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Asbestos in the Great Lakes Basin with Emphasis on Lake Superior: A Briefing Document

International Joint Commission. Great Lakes Regional Office

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ASBESTOS IN THE GREAT LAKES BASIN

with Emphasis on Lake Superior

A BRIEFING DOCUMENT

prepared for

THE INTERNATIONAL JOINT COMMISSION

MARCH 3, 1975

ASBESTOS IN THE GREAT LAKES BASIN

INTRODUCTION

In March 1974, the Great Lakes Research Advisory Board directed Regional Office staff to prepare a state-of-the-art report on the status of research investigations on asbestos in the Great Lakes Basin. A preliminary review draft of the report was presented to the Research Advisory and Water Quality boards in June. A revised draft was presented to the two boards in September and at the Commission's October meeting it was decided to delay submission of the report to the Commission until the U.S. Environmental Protection Agency had consolidated its comments into one review. The February 1975 document incorporates pertinent comments from the various reviews.

The report presents chapters on the properties of asbestos; analytical methods; health effects; treatment and removal; distribution throughout the Great Lakes Basin, particularly in the Lake Superior; research needs and conclusions. Appendices concern the current investigations and materials relating to the Reserve Mining Case.

This document summarizes the information in the Research Advisory Board's report and gives the Commission the objective views of the Regional Office staff in light of the most recent research progress and programs.

PROPERTIES OF ASBESTOS

The generic term asbestos describes various fibrous mineral silicates which are hydrated and contain 40 to 60% silica combined with oxides of metals such as iron and magnesium. Asbestos minerals present a wide range of fibre diameter (fibre: by definition, a mineral form three times as long as wide), tensile strength, flexibility, and surface properties. The two major varieties of asbestos forms are the sheet silicates (chrysotile) and the fibrous or block-like amphiboles (anthophyllite, cummingtonite, grunerite, crocidolite, tremolite, eckermanite). The small differences in their basic crystal unit cell physical dimensions make it difficult to differentiate among these minerals. Moreover, in many instances, chemical compositions may overlap.

Ninety per cent of the commercially-valuable form of asbestos is chrysotile, which occurs in curved, open fibre bundles. These easily fragment into tubular fibrils. By comparison, the amphiboles have straight fibres which do not readily fracture or change shape.

Asbestos fibres vary in their porosity and permeability. The changing electrical surface charge of asbestos fibres resulting from variations in pH (a measure of acidity or alkalinity) determines the conditions for their dispersion, flocculation, and precipitation. Chrysotile flocculates at a pH of 11.8 (alkaline); cummingtonite requires slightly acidic conditions at a pH of 5.2 to 6.0.

DISTRIBUTION

Asbestos fibres are found throughout the Great Lakes System in the air and water, but only chrysotile is found in most localities. The fibres result from natural processes as well as from mining, milling and beneficiation processes and their wastes; manufacturing operations; and through use of commercial products (over 3000) containing asbestos.

Fibres which reach the atmosphere are transported by air currents from the point sources. Dust prevention measures and stack filters reduce but do not eliminate release of the fibres to the air. The asbestos fibres input to the Great Lakes from dry fallout and dust washed out of the air by precipitation is presently not known; however, current investigations may provide some data.

Basin potable water supplies have been sampled by various U.S. and Canadian agencies. Chrysotile is found in most locales tested; amphibole fibres of the cummingtonite-grunerite type are found exclusively in the western end of Lake Superior and can be traced to the Reserve Mining Company's taconite tailings discharge at Silver Bay, Minnesota. Typical concentrations of chrysotile asbestiform fibres in distribution systems average 1.6×10^6 fibres per litre with 90 per cent of the areas measured testing under 3×10^6 fibres per litre. Duluth, however, averaged 44×10^6 fibres of amphibole per litre from March 1973 through January 1974. Filtration systems now in use remove up to 90 per cent of the fibres. Research is continuing in improving the efficiency of filtration systems.

Sediment sampling programs have been conducted at the western end of Lake Superior. Asbestiform amphibole fibres have been found in association with taconite tailings to a depth of 7 cms in an area 6 miles into the lake from Silver Bay.

The nature of water movement in the western end of Lake Superior is generally counterclockwise and slow. However, amphibole fibres have been found in the water supply of Thunder Bay. These may be caused by an annual short-term change in the current patterns.

ENUMERATION AND IDENTIFICATION

Sophisticated equipment has been utilized for several years to study a wide range of materials and their characteristics in the micrometre and submicrometre range. The transmission electron microscope, and the techniques of selected area electron diffraction and electron microprobe analysis were utilized to detect and identify asbestos and asbestiform fibres in atmospheric samples prior to their application to aqueous samples. Considerable skill, training, and care are required to ensure proper operation of the equipment and proper interpretation of its input.

The presence of asbestos and asbestiform fibres in public water supplies requires not only detection and identification but also quantification of these materials. The methodology for sample collection, handling, and preparation for analysis consists of several sequential steps, each of which may introduce a bias or a loss of precision into the final result. In addition, for each step variations exist which have emerged based. upon analyst and equipment requirements and constraints; comparability of these alternatives has not necessarily been demonstrated. A quantitative, bias-free procedure has not been required until recently. The development of a standard method has not been intensively pursued since more time and money are required than most jurisdictions have available. Possibly one could not be developed until now since the methodology required rather complete characterization.

The present instrumentation available appears more than adequate to detect, identify, and quantify asbestos and asbestiform fibres. Present analytical methodology for preparing samples for analysis can provide

adequate precision. The thrust of present work should be directed toward the development of a standard procedure to ensure that the sample analyzed is accurately representative of the body of water from which the sample was withdrawn; i.e. that the number and the nature of the fibres remain unaltered. Concurrently, a viable quality control scheme needs to be developed and implemented to ensure the validity of analytical results.

HEALTH ASPECTS

From industrial experience inhaled asbestos fibres are known to be carcinogenic. The threshold value beneath which carcinogenic effects do not occur is unknown nor has a dose response curve been established. The relative carcinogenicity of different forms of asbestos has not been determined, nor is it known if the length of fibres inhaled is pertinent.

The question of whether or not ingested asbestos fibres are carcinogenic - and if so, at what dosage - is not only unanswered, it is just now beginning to be intensively addressed. If animal feeding studies result in asbestos associated cancers, it is a virtual certainty that ingested asbestos will be adjudged a human carcinogen, despite the possibility of interspecies incomparability. On the other hand, if cancers do not ensue from the feeding of asbestos, it is a virtual certainty that the question of the carcinogenicity of ingested asbestos to man will be deemed unanswered due to the possibility of interspecies incomparability. This possibility is enhanced by the extended latent period observed in the development of cancers associated with inhaled asbestos.

Given the uncertainty as to the health effects, if any, of ingested asbestos, the U.S. Federal judiciary has wrestled with the problem of balancing equities in a case where one possible equity, human life, has no corresponding right, claim or interest which can be balanced against it. The Federal Court of the District of Minnesota has estimated the unknown probabilities as requiring the cessation of Reserve Mining's operations. This estimation has not won the assent of the Appellate Courts. At the

present time there is essentially no evidence to either support or refute the District Court's estimation.

RESEARCH STATUS

In its report the Board pointed to eleven specific research needs. These can be divided into areas of health, analytical methods, distribution and material balance.

Health research needs listed are currently under investigation by the U.S. EPA, Duluth, CCIW and MOE. EPA's asbestos feeding studies may provide the answers to questions about the short-term effects of asbestos. Their experiments relating to fibres in drinking water should also provide useful results. CCIW and Ontario Ministry of the Environment are cooperating in efforts to greatly improve removal of asbestiform fibres from drinking water. EPA also has a major program to improve and, if possible, standardize sampling and analytical procedures for identification and counting asbestos fibres.

CCIW and EPA are examining aspects of distribution, including species concentration and fibre length in water and sediments. Their research is concentrated, but not limited to the upper lakes, particularly Lake Superior. Sources and magnitudes of atmospheric contributions of asbestos to the waters of the upper lakes are being investigated cooperatively by the International Reference Group on Upper Lakes Pollution. This group is also examining the likelihood of transboundary pollution.

Listed research needs which presently are not being addressed include investigation of the manner in which asbestiform minerals weather and go into solution; determination of the significance of resuspension of asbestos from lake-bottom and from land; compilation of an inventory of production, use, disposal and ultimate fate of asbestos products; and evaluation of the potentiating effects of asbestos fibres and metals associated with them by pathogens including viruses. These areas of research appear less important than those already being addressed.

They are, however, areas to be examined in the future.

The most pressing need is to improve the sample collection and preparation procedures preliminary to identifying and enumerating asbestos fibres. Without proper sampling and sample preparation all the following analytical steps are open to question. Research results too are therefore also subject to question.

Regional Office staff believe the Commission should urge continued emphasis on analytical sampling, quality control, and standard procedures by participating agencies. Determining and defining potential human health hazards, precisely detailing distribution (the two other major research needs), and the validity of all ongoing and future research are dependent upon advancing the state of the art of sampling, sample preparation and analytical procedures quality control.

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IJC RELEASES ASBESTOS REPORT

The International Joint Commission today forwarded to Governments its Research Advisory Board's report, "Asbestos in the Great Lakes with Emphasis on Lake Superior."

U.S. Chairman, Christian A. Herter, explained that the Board began preparation of the report in March 1974 in response to its members' and the Commission's expressed interest in gaining an objective perspective on the issues relating to the asbestos question, particularly the transboundary pollution and public health aspects After intensive review by the Research Advisory Board, the Water Quality Board and their member agencies, the report was submitted to the Commission this week.

Professor Maxwell Cohen, Canadian Chairman, said that he believed the Board did provide an objective state-of-the-art report by bringing together published literature and stating the progress of ongoing programs.

Four conclusions are presented in the report. 1. There are problems with identifying and counting asbestos fibres. 2. Despite the problems, sampling programs will continue because of potential health hazards. 3. The hazards from inhaled asbestos are proven, but scientists do not agree about hazards resulting from ingested fibres (swallowed). 4. There is possible transboundary pollution from asbestos in Lake Superior.

Of the eleven recommended areas of research which the Board proposed,

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the Commission stressed three in its submission to Governments: improvement of procedures of sample collection and preparation-for-analysis, evaluation of present and predicted future levels of asbestos species, concentrations and size distribution in air, surface waters and sediments in the Great Lakes; and determination of public health effects of asbestos fibres in drinking water.

The report has chapters concerning the properties of asbestos, its enumeration and identification, health effects, treatment and removal from water, distribution in the Great Lakes Basin and its presence in Lake Superior. Appendices relate to current investigations and information concerning the Reserve Mining Corporation's taconite mining operations.

Copies of the report are limited. The document can be obtained from the Commission's Regional Office, 100 Ouellette Avenue, Windsor, Ontario N9A 6T3. Additional copies will soon be made available through the National Technical Information Service, Springfield, Virginia.

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IJC NEWS

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TECHNICAL NOTES

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