Disputes on the safety of asbestos

British and American scientists are currently advising in a lawsuit concerning the health hazards of asbestos. This case is the latest in a long history of disputes on the dangers of this widely used mineral. The arguments will be clarified when the International Agency for Cancer Research publishes within the next few weeks its report on asbestos hazards

Dr Christopher Wagner was formerly Asbestosis Research Fellow in Johannesburg. He is now a member of the scientific staff of the Medical Research Council's Pneumoconiosis Unit, Penarth, Wales

Asbestos (from the Greek for unquenchable) is a broad term embracing a number of fibrous silicotic minerals found throughout the world. They occur in two main groups: chrysotile (white), and the amphiboles which include crocidolite (blue), amosite (brown) and anthophyllite (white). Although they differ both physically and chemically, these minerals have two common features: they can be woven and are resistant to flames.

These properties were recognised by stone-age men who used asbestos to manufacture cooking utensils, and were appreciated by the Egyptians who used asbestos cloth for the ceremonial trappings in Royal cremations so that the ashes of the corpse could be readily retrieved. From this early period, asbestos materials were regarded as curiosities until the late 1870s. From then on the value of asbestos in the industrial age began to be realised. The ancient mines in the Alps, Cyprus and the Ural Mountains were re-opened and huge new deposits were discovered in the Province of Quebec in Canada. As the demands increased, mining engineers remembered reports of a blue fibrous mineral seen near the Orange river in South Africa.

Initially, asbestos was used for fire-proofing and heat insulation, but other uses were rapidly discovered. Mixed with cement the asbestos acted as a scaffolding in making roofing tiles, wall boards, plaster boards, pressure piping, guttering and ceiling tiles. Finely woven asbestos produced an ideal filter for beer, wine, medicines, and removing bacteria from drinking water. When coarsely woven and later combined with resins, asbestos formed friction materials ideal for the brake lining and clutch facings. It may be bonded with asphalt and plastics for floor tiles, roofing materials, and more recently, for a diverse range of products. This bonded material was used in the covering of the nose cones of space-craft, where an outer covering of asbestos overcomes the intense heat of re-entry into the earth's atmosphere.

With this wide industrial potential, a rapid expansion of the world's asbestos production has occurred, from 100 tons in 1878 to over 4 000 000 tons in 1972. The majority of this is the white wool-like asbestos, chrysotile, which is found in serpentine, but on a much smaller scale the blue asbestos is being mined at its original site of discovery near the Orange river in the Cape Province in South Africa.

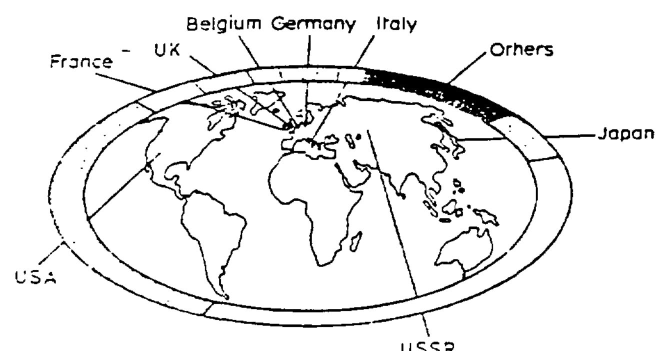
At first it was difficult to find a market for the blue fibre. Then, in 1900, the German Naval Engineers were looking for a suitable material for fire-proofing the ships of the new German Navy. Chrysotile had proved unsatisfactory but the blue crocidolite was found to be far more resistant to corrosive fluids and sea-water. They decided therefore, to use this material in their ships and were followed by Britain, France and Italy. Factories to prepare the blue fibre were established in London, Paris, Hamburg and Turin.

The blue fibre occurs in banded ironstone, was discovered later in the Transvaal associated with a brownish-grey fibre (amosite), and both these fibres were then produced commercially. Later, the blue fibre was found in Western Australia and Bolivia. Several other similar fibres were produced commercially on a small scale in Finland and the state of Georgia in the USA. but amphibole fibres never accounted for more than 10 per cent of the total production. Figures 1 and 2 show where the asbestos is produced and where it is used.

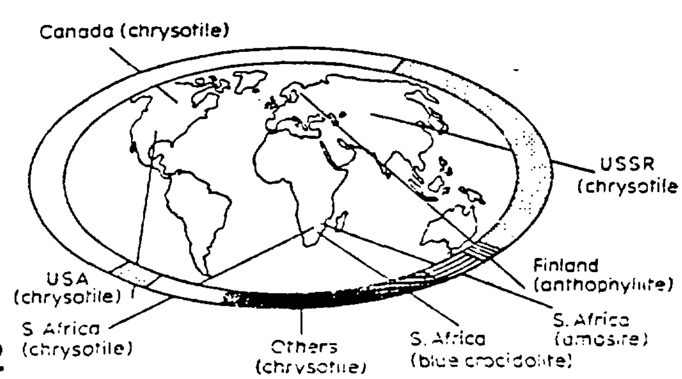
It cannot be disputed that asbestos has been extremely valuable in saving lives and improving the quality of existence for a large part of the world's population. One only has to consider the part played by asbestos in fire control and the reliance of vehicles on asbestos lined brakes. Countless human lives have been saved by the insulation of passenger and naval ships, and by the removal of bacteria by filtration from potable fluids. However, concomitant with the increasing use of asbestos people began to realise that there were a number of health hazards to those exposed to the airborne dust.

Figure 1 World distribution of asbestos usage

Figure 2 World distribution of asbestos mining



1 Annual consumption 4 000 000 tons



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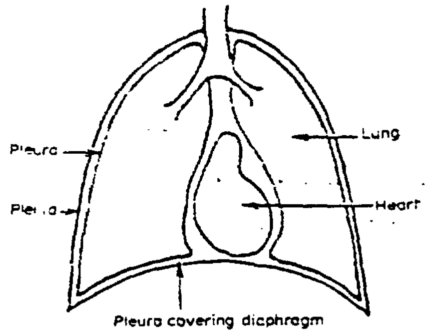

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Figure 3 Anatomy of the human thorax showing the site of the pleura

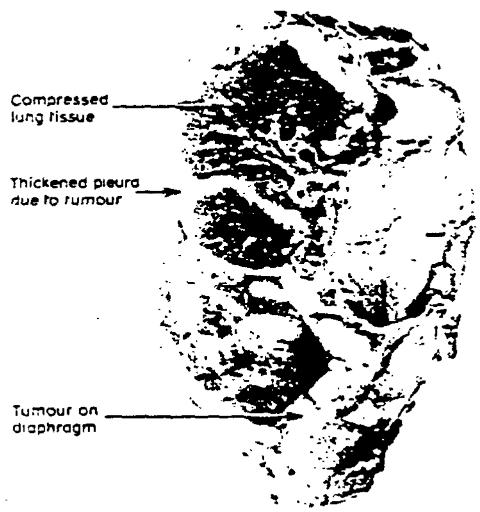

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Figure 4 Pathological picture of mesothelioma

In 1900 a post-mortem on an asbestos worker in London showed that he had died from scarring of the lungs, not due to tuberculosis. He was the last survivor of ten men, less than 35 years of age, who had been working for 14 years with asbestos textiles. A similar incident occurred in Normandy.

During the next 30 years, sporadic cases were reported from among the textile workers in Europe and America, and the workers in an asbestos mill at a mine in South Africa. In 1928, Dr E. R. A. Merewether, the Chief Medical Advisor to the Inspector of Factories, considered the whole asbestos industry in Britain should be studied. He conducted an investigation with an engineer named C. W. Price. They found that 28 per cent of the asbestos workers in the textile industry had evidence of pulmonary fibrosis ("asbestosis"). This report was published in 1930. In 1931 legislation was brought in to improve the factory conditions, and allow for initial and periodical examination of the people employed in dusty processes. Then, in 1935, cases of carcinoma of the lung occurring in workers with severe asbestosis were reported from London and South Carolina. However, before the suspicion that the tumours were caused by exposure to asbestos could be more fully investigated, Germany and Britain began rearming and asbestos became an essential product so that precautions in its use were by necessity not so strictly enforced.

In Britain, there was a sudden call for gas-masks with blue asbestos filters. When the War came, the ventilation of the factories became worse under black-out conditions, and the need for asbestos-containing arti[illegible] creased. A similar trend occurred in the United States, and the importation of amphibole asbestos from South Africa was given a top priority, as the fibre was required for insulating the naval vessels and Liberty ships under construction.

Merewether and his colleagues warned the industry of the dangers, but accepted the fact that little could be improved during the War. He continued to collect evidence of cancer of the lung and in 1947, he reported that 14 per cent of all death certificates for men which mentioned asbestosis, recorded that death was due to cancer of the lung. By 1952 it was 20 per cent and in 1969 over 60 per cent. In 1955, Sir Richard Doll studied those in dusty occupations in an asbestos textile factory and concluded that the incidence of carcinoma of the lung was ten times higher than expected.

At this stage, a further hazard of asbestos exposure was discovered. In South Africa we saw a series of rare tumours of the chest wall. The chest is lined by a double layered membrane called the pleura (Figure 3); this separates the lungs from the chest wall. To allow the two layers to move smoothly during respiration, they are lined by a layer of lubricating cells called the mesothelium. These rare tumours were mesotheliomas arising from this tissue (Figure 4). In 1957, we diagnosed 16 of these tumours and by 1961, 85 had occurred. In the few cases in which lung tissue was available asbestos fibres were seen. Epidemiological studies revealed that the majority of these cases had been associated with the asbestos mining area of the Cape Province where the blue asbestos (crocidolite) was mined.

South Africa produces all the major types of asbestos — chrysotile, crocidolite and amosite. We had been studying all the asbestos fields and the mesotheliomas were only associated with people living and working in the Cape asbestos fields. There were other important facts. First, these tumours, unlike the carcinomas of the lung previously reported, were associated with exposure to asbestos dust and not necessarily with severe pulmonary scarring which was a feature of the cancers of the lung in asbestos workers. Second, in some cases the exposure had been for only a few months. Third, there was a very long period between initial exposure and the occurrence of the tumours. In some cases, people who had been born on the Cape asbestos fields and left in early childhood developed these tumours in their 50s and 60s.

This was the first time that a specific type of asbestos had been incriminated. To test the hypothesis, it was necessary to show that these tumours occurred among those people working with the blue asbestos in Europe, and not in places where the exposure had been to other types of asbestos. The latter were hard to find as, in the majority of industrial countries, the asbestos workers have been exposed to several types of fibre. It therefore became important to compare conditions in the asbestos mining areas of the Cape Province in South Africa, with those mines in Quebec, Canada and in the Svedlosk area of

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Summary of IARC findings on asbestos hazards*

1 That all types of asbestos produce pulmonary scarring if there has been excessive exposure to the dust.
2 Cancer of the lung occurs among workers who have had excessive exposure to all types of asbestos dust.
3 Cancer of the lung is far more common among workers who are cigarette smokers. (The two carcinogens, asbestos and cigarette smoke, appear to combine multiplicatively in the production of lung cancer.)
4 Mesotheliomas of the pleura and the peritoneum (the lining of the abdominal cavity) are more common among those exposed to asbestos than the general population. More than 1000 cases have been reported in people exposed to asbestos.
5 There is no evidence of an increased rate of mesotheliomas among miners, and those living in the vicinity of the mines, in any mining area except the crocidolite mines in the Cape Province in South Africa.
6 In industry, crocidolite asbestos has been definitely implicated in the development of the mesotheliomas, and crocidolite asbestos has been identified in the lungs of asbestos workers with mesotheliomas from Germany, Italy, Britain, France, Holland, Sweden, South Africa, Australia, Canada and the United States. In two reports from the United States it was stated that men who developed mesotheliomas were exposed only to chrysotile or only to amosite. But evidence of the amount and type of asbestos actually in the lungs of these cases of mesotheliomas has not been produced. The risk of mesotheliomas is, on present evidence, generally agreed to be greatest with crocidolite.
7 Mesotheliomas have occurred in people who have had neighbourhood exposure to asbestos dust either from living in close vicinity to mills and factories before the dust was controlled, or from the cleaning of protective clothing of relations who brought their overalls home before this practice was forbidden.
8 It was shown that asbestos fibres could be recovered from the lungs of the majority of individuals living in urban communities. However, there was no evidence to suggest that anyone had developed disease from exposure to the ambient air.
9 There was no evidence that exposure of the general population to the small amounts of asbestos fibre in beverages, drinking water, food or pharmaceutical preparations increased the risk of cancer.
* These findings include both those from the Advisory Committee to the Director of the IARC and the IARC Working Group on the Evaluation of the Carcinogenic Risk of Chemicals to Man: Asbestos.

the USSR. For such an undertaking, international support was required and this was obtained from the International Union Against Cancer (UICC) and later, the International Agency for Research in Cancer (IARC). In addition, it was necessary to establish a good working relationship with the Unions and the asbestos industry. This study was based at the Medical Research Council's Pneumoconiosis Unit, which was experienced in the epidemiology of occupational disease.

A considerable amount of research was carried out during the period 1962-72 and in order that the findings could be summarised they were discussed at a meeting under the aegis of the IARC, at which more than 100 experts on various facets of the problem took part. After this meeting, an Advisory Committee drawn from this assembly presented its conclusions to the Director of the IARC. The Proceedings and the Report of the Committee will be published within the next few weeks (see the summary above).

These findings, which summarise the state of our *scientific* knowledge about asbestos-related hazards, are given here because there have been several sensational reports about the dangers of asbestos to the general population, especially in the United States. In October/November, 1973 a series of articles in The New Yorker, an American magazine, presented a highly prejudiced view, drawn uncritically from the edits of a single investigator. Fortunately, his alarming statements, given in evidence in a recent legal case in the States, were exposed to heavy criticism. This provided the court and the American public with information from which they may be able to assess better the validity of the evidence.

Meanwhile, particularly in Britain, steps were being taken to improve the working environment. The asbestos industry in this country had formed the Asbestosis Research Council which issued a series of Codes of Practice to ensure the safe use of asbestos, especially for insulating which had not been covered effectively in the earlier regulations. They also modified the methods used in spray insulating. In the major factories automation was increased. A great improvement being the wet processing of the fibres for textile production.

In 1968, a subcommittee of the British Occupational Hygiene Society produced a report on the concentration of dust which had to be met to prevent the occurrence of asbestosis. The value they obtained was realistic and acceptable to industry, but only because of the tremendous improvements that had occurred in ventilation during recent years. The figure applies only to chrysotile, the most commonly used type, and was based on very limited data, though on all that was available at the time.

The New Yorker articles contain much ill-informed criticism relating to the derivation of this hygiene standard—the limitations of which were clearly stated in the original article. It is surprising that nearly ten years after the Conference on "The Biological Effects of Asbestos" at the New York Academy of Sciences, no definitive new data have been published in the US relating measured dust dosage and the incidence of asbestos-related diseases.

In the large textile factory where Professor Doll had found the high incidence of carcinoma of the lung, a further survey published in 1967 showed that the incidence of carcinoma of the lung among those employed after 1933 was no greater than the general population. This indicated that if reasonable precautions were taken, asbestosis and the carcinoma of the lung associated with it could be controlled. In the same year, the Medical Inspector of Factories published "Problems arising from the use of Asbestos". This suggested that the use of crocidolite, the blue asbestos, should be controlled in Britain. The Act was amended, and by 1970, import of

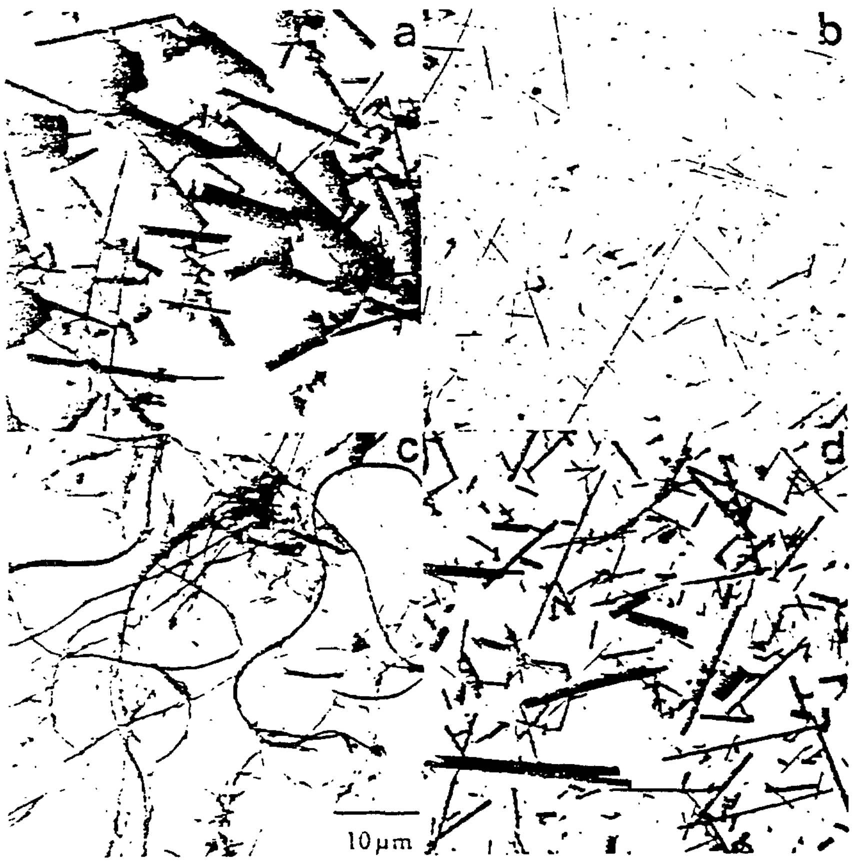

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Figure 5 Physical form of the four types of asbestos
(a) anthophyllite
(b) crocidolite
(c) chrysotile
(d) amosite

blue asbestos into Britain had ceased, and it could only be stripped from existing installation under supervision of the Inspectorate of Factories.

The most remarkable improvement has been in the Royal Naval Dockyards, where a considerable amount of blue asbestos had been used as insulation and fire proofing on the warships, particularly the aircraft carriers. All the blue asbestos has been removed from these ships, using sophisticated precautions, and has now been replaced by material containing a minimal amount of asbestos fibre. One frigate has been successfully insulated without asbestos.

What gives the blue asbestos the peculiar properties which can lead to the development of these unusual tumours? As yet, we have no proved answer but some indications have been discovered. When asbestos is injected into the pleural cavity of rats, mesotheliomas develop two years later. If rats inhale the asbestos they develop asbestosis and, in a few, cancers of the lung. Therefore, we have an experimental model to test various hypotheses. The first hypothesis was put forward by Dr Jack Harington who found that there were primitive oils and waxes associated with the blue asbestos, due to algae occurring at the time of its original formation some 3000 million years ago. These waxes contained small quantities of carcinogenic aromatic hydrocarbons. A series of experiments have shown no difference in the number of tumours produced by the oil containing fibre compared with fibre from which all the hydrocarbons have been removed. The second suggestion was that trace elements, particularly nickel, played a part in the tumour development. Animal inoculation experiments have shown no association between trace element content and tumour incidence.

Recently, we have published evidence indicating that the physical form of the fibre is an important factor in the development of the experimental mesotheliomas, the crocidolite fibre having a particularly fine needle-like shape (Figure 5). We were also able to produce the tumours with other fine fibrous materials. This is important as a number of these were being produced synthetically both as a substitute for asbestos and as "scaffolding" for various composite materials. For some purposes from the engineering point of view the finer the fibre, the more successful the product. Our present experiments indicate that irrespective of the mineralogical nature all fibres less than 0·5 microns in diameter may produce tumours if inoculated into the pleural cavity of the rats. Thus manufacturers may be warned of the increasing hygiene risk as the fibre diameter is reduced.

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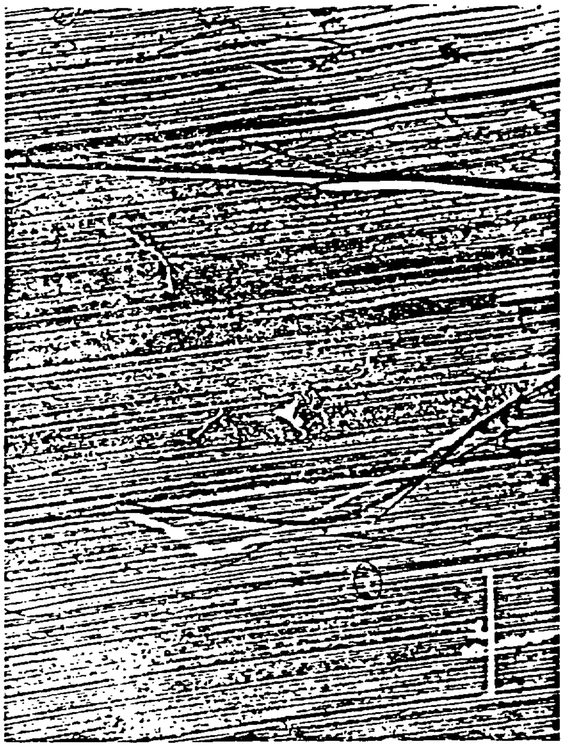
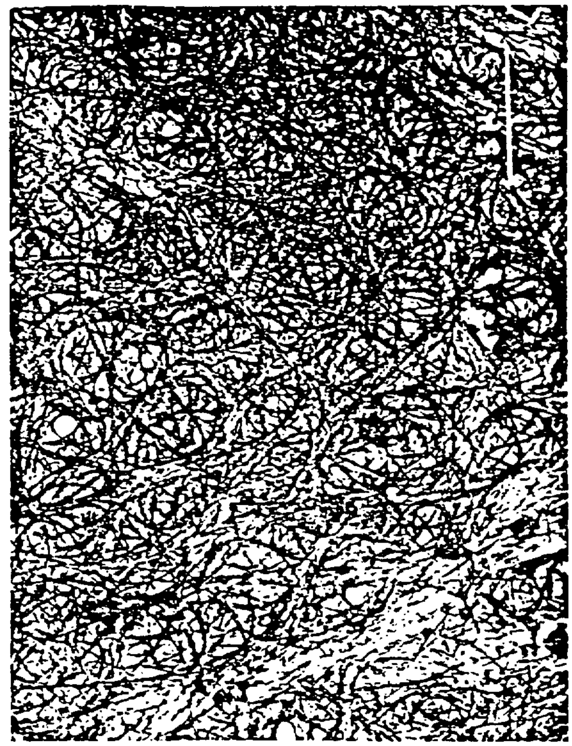
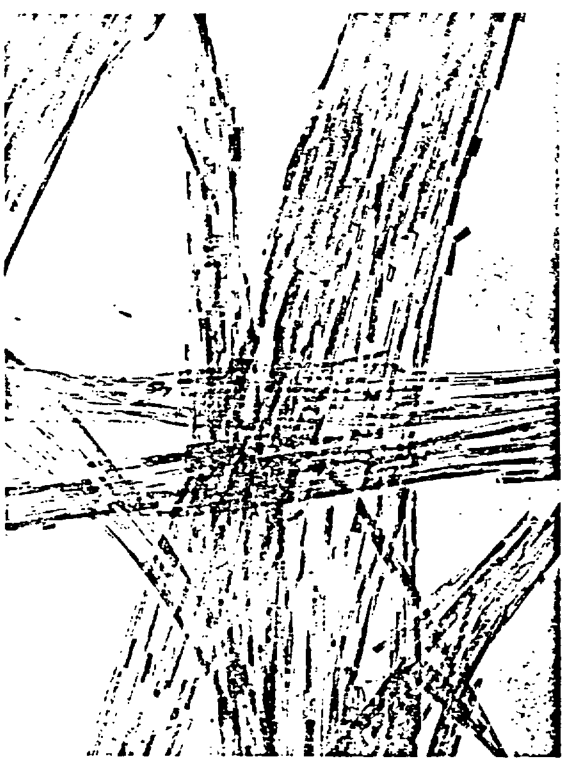
ELECTRON MICROGRAPH ILLUSTRATIONS



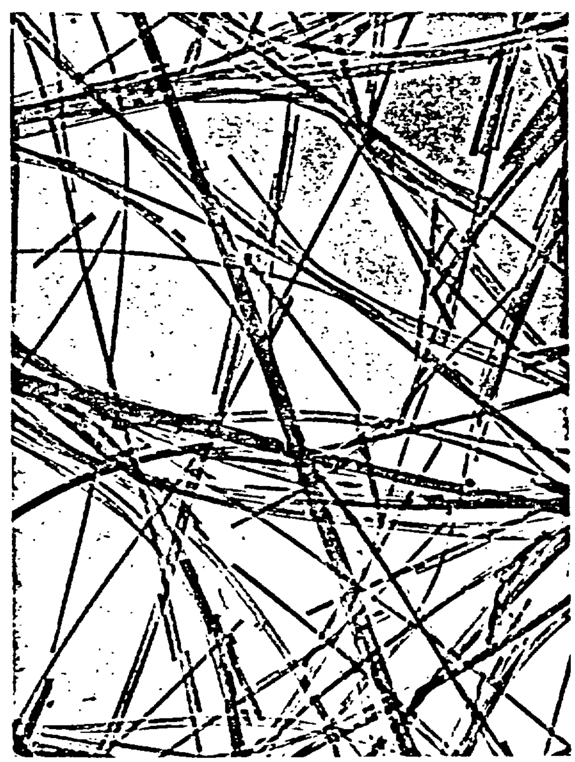
Typical Canadian asbestos fiber structure



Typical Calidria asbestos fibers



Dry processed asbestos fibers



Wet processed Calidria asbestos fibrils

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