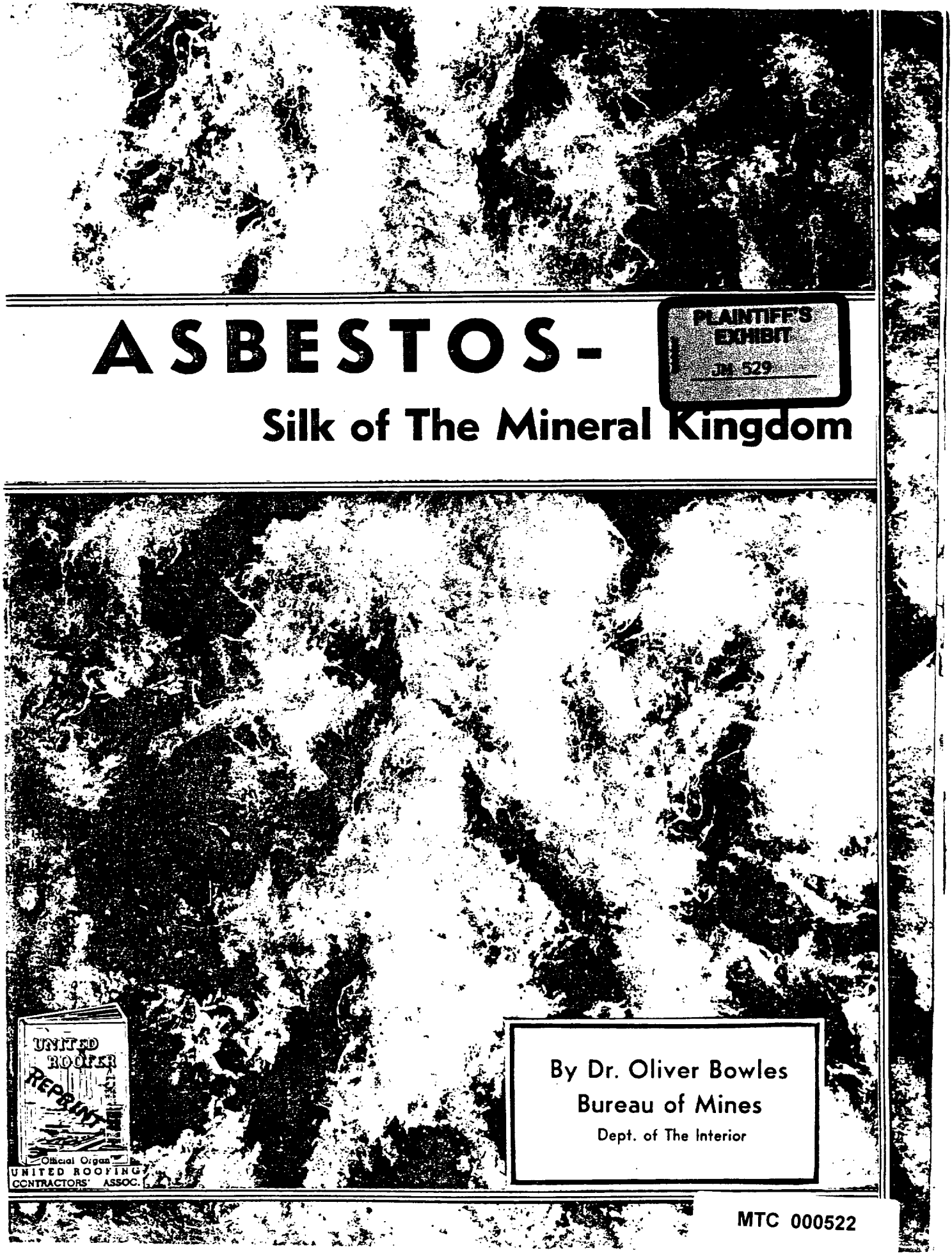


# ASBESTOS-

## Silk of The Mineral Kingdom

PLAINTIFF'S EXHIBIT
JM 529

By Dr. Oliver Bowles
Bureau of Mines
Dept. of The Interior

UNITED ROOFER
REPRINT
Official Organ
UNITED ROOFING CONTRACTORS' ASSOC.

MTC 000522

# ASBESTOS-

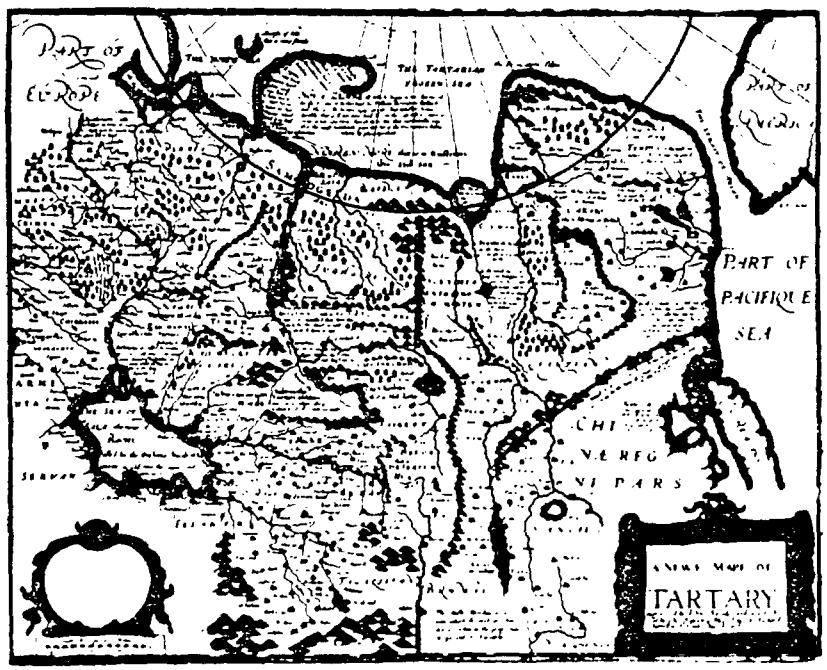
## Silk of The Mineral Kingdom

By Dr. Oliver Bowles
U. S. Bureau of Mines

THE numerous mineral commodities that are exploited for human use fall into two great groups, the metallic and the nonmetallic. Those of the former group are smelted in furnaces for recovery of the iron, copper, lead, zinc or other metal, and the metals thus obtained are fabricated into innumerable articles to meet the demands of an industrial age. The second group, the nonmetallics, excluding fuels which are not pertinent to this discussion, comprise those minerals that are not used as sources of metals but are applied in other ways, for instance, as building stone, roofing, road material, paint ingredients, abrasive and polishing powders, fertilizer and chemical raw materials, or as constituents in paint, rubber, pottery, glass and numerous other products.

Some of them are heat-treated or calcined as, for instance, the limestones employed in lime and cement manufacture, but for the most part the members of this great group of nonmetallic minerals are used in the form in which they occur in Nature. Thus nothing is done to a building stone except to shape it into a block or column and impart to it some desired surface finish as by rubbing or polishing. A roofing slate is split to the desired thickness and trimmed to shape.

But no attempt is made to change its structure or composition. Sand, gravel, and crushed stone are merely graded according to the desired size of fragments, sheets of mica for electrical use are simply split and cut to the proper shape, and talc or clay for paper-making is merely pulverized to the desired fineness. For many of these uses the requirements are quite exacting and much depends upon the skill with which Nature fabricated them. For the most part, man is powerless to change the physical character of these minerals; he is limited primarily to selection, for only here and there has Nature been kind enough to prepare the materials in the form in which man can employ them to best advantage. Mica, for example,




*This map of Tartary is copied in part from an original made in the 16th Century. Because of the reduction in the illustration it is impossible to read the fine print, but in the extreme right central part of the map is an inscription which offers conclusive proof that the ancient Tartars not only knew of the existence of Asbestos, but were among the first to weave it into cloth. It reads:*

*"In this country is a Hil out of which they dig earth called by Plinv terra asbestos, having fine veines like frasse which being spun and weaved yeeeld cloth that wil nut burn in the fire."*

*For the reproduction of the map we are indebted to the Keasbey & Mattison Company.*

MTC 000523


Published by AsbestosClaims.Law
asbestosclaims.law/library/21243/2

is widespread; 40 percent of any ordinary roofing slate consists of mica in minute particles, but good electrical sheet mica is not easy to find.

Asbestos is another of these nonmetallic minerals that depends for its value on its special properties. The principal asbestos of commerce, known as chrysotile, is a form of the mineral serpentine. Massive serpentine is commonly spotted and mottled with yellows and greens that resemble the markings of a snake, hence the name, "serpentine." Dense, fine-grained, attractively-veined and colored varieties of serpentine are sometimes polished and sold as ornamental marble, the variety known as verde antique.

Aside from this relatively small use, massive serpentine is virtually worthless, but under certain peculiar circumstancesNature, instead of fashioning it in small interesting grains, drew it out into filaments as strong and flexible as silk. In this special form it is known as asbestos. Massive serpentine is so valueless that millions of tons of it are discarded as waste at the asbestos mines. No use, and therefore no market can be found for it, but high-grade chrysotile asbestos of exactly the same composition is worth $750 a ton because of its special physical form. It is valuable because it can be separated easily into fibers that have the flexibility and strength of silk but are noninflammable. These fibers may be spun into yarn and woven into cloth that resemble ordinary fabrics but they will not burn.

## ALCHEMIST'S DREAM

Because of the high value of this material, how desirable it would be to devise a means whereby it could be made in a factory! The old dream of the alchemist that base metals could be turned into gold is now, through the wizardry of chemical research, approaching the realm of reality. How much simpler it would seem to change massive serpentine into fibrous serpentine. No chemical change is required, but merely a change in the form of the mineral. It appears to be an easy problem, but no one yet has been able to devise a spinning wheel that will make filaments of mineral silk as Nature makes them.

Nature has facilities that man cannot duplicate. With powerful machines man may approach the attainment of pressures like those exerted upon rocks within the earth, and with modern furnaces he can obtain temperatures that will melt rocks into white-hot liquids, but the time element is Nature's own particular tool. Nature is never hurried. A million-year period is but as a day, or an hour, or a second in the realm of natural geological processes, and human experience is, in comparison, too fleeting to permit man to utilize time as Nature uses it in developing mineral or rock structures. Deprived of this element of time, as well as limited in other directions, man is unable to simulate Nature's processes. He cannot make asbestos. Therefore we must be content to exploit it where we find it, and, unfortunately, Nature was not generous with the supply.

Although the year 1864 marks the beginning of the organized asbestos products industry, we must not presume that asbestos was unused before that year. That old veteran of many wars, Charlemagne, king of the Franks from 768 to 814 A. D., averted a war by the use of asbestos, and this he did with an asbestos tablecloth. When the savage hordes of Harun-al-Rashid threatened invasion of his Empire he called a peace conference. In the presence of the Moslem ambassadors he threw his tablecloth into the fire to cleanse it, and when he drew it out unburned and unharmed in any way, they went back home and advised Al-Rashid to avoid war with one who practiced such white magic.

There are various references to the use of asbestos throughout the middle ages, but the earliest of all goes back to 450 B. C. In that year Callimachus, a famous Greek sculptor and originator of the Corinthian column, was given the task of fashioning a lamp to burn at the feet of Athenia. The lamp was of solid gold and its wick was made of asbestos fiber. It was kept burning perpetually. Oil was supplied once a year, and it is recorded that the wick was not consumed by the fire.

Romans, Chinese, and Egyptians used asbestos in these early years, chiefly as cremation cloth to preserve the ashes of the dead.

The original name applied to this mineral by the ancient Greeks was "amiantos" which means unstained, untainted or undefiled, and doubtless referred to the cleansing of asbestos fabrics by throwing them into the fire. The French have retained this name for they call asbestos "amiante."

The word "asbestos" first applied by Pliny is really a misnomer for it means inextinguishable or unquenchable, words that have just the opposite meaning of "incombustible" a characteristic property of asbestos, Pliny doubtless had in mind the wick of the lamp that burned perpetually at the feet of the goddess of Athens. As is often the case, the word which is least correct on the basis of etymology has become firmly established by use, so the name "asbestos" has been retained in the English, and "Asbest" in German.

Marco Polo in his travels through Siberia in 1250 saw textiles that resisted the fire and he was informed that they consisted of the skins of salamanders, lizard-like animals that the ancients claimed could live in the fire. He was, however, too much of a scientist to accept this statement. He traced the origin of the fiber to native asbestos-bearing rock, and learned how the fibers were obtained and prepared.

## SCOTSMAN'S STORY

There are gaps of even hundreds of years in the history of this strange mineral Virtually no mention was made of it from Marco Polo's day, 1250 A. D., until 1676, when a Chinese merchant exhibited a handkerchief of "salamander's wool" or "lumin asbesti" at a meeting of the Royal Society in London. In 1679 mention was made of a valuable asbestos napkin belonging to Ferdinand the Third. William Lithgow, a Scotchman, writing about the minerals of Cyprus early in the 17th century referred to "the admirable stone amiante whereof they make linnen cloth that will not burn, being cast into the fire, but serveth to make it neat and white."

Between 1710 and 1720, during the reign of Peter the Great, asbestos was obtained in the Ural Mountains of Russia, and a small factory making asbestos socks, gloves and other products was operated for a time.

MTC 000524

HEAT insulation is one of the outstanding uses of Asbestos. During the past 20 years asbestos building materials have been widely employed. Asbestos cement roofing shingles are used very extensively. Corrugated asbestos siding, asbestos millboard, and asbestos cement pipe are important products. Time is too short to enumerate the hundreds of diverse uses, from asbestos potholders and mats familiar to every housewife to theater curtains, firemen's helmets and suits, asbestos gloves, asbestos paper, stove linings, fire-proof paints, acid filters, brake linings and even fire-proof Santa Claus whiskers.

Asbestos paper was made as early as the year 1700, and the object in that early period was to preserve printed or written records from destruction by fire. The praiseworthy objective of securing an imperishable document was defeated, for although the asbestos paper would withstand the fire, the ink would not. The value of asbestos paper for heat insulation was later recognized, and at present more of it is made in a single day than was made in an entire year 25 years ago.

## Canadian Fiber

Now let us examine more intimately the properties of this strange mineral. The solid mass of fibers as it occurs in Nature may be separated into a loose fluffy mass. The question will naturally arise as to how fine these fibres are. That is a difficult question to answer because separation and subdivision may be continued indefinitely. The fineness that can be attained is limited only by the delicacy of the tools used, and the skill of manipulating them. Some Canadian fibers when measured were found to be so fine that 3,300 of them could lie side by side within the space of one inch. Asbestos from some localities fibernizes or separates more easily than that from other places; and, other things being equal, those that fiberize easiest are the most valuable.

Although chrysotile is the principal variety, other varieties are used. Crocidolite, or blue asbestos, is produced in Africa in considerable quantities, and small quantities in Australia. Amosite, an unusually long-fibered variety, is mined only in Africa. Anthophyllite occurs widely in the United States and other countries but it is so weak and brittle that it finds very limited use and commands a price of only a few dollars a ton. Tremolite is stronger and is exception resistant to chemical action. A few hundred tons of it are mined each year in the United States for acid filters and other special uses. Mountain leather and mountain cork are mineral curiosities of no commercial value.

Now where can we find adequate supplies of chrysotile asbestos so essential to the automobile, heat-insulation, building and other industries? The most important deposits in the world are those in Quebec, Canada.

It is recorded that in 1870 Charles Webb who owned a rocky ledge of land at Danville, Quebec, offered it to James Gifford for $50, but Gifford turned down the offer because the land was so rocky that he could not even fence it for a pasture. That same rugged ledge is now the site of various asbestos mines which have produced many million dollars worth of asbestos. Several companies have extensive operations near Thetford Mines, Quebec. The Quebec deposits consist of veins of asbestos running through massive serpentine. The fibers cross the veins running from wall to wall. Much has been written on the origin of these veins, and the conclusion is that the asbestos crystals or columns grew from solutions originating in the serpentine and that as the fibers grow in narrow fissures they forced the walls apart. The length of the fiber is governed in general by the width of the vein. They range in width from an inch or two down to mere hair lines. The value of the fiber depends greatly on its length. The large veins provide the most valuable asbestos. The masses of asbestos are broken from the rock by hand-sledging, and this hand-cobbed fiber is known as crude asbestos which sells at $500 to $750 a ton. No attempt is made to separate the shorter fiber veins from the rock by hand. Such rock is crushed and passed through a mill, which will be described later. The Canadian deposits are very extensive. Drill holes have been sunk to test their depth and at 1,700 feet there is no material change, either in quantity or quality. Apparently, therefore, there is no danger of the reserves being exhausted for many years, even though production exceeded 370,000 tons in 1937.



*Close-up of a ledge-face in the huge Danville pit, showing veins of the finest cross-fibre chrysotile asbestos in place in the serpentine matrix*

MTC 000525


Published by AsbestosClaims.Law
asbestosclaims.law/library/21243/4

What other important deposits are there in the world? Asbestos was discovered in the Union of South Africa as early as 1815, but real development did not occur until the Cape Asbestos Co. was established in 1893. The Union has since become an important producer. The most spectacular growth of the industry, however, occurred in Rhodesia. Interest was first aroused in the Shabani area about 1914 when a few hundred tons were produced, now the Shabani mine accounts for almost the entire Rhodesian output which reached nearly 60,000 tons in 1938.

Another large producer is Soviet Russia. Before the World War Russia ranked next to Canada as an asbestos-producing country. During the revolutionary period the industry was nearly at a standstill, but lately it has revived on a large scale. Figures obtained are not very reliable but they indicate an annual production of nearly 100,000 tons.

Italy produces 2,000 to 4,000 tons a year and Cyprus has an annual output of 20,000 tons of short fiber chrysotile. Small quantities are produced in Australia, Finland and few other countries.

By this time I am sure you are curious to know where the United States appears in this picture. Although this country is generously supplied with a great variety of commercial minerals, Nature was stingy with asbestos. The United States is the largest manufacturer of asbestos products in the world, but domestic mines furnish only 4 to 5 percent of our requirements of raw materials. Beautiful asbestos occurs in Arizona, but the deposits are relatively small, have difficult transportation problems, and are far from markets. Production has never been more than a few hundred tons a year.

The only mine in the United States producing asbestos in quantity is near Eden in northern Vermont. This occurence is regarded as an extension into the United States of the deposits in Quebec, Canada. I had the privilege of visiting this mine last June and found it operating night and day with a total force of 180 men. It produces several thousand tons a year of well-prepared and carefully-graded asbestos of short to medium lengths. No long fiber is obtained in this area. The Vermont asbestos does not occur in cross-fiber veins. It is known as slip fiber for it occurs chiefly on smooth surfaces where the serpentine rock under intense pressure has been fractured, and the broken fragments ground and pressed against each other.

Aside from the Vermont and Arizona operations, the only asbestos produced consists of a small and sporadic output of chrystile in California, a small tonnage of tremolite in Maryland and of anthophyllite in Georgia, Montana, North Carolina and Washington.

OF the total world tonnage of asbestos sold during 1935 Canada produced 54 percent, Soviet Russia 25, Rhodesia 10, Union of South Africa 4½, Cyprus 2, and the United States 2 percent. Thus over 70 percent is controlled by the British Empire, 25 percent by Soviet Russia, and less than 5 percent by the rest of the world.

Contrasted with these figures for production, striking differences are found in the percentage consumed by each of the leading nations. The United States leads with 38 percent of the world total, and the other principal consumers are Russia 20 percent, United Kingdom 9, Germany 7, Japan 7, France 4, Belgium 3, and Italy 3.

Except for Soviet Russia not a single important producing country is an important consumer. On this account the international trade in asbestos is of great importance. The United States has the largest number of asbestos products factories of any country in the world. Our records, compiled in cooperation with the editor of the magazine "Asbestos," show 73 important factories, and scores of other factories use asbestos in a small way. The value of the asbestos products made in these factories in 1937 was more than $96,000,000. Ninety-five percent of the raw asbestos for these factories must be imported from Canada, Africa, Russia and Cyprus. The United Kingdom also has many large factories and produces no asbestos. Its supplies are obtained chiefly from Africa with substantial quantities from Canada. Japan and the central European countries except Italy are practically barren of domestic asbestos to supply their mills. Soviet Russia, on the other hand, has built several large asbestos products factories, and more than half of its production is consumed in its own plants. The remainder is exported chiefly to the central European countries.

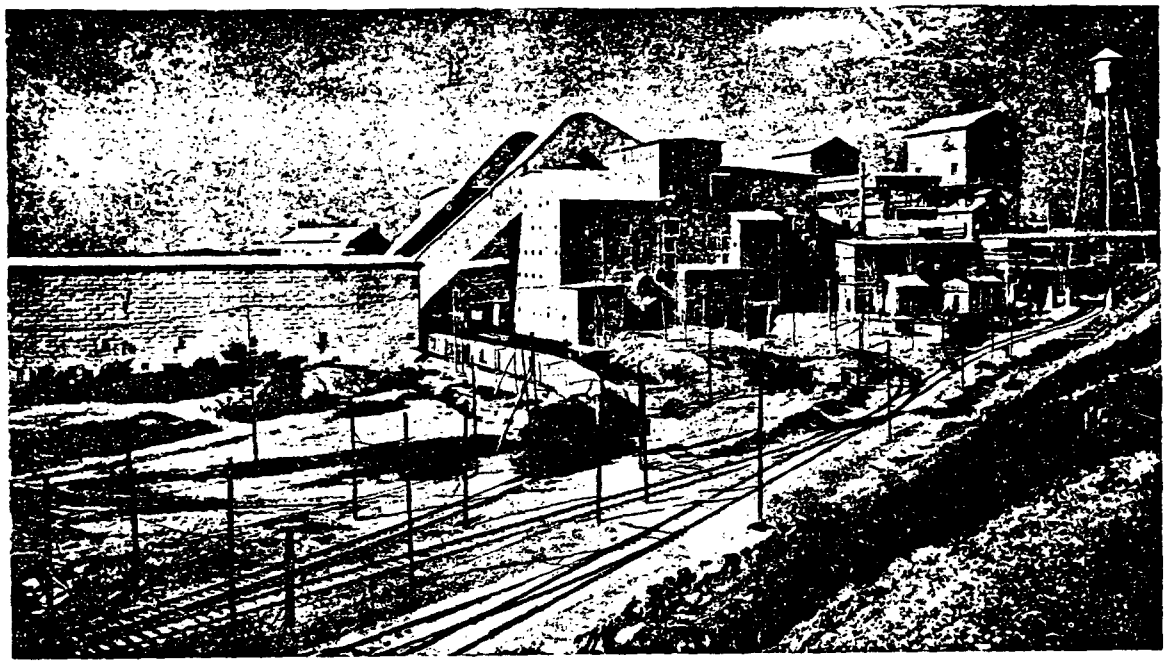



***Illustration shows a portion of a Canadian asbestos mine. Some idea of the size of the asbestos seams running through the rock can be seen by comparing the rock with the hat in the foreground***

### Sources of Supply

The dependence of the United States on foreign sources of supply is an important problem to which the Bureau of Mines has devoted much study. Fortunately for more than 100 years we have maintained peaceful and cordial relations with our northern neighbor, Canada, from whom

MTC 000526



most of our supplies are obtained. However, during recent years increasing quantities of the longer, higher-priced fibers are obtained from Africa, and, at times of international stress as at present, the problem of transportation may become difficult. A shortage of imports would affect first of all the supplies of the long spinning fibers, because the percentage of such fibers is not high in the Canadian deposits, and interruptions to shipping would curtail the imports of long fibers from Africa. The trend toward the use of molded brake linings relieves the situation somewhat, because the shorter fibers that are more abundant may be used for this purpose. The roofing trade may be interested in the claim made by one authority that shortage of supply would affect first of all the fibers of shingle grade.

How is asbestos mined? It occurs in veins or stringers enclosed within tough massive rocks. Most of the occurrences are in rugged mountains in remote parts of the earth. Some of the mines are open pits, others extend deep underground. The Canadian mines were for many years of the open pit type but recently it has been found more advantageous to work underground.

A story is told of a man who, in giving advice to his son, told him to always start at the bottom in any enterprise that he undertook and to work up. And the son replied, "All right, Dad, but how about digging a well?" In one Canadian mine they are actually doing that which seemed so impossible to this young man. They block out a mass of asbestos-bearing serpentine 160 feet square and 500 feet deep. They put tunnels and loading chutes beneath it, then blast it to fragments and excavate it from the bottom. The mass slowly sinks, and the broken rock is removed through tunnels and hoisted to the surface until eventually the entire block is gone. This complicated but efficient method is known as block-caving.

Most of the African mines are worked underground by various methods. In Soviet Russia both open pits and underground mines are worked. The Arizona fiber is obtained in narrow tunnels but the Eden, Vt., deposit is worked to advantage as a great open quarry with a face over 100 feet high.

Peculiar problems arise in testing asbestos-bearing rock to determine its value. If one is dealing with an ore of gold, silver, or copper, it is a simple matter to make an assay or analysis to determine the quantity of valuable metal present in each ton of ore. An analysis of an asbestos ore, however, is quite useless, because the gangue or barren rock may have almost exactly the same composition as the valuable fibers; they both consist of serpentine. Even a laboratory mill designed to separate fiber from rock may give quite misleading results, because what one has to determine is not the actual content of fiber but rather the quantity of fiber that can be recovered by commercial milling processes. The only reliable means of determining the value of asbestos ore is to take a few tons to a commercial mill, and to classify and weigh the fiber recovered.

**Unique Features**

Asbestos milling has many unique features. The purpose is to separate the asbestos from the rock with as little damage as possible to the delicate fibers, because the value of chrysotile depends largely on the length of the fiber. When fiber ⅛ inch long is worth $100 a ton, fiber ¼ inch long is worth about $400 a ton. Thus breaking fibers in half destroys about three-fourths of their value. To avoid breakage the thick veins containing long fibers are broken out by hand sledging and are not passed through the mill. Hand-cobbed masses are called crude fibers.

Many commodities, such as eggs, must be handled carefully, but one is not accustomed to thinking of an ore-bearing rock as a material that could be scrambled by rough treatment. True the rock containing the shorter fibers is crushed, and later beaten to fragments in jumbo mills equipped with rotating blades, but the greatest care is exercised to avoid rough handling of the asbestos fiber. A powerful air current sweeps through the beater mill, and the moment a fiber is set free from the rock the air current carries it away before the rotating arms or flying rock fragments can damage it. The pulverized rock is screened to remove the fines and the larger fragments

MTC 000527

are further reduced by beaters. This is the only ore-milling process that employs vacuum cleaners in connection with screens. Near the point of discharge of each vibrating screen a hood about 3 inches wide extends across the full width of the screen. The shaking action brings the fiber to the surface of the rock fragments and as it passes under the hood a powerful suction fan generates an air current that picks up the fiber and carries it away to a storage bin. The recovered fiber is graded by length and sold for various uses. Vermont fiber, for example, is



***The colored boy in the illustratioin above is an asbestos worker in an African asbestos mine. The white streaks running through the rock are asbestos fibres.***

graded according to use into shingle stock, the highest grade selling at about $57 a ton, paper stock $40; cement stock $25 and shorts and floats ranging from $12 to $18 a ton. The milling of asbestos is costly because of the many successive steps, and the care with which the fiber must be handled. Furthermore, the percentage of fiber is usually low. In Canada only 6 percent of the rock milled is recovered asbestos; in Vermont 5 percent.

Another unique feature of asbestos milling is the necessity of keeping the ore free from wood or other fibrous material. Suppose a piece of a railway tie or mine prop should go into the crusher with the ore, it would be carried along to the beaters, and would be fiberized and collected with the asbestos. As non-inflammability is one of the chief virtues of asbestos, contamination with foreign materials that will burn would be highly detrimental. Accordingtly in asbestos mines, all railway ties, cars, mine supports, and other mine structures are of iron or steel. No wood is used. Furthermore, all mine and mill workers are strictly forbidden to throw burnt matches or cigarette boxes where they may be collected with the ore.

During my visit to the Eden, Vt., mine last June, while taking photographs, I found it necessary to put a new roll of films in my kodak. Standing on a great waste pile in the wilderness of northern Vermont it seemed perfectly harmless to throw on the ground the box that held the new roll of films. The superintendent who accompanied me made no remarks, but how embarrased I was to see him pick up the box and put it carefully in his pocket. This incident illustrates how important it is to keep all foreign fibrous materials away from asbestos ore.

There are now on the market certain manufactured mineral fibers that resemble asbestos in some respects. The best known is rock wool now widely used for home insulation. Another product is fiberglas for mulching garden plants. Recent glass wool products are quite remarkable because they can be made into yarn and thread or woven into cloth. They are all made by mixing minerals in certain definite proportions, melting the mixture to a liquid state, and blowing or drawing the molten mass into fine filaments. These materials are employed to some extent for heat-insulation, but generally in fields of application where asbestos is not used. The possibility of substituting them for asbestos in brakebands and for other special uses is doubtful.

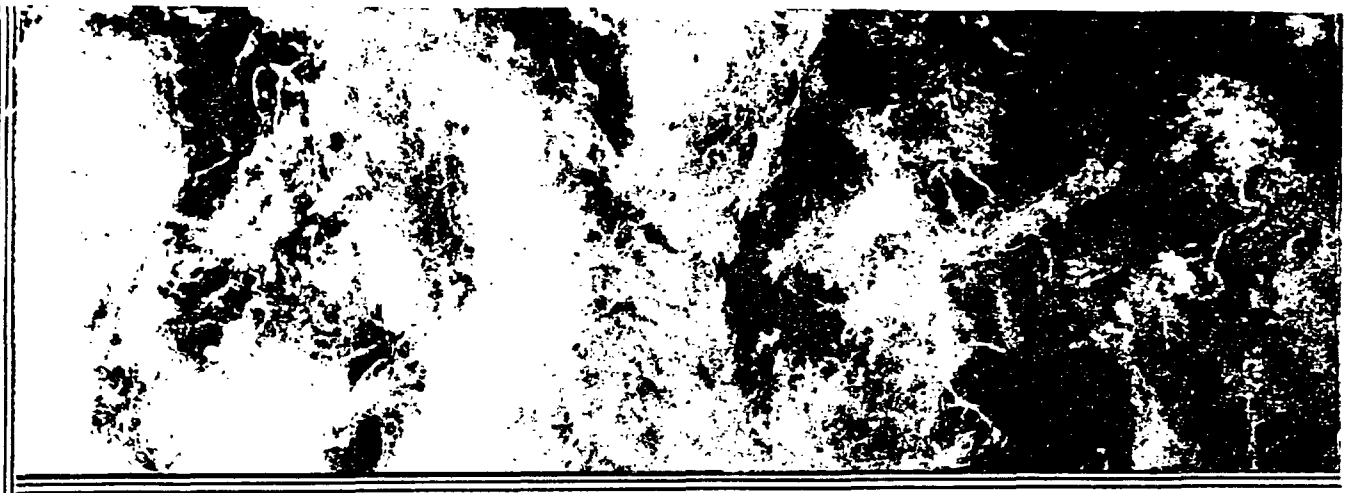
### Foreign Supplies

Possibly the most outstanding feature of the asbestos industry is the dependence of our country on foreign supplies. During the past 20 years I have examined hundreds of samples of asbestos sent to the Bureau of Mines from numerous localities in many States, but nearly all of them have proved to be of little value. Only occasionally has a promising sample been received and when this has happened we have invariably found after diligent inquiry that the occurrence was too small to warrant commercial development. Some day this situation may be relieved just as it has been with respect to potash. During the World War our country was almost barren of potash supplies, but now, owing to the remarkable discoveries in Texas and New Mexico, the United States is virtually independent of foreign supplies. It is possible for you, therefore, in your wanderings to render a real public service by searching diligently the serpentine rocks that occur in many areas, chiefly those in remote and rugged regions, to see if you can find therein this elusive mineral silk that seems to occur in quantity nowhere on the American continent except in Quebec and Vermont.



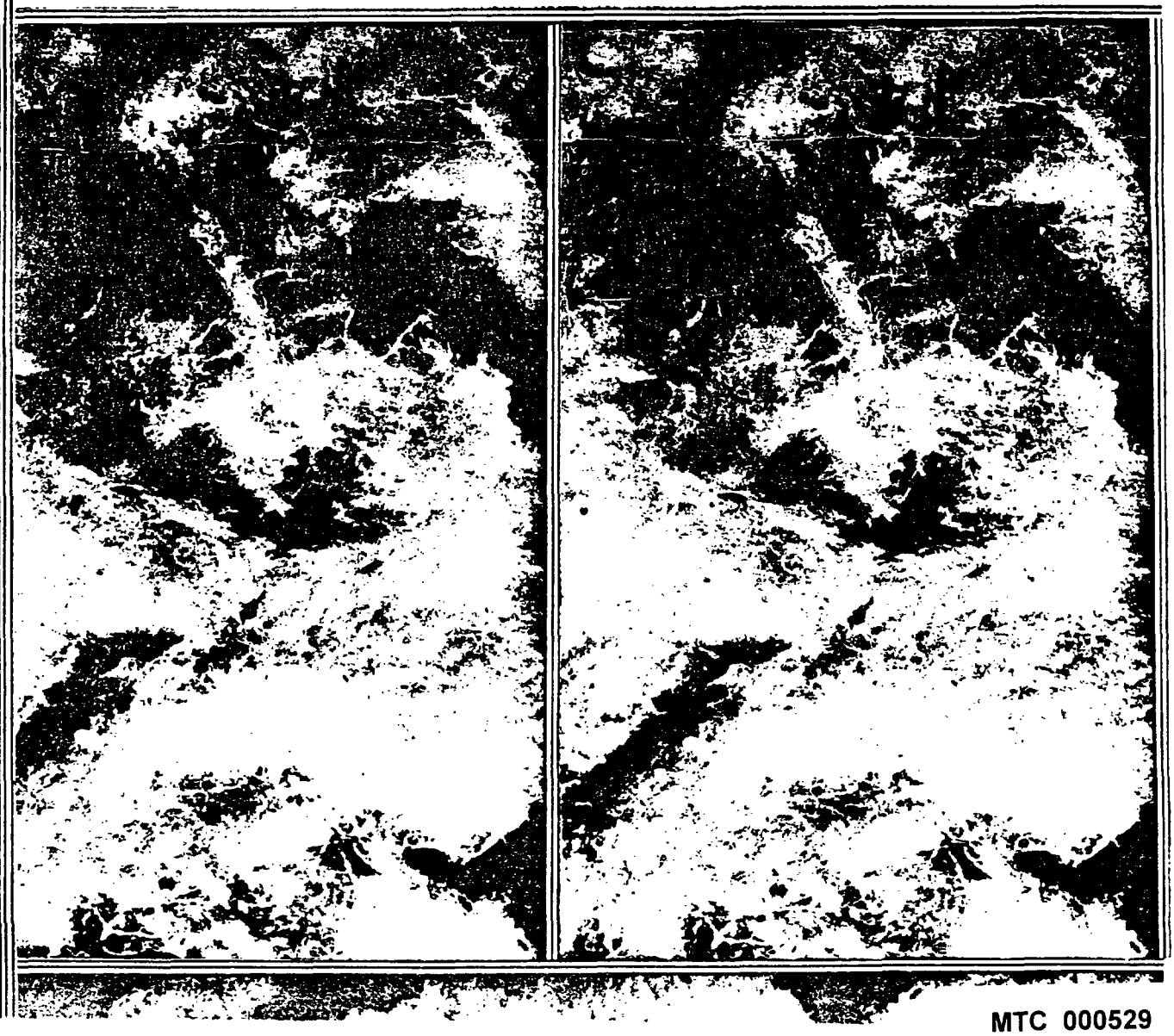
MTC 000528


Published by AsbestosClaims.Law
asbestosclaims.law/library/21243/7



# ASBESTOS-

## Silk of The Mineral Kingdom



MTC 000529