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THE NUNYERRIE CHRYSOLITE DEPOSITS.

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INTRODUCTION.

The Nunyerrie Asbestos Claims are situated at latitude 21°34'17" South and longitude 117°52' 42" East on the track between Mt. Florence and Croydon, and are about 60 miles southeast of Roebourne. The distance by road to Roebourne via. Mt. Florence is approximately 155 miles.

The Nunyerrie Asbestos Deposits are associated with a remnant of metamorphosed ultrabasic rocks in granite country, which is part of a group of Pre-Cambrian rocks of Archaean age. The ultrabasics form an east northeast trending ridge about 1 mile long and 250 feet average width, which rises to a maximum elevation of 300 feet above the general level of the surrounding country. The belt of ultrabasics is highly sheared and jointed and consists chiefly of serpentines, but talcose rocks, chlorite schists, authophyllite rock and what appear to be hydro-biotite schists also occur. The ultrabasics have an intrusive junction with the surrounding granite rocks, and they are intruded by quartz veins and granitic dykes.

A thick series of flatly bedded basic lava flows occurs as a capping on the higher country surrounding the belt of Archaean rocks, and a few of the higher hills within the belt are also capped with basalt. The basic volcanics are presumably part of the Nullagin a Group of Proterozoic age, but they show a marked lithological resemblance to the Antrim Volcanics of Cambrian age in the East Kimberleys.

The Nunyerrie ridge of ultrabasic and the surrounding country is well shown on aerial photograph E 5062, run 8, survey 168, Pyramid.

THE DEPOSITS.

The principal asbestos deposits are at present (July 1951) included in mineral claims 48 and 68 held by Mr. L. Hancock, who commenced operations in the area at the beginning of 1947.

These deposits occur over a length of about 2,500 feet in the belt of metamorphosed ultrabasic rocks. Several lines of chrysotile lodes occur in the area, and they have previously been mapped and described in some detail (Finucane, Sullivan, and Telford, 1939). Further mining has been carried out since that time, and some additional geological information has been obtained as a result of the recent investigations.

The chrysotile lodes, which are the most important in the area, have a general east northeast strike and usually dip at about 70 degrees north northwest. They consist of zones of serpentine rocks containing numerous veinlets of cross fibre chrysotile. The lodes are lenticular in character attaining a maximum width of about 5 feet, and so also are the cross fibre chrysotile veinlets, the fibre in which attains a maximum length of about 2½ inches. The No. 1 lode has been tested over a length of 400 feet and has fibre showing over an average width of 12 inches; the No. 2 lode has been traced over 150 feet and shows fibre over an average width of 9 inches; and the No. 3 lode has been opened up over a length of 500 feet and shows fibre over widths ranging from 12 to 30 inches. Other

Chrysotile lodes have been opened up about $\frac{1}{4}$ mile east northeast of the No. 3 lode workings.

In the No. 3 lode working the quality of the fibre is reported rather erratic in the oxidised zone, that is above the 60 feet level, but good quality chrysotile is reported to have occurred consistently below this level. It may be expected that similar conditions will exist in other lodes.

In addition to the chrysotile lodes, picrolite and tremolite lodes occur in the area.

The picrolite is similar to chrysotile, but has a weaker tensile strength. The picrolite, which so far has been mined, occurs near the northern serpentine granite junction near the northeastern end of the area mapped (Finucane, Sullivan and Telford, 1939, Plate 1). The wall rock nearest the granite is talc and that farthest from it is serpentine. Other occurrences of picrolite have been seen at the junction of talc and serpentine rocks. The so-called "Dead Lode" intersected in the adit 30 feet south east of the No. 3 chrysotile lode at the 130 ft. level is now referred to as a picrolite lode. This lode strikes approximately east-west and junctions with the No. 3 Lode about 75 feet south-west of the adit. It is interesting to note that over the last 40 feet before the junction the picrolite changes to chrysotile and the host rock from talcose rock to serpentine. The eastern extension of this picrolite lode was traced at the surface, and it was found that the picrolite changed to tremolite and the host rock completely to talc, as the granite junction was approached. A thin dolomite dyke (W.A. Lab. No. 11172), follows the course of this picrolite - tremolite lode and eventually enters the No. 3 lode channel where it has a pseudomorphic structure after chrysotile.

As was seen in the case of the picrolite - tremolite lode described above the tremolite always occurs in close association with talc, and the lodes occur at, or very close to, the granite junction. One occurrence of tremolite about $\frac{1}{2}$ mile southwest of the Nunyerry mine is in a lens of talc entirely surrounded by granite.

The origin of the asbestiform deposits appears to have been in two stages. It appears that firstly, the chrysotile was formed during the autometamorphism of the ultra-basic rocks, and later regional metamorphism particularly the effects associated with the intrusion of the granite has caused a transition of the chrysotile through picrolite to tremolite, and an alteration of the serpentine through various stages to talc. Detailed mapping of the different varieties of rock in the ultra basic belt would be very helpful in indicating the distribution of the three different asbestiform minerals.

It would appear that the persistence of the known chrysotile lodes at depth is dependent on whether or not the granite intersects them, or comes in close proximity to them. The fact that both the northern and southern granite boundaries dip steeply north-westward at the surface, parallel with the dip of the main chrysotile lodes, gives every hope, however, that they will not be effected for at least another several hundred feet. Drilling of the lodes at depth, however, safeguards against this eventuality.

THE WORKINGS.

Since taking over the mine Mr. L. Hancock's work has been concentrated chiefly on what is known as the No. 3 Lode, but some work has been done at the northeast end of the asbestos-bearing zone.

The main haulage way on the No. 3 Lode is the bottom adit, and driving has been carried out from it 226 feet northeast and 108 feet southwest at the 130 feet level. The block of ore occurring above the drives at the 130 feet level has been almost completely stoped out upwards to the 60 feet level, over a width varying from 2 to 5 feet and averaging about 3 feet. There is an internal shaft 75 feet deep off the 130 feet level at about 50 feet southwest of the adit. Driving had been carried out from the bottom of this shaft (i.e. at the 205 feet level) 140 feet northeast and 72 feet southwest, at the time of inspection. Driving was in progress at the 205 feet level, and a little stoping had been done above the northeast drive. The intention is to drive on the lode at the 205 feet level over a similar length to that at 130 feet level and then remove the block of ore between the two levels by stoping.

Work at the northeastern end of the asbestos zone has consisted of open cutting a picrolite lode over a short length to a shallow depth, and the sinking of a shaft on a good showing of chrysotile.

PRODUCTION.

The total production of chrysotile from Nunyerry as reported to the W.A. Mines Department to the 31st. December, 1950 is as follows:-

| <u>Period of Production.</u> | <u>Company or Lease.</u> | <u>Chrysotile (long tons)</u> | <u>Value (£s)</u> |
|------------------------------|--|-------------------------------|-------------------|
| 1934 - 36 | "Nunyerry" M.L. 349 ^h | 255.70 | 5,235 |
| 1936 - 37 | "Chrysotile Ltd. M.L. 349 ^h | 62.40 | 1,335 |
| 1939 | P.A. 681 ^h | 0.48 | 36 |
| 1940 | P.A. 746 ^h | 2.50 | 45 |
| 1941 | M.C. 190 ^h | 3.25 | 135 |
| 1942 - 43 | P.A. 794 ^h | 35.50 | 1,680 |
| 1943 - 45 | M.C. 263 ^h | 40.03 | 2,188 |
| 1947 - 50 | M.C.'s 48 and 68 | 501.89 | 29,423.55 |
| Totals:- | | 901.75 | 40,077.55 |

For the production between 1947 and 1950 the proportions of the various grades of chrysotile produced are as follows:-

| <u>Year.</u> | <u>Grades (tons).</u> | | | | | |
|--------------|-----------------------|-----------|-----------|-----------|-----------|----------------------|
| | <u>1.</u> | <u>2.</u> | <u>3.</u> | <u>4.</u> | <u>6.</u> | <u>F^o</u> |
| 1947 | 2.86 | 8.21 | 46.15 | 21.35 | - | - |
| 1948 | 2.48 | 5.85 | 44.80 | 18.18 | - | - |
| 1949 | 2.55 | 8.33 | 41.30 | 33.22 | 40.39 | 2.92 |
| 1950 | 1.81 | 5.36 | 39.87 | 22.40 | 128.51 | 21.93 |
| Totals: | 9.70 | 27.75 | 162.12 | 95.15 | 168.90 | 24.85 |

o Floats.

Production of chrysotile as reported by Mr. Hancock from 1st. January, to 30th. June 1951, is as follows:-

| <u>Grades (Tons).</u> | | | | | |
|-----------------------|-----------|-----------|-----------|-----------|-----------|
| <u>1.</u> | <u>2.</u> | <u>3.</u> | <u>4.</u> | <u>6.</u> | <u>F.</u> |
| 1.4 | 4.65 | 27.2 | 34.5 | 51 | 0.75 |

Picrolite has been produced since 1949, and details of proportions of the various grades produced are as follows:-

| <u>Year.</u> | <u>A.</u> | <u>B.</u> | <u>C.</u> | <u>D.</u> |
|--------------|-----------|-------------|-------------|-------------|
| 1949 | 0.57 | 2.22 | 6.44 | 3.33 |
| 1950 | <u>-</u> | <u>0.09</u> | <u>0.32</u> | <u>0.45</u> |
| Totals: | 0.57 | 2.31 | 6.76 | 3.78 |

Grades A to D correspond with grades 1 to 4 respectively.

During 1951 an additional $\frac{1}{2}$ ton of mixed grades of picrolite has already been produced.

The total production of tremolite to the 30th. June 1951 has been 1 ton of talc - tremolite rock.

RESERVES AND GRADES.

The No. 3 chrysotile lode has a length of about 300 ft. at the surface and it has been opened up over lengths of 334 feet and 212 feet respectively at the 130 feet and 205 feet levels.

At the 130 feet level little asbestos was showing in the faces of both the northeast and southwest drives. Judging from surface indications, however, it seems likely that the poor showings of asbestos were only local and further driving would be possible at this level, particularly to the southwest to bring the total length of driving to at least 500 feet. Equal possibilities occur at the 205 feet level where driving was in progress in both the northeast and southwest drives on good showings of asbestos. In the block of ore already stoped by Hancock between the 130 feet and 60 feet levels, the average width of lodes mined is about 3 feet and 10 percent of the material is reported to have been chrysotile ranging between grades 1 and 4. An examination of the outcrop of the lode and exposures of it in the underground workings suggest that these are reasonable figures to adopt for further mining of this lode channel.

Based on the factors for the No. 3 lode quoted above, that is a length of 500 feet, and average width of 3 feet and 10 per cent. recovery of fibre from grade 4 upwards and using a conversion factor of 15 cubic feet per long ton, the reserves of chrysotile from grade 4 upwards in No. 3 Lode amount to 10 tons per vertical foot. At least an equal quantity of reserves of chrysotile can be reasonably expected, to occur in the other chrysotile lodes (including No. 1 and No. 2 lodes) in the asbestos bearing belt.

The total available chrysotile reserves are therefore about 20 tons per vertical foot of fibre from grade 4 upwards. Based on available production data the proportions of grades 1, 2, 3 and 4, in the reserves would be 1 : 2.86 : 16.71 : 9.81 respectively. In addition to these grades of chrysotile, a proportion of "Floats" (i.e. mixed grades 1 to 4) has also been produced.

The residues after recovery of the grades 1 to 4 chrysotile and the "floats" consist of a small proportion of short fibre and crushed serpentine and they are classed as No. 6 Grade. About 220 tons of No. 6 grade material has already been sold for grinding and tile manufacture and there is a dump of residues reported to contain 5,000 to 6,000 tons at the mine.

The Western Australian Government Chemical Laboratories reported as follows on a grab sample of material from the residue dump -

Lab. No. 11170/51.

The sample was screened through 30 mesh and the products +

and - 30 mesh each crushed twice through rolls, then screened on 60 mesh.

The products refusing 60 mesh were steeped in water, decanted, dried and further cleared by suction. A small amount of very short fibre passed the 60 mesh sieve and was not recovered.

Preparation of separated fibre - 26% approx.

Apart from chrysotile deposits there are deposits of picrolite and tremolite in the ultra-basic belt, and small quantities of both have already been marketed. Little can be said regarding the reserves and grade of the piccolite and tremolite lodes, as they have not been examined in detail and have not been opened up to any extent. Numerous lodes of both these minerals occur in the area however, and fairly large quantities could very likely be produced if the demand warranted it.

The name "picrolite" appears to have been applied more as trade name than a mineralogical name, and refers to poor quality chrysotile fibre having a weaker tensile strength than normally.

The tremolite lodes usually occur close to the granite junction and appear as cross fibre veinlets in talc rock. A talc-tremolite lens entirely surrounded by granite was noted about $\frac{1}{2}$ mile southwest of the Nunyerrie mine. The production to date has been a talc-tremolite mixture.

PRICES.

Prices as reported to the W.A. Department of Mines are as follows:-

Average Run of Mine prices for chrysotile grades 1 to 4 is £78.4. per long ton F.O.B. Port Samson.

Price for Grade F. Chrysotile is £39.2. per long ton F.O.B. Port Samson.

Price for Grade 6, Chrysotile is £28 per long ton F.O.B., Port Samson.

Average run of Mine price for picrolite grades A to D is £44.8 per long ton F.O.B. Port Samson.

American prices as quoted in the Engineering and Mining Journal, April 1951, are as follows:-

| | | |
|------------------------|-----------------|---------------|
| Grade No. 1 | \$960 to \$1500 | per short ton |
| Grade No. 2 | \$595 to \$ 900 | " " " |
| Spinning Fibres | \$275 to \$ 475 | " " " |
| Shingle Fibre (shorts) | \$123 to \$170 | " " " |

CONCLUSIONS.

The investigation has indicated that important deposits of chrysotile asbestos occur at Nunyerrie.

The No. 3 (Main) Lode is capable of yielding about 10 tons of fibre ranging between grades 1 and 4 per vertical foot, by mining over a length of 500 feet and an average width of 3 feet. At least an equal quantity of fibre from grade 4 upwards is considered to be present in other chrysotile lodes in the area, below the oxidised zone. These lodes can reasonably be expected

to persist for another several hundred feet, but the limiting factor is the position of the granite country with relation to the lode, as the proximity of granite is known to have a detrimental effect on the quality of the fibre and the persistence of the chrysotile lodes. Drilling of the lodes at depth would safeguard against this eventuality.

A market is said to be available for the residues (consisting of short fibre and ground serpentine) remaining after the recovery of grades 1 to 4 chrysotile, and 220 tons of these residues, which are known as grade 6 material, have already been sold. Reserves of residues are estimated at 5,000 to 6,000 tons. Mr. Hancock claims that due to high cartage costs to Roebourne and delays in shipping the No. 6 grade material cannot be marketed at a profit. Proposals have been put forward by him for a new road to reduce cartage costs from the mine to Roebourne, and for a reduction in the sea freight rate from Roebourne to Fremantle. These matters are receiving consideration by the State Government and by the Mining Engineering Section of the Bureau of Mineral Resources.

In addition to Chrysotile lodes, picrolite and tremolite lodes occur in the area, and small quantities have already been marketed. The tremolite lodes occur in massive talc rock.

Although reliable estimates of reserves of picrolite, tremolite and talc are at present unavailable, fairly large quantities of these minerals could reasonably be expected to be produced from the area, if the demand warranted it.

REFERENCES.

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|--|-------|--|
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