

RECORDS OF THE GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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TITLE: AN OUTLINE OF THE RESULTS OF
RECENT IRON ORE EXPLORATION
IN WESTERN AUSTRALIA, 1961-62.

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AN OUTLINE OF THE RESULTS OF RECENT IRON ORE EXPLORATION
IN WESTERN AUSTRALIA, 1951-62.

by

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SUMMARY

The systematic investigation of the iron ore resources of Western Australia has confirmed the long held view that this State can be ranked among the largest iron ore regions of the world.

The Hamersley Range deposits eclipse in magnitude all others in the State and Commonwealth and a great deal of work remains to be done before the total potential of this region can be reliably assessed. Work in the northern area of the Pilbara and in the Yilgarn and Murchison has substantially increased the known reserves of these areas. These deposits are much smaller than those of the Hamersley Range but the grade of ore is generally higher.

From the data available an attempt has been made to estimate the ore reserves of the State in areas of recent investigation. These figures are necessarily approximate, and not all the ore included can be assumed to be mineable. However, most of the figures are conservative and no account has been taken of the enormous quantities of scree ore and beneficiable material that are available.

The limonitic ores of grade between 48 and 60 per cent iron are estimated to amount to 5,500 million tons, most of which would be mineable by virtue of the mesaform nature of occurrence of these ores.

The hematite-goethite ores of grade between 55 and 68 per cent iron amount to 2,500 million tons. About 80 per cent of the reserves of this type of ore are to be found within the Hamersley and Ophthalmia Ranges.

The total known iron ore potential of the State is therefore of the order of 8,000 million tons of ore of grade exceeding 50 per cent. It appears certain that further exploration will substantially increase these reserves, particularly those of the higher grade, direct shipping hematite-goethite ores.

INTRODUCTION.

The intensified search for iron ore in Western Australia during the past two years has confirmed that this State is one of the major iron ore regions of the world. The resources are surpassed only by those of India, Brazil and possibly the U.S.S.R.

The largest deposits occur in the Pilbara, North-West Division, and particularly in the Hamersley and Ophthalmia Ranges. These deposits have been investigated by the Geological Survey of Western Australia, Consine Pictinto Australia Pty. Ltd., Broken Hill Pty. Co. Ltd., Basic Materials Pty. Ltd., and by geologists and prospectors of other interested organizations. Mt. Goldsworthy Mining Associates have explored the iron ore potential of the De Grey basin in the northern section of the Pilbara.

Western Mining Corporation and Broken Hill Pty. Co. Ltd. have investigated the iron ore occurrences in the Yilgarn and the Geological Survey have mapped and drilled the iron ore bodies of the Weld Range near Cue.

The following sections summarise the results of exploration and assessment of the various iron ore fields within the State. Figures quoted for reserves are necessarily approximate and incomplete and, in general, must be regarded as conservative.

GEOLOGICAL FEATURES OF IRON ORES IN WESTERN AUSTRALIA.

Most iron ore deposits in Western Australia are either directly associated with, or derived from, Precambrian rocks of Archaean or Proterozoic age. The ores themselves are usually of much younger age and have been developed by a variety of processes. Three main groups of iron ore bodies may be distinguished. These are as follow:

1. Replacement ores
2. Leached ores of the Lake Superior type
3. Sedimentary ores.

The Replacement Ores are mainly confined to rocks of Archaean age, usually jaspilites, and appear to have developed as a result of complete metasomatic replacement of the jaspilitic host rock. The character of the ore bodies has often been modified by metamorphism and strong folding. In general these ores are high grade hematite and lenticular and steeply dipping. The ore bodies of Tallering Peak, the Weld Range and Mt. Goldsworthy best exemplify this type of deposit.

The Leached Ores are of supergene origin and possess some of the characteristics of the older replacement ores. These have developed as a result of selective leaching of silica from jaspilite by meteoric and groundwaters over a protracted period of time with the production of a residual up-graded end product. The ores consist of an admixture of hematite and goethite and the relative proportions of these two mineral components determine the grade of the ore. In some cases there has apparently been considerable remobilization of iron and some degree of replacement has occurred to give bands of massive high grade hematite resembling that of the older replacement ores.

These ores constitute the bulk of the high-grade ore potential of the State and are best exemplified by the large ore bodies of the Hamersley Range, some of which contain as much as 200 million tons of ore of grade exceeding 60 per cent iron. The Sedimentary Ores are found within the drainage systems radiating from the Archaean and Proterozoic jaspilites and are

considered to represent the end product of a complex cycle of weathering and de-silicification of jaspilite detritus. This detritus, itself rich in iron, filled many of the valleys in the Hamersley Range during the early Tertiary peneplanation when a subdued landscape of broad valleys and gently rolling hills was developed.

The jaspilite detritus appears to have been subsequently transformed in situ, firstly into hematite-goethite conglomerates, and ultimately into pisolitic limonite-goethite iron ore. Rejuvenation of the rivers by uplift and the onset of a more pluvial climatic period swept much of this pisolitic material downstream where it accumulated in the stretches of the rivers where the gradient was lower. In short, these ores are regarded as alluvial placer deposits. These have been dissected by more recent erosion, probably modified to some degree by laterization, and now stand as prominent iron-capped mesas, which in the Robe River can be followed almost continuously for 60 miles.

The ore ranges in grade between 48 and 60 per cent and the reserves are to be measured in thousands of millions of tons. Similar ores are found in the drainage systems from the Archaean jaspilites in the De Grey basin.

The stratigraphy of the Hamersley Range has been outlined in a previous report (Records G.S.N.Z. 1962/3). It was early recognized that the leached hematite-goethite ores were confined to the three major jaspilite iron formations of the succession. These have been termed the Eoilescott, Brockman and Marrenauba Iron Formations in order of increasing age. Of these the Brockman Iron Formation is the thickest and most extensive. It is exposed over an area of about 6,000 sq. miles and forms most of the high country in the Hamersley Range. Most of the large hematite-goethite orebodies have been found in this formation.

and the favoured ore zones are in the limbs and troughs of synclinal folds and close vertically to the level of the Tertiary erosion surface. Extensive areas of the Brockman Iron Formation remain to be mapped and explored and it is certain that many more ore bodies will be located.

EXPLORATION ACTIVITIES

Geological Survey of Western Australia

The Geological Survey commenced a regional survey of the Pilbara iron ore province in May, 1962. The principal aims of this survey were the determination of the extent of the iron province and a general assessment of the nature and quantity of the ore. Close liaison has been maintained with all exploration companies. In the course of this work the Survey geologists have discovered numerous iron ore bodies and mapped about 10,000 sq. miles of previously unmapped country. The programme will be continued in 1963.

Iron ore deposits in other parts of the State have been examined, notably in the Yilgarn, and the programme of drilling and assessment of the Weld Range ore bodies has been completed.

Broken Hill Pty. Co. Ltd.

This company holds numerous Temporary Reserves covering both limonitic sedimentary ores and hematite-goethite ores. The company commenced an investigation of the hematite-goethite ore near Roy Hill about the middle of 1961. Surface sampling of the ore by the Geological Survey had given encouraging results, particularly in the area covered by the ministerial reserve. The company mapped and drilled the surrounding deposits but found that the ore was thin and variable in grade. The field staff were withdrawn from this area to the Robe River after the granting of additional reserves in February. Work has since been resumed in the Chichester Range which represents a westerly continuation of the Roy Hill iron ore horizon, and a drilling programme is planned.

During 1962, the main efforts of the company have been directed to the detailed survey of the limonitic ores in the

lower Robe River near Deepdals where the company holds 12 Temporary Reserves. These reserves cover the largest development of the piscolitic limonite ore in the province. The individual orebodies have been mapped and surface samples, access roads have been constructed and a comprehensive drilling programme has been in progress for the past six months. Some of the individual deposits are in excess of 300 million tons and the total inferred reserves are of the order of 3000 million tons of ore of grade exceeding 50 per cent iron. Much of the piscolitic ore in these deposits ranges between 56 and 58 per cent iron. These deposits are the closest to the coast of any in the Pilbara iron ore province.

The company also holds reserves covering limonitic ores south of the Robe River at the Cane River and on Duck Creek. These have been mapped and surface sampled both by the company and the Geological Survey and inferred reserves are computed at 500 million tons.

Conzinc Riotinto Australia Pty. Ltd.

Conzinc Riotinto hold numerous Temporary Reserves covering both hematite and limonite ores mainly within the Hamersley Range. The initial activities of the company were directed to the mapping and sampling of the limonitic ores at Duck Creek, the Turner River, Boolgeeda Creek and the southern branch of the Fortescue River. Inferred reserves of this type of ore on ground held by the company are of the order of 1,250 million tons. In general the Duck Creek and Turner River limonites are thinner and of lower grade than similar ores in the Robe River.

Late in 1961 the geologists of the company located several hematite ore bodies near Hamersley Station. These were mapped, sampled and drilled.

Further regional exploration led to the discovery of larger ore bodies of hematite near Mt. Brockman on the north and south limbs of the Brockman syncline. The company established their main camp at Boolgeeda, six miles south-west of Mt. Brockman and have since exhaustively explored the iron

ore potential of the surrounding districts. Four large hematite-goethite orebodies have been located close to the camp and the total inferred reserves of these must be of the order of 500 million tons. These have been mapped at large scale and drilled.

In August and September, 1962, the company conducted an intensive mapping and exploratory programme using a helicopter. Attention was principally directed to the western extension of the Brockman syncline and to the Turner syncline, which lies to the south-east of the camp. Many more ore bodies were discovered and a large area of the important iron formations was accurately delimited. No assessment has yet been made of the new deposits discovered during the helicopter survey but many of them must be greater than 100 million tons and cumulatively they must include at least 1000 million tons.

Henceforth the company activities will be mainly directed to large scale mapping and sampling and drilling of the ore bodies. With the amount of ore in sight, this will be a protracted and expensive programme.

Basic Materials Pty. Ltd.

This company holds 17 Temporary Reserves in the Robe River drainage system which mainly cover the sedimentary limonitic ores. The ore bodies in the lower section of the Robe River, adjoining those held by B.H.P., have been mapped and face sampled. Access roads to the summits of the mesas have been constructed and drilling is about to commence.

Indicated reserves so far established total 300 million tons of ore of grade exceeding 55 per cent with the highest grade of the order of 59 per cent.

There are extensive deposits of iron ore of conglomeratic and pisolitic character in the gorges in the upper reaches of the Robe River. Some of this ore exceeds 60 per cent iron. The company have scout sampled these deposits but their full extent is as yet unknown. The deposits have been examined by the Geological Survey and inferred reserves are conservat-

ively estimated to be of the order of 100 million tons.

Messrs. Hilditch and Warman

This group, which is co-operating with Mitsubishi Co. of Japan, holds an extensive area under Temporary Reserves in the south-eastern sector of the Hamersley Range and in the Ophthalmia Range. Up to the present most of their work has been of an exploratory nature and many large and high-grade hematite ore bodies have been located.

The most important deposits so far sighted are those near Mt. Newman and at Welli Welli Spring. At Mt. Newman, and in surrounding areas in the Ophthalmia Range, the largest deposits in the entire Pilbara province have been recorded. Along the southern flank of the Ophthalmia Range, east of Mt. Newman, hematite is almost continuously developed in the jaspilite for a distance of 16 miles. The Whaleback orebody, situated 4 miles south-west of Mt. Newman Homestead has been examined by Mitsubishi geologists and estimated to contain 228 million tons of hematite of grade exceeding 65 per cent. Much of the ore in this district is of similarly high grade. The Mt. Newman area has been examined by the Geological Survey in company with one of the principals of the group and the hematite ore reserves are conservatively estimated at 500 million tons.

Large deposits of high-grade hematite also occur near Welli Welli Springs where at least 70 million tons can be inferred. Much of the country held by this group has not yet been thoroughly explored due to difficulty of access but it appears certain that many more ore deposits will be located. The group have concentrated their efforts on the location of premium ore of highest grade and it would appear that such deposits are more abundant in this sector of the iron province than elsewhere. It is unfortunate that these high-grade deposits are so far from the coast.

Mt. Goldsworthy Mining Associates

During the past six months Mt. Goldsworthy Mining associates have undertaken a vigorous programme of detailed mapping and assessment of the Mt. Goldsworthy iron ore bodies and continued exploratory work in other Temporary Reserves in the Ord Range, and at Yarrrie, Strelley Gorge and Abydos.

At Mt. Goldsworthy drilling has proved the presence of an additional large ore body south of and roughly parallel to the main ore lens. This body lies at a lower stratigraphic level than the main lens and substantially increases the possible reserves. The main ore lens has been explored by two adits and numerous diamond drill and percussion holes.

Total indicated and inferred reserves at Mt. Goldsworthy now amount to 66,120,000 tons of ore of grade exceeding 55 per cent. Of this, 42,830,000 may be regarded as indicated and 23,290,000 as inferred. If the structural interpretation by the company geologists is correct there is every likelihood that these figures could be greatly increased.

Regional exploration has revealed the presence of iron ore bodies in the Ord Range which lies about 40 miles east of Port Hedland. This area is being drilled at present and inferred reserves are of the order of 60 million tons.

Several ore bodies have been located in the eastern block of Temporary Reserves near Yarrrie. These have been surface mapped and sampled but no drilling has yet been undertaken. Inferred reserves in this area are estimated at 32 million tons.

In the southern Temporary Reserves two hematite-goethite ore bodies have been found and there is a distinct possibility that more may exist. Inferred reserves in this area are placed at 16 million tons.

Messrs. Rhodes and Sims

This group holds Temporary Reserves near Nimingarra in the northern Pilbara. The most important deposit lies within T.R. 1988 and has been mapped and drilled. High grade massive hematite and low grade platy hematite/^{are}present and total inferred reserves are of the order of 75 million tons.

Western Mining Corporation

Western Mining Corporation has been engaged in the detailed investigation of the Talling ore bodies, the Koolanooka ore body near Morawa and the orebodies at Mt. Jackson, Mayfield and Windarling in the Yilgarn. Indicated reserves at Talling and Koolanooka are 3 and 1.8 million tons respectively. At Mt. Jackson in the Yilgarn 30 million tons of high grade hematite ore have been indicated and there are a further 25 million tons in the North Windarling ore bodies. Smaller ore bodies have been investigated at Manning Range, Pigeon Rocks and Mayfield.

SUMMARY OF IRON ORE RESERVES.

The following tables summarize the distribution of iron ore throughout the State. Figures for reserves are approximate as many of the largest orebodies have as yet only been briefly examined. In such cases estimates have been conservative.

TABLE 1. -- HAMERSLEY-OPHTHALMIA RANGE

<u>Area</u>	<u>Type of Ore</u>	<u>Reserves</u> (Millions of tons)
Robe River	Limonite	3,400*
Cane River	Limonite	500
Duck Creek	Limonite	600
Turner River	Limonite	250
Boolgeeda Creek	Limonite	110
S.Branch of Fortescue River	Limonite	270
Dales Gorge	Limonite	100
Others	Limonite	<u>200</u>
	<u>Total</u>	<u>5,430</u>
Hamersley Station	Hematite-goethite	60*
Mt. Brockman	Hematite-goethite	500*
Mt. Samson	Hematite	200
West Brockman Syncline	Hematite-goethite	500
Mt. Pyrtou	Hematite-goethite	30
Mt. Lockyer	Hematite-goethite	30
Mt. Whaleback (Ophthalmia Range)	Hematite	220
Ethel Gorge (Ophthalmia Range)	Hematite-goethite	300
Welli Welli	Hematite-goethite	70
Others	Hematite-goethite	<u>100</u>
	<u>Total</u>	<u>2,010</u>

TABLE 2 - NORTH PILBARA - DE GREY BASIN.

<u>Area</u>	<u>Type of Ore</u>	<u>Reserves</u> (Millions of tons)
Mt. Goldsworthy	Hematite	65*
Ord Range	Hematite-goethite	60
Yarrie	Hematite-goethite	32
Strelley Gorge -Abydos	Hematite-goethite	16
Nimingarra	Hematite-goethite	<u>75*</u>
	<u>Total</u>	<u>249</u>

TABLE 3 - YILGARN AND MURCHISON AREAS.

<u>Area</u>	<u>Type of Ore</u>	<u>Reserves</u> (Millions of tons)
Koolyanobbing	Hematite-limonite	60*
Bungalbin	Hematite-limonite	110
Mt. Jackson	Hematite	30*
N. Windarling etc.	Hematite	38
Mayfield	Hematite	8
Tallering	Hematite	3*
Koolanooka	Hematite	2*
Weld Range	Hematite and magnetite	<u>30*</u>
	<u>Total</u>	<u>281</u>

*Reserves partly proven and indicated, all others are inferred.

TABLE 4 - TOTAL ORE RESERVES.

<u>Area</u>	<u>Limonitic Ores</u> (48-60% Fe)	<u>Hematite Ores</u> (55-68% Fe)
Hamersley-Ophthalmia Range	5,430	2,000
North Pilbara - De Grey Basin		249
Yilgarn - Murchison Area		281
Totals	<u>5,430</u>	<u>2,530</u>

GRAND TOTAL = 7,970 million tons