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# Pulmonary Changes after Exposure to Vermiculite Contaminated with Fibrous Tremolite[1-3]

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SUMMARY Workers exposed to vermiculite contaminated with fibrous tremolite were surveyed for the presence of respiratory symptoms by questionnaire, and for pneumoconiosis by chest radiograph. Pulmonary function was measured by spirometry and single-breath carbon monoxide diffusing capacity (DLcosb). Fiber exposure indexes, expressed as fiber/ml-yr, were derived for each worker from available industrial hygiene data and work histories. The estimated cumulative exposure for the work force ranged from 0.01 to 39 fiber/ml-yr. Discriminant analysis demonstrated significant correlates with shortness of breath and pleuritic chest pain to cumulative fiber exposure. The radiographic changes were limited to pleural changes and involved 4.4% of the population. Parametric and discriminant analysis demonstrated a significant correlation with radiographic changes and cumulative fiber exposure. There were no correlations between spirometry or DLcosb and fiber exposure. Exposure to vermiculite contaminated with fibrous tremolite can cause pleural changes in occupationally exposed workers. This is supported by the previously identified 12 cases of benign pleural effusions in this working population and the association of pleural radiographic changes and pleuritic chest symptoms with cumulative fiber exposure. The lack of significant parenchymal radiographic, spirometric, and DLcosb changes most likely reflects the low cumulative fiber exposure. AM REV RESPIR DIS 1984; 129:952–958

## Introduction

Vermiculite is the geological name given to a group of hydrated laminar aluminum-iron-magnesium silicates. It has the unique property of expanding as much as 12 times its original size with the application of heat between 427° and 1,093° C (1, 2). Unexpanded vermiculite is mined mainly in Montana, Virginia, and South Carolina in the United States, and in South Africa, and it is shipped to approximately 47 regional expander plants located in 30 states. The domestic uses of expanded vermiculite relate to its fire resistance, insulation, and ion exchange properties, but, additionally, it is used as a soil additive, animal feed bulking agent, and as a carrier for various chemicals, including herbicides, insecticides, fungicides, and fertilizers (2).

Investigations of some of the unexpanded vermiculite ore have demonstrated contamination of the ore with fibrous minerals (3). Montana ore contains a fibrous form of the amphibole tremolite. Virginia and South Carolina vermiculite ore contain a type of tremolite that, when milled, tends to form cleavage fragments that have fibrous characteristics with low length-to-width aspect ratios. South African ore is currently felt to be free of amphibole or cleavage fragment contamination (4).

A rurally located company that processed mainly Montana vermiculite ore to its expanded form for use as an inert carrier for herbicides and fertilizers reported a cluster of 12 cases of pleural effusions of unknown origin among their employees over a 12-yr period. Environmental sampling of work areas revealed airborne fibers believed to be tremolite. There was concern that the observed cluster of pleural effusion cases represented manifestations of exposure to the fibrous contamination of the vermiculite. The present study was undertaken to assess the respiratory status of current workers exposed to vermiculite contaminated with fibrous tremolite in this plant facility.

## Methods

### *Study Population*

The study population surveyed included all employees with a past history of vermiculite exposure and a control group of employees without such exposure. There were a total of 530 employees asked to participate in the study; 9 refused and 9 were not available because of vacation or illness, giving a total of 512 employees (97%) interviewed.

### *Medical Examination*

All employees were interviewed by trained personnel using a modified American Thoracic Society (ATS) Respiratory Questionnaire (5). The major modifications of the questionnaire were the inclusion of questions pertaining to previous employment with asbestos and other fibrous mineral exposure, questions about time employed within various locations in the facility, and questions relating to pleuritic-type chest pain and illnesses with pleural manifestations.

A limited physical examination was performed on each employee for the presence of late inspiratory rales (crackles) in 4 different chest locations and for the presence of nail clubbing.

Spirometry was performed using an Ohio-Med 822 dry rolling seal spirometer (Ohio Instruments, Pine Brook, NJ) with a Spirotech 200 microprocessor (Spirotech, Inc., Atlanta, GA). Tests were accomplished according to ATS criteria using trained technicians (5). Employees were retested at a later date if they had had a respiratory infection within the preceding 3 wk.

Tests performed were forced vital capacity (FVC), forced expiratory volume in one second ($FEV_1$), ratio of $FEV_1$ to FVC expressed as a percentage ($FEV_1/FVC\%$), and forced expiratory flow during the middle half of the FVC ($FEF_{25-75}$). All results were temperature corrected to BTPS. Results were expressed as measured values and as percentage of predicted using the normal values of Knudson and coworkers (6).

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