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A STUDY OF WORKERS EXPOSED TO TALC AND OTHER DUSTING COMPOUNDS IN THE RUBBER INDUSTRY*

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TALC and similar minerals are widely used in industry. In the Mineral Yearbook Johnston and Barsigian (1) report that in 1946 over 450,000 short tons of domestically produced talc, pyrophyllite, and ground soapstone were consumed, of which 77 per cent was utilized in five industries—paint, rubber, roofing, ceramics, and insecticides. The paint industry alone used 23 per cent of the total.

CHEMICAL COMPOSITION

One should note that the above-mentioned report groups talc with materials of like commercial applications rather than with those of mineralogical or chemical similarity. Actually talc is a hydrous magnesium silicate with the formula $Mg_3Si_4O_{10}(OH)_2$. Other minerals which have similar uses are: pyrophyllite, a hydrous calcium magnesium silicate, $Ca_2Mg_5Si_8(OH)_2$; serpentine, a hydrous magnesium silicate, $Mg_3Si_2O_7(OH)_2$; and dolomite, a calcium magnesium carbonate, $CaMg(CO_3)_2$. Tremolite, frequently found in nature with talc, has a fibrous variety which is used to some extent as asbestos (2). Soapstone is the granular to cryptocrystalline form of talc.

Apparently the physical characteristics of all these materials are so much alike that they may be used in almost identical applications and therefore are designated commercially as *talc*. Schulz and Williams (3) pointed out that "talc as used industrially generally refers to a substance which meets certain physical requirements rather than one which has a definite chemical composition." In an examination of 71 analyzed samples they found extreme variation in composition.

PHYSIOLOGICAL EFFECTS

In general, most silicates of this kind were considered harmless until 1933 when Dreesen (4) studied conditions in tremolite mines and mills. He found dust exposures averaging as high as 1,440 million particles per cubic foot in pneumatic drilling operations and as low as 4 million outside the mill proper. He reported that "in only three cases (5%) were the X-ray findings within the limits of normal; 38 (67%) showed evidence of an early or first-stage pneumoconiosis." Only one case—that of an individual who had been in the tremolite mills for over 40 years—had fibrosis advanced beyond the first stage. Dreesen concluded that the resulting pneumoconiosis was not disabling.

In 1935 Dreesen and Dalla Valle (5) reported dust concentrations varying from 32 to 1,672 million particles per cubic foot in two Georgia mills. Among 66 workers examined, they found 8 having advanced pneumoconiosis with disability and 14 having roentgenographically demonstrated slight pneumoconiosis without disability. The dust was found, by analysis, to consist chiefly of soapstone, but it also contained 10 per cent tremolite. The authors stated that the dust of the Georgia mills appeared to be more injurious than that reported by Dreesen (4). However, the study made in Georgia showed much higher concentrations of the dust. Furthermore, quite a few of the miners had worked in hard rock, although only 6 out of 13 showed pneumoconiosis stage I.

Eason, Trice, and Carpenter (6) reported pulmonary fibrosis among miners and millers of pyrophyllite, characterized roentgenographically by massive tumor-like shadows bilaterally situated in the subapical region or by granular densities distributed throughout the lungs. Of 101 workers, 35 per cent of those with two or more years of exposure showed evidence of pathologic changes in the lungs. The pyrophyllite dust contained from 25 to 35 per cent quartz.

Porro, Patton, and Hobbs (7) found 15 cases of pneumoconiosis in two tremolite mines and mills in New York State. According to them, the composition and concentrations of the dust were the same as those reported by Dreesen (4), who had previously surveyed one of the plants. Nondisabling pulmonary fibrosis was found in almost

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all of the workers examined. Of the 15 patients, 7 were known to have worked in other types of mining operations. Dyspnea was an almost universal complaint, and several patients had cyanosis and club fingers. In all of those tested with a spirometer, vital capacity was very low (35–52 per cent). In the 5 postmortem examinations asbestosis bodies were a fairly frequent finding in lesions of the lungs. This may not be puzzling when it is recalled that tremolite is characteristically fibrous.

Further studies in tremolite mines and mills of northern New York by Siegal, Smith, and Greenburg (8) disclosed 32 cases of advanced fibrosis in a group of 221. Dust counts in the mines varied from 6 to 5,000 million particles per cubic foot in milling. The talc was of the asbestine variety and was mingled with tremolite and anthophyllite. The fibrosis tended to be disabling and was frequently accompanied by dyspnea, cough, and fatigue.

Prompted by these reports and by proposals for the inclusion of a limit for talc among dust hazards in certain state codes (9, 10, 11) we made a study in two rubber plants where workers had been exposed to talc and other dusting compounds for periods as long as 36 years. Talc dusting experiments were made on laboratory animals, the results of which will be reported in a separate communication.

Dusting Rubber

As rubber is naturally tacky, it must be coated with a lubricant to keep it from sticking together. Many materials are used, both in the wet and the dry state, for this purpose. Among them are talc, pyrophyllite, mica, clay, walnut shell dust, corn starch, whiting, et cetera. Operations employing these materials in the dry state tend to be very dusty. In recent years control ventilation has reduced the concentrations of the dusts, but there are still operations, especially of an intermittent or temporary nature, which it is difficult or impractical to control. In these operations dust respirators must be relied upon for protection.

For the past six years periodic dust surveys have been made of several processes in the manufacture of inner tubes and in the reclaiming of rubber. The occupations in which talc was the only dust to which workers were exposed were those of tuber operators, tube bookers, tube cure men, and liner rerolling. Those jobs in which the major exposure was to whiting and the minor to talc (in the past, to pyrophyllite) were those of refiner operators, strainer operators, mill men, truckers, slab checkers, and shipping laborers. The results of the surveys have been averaged for the period 1943 to 1948 and are presented, together with the number of years of total exposure of the various occupations, in tables 1 and 2. It must be emphasized that before the installation of control ventilation the dust concentrations were probably much higher.

TABLE 1

Average Dust Concentration and Period of Exposure for Workers in Talc

Workers exposed	Years of exposure	Millions of particles/cu. ft.
6 tube machine operators	20–34	20
3 tube bookers	32–36	35
10 tube cure men	10–34	15
1 liner reroller	14	50

TABLE 2

Average Dust Concentration and Period of Exposure for Workers in Whiting, Pyrophyllite, and Talc

Workers exposed	Years of exposure	Millions of particles/cu. ft.
13 refiner operators	13–25	50
3 strainer operators	15–25	75
1 mill man	24	50
1 trucker	20	30
1 slab checker	23	50
1 shipping laborer	24	150

Dust Composition

The dusting compound used in the tube operations and in rerolling liners is a pure talc from a deposit near Johnson, Vermont, and contains no free silica, tremolite, chrysolite, chrysotile, or actinolite. It has the following composition:

Talc Analysis

Silicon dioxide	34.86%
Ferrous oxide	6.30
Aluminum oxide	1.22
Manganese oxide	0.09
Sodium oxide	0.53
Potassium oxide	Trace
Combined water	6.17
Carbon dioxide	15.10

Whiting (calcium carbonate) is the principal compound for dusting reclaimed rubber. Until about six years ago pyrophyllite containing 65 per cent free silica was used for certain stocks, but since that time talc has been used for these special applications, but the use of both compounds amounted to only about 10 per cent of production.

Clinical Investigation

The two groups of workers included in this study were specially selected for type and length of exposure. Only those with the longest and heaviest exposures were included. Complete physical examinations, including blood counts, urinalysis, blood pressure readings, and vital capacity determinations, were made. For the latter tests the Scott-McKesson apparatus was employed, and readings below 85 per cent were considered indicative of disease of the heart or the lungs. Roentgenograms of the lungs were made on 14″ × 17″ films and interpreted by a qualified radiologist with considerable experience in the diagnosis of pneumoconiosis.

Tube Workers

Physical and Roentgenographic Examinations

The first group, presented in table 3, was composed of 20 men who had been exposed to talc alone for periods ranging from 10 to 36 years. All of the men were working at the time of the study and were in apparent good health. None of them presented any symptoms referable to the lungs, such as dyspnea, cough, or shortness of breath. None had clubbing of the fingers or cyanosis. Only one member of this group had subnormal (71 per cent) vital capacity. This finding can perhaps be explained by the presence of an enlarged heart, as determined by the Hodges-Eyster formula.

In this group the roentgenographic findings were either completely normal or showed only the chronic changes found in industrial urban dwellers. (See figure 1.)

TABLE 3

Physical Examination, Vital Capacity Determinations and Chest Roentgenograms on Workers Exposed to Talc

Worker	Age	Years of Exposure	Millions of Particles/Cu. Ft.	Blood Pressure	Vital Capacity	Heart	Chest Roentgenograms	Remarks
117R	62	25	20	144/92	86%	—	Negative	
118R	62	30	35	152/80	105%	—	"	
119R	53	24	20	112/68	119%	+10	"	Coal miner—10 years
126R	49	31	35	132/78	122%	—	"	
908R	53	25	20	142/82	71%	+17	"	
251R	50	30	15	142/80	112%	—	"	
196R	53	20	20	160/90	94%	Normal	"	
167R	62	36	35	120/80	95%	"	"	Coal miner—11 years
187R	49	30	15	140/70	94%	—	"	
205R	49	32	15	130/80	118%	—	"	
186R	49	25	15	124/90	107%	—	"	
246R	51	10	15	110/70	121%	—	"	
209R	47	32	15	95/65	86%	—	"	
207R	52	31	15	112/80	102%	Normal	"	
17R	58	27	15	140/95	118%	—	"	
287R	50	24	20	138/78	116%	Normal	"	Coal miner—15 years
206R	57	34	20	194/94	85%	—	"	
290R	43	14	50	104/71	105%	—	"	
292R	51	19	15	110/65	93%	—	"	
286R	39	18	15	120/55	114%	—	"	

Reclaiming Rubber Workers

Physical and Roentgenographic Examinations

The second group, presented in table 4, was composed of 20 men with a major exposure to whiting and minor exposures to pyrophyllite and talc. The exposure periods of this group ranged from 10 to 25 years. All of these men were also working at the time of the study, and none complained of or presented symptoms referable to the lungs, such as dyspnea, cough, or shortness of breath. No clubbing of the fingers nor cyanosis was noted.

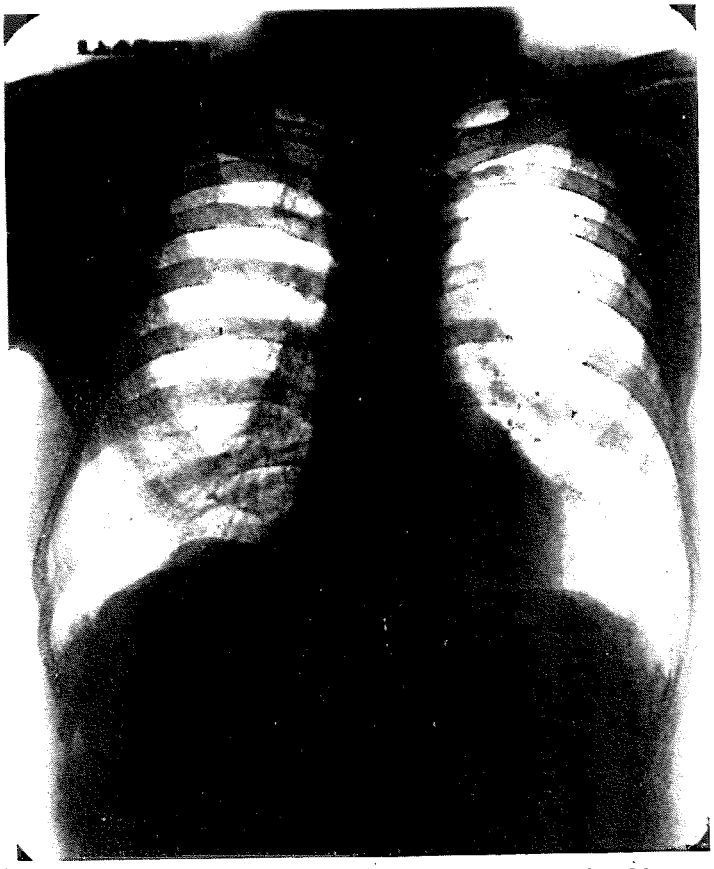

FIG. 1. This man is 62 years old and has worked in the rubber industry for 36 years with an average talc exposure of 35 million particles per cubic foot. His vital capacity was 95 per cent. These lungs show only truncal accentuation of the lower lobes.

TABLE 4

PHYSICAL EXAMINATION, VITAL CAPACITY DETERMINATIONS AND CHEST ROENTGENOGRAMS ON WORKERS EXPOSED TO WHITING, PYROPHYLLITE, AND TALC

WORKER	AGE	YEARS OF EXPOSURE	MILLIONS OF PARTICLES/CU. FT.	BLOOD PRESSURE	VITAL CAPACITY	HEART	CHEST ROENTGENOGRAMS	REMARKS
229R	55	23	50	160/100	71%	+17	Negative	Previously coal miner
244R	62	15	0	158/86	60%*	+25	"	
228R	47	24	50	104/56	85%	Normal	"	
953R	49	24	150	132/90	68%	"	Pneumonoconiosis III	Coal miner—5 years
195R	51	23	50	124/90	116%	—	Negative	
226R	59	24	50	140/70	99%	—	"	Coal miner—13 years
248R	54	10	75	130/90	90%	Normal	"	
170R	42	13	50	120/70	123%	"	"	
165R	49	20	50	130/80	73%	"	"	
18L	48	20	50	112/62	110%	—	"	
185R	64	18	50	180/98	101%	+10	"	Foundry—7 years
247R	54	20	50	160/85	119%	Normal	"	Coal miner—4½ years
234R	54	23	75	120/70	110%	—	"	
231R	53	23	50	132/80	97%	—	"	
232R	55	25	50	130/70	74%	+21	"	
164R	61	14	50	142/95	97%	Normal	"	
184R	55	25	75	110/65	106%	—	"	
235R	55	24	50	175/100	94%	—	"	
217R	57	20	30	165/95	94%	Normal	"	Coal miner—19 years
972R	55	23	50	182/120	56%†	"	"	

* The subject was unsatisfactory—uncooperative.

† The subject was 5 feet 2½ inches in height and weighed 203 pounds.

Six had vital capacities considered subnormal; of these, 3 had enlarged hearts, as determined by the formula mentioned above.

In this second group only one chest roentgenogram showed abnormality, which was considered third-stage pneumoconiosis. The man also had lowered vital capacity, but he appeared to be suffering no disability. He had previously worked in the mining industry for five years. (See figure 2.)

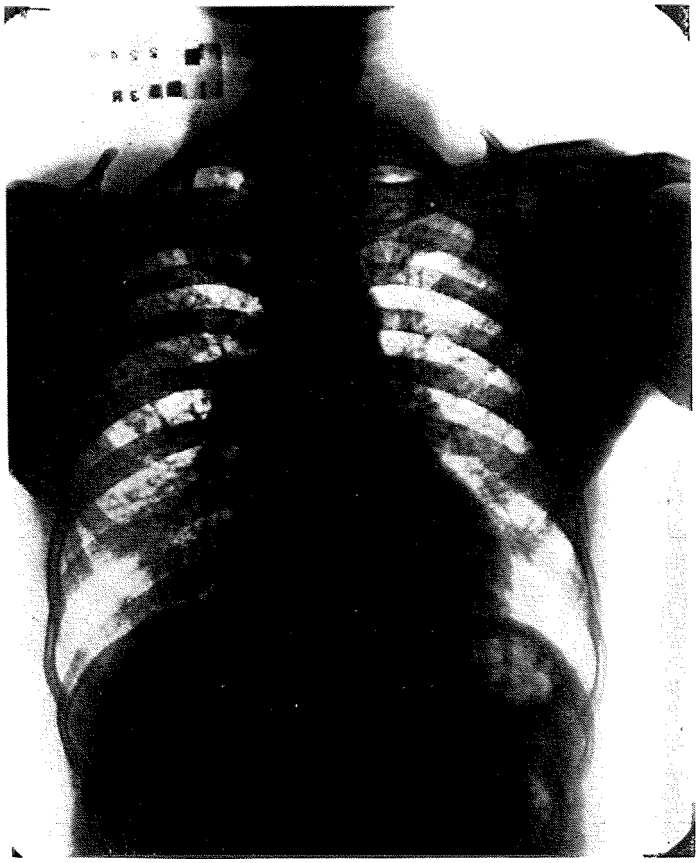

FIG. 2. This man is 49 years old and has been employed in the rubber industry for 24 years with an average exposure to pyrophyllite and whiting of 150 million particles per cubic foot. He worked in coal mines for a period of five years. His lungs show well-advanced pneumoconiosis diagnosed as grade III. His vital capacity was 68 per cent. In spite of the well-advanced pneumoconiosis and lowered vital capacity, he showed no disability. His work record shows that he has lost only three weeks from illness over the past 24 years.

Another group of 16 men engaged in the same rubber processes but with shorter exposure periods were examined in the same manner. All chest roentgenograms were normal.

The producer of the talc discussed in this study stated that periodic roentgenographic examinations among his employees have failed to reveal any changes due to talc (12).

DISCUSSION

Previous publications reporting *talc* as a cause of disabling pneumoconiosis do not present exposures restricted to that mineral. In the New York mines and mills the dust was composed of equal proportions of tremolite and talc. Porro *et al* (7) published illustrations contrasting the fibrous structure of tremolite with the granular nature of talc. In the Georgia studies the dust was principally soapstone, a form of talc, but also contained 10 per cent tremolite. The dust in the North Carolina studies was *not* talc but pyrophyllite and, furthermore, contained from 25 to 35 per cent quartz!

In an excellent discussion of the entire matter Pendergrass and Robert (13) stated "... the occurrence of an asbestosis-like reaction following prolonged exposure to talc would seem unlikely. Further controlled investigation, designed to eliminate the possible complicating factors of quartz-contaminated dust and infection, is, however, imperative before concluding with finality that the roentgen changes are the reflection of a specific and progressive fibrosis, and that talc is the sole

etiologic agent in their production. In this regard, it seems quite probable that the described coexistent nodulation may be silicotic in origin. In the reported autopsy cases there had been other opportunities for the inhalation of dusts presumably contaminated with silica, and in the mining of talc itself similar exposures have not been excluded."

Summary and Conclusions

1. A review of the literature indicates that dust exposures producing pneumoconiosis allegedly due to talc were not restricted to that mineral alone, as tremolite, pyrophyllite, and even quartz were also involved.

2. Physical examinations and chest roentgenograms of a group of 20 men exposed to talc dust (hydrous magnesium silicate) for periods ranging from 10 to 36 years in rubber inner tube production were normal for men of their age group and urban industrial environment.

3. Similar examinations of another group of 20 men exposed for periods ranging from 10 to 25 years to whiting (calcium carbonate), with minor exposures to pyrophyllite (65 per cent quartz) and to talc, in rubber-reclaiming operations disclosed all to be normal except one whose condition was diagnosed as pneumoconiosis stage III. This man had the highest dust exposure in the two groups (150 million particles per cubic foot) and had a previous occupational history of five years in mining.

4. The findings of the present study indicate that long exposure to talc does not appear to produce pathologic changes in the lungs.

5. Proposals that limits for silicate minerals be added to lists of maximum allowable concentrations should include careful definition of chemical and mineralogical composition.

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