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Fibrogenic and carcinogenic characteristics of asbestos occurring in Mohmand Agency, northern Pakistan

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ABSTRACT: *This study has been carried out to identify the fibrogenic and carcinogenic characteristics including the type, physical dimension, and the fiber dose over time-weighted averages (TWA) of asbestos fibers mined, milled and used in Mohmand Agency. Fifteen representative rock and air samples of respirable Particulates matter (0.45-10μm) collected from various mines and milling units were analyzed using X-Ray Diffraction (XRD), Polarized Light Microscope (PLM) and Scanning Electron Microscope (SEM). The types of asbestos were classified as chrysotile, tremolite and anthophyllite. The concentration of asbestos fibers identified in respirable particulates* ($PM_{10,\ 7,\ 5,\ 3,2\ and\ <2}$ *μm) were higher than the permissible limit (0.01f/cc per 8 hours) in the indoor environment. Majority of the fibers were found < 0.3 μm in width/diameter and >8 μm long and indicate that the type of asbestos fibers released during mining and milling in Mohmand Agency is potentially carcinogenic.*

INTRODUCTION

Asbestos is a commercial term commonly used for six different types of naturally occurring fibrous crystals (crocidolite, amosite, chrysotile, anthophyllite, tremolite and actinolite) composed of hydrated aluminum-magnesium silicates with varying composition. The two major classes are serpentine (limited to chrysotile) and amphiboles, which include all the remaining asbestos fiber types. As a naturally occurring rock fiber, asbestos is mined, then broken down from mineral clumps into groups of loose fibers. It has been used in more than 3000 products, including heat resistant textiles, asbestos cement products, special filters for industrial chemicals, thermal insulation products, friction material, gaskets, floor tiles, roofing materials, packing materials, paints and protective paper etc (Shirde, 1973; Jehan, 1996).

Exposure to all types of airborne asbestos including chrysotile, tremolite, amosite, anthophyllite, antigorite, crocidolite and mixtures of all those have resulted in high incidences of various cancers (Lungs, Larynx, Gastrointestinal, Ovarian Cancer) and malignant mesothelioma in human. (IARC, 1987; McDonald, 1980; Acheson et al., 1982; Berry & Newhouse, 1983; Suzuki et al., 2004). The health effects are the ultimate function of the fibrogenic and carcinogenic characteristics including fiber size (length, diameter) and fiber dose over time-weighted averages (TWAs) of asbestos fiber. Generally fibers <3μm in diameter and >8μm in length are considered potentially carcinogenic and the risk of cancer increases as fiber concentration increases and the diameter decreases. There are extensive evidence relating to the importance of fiber size in lung deposition and clearance of fibers, which in turn govern the bioavailability of fibers at target tissues (Lippmann, 1993).

Fiber diameter is the major determinant for the deposition of fibers. Only fibers less than about 3.5 μm in diameter can reach the alveolar spaces. Fiber length also influences the deposition and clearance of fibers. Fibers longer than 20 μm are more readily deposited by interception at airway bifurcations. In general, short fibers ($<5\mu$m) are cleared more rapidly than long fibers ($>5\mu$m). Fiber size also plays an important role in relation to cellular mechanisms of toxicity and carcinogenicity. Long fibers of a given fiber type are generally more biologically active than shorter fibers. Furthermore, long fibers ($>5\mu$m) are more carcinogenic and fibrogenic than short fibers of asbestos and other fibers ($<5\mu$m) in chronic studies in rats by inhalation (Davis et al., 1986; Davis & Jones, 1988).

Several preliminarily research studies were conducted regarding the occurrences, petrogensis, economics and environmental impacts in parts of Mohmand and Malakand Agency and District Charsadda (Qaisar & Khan, 1967; Qaisar et al., 1967; Rafiq et al., 1984; Rafiq 1984; Hamidullah, 1984; Jehan, 1996; Jehan & Hamidullah, 1997; 1999; Jehan, et al., 1997, 2002). But no detailed work was carried out to characterize the fibrogenic and carcinogenic characteristics of airborne asbestos fibers. The present study is concentrated to characterize the fibrogenic and carcinogenic characteristics including the type, physical dimension and the fiber dose over time-weighted averages (TWA) of asbestos fibers released during mining and milling in Mohmand Agency (Fig. 1 & 2)

Fig. 1. A huge quantity of asbestos fibers released during milling in Sari Killi, Mohmand Agency.

Fig. 2. Occupational exposure to airborne asbestos during milling and packing of asbestos in Nawa Killi, Mohmand Agency.

METHODOLGY

Raw asbestos samples were collected from different asbestos mines including Shano Koroona (Gumbati), Daniskool, Kuchian and Qila located in Mohmand Agency. Air Sampler (Model No. 1200/VFC) was used to collect respirable Particulates Matter (PM10). Filters including Wattman 0.45, 2, 3, 5,7,10μm and of glass fiber >1μ pore sizes were used to collect respirable particulate matter. Due to the unavailability of the power and the non-cooperative attitude of the owners of the mines and milling units, short-term limit (15-30 minutes) sampling strategy was adopted to collect the air samples in the target area.

Five representative raw asbestos samples and seven indoor air samples of respirable particulate matter collected from different asbestos milling units were analyzed by using X-ray diffractometer (XRD) to identify the various types of asbestos fibers present in each sample. Rock samples were analyzed by using Rigaku XRD by continuous and step scanning at 2 to 65^0 theta angle at a voltage of 40 kv and 20 ma with Cu-Kα target.

Air samples were analyzed by step scanning at 2-65° theta angles at a voltage of 35 kV and 20 ma with Cu-Kα target. Six representative air samples including three each collected from milling units were subjected to Joel Scanning Electron Microscope (SEM) to identify the size and concentration of asbestos fibers. The SEM analyses were performed at the Central Laboratory, University of Peshawar.

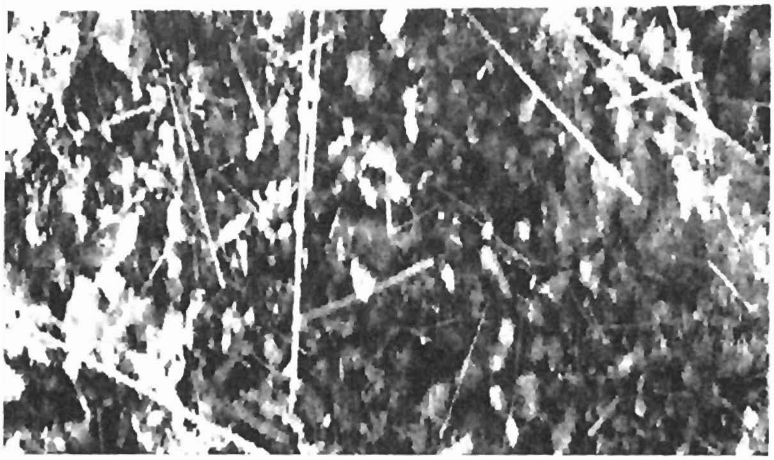
RESULTS AND DISCUSSION

Types of Asbestos Fiber

The analytical results of XRD of raw asbestos samples show that the type of asbestos occurs and mined in Mohmand Agency including Shano Koroona (Gumbatai), Danish Kool, Kuchian and Qila are identified as anthophyllite tremolite and chrysotile (Table 1). The indoor respirable particulates of 2, 7 and 10μm subjected to XRD also composed of anthophyllite and chrysotile (Table 2; Fig. 2a & 2b). However, no asbestos fibers of <2μm could be detected due to the analytical limitations of XRD.

TABLE 1. XRD DATA OF RAW ASBESTOS SAMPLES COLLECTED FROM VARIOUS MINES LOCATED IN MOHMAND AGENCY

S. #	Location	D. Values				Type of Asbestos Fibers
1	Shano koorona (Gumbati)	d	3.04	8.10	3.20	Anthophyllite
		I	100	50	20	
2	Danish Kool	d	3.04	8.10	3.20	Anthophyllite
		I	100	50	20	
3	Kuchian	d	3.05	8.18	3.20	Anthophyllite
		I	100	50	20	
4	Qila 1	d	8.41	3.27	2.7	Tremolite
		I	100	70	42	
5	Qila 2	d	7.3	3.64	4.57	Chrysotile
		I	100	70	50	



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