TR2-33-41

SAVAGE RIVER IRON ORE DEPOSITS

by TERENCE D. HUGHES

Introduction

The recent increased interest in iron ore deposits in Australia has been reflected in this State by geological and geophysical investigations of most of the Island's major iron deposits. In May, 1956, magnetometer flights were carried out by the Bureau of Mineral Resources' DC3 aircraft " MIN " over several known iron-bearing areas of north-western Tasmania. Some interesting anomalies were revealed, including a pronounced one crossing the Savage River, covering the iron deposits originally known as the Rio Tinto. In the early part of this year a ground partly from the Bureau of Mineral Resources, led by Dr. O. Keunnecke, carried out a ground magnetometer survey. Although the results of this survey have not yet been issued, it is understood that they are promising.

A geological examination of the area was made by the writer in company with geologist A. B. Gulline, in May of this year. In order to avoid confusion with the Rio Tinto Exploration Company who are operating in this area, it has been decided to alter the name of these deposits to " The Savage River Iron Deposits ".

Location and Access

At 21 miles from Waratah, where the Waratah-Corinna Road reaches its highest elevation on Long Plains (a trig. station is close by) a pack track trends towards the west. This is the old Specimen Reef track which traverses the Savage River Iron deposits at from five to eight miles from the road. South of the Savage River the track skirts to the east of the iron, but north of the river it traverses the middle of the iron deposit and follows the ridge top. In the last year the Department has had this track cleared and except that it is rather wet in winter, it provides excellent walking. Some grades on the track are very steep, particularly in crossing the Savage River where, in a distance of less than two miles, it drops 800 feet to river level and rises to the same height on the other side.

A cage is in operation across the Savage River and although some of the bolts are rusty it can be used with comparative ease. At rare intervals in the summer, the river drops sufficiently to allow a crossing on the rocks.

At 24 miles on the Waratah-Corinna Road a second track, the Bullocks Head Track, runs north-west and joins the former track before it descends to the Savage. This track has not been cleared and although its distance is about the same as the other it is considered that the grade, as it crosses Main Creek, would be much steeper.

Traverses at intervals of about 600 feet have also recently been cleared across the iron formation.

At the present time, three areas are being prepared for a helicopter to land. As shown on the plan, one of these heliports is situated in the north, one in the south of the area, and one on the old camp site near the Savage River.

Corinna, on the Pieman River, lies 20 miles to the south. At present the mouth of the Pieman is blocked by a sand bar to all but vessels of very shallow draft. However, if this were removed and a breakwater built Corinna could doubtless become an adequate port, as there is a depth of 30 to 40 feet of water there.

History and Previous Literature

In the seventies of last century, during one of his exploration trips to the West Country, Surveyor C. P. Sprent discovered these iron deposits and drew prospectors' attention to the idea that they were limonite cappings of enormous tin bodies. When this proved not so, attention was paid to the gold and copper content of the iron bodies and their adjacent rocks and by 1898, Jones[1] reported that five tunnels had been put in by the Rio Tinto Co. In 1903, Twelvetrees[2] visited the deposit and in his report gave some previous history of the place. Prior to 1895 two companies drove adits from just above the Savage River, the Orluzza Gold Mining Company to the north and the Savage River Silver-prospecting Company to the south. Neither of these companies apparently found anything sufficiently rich to continue to a production stage. In 1895 the Rio Tinto Company N.L., with a nominal capital of £15,000 was formed and by 1898 had driven 1550 feet of which they stated 1400 had been in " ore " (though of what is not mentioned). It was thought that the magnetite consisted largely of the leached portion of the deposits and that in depth sulphides (including copper sulphide) would predominate. It was therefore decided to sink on the lode to test the unleached portion. Unfortunately, money had almost run out and the temporary shut down of the company seems to have been permanent.

By 1919, when the " Iron Ore Resources of Tasmania " was written, attention had once more been focussed on these deposits as a source of iron, and the leases were held by a Waratah Syndicate. Reid[4] described the deposits in this publication, took many surface samples and estimated iron reserves at 20 million tons. He divided the ore into five main and several smaller lenses and gave it as his opinion that the main ore bodies consisted of magnetite and hematite. He states that the sulphides do not appear to be mixed with the iron oxides in the main lenses, but are usually found as separate bands adjacent to these.

Between this time and 1939, when Woolnough visited the locality, much surface trenching and at least one adit had been driven. In his report, Woolnough[6] condemns the deposit. He considers that the lenses are even smaller and more discontinuous than stated by Reid, and considers that below the zone of oxidation the bodies will be strongly "pyritous".

Topography

The most striking topographic feature in this locality is the broad peneplain extending for many miles at heights of 1100-1300 feet above sea level. Into this the major drainage channels are rapidly cutting and are still in a youthful stage of erosion. Near the iron deposits the Savage River and Halls Creek have cut down 800 feet into the plain and at their confluence are not much more than 400 feet above sea-level. Webster Creek flowing from the south to the Savage has not yet cut a deep valley. It is much smaller than Halls Creek. The major streams rise rapidly after rain and can then be crossed only by cages or high-level bridges.

Geology

Although at first sight, there are many different rock types occurring near the iron deposits, more detailed work reveals that they are all of common origin and have been altered in various ways by different processes over a long period of time. Rock types that may be seen in outcrop or as floaters near the iron outcrops are amphibolites (of fine to medium grain size) chlorite schists, talc schists, quartz schists, dolomites and quartzites: some very different in appearance from others; yet field mapping and microscopic work reveal common origins. These rocks represent an intrusion of basic material into rocks of Precambrian age. This intrusion probably occurred in the Cambrian. The portion that is least altered occurs where the iron is sparsest, that is an area bounded by Halls Creek, the Specimen Reef Track and Traverses C 31 and D 15. Here the rock, although well jointed and in places quite heady, shows no schistosity, except in localised areas. In the appendix the accounts of 1 and 2 (D 150'W and Halls Creek 150'S of D Traverse) refer to this rock type. Throughout this rock, however, in localised shears are developed, sometimes only for a few inches, chloritic schists that have exactly the same appearance in hand specimen as the schists that occur, mostly in floater form only, so widely over this area. The same effect as produced by local stresses is thus produced on a grand scale by regional forces and the resulting schists, chloritic and even talcose, although they differ greatly in appearance from the unaltered amphibolite, are merely different facets of the same rock. It is interesting to note that the two places in this general locality where schistosity does not occur to any marked degree are: (*a*) between Halls Creek and the track north of the Savage; and (*b*) south of the Savage along and just west of the Track. The reason for (*a*) seems to be that there is no large deposit of iron oxide in this area, that is no solid mass against which the amphibolites could be squeezed. In area (*b*) the amphibolites seem to have been protected between two lenses of iron oxide.

Another variant of the original rock is the dolomite. This rock has only been observed in outcrop along the Savage River, although it has been reported in old adits. In appearance it is a typical pale pink fairly coarsely crystalline rock with frequent calcite veins. No bedding is apparent although there is some shearing, striking north and dipping very steeply to the east, which simulates bedding. However, in thin section, can be seen "in the matrix and as discrete fragments carbonate in acicular crystals, closely resembling the fine grained amphibolite texture", which suggests an igneous origin for this rock.

In the same geological period as the orogeny that sheared the amphibolite, that is probably during the Devonian, another factor occurred which further altered some of these rocks. The introduction of silica caused the formation of; (*a*) siliceous amphibolite schists; and (*b*) quartzites, which are silicified dolomites. This silicification is purely local and examples of (*a*) may be found near the track round stations D 14 to D 16, that is about half a mile north of the Savage River. No outcrops of the silicified dolomite have been observed but large boulders of it can be seen in the creek which crosses the track south of the Savage between B 2 and B 3, at 500 W on B Traverse and in Webster Creek. Descriptions of thin sections (D 16 50E) and (D 14) of the silicified amphibolite and of the silicified dolomite (B500W) may be found in the appendix.

The sedimentary series into which the basic rocks have been intruded belong to a group of quartz schists, quartz sericite schists, phyllites and slates which can be seen occasionally in outcrop on the track between Webster Creek and the Waratah-Corinna Road. The cleavage has a general northerly strike and a dip to the east at high angles. Veins and bunches of quartz traverse these rocks and after the break up of the rock, form the familiar quartz gravel along the track.

A good outcrop of quartz-mica schist occrs at Stations 97-98, just east of the beginning of traverse "A" on the track. This is described (97-98) in the appendix.

These rocks were named by Twelvetrees in 1908([3]) "Long Plain Schists" and he described them as "sericitic, graphitic and quartz schists, striking a little east of north" and of Precambrian age. This same series is described by Spry and Ford 1957([7]) as the Corinna Beds, consisting of quartzites, phyllites and slates and of Precambrian age.

Certainly these beds occur stratigraphically below the Dundas Beds and are therefore probably very high in the Precambrian.

Between traverses F and G and north of G, in the northern portion of the area are numerous boulders of Tertiary basalt. At intervals along the track also are Tertiary gravels. These Tertiary beds appear of very small extent and thickness and it would appear that the present erosion cycle has almost reached the base of the basalt. A few basalt boulders also occur to the east of the track in the vicinity of traverses D 16 and E.

River terraces of recent alluvium occur in the southern bank of the Savage, near the cage crossing. Cuts and trenches have been put into these by osmiridium seekers.

The Iron Deposits

In view of the differences of opinion that have been expressed in the past regarding origin, purity and extent of these iron ores, the following are the author's views given in tabulated form:—

1. The iron oxide was formed as a magmatic segregation at the time of the intrusion of the basic rocks—that is during the Cambrian orogeny.

2. It therefore formed in a series of concentrations or pockets in the rock itself and the boundaries between the iron and amphibolite cannot be deduced from any structural evidence, except that in conformity with the planes of schistosity these boundaries have a steep dip to the east.
3. During the Devonian Period shearing occurred in both the iron and the amphibolite and along these passage-ways hydrothermal solutions of pyrite and quartz with a small percentage of other metallic minerals were introduced. Thus, the pyritic content of the iron is local and should not increase with depth. A sample taken over 70 feet in an adit showed but 1·5% iron pyrite.
4. At the surface the iron has been oxidised, hardened and purified of its sulphur content. An assay shows very high iron content, no sulphur and a greater proportion of hematite and limonite to magnetite, than at depth.
5. The reserves of ore appear much larger than was previously thought and must be of the order of hundreds of millions of tons. It does not appear that the area covered by talus from outcrop iron is large compared with the area actually underlain by the iron itself.
6. On the accompanying map, the boundaries of the iron oxide must not be taken too literally. Owing to the heavy undergrowth, boundaries of the iron were plotted along cut traverses only. Small areas of amphibolite may remain in the centre of iron segregations just as small pockets of iron may occur isolated in the amphibolite.

These rather brief statements may be amplified in the general account of these iron deposits. The idea of the segregation of iron oxide crystals early in the cooling of a magma and their concentration either by sinking or marginal-accumulation to form aggregates sufficiently large to become ore deposits is quite an old one. This was the method by which it was thought the immense iron deposits at Kiruna and at various places in the U.S.A. were formed. Latterly, however, some writers believe that the Swedish deposits are injections rather than segregations. These Savage River deposits, however, seem to have been formed by magmatic differentiation in place, and not to have been injected after the solidification of the magma. It is interesting to note that thin sections of the amphibolite away from the iron outcrops show ilmenite but no magnetite.

Because of the mode of origin, it is expected that the boundaries of the iron will be sharp but irregular. The intrusion of the basic rock is in a north-south direction and regional stresses have produced a general steep easterly dip. The iron is thus contained in a north trending zone and consists of a number of lenses with steep dips to the east. The iron outcrops boldly in a number of places, particularly on the north and south banks of the Savage River. This river has cut a trench some 800 feet deep through the main southern concentration of the iron and the fact that the outcrop, in plan, swings very little to the east suggests a very steep dip for the lens. As outcrop is limited, vegetation thick and the origin igneous, the boundaries of the iron ore must be taken as approximate only. However, by the outcrop observed, it is believed that reserves will prove to be large indeed and it is suggested that, taken to 500 feet in depth, the possible reserves of the two larger concentrations will be of the order of 200 million tons.

As already mentioned it is believed that the pyrite, and some silica, are a different generation from the iron oxides. These minerals, of which pyrite is the more significant, have been introduced along joint and shear planes impartially into the amphibolite and magnetite. The only adit open for inspection shows two small faults, striking N.N.W., one at 15 feet and the other at 65 feet from the portal, Pyrite is concentrated along these two faults. An analysis of a continuous sample along the wall of this adit showed:

	%
SiO_2	3·03
Al_2O_3	2·52
FeO	20·13
Fe_2O_3	68·10
MnO	0·22
TiO_2	Trace
FeS_2	1·52
P_2O_5	Trace
Cu	Trace
Cr_2O_3	Trace

This shows 65% of magnetite and 23% of hematite and limonite or 88% of iron oxide and 63·2% of iron. The iron oxides in this adit are very soft and although the walls are standing well the material could be scraped off for a sample without any trouble.

At the surface in most places the sulphides have been oxidised and the other impurities leached out. A composite analysis of pieces taken from various outcrops showed:

	%
SiO_2	0·4
Al_2O_3	0·4
FeO	7·2
Fe_2O_3	87·9
MnO	Trace
TiO_2	2·7
S	0·05
P	Trace

which shows much more Fe_2O_3 (71·9%) than magnetite (23·2%) and 67% of iron. In the Iron Ore Resources Reid quoted the analyses of 17 surface samples, the average iron content of which was 67·4% iron.

Some material taken from the dump of an adit, now fallen in, near D 27 Traverse was assayed. This appeared to be of low grade, but the iron content was still 63% almost all in the form of magnetite. viz.:

	%
SiO_2	5·75
Al_2O_3	0·2
FeO	26·8
Fe_2O_3	60·2
MnO	Trace
TiO_2	3·4
S	0·2
P	Trace

These lenses of iron oxide are most favourably situated from the mining point of view, forming as they do the tops of two prominent ridges—one to the north and the other to the south of the Savage River. From river level, these ridges reach a maximum height of 800 feet. The southern lens could be open cut, without any major worries, right down to river level. The main northern lens varies in surface elevation from 600 to 840 feet.

Other Minerals

Twelvetrees in his 1903 report quotes various company figures of assays for gold, silver and copper which are high grade (such as 8 dwt. gold and 22% copper) and obviously not representative of any formational width. To the west of the main deposits in the vicinity of the Savage River and in traverse F are concentrations of sulphides, which appear quite narrow on the surface, where outcrop is limited, but which apparently, from old reports, have sizable widths where intersected in adits. Unfortunately, any adits into this sulphide material are inaccessible. Material from the dump of an adit driven from Halls Creek between traverses C 31 and D showed plentiful pyrite but no copper in hand specimen; similarly no copper was seen in surface outcrop. On the other hand the persistence of this sulphide zone over a long distance seems likely. Definite sulphides were found to the west of the iron in Traverses F, C 29 and C 12 and indications of gossanous material in Traverses C and B. Near the Savage River north bank, just east of the magnetite outcrop, two adits have been driven on what appears to be a sulphide formation.

As has been suggested earlier, it is considered that the sulphides, pyrite and chalcopyrite, as well as gold and silver were intruded into both the iron oxide and amphibolite during the Devonian metallogenetic epoch. That being so, it may well be that in this area are deposits large enough and of a grade high enough to develop. During investigations into the iron ore, one such may well be located.

It may be mentioned in passing that in this general area, along the bed of the Savage River and in remnants of river terraces which survive here and there along the steep river banks, alluvial gold and osmiridium have been won in the past. On both banks of the river, near the cage crossing, are remains of adits and trenches in alluvial material. In 1921 Read[5] reported that between 70 and 80 men were working along the Savage River over a distance of 15 miles. The origin of the osmiridium is doubtless to be found in the ultra-basic rocks through which Nineteen Mile Creek, a tributary of the Savage passes about three miles east of this area. Consequently, the osmiridium here is generally fine grained and terrace ground has been reported as containing eight to ten grains per ton.

Recommendations

Both from magnetometer surveys and ground geological observations, the answer seems to be that there are immense deposits of iron ore in this locality. Certainly the concentration of iron is not continuous over the whole three miles but at least two of the lenses appear to have possible reserves approaching 100 million tons each. Whether the iron oxide is continuous in these lenses and whether it contains material deleterious to treatment will have to be ascertained by drilling.

A drilling programme is dependent on the money available, but I would suggest two stages. The first stage should be two holes in either Traverse B or B 8 with possible further bores in traverses north and south and two holes in E Traverse, again with possible further bores north or south. Whether or not holes were drilled in traverses north and south of the two initial traverses would depend on the results obtained and the money available. The bores should be sited about the eastern boundary of the iron and should have a dip of 40-60° to the west. The reason the drilling is preferred from the east rather than from the west is that (*a*) the bodies probably have a steep dip to the east and (*b*) the main sulphide deposits probably occur west of the iron and these may be picked up in a bore.

Before drilling is commenced it will be necessary to study the report and plans of the Bureau of Mineral Resources on the results of the ground Magnetometer Survey to see that there is no conflicting evidence.

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APPENDIX

by G. EVERARD

The following petrographic descriptions apply to specimens collected by Senior Geologist Hughes at Rio Tinto.

The examination has revealed that these rocks have had a complicated history. Carbonate rocks have been replaced by quartz. Amphibolites have been altered to carbonate rocks by replacement, and also to quartzites by direct replacement with silica. The amphibolites show structures that suggest a still earlier phase; but the petrographic evidence is not sufficient to establish this earlier rock type.

1. D 150′ W

Fine grained dark-green rock.

In thin section the rock is a structureless aggregate of ragged plates and acicular crystals of green hornblende with very fine grained interstitial quartzo-felspathic material. Euhedral crystals of ilmenite are disseminated through the section, and there is much sphene in granular aggregates, often associated with the ilmenite.

The rock is an amphibolite.

2. Halls Creek 150′ S of D Traverse

Greenish massive looking rock but some specimens are strongly sheared.

In thin section the rock is a mass of roughly aligned needles of green pleochroic hornblende. A minor amount of twinned plagioclase appears interstitially, together with some material that may be quartz, but does not give a defined interference figure for identification.

The rock is an amphibolite.

3. **D 16 50′ E**

Fine green sheared and banded rock. The specimen is somewhat weathered and contains clay material.

In thin section the rock is a confused aggregate of acicular hornblende in a quartzo felspathic matrix. Traces of former structure remain in whirlpool-like masses of acicular amphibole, and shattered crystals and mosaics of quartz and plagioclase. There are masses and veinlets of quartzo felspathic material and opaque white masses of kaolinised felspar.

The rock is a fine grained amphibolite.

4. **97 — 98**

Grey and white mottled rock. Shearing is prominent and quartz the principal mineral, with white mica appearing in the shears.

In thin section the rock appears as a fine mosaic of quartz grains in a network of white mica.

The rock is a schistose quartzite.

5. **D 14**

Light greenish banded rock. Irregular layers of quartz occur interbanded with greenish layers, which also contain quartz.

In thin section the rock consists essentially of a fine mosaic of equi-dimensional quartz grains. There are also patches and veins of similar but finer mosaic, sharply marked off from the rest. Superimposed on this structure are vague bands and cloudy masses of opaque white material, sometimes stained brown with iron oxide. In these cloudy bands are ragged plates and masses of green fibrous hornblende, and aggregates of fine granular yellow epidote.

6. **D 620 E in River**

Pale-pink sheared rock, showing carbonate crystal faces up to 3 mm. across.

In thin section the rock is seen to be composed completely of carbonate. The larger crystals are set in a matrix of smaller crystals, all showing typical rhombohedral cleavage. However, in the matrix and as discrete fragments is carbonate in acicular crystals, closely resembling the fine grained amphibolite texture.

7. **B 500 W**

This is a fine grained brown quartzite. The colour is due to opaque argillaceous and limonitic material, occurring as cloud-like colourations and as interstitial material between quartz grains. Clear patches of quartz with rhombohedral cleavage show that silica has replaced carbonate and that the rock was originally a limestone or dolomite.