GRAPHITE PNEUMOCONIOSIS

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Few authors have dealt with graphite pneumoconiosis. Material on forty-one cases, including early ones, has been collected by Koopman (1924), Hollmann (1928), Lochtkemper and Teleky (1932), Kaestle (1932), Koelsch (1933), Bruusgaard (1938), Dunner and Bagnall (1946), Dassanayake (1948), Gloyne, Marshall, and Hoyle (1949), and Harding and Oliver (1949). Little attention appears to have been paid by medical observers to the chemical nature of the inhaled graphite, the pathological action on experimental animals, and the relative dangers of the various stages in the working process.

Conditions in the Chisone Valley

The observations presented in the present communication were made in the Chisone Valley of Piedmont, where over three hundred tons of graphite are produced annually, that is about 60 per cent. of the whole production in Italy. The mineral is found in seams in this valley in the Cottian Alps, in the mining region in the vicinity of Turin. The seams are located in the central gneiss zone at the base of a series of crystalline schists. It is a crypto-crystalline graphite (so-called amorphous graphite) similar to the Styrian graphite of Austria. It is enclosed in setting-in rocks of varying composition, the average content of free silica being 15 to 35 per cent. The following approximate values are given for the commercial product:

		%	
C...	..	56.20	
Si O ₂	..	24.86	(free Si O ₂
Al ₂ O ₃	..	8.56	approx. 11%)
Fe ₂ O ₃	..	2.97	
Ca O	..	0.55	
Mg O	..	1.48	
Calcination losses	..	3.73	
Alkali (by differences)	..	1.65	
		100.00	

The content of free SiO₂ was checked by x-ray diffraction analysis. The mines are located at various levels from 1,700 to 2,800 feet above sea level. Drilling, when heading, is generally dry, by pneumatic drill, and face work is mainly done by hand pick.

The grinding plant and the processing plant for electrode production are situated at the bottom of the valley. The grinding mills are of two kinds: (1) Raymond Bros rollers, and (2) ball mills.

Electrode processing is a complicated operation with many stages, two of which are dusty: (1) baking of the meal, and (2) machining the electrodes on lathes and grinders.

TABLE 1
MILLIONS OF PARTICLES OF DUST PER CUBIC FOOT DURING WORKING CONDITIONS

Mines ..	Heading work	527.810
	Face work	365.840
Mills ..	At mouth of bag-filler ..	11.890
	Rare material shop ..	4.410
Electrode plant	Lathes	6.280
	In front of oven section ..	12.510

Average Dust Values during Working Conditions

Dust determinations with the thermal precipitator at various points gave averages in working conditions as shown in Table 1. Between 91 and 99 per cent. of the dust particles suspended in the working places were between 0.2 and 5 μ in size.

Radiographic Investigations

Clinical and dust-counting investigations were carried out in 1946, 1947, and 1948, and included mass miniature radiography of all workers exposed to graphite dust, underground or on the surface, in

five collieries. Also in one plant all workers engaged in processing electrodes of natural graphite, and in one plant those engaged in milling and refining graphite, were radiographed. Radioscopy and normal-sized radiography were carried out when necessary. As a result some patients were admitted to hospital for more detailed examination. Table 2 gives the gross findings, and Table 3 the frequency of pneumoconiosis, in different classes of workers.

Clinically, graphite pneumoconiosis produces no disturbance except some dyspnoea of effort, which is perhaps more apparent in more advanced cases. Harsh breathing without adventitious sounds is often noticed. The condition is rarely associated with pulmonary tuberculosis, which is not usually present except in healed or inactive forms. Emphysema is also rare.

From the radiological point of view, no important differences were noticed between pneumoconiosis of miners, who, besides graphite, inhale dust caused

FIG. 1.—The calibration of electrodes.

by drilling setting-in rocks, and pneumoconiosis of millers and workers in the electrode plant. It is true that among millers, radiological features of reticulation alone were observed; but three cases are too few to yield a typical, or at least, characteristic picture of this particular form. Reticulations in miners and electrode workers show some poly-

TABLE 2
FINDINGS OF INVESTIGATION AMONG WORKERS EXPOSED TO GRAPHITE DUST

No. of workers examined	Reticulation		Pneumoconiosis		Total pneumoconiosis	Pulmonary tuberculosis			Total pulmonary tuberculosis
	Slight	Advanced	Nodular	Massive		Healed	Inactive	Active	
415	10	6	7	1	24	8	8	2	12
%	2.4	1.4	1.7	0.2	5.8	1.9	1.9	0.5	3.2

TABLE 3
FREQUENCY OF PNEUMOCONIOSIS IN DIFFERENT CLASSES OF WORKERS

Class of Worker	No. of workers	Slight reticulation	Advanced reticulation	Nodulation	Massive reticulation	Percentage of pneumoconiosis
Miners	66	5	3	4	1	19.5
Millers	13	1	2	—	—	23
Electrode workers ..	336	4	1	3	—	2.4

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FIG. 2.—A man aged 73 years, a graphite sacks polisher for twenty years ; reticulation.

FIG. 3.—A man aged 40 years, a graphite miller for eleven years : advanced reticulation.

morphism, with a fine mesh network tending to become generalized ; the hila are usually enlarged but of normal density. Nodulation generally appears with rather large and not very numerous nodules, showing little tendency to coalesce. Emphysema is rare ; the hila are moderately

FIG. 4.—A man aged 61 years, a graphite miner for forty years ; nodulation.

FIG. 5.—A man aged 68 years, a graphite electrode turner for twenty-five years ; advanced nodulation.

enlarged but are rarely of heightened density. Tuberculous lesions usually show the radiological features of quiescence.

Among miners, reticulation appears after fourteen or fifteen years' work ; it becomes more frequent after twenty to twenty-five years. Sparse nodulation appears after twenty-two to twenty-four years, increasing in frequency after twenty-six to thirty

FIG. 6.—A man aged 51 years, a graphite miner for twenty years; massive pneumoconiosis.

FIG. 7.—A man aged 55 years, a graphite miner for thirty-three years; massive pneumoconiosis.

years; the only case of massive pneumoconiosis was in a miner who had had thirty-three years' service. Among millers too, reticulation appears after fourteen or fifteen years' work. Among workers employed in processing electrodes, reticulation appears within ten years of entering employment and increases in frequency after fourteen or fifteen years; nodulation, too, is comparatively early, beginning after fourteen or fifteen years' exposure to dust and reaching a maximum frequency after twenty-two to twenty-four years.

Prognosis

Prognosis is generally favourable; tuberculosis is less frequent than in typical silicosis. Since specific lesions are more frequent among the young workers and do not increase among the older ones, it is possible that inhaling graphite dust does not aggravate the progress of tuberculous lesions but facilitates fibrosclerotic development.

Conclusion

The cases of pneumoconiosis examined are, since Chisone Valley graphite contains about 10 per cent. free silica, an example of benign mixed pneumoconiosis, in which graphite tends to alleviate the sclerosing action of silica, even though it does not suppress it altogether. Allowable dust concentrations in graphite working as found by me are lower than twelve million particles per cubic foot.

It is to be hoped that this condition will at an early date be admitted as an occupational disease and that adequate medical and financial provisions will be made for workers who, as a consequence of this pneumoconiosis, suffer disability.

Summary

A clinical and radiological investigation has been carried out among graphite workers of the Chisone Valley, Italy, by means of periodic checks lasting three years. Twenty-four cases of pneumoconiosis have been examined; these have made possible a sketch of the clinical-radiological picture, evolution, and prognosis. Conditions of dust exposure have also been investigated.

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