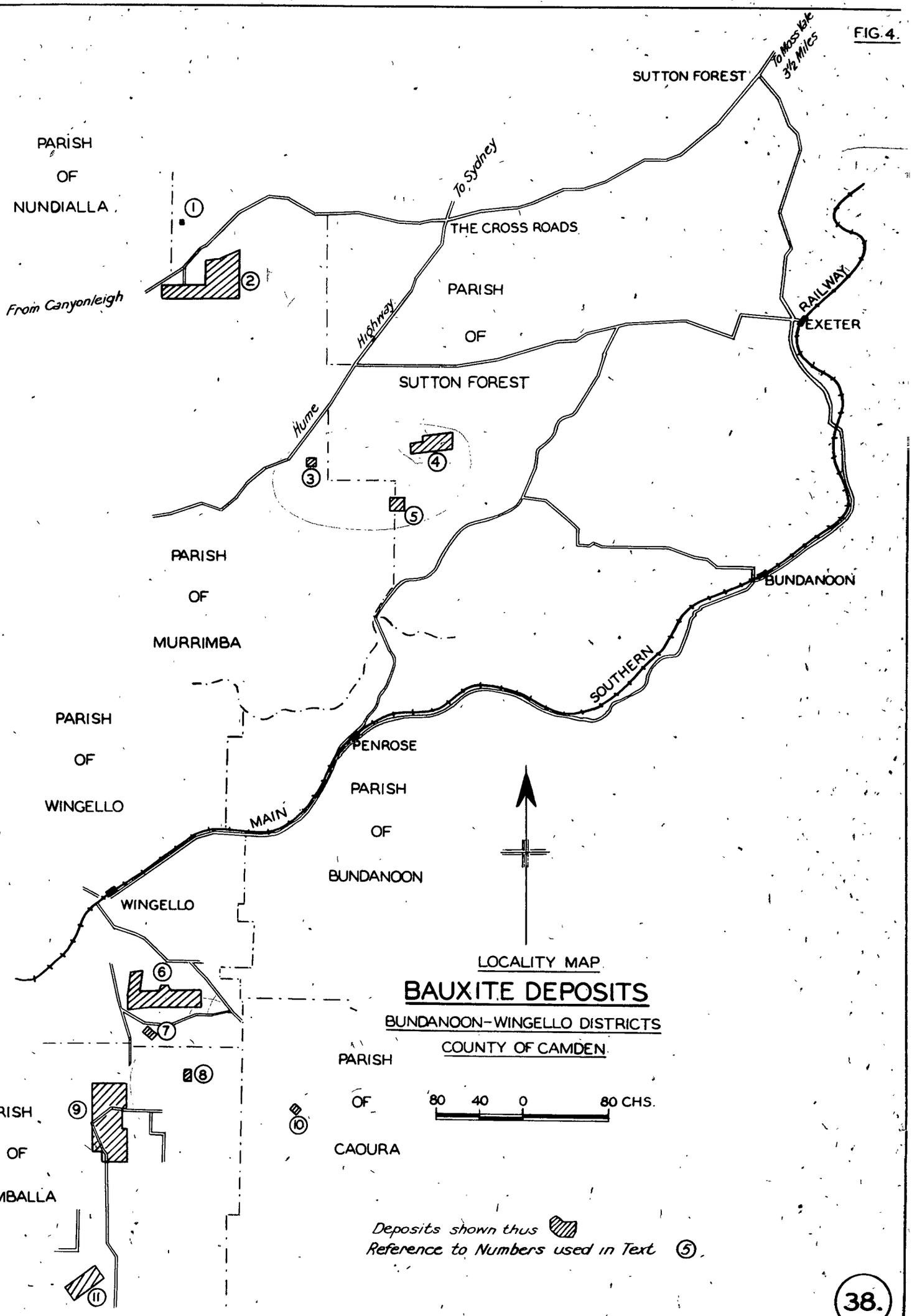
LOCALITY MAP

PRINCIPAL BAUXITE DEPOSITS EMMAVILLE-INVERELL DISTRICT

Scale 10 Miles - 1 Inch

REFERENCE TO NUMBERS USED IN TEXT ○3.


DEPOSITS EXAMINED
NOT INVESTIGATED
LOCALITY MAP
BAUXITE DEPOSITS
COUNTY OF ARGYLE
FIG. 3
80 40 0 80 CHS
GREAT
SOUTHERN
RAILWAY
MARULAN
RIVER
WOLLONDILLY
OLD MARULAN
HIGHWAY
NATTERY
HUME
MARULAN
JERRARA
BUNGONIA
BUNGONIA CK
GUNDARY
BUNGONIA
INVERARY
CK
YARRALAW
QUIALIGO
YARRALAW
CK
NERRIMUNGA
WINDELLAMA CK
MULLENGULLENGA



LOCALITY MAP

BAUXITE DEPOSITS

BUNDANOON–WINGELLO DISTRICTS

COUNTY OF CAMDEN

Deposits shown thus ▨

Reference to Numbers used in Text (5).