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# Asbestosis Research Project

## ANNUAL REPORT 1970

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DEPARTMENT OF MINES
ASBESTOS MINING INDUSTRY
AND THE
PNEUMOCONIOSIS RESEARCH UNIT

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Published by the
**Pneumoconiosis Research Unit**
of the
**Medical Research Council of South Africa**

*Printed by*
*G. M. Horne Johannesburg*




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## INTRODUCTION

The Executive Committee of the Asbestosis Research Project controls the funds for the research projects. Exclusive of the cost of work undertaken by the Air Quality Section of the Government Mining Engineer's Division, all expenditure is met jointly by the State and the asbestos producers in equal share. This Annual Report covers the period 1st January to 31st December, 1970.

## ORGANIZATION

On 31st December, 1970, the Executive Committee was constituted as follows:

| | | |
|---|---|---|
| *Chairman* | T.L. Gibbs | Government Mining Engineer |
| *Members:* | F.A. Snyman | Department of Mines |
| | F. Baunach | Asbestos Mining Industry |
| | J.G. Mackeurtan | Asbestos Mining Industry |
| | C.H. Walters | Asbestos Mining Industry |
| | S.F. Oosthuizen | Medical Adviser to the Minister of Mines |
| | J.J. Theron | Medical Research Council |
| | G.G. Pienaar | Medical Research Council |
| | I. Webster | Pneumoconiosis Research Unit |
| | G.K. Sluis-Cremer | Co-opted Member, Chairman, Asbestosis Advisory Committee (Medical) |
| | C.T. Hardy | Co-opted Member, Chairman, Asbestosis Advisory Committee (Engineering) |

The Executive Committee is supported by two research advisory committees, one dealing with medical and the other with engineering matters.

## RESEARCH ADVISORY COMMITTEE (MEDICAL)

| | |
|---|---|
| G.K. Sluis-Cremer | M. Hurwitz |
| S.F. Oosthuizen | J. Gluckman |
| J.J. Theron | H.A. Shapiro |
| I. Webster | G.G. Pienaar |
| S. Zwi | |

## RESEARCH ADVISORY COMMITTEE (ENGINEERING)

| | |
|---|---|
| C.T. Hardy | L.N. Kuyper |
| R.S.J. du Toit | S.A. Kirton |
| J.W. Cockerill | P.C.B. Wentzel |
| W.D. Morgan | R.E.G. Rendall |
| O.D.T. Wright | A. de M. Malan |
| I. Webster | M.R. Oberholzer |
| W.T.P. Mostert | H.W.J. Jacobs |



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## CO-ORDINATOR'S REPORT

The year reviewed in this Annual Report has again been productive and rewarding for the scientific staff taking part in the various projects.

One of the highlights has been the start made to determine the relationship between cumulative dust exposure on asbestos mines and the eventual development of asbestosis. This project was considered so important that funds were used from this year's budget although they had not been allocated until April, 1971. The examination of retrospective records and the prospective recording of occupational service on the asbestos mines will play a great part in our understanding of asbestosis.

The electron microscope has been well used on the Asbestosis Research Project during the year. It is now possible to identify not only the chrysotile from an amphibole fibre but also the different types of amphibole asbestos. Such a study is of particular value when only a few fibres are to be found in polluted atmosphere or extracted from lung material. The use of the electron microscope in the study of atmospheric fibres will allow the source of the pollution to be defined far more closely.

The pathology of asbestosis has been defined as a desquamative alveolitis due to the presence of fibres or bodies in the alveolar spaces. Recent evidence has indicated that although the asbestos needle is fibrogenic the coating of an asbestos body may well be a protective substance (derived from the lung) which prevents this fibrogenic action.

The caution advocated by scientists in this country in insisting that asbestos alone may not be the cause of the development of a mesothelioma of the pleura has been shown to be wise. A number of reports now indicate that, in a significant percentage of cases of mesothelioma, a history of asbestos exposure could not be elicited.

It is regretted that the Unit has not been able to assist the non-mining industries which use asbestos even although repeated requests for such assistance have been made. Recently a questionnaire was received by an asbestos manufacturing concern from an International Organization and submitted to the Unit for the completion of certain paragraphs. The information which this Unit could give was indeed meagre.

It is hoped that the Institute of Occupational Health will be established as soon as possible so that the staff will be able to investigate the problems presented by the users of asbestos.

I. Webster
Co-ordinator



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# MEDICAL SECTION

## PATHOLOGY DIVISION

### SURGICAL PATHOLOGY

The examination of specimens for the diagnosis of a pulmonary lesion is indeed of great value to the members of the Pathology Division as well as the whole research project.

The basic lesion of asbestotic fibrosis having been defined as a desquamative alveolitis, special attention was paid to specimens from those patients in whom the pre-operative diagnosis was considered to conform to this type of interstitial pneumonia. Not only was tissue prepared for histological diagnosis, but small fragments were also selected for electron microscopical examination, and other tissue was preserved for immuno-histochemical study at a later stage. Three such cases have been examined during the year and the findings are given under the research activities.

One patient with diffuse lung changes on radiological examination, was found at thoracotomy to have pleural and diaphragmatic plaques similar to those found in asbestosis. Although he was a painter by trade and a recent immigrant to this country from the United Kingdom, even close and direct questioning elicited no history of exposure to asbestos. Histologically the appearances of the plaques are similar to those found in cases where a history of asbestos exposure was obtained. In the material extracted from the plaques, occasional needles resembling asbestos fibres were found, and the asbestos nature of the fibres was confirmed by electron diffraction studies under the electron microscope. The number of needles found was indeed small and, as their finding was possibly incidental, further specimens from localised pleural plaque formations will be examined.

Pleural biopsy specimens have been submitted for diagnosis from the West End Hospital Kimberley, the Thoracic Surgical Units and from different mine hospitals. The following table gives the number of pleural biopsy specimens diagnosed as tuberculosis and those diagnosed as mesothelioma or metatastic carcinoma.

PLEURAL BIOPSIES

| | *White* | *Coloured/Bantu* |
|---|---|---|
| Total | 53 | 559 |
| Tuberculosis | 4 | 119 |
| Mesothelioma | 7 | 16 |
| Carcinoma | 10 | 7 |

### STATUTORY AND ROUTINE SERVICES

#### Miners' Medical Bureau

Of the 154 heart and lung specimens examined for the Miners' Medical Bureau, 23 were from White, 13 from Coloured mine workers and 118 from Bantu mine employees.



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The following table summarises the results of these examinations:

| | Number | White | Coloured | Bantu |
|---|---|---|---|---|
| **MINERS - ASBESTOS SERVICE ONLY** | | | | |
| Total | 68 | 2 | 12 | 54 |
| No Asbestosis | 31 | 1 | 4 | 26 |
| Asbestosis | 37 | 1 | 8 | 28 |
| Asbestosis and T.B. | 8 | – | 4 | 4 |
| T.B. only | 3 | – | – | 3 |
| Mesothelioma | 2 | – | – | 2 |
| Bronchogenic Carcinoma | 1 | – | – | 1 |
| **MINERS - MIXED SERVICE** | | | | |
| Total | 86 | 21 | 1 | 64 |
| No Asbestosis | 50 | 15 | – | 35 |
| Asbestosis | 36 | 6 | 1 | 29 |
| Asbestosis and T.B. | 9 | 1 | – | 8 |
| T.B. only | 8 | 2 | – | 6 |
| Mesothelioma | 1 | 1 (peritoneal) | – | – |
| Bronchogenic Carcinoma | 2 | 1 | – | 1 |

## RESEARCH ACTIVITIES

It was most unfortunate that a number of monkeys and baboons in the animal colony developed tuberculosis and, as none of the measures taken prevented the spread of this infection, almost all of the primates were killed. From the "dose response" experimental dust rooms six baboons exposed to long-fibre crocidolite have been taken out and have been housed outside. These animals had been exposed for 15 months and, although it was planned to expose them for 18 months, their exposure time has been sufficiently long not to affect the experiment unduly, provided there is no further evidence of infection.

### Aetiology

*Dose-response relationship of asbestos fibre*

The dust rooms were in operation for this project during the year. In the one room the concentration was approximately 32 mg cub. metre and in the other 15 mg cub. metre. As mentioned, dusting was stopped at the end of the year. As soon as the rooms have been cleaned and fumigated, other animals will be exposed and all the animals will be killed approximately one year after commencement of dusting. Animals will be removed from the room at 3,6,9, and 12 months and kept until the period of 12 months has elapsed. From this experiment it is hoped that the effect of different periods of dusting may be assessed and that some information will be obtained on the progression of asbestotic fibrosis.

*Fibrogenic response of the U.I.C.C. standard samples*

Batches of the specific pathogen-free rats were inoculated intratracheally with suspensions of the different samples. Some of the animals were killed 10 months after the



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inoculation and there is evidence of the lung reaction to asbestos. As none of the animals showed any evidence of infection or of bronchiectasis, it was decided to keep them alive for a longer period than originally planned. By doing so, any difference in the fibrogenic response may become more evident.

Once again the inoculation with chrysotile proved different. Although it was possible to inoculate a 25mg ml suspension of crocidolite, amosite, and anthophyllite, it was only possible to introduce the same amount of the samples of chrysotile by giving two injections. The initial mortality with all types of asbestos was high and particularly so with the suspensions of chrysotile.

*Crocidolite country rock*

The relatively non-fibrous country rock experiment designed to explain the finding of concentric fibrosis of the silicotic type in some of the asbestos employees, continued throughout the year. Shortly after the experiment started one of the animals died and a mesothelioma of the pleura was found. Animals killed to prevent the spread of the tuberculous infection show that the finely ground country rock is distributed in macrophages, many of which are retained in the alveolar spaces, but others are in the perivascular spaces. After 15 months there is early organisation of the alveolar spaces. Some of the smaller particles are coated, but it is possible that the coated particles are very short fibres cut in cross section. No other animal has developed a mesothelioma. As in the animals exposed to the long-fibre and the short-fibre dust clouds, a chronic fibrous pleurisy with adhesions between the visceral and parietal pleurae was found.

**Pathogenesis**

*Development of asbestotic fibrosis*

As the early lesion of asbestotic fibrosis is a desquamative alveolitis, special attention was paid to cases showing this pathological pattern and which had not been exposed to a fibrogenic dust. There appear to be many causes for the condition known as a fibrosing or sclerosing desquamative alveolitis, and, in some of them, the cells first affected are those of the capillary endothelium. The swelling of these cells opens up the intercellular canals of the endothelium, allowing plasma to enter the tissue between the capillary and the epithelium of the alveolar space.

Specimens from the monkeys exposed to asbestos have been taken to determine whether the endothelial cell is affected in asbestosis. Should this be the case, then many of the difficulties in explaining the nature of the fibrosis in asbestosis might be resolved.

*Asbestos in alveolar macrophages*

Although it is still difficult to cut sections from blocks containing tissue with asbestotic fibrosis, it has been possible to examine alveolar macrophages from cultures. One of the striking features is the lack of any evidence of a toxic effect in the macrophages. The fibre is taken into the macrophage by invagination of the cell membrane, which forms the phagosome in the cytoplasm. Eventually the phagosome collapses, leaving the cell membrane in close proximity to the fibre. Unlike macrophages incubated with silica, there is no evidence of vacuolation of the cytoplasm and the mitochondria do not show any significant changes.

*Influence of asbestos dust on surfactant*

As the pathological pattern produced by asbestos fibres is a desquamative alveolitis and as the fibres remained in the air spaces for a long time, it was decided to investigate the effect of the fibre on the low surface tension material lining the alveoli.



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A method for the measurement of pulmonary surfactant has been established using a Wilhelmy bath and strain gauge. The data are recorded on a direct write-out X-Y recorder. The reliability of the method has been evaluated by using fluids with a known surface tension, i.e. water and alcohol. Biological surfactant, obtained from a number of sources (rat, monkey, baboon and man) by a standardised method of homogenising the lung, is being measured to establish normal values.

Surfactant is formed by the cells lining the lower respiratory tract and consists mainly of a complex phospholipid. Many years ago it was found that the chylomicron count of blood from the pulmonary vein was only 60% of the amount entering the lung in the pulmonary artery. It is suspected that the chylomicrons may be the source from which the alveolar epithelial cells manufacture surfactant. For this reason work is being done on the absorption of chylomicrons by the lung and the synthesis of surfactant, to determine whether mineral dusts interfere with this process. So far it has been shown that a mechanism exists for hydrolysis of the chylomicrons in the lung tissue. Analysis of surfactant fatty acids has shown considerable variation in composition, depending on diet and environment. The lipid metabolism appears to be particularly disturbed in animals with the follicular type of nodal bronchiectasis. This work is continuing.

**Asbestos Fibres**

A large proportion of the work on asbestosis has been devoted to the study of the asbestos fibre. This was done so that electron microscopical techniques might be applied to the fibres and because it has been confirmed that up to date no case of mesothelioma has been found in persons exposed to the crocidolite of the Northern Transvaal. It is also important to be able to identify the nature of the fibres found in samples taken from a polluted atmosphere.

1. *Replica studies*

Carbon-platinum, very thin, replica films were made of known and unknown fibres collected on freshly cleaved mica strips. The samples were first cleared of organic matter by treatment in a Coleman Model 40 low-temperature asher for 20 minutes. The coating was cut on both sides of the sample strip and this strip was floated onto deionised water and transferred to concentrated HF. Following 3 hours of hydrofluoric acid treatment to remove the fibres, the film was washed and collected on copper grids.

With this technique it has been possible to differentiate amphibole asbestos from chrysotile asbestos:

1.1 Amphibole asbestos fibres are found to be separated from one another and have striations along the fibre axis, suggesting a prismoidal cross section.

1.2 Chrysotile asbestos fibres have fibrils occurring in clumps. Fibres are irregularly broken consisting of fibrils of differing lengths.

1.3 Glass fibre and ceramic wool have a thin coating covering the fibres and appear to have a circular cross section.

It is hoped to use 2 other replication materials namely Polyvinyl alcohol and "Cellotas". These are water soluble and are safer methods for obtaining replicas than is HF. In samples taken from an urban atmosphere, fibres of amphibole asbestos and glass wool were found. In addition there were splinter-like objects which have not yet been identified. Samples taken from a building in which asbestos was used for insulation purposes, showed asbestos fibres. This indicated that the atmosphere inside the building contained asbestos fibres.



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2. *Diffraction pattern studies*

Selected area diffractions of asbestos fibres imbedded in nitrocellulose film revealed the following:

2.1 The amphiboles and chrysotile fibres all produce characteristic patterns of parallel rows of spots, having repeat distances of 5.3Å along the fibre axis. These are the crystalline layer lines (i.e. "d" spacings) and are characteristic of all asbestos minerals and distinguish asbestos from other fibres e.g. glass fibre. However, this feature is not applicable for distinction of the different amphiboles and chrysotile. The amphiboles and chrysotile are distinguishable in two other respects (intensity distribution and relative spacing) as follows:

2.1.1 Amosite has an intensity pattern which is not systematic or consistent.

2.1.2 Anthophyllite has a consistent and systematic spot pattern of 6 intense second order spots. There are, however, deviations from this pattern and this problem is being investigated.

2.1.3 Crocidolite has a diffraction pattern of spots separated by alternating long and short spaces.

2.1.4 Chrysotile has diffraction patterns of extended arcs due to the curvature of the lattice.

It has been possible, by using these criteria which were first studied in known samples, to distinguish unknown samples.

3. *Pendelösung fringes*

These are fringes which occur along the fibre axis when they are viewed in the transmission mode. Pendelösung fringes give the wedge angles of fibres, i.e. the angle between adjacent faces of the amphibole fibres. The narrower the fringe the greater the wedge angle of the fibre, and the wider the fringe the narrower the wedge angle.

These observations might add to the criteria for distinguishing the amphiboles. This method is now under investigation.

4. *Periodometer studies*

When diffraction patterns of fibres were projected in the Periodometer, a further optical diffraction pattern resulted, with background electron noise largely filtered out. This type of pattern is known by crystallographers as a Patterson projection. Each spot in such a pattern represents a projection of the interatomic vectors and gives direct reading of spacings. It should thus be possible to distinguish the super lattice of iron ions which may have displaced metallic ions. By this means the periodic and spatial array can be studied further.

*Inoculation of fibrous minerals*

In addition to the work on this subject reported at the International Congress in 1969, the following fibrous minerals have been studied:

Actinolite
Chlorite
Amosite in which the suspension only contained fibres up to 10 micrometers in size.

Suspensions of these minerals were inoculated intratracheally into specific pathogen-free rats and, as there was no reaction in the animals which were killed, it has been decided to keep the animals alive for longer.



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**Asbestos Service only**

| | Race | | Tuberculosis | Mesothelioma | Bronchogenic Carcinoma |
|---|---|---|---|---|---|
| No Asbestosis (31) | White | 1 | - | - | - |
| | Coloured | 4 | - | - | - |
| | Bantu | 26 | 3 | - | - |
| Asbestosis (37) | White | 1 | - | - | - |
| | Coloured | 8 | 4 | - | - |
| | Bantu | 28 | 4 | 2 | 1 |

**Mixed Service including Asbestos**

| | Race | | Tuberculosis | Mesothelioma | Bronchogenic Carcinoma |
|---|---|---|---|---|---|
| No Asbestosis (50) | White | 15 | 2 | 1(Peritoneal) | 1 |
| | Coloured | - | - | - | - |
| | Bantu | 35 | 6 | - | - |
| Asbestosis (36) | White | 6 | 1 | - | - |
| | Coloured | 1 | - | - | - |
| | Bantu | 29 | 8 | - | 1 |

**Pathology**

The pathology of asbestosis has been studied in man and in animals. The incidence of a non-specific, chronic pleurisy is high in man and almost universal in the primates exposed to asbestos. As the presence of the chronic pleurisy will be associated with a certain degree of collapse of the alveoli, the practice of dividing the pathological finding of asbestosis into the three categories of slight, moderate and marked is suspect.

The main type of fibrosis found is of a sclerosing alveolitis. There is only a small component of the fibrosis in the alveolar walls. To obtain a better understanding of the development of this type of lung reaction, it was decided to investigate the changes found in the lungs of miners dying as a result of accidents.

All cases of miners dying from trauma, except those with direct injury to the lung, are being examined. Three sections from each lung are taken and to date histological sections from over 300 cases are ready for examination.

The cases are being divided into groups according to the length of time elapsing between injury and death. The extent of the lung lesions in the various groups will be determined and the changes compared.

To get the exact time of accident and death, lists of cases are being sent to the various District Surgeons and Hospitals concerned in the autopsies, asking for the details required. This information is coming in very slowly. It has also been found that most cases die almost immediately after injury. Consequently there is as yet insufficient material for classification into the necessary groups and for starting the examination of the sections.



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The examination of cases of pneumonitis has been started, as in some viral infections the lesion is that of a desquamative alveolitis. One of the greatest values of the large number of heart and lung specimens examined each year is the availability of material for such investigations as the above.

The pathological features of 6 cases of asbestosis with large opacities on radiology have been studied, and the following patterns were noted:

1. Diffuse hyaline fibrosis with areas of concentric fibrosis.
2. Diffuse hyaline fibrosis with areas of concentric fibrosis, foci of necrosis and calcification.
3. Diffuse hyaline fibrosis with elastosis and foci of concentric fibrosis.
4. Diffuse fibrosis with smooth muscle fibres and dilated airspaces containing non-granular cells.

The finding of silicotic islets in cases of asbestosis is of interest, but no explanation of this is apparent at present. It was thought that the animals exposed to a dust cloud of country rock might develop foci of concentric fibrosis, but this has not occurred.

That the massive fibrosis is associated with the inhalation of asbestos is confirmed by the finding of massive fibrosis in the animals exposed to a dust cloud of long-fibre crocidolite. Histological examination of the areas of fibrosis revealed no evidence of concentric fibrosis of the silicotic type, nor was there evidence of muscular hyperplasia.

**Complications**

As in previous years, the accent in this section of the work was on the development of mesothelioma, especially of the pleura. Thirty-four cases were diagnosed in the Unit and, of these, eight were submitted to the Asbestos Tumour Reference Panel where the diagnosis was confirmed. One case considered to be a mesothelioma by a member of the Unit and accepted by the International Group was not confirmed by the South African Panel. This patient is well some 10 months after the pleural biopsy specimen was examined.

The cases of mesothelioma were diagnosed on the following specimens:

| | |
|---|---|
| Autopsy specimens | 4 |
| Pleural biopsy specimens | 27 |
| Pleural fluid | 3 |
| Total | 34 |

**Electron Microscopy**

In order to determine whether asbestos fibres are present in the mesotheliomas, the small fragments which were left in the histology blocks were removed and prepared for electron microscopy. These sections are being cut and will be examined.

**Benzopyrene hydroxylase**

It has been postulated that the occurrence of mesothelioma and bronchogenic carcinoma in asbestos workers is related to the combined effect of cigarette smoke and asbestos. However, a third factor seems to be operative which modifies the effects of the other two factors. This is thought to be metal ions which modify the activity of benzopyrene hydroxylase. The latter is a tissue enzyme which is able to oxidize benzopyrene and other carcinogens. The interference of metal ions such as nickel, iron, chromium, copper and manganese with the activity of benzopyrene hydroxylase has been investigated and preliminary results indicate an inhibition by all these metal ions. However, the apparatus used was not satisfactory so that unequivocal results were not obtainable. A new spectrofluorometer has been purchased for use in future experiments.

**International Union Against Cancer**

Five sets of U.I.C.C. Standard reference samples were sent out during the year. Numerous other samples of ground and unground fibre and country rock were despatched to other workers interested in trace element pick-up during grinding of asbestos.

**Dust Samples used in Animal Experiments**



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As a result of the discussions which followed on the paper presented by Dr. Webster on *The Role of Animal Experimentation in Asbestosis* at the Conference in Cardiff, specimens of the dusts used were sent to Dr. Spiel of the Johns-Manville Research Centre in addition to the laboratories in South Africa.

Much interest was shown in the finding that finely ground crocidolite did not produce fibrosis in the lungs whereas the crocidolite did. In addition, the finding of a mesothelioma in an animal exposed to ground country rock of the Northern Cape, suggested, that more specialised examinations should be carried out.

| AGENCY | METHOD | FINDING |
|---|---|---|
| **1. Quartz Content** | | |
| Chamber of Mines of S.A. | X-ray diffraction | Some quartz |
| National Institute for Metallurgy | Petrographic microscopy | Quartz 5th in order of abundance |
| Johns-Manville Research and Engineering Centre | X-ray diffraction | Trace quartz |
| | Petrographic microscopy | Quartz small |
| **2. Crocidolite Fibre** | | |
| Chamber of Mines of S.A. | X-ray diffraction | Very little crocidolite |
| National Institute for Metallurgy | Petrographic microscopy | Subordinate amounts of riebeckite much altered to chlorite |
| Johns-Manville Research & Engineering Centre | X-ray diffraction | Trace crocidolite |
| | Petrographic microscopy | 1%-2% crocidolite* |
| Pneumoconiosis Research Unit | Optical microscopy | Very subordinate amounts ~ 1% |
| *Possibly elongated riebeckite crystals. | | |
| **3. Major and Trace elements** | | |
| National Institute for Metallurgy | Semi-quantitative spectrography | Major-Fe, Mg, Si. (1%) Minor-Al, Ca, Mn, B (1-0.01%) Na, Ti. |
| Johns-Manville Research & Engineering Centre | Chemistry and spectrography | Trace-Sr, As, Cu. (< 0.01%) Major-Fe, Mg, Ca, Si. (> 1%) Minor- Na, Mn, Al, Ti. (1-0.01%) K. Trace-Cr. (< 0.01%) |
| **4. Major Constituents** | | |
| National Institute for Metallurgy | Petrographic microscopy | Siderite, chlorite, riebeckite, magnetite, calcite, quartz, pyrite, chalcopyrite |
| Johns-Manville Research & Engineering Centre | X-ray diffraction | Magnetite, siderite, mica, trace quartz; pos. trace, kaolin and crocidolite |
| | Petrographic microscopy | Crocidolite 1-2% carbonates-minor content Mica-minor content Quartz-small content |



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### General

In general the analyses carried out by the different agencies agreed well, but the following discrepancies should be noted. The Johns-Manville petrographic analysis indicates a higher proportion of crocidolite in the country rock than did the other analyses. This could be due to the uncertainty in defining the limits between tabular riebeckite crystals and crocidolite fibres.

The same agency found a considerable difference between the $SiO_2$ content of ground and unground country rock by chemical analysis. This is inexplicable and is not confirmed by their X-ray diffraction and petrographic analyses.

Assistance given to other workers investigating problems associated with asbestos included samples of milled and unmilled crocidolite to Dr.L.Cralley of the Bureau of Occupational Health, Cincinnati, U.S.A. Dr. Cralley is investigating the biological effect of trace metals on fibres resulting from asbestos milling on workers exposed to asbestos dust.

Samples of airborne dust collected in the North West Cape and the North East Transvaal were supplied to Dr. V. Timbrell, of the Pneumoconiosis Unit in Cardiff, who is attempting to explain the difference between the incidence of mesothelioma in these two districts by reference to the difference in the retention of their fibres. He considers that the difference in the average diameter of the fibres may be the reason for the complete absence of mesothelioma in people exposed to the Northern Transvaal Asbestos.

## CLINICAL SCIENCES DIVISION

### LUNG FUNCTION TESTS

The single-breath CO diffusion method of measurement of lung diffusion has now been replaced with the more sophisticated and sensitive steady-state method done in conjunction with an effort test.

The new test is more complicated and requires regular visits from the Central Laboratory personnel to give guidance and check the instruments.

In general the procedure is working well and, although the procedure is more time-consuming, about 20 tests have been carried out.

### RADIOLOGY

The project to examine radiologically all persons working on mills in the North-West Cape, Penge, Shabani and Havelock has been completed. The X-rays have been read by Dr. G.K. Sluis-Cremer and are now in Cardiff to be read by Dr. J.C. Gilson. Thereafter they will be read by Dr. A. Solomon.

### SURVEY - 1952 to 1956

The survey of Europeans in the service of South African Asbestos mines from 1952 to 1956 has been completed and a report prepared. The results will be published as a paper in "Environmental Research".

## ENGINEERING SECTION

### GENERAL

Asbestos fibre produced in South Africa is obtained from three areas - the northern Cape supplying Cape Blue, the north-eastern Transvaal producing Transvaal Blue and amosite and the eastern Transvaal chrysotile. The output of fibre from these fields in 1970 amounted to over 288,000 metric tons which is approximately 8 per cent of the total rock broken in the mines.



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The breaking, loading and the hoisting of the ore and its reduction in the dry state to obtain marketable fibre and the dumping of waste products are operations which if uncontrolled liberate dust and fibre particles.

Investigations are conducted by the asbestos producers in collaboration with the Air Quality Section of the Government Mining Engineer's division and the Pneumoconiosis Research Unit of the Medical Research Council on the engineering aspect of reducing exposure to dust. The programme of such investigations is controlled by the engineering section of the Asbestosis Research Advisory committee, who advise the Executive committee of the Asbestosis Research Project who pass on to the industry recommendations on steps to be taken for improvements in environmental conditions underground and in and around treatment plants. Assistance is given by Inspectors of Mines to achieve and maintain the standards aimed at.

At the invitation of the large producing companies, special visits were made during the year to the asbestos fields where members were able to view the advancement made in dust control at the mines. The changes made over the years have resulted in improved operational performance and, in many cases, the employment of a lesser number of workmen in potentially dusty occupations. The changes made include improvements to existing mills as well as the erection of complete new modern mills, the designs being in conformity with better dust control. There is a general overall improvement regarding dust control compared with past performance but places were seen where the desired standards had not been achieved. Also, in some cases, effective use was not being made of the devices and equipment provided for dust control. In this respect, the need for better education of workmen regarding good housekeeping and awareness of the need for dust prevention was apparent.

**Committee membership.**

The Committee's membership increased during the year by the appointment of a representative of the Northern Cape Mine Manager's Association and of a representative of the South African Railways.

**Conferences.**

An invitation was accepted by Dr. R.S.J. du Toit, head of the Air Quality Section of the Government Mining Engineer's division and a member of the committee to attend a Colloquium on Asbestosis held in Sardinia arranged by the Sub-committee on Asbestosis of the Permanent Commission and International Association on Occupational Health. The delegate also attended the International Symposium on Inhaled Particles held in London.

**Cumulative Dust Exposure Records.**

An important project started during the year is the building up of cumulative dust exposure records of workmen in the asbestos mining industry. Recording of exposure prior to 1971 and currently thereafter will be started early in 1971.

Satisfactory progress can be reported but the Committee was faced with a number of problems.

(a) **Working complement.**

Although it was realised that Bantu made up approximately 70% of the working population, it was decided to obtain records for the White and Coloured populations as a first step in order to determine and rectify any problems which might arise in the compiling of the records and retrieval of information from the records.



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(b) **Average dust levels on mines.**

The average dust level is known for the asbestos mines in South Africa and records have been kept for a number of years. Although it was realised that the application of the "mine mean" to the individual occupations carried a certain degree of inaccuracy, it was decided to use this information for the retrospective records.

(c) **Strategic Dust sampling.**

In order to decide whether sampling at strategic places would be sufficient for estimating the future exposures of persons, preliminary tests were carried out at a large mine. The results are being assessed.

(d) **Parameters of a dust cloud.**

Although it was decided to record on the cards the concentration of free-silica-equivalent-particles, with shifts as the time parameter, the percentages of long fibres, short fibres and quartz particles will be recorded in addition.

(e) ***Keeping of records.***

A card will be kept in the mine office and a master card at the Pneumoconiosis Research Unit.

(f) **Retrieval of Records.**

Preliminary discussions have been held as to whether the records should be kept on computed tapes using the Witwatersrand University Computer with a Terminal in the P.R.U. or whether a card sorting system could be sufficient. No decision has been taken on this point as it will depend on the type of retrieval system which the P.R.U. will use for the other records.

(g) **Design of a suitable card.**

A suitable card was drawn up and has been printed. The card was designed so that it could also be used for recording the service of the Bantu empolyees.

**Dust Condition t Mines.**

The Committee reviewed the work done on developing a wet process of treatment of ore, but the high cost involved in respect of the operation without extra separation being obtained resulted in this project being deferred.

The advantage of having an alarm system installed in mills to give warning of an increase in the concentration of dust was given consideration. As yet, it appears that the setting of the device to actuate the alarm at a determined level of dustiness presents difficulty.

Work continued on methods of controlling dust while fibre is being packed. It is estimated that 60"„ of all fibre is pressure-packed, 35"„ is screw-packed and the remaining 5"„ is hand-tamped. The operation of tamping a bag by hand and compressing the fibre manually necessitates the workman being exposed to the stream of fibre-laden air expelled by each thrust of the tamping rod. A dust extraction hood is difficult to site without interfering with the operation, thus it is essential that respirators be worn. A similar sudden thrust into the bag by the piston of the pressure packer expels dust-laden air. This matter is being investigated energetically.

The position in regard to impervious containers is now largely satisfactory but the committee continues to give attention to this aspect. No new type of bag was offered for test during the year. Attention was drawn to a development on trial by a producer company of "canning" a 150 kg weight of asbestos fibre.

Methods in use to dry the wet ore from the sorting plant were found by sampling to create a significant amount of dust. The ore fed to the mechanical dryers must have a



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moisture content of not more than 12½ %, and initial drying is done by spreading the ore in layered stacks in the open to drain and be dried by wind and sun. When dry, it is loaded into trucks for transport to the mill. Means to safeguard workmen loading ore from these areas and those working in the vicinity of mechanical dryers are to be further investigated.

Investigation is being done into the possibility of preventing workmen being exposed to dust when cobs are tipped on to stockpiles and at the primary mill bins.

A dust survey of sampling rooms in which grading and other tests are done showed that, in places, unsatisfactory conditions prevailed and that ventilation should be improved.

The committee is alive to the fact that the provision of equipment for the prevention of the formation and liberation of dust is not, **per se**, sufficient to protect the health of workmen and all personnel must be aware of the need to use and maintain in good condition the means provided for dust control. To inculcate a sense of responsibility concerning their own and the health of others, supervisory staff and workmen on the mines are given periodical lectures by trained persons making use of visual aids.

The improvement of health conditions underground was reviewed, the most important step having been the increase in the amount of air coursed through the underground workings by the provision of larger fans and extra airways from surface. Improved distribution of the air to the individual working is receiving consideration and one company employed the services of a ventilation consultant to advise on this aspect. Several instances were encountered by Inspectors, however, where ventilation was inadequate.

Change houses for underground workers are provided at the shaft heads and compounds. These change houses are also used by the plant workers. Consideration is being given on the new mines to the better design of the change house whereby the worker divests himself of his work clothes in one section, passes to the shower rooms and then on to the section where his ordinary clothes are kept.

Progress is continuing with the paving in various forms of areas around shafts and mills. This facilitates the cleaning up of spillage and wetting down of the environs.

Roads from the shafts to the mills are progressively being improved and water carts are in daily operation where necessary. For the transportation of ore between mines and mills, lorries and tractors and trailers are used where long distances are covered. Conveyor belts, cocopans and diesel locomotives with 3-ton trucks are used, in places, over shorter distances. The loads in transit are usually covered with tarpaulins and as a rule the ore is transported in a wet state. To obviate spillage overfilling of trucks is avoided.

The transfer of ore from lorries, trucks and conveyor belts into the mill bins is also an operation which liberates dust. This matter is being further investigated.

**Tailings.**

The method of disposal of tailings and filter plant dust is dependent on the available water supply. A few small mines use wheelbarrows to transfer the tailings in a dry state in plastic bags to the dumping site where they are buried. On the larger mines tailings and filter plant dust are transported in a semi-wet state by tractor and trailer, lorry or cocopan for disposal. Where gold mine type slimes dams are built, grassing of the permanent walls has achieved a high degree of success. In other cases the tailings are covered with fibre-free waste rock.

The prevention of the dissemination of dust from tailings dumps by spraying a test portion with a plastic compound is being investigated. The period of test necessary to allow exposure to all kinds of weather has not yet expired. It was also noted that a considerable reduction came about in the amount of dust scoured by wind off the slimes dams in the Witwatersrand area when contour walls were built across the top surfaces of the dams.

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## *PERSONNEL*

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| Co-ordinator | - Dr. I. Webster |
| Secretary | - Mrs. E.C. Shute |

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| Head of Department of Morbid Anatomy | - Dr. I. Prinsloo |
| Head of Department of Bacteriology | - Dr. S.D. Berson |
| Head of Department of Chemistry | - Dr. T.A. Kibroe-Smith |
| Head of Department of Dust Technology | - Mr. R.F.G. Rendall |
| Head of Department of Radiology | - Dr. A. Solomon |
| Administrative Officer | - Mr. B.J. Vorster |

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Miners' Medical Bureau — Department of Mines

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| **Head of Division** | - Dr. G.K. Sluis-Cremer |



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