Hiroshima Journal of Medical Sciences
Vol. 30, No. 3, September, 1981
HIJM 30-27



# CHEST X-RAY FINDINGS ON PYROPHYLLITOSIS*)

By

Ken-ichi ARITA, M. D., Osami NISHIDA, M. D.,
Takashi KOBAYAKAWA, M. D., Mitsuhide HIRAMOTO, M. D.,
Hiroyuki ARITA, M. D., Kenta FUJIWARA, M. D.,
Shigekiyo NAKANISHI, M. D., Hirofumi FUKUHARA, M. D.,
Masato OBI, M. D., Noriko MITAO, M. D.,
Faisal YUNUS, M. D. and Yukio NISHIMOTO, M. D.

*Department of Internal Medicine, Hiroshima University School of Medicine, Hiroshima 734, Japan*
(Received May 26, 1981)

## ABSTRACT

An outline of the chest X-ray findings on pyrophyllitosis was described in terms of working environments and its length of term in the dust. It was clarified that in pyrophyllitosis granular shadows were distributed in the upper and middle lung fields, which used to indicate an accretion trend at an early stage. A fast development of fibrosis in the lung was also assumed, from which standpoint, too, the malignancy of pyrophyllitosis is considered to be very serious. It requires careful and sufficient course-observations, while on the other hand an earlier isolation from such work in the dust must be taken into consideration.

## INTRODUCTION

A number of studies have so far been made on silicosis caused by inhalation of free silica dust, which have provided us with much knowledge of such clinical features[1]. However, as to pyrophyllitosis caused by inhalation of the dust containing aluminium silicate, the details of clinical features have not been clarified so much yet because ores are yielded in the limited area and pyrophyllitosis is complicated with silicosis in certain occupations. In Japan, Yoshimi[2] has reported on this subject followed by Sera et al.[3] and the authors[4], but no other practical studies based on the results of chest X-ray examinations are available except for those of the authors[5] and Sakurai et al.[6] Accordingly, we will show the results of chest X-ray examinations of pyrophyllitosis.

## SUBJECTS

In Shobara, Hiroshima Prefecture, there are several pyrophyllite mines and processing workshops. The "crushed pyrophyllite ores" is called the "pyrophyllite clay", mainly consisting of Pyrophyllite ($Al_2O_3 \cdot 4SiO_2 \cdot H_2O$), Kaolinite ($Al_2O_3 \cdot 2Si_{O_2} \cdot 2H_2O$) and Diaspore ($Al_2O_3 \cdot H_2O$), being widely used for production of glass fiber, fillers for paper manufacturing, tile and agricultural chemicals. Some years ago, pyrophyllite ores were obtained out of the drift, but

*) 有田健一，西田修実，小早川隆，平本光英，有田浩之，藤原謙太，中西重詩，福原弘文，小尾正人，三田尾典子，ファイサル・ユーヌス，西本幸男：蠟石肺の胸部X線所見

nowadays they are available by the open-air mining, being carried to the processing workshops after being crushed into small pieces a few centimeters round (Group 1). At the time of ore crushing a fair amount of dust comprising not only pyrophyllite but free silica comes out and is inhaled by the laborers, which fact draws our attention. The amount of dust, in 1981, was 0.3–0.7 mg/m³ in this process and 20 cases of pyrophyllitosis were those working in it.

The crushed stones carried to the workshops are smashed into fine particles in the water tank to about 2–3 $\mu$, and after being bleached with drug taken out from the water tank (Group 2). 5 cases of patients used to work in this process, which had comparatively less occasion of inhaling the dust.

The pyrophyllite clay brought out of the water tank is dried and packed into bags as the final product (Group 3). The dried pyrophyllite clay is of such fine particles as to float in the air by a touch with fingers, thus while being packed into bags a great deal of the dust is observed floating in the air. The amount of dust, in 1981, was 0.48–1.5 mg/m³ in this process. This is to be noted as the process with the highest opportunity of inhaling the pyrophyllite dust. 34 cases of pyrophyllitosis were observed in this process. 8 cases belonging to both Group 1 and Group 3 were named as Group 4.

Table 1 indicates all 67 cases according to their age, sex and working process. Those in their forties and fifties were counted to be more than a half, and male exceeded in Group 1 and 2 while female exceeded in Group 3.

**Table 1.** Distribution of Pyrophyllitosis by Age, Sex and Working Process

| | Age(y.) | —39 | 40—49 | 50—59 | 60— | Total |
|---|---|---|---|---|---|---|
| Group 1 | male | 0 | 5 | 11 | 1 | 17 |
| | female | 0 | 1 | 2 | 0 | 3 |
| Group 2 | male | 0 | 3 | 2 | 0 | 5 |
| | famale | 0 | 0 | 0 | 0 | 0 |
| Group 3 | male | 1 | 5 | 4 | 1 | 11 |
| | female | 0 | 13 | 9 | 1 | 23 |
| Group 4 | male | 0 | 2 | 3 | 0 | 5 |
| | female | 0 | 2 | 1 | 0 | 3 |
| Total | | 1 | 31 | 32 | 3 | 67 |

Note: Group 1—workers in power crushing, Group 2—workers in machinery repair and loading/unloading of the bags, Group 3—workers in drying or packing, and Group 4—workers belonging to both Group 1 and Group 3 (See the text).

## METHODS AND RESULTS

Variations in the passage of time were studied by observing the chest X-ray films of those 67 cases according to the revised law on pneumoconiosis[7] and by accumulating their films in the past as far as possible.

**Table 2.** Classification of Chest X-ray Films

| Chest X-ray findings \ Age(y.) | | —39 | 40—49 | 50—59 | 60— | Total |
|---|---|---|---|---|---|---|
| Group 1 | $PR_1$ | 0 | 0 | 0 | 0 | 0( 0) |
| | $PR_2$ | 0 | 2 | 4 | 1 | 7(35) |
| | $PR_3$ | 0 | 0 | 4 | 0 | 4(20) |
| | $PR_4$ | 0 | 4 | 5 | 0 | 9(45) |
| Group 2 | $PR_1$ | 0 | 0 | 1 | 0 | 1(20) |
| | $PR_2$ | 0 | 2 | 1 | 0 | 3(60) |
| | $PR_3$ | 0 | 1 | 0 | 0 | 1(20) |
| | $PR_4$ | 0 | 0 | 0 | 0 | 0( 0) |
| Group 3 | $PR_1$ | 0 | 1 | 1 | 0 | 2( 6) |
| | $PR_2$ | 0 | 9 | 3 | 0 | 12(35) |
| | $PR_3$ | 1 | 3 | 1 | 0 | 5(15) |
| | $PR_4$ | 0 | 5 | 8 | 2 | 15(44) |
| Group 4 | $PR_1$ | 0 | 0 | 0 | 0 | 0( 0) |
| | $PR_2$ | 0 | 1 | 1 | 0 | 2(25) |
| | $PR_3$ | 0 | 1 | 3 | 0 | 4(50) |
| | $PR_4$ | 0 | 2 | 0 | 0 | 2(25) |
| Total | $PR_1$ | 0 | 1 | 2 | 0 | 3( 4) |
| | $PR_2$ | 0 | 14 | 9 | 1 | 24(36) |
| | $PR_3$ | 1 | 5 | 8 | 0 | 14(21) |
| | $PR_4$ | 0 | 11 | 13 | 2 | 26(39) |

Note: 1. Figures in parentheses indicate a percentage to each Group.
2. Group 1—workers in power crushing, Group 2—workers in machinery repair and loading /unloading of the bags, Group 3—workers in drying or packing, Group 4—workers belonging to both Group 1 and Group 3 (See the text).

**Table 3.** Distribution of Granular Shadows by Group and Lung Field

| | Granular shadow | | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|---|---|
| Right lung field | Upper lung field | (−) | 0( 0) | 0( 0) | 2( 6) | 0( 0) |
| | | $PR_1$ | 7(35) | 3(60) | 8(24) | 1(12) |
| | | $PR_2$ | 2(10) | 1(20) | 8(24) | 2(25) |
| | | $PR_3$ | 2(10) | 1(20) | 8(24) | 3(38) |
| | | $PR_4$ | 9(45) | 0( 0) | 8(24) | 2(25) |
| | Middle lung field | (−) | 0( 0) | 0( 0) | 0( 0) | 0( 0) |
| | | $PR_1$ | 2(10) | 2(40) | 10(29) | 1(12) |
| | | $PR_2$ | 10(50) | 3(60) | 12(35) | 3(38) |
| | | $PR_3$ | 5(25) | 0( 0) | 7(21) | 4(50) |
| | | $PR_4$ | 3(15) | 0( 0) | 5(15) | 0( 0) |
| | Lower lung field | (−) | 0( 0) | 1(20) | 0( 0) | 0( 0) |
| | | $PR_1$ | 11(55) | 3(60) | 22(65) | 3(38) |
| | | $PR_2$ | 7(35) | 1(20) | 11(32) | 3(38) |
| | | $PR_3$ | 1( 5) | 0( 0) | 1( 3) | 2(25) |
| | | $PR_4$ | 1( 5) | 0( 0) | 0( 0) | 0( 0) |
| Left lung field | Upper lung field | (−) | 0( 0) | 1(20) | 5(15) | 0( 0) |
| | | $PR_1$ | 7(35) | 2(40) | 13(38) | 3(38) |
| | | $PR_2$ | 8(40) | 2(40) | 14(41) | 3(38) |
| | | $PR_3$ | 1( 5) | 0( 0) | 1( 3) | 1(12) |
| | | $PR_4$ | 4(20) | 0( 0) | 1( 3) | 1(12) |
| | Middle lung field | (−) | 0( 0) | 0( 0) | 0( 0) | 0( 0) |
| | | $PR_1$ | 6(30) | 2(40) | 9(26) | 1(12) |
| | | $PR_2$ | 8(40) | 3(60) | 11(32) | 3(38) |
| | | $PR_3$ | 3(15) | 0( 0) | 5(15) | 4(50) |
| | | $PR_4$ | 3(15) | 0( 0) | 9(26) | 0( 0) |
| | Lower lung field | (−) | 1( 5) | 1(20) | 1( 3) | 1(12) |
| | | $PR_1$ | 11(55) | 4(80) | 25(74) | 3(38) |
| | | $PR_2$ | 7(35) | 0( 0) | 6(18) | 3(38) |
| | | $PR_3$ | 1( 5) | 0( 0) | 2( 6) | 1(12) |
| | | $PR_4$ | 0( 0) | 0( 0) | 0( 0) | 0( 0) |

Note: 1. Figures in parentheses indicate a ratio to the cases included in each lung field and each Group.
2. Group 1—workers in power crushing, Group 2—workers in machinery repair and loading/unloading of the bags, Group 3—workers in drying or packing, and Group 4—workers belonging to both Group 1 and Group 3 (See the text).

Table 2 shows classification of the chest X-ray films, the newest one per every case, according to their age and the Group they belong to. By the revised law on pneumoconiosis, the chest X-ray findings were divided into four types, namely, $PR_1$; a few small opacities in the both lung fields without large opacities, $PR_2$; many small opacities in the both lung fields without large opacities, $PR_3$; a great number of small opacities in the both lung fields without large opacities, $PR_4$; large opacities in the lung fields. Many cases were found with $PR_4$, especially in Group 1 or Group 3. And the granular shadow appearance in Group 1 and Group 3 resembled each other. In Group 2, most of them were classified to $PR_1$ or $PR_2$. The period working in the dust was 21 years and 4 months±7 years and 11 months with the cases in Group 1, 26 years and 7 months±6 years and 4 months with

**Table 6.** Variations of Chest X-ray Findings in the Course Time (years)

| Group | Name | Sex | Age | Course time since starting work in the dust (years) 10 20 30 40 |
|---|---|---|---|---|
| Group 1 | K. Y. | M | 40 | |
| | Y. S. | M | 43 | |
| | M. Y. | M | 44 | |
| | M. H. | M | 49 | |
| | K. K. | M | 50 | |
| | I. M. | M | 50 | |
| | A. S. | M | 51 | |
| | N. S. | M | 52 | |
| | E. T. | M | 54 | |
| | S. T. | M | 54 | |
| | M. Y. | M | 54 | |
| | E. H. | M | 57 | |
| | S. K. | M | 64 | |
| | K. K. | F | 51 | |
| Group 2 | Y. K. | M | 49 | |
| Group 3 | I. T. | M | 38 | |
| | A. T. | M | 48 | |
| | I. K. | M | 50 | |
| | H. S. | M | 50 | |
| | N. S. | M | 52 | |
| | A. G. | M | 56 | |
| | A. T. | M | 64 | |
| | N. I. | F | 43 | |
| | N. T. | F | 45 | |
| | K. T. | F | 45 | |
| | S. T. | F | 46 | |
| | K. S. | F | 47 | |
| | T. F. | F | 47 | |
| | M. H. | F | 49 | |
| | M. M. | F | 50 | |
| | M. N. | F | 50 | |
| | O. M. | F | 51 | |
| | Y. M. | F | 36 | |
| | Y. Y. | F | 60 | |
| | K. F. | F | 66 | |
| Group 4 | M. K. | M | 46 | |
| | N. W. | M | 47 | |
| | M. S. | M | 53 | |
| | N. Y. | M | 54 | |
| | K. T. | M | 54 | |
| | K. Y. | F | 48 | |

Note: 1) The age refers to the time of the latest chest X-ray examination.

2) Group 1-workers in power crushing, Group 2-workers in machinery repair and loading/unloading of the bags, Group 3-workers in drying or packing, and Group 4-workers belonging to both Group 1 and Group 3 (See the text).

3) The screen-tone indicates the period after isolation from "pyrophyllite clay" dust inhalation environment.

**Table 7.** Variations of Chest X-ray Findings after Isolation from "Pyrophyllite Clay" Dust Inhalation Environment

| Group | Name | Sex | Age | Chest X-ray findings immediately before isolation | Course time after isolation (years) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| Group 1 | T.M. | M | 50 | 1/1 | 2/1 3/2 3/2 | | | | | | |
| | K.K. | F | 51 | 1/0 | 1/0 | | 3/2 3/3 3/3 | | | | |
| Group 3 | I.T. | M | 38 | 0/1 | 1/0 | | 1/2 2/3 3/3 | | | | |
| | N.T. | M | 44 | ? | | | 0/0 | | 1/1 | 1/1 1/1 2/2 2/2 | |
| | A.T. | M | 48 | 1/0 | 1/2 | | 2/1 4A 4A | | | | |
| | E.M. | M | 48 | ? | 1/1 | | 1/1 1/1 2/2 | | | | |
| | S.S. | M | 48 | 1/1 | 1/1 | | 1/1 1/1 2/1 | | | | |
| | A.S. | F | 45 | 1/2 | 1/2 2/3 | | | | | | |
| | T.F. | F | 47 | 2/1 | 2/2 3/2 3/3 | | | | | | |
| | T.I. | F | 47 | 2/1 | 2/2 | | 2/2 2/2 2/3 | | | | |
| | M.N. | F | 50 | 2/2 | 2/2 2/2 | | 2/3 3/2 4A | | | | |
| | O.K. | F | 50 | 0/1 | 1/0 | 1/0 | | 1/1 1/1 1/2 | | | |
| | O.M. | F | 51 | 2/2 | 2/2 4A 4A 4A 4A 4A | | | | | | |
| Group 4 | M.K. | F | 47 | 1/0 | | | 1/2 2/1 2/2 2/2 | | | | |

Note: 1) The age refers to the time of the latest chest X-ray examination.
2) Only the patients of $PR_2$ or below immediately before isolation were chosen to study findings after isolation.

since their working in the dust and change of chest X-ray classification. With a view to studying the development of pneumoconiosis, 44 cases which proceeded to $PR_3$ or $PR_4$ (14 cases in Group 1, one case in Group 2, 20 cases in Group 3, and 6 cases in Group 4) were picked up as subjects out of 67 cases in all. One case in Group 1 arrived at $PR_3$ or $PR_4$ the earliest after about 13 years from his working in the dust, while another in Group 4 also indicated the similar variation. On the other hand, the one in Group 3 arrived at $PR_3$ or $PR_4$ the earliest about 8-9 years after his working in the dust, which fact suggests the severer malignancy in Group 3 working in the dust. Furthermore, it was assumed that it takes a fairly long time to arrive at $PR_2$, but once it passed through this period the granular shadows tended to accrete forming faint macular shadows spreading to a certain extent, and on the other hand, it was also observed that reticular and linear shadows were added forming a large shadow. Thus, such transition from $PR_3$ to $PR_4$ was rapid, while some moved directly from $PR_2$ to $PR_4$ without passing through the stage of $PR_3$.

Next, an explanation is made about Table 7, which indicates variations of chest X-ray findings with the cases removed out of the environment of inhaling pyrophyllite clay dust either by changing their work to another in dust-free area or by retiring from the work. With a view to studying variations of the chest X-ray findings after leaving the work in the dust, 14 cases with less serious than $PR_3$

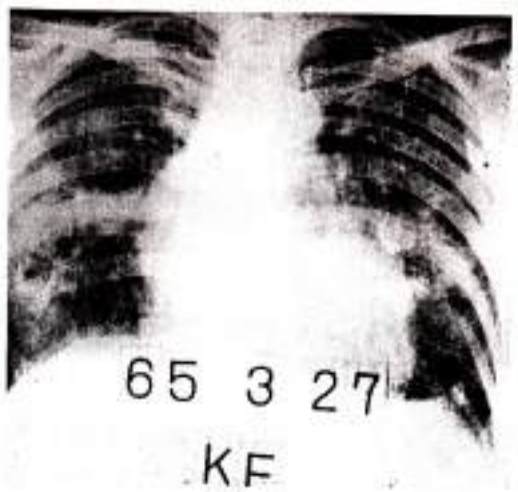


**Fig. 1**

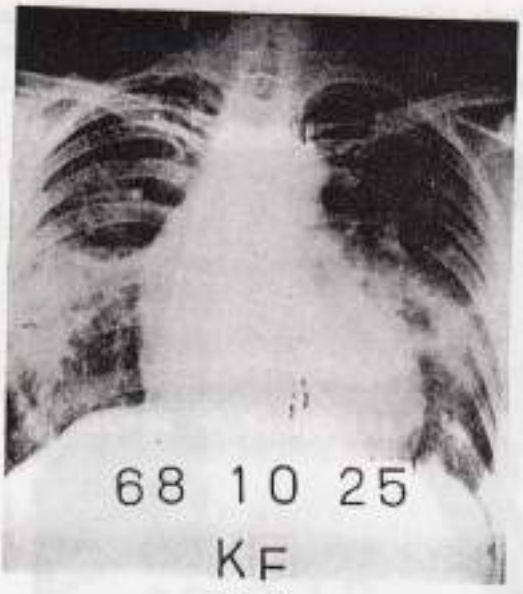

Fig. 2

Fig. 4

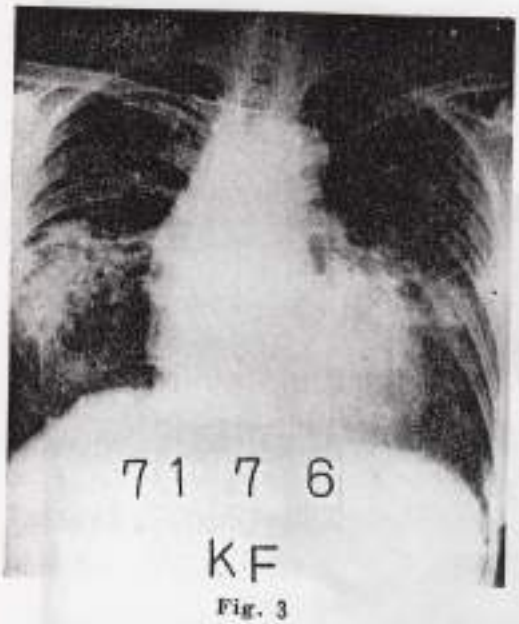

Fig. 3

Fig. 5

in the chest X-ray findings immediately before isolation from the work were chosen as subjects. Regardless of differences in Groups, a stable development to malignancy of the chest X-ray findings was observed.

Lastly, the authors would like to show the characteristic variations on the chest X-ray films with some examples as follows:

*case* 1: K. F. (Figs. 1-6) Engaged for 29 years in drying and packing.

Fig. 1 was taken two years after isolation from the work. It shows the chest X-ray findings of the typical pyrophyllitosis. That

Fig. 6

is, in both lung fields the granular shadows indicate a trend of accretion. Fig. 3 was taken six years later than the above. Notice-

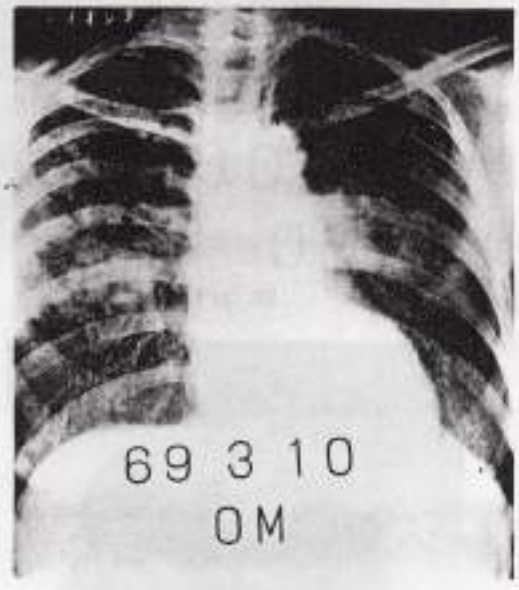


Fig. 7


Fig. 8

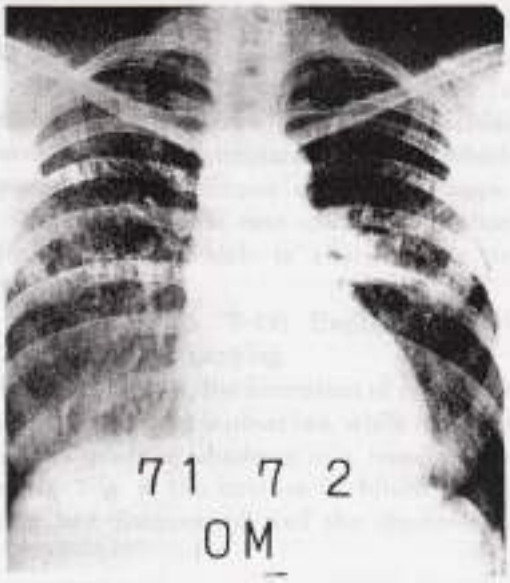


Fig. 9

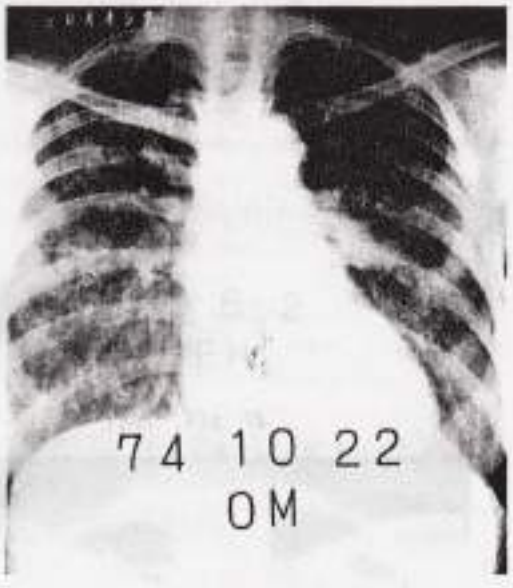


Fig. 10

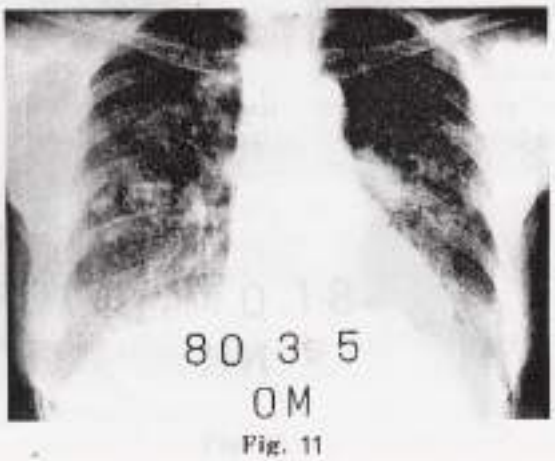


Fig. 11

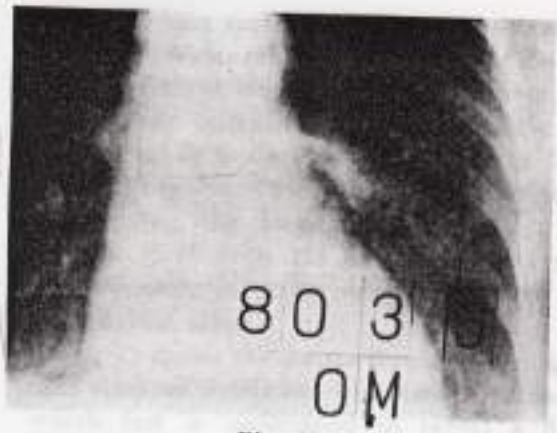


Fig. 12


Fig. 13


Fig. 14

ably it shows the emphysematous change at the left apex, the large opacities on both sides being shrinked. Fig. 5 and Fig. 6 show a reduction of faint shadows and large opacities are retracted and agglutinated, around which emphysematous and fibrous change are apparent. This is a specific case showing variation of faint shadows, which is characteristic in pyrophyllitosis.

*Case* 2: O. M. (Figs. 7-14) Engaged for 31 years in drying and packing.

In Fig. 7 and Fig. 8, the formation of cavities at hilum of the left lung is observed, while the right lung shows granular shadows in a trend of accretion. In Fig. 9, the cavities at hilum of the left lung has disappeared, and the shadows in

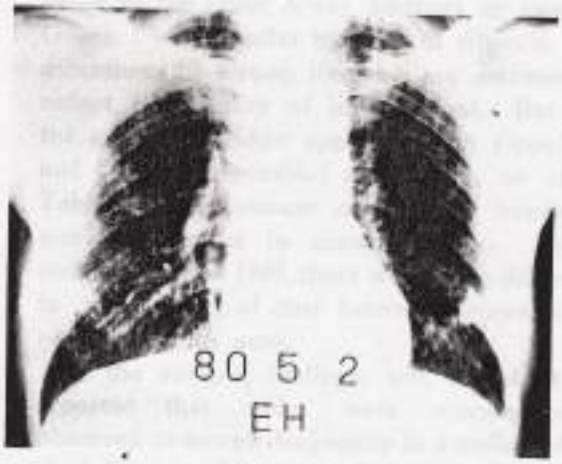


Fig. 15


Fig. 16

the right lung accreting become more faint but cover a wide range. Figs. 10–14 show a marked fibrous change all over the lung fields and a large opacities at the right middle lung field. Fig. 13 is an enlargement of Fig. 11, in which formation of focal emphysema is observed surrounding the large opacities.

*Case* 3: E. H. (Fig. 15) Engaged for 32 years and 8 months in power crushing of ores at a pyrophyllite mine.

Fig. 15 shows the clearer distribution of granular shadows compared with case 1 or case 2, which fact is understood to reflect a difference in quantity or quality of inhaled dust.

*Case* 4: N. W. (Fig. 16) Engaged for 15 years and 1 month in digging at a pyrophyllite mine and 11 years and 2 months in clay packing.

As shown in Fig. 16, distribution of granular shadows, pleura rolling into the large opacities and emphysematous change in the lower lung fields are recognized. This is also similar to the findings observed in silicosis.

## DISCUSSION

Pyrophyllitosis is a disease caused by inhalation of the dust containing aluminium silicate. An outline of the chest X-ray findings in this disease has been explained in the text, wherein those engaged in power crushing of ores at mines with clinical features of pyrophyllitosis complicated with silicosis (Group 1) were studied separately from those occupied in drying and packing at workshops with more typical clinical features of pyrophyllitosis (Group 3), because the former had opportunities of inhaling free silica dust other than pyrophyllite dust, as stated in the report of Sera et al.[3] too.

Subjects were distributed much in their forties and fifties, more male in Group 1 and more female in Group 3. In the pyrophyllite-related business which is one of the few labor possibilities in this district, all the family work togther, therefore, on many occasions pyrophyllitosis used to be found collectively in a family.

Meanwhile, one of the characteristics in chest X-ray findings was a trend that granular shadows easily develop to accretion. As shown in Table 3, granular shadows are more thickly distributed in the upper and middle lung fields, but, as it is apparent from the course of chest X-ray findings in Table 6, granular shadows are accreting at the same time showing mixture of strand, linear and reticular shadows and elevation of hilum. The authors[5] reported in 1969 that upon the health examination of the laborers working in same pyrophyllite mines, nothing that belonged to $PR_3$ was found out of 445 cases, a possible explanation of this fact is that pyrophyllitosis is a disease with characteristic of a strong trend of accretion, and that those who received the health examination had their average working experience of 9 years, which is too short to trace the course sufficiently. Anyhow, the transition from $PR_2$ to $PR_4$ was fast and in many cases moved directly to $PR_4$ not through $PR_3$. Especially, the trend above mentioned was apparent in cases of Group 3 and some of the chest X-ray findings in cases of Group 1 were similar to those of silicosis. The differences by Group like this are estimated to reflect the quality of inhaled dust. But since the granular shadow appearance in Group 1 and Group 3 resembled each other, as shown Table 2, the amount of dust in mines and workshops must be considered too. By our measurement in 1981, there were some differences in the amount of dust between processes, but not so obvious ones.

In the autoptic findings, too, Kugai et al.[6] reported that nodes were macroscopically observed to accrete frequently in a stellate shape. And Sera et al.[3] reported that small nodes of unclear indeterminate form as small as a half rice grain were distributing or gathering, thus such variations are noted also to be reflected on an accretion trend in the chest X-ray findings.

Yoshimi[2] reported, on a case indicating the marked respiratory symptoms of $PR_4$ after 8 years of working, that compared with the case of silicosis in which it took more than 10 years to arrive at $PR_4$, pyrophyllitosis was of the severer malignancy. In the present authors' study, too, in addition to the earlier appearance of accretion trend the more intensive malignancy of pyrophyllitosis was suggested.

It is also reported that in many cases there are non-tuberculous cavities[1,3,5], and in the present study, too, one case had cavities. It might be on account of a series of pathological variations including accretion of nodes, accompanied enlargement of granulation tissue and cavitation, which should be carefully noted dur