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ASBESTOS

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ASBESTOS.

By P. E. Joseph.

For many years the United States has lead all other countries in the manufacture and use of asbestos, drawing most of the raw material from Canada. Now, however, we are producing some excellent asbestos in our own country. The most notable feature of the asbestos industry in 1914 was the development of a new field in Grand Canyon, Arizona, which is furnishing a grade of fibre that compares very favorably with the Canadian. For electric installation the Arizona asbestos is even better than the Canadian, as it contains a lower percentage of iron.

J. S. Diller, of the United States Geological Survey, in his report on the production of asbestos, shows that in 1914 the United States produced and sold 1,247 short tons, valued at $18,965, a gain of 13 per cent in quantity and 72 per cent in value as compared with the production of 1913. Besides the small production in California and Virginia there were three important producers:—two in Georgia, who furnished the greater portion, and one in Arizona, which produced high grade material only.

TYPES OF ASBESTOS AND THEIR MODE OF OCCURRENCE.

There are three types of asbestos fibre—namely cross fibre, slip fibre, and mass fibre.

Cross fibre asbestos occurs in veins, and, if not disturbed, the fibres run directly across the vein from wall to wall. Asbestos of this type occurs as veins of chrysotile in serpentine, derived from peridotite, a deep seated igneous rock, as found near Lowell, Vermont, Casper, Wyo., and at the Thetford mines in Canada. The cross fibre asbestos also occurs as veins of chrysotile with serpentine in limestone, as in the Grand Canyon of the Colorado in Arizona.

Slip fibre asbestos occurs in slipping planes, and the direction of the fibres is parallel to the direction of the slipping. In many

places it is associated with slickensides and may be widely distributed throughout the rock in the planes of faulting. Where the slipping is extensive the slip-fibre asbestos may form vein deposits of considerable size. This type usually occurs in courtlandite and pyroxenite, which locally may pass into peridotite, as at Bedford and Rocky Mount, Virginia.

Mass fibre asbestos occurs as fibrous bundles of amphibole (anthophyllite), composing stocks and dikes of fibrous amphibolite. The fibres may be parallel or divergent, and in places, radial. This type is different from the cross fibre and slip fibre types in that it never occurs in veins, but always forms the whole mass of the rock in which it is developed. Good illustrations of this type of asbestos are the deposits at Sall Mountain, Ga., and Kamiah, Idaho.

ORES OF ASBESTOS.

The ores of asbestos are the fibrous asbestiform minerals of the serpentine, amphibole, and pyroxene groups. Pyroxene however, very seldom assumes an abestiform character, and is of very little importance as an ore of asbestos.

Chrysotile—Fibrous variety of serpentine.

Composition—$H_4 Mg_3 Si_2O_9$, with replacement by iron.

General Description—A coarse or fine fibrous mineral, green, yellow or black in color, and usually of several tints, dotted, striped and clouded.

Physical characteristics—

Hardness—(2.5 to 4) easily scratched by knife.

Lustre—greasy, waxy or silky.

Streak—white.

Color—green to yellow, brown. red, black or variegated.

Sp. Gr.—(2.5 to 2.65) light.

Translucent to opaque.

Greasy feel.

Qualitative Tests—If heated in blowpipe flame, it fuses on edges. A little of the powdered ore heated in a closed test

tube yields waer, which is seen o collect on the sides of the tube. In cobalt solutions become pink. Soluble in hydrochloric acid, with a residue.

Remarks—Chrysotile is a secondary mineral formed from olivine, amphibole, pyroxene, etc. It is associated with these and with magnetic, ganrierite, chromite, delomite, etc.

Amphibole Group

Composition—The amphiboles are metasilicates of calcium and magnesium, with ferrous iron replacing the magnesium. Sometimes contain molecules of sodium and potassium, aluminum, and ferric iron.

General Description—In long or short srystals with six-sided cross-section. Also columnar, fibrous and granular masses, rarely in imperfectly shaped crystals forming layers or plates (lamellar structure), often radiated.

Colors—white or shades of green, brown and black.

Physical Characteristics—
Hardness (5-6) scratched by knife with difficulty.
Lustre—vitreous to silky.
Streak—white or greenish.
Color—white, gray, green, black, yellow and red.
Cleavage—good prismatic, angle of 124° 11′.

Sp. Gr. (2.4 to 3.4) moderately heavy.
Transparent to opaque.
Tenacity brittle to tough

Qualitative Tests—Usually fuses easily to a colored glass, which may be magnetic. Not affected by acids. Distinguished from similar species by its physical properties, such as cleavage, crystalline form, and tendency to separate into fibres.

Varieties

Anthophyllite—An ortho-rhombic amphibole. An iron-magnesium metasilicate. (Mg, Fe) SiO_3. Rarely in distinct crystals. Commonly of asbestiform character. Color gray to various shades of green and brown.

Tremolite—$CaMg_3 (SiO_3)_4$. Most frequently found in impure, crystalline, dolomitic limestones, where it has been formed during the crystalliation of the rock, while undergoing metamorphism; white to gray in color.

Actinolite—$Ca (Mg\ Fe)_3 (SiO_3)_4$. Commonly occurs in crystalline schists, often being the chief constituent of green hornblendic schists and greenstones. Bright green or grayish in color.

Hornblende—$CaMg_3 (SiO_3)_4$ with $Na_2 Al_2 (SiO_3)_4$ and $Mg_2Al_4(SiO_6)_2$. Found in igneous rocks, such as granites, syenites, diorites, gabbros, and in some peridotites; rarely in dark traps and basalts. Also occurs in the metamorphic rocks, such as gneisses and hornblende chists. Black or green in color, with lustre something like a horn.

Glaucophane—A sodium amphibole, blue in color and occurring in indistinct prisms or in columnar and fibrous masses, especially in metamorphic schists.

Crocidolite—A blue to green fibrous amphibole.

The most important ores of asbestos of amphibolic origin are the minerals actinolite, tremolite and anthophyllite.

ASBESTOS IN ARIZONA.

The asbestos of Arizona is not only excellent in quality, but it is unique in its mode of occurrence. It occurs as chrysotile in cross-fibre veins with serpentine in limestone. The veins are not open fissure veins, but were deposited by the replacement of serpentine in the planes of weakness later than the development of the serpentine itself. This is clearly shown by the absence of rock crushing and the remarkable continuity of the veins approximately in the plane of stratification.

So far as is known, the asbestos in Arizona is all of the same occurrence, and is of excellent quality, so it can be mined for the highest grades alone. The asbestos occurs in the Grand Canyon of the Colorado, and in the vicinity of Globe, on Ash Creek.

ASBESTOS OF THE GRAND CANYON.

The asbestos of the Grand Canyon lies west of the mouth of the Little Colorado. It forms a long, narrow strip lying at a definite geologic horizon among the Algonkian strata in the depths of the Grand Canyon of the Colorado, about 4,000 feet below its rim, and in places over a thousand feet above the river. The strata in which the asbestos occurs, although deep seated and of great age, are not as a body crushed, fractured or metamorphosed, but slope generally to the north or northwest at angles of 10 to 20 degrees, and are locally cut by normal faults of small displacement.

GEOLOGICAL SECTION OF THE ASBESTOS-BEARING ROCKS IN ASBESTOS CREEK CANYON, AS MEASURED BY L. F. NOBLE.

Diabase—		
Layer of green serpentine	2	feet
Pure white crystalline limestone	1½	feet
White crystalline limestone with banks and nodules of serpentine	2	feet
Serpentinous layer carrying veins of asbestos	1	foot
Banded crystalline limestone carrying bands of serpentine	10	feet
Nodular cherty limestone	4	feet
Soft blue slate	5	feet

The serpentine and asbestos occur in the limestones only where these strata are invaded by diabase sills; where the diabase lies between shales there is no development of these minerals in the invaded strata, and in no place in the area are they developed within the diabase itself. The deposits are a product of contact metamorphism due to the invasion of the limestone by the diabase. The serpentinous layer that carries the asbestos is usually from 12 to 14 inches in thickness, and the general trend of the asbestos veins within it is parallel to the bedding of the limestone. Locally the asbestos fibre is four inches long, extending from one side of the vein to the other, but generally the veins do not exceed 2½ inches and in many places they appear as a series of small parallel veins. The larger

veins are of remarkable continuity and are known to extend for 150 feet. These veins have few parting of chalcedonic quartz with rough borders. The asbestos in the massive specimens assumes a beautiful golden yellow color, shading in places to pale green; the individual fibres are pure white and very silky.

Although these deposits are located at the bottom of the Grand Canyon, thus making the cost of transportation of the asbestos to the railroads very high, still there are no mechanical problems in connection with the mining and transportation of this asbestos that cannot be overcome, provided that it is of sufficient quantity and of such quality as to warrant the outlay.

ASBESTOS IN GLOBE DISTRICT.

The first discovery of asbestos in the Globe district was made by T. D. West in 1913, on Ash Creek. Fourteen claims were taken up by T. D. West and F. Patee on Ash Creek, about 25 miles in a direct N. 25° E. line from Globe. Ash Creek is a short stream, heading against Sycamore Creek and flowing north through a rugged canyon into Salt River. The asbestos occurs at a depth of 600 feet in the canyon, the eastern slope of which has the following geological section:

	Thickness
Diabase	175 feet
Layers of gray-white limestone, carrying 3 belts of asbestos 12 to 24 inches in thickness	30 feet
Gray limestone, partly cherty, locally banded and containing sheets and nodules of serpentine and some asbestos	150 feet
Quartzite and some conglomerate	300 feet

Nodules of serpentine occur here and there in the locally banded limestone near the asbestos belts. The asbestos belts, especially the one near the contact with the diabase, are more or less continuous for a mile, but vary from place to place.

The principal belt is the one nearest the diabase and is usually separated from the diabase by a few feet of limestone. Other belts occur higher up in the limestone to a distance of about 30 feet. The limestone is cut by a dike of diabase rising from the

main body; the highest grades of asbestos are found in the limestone where it is cut by the diabase dike.

Since the first discovery of asbestos in the Globe district by West, a number of other claims have been located, all in the vicinity of Globe, and very active development work is carried on throughout the district. A notable event in the asbestos industry of the state has been the recent installation of a milling plant at the Fisk and Snell property on Ash Creek, 40 miles from Globe. The mill was constructed by E. Torrey, who was brought here from the Canadian asbestos field for the purpose and embodies many new principles that are the outgrowth of the inventor's many years of experience in asbestos mining and milling.

In occurrence, origin, quality and quantity, the asbestos deposits of the Globe district are the same as those of Grand Canyon district, but the former are much more accessible, being at a depth in the canyon of not more than 800 feet and within 30 to 40 miles by trail and wagon road from the railway.

ASBESTOS IN THE UNITED STATES.

Other states that have been producers of asbestos are Georgia, Vermont and Wyoming. Vermont has long been the chief producing state, having furnished more than three-fourths of the total production in the country in 1912. But in 1913 all of the asbestos produced in this country came from two deposits in Georgia and one in the Grand Canyon district of Arizona. Wyoming asbestos comes from two localities—Caspar Mountain and Smith Creek. The development of these localities is limited on account of lack of transportation facilities. Numerous asbestos prospects have been reported from California, but they have not as yet resulted in definite production.

The United States has been the greatest producer and user of manufactured asbestos, drawing most of the raw material from Canada. In 1913 Canada exported 103,812 short tons, and of these 86,564 short tons, or more than 80 per cent of all that was exported from Canada, were shipped to the United States. The imports from other countries in the same year

amounted to 173 short tons, or about 0.2 per cent of the import from Canada.

USES AND PRICES.

The properties of asbestos, such as its combustibility, non-conductance of heat and electricity, and its fibrous structure make it one of the most useful minerals for many and various structural purposes. Indeed, now that a fairly abundant supply of the raw material has been assured at a more or less reasonable cost, there would seem to be no limit to the growing demand, especially as new uses are being daily found.

It is used in making lumber, roofing, plaster, and stucco. Fire-proof theater curtains are also made from asbestos. It has also a wide application to military purposes, such as closing the breeches of big guns, in connection with torpedoes, in the manufacture of time-fuses and dynamite shells, etc. In fact, its uses are so many and various that to merely enumerate them would take more space than permissible on these pages, and I will therefore limit myself to saying that its principal applications are for fire preventive purposes, and for electrical and heat insulating purposes.

The prices of asbestos in the United States are controlled by the Canadian market, unmanufactured asbestos being admitted free. The New York prices per short ton for Canadian chrysolite fibre during 1913 were as follows:

No. 1 Crude (high grade asbestos, not requiring milling)	$320 to $350
No. 2 Crude	200 to 225
No. 1 Fibre	100 to 125
No. 2 Fibre	75 to 100
Shorter Fibres	10 to 30

The prices offered for the Arizona chrysotile fibre were the same as for the Canadian, while that of the amphibole variety of asbestos fibre averaged $10 a ton.