FILE NAME: Colonial Sugar Refinery (CSR)

DATE: 1968

DOC#: CSR064

DOCUMENT DESCRIPTION: Proceedings of the First Australian Pneumoconiosis Conference

FIRST AUSTRALIAN PNEUMOCONIOSIS CONFERENCE

A conference on airborne dust in industry, its measurement, control and effects on health.

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Price $10.00 (includes postage)

Proceedings of the

FIRST AUSTRALIAN PNEUMOCONIOSIS CONFERENCE

held within

The University of Sydney

February 12th, 13th and 14th, 1968



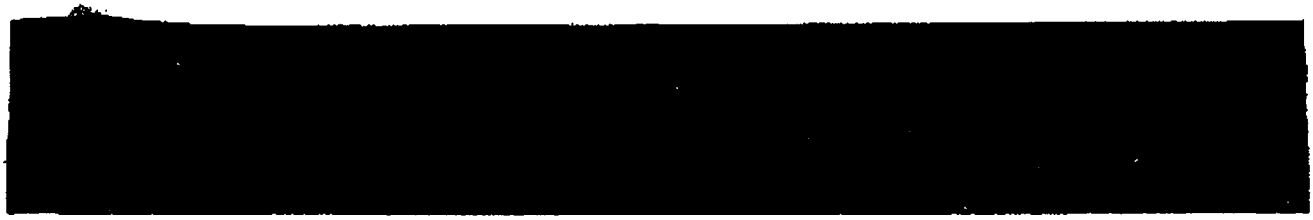
ASBESTOS MINING
WITTENOOM, WESTERN AUSTRALIA

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Asbestos is a common mineral in Western Australia, and anthophyllite and crysotile have been mined since the early 1920's, but the mines were little more than prospecting shows, producing at most a few hundred tons of fibre per annum, and rarely employing more than twenty men.

Mr. Lang Hancock discovered large crocidolite deposits at Wittenoom in 1939. Because of wartime pressures, the Colonial Sugar Refinery bought him out and created a wholly owned subsidiary - Australian Blue Asbestos - in 1943. This mine operated until 1966, when poor fibre return, labour problems, transport costs, etc., forced its closure. From 1943-1950, production of fibre rose from a few hundred tons to 1,000 tons, and the labour force from 50 to 200. Production then began to rise progressively to 4,000 tons by 1954, 7,000 tons in 1958, and from 1958-1966, from 11,000 to 15,000 tons. The number of men employed annually also rose to between 300 and 400.

For many reasons, there were very considerable fluctuations in these production figures and in the number of men employed. The very high temperatures (a succession of centuries in the summer), the barrenness of the terrain, lack of amenities, the dust, and a main labour force consisting almost entirely of





A machine miner in 39" stope. Five of the underground miners in the series had Vibration (Raynaud's) Disease.

new migrants to Australia, led to a very high labour turnover - in the region of several hundred percent per annum. Probably fewer than 20% of the men employed at any one time had been there for as long as three years. That is, there was probably a small nucleus of men who, over the years, had an exposure to dust of three years, or more, and this included tradesmen, supervisors and managerial staff.

Although the Health Department first became concerned about dusty conditions in the mine and mill in 1948, and all miners had had an initial clinical examination with a chest x-ray, and annual periodical chest x-rays subsequently, the first diagnosis of asbestosis was not made until 1958.

The first patient was an Italian migrant, aged 33 years, an underground scraper driver, who developed pulmonary tuberculosis, which did not respond to chemo-therapy, and he had a lobectomy. Examination of the resected specimen showed extensive interstitial fibrosis and asbestos bodies, and the pathologist diagnosed asbestosis.

Subsequent enquiries have shown that there may have been at least another two asbestos miners diagnosed in earlier years as suffering from pneumoconiosis, but this was recorded simply as silicosis - one had had lengthy underground gold mining, and the other fifteen years as a stonemason in Italy.

In June 1958, because of the case previously mentioned, the periodical annual examination of miners included clinical examination, which revealed a small group of new cases of pneumoconiosis.

ANALYSIS OF MEN AFFECTED

Since June 1958, 103 men who worked at Wittenoom have developed pneumoconiosis:

Mill workers	41
Underground workers	29
Mixed underground and mill workers	6
Men with other significant mining	24
Men excluded because of lack of detail	3
	103

The twenty-four men with other significant mining experience have been excluded from detailed consideration because of previous lengthy mining outside of Wittenoom - coal in Europe, tunnelling in Italy, gold in Western Australia.

The three men excluded for lack of detail were diagnosed on chest x-ray alone - two of these, for example, on x-rays of ill men forwarded from Italy for purposes of compensation.

[redacted]



This is a general view of the mill. The entrance to the underground workings lies in the face of the gorge opposite the upper part of the mill. There is dust emission from the stack in the lower left-hand corner and tailings from the mill have been used for road surfacing.

[redacted]

Of 103 men, therefore, 33 have been excluded, leaving 70 for consideration in this study.

INCIDENCE RELATED TO PRODUCTION

It would appear that, although working conditions were poor and dusty, this did not cause significant lung disease whilst the production of fibre remained low. Continuance of the poor conditions and increased production of fibre created a situation where pulmonary disease began to appear after relatively short periods of exposure to dust.

The usual procedure was to x-ray men first, and then to clinically examine everyone with more than twelve months dust exposure and, of course, anyone else who requested it.

As a result of this, it is not possible to identify clearly presenting signs or symptoms. In most instances, a chest x-ray abnormality was first noted; but complaints of dyspnoea, the presence of basal crepitations, finger clubbing, abnormal lung function tests, etc., were very often present. Sometimes these signs and symptoms occurred singly, or in combination with normal chest x-ray, and several were diagnosed at post mortem, or on lung biopsy, in the absence of any of them.

DIAGNOSTIC CRITERIA

Abnormal Chest X-ray

Dyspnoea
Basal crepitations
Finger clubbing
Abnormal lung function tests
Lung biopsy/post mortem
(Bilateral pleural effusions)

This is not to suggest that an abnormal chest x-ray is the earliest sign of asbestosis. This is not true. It is merely that, with the acute type of pneumoconiosis which occurred, an abnormal chest x-ray appeared just as quickly as other signs and symptoms. A man with two years exposure in the mill might have a normal chest x-ray and no symptoms in one year, but have dyspnoea, finger clubbing, basal crepitations and an abnormal chest x-ray the following year.

Abnormal chest x-rays were also found in the absence of any signs or symptoms.

Unusual Presentation

Four mill workers presented with chest x-rays, which did not show any evidence of pneumoconiosis:

[redacted]

1. S, who developed a pleural mesothelioma, had finger clubbing and basal crepitations, but what one could see of his remaining lung was normal.

2. G, a chronic bronchitic, with dyspnoea, finger clubbing and basal crepitations, whose x-ray, within a very few years, showed typical, fairly extensive asbestosis.

3. G, developed tuberculosis, and the diagnosis of asbestosis was made initially on abnormal lung function tests and subsequently confirmed at post mortem.

4. P, had tuberculosis with marked finger clubbing and the diagnosis was made after examination of a resected lobe.

Four underground workers had no suggestive x-ray changes:

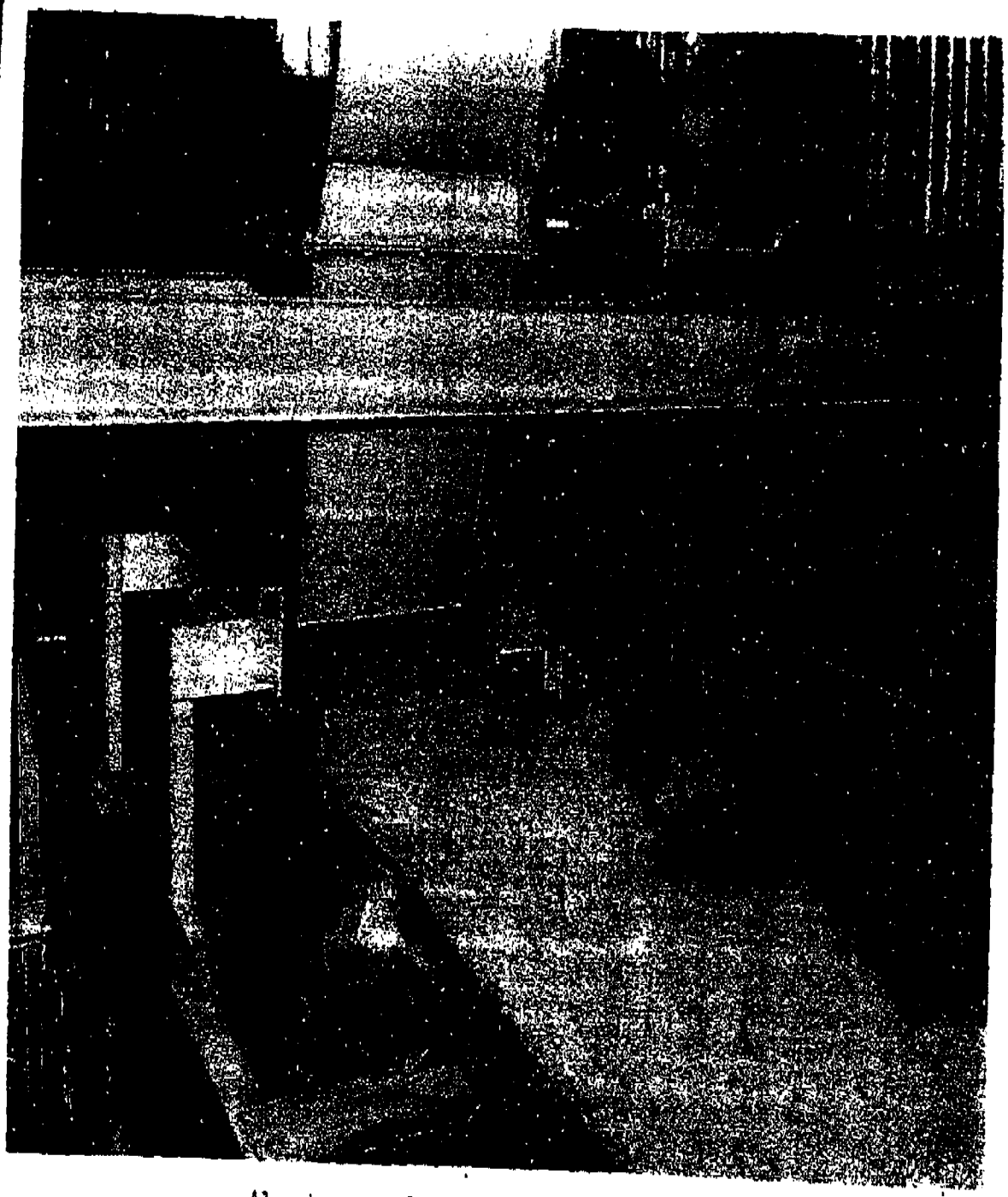
1. B, complained of pain on inspiration. It was suggested at one time that pleuritic pain or, at least, pain on inspiration, limiting inspiration, was a common and early presenting symptom of asbestosis but, in fact, only seven men out of the total, including those with other mining experience, complained of significant chest pain. He also developed a threatening attitude in regard to his Workers' Compensation claim, and this might have had something to do with the eventual diagnosis; but he also had finger clubbing and suggestive lung function changes.

2. C, had no signs or symptoms, but the disease was found in a lobe resected for tuberculosis, and he subsequently developed fairly typical x-ray changes. He is unco-operative and there is no record of whether he ever developed finger clubbing or basal crepitations. However, he is apparently alive and well some seven years afterwards.

3. DM, complained of dyspnoea, and had basal crepitations, and a few years after diagnosis was made developed typical x-ray changes.

4. P, a man with eight years underground asbestos mining, complained of dyspnoea, developed a deep vein thrombosis, with pulmonary infarcts and a bilateral pleural effusion which, by raising and fixing his diaphragm, caused a tight, restricted lung. Post mortem, following a coronary thrombosis, showed a marked fibrosis, tending to be both nodular and interstitial with many asbestos bodies. The nodules were apparently too immature to be identified definitely as silicotic and perhaps this stage of disease, as with the previous men, should not be included in a survey of this type, where it is obviously too young, even in terms of pathology, to produce diagnostic signs and symptoms.

This man illustrated the difficulty experienced in advising workers in this industry whether they might safely continue, or not. Perhaps the only medical advice one could have



Almost pure asbestos fibre in the lower part of the mill heading for the bagging section.

ever given, in view of the dusty conditions and history, was "If you are thinking of going - don't!" and "If you are there - leave!" but this is not the advice they wanted. They were making very big money and they wanted to know if they could continue to make this big money and, if there were no signs of clinical disease, one could not advise them to leave.

It was hoped that our obvious concern for their health, the diagnosis of lung disease in young men after short exposures, and the deaths of men they had known, would influence them strongly to leave. This did not happen, and it was not unusual to diagnose disease in a man, even with symptoms, and find that he refused to accept medical advice to cease work in this industry. Medical advice to leave was often resented, and to advise a man to leave, simply on suspicion of industrial disease, was countered by a demand for compensation, which could not be met in the absence of identifiable disease.

The difficulty was aggravated too by the rapidity of onset of disease where, as has been described, men could proceed from nothing abnormal to grossly abnormal in twelve months.

GENERAL OBSERVATIONS

Mill workers with pneumoconiosis

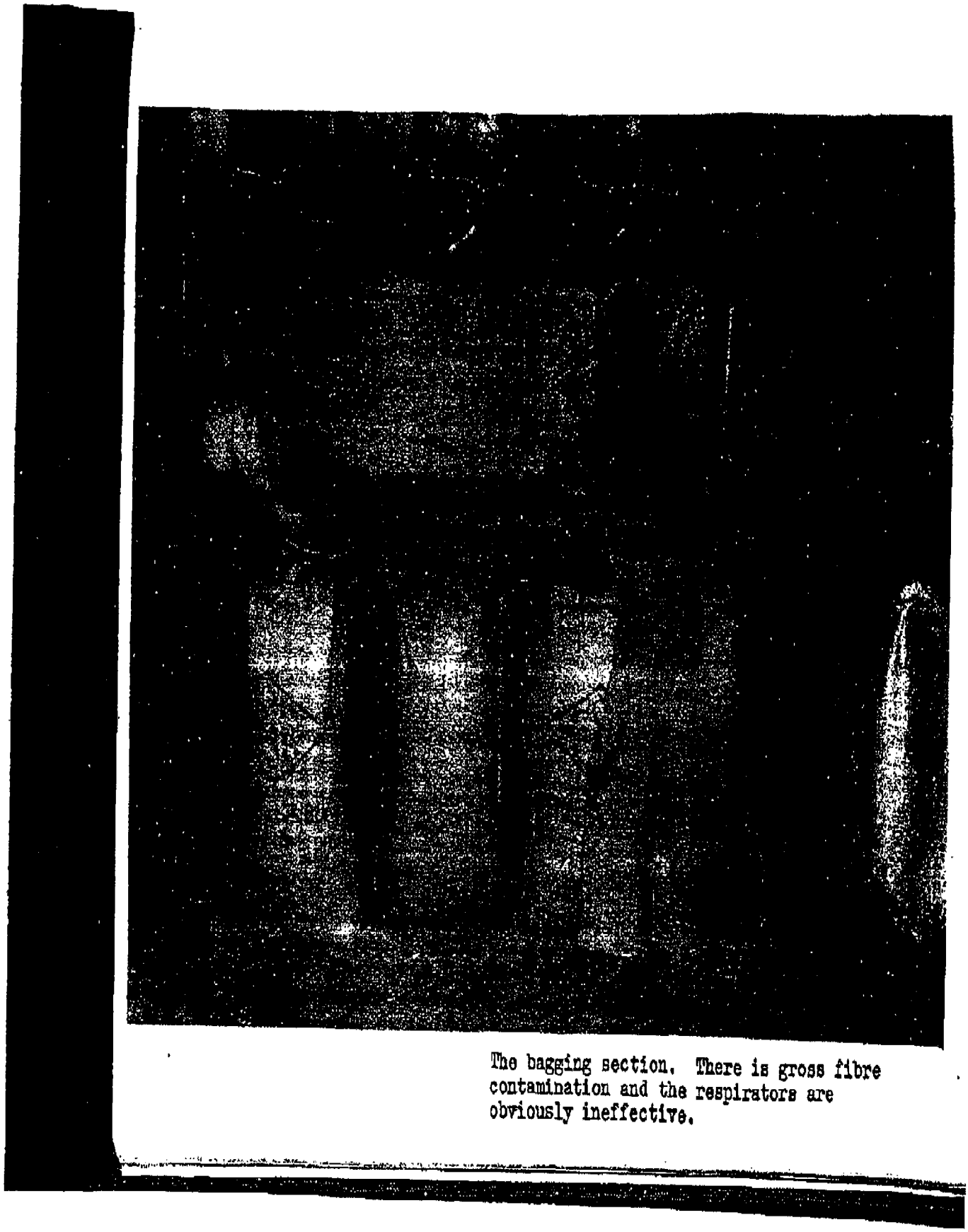
Year commenced work	Number affected	Year diagnosed	Number affected
1940-1944	2	1940-1944	-
1945-1949	4	1945-1949	1
1950-1954	19	1950-1954	-
1955-1959	16	1955-1959	8
1960-1964	-	1960-1964	24
1965 plus	-	1965 plus	8

Underground workers

Year commenced work	Number affected	Year diagnosed	Number affected
1940-1944	-	1940-1944	-
1945-1949	-	1945-1949	-
1950-1954	17	1950-1954	-
1955-1959	11	1955-1959	4
1960-1964	1	1960-1964	12
1965 plus	-	1965 plus	13

The date on which the men commenced work, and the year of onset of disease, corresponds with the increased production of fibre from 1,000 to 4,000 to 15,000 tons per annum from 1950 onwards, in conditions which had initially given rise to concern.

[redacted]



The bagging section. There is gross fibre contamination and the respirators are obviously ineffective.

Although underground conditions were bad, the mill appears to have been more dangerous.

More patients with acute disease after short exposures will probably appear within the next year or so, but the latest date of commencement in the diagnosed cases in the mill was 1959, and underground 1960. One can hops that this reflects improved working conditions, better ventilation and more effective dust extraction, especially in the mill.

However, from personal inspection, from 1959 and, as Mr. Major will demonstrate, even in 1966 dust concentrations in the mine and mill remained too high and one may expect, after an interval of a few years, new cases of the more chronic and usual type of pneumoconiosis to appear.

AVERAGE LENGTH OF EXPOSURE TO DUST

	No.	Age	Length of exposure	Interval between commencement & diagnosis
Mill	41	45 years (range 24-67)	5.25 years (range 1-14)	8.4 years (range 2-16)
Underground	29	40 years (range 29-51)	6.6 years (range 3-12)	9.7 years (range 5-14)

The average length of exposure in the mill for development of the disease was 5.25 years, with a range between 1-14; and of the underground workers 6.6 years, ranging from 3-12, the average age being 40 to 45 years respectively.

Of the twenty-six men who had had significant dust exposure before coming to Wittenoom, the average exposure of eighteen of them was 4.7 years. It had been thought that previous dust exposure would make a man particularly susceptible, but the effect of the previous dust burden appears to have been additive only.

The shortest exposure in the mill was one year only, and this produced clinical evidence of lung disease in two years. Two men carting tailings on contract, probably working twelve hours a day, six days a week, although in the open air, developed disease after only two years exposure. The interval between commencement of exposure and the appearance of diagnostic signs of disease was very short in a few cases, very much shorter than I have ever seen described.

DISTINCTION BETWEEN MINE AND MILL WORKERS

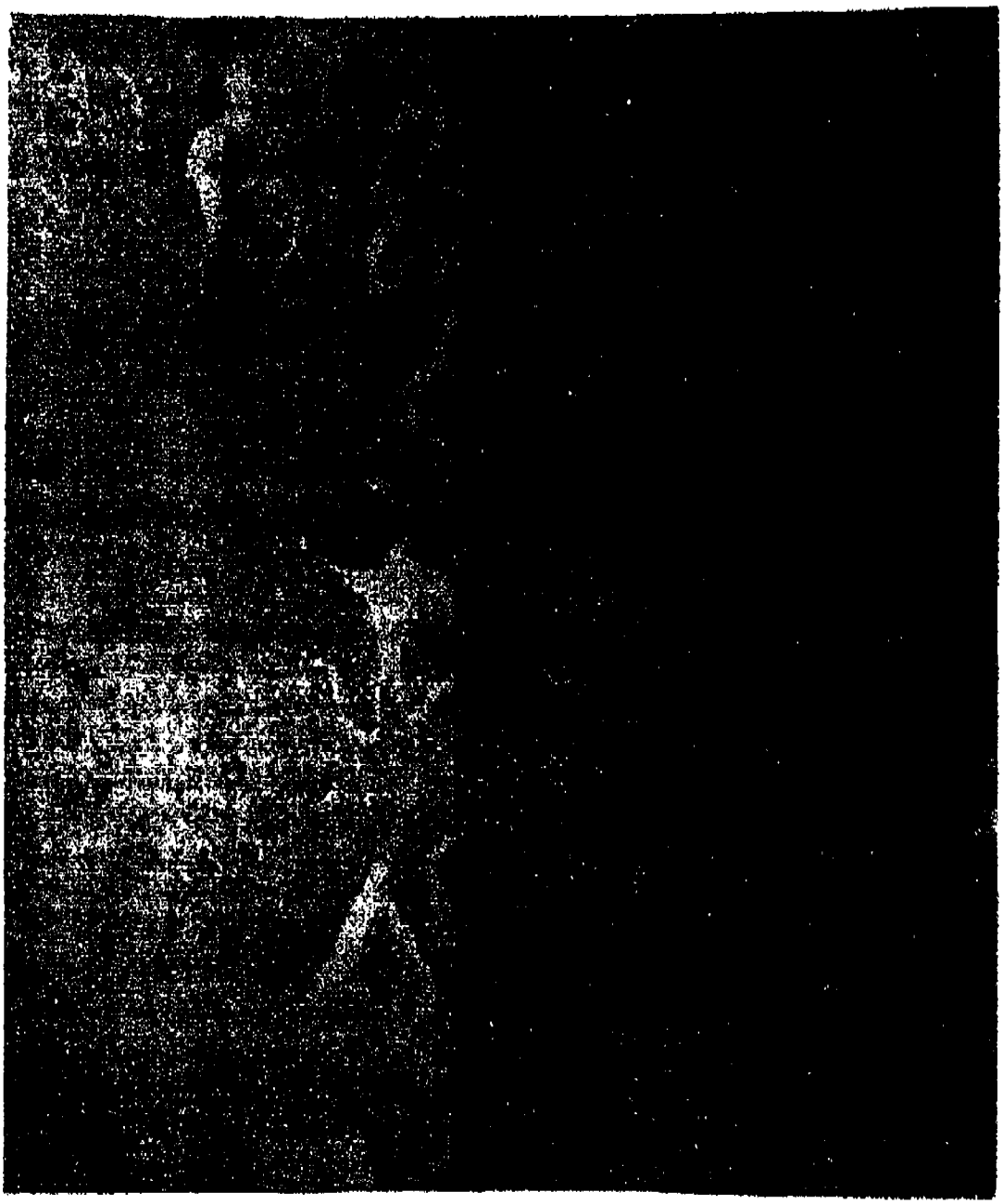
In the underground mine, the asbestos vein was rarely more than nine inches in height so that, even in a 39" stope, there was another 30" of face, mainly quartzite; whereas, in the mill, the whole purpose of the operation was to obtain a purer fibre so that, whilst there may have been a lot of silica dust in the upper earlier parts of the mill, the crushers and shakers, the final mill process involved pure fibre only.

Clinically, it had always seemed that, although asbestos workers appeared to develop silicosis and asbestosis, asbestosis was more important in the mill workers, and silicosis in the underground workers. This appears to be confirmed by the prevalence of finger clubbing and basal crepitations in mill and mine workers.

	No.	Finger clubbing	Basal creps.	Asbestos bodies in sputum
Mill	41	16 (40%) (ult. 22 50%)	21 (50%) (ult. 27 60%)	18 (44%)
Underground	29	6 (21%) (ult. 8 28%)	8 (28%) (ult. 9 31%)	8 (38%)

Of the mill workers 50%, rising to 60%, had persistent basal crepitations, as opposed to 28% to 31% of the underground workers, and three mill workers had chronic bronchitis, or such extensive disease, as to cause so many adventitious sounds as to prevent one from finding crepitations if they had been present.

These basal crepitations are, of course, common in conditions causing interstitial pulmonary fibrosis, but we have found that these fine, rarely coarse, persistent crepitations are the most typical and convincing sign of disease in asbestos workers. In the light of our experience their presence almost justifies the diagnosis, even in the absence of any other sign or symptom and, if it was a matter of advising a man to leave the industry, then their presence would be sufficient. A careful examination must be made as they may only be heard in small localised areas. Forgacs (1) recently suggested that these noises are due to miniature bangs, or explosions, caused by the sudden equalisation of air pressures upstream and downstream in partially deflated areas during inspiration, and that these occur maximally and audibly at the bases where there is an additive, gravitational deflationary effect. The degree of deflation can be estimated by the effect of placing the patient horizontal, when the noises



Right side shows the edge of a silicotic nodule and on the left side slightly high-power shows interstitial fibrosis and asbestos bodies.

diminish or disappear. I have only had the opportunity of trying this out on a few of these men. Crepitations heard at the bases with the patient erect did disappear when he lay down prone.

ASBESTOS BODIES

Forty percent of all the men had asbestos bodies in their sputum. Their presence does not appear to have any special significance, and half the men diagnosed had no sputum to examine.

An effort was made to see whether the townspeople had asbestos bodies in their sputum or not, but no-one could be found in the town with sputum at all.

COUGH AND SPUTUM

	No.	Cough	Sputum	Dyspnoea	Smoker
Mill	41	29 (71%)	23 (55%)	30 (73%)	28 (70%)
Under-ground	29	21 (73%)	14 (48%)	21 (73%)	22 (73%)

The prevalence of persistent, productive cough and dyspnoea was similar in both groups and certainly, insofar as a productive cough was concerned, was obviously more related to smoking habits than dust exposure or pneumoconiosis. Six underground and eleven mill workers had chronic bronchitis, 16 of whom smoked. The smoking habits of the other were not recorded.

CHEST X-RAYS

As mentioned previously, the commonest presenting abnormality was the chest x-ray.

Although 17" x 14" films were always used, the quality of the films obtained from a mobile unit was variable, and the earliest abnormal changes extremely difficult to define. Perhaps there was an impression of a general, slightly diminished translucency, with a fine arborisation spreading out from the hilum to the periphery; but this was so often accompanied by an increase in weight, with a rising diaphragm, in the stocky mesomorphic heavy-chested Italian miner so frequently employed and so suited to working conditions, especially underground, that it was often difficult to know whether lung disease was present or not.

A rather soft film in one year might make a man highly suspect, while a slightly more penetrated film the following year gave a false impression of security. Obviously films not in full inspiration were troublesome. Probably the earliest changes



Section of lung from mill-worker under polarised light showing doubly refractile silica particles and asbestos bodies.

could best be described by what used to be understood by the term "reticulation", proceeding fairly rapidly to a picture corresponding to the upper limit of P.3, lower limit N.3, of the International Labour Organization Classification of Radiograph, 1958. The usual classical picture of asbestosis which has been described with a ground glass appearance at the bases and lower two-thirds of the lung fields and a normal upper third has not been very common at Wittenoom. The general picture is that of silicosis and it is not unusual to find, even at a late stage, in the mill workers, fairly clear peripheral bases. The general appearance of the underground workers' x-rays would correspond to P.2/3 of the I.L.O. classification, sometimes proceeding to A, B and C shadows, and none of them showed asbestosis.

The mill workers' x-rays showed a finer, much more generalised change, which is very difficult to describe, and again A, B and C shadows appeared. Seventeen (40%) had definite radiological basal asbestosis and in a few of these without evidence of nodular disease elsewhere. Some mill workers, again, progressed to typical N.3 nodules with A, B and C shadows.

PLEURAL EFFUSIONS

Six men developed bilateral pleural effusions for no very apparent reason. Pleural fluid examination and biopsy, where performed, were unremarkable. Four of these subsequently developed signs of pneumoconiosis. (The fifth died of sub-arachnoid haemorrhage. No post mortem was done and the sixth is still being followed up.) Two other men developed bilateral pleural effusions, following obvious clinical, deep-vein thrombosis and pulmonary infarction, and later developed signs of pneumoconiosis. The raised adherent diaphragms not only produced tight lungs but, by diminishing translucency at the bases, caused considerable difficulty in diagnosis.

Bilateral pleural effusion is not a very common condition, and eight in such a small series seems remarkable.

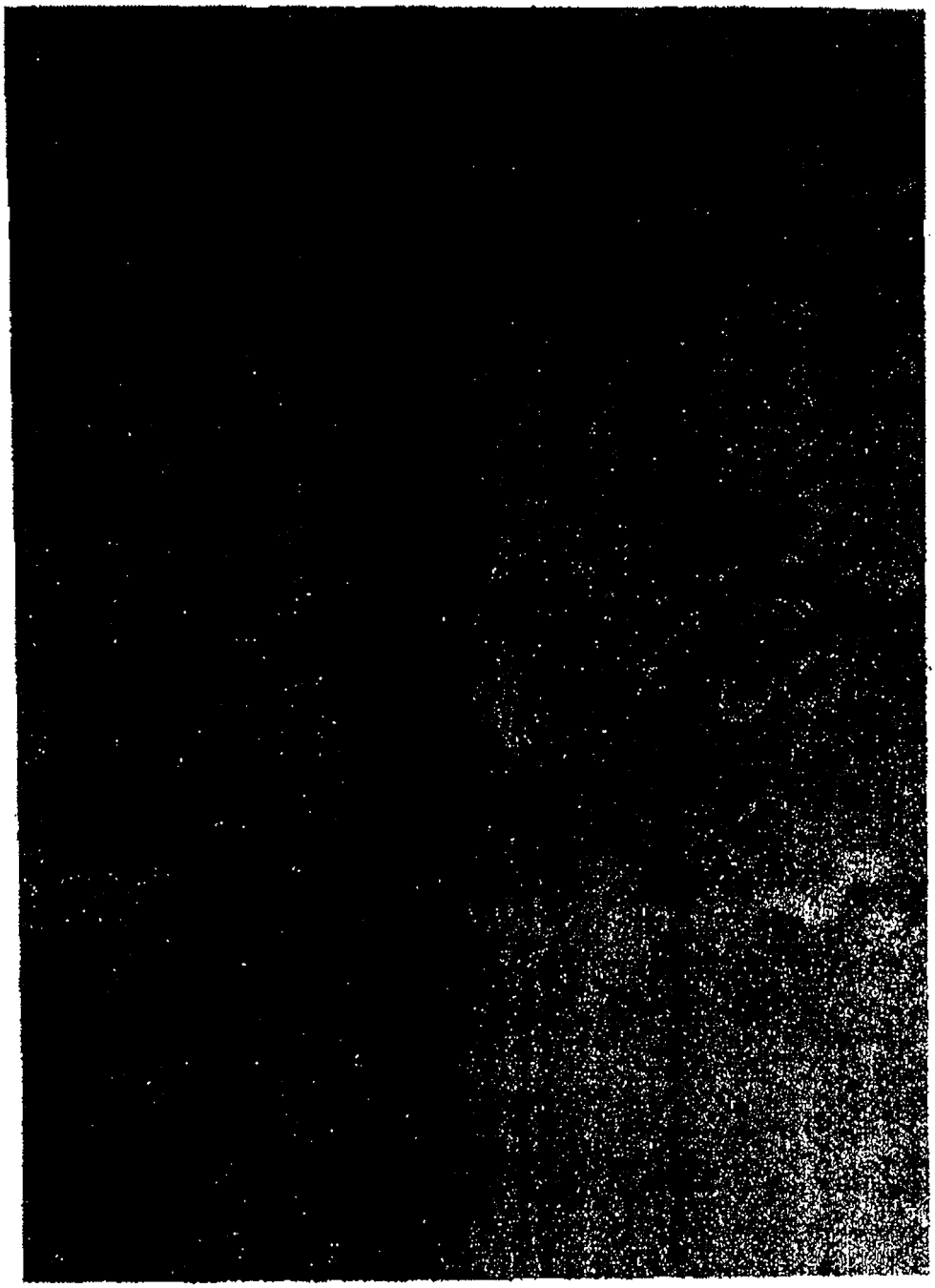
PLEURAL PLAQUE

Pleural plaques have not been found in either mine workers or townspeople; the townspeople were x-rayed on 70 mm film on at least two occasions.

LUNG FUNCTION TESTS

There were no facilities at Wittenoom for routine lung function testing. Our policy, certainly in the earlier years, was to admit doubtful cases to hospital for full investigation.

A number of men had quite extensive lung function tests and certainly, as their disease progressed, typical changes such



High-power view of the lung of a mill worker showing the edge of a silicotic nodule and asbestos bodies and interstitial pulmonary fibrosis.

as those described recently by Dr. Elder (2) occurred but in only two men, with a normal vital capacity at diagnosis, was a gas exchange defect demonstrated, and this was minimal.

Twenty-seven out of 41 (66%) mill workers, and 21 out of 29 (72%) underground workers, had vital capacity and forced expiratory volume, one second (FEV_1), estimations done at, or very soon after, the time of diagnosis.

Finding a decreased vital capacity with a relatively high FEV_1 suggested restriction and the absence of obstructive airways disease was useful supporting evidence of pneumoconiosis when other signs were equivocal.

Once again, the mill workers compared very unfavourably with the underground miners. Ninety percent of the mill workers had a reduced vital capacity, as against 62% of the underground workers. Of the mill workers with a reduced vital capacity, 19 (70%) had a forced expiratory ratio $FEV_1/V \times 100$ above 75%, and 11 above 80%. Of the underground workers, 13 out of 21 (62%) had a reduced vital capacity, and 7 (54%) had a forced expiratory ratio above 75%.

PATHOLOGY

Lung sections were available from three underground, and twelve mill workers (nine post mortems, six lung biopsies).

The significant finding has been the admixture of disease, extensive interstitial pulmonary fibrosis with asbestos bodies and silica nodules, and silica particles (even in mill workers) could also be demonstrated.

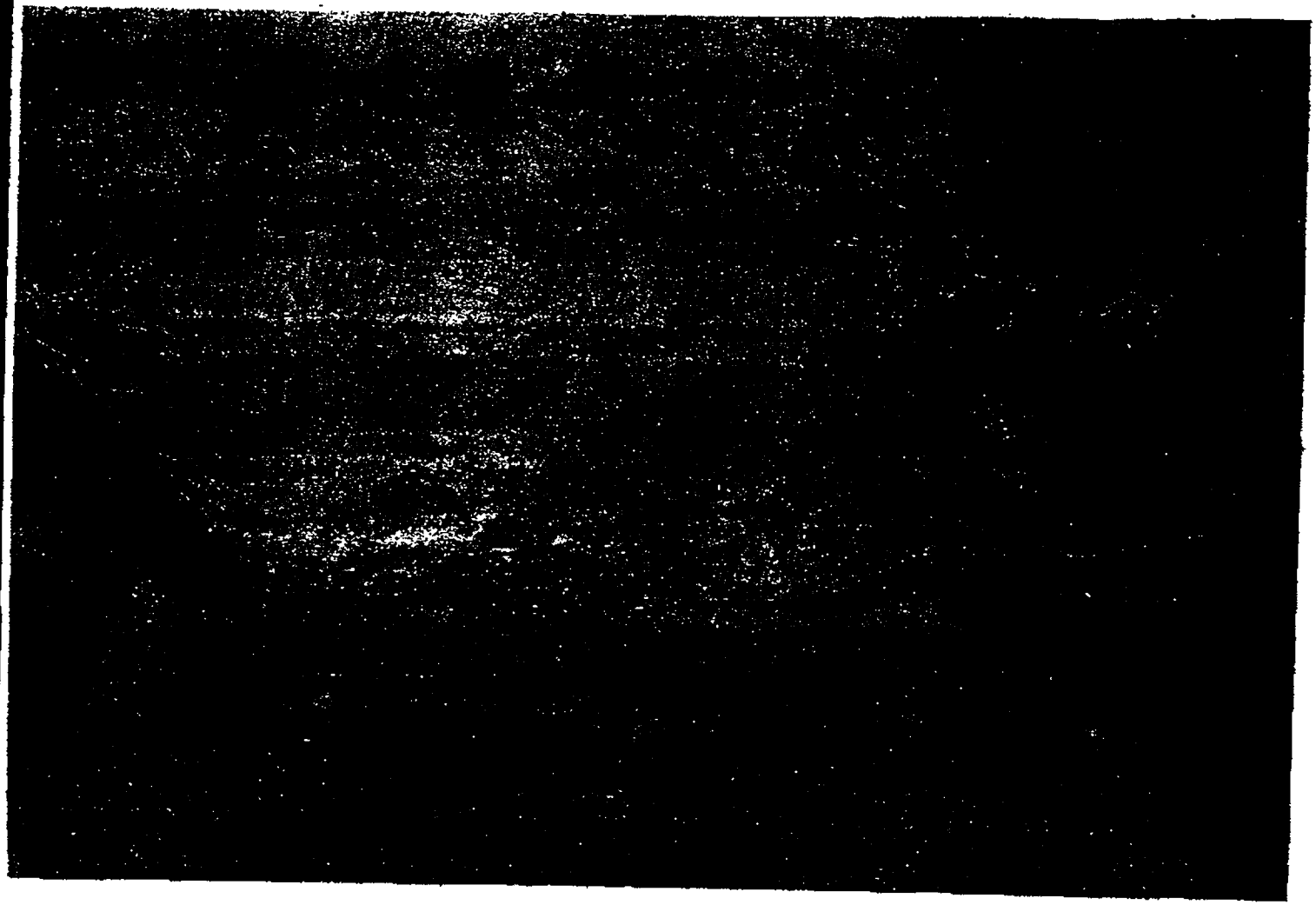
ASSOCIATED CONDITIONS AND PROGRESS

	No.	T.B.	Cancer	Dead	Totally disabled
Mill	41	4 (12%)* (+ 1)**	1 lung 1 meso-pleura	14 (34%)	11 (27%)
Under-ground	29	2 (10%) (+ 1)	-	2 (7%)	4 (19%)

* Diagnosed

** Developed later

A single instance of lung cancer occurred in a very heavy cigarette smoker.



Sample of ore body, showing narrow seams of fibre.

A pleural mesothelioma, which has been previously described (3), occurred in a man who worked in the mill from 1947 to 1949, the tumour appearing in 1960.

The high labour turnover has meant that very many men have been exposed to high dust concentrations for short periods, but there has been too brief an interval since their exposure for lung cancers or pleural or peritoneal tumours to have occurred. In fact, the pleural tumour described at ten years is after one of the shortest intervals described.

A particularly bad feature of Wittenoom was the persistent use of mine tailings for road surfacing, which exposed the townspeople and children to loose dust containing a varying percentage of blue fibre.

Eight men developed pulmonary tuberculosis, four with atypical mycobacteria. This number is high, but it is associated with silicosis, and several of the men were close contacts, who normally worked, drank and smoked together for long hours.

As regards the fate of these men, contrary to what is sometimes claimed in asbestosis, the pneumoconiosis, in almost every instance, continued to progress, even after exposure to dust had ceased, possibly because of the silica present.

The mill workers fared very badly compared to the underground workers. Fourteen are dead and eleven totally disabled, compared to two and four underground workers.

Causes of Death

	Mill workers	Underground workers
Tuberculosis and pneumoconiosis	4	1
Pneumoconiosis	6	-
Pleural mesothelioma	1	-
Lung cancer	1	-
Sarcoma	1	-
Cancer of the oesophagus	1	-
Coronary thrombosis	-	1

One man returned to Italy in 1963, and has been lost sight of.

CONCLUSIONS

It is obvious that the mine and mill were too dusty and poorly ventilated. The early onset and extensive acute disease which has affected nearly everyone who stayed there long enough must be attributed solely to the very high concentrations of finely divided siliceous and asbestos dust to which they were exposed. Earlier work by Englebrecht (4) in South Africa suggested that

added quartz increased the fibrogenicity of crocidolite, but he used cleansed extracted fibre and later work (5) has shown that natural milled asbestos already has an optimal quartz content. Medical examinations should have been done at six monthly intervals and should have included routine lung function tests, with some measurement of gas diffusion.

The rapidity of onset and progression of disease was continually surprising and we despaired at making an early diagnosis and at our inability to advise these men properly. Most of the men were migrants to Western Australia; the language problem and the isolation of the mine also increased the difficulty.

The men, at least in the mill, did try to wear respirators, but these could never have been very effective and, in some ways, were just a bad joke. Keener interest and encouragement in the use of respiratory protection would have been worthwhile but the heavy work in very high temperatures would make success unlikely.

The causes of this tragedy were complex but a contributory factor was the dichotomy which was introduced in 1926 when the Commonwealth Government undertook the periodical examination of miners and the State Government Mines Department continued to be responsible for health, safety and welfare in the mining industry.

The Acts, and system of medical examinations, were excellent, and well ahead of their time, but the legislation, regulations and practice in regard to dust suppression and ventilation and, indeed, everything regarding the health of miners was never related to the results of the medical examinations. The State Health Department took over the medical examination of miners in 1953/1954 and, despite willing co-operation from both the Mines and Health Departments, the effects of this dichotomy are still apparent.

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