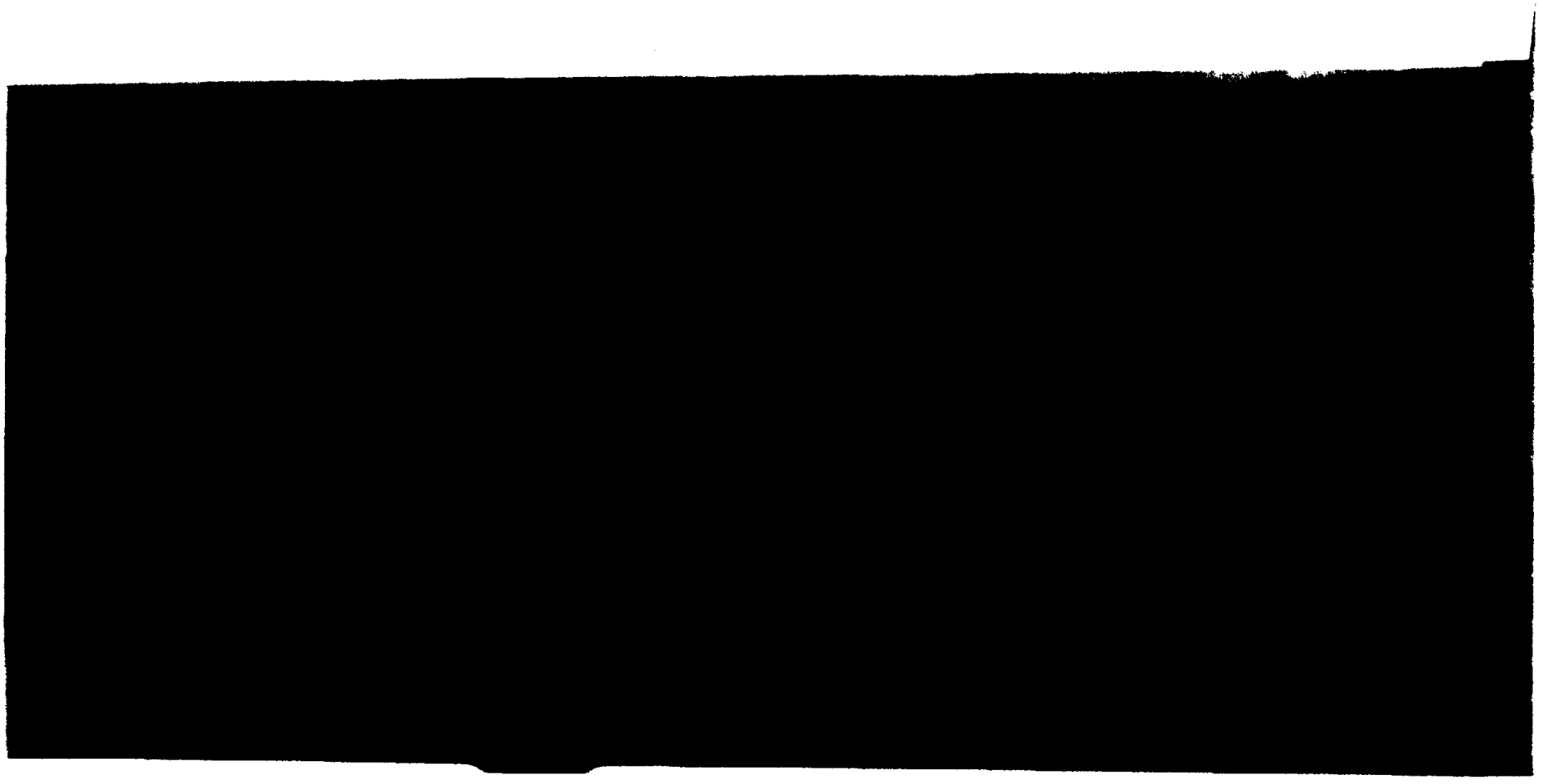
LANGER, ARTHUR PH.D.

CONWED CORPORATION V. UNION CARBIDE

DEPO: 1/14/94 (W/EXHIBITS)



IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

| | |
|---|---|
| In Re: | |
| Asbestos Products Liability Litigation (No. VI) | Civil Action No. MDL 875 |

UNITED STATES DISTRICT COURT
FIFTH DIVISION
DISTRICT OF MINNESOTA

| | |
|---|---|
| CONWED CORPORATION, Plaintiff, | |
| -against- | Case No. Civ. 5-92-88 |
| UNION CARBIDE CHEMICALS AND PLASTICS COMPANY, INC., (f/k/a UNION CARBIDE CORPORATION), Defendant, | |
| -and- | |
| UNION CARBIDE CHEMICALS AND PLASTICS COMPANY, INC., (f/k/a UNION CARBIDE CORPORATION), Third-Party Plaintiffs, | |
| -against- | |
| OWENS-CORNING FIBERGLAS CORPORATION, WALKER JAMAR COMPANY, A.W. KUETTEL & SONS, INC., API, INC. and MacARTHUR COMPANY, Third-Party Defendants. | |

January 14, 1994
ARTHUR M. LANGER

**Doyle Reporting, Inc.**
CERTIFIED STENOTYPE REPORTERS
Total Litigation Support
WALTER SHAPIRO, CSR
CHARLES SHAPIRO, CSR
369 LEXINGTON AVENUE
NEW YORK, N.Y. 10017
(212) 867-8220

January 14, 1994
10:25 a.m.

Deposition of Non-Party Witness ARTHUR M. LANGER, taken by Defendant, pursuant to notice, at the offices of Kelley Drye & Warren, Esqs., 101 Park Avenue, New York, New York, before Robert E. Levy, a Certified Shorthand Reporter and Notary Public within and for the State of New York.

A p p e a r a n c e s:

STICH ANGELL KREIDLER & MUTH, P.A.
Attorneys for Plaintiff
The Crossings, Suite 120
250 Second Avenue South
Minneapolis, Minnesota 55401

By: ROBERT D. BROWNSON, ESQ.,
of Counsel

FOLEY & LARDNER, ESQS.
Attorneys for Defendant
777 East Wisconsin Avenue
Milwaukee, Wisconsin 53202-5367

By; TREVOR J. WILL, ESQ.,
of Counsel

-and-

KELLEY DRYE & WARREN, ESQS.
101 Park Avenue
New York, New York 10178

By: ALAN GERSON, ESQ.,
of Counsel

oOo

A R T H U R M. L A N G E R, (residing at 6 Rochambeau Drive, Hartsdale, New York), having been first duly sworn by the Notary Public (Robert E. Levy), was examined and testified as follows:

EXAMINATION BY

MR. WILL:

Q. State your name, please.

A. Arthur M. Langer.

Q. And Dr. Langer, my name is Trevor Will. We have met before. I'm going to be taking your deposition today. I understand you have been deposed before?

A. Yes.

Q. If I ask you something that doesn't make sense or that you don't hear, let me know and I'll either try to rephrase it or have it read back. If you answer the question I'll have to assume that you heard it, understood it and answered it to the best of your ability, all right?

A. Yes.

Q. And also as you are doing, please use yes or no rather than uh-huh or uh-uh, because

that is hard for the reporter.

A. Agreed.

Q. If you need a break for any reason let me know and at an appropriate point, we will stop and go off the record.

A. Fine.

Q. Did you bring a copy of your CV with you today?

A. Yes.

(Handing)

MR. WILL: I would ask the reporter to mark this as Exhibit 1.

(Whereupon, curriculum vitae of Arthur M. Langer marked Langer Exhibit 1 for identification, as of this date.)

MR. WILL: Let me ask you to mark this as 2.

(Whereupon, notice of deposition marked Langer Exhibit 2 for identification, as of this date.)

MR. WILL: And this will be three.

(Whereupon, document entitled "Mineralogical Analysis of Chrysotile Ore Specimens Obtained in the KCAC Pit

(Formerly Union Carbide's New Idria Deposit), Summary" marked Langer Exhibit 3 for identification, as of this date.)

Q. Is Exhibit 1 complete, Doctor?

A. Complete in the sense that this is the document that I brought today and represents my updated curriculum vitae, yes.

Q. Do you have anything to add to it, any publications or abstracts since that was prepared?

A. No.

Q. And what was the date of the last revision?

A. Sometime late December, mid December, something like that.

Q. December of 1993?

A. December of 1993, yes.

MR. WILL: At the request of Mr. Brownson, I will put on the record that I did serve a copy of the notice of Dr. Langer's deposition on all parties to this case and they have for whatever reason chosen not to appear, but I did serve everyone.

Q. Doctor, when were you first contacted by anyone at Conwed or working for Conwed about this case?

A. I believe it was sometime in 1993.

Q. Who was it that made that contact?

A. Mr. Brownson.

Q. And had you worked with Mr. Brownson before?

A. Yes.

Q. Was this the first time you had been contacted by Mr. Brownson to do any work for Conwed?

A. No.

Q. When was the first time you were contacted to do any work for Conwed?

A. A year, perhaps 1990 or 1989.

Q. In this particular case, the Conwed versus Union Carbide case, what was it that you were asked by Mr. Brownson to do?

A. Mr. Brownson asked me to review general materials pertaining to the Union Carbide asbestos deposit in California. He asked me to review documents pertaining to -- reports, rather, pertaining to the biological potential of

chrysotile asbestos. He asked me to review documents pertaining to industrial hygiene surveys in user facilities, meaning facilities which used the Union Carbide product. He asked me to determine size distribution, characteristics of a chrysotile aerosol generated from the Union Carbide product. He asked me to attend a meeting in California concerning the Environmental Protection Agency's Superfund cleanup operation at the New Idria chrysotile deposit. Essentially that was what was asked of me.

Q. Were you asked to review ore samples or samples of material?

A. Yes.

Q. The general materials regarding the Union Carbide deposit in California, what were those materials?

A. In accompanying Mr. Brownson, we visited the operation which was formerly Union Carbide's operation, now called the King City Asbestos Corporation.

Q. Maybe I can interrupt you?

A. Please.

Q. I didn't ask a very clear question.

You said you first were asked to review some general materials?

A. Right.

Q. Regarding the Union Carbide deposit?

A. Right.

Q. Okay. And by that, I assume you meant some written materials?

A. Sure, right, yes, within the mineralogical literature there are reports concerning the mineralogy of the deposit and there are existing reports on the nature of the serpentine itself and the general geology, mineralogy and structure of that particular geological feature.

Q. Did Mr. Brownson provide you with any of those materials or were you asked to look them up and review them yourself?

A. No, this basically was my assignment.

Q. Do you recall which general pieces of literature or reports you reviewed?

A. Yes, there are several papers by Dr. Mumpton, who now is affiliated with the state university, Dr. Sheldon Thompson, both of whom at that time worked for Union Carbide. There is a

guidebook to the area by a Professor Fowkes at one of the local colleges in Coalinga. There are several other reports but I can't at the present time recall the senior authors, but there are some general reports.

Q. Okay. You said Mr. Brownson asked you to review reports on the biological reports of chrysotile asbestos?

A. Yes.

Q. And again was that something you were asked to research?

A. Yes.

Q. Were any of those furnished to you by Mr. Brownson?

A. None.

Q. And how much time did you spend researching the literature on biological affects of chrysotile asbestos?

A. Total hours?

Q. Yes. For this project.

A. Maybe 30 hours.

Q. Are there any --

A. Plus or minus.

Q. Which studies or papers or articles

did you find that you felt to be important on this question of biological effect?

A. There is a series of experimental studies by Wagner and colleagues. A series of studies by Davis and colleagues from Edinburgh. Studies in the United States by Brody, Kagan. A study of ours in which the senior author is Yager. Studies from Germany, and this is Muhle, a study by Pott, a study by Maltoni. I'm sure there are others but I've just -- I'm just blocking on them.

Q. All right.

A. But there are a number of studies which pertain to in vitro tests using cells, challenged by mineral dust, a number of studies involving animals involving inhalation studies, and of course studies involving epidemiological studies of cohorts of workers exposed to the mineral.

Q. Of the studies that you reviewed, how many of them involved specifically the so-called calidria asbestos or Coalinga asbestos?

A. Maltoni used the Coalinga asbestos. Muhle used Coalinga asbestos. We used the Coalinga asbestos.

Q. "We" meaning the Yager paper?

A. Yager et al., right.

I didn't mention Frank Platek's paper. He is from NIOSH. They used Coalinga material. Pott used Coalinga material.

Q. Other than those five studies, are you aware of any other studies reporting on the health effects of Coalinga asbestos in the literature?

A. There may be others but I'm just not recalling. I cannot recall of others.

Q. You said you were also asked to review industrial hygiene reports at facilities where they were using Union Carbide asbestos, is that correct?

A. Yes.

Q. Approximately how many of those reports did you review?

A. There are hundreds of these reports and I have not as yet reviewed all of them. It is just so voluminous but I'm in that process now. I brought some of these with me.

Q. What is the reason for reviewing those reports? How do they fit into your role in

this case?

A. They fit into this case in the following way. I am one of those individuals, and I believe that many others in the field believe that mining and milling of chrysotile is associated with one set of risks whereas those risks change in the user industries, so mining and milling of chrysotile may be a relatively low-risk operation but user industries that manipulate for different purposes may not have the same control technology or the same control strategies and workers may be exposed to higher concentrations of

Q. In your view is the difference in risk between the mining and milling occupation on the one hand and the user industries on the other due to a change in the nature of the fibers itself that results from the milling process or is it the result of differing concentrations or is it some combination?

A. Probably a combination.

Q. What do you believe happens to the fiber during the mining or milling process that changes the risk?

A. During mining and milling?

Q. Yes.

[redacted]

During the crushing operation if the ores are still wet, the concentrations of fiber are not that great either. It is only when the materials are dried and processed through milling do they become more dusty, and when one raises dust, then the risk associated with exposure increases.

Q. Is it basically then the quantity of dust that dictates the level of risk?

A. That is one of the factors. That's right.

Q. Is that in your view the most important factor?

A. It is one of the important factors. Talking about chrysotile?

Q. Yes. Chrysotile.

A. That is one of the factors, important factors, cumulative dose, sure.

Q. Is there anything that happens to the fiber itself during the milling process other than whether it is wet or dry, talking about actual changes in the fiber itself that you believe

Q. You mentioned dust control. Is the dust control used by the user industry an important factor in the risk to the workers in the user industry?

A. I'm sorry. Could you --

Q. Sure. Is the dust control or lack thereof employed by the user industry an important factor in determining what the risk is to a worker in the user industry from the chrysotile fiber?

A. Yes.

Q. Who was it that, to your knowledge, actually conducted those air hygiene studies that you referred to?

A. There are some names which are indicated in these documents that I have brought, and I'm assuming that these are industrial hygienists.

Q. Do you know for whom they worked?

A. I believe they worked for Union Carbide.

Q. To your knowledge, then all of these studies were done by Union Carbide?

A. Apparently so.

Q. All right. Do you have any criticism

of the technique employed by those industrial hygienists in doing their air hygiene surveys?

A. No.

Q. Do you have any critique of the conclusions which they drew, if any?

A. Given the date of the report, given the standards at the time, and given the data, do I have any criticism?

Q. Yes, of what conclusions they drew?

A. Well, one doesn't want to be a Monday morning quarterback. You have to take it at face value. No.

Q. Sitting here today in 1994, the standards for permissible exposures to asbestos have changed, is that correct?

A. Yes.

Q. From what they were when these air hygiene studies were being conducted?

A. Yes.

Q. Now you mentioned also that you were asked to investigate the size distribution characteristics --

A. Yes.

Q. -- of the calidria asbestos fiber?

A. Yes.

Q. What did that involve?

A. We had made, in the university, a chamber from which we could generate an aerosol through air movement across a specimen, and we milled one of the commercial grade Union Carbide pellet classes for approximately three seconds just to break them, and this material was then subjected to an air flow and we collected the fibers generated during this release and we analyzed those fibers, although we are still crunching numbers.

Q. What was the purpose of doing that?

A. Well, one of the frequently heard criticisms involved in generating a size distribution on any specimen is that we use a dispersion in an aqueous medium, in water, and this may introduce artifacts in that the way to determine the size distribution of a dust cloud to which workers might be exposed would be to generate an aerosol and see what is actually in the air.

Q. Why are you interested in the size distribution characteristics of the asbestos from

Union Carbide?

A. It is frequently heard that the Union Carbide deposit is a short fiber and therefore does not possess biological potential.

Q. When you say it is frequently heard that the Union Carbide deposit is a short fiber, what is meant, to you, by short in that context?

A. Well, there are two meanings of the word "short." One meaning is a commercial meaning and the other is a biological meaning. For sure, the deposit in California is a short commercial fiber, for sure. In fact it is just about one of the shortest dispersed preparations made commercially anywhere.

Q. Before we leave that, what length would you expect to find in something considered a short commercial product?

A. Well, I'm thinking of the Quebec standards, the screening technique in which there the technique for -- let me change this. The protocol for determining the size of a fiber is based on this particular technique originated in Canada because fibers of different lengths impart certain qualities to products. Weaving or

spinning grades are AAA, AA, A or something like that or a 3. Fine materials, commercially short fiber used in a product like a floor tile or a ceiling tile in the Canadian classification is a 7.

Now, the Coalinga-type fibers are all 7's. Now the Quebec screening, to answer your question specifically, the Quebec screening technique consists of three screens and a catchment device in which 16 ounces of a fiber preparation is dumped on top and the screen is subjected to certain motion and the materials filter through, and the screening, the Quebec screening classification then requires the material be weighed and to the nearest ounces of the 16 ounces, you have four figures which reflect screen A, screen B, screen C and then the catchment pan, so a typical cement fiber might be 2, 6, 6, 2 or something like that but it has to add up to 16. The fibers out in California in the Coalinga deposit would be 0, 0, 0, 16. Now that is a commercial classification.

Q. In terms of their "length," what would you expect to --

A. I know this is hard to believe but that first screen catches materials that are greater than about .5 inches. It is .5 or 6, something like that. Now a half inch, that is 25.4 millimeters, so that is 12 millimeters. That means fibers less than 12,000 microns in length fall through it.

The next one, actually the bottom screen would be fibers less than about a thousand microns in length passes through it.

Q. Which is one millimeter?

A. Which is one millimeter, that's right, so it is a little bit more than a millimeter, something like that. So the commercial application when we talk about long fiber, short fiber, biologically, it is less than five microns or greater than five microns. So we are dealing with a different entity.

Q. So then what is considered a short fiber commercially is something that is less than approximately one millimeter in length?

A. That's right.

Q. And what is considered a short fiber biologically is something less than five microns

in length?

A. That's right.

Q. Now, when you said it was often stated that --

(Pause)

Q. Dr. Langer, when you mentioned earlier that it was often said that the chrysotile from the Coalinga area was a short fiber and therefore biologically inactive, was the "short" in that comment being used in the commercial sense or the biological sense or do you know?

A. It is frequently heard from biologists or those in certain medical fields, and these individuals assumed that when a commercial application was a short fiber, they immediately thought of biologically short. Which is not uncommon. But it is quite different, of course.

Q. Now, am I correct that the size distribution analysis that you are doing is with respect to the five-micron standard for biologically short?

A. Yes. Well, we do it all, but we are interested in what percentage of the total aerosol is greater than five microns.

Q. Are you using other cutoff points besides five microns for calculating percentages, in other words --

A. We are looking at other size increments, less than one, one to two, two to three or five to 10 or greater than 10.

Q. You say that those numbers have been, or some of the data has been obtained but the calculations haven't been done?

A. Yes.

Q. Do you have a sense of what the data show, at least preliminarily?

A. We can generate an aerosol with I think it will be greater than 10 fibers per c.c. of air greater than five microns in length per cubic centimeter of air.

Q. And in that dust sample, how many fibers would there be less than five microns?

A. Maybe a hundred times.

Q. So that you would expect to find something on the order of 1,000 fibers below five microns and per 10 fibers above five microns?

A. Yes.

Q. Do you know which grade of Union

Carbide calidria asbestos was used for this?

A. I think we used RG-100.

Q. And was that actually Union Carbide product or King City Asbestos Corp.?

A. No, these are historical samples that we have in our laboratory marked Union Carbide.

Q. When were they obtained, do you know?

A. In the '70s. When I was at Mount Sinai.

Q. So they were obtained by Mount Sinai Hospital in New York?

A. No. By me as an individual.

Q. When you were --

A. When I was at Mount Sinai, yes.

Q. When you say you are generating an aerosol, does that mean anything more than just dust in the air?

A. That is it.

Q. When you milled this fiber pellet, what type of equipment did you use?

A. We used a mill made in Germany. It is a blade mill. And it consists of -- it looks like an inverted malted milk machine with a chamber and the blade spins and it shatters

materials.

Q. You say you used about three seconds?

A. It could have been less. What we were trying to do is just -- let me backtrack for a second. These pellets tend to be friable, and if a pellet were to break, or a pellet were to be subjected to a saw in some process, what would happen to this material. And we wanted to -- it is impossible to reproduce everything. We just wanted to break down some pellet so it no longer had a physical state in which it was a pellet but rather it had broken as if somebody stepped on it.

Q. If the pellet were broken through some mechanism other than a blade, do you believe that would affect the fiber distribution characteristics?

A. It is possible.

Q. Would the length of time to which the pellet was subject to milling or processing affect the fiber distribution characteristics?

A. Yes, it probably would shorten it, but this is just a guess. It would change it. How it would change it, I can't predict.

Q. Is the technique that you used in

aerosolizing this pellet supposed to in way way replicate how the pellets were subjected in Conwed?

A. No.

Q. Are you aware of where the Union Carbide pellets were placed in the Conwed production process?

A. No.

Q. If the pellets were dumped into a watery solution, and then basically pulverized or mixed together with other ingredient, would that have an impact on fiber size distribution characteristics?

A. Probably.

Q. Do you know what that impact would be?

A. No.

Q. You mentioned that you were also asked to -- when do you expect to have the results completed of your fiber size distribution?

A. We are working on it now. It is just a matter of looking at the final data sets. A couple of weeks. Then we are busy with so many other things.

Q. How many times did you run this particular experiment with the blade mill?

A. You mean how many times was an aerosol generated?

Q. Yes.

A. Several times.

Q. Several meaning three to five?

A. No, I would say two or three.

Q. Does your data suggest variation between the two or three samples or are the results consistent?

A. Well, that is something that we are looking at now. Just how consistent this is.

Q. You said that Mr. Brownson also asked you to attend a meeting in California?

A. Right.

Q. About the Superfund cleanup at the New Idria area?

A. Right.

Q. And what was your -- do you know what the purpose of asking you to go to that meeting was?

A. Just to hear what was going on. How the federal government perceived the problem.

Q. How does the government perceive the problem, to your knowledge?

A. Apparently they perceive a hazard.

Q. What is the nature of that hazard? Is it asbestos in the air, asbestos in the water?

A. Both.

Q. What is the source of the asbestos that the government is worried about?

A. Well, principally, the asbestos deposit itself, the runoff from that deposit and the fibers which are in the soils and alluvium in the area and water in the California aqueduct system.

Q. Are the Johns-Manville and Atlas mine sites in the New Idria area?

A. Yes.

Q. Thought to be responsible for this problem?

A. Yes.

Q. How about the Union Carbide site?

A. No.

Q. What air concentrations are the federal government reporting?

A. I don't think they are reporting any.

The data I have seen are 0001 or below. Something like that. 0.0001.

Q. That is considered not atypical for ambient air throughout the country?

A. I would say so, yes.

Q. Do you believe based on what you know that there is any health risk from the asbestos concentrations in the air or the water that the federal government is talking about in this area?

A. Do I believe there is a risk?

Q. Yes.

A. No. If there is a risk it is very low.

Q. You are talking something less than winning the lottery or being hit by lightning?

A. Something like that.

Q. What is the federal government proposing to do about this risk?

A. What have they done? They have done the following. They have dismantled the Johns-Manville mill. They have moved the tailings deposits. They have rerouted waterways. They have reconstructed roads. They have buried the mill on the site. They have proceeded with

similar actions at Atlas. They have proceeded to change the configuration of the Pasajero catchment basin which during times of flooding spills over into the California aqueduct system. And there is some talk of modifying several hundred acres of area out there at an additional cost of $75 million.

Q. In your view, is that money well spent?

A. No.

Q. Were you asked to give your observations on what was going on there?

A. No.

Q. You were just there as an observer?

A. I was there as an observer.

Q. Okay. Other than attending that one meeting, have you been asked to do anything else with respect to the Superfund cleanup efforts there?

A. Well, they would like me to come back next year and give a talk, as a matter of fact.

Q. That would be on the government's tab?

A. I guess.

Q. Not on Mr. Brownson's tab?

A. I guess.

Q. How, if at all, do you think that what occurred at that meeting and what you observed relates to what you have been asked to do in this case, the opinions you have been asked to give in this case?

A. California is a very interesting place, and the fact that the government focused on this particular site, this particular material is a naturally occurring material. This represents the only Superfund site in the United States which is a natural outcropping of materials. And on the basis of the data provided to the government in their perception, they are investing $100 million on ameliorating this.

Q. Basically changing nature?

A. If you will.

Q. As you put it, this is not a situation where people have collected toxic chemicals from other places and dumped there in the ground?

A. No, no, no, not at all.

Q. This is just a mineral that was in

the ground to begin with?

A. Yes.

Q. You also mentioned that you were asked to collect and review samples of ore from the KCAC asbestos mine, the former Union Carbide mine?

A. Yes, that's right.

Q. In fact on July 27 of 1993, you did tour the mine site and collect materials?

A. That's right.

Q. Have you now had a chance to analyze those?

A. Yes.

Q. What were you asked to look for in the course of that analysis?

A. What is present in the deposit, are there mineral fibers present other than chrysotile. And if so, what are they and what are their concentrations and could this have an impact on biological potential.

Q. Were you specifically looking for amphibole fibers?

A. Yes.

Q. And why were you looking for

amphiboles?

A. It is -- there is a currently held belief that several of the diseases associated with chrysotile exposure may be explained wholly or in part by the presence of associated minerals within chrysotile, specifically certain amphiboles.

Q. Is it known that amphiboles can cause asbestosis, lung cancer and mesothelioma without chrysotile?

A. Amphibole asbestos materials can produce those diseases without the presence of chrysotile, yes.

Q. Have you now completed your work in analyzing the samples from the mine site?

A. I've completed the laboratory work. I'm still looking at certain kinds of data to more and better understand the nature of nonchrysotile fibers which are present in some of the samples.

Q. In terms of the biological definition, the short fibers being below five microns --

A. Right?

Q. -- who was it that came up with that

criteria for the short, if you will?

A. Actually it goes back to the 1950's, 1960's when the British changed over standards from total particles to fibers and the five-micron size length was incorporated in the new counting strategy for analytical purposes, with the support of some very limited biological data.

Q. So that when the British standards changed from counting particles to counting fibers, they told the industrial hygienists to count only fibers longer than five microns?

A. Well, this is developed. No one told anyone anything. It was basically a group of people, the fact that they were working for Turner Newall, and it was found that when one counted total particles, you didn't care how long the fibers were, but once the fibers went below a certain length it was more difficult to get reproducible results.

And the wisdom at that time was that asbestosis was produced by the disintegration of long asbestos bodies releasing silicic acid and involving a cellular process much like silicosis. So you had a convergence of the need to

distinguish particles from fibers using a light microscope. You had the constraints of developing a system that was reproducible when you reexamined the same specimen. You needed a counting protocol which could be used by different laboratories and still come up with the same answer. And there was this prevailing biological hypotheses concerning the disease of interest at that time, which was principally asbestosis.

Q. And the hypotheses at that point was that fibers below five microns would not produce asbestosis?

A. The prevailing view at that time. The prevailing view.

Q. When you mentioned that that was based on some limited biological work --

A. Yes.

Q. -- whose work was that?

A. Beattie & Knox's work that was presented in 1959, published in 1960 in the proceedings of the conference -- it is generally called the inhaled particles and vapors meeting but it was a meeting held -- a pneumoconiosis meeting held under the auspices of the British

Occupational Hygiene Society.

Q. Have you then as a mineralogist accepted that five micron definition essentially ever since you have been working in the field?

A. No, actually I've had a long interesting journey through this.

Q. Maybe I should rephrase the question. Would it be correct to say that ever since you have been working in the field, you have been aware of the fact that in biological terms something below five microns is considered short?

A. Generally held, yes.

Q. Okay. This is not a definition that you came up with?

A. No.

Q. This is something shared throughout the scientific community?

A. Parts of the scientific community, yes. And I would say -- yes.

Q. Shifting gears, I want to ask you about the other cases that you've worked on for Conwed Corporation. Can you tell me what those involved?

A. They involved property damage

litigations.

Q. Where were they?

A. Let's see, I think they involved the Annerundel County, Maryland school cases, Baltimore County cases. These were ceiling tile cases in buildings.

Q. So is this the third case that you've worked on for Conwed?

A. It could be. There could have been one more.

Q. Were all of the other ones so-called property damage cases?

A. Yes.

Q. Building owners that were suing for the cost of removing Conwed ceiling tiles?

A. Yes.

Q. And in those cases, were you asked to assess the biological risk to occupants of the school buildings from asbestos released by the tiles?

A. No.

Q. What were you asked to do?

A. Examine the tiles, determine if asbestos existed in the tiles, fiber type and

concentration. Basically a certain assay.

Q. Were you asked to give any opinions at all about a health risk posed by those products in those buildings?

A. I don't think so, as I sit here.

Q. Have you ever been involved with Conwed in a case where someone was suing Conwed alleging personal injury as a result of working with or around Conwed ceiling tiles?

A. I don't think so.

Q. Have you ever heard of such a case?

A. I don't think -- no. If I had some knowledge, I can't recall.

Q. You've also worked with Mr. Brownson for other clients of his other than Conwed?

A. Yes.

Q. Which other --

A. Asbestospray.

Q. That is Mr. Levine's company?

A. It was.

Q. In Brooklyn?

A. Yes.

Q. First of all, how many cases have you worked on for Asbestospray?

A. The City of Wichita Convention Center. When I say worked on these cases, I've analyzed air samples, I've provided data. That does not mean I was deposed nor testified but just general assistance in cases. City of Wichita Convention Center. Kansas City International Airport. Transworld Airline International Terminal at Kennedy Airport, New York. Boys High School in New York, Brooklyn, New York. The State of West Virginia for the University of West Virginia Coliseum. University of South Carolina.

Q. And in those cases your role has been to analyze materials to see if there is asbestos in them?

A. Principally, although I did testify down in Morgantown, West Virginia.

Q. In any of the other cases, other than the West Virginia case, have you given testimony either by way of deposition or in court?

A. I think in several of those cases I gave deposition testimony but never at trial.

Q. Did you testify at trial in West Virginia?

A. Yes.

Q. How about in Wichita?

A. No.

Q. In the West Virginia case, did your testimony in any way touch upon health effects or risks of the products in question?

A. In a way, yes.

Q. In what way?

A. Level of dust, comparison of the workplace with the coliseum, levels of the fiber in the air in the coliseum.

Q. Did you offer opinions on what health risks, if any, those fiber levels present?

A. I don't know if I was allowed to.

THE WITNESS: Did I -- I'm turning to Mr. Brownson.

Did I offer any opinions as to the health risks?

MR. BROWNSON: I don't remember.

THE WITNESS: I don't remember either.

MR. BROWNSON: I'm sure I did but I don't remember if you did.

A. It was just a relative gauging of exposures to a fiber in the workplace as compared

to what they were in the coliseum.

Q. For an occupant or somebody attending a basketball game?

A. Exactly.

Q. What type of asbestos fiber did Asbestospray use in their product?

A. In West Virginia, it was amosite.

Q. Did they also use chrysotile in any of their products?

A. There is a formulation with chrysotile, and that was -- I think chrysotile was in the Kansas City International Airport.

Q. Is their product a plaster -- sprayed on plaster material?

A. It is a cementing agent and it is tamped.

Q. Is it applied for fireproofing?

A. Yes.

Q. All right. Other than for Mr. Brownson, have you done other work -- let me rephrase that question because we will be here all year.

Am I correct that you've worked for other clients as well as Mr. Brownson's clients in

analyzing building materials for asbestos content?

A. Yes.

Q. Do you know a fellow named Ray Balzer?

A. Roy Balzer, yes.

Q. Have you ever worked with Mr. Balzer?

A. Worked with him directly?

Q. Yes.

A. No.

Q. What is his field or area of --

A. He studied at Berkeley with Clark Cooper. I believe he has a PhD in epidemiology or public health.

Q. Do you recognize him as having expertise in the field of asbestos risks from building materials?

A. Asbestos risks?

Q. Let me try again.

Do you recognize him as having expertise in health risks to building occupants or workers from the presence of asbestos-containing materials in the building?

A. That sounds like a legal question. A real legal question.

Q. From a scientific --

A. From a scientific point of view, he knows what air samples are all about and he knows how to obtain the data and generate the numbers, and he, like every intelligent other person, can compare this with exposures in other instances and draw some conclusions. So do I recognize his capability in doing that, yes of course.

Q. Have you ever spoken with Dr. Balzer about Conwed asbestos products?

A. No.

Q. Do you know whether he, Balzer, has ever done any work for Conwed?

A. No.

Q. In this case, are you planning to give any testimony about health risks from calidria asbestos to workers in the Conwed plant in Minnesota?

A. If someone asks me what I think, I'll tell them my opinion.

Q. In your opinion, are Conwed ceiling panels containing calidria asbestos and only calidria asbestos, a health risk to building occupants in --

A. No.

Q. I was going to say in buildings where those tiles are installed?

A. No.

Q. Why is that?

A. Because all of the data which I have seen concerning the use of Conwed tiles in structures show that the levels inside those buildings are indistinguishable from ambient levels. Therefore the risk is extraordinarily low.

Q. So low to be trivial?

A. I would say so low as to be phantom. We have to worry about other things in society and the risks are trivial, that's right.

Q. How about to a person who is, say, a janitor or a maintenance man, cleaner in that building?

A. Tell me how frequently they move the tiles, what fiber levels they are exposed to, calculate a cumulative dose and a time weighted average and we can then tell you what the risk is.

Q. All right. So that to know whether somebody was at risk from working with a

calidria-containing Conwed ceiling panel, what you would really want to know is what dose of asbestos are they getting out of the panel?

A. Yes.

Q. Would that same answer be true with respect to what risk a person had who was working in the Conwed plant itself?

A. Yes.

Q. In order to evaluate the risk you need to know what the dose was?

A. Yes.

Q. In a factory, the dose that a worker gets of dust is determined by, among other things, whatever air hygiene or dust-handling equipment is in place in the factory, is that correct?

A. Sure.

Q. To your knowledge, did Union Carbide have any direct say or control over what dust equipment or air-handling equipment was used in the Conwed plant?

A. I don't know.

Q. Doctor, in your opinion, are pleural plaques a disease?

A. Is it a pathological lesion? It is

something that is not normally there? Yes.

Q. How about clinically, are they considered a disease from a clinical point of view?

A. It could. Pleural plaques can cause clinical disease.

Q. How about in the ordinary course?

A. No.

Q. How about localized pleural thickening, is that from a clinical perspective considered a disease?

MR. BROWNSON: I object. I object to the form of the question. Considered by whom, by him or by others?

MR. WILL: By him.

MR. BROWNSON: Okay.

Q. So the point of my question is, I am trying to distinguish a situation where you have substantial diffuse pleural thickening over half or something like that or three-quarters of the pleura. I'm just talking about localized areas.

MR. BROWNSON: All these questions deal as to his views, if any, as opposed to --

MR. WILL: Yes. His views.

A. From what I gather in the literature, a localized thickening or plaque does not cause clinical symptoms.

Q. In terms of the testimony you have given in other cases, you have -- well, I'll just ask it this way. Am I correct that it is your opinion that chrysotile does not cause peritoneal mesothelioma?

A. Yes.

Q. Is it your opinion also that chrysotile is unlikely to cause pleural mesothelioma?

A. It is less potent, but yes, of course.

Q. How many pure chrysotile-exposure pleural mesotheliomas are you aware of that have been reported in the literature?

A. The numbers are low, yes.

Q. Probably under 15, 20?

A. One question at a time.

Q. Under 20?

A. Under 20? Pure chrysotile verified by tissue burden studies, is that correct?

Q. Yes.

A. It could be that number.

Q. For a while it was thought that the Rochdale and Ferodo plant had some pure chrysotile mesotheliomas?

A. Yes.

Q. But later investigation showed that they were contaminated with crocidolite?

A. They were related to crocidolite, yes.

Q. In terms of ability to cause pleural mesothelioma, would you say -- of the asbestos minerals, would you say that crocidolite is the most potent?

A. Yes, generally so.

Q. Amosite, second?

A. Probably tremolite asbestos in the true asbestos form is probably second, up with crocidolite. Amosite next.

Q. Where do you put chrysotile?

A. Below that.

Q. Am I correct that you believe that in order for chrysotile to cause pleural mesothelioma, there has to be a very high dose?

A. Yes.

Q. High enough that you would expect to find asbestosis in that person?

A. I'm shaking my head. Probably yes.

Q. At least on pathological examination?

A. Yes.

Q. Perhaps not by x-ray but certainly on pathological review?

A. Yes. Yes.

Q. How about lung cancer, do you believe there is a difference in the ability of different asbestos fibers to cause lung cancer?

A. Yes.

12

Q. Which do you feel is the most potent? And let's say the absence of confounding factors at this point, so assume a nonsmoker, if you will.

A. All right. A nonsmoker. I am one of those people who believes that the amphibole asbestos varieties produce more lung cancers than chrysotile.

Q. Now if you add smoking into the mix, there is supposed to be a synergistic effect, is that correct?

A. Yes.

Q. And is the synergistic effect in your opinion any different with amphibole than it is with chrysotile?

A. It probably is different but I don't know.

Q. You would expect a greater synergism with the amphibole?

A. Well, actually if you follow along the newer concepts of how cigarette smoking interacts with asbestos fiber, it is probably chrysotile which is more carcinogenic.

Q. Is that because of the surface area?

A. In part, yes.

Q. Any other reason?

A. Chrysotile absorbs certain organic biological compounds more easily, and it is thought that the carcinogens from cigarette smoke attach to the organic material carried on the surface of the fiber. So the more lipid the surface of the fiber, the more carcinogenic compound is carried to the target cell.

Q. You said this would be the modern thinking?

A. Yes.

Q. You are not aware of any experiments that have been done to try to prove this one way or the other?

A. No.

Q. In terms of relative risk of lung cancer, can you give me some sense of where in a nonsmoker chrysotile stands versus the amphiboles?

A. Other than animal data?

Q. Talking about human data.

A. Who has a population of nonsmokers? No one. So no, those data are unavailable.

in 1

was

OCF.

Q. I think it was Eagle Pitcher at that point. You were called to testify that the chrysotile in the Eagle Pitcher cements could not have been a cause of Mr. Pennock's mesothelioma?

A. I don't know if I testified to that, but we were looking at different fiber types and concentrations and other factors, but yes.

Q. Have there been other cases -- have

there been any cases where you have testified in a personal injury context that you did not believe that chrysotile played a role in the plaintiff's development of mesothelioma?

A. I wonder if I ever testified too. The last personal injury case that I was involved in here in New York involved the finding of a mixture of fibers in the pulmonary tissues of an electrician who succumed with pleural mesothelioma. And at that time, the fibers in the tissues consisted principally of crocidolite with an extraordinarily small portion of chrysotile. Crocidolite would have to be called the causative agent. I don't think I have ever dismissed chrysotile in a role, but rather given the relative potencies one has to come to some general conclusion.

Q. What type of fiber burdens would you expect to see in the lung of a person whose mesothelioma you believe was caused by chrysotile? What kind of fiber burdens --

A. At least hundreds of millions of fibers per gram of dry lung tissue.

Q. The normal white developed male lung

has approximately how many dried grams in it?

A. The ratio is generally one to 10, meaning that for every 10 grams of wet tissue, this can be reduced by heating and dehydration to one gram, so in an adult lung, a male, with a 1,000-gram right lung, this could be reduced to 100 grams of dry lung.

Q. How about the left lung, how many --

A. It is smaller. We are talking in generalities. Could be 1500 grams, 1200 grams. In women it could be 850 grams or 650 grams, something like that.

Q. But an average white male -- lung size does --

A. It depends on physiology, race and other factors.

Q. So we are talking about white males, say approximately a thousand grams of wet tissue on the right lung and 900 on the left?

A. 900, 850, something like that.

Q. When was the first time you ever looked at calidria asbestos samples?

A. 1960's.

Q. What was the reason for doing that?

A. I was interested in characterizing asbestos used in the United States and in various products.

Q. From what perspective, characterizing it as to what?

A. Just looking at it in terms of mineralogical composition, fiber length, fiber character.

Q. Is that when you acquired some calidria from Union Carbide?

A. Yes. I think I got those fibers in the early '70s. 1970, 1971, '72. Something like that.

Q. So that would have been your first examination of calidria at that pint?

A. I'll tell you when I became interested in calidria. This is just an aside. I was at a meeting, mineralogical meeting, mineralogy of asbestos in Oxford in 1968, and Fred Mumpton presented data on the New Idria deposit and I obtained some speciments at that time.

Q. Shortly after that meeting and then you began looking at them?

A. I was interested. It was a new kind

of product, new kind of material.

Q. Did the first calidria you obtained come from Union Carbide or were those samples in '70/'71 after you had already done some looking at it?

A. No, they came from Union Carbide, I'm sure.

Q. What did you do, just call up Union Carbide and say, "I'm interested in investigating your product, could you send me some samples"?

A. Essentially yes, but I think I wrote to someone. I don't know whoever or whomever.

Q. What conclusions, if any, did you draw from your first review of the calidria asbestos?

A. When I first looked at the stuff?

Q. Yes, in the early '70s; late '60s, early '70s?

A. Well, you would have to go back and look at some of my early papers.

Q. Well, for example, did you ever call up Union Carbide and say something to them like, "I've looked at your asbestos and I think the fiber is a real health hazard to people using it"?

A. I'm sitting here thinking. I may have. I don't know. Would I have called someone to say that? I must have discussed it at meetings.

Q. Well --

A. Is it a health hazard? What do we talk about at meetings. In my 1974 paper on size distribution of asbestos minerals, which was published in the Environmental Health Perspectives, I talked about size distribution of fibers and whether or not length was important, and I said if length is important, then anthophyllite should produce the most mesotheliomas, followed by amosite, followed by crocidolite, that is if length is the major determinant of mesothelioma production. But it didn't work like that. It worked in the opposite

Q. What your comment said was this might warrant investigation?

A. Yes.

Q. My question was more narrow. Do you remember in the late '60s or early '70s ever having a conversation specifically with the people at Union Carbide in which you said to them, in words or to that effect, "I have done some research on your asbestos and I think you've got a real hazard here that you ought to be concerned about"?

A. No.

Q. Other than what you put in your scientific papers that may have been published or said at scientific meetings, did you have any communication with anyone suggesting that the Union Carbide calidria asbestos that you were analyzing was a potential health hazard in the factories or plants where it was being used?

A. I can't recall. I don't think so.

Q. All right. At least as we sit here today, you don't recall ever doing such a thing?

A. I don't recall, no.

Q. And if you had ever done that, that would be something, at least at that time, unusual for your general practice, wasn't it?

A. Well, it was unusual for me. I'm not so sure it was unusual for Irving Selikoff, but -- it was unusual for me to do that, yes.

Q. Did you ever go to Mr. Selikoff or any other colleague at Mount Sinai between '68 and '74 and say to them words to the effect that "I've been looking at the calidria asbestos, short fiber, and perhaps you should get the word out to warn people about this"?

A. Maybe a little background without going into the details of this. We were interested in the fibers which were in the mainstream of commerce with the greatest number of applications. And the stuff from Coalinga was going into things like floor tiles and ceiling tiles and I don't think it concerned us very much. So we were interested in construction products coming out of the Manville deposits or the other deposits from Canada, so our focus was there.

Q. Would it be correct to say, Doctor, that you are not aware of anyone from Mount Sinai during this period 1968 to 1974 going to Union Carbide and saying something to the effect of, "We have been looking at your calidria asbestos and we

think it is a potential hazard in the plants where it is being used"?

A. I don't have any knowledge of that, no.

Q. That is what I asked you. You are not aware of any such conversation?

A. No.

Q. Okay. All right. Let's look at what I have earlier marked as Exhibit 2, just to be compulsive and go in order. This is a copy of the notice of your deposition?

A. Right.

Q. And you received a copy of that?

A. Yes.

Q. Okay. We will come back to that a little later. Let's talk about Exhibit 3, which is your report in this case, is that correct?

A. Right.

Q. That is the report on your analysis of the materials that you obtained from the KCAC mine?

A. Right.

Q. This past July?

A. Yes.

Q. And do you have any plans at this point to -- let me back up.

You said you had completed the laboratory work, is that correct?

A. Yes.

Q. But you said you might do some additional work on what you described as the nonchrysotile fibers?

A. Yes. This is just the analysis of diffraction patterns.

Q. That you've already done the diffraction patterns?

A. I've already done the electron microscopy. I have photographed the diffraction patterns but I have not obtained the plates nor the prints as yet.

Q. Will those plates of the diffraction patterns help you to perhaps identify precisely what minerals are in the sample?

A. Yes.

Q. Other than identifying those as to date, unidentified minerals, is there any other work that you plan on doing with respect to the analysis of the samples taken from the mine?

A. Probably not, no.

Q. Am I correct that in your -- backing up, you had 12 different samples, is that right?

A. Right.

Q. And you also had some of the RG-100 pellets that had been given to you by Union Carbide back in the early '70s?

A. I have RG-100, 144, 244.

Q. For purposes of this report, the only pellets that you looked at though were the RG-100, is that right?

A. That's right.

Q. Was there a reason you picked the RG-100 and not one of the other pellets?

A. No.

Q. Are you aware of what grade of Union Carbide pellet was used at Conwed?

A. I think it is 144. It may be 244. I have some attributions to some dust counts.

Q. What is your understanding of the difference between the Union Carbide grades 100, 144 and 244?

A. My understanding, there is a different degree of processing and beneficiation.

Q. What do you mean by beneficiation?

A. It is a general term of grading of ore to concentrate of that which is being extracted and that which is being discarded.

Q. So --

15

A. It is a general term.

Q. So 244 would be "purer asbestos" than 100?

A. Well, make no mistake about it, these are awfully pure. So that the degree of purity would require another analytical study, if you really want to characterize in terms of analytical purity, but for our purposes, I believe it is okay.

Q. Just generally that is your understanding, that the RG-144 and 244 have additional refining steps beyond the RG-100 to try to remove so-called impurities?

A. That is my understanding.

Q. In terms of what you find in the ore then, am I correct you would be -- you would want to look at the RG-100 to be sure that what you were looking for hadn't been removed in the additional refining?

A. I don't understand that question.

Q. If your point in doing the analysis of these materials is to try to see what else is in the product other than chrysotile asbestos, you would want to look at the RG-100 because that presumably has the most nonchrysotile objects or materials in it?

A. I don't think it makes any difference. It is like top grades of nytal 100, 200 and 300. There are some minor differences that they are interchangeable. Frequently they are. So I am unimpressed with differences that I see by optical microscopy so it didn't matter to me. There was no selection on the basis that, gee, this might have the most mineral A in it as associated mineral. No, that didn't drive this assay.

Q. I was just suggesting in terms of being conservative, if you take the one that goes through the least refining steps, you are guarding, however slightly, on the side of making sure that anything that is there you will find, would that be correct?

A. No, that didn't enter into the assay.

If I wanted to do an assay like that, I would have ground up the host rock and looked at the host rock rather than the ores. If that guided me -- looking at this material, why would you want to look at the host rock which is discarded in the boulders and all of that sort of stuff. It is kind of interesting if you are doing the genesis of the ore deposit, but other than that, it is not helpful.

Q. Was there any reason then that you chose the RG-100 as opposed to the 144 or the 244?

A. I think I had most of that in the laboratory. That was just available. And it could also be RG-100, I think is mentioned in several of these papers that I described to you earlier.

Q. Are you aware that people have been analyzing this material for something like 100 years?

A. Well, this is true. And I also would offer the following piece of information, that when the original prospectors went over that deposit, they thought it was talc and not asbestos.

Q. Did you find anything -- backing up, you did find chrysotile asbestos in the samples?

A. Sure.

Q. Putting aside the chrysotile asbestos for a moment, did you find anything in the samples

[redacted]

intergrowth structure of some kind which might conceivably cause disease, but there is no evidence of that either. So to answer your question, the answer is not at this time, no. There are some suggestions but I don't know.

Q. Let me see, I think I asked you this

question in terms of pleural plaque but let me refine the question a little bit. Setting aside the chrysotile asbestos for a moment, did you find anything in any of the samples that is associated with asbestosis, lung cancer or mesothelioma in humans?

A. Anything else?

Q. Right.

A. In humans?

Q. Right.

A. Well, I don't want to get Union Carbide nervous, but there is some chromite magnetite, but I don't think that would be a problem.

Did you find something? You are asking me did I find something. I would have to think of all of the minerals there and how many of those are associated with disease. Is it chrysotile, yes, okay, the amphibole asbestiform materials are not there. Nemalite, experimentally in animals, laboratory animals. Does that mean that coalingite is also active? I don't think so. So chromite has produced diseases in certain instances but this is an associated minor mineral.

And I'm not even sure people inhale the thing. So I would say, well, there is some -- probably not. No.

Q. Let me ask you the question this way then. Would it be your opinion that whatever health effects are associated with calidria are due to the chrysotile component as opposed to anything else?

A. Yes. Probably yes.

MR. WILL: Off the record.

(Discussion off the record)

Q. Doctor, in the course of preparing this report, do you have any other data compilation or notes of your analysis?

A. Sure.

Q. Did you bring that with you today?

A. No.

Q. What else do you have?

A. Well, I have all my laboratory notes and the x-ray diffraction tracings and things like that, and the reason I provided a summary report is that I have not had time to give you all of the details but that essentially is what the data will support, that there is chrysotile there, there are

the other serpentine minerals present and there are these other minerals associated with serpentines. Period. That's it.

Q. As far as you are concerned, is your analysis of the samples and the RG-100 consistent with the other analyses that have been published in the literature?

A. Yes, generally so.

Q. Prior to doing this particular piece of research for Mr. Brownson, had you ever before done an analysis of ore from -- let me be careful -- material either processed or unprocessed from the KCAC mine?

A. KCAC specifically.

Q. Or -- from the pit, put it that way?

A. Yes.

Q. You mentioned you had looked at some of the Union Carbide samples that had been given to you in '68 or somewhere in that '68/'71 time frame?

A. Right.

Q. Did you later have occasion to get additional samples from either the mill or from the mine?

A. I got some other samples, yes, and my colleague Dr. Nolan got some samples, and he was involved in this litigation, I think.

Q. Did you do anything to review the samples that Dr. Nolan got?

A. No.

Q. Maybe I can do this a little less clumsily. I understand -- I know of two occasions when you have reviewed either processed or the raw ore. One would be in the '68 to '71 time frame?

A. Something like that.

Q. When you got samples from Union Carbide?

A. Right, right.

Q. The second would be this time for Mr. Brownson?

A. Right.

Q. Okay, and you said there were some other times --

A. There had to be. People send me samples all the time, so I would say yes, there had to be other instances, sure.

Q. Do you remember what the other instances were next with?

A. No. I've looked at literally hundreds of samples that people send me. They send me samples from all over the country, what is in this and so on and so forth, but -- so I'm sure I've had an opportunity over the past 28 years to look at other samples of this, sure.

Q. And the findings that you reached in this case were, as far as you know, consistent with all of your previous findings?

A. I think so, yes.

Q. On page 1 of your report, which shows it was faxed to me, it has been faxed so many times it keeps growing as people put cover sheets on, but in any event, the title page about three-quarters of the way down the page, you say that some fibers displayed anomalous blue-gray birefrigence.

Q. First of all, what is blue-gray birefrigence?

A. When minerals are examined by means of polarized light, microscopy, the minerals, those which are crystalline, display colors which are the product of light entering the crystal and being affected by the mineral's crystal structure.

And different minerals display different colors as a function of their chemistry and structure. This particular color is not usually found with chrysotile.

Q. That is why you said it was anomalous?

A. Meaning that instead of a straw yellow color, like this pad, it was darker and bluish, generally a color not found for this particular material.

Q. Did you associate the blue-gray birefrigence with any particular mineral or substance?

A. Generally in thicker specimens, it is a sign of strain that the mineral was subjected to some force, external to it, and the crystal structure deformed in some way.

Q. Would this be then an indicator of the geologic history of that area?

A. It is possible. Since I found associated features in a feldspar, I would assume that this is related to some of the tectonic forces.

Q. Am I correct that this blue-gray

birefrigence was in the chrysotile fibers themselves?

A. In some.

Q. In some of them, not all of them?

A. Some of them. It was just an observation.

Q. Over on the second page you mention that you analyzed the RG-100.

A. Right.

Q. And then you talk about the aliquots?

A. Yes.

Q. What exactly is an aliquot?

A. That is a subsample. You have the material and you select portions of it to analyze, not the whole thing.

Q. How many subsamples of the RG-100 did you analyze?

A. Looked at by polarized light --

Q. Yes.

A. Maybe up to 10.

Q. How about of the ore samples from the pit?

A. Two or three each.

Q. So since there were 12 samples, you

probably had 36 aliquots that you would look at? Something like that?

A. Give or take.

Q. Somewhere between 24 and 36?

A. Probably more, but --

Q. Okay. And you indicated that under polarized light microscopy, you did not observe any amphibole material?

A. That's correct, but there was one fragment that could have been an amphibole.

Q. Let me ask you about that, that was a --

A. Nonasbestiform.

Q. Meaning it was not fiberous?

A. Correct. A fragment.

Q. And you describe it as a single crystal?

A. Yes.

Q. Were you able to identify what that mineral was?

A. No.

Q. Was that one of the x-ray diffraction plates that you are waiting --

A. No, no.

Q. Did you attach any particular significance to the appearance of that fragment?

A. No.

Q. How were you able to identify this fragment as a possible amphibole under light microscopy?

A. This is the technique. A powder is immersed in some general mounting medium because a powder by itself will just refracture light from its boundary. You want to compare the properties of light coming through this crystal with the properties of light which surrounds it. So we use immersion oils with known indices of refraction, known densities.

Light behaves in a certain way. Light enters the medium and is slowed in some fashion. Velocity of light in air, about 1.00. The velocity of light in water is 1.33. So it is slowed down approximately 33 percent. When light enters minerals, depending on the crystal structure and the chemistry, light slows and breaks into component parts according to these properties of the mineral.

I have a collection of mineral oils,

a standard set of oils which change in increments of 0.002 units, let's call them units. These immersion oils range from approximately 1.400 to approximately 1.800. The minerals which have high density which have iron in the structure, like for example olivine and pyroxene have high indices of refraction.

When I scan a specimen, I use an immersion oil which will allow me to visualize, for example, chrysotile. My normal scanning oil has an index of refraction of 1.515. Now chrysotile has, for example, one of the indices parallel -- vibrating to the long fiber direction. Approximately 1.556. Now the difference between 1.556 and the immersion oil 1.515 allows me to visualize chrysotile very well because there is a difference in index of refraction, and it means that I can, that the mineral has what is known in the optical crystalography field as high relief.

There is a marked difference in the transmission of light in these two materials and so there is a contrast. There are edge effects. Now if you scan a field of a powder at 1.515 and you see a mineral which looks like a mountain, it

looks like a grain which stands out very high, it is either very much lower in index than the mounting oil or very much higher.

Now given the assemblage of minerals, I assume that I was not looking at cristobalite or opal but rather I was looking at a crystal which was a ferromagnesium mineral which made up the serpentine host. Now when it is rounded with high birefrigence, slightly altered serpentinized, it is probably olivine of some form. If it has very high relief but yet has a certain pattern of cleavage which are more rectagonal, rectangular, I made up a word, rectangular, this is more characteristic of pyroxenes.

Now I can't analyze the materials I'm looking at when immersed in an index oil 1.515. I have to take another aliquot powder and use a different liquid and hope to find a similar grain to measure the characteristics. Sometimes you see it, sometimes you don't.

What looked like a fragment of amphibole based on certain extinction characteristics, when the crystal became darkened when viewed between crossed Nichols, that is the

name of a prism, and has certain characteristics of amphibole, one has to measure the indices of refraction. If you find other pieces like it and it is more frequent or more abundant or occurs with greater concentration, you can do this. But when that is the only fragment you found, you cannot. So it remains unknown. The other minerals were more, behaved better. They were there in higher concentration and it allowed me to perform more analytical work.

Q. Let me see if I can ask a shorter question here.

A. Please.

Q. All right. On page 2, you say that you found this in one specimen number one, you found this fragment?

A. That's right.

Q. You were not able to find a similar fragment in any of the other specimens?

A. That's correct.

Q. Because you were not able to find a similar fragment in other specimens, you were unable to do the necessary test to identify the mineral?

A. Yes.

Q. Now, my question was based upon what you were able to observe through the optical microscope, of this unique fragment that you found, you felt it was some type of amphibole?

A. It was a good probability.

Q. And what was it that made you feel that was a good probability? In other words, what about the characteristics of that particular fragment?

A. It was not olivine because it did not have the very high relief. It was not pyroxene because it did not display any of the pyroxene cleavage characteristics and it looked like what I frequently see as fragments of amphibole. A cleavage fragment.

Q. Do you have any way of identifying which amphibole it was like?

A. No. It could have been a fragment of pyroxene viewed on edge. That is a possibility too. But --

Q. Could have been a lot of different things?

A. Well -- a lot. Well, it could have

been --

Q. Some?

A. Some. One of 20 minerals or one of 10 minerals, something like that.

Q. How many different minerals are there in the amphibole family?

A. You mean discrete amphibole species?

Q. Yes.

A. I don't know. There could be a hundred. There could be 150.

Q. All right.

A. I mean I could list maybe 20 or 25 principal ones, but then there are, you know, oddball things that people find somewhere. One of something, yes.

Q. Langerite?

A. Yes, Brownsonite.

Q. From page 2 to 3, you say, "It is important to note that fibers are observed within the specimens which exceed 100 microns in length."

A. Yes.

Q. All right. Now, are those fibers in the RG-100 specimens or in the ore specimens?

A. Okay, the longer fibers were found in

the ore specimens. That is true.

Q. I'm just trying to figure out to which specimens that sentence refers. Does it refer to ore or RG-100?

A. Since it's a separate paragraph and not in the RG-100 paragraph, there are fibers found in matrices of serpentine that are greater than a hundred microns in length. This is true.

Q. Well, over on the very first page, you indicate that at 100 times magnification, several of the finer bundles approached 1 millimeter in length?

A. Where do I say that?

Q. About halfway down.

A. That's right. Yes.

Q. All right, so that --

A. These are the 12 specimens in the pit. Some of the fibers approached a millimeter.

Q. Okay, so does that mean then that the reference over on page 2 to 3 about 100 microns which would only be about one-hundredth of a millimeter --

A. That would be in the ore specimens as well.

Q. Right.

A. Right.

Q. If --

A. Actually the short fibers were in the muds that were collected.

Q. When the fiber bundles in the ore that were approximately one millimeter in length were processed at the mill, would you expect them to break up and shorten?

A. Probably, yes.

Q. Are those fiber bundles made up of smaller fibriles?

A. Yes.

Q. What is it that holds the fibriles together, what force --

A. One of the great mysteries of life, isn't it. Whatever the forces are, the materials are thought to be essentially the magnesium silicate material itself, which is really some substance that we call sepiolite, which is a magnesium silicate hydrate which may or may not be crystalline, or the fiber bundles are packed together in such a way that their surface properties interact with each other, but those

forces are not very great, so --

Q. All right. Over on page 3, you are talking now about the x-ray diffraction, and you say that, "The following minerals were detected," and you say chrysotile, and there is a parenthesis, "Predominantly the 2M polytype."

A. Yes.

Q. What does that mean?

A. That connotes the essential crystal structure. When you compare the pattern you obtain with the available extra data in the literature, this pattern conforms to 2M. It is a monoclinic form. It is a stacking reference. How the minerals hung together.

Q. Then down at the bottom of that paragraph, you say that when you looked at the RG-100 specimen you found chrysotile, lizardite, which is another serpentine.

A. Yes.

Q. And antigorite, which is another serpentine.

A. Yes.

Q. And brucite, that is another --

A. That is a magnesium hydroxite.

Q. And coalingite?

A. Yes, right.

Q. What family is the coalingite in?

A. Coalingite is an alteration product of brucite.

Q. What percentage of the material by weight would you say was brucite or coalingite?

A. Small. Trace. Barely detectable.

Q. In terms of the x-ray diffraction analysis, what were your detectable limits?

A. Well, given this matrix, maybe a half of a percent or a little less. Just kicking it at a thousand watts -- if I had a 2,000-watt generator we would detect lower. We would wallop the material. The RG-100 we are running 95 or better chrysotile.

Q. But the detection limits were about half of 1 percent?

A. Yes, I would -- yes. I'm shaking my head. You admonished me not to but I'm shaking my head. Yes, it is about that.

Q. You are satisfied that if there were amphibole fiber in this material, you would have found it?

MR. BROWNSON: I object to the form of the question. In these samples or in the entire mine?

MR. WILL: I'll rephrase the question.

Q. Doctor, am I correct you are satisfied if there had been amphibole fibers in the samples or in the RG-100, you would have found it?

A. I think they are less than the levels of detection if present.

Q. And based on the best science, if you will, that you could do, you were not able to find them, is that correct?

A. That's correct.

Q. Down at the bottom of page 3, you refer to something called serpentine polymorphs?

A. Yes.

Q. Polymorph means many structures or many --

A. A polymorph in the physical or chemical meaning is a term of the same chemistry but a different structure, and therefore it has different properties. Like silical polymorphs.

Q. By the way, has Mr. Brownson given you any other papers or test data that suggests that anyone has ever found fiberous amphibole in any material, whether ore or pellets, taken from the Coalinga mine?

A. No.

Q. Over on page 4, you are talking about analytical electron microscopy.

A. Yes.

Q. And you said that it was decided based on resources that only the final ore product would be examined in detail?

A. Right.

Q. I assume that means that you didn't have enough money to do all of it?

A. Well --

Q. Or Mr. Brownson didn't.

A. Well, we can extend this project into two years and have post-docs work on it to look at all those specimens by analytical EM. It is a time-consuming, resource-consuming, costly enterprise. And I -- this is not at Mr. Brownson's direction, by the way.

Q. Okay.

A. I felt looking at the specimens by polarized light microscopy that if I found amphiboles in the part of this ore which is discarded, what in the hell would that -- what would that mean. It wouldn't mean very much. Then going one step further, given materials that would be processed through the mill and the ore, let's look at it by extra diffraction and let's see what that shows, and it basically shows that much of the debris is taken out. Then when you do analytical electron microscopy, which is an investment of these resources, look at the -- look at some product that might have entered that workplace.

Q. O.K.

A. After everything is removed and discarded, what is left. What would an aerosol look like.

Q. What actually went to Conwed, in other words?

A. Presumably. Right.

Q. In the next paragraph down, you mention that the diffraction patterns are consistent with standards with clinochrysotile?

A. Yes.

Q. What is clinochrysotile?

A. That is the monoclinic form. The 2M form.

Q. Now on the bottom paragraph on page 4, you reference that occasionally you observed an electron-dense mineral fiber with an aspect ratio greater than 15 to 1?

A. Right.

Q. And you said that morphologically -- that means structurally?

A. Form.

Q. -- formwise, this mineral resembles an amphibole?

A. Right.

Q. What did you mean by that?

A. It just resembles one. It looks like.

Q. Did you take a picture of that?

A. Yes.

Q. Do you have that with you?

A. I think so.

(Handing)

A. These are some of the preliminary

ones. This is the selected area diffraction pattern (indicating). I said an aspect ratio of greater than 15, correct?

Q. Yes.

A. That aspect ratio of that one is 19 to 1.

MR. WILL: Off the record.

(Discussion off the record)

(Whereupon, photographs marked Langer Exhibits 4-A, 4-B and 4-C for identification, as of this date.)

(Recess taken)

BY MR. WILL:

Q. Dr. Langer, let me show you what we have marked as Exhibit 4-A. Can you tell me what that is?

A. This is a print, a photomicrograph taken on an electron microscope of one of the nonchrysotile fibers found in this specimen.

Q. Okay. And that was -- you indicated that has an aspect ratio of about 19 to 1?

A. Correct.

Q. O.K.

A. Length to diameter. Yes.

Q. All right. And that was done in your lab?

A. Yes -- no. No.

Q. Sorry. Where was it done?

A. This was taken on the instrument in the department of pathology up at Mount Sinai.

Q. So you took the samples up there to have the photomicrographs?

A. I took the grids up there. Right.

Q. I show you what has been marked as Exhibit 4-B. Can you identify that for me?

A. 4-B is a selected area electron diffraction pattern obtained on this fiber.

Q. Now, what is that supposed to show?

A. The beam of electrons, the beam passes through the crystal, the crystal -- the atoms in the structure interact with this beam of electrons. The electrons are scattered as x-rays are scattered, and the scattered electrons form patterns which conform to the structure of the material.

Q. Okay. And then by comparing those patterns to the known patterns of other materials, you can try to identify them?

A. Yes. You can do comparisons or you can actually measure the spaces between those particular reflections and generate information concerning the actual interatomic space action present in the material.

Q. Let me show you what we have marked as 4-C. What is that?

A. 4-C represents an energy dispersive x-ray spectrum obtained on this particular fiber. It shows the chemistry, the essential chemistry of the fiber.

Q. Is there any way of saying that this long fiber isn't simply a number of chrysotile fibriles still adherent to each other?

A. Probably isn't.

Q. Why is that?

A. The diffraction pattern shows that it is not a chrysotile pattern, although superimposed in here there are some reflections which might eventually be indexed as a chrysotile pattern, but it is more than chrysotile. This seems to be a mixture of structures and the energy dispersive x-ray spectrum. The chemistry shows that the magnesium signal is too low for chrysotile.

Q. Okay. Based on the x-ray spectrum or the diffraction picture, have you been able to identify that material?

A. Not yet.

Q. Okay.

A. I've spent another day just on this particular stuff and I have not been afforded the opportunity to examine the plates in detail.

Q. All right. There are two hand-drawn black arrows --

A. Right.

Q. -- on Exhibit 4-C?

A. Correct.

Q. What are those for?

A. Those mark out what is the presence of two trace elements. Elements present in small concentrations. The arrow at approximately 640 KEV -- actually it is 6,400 electron volts is probably iron, and the pattern, the small peek at approximately 590 or 5,900 electron volts may be manganese. So there are traces of other elements.

Q. Are those traces of iron and manganese significant in identifying this material?

A. Iron you would expect in this particular material. Manganese, if that is manganese, it could be some heavy metal, that is the majority of the spectrum lies outside of this particular region.

Q. You said that the electron diffraction pattern suggests a complex structure?

A. Right.

Q. Is that because of the superimposed chrysotile pattern?

A. It could be.

Q. Anything else about the pattern that you thought was complex?

A. Other than the fact I can't immediately identify what it is, yes.

Q. Okay. Are you familiar with the x-ray diffraction pattern of, say, crocidolite?

A. Yes.

Q. How about tremolite?

A. Yes.

Q. How about amosite?

A. Yes.

Q. Does this extra diffraction pattern --

A. For x-rays, no, I didn't identify those peaks either. By selected area diffraction, no. They are not and the chemistry is certainly not.

Q. You mention in your report something that you call a talc bowl. What is a talc bowl?

A. That is a structural mixture of talc and an amphibole, generally anthophyllite in which there are regions of different mineral in the same ribbon, in the same fiber.

Q. You were suggesting this may just be a structure that has mixed minerals in it?

A. That's right. It is possible.

Q. You didn't find talc in this particular fiber, did you?

A. No. Actually talc would be a good guess because the magnesium signal for talc is about half of that of chrysotile.

Q. You mention in your report the magnesium silicon ratio?

A. Right.

Q. And then you give a ratio for chrysotile of 0.75 to 0.85?

A. That is about right.

Q. What ratio is that?

A. Magnesium to silicon.

Q. But is that number of atoms, weight --

A. Those are the number of x-rays generated on the specimen. You can recalculate on the basis of a first order approximation the atomic percent based on that particular x-ray count.

Q. And you say the ratio then of magnesium to silicon, it is that there is approximately three-fourths to 85 percent magnesium x-rays to silicon x-rays?

A. That is exactly what it states, yes. It implies little else other than the fact that the elements are present in approximately equal atomic weight percent. Approximately.

Q. And when you did the magnesium silicon ratio for this fiber here, you got a considerably lower percentage?

A. Yes. That's right. Correct.

Q. When you talk about a discredited serpentine mineral, what do you mean by that?

A. There is a convention followed that

every claim of a new mineral has to be -- the data has to be presented to some body of mineralogists, either the Mineralogical Society of American or the International Mineralogical Commission or whatever, and the data are presented and people determine whether or not these are distinctly new minerals or whether they are variants of what exists previously or what is known.

And the problem in the old nomenclature, there must have been 50 different serpentine minerals. No one used electronmicroscopes because it was not a tool routinely used by mineralogists, but bulk techniques were used to characterize specimens. Bulk chemistry, meaning a whole specimen was analyzed chemically or x-rayed a fraction or something else, and frequently minerals with names like Deweylite and picrolite and Stevensonite and so on were found to be mixtures of chrysotile and lizardite, chrysotile and antigorite, antigorite and lizardite. So many of these minerals have been subsequently reevaluated with newer techniques, and these are mixtures, these are not separate entities. So they are discredited. Like

amosite.

Q. What did you mean by a discredited mineral?

A. The mineralogists are asked not to use the term anymore because it is something else.

Q. So this large fiber may be one of these conglomerate structures?

A. Exactly. I just don't know that yet.

Q. Okay, but it may be?

A. It may be.

Q. In your opinion, is the fiber in the photograph Exhibit 4-A a different material than the crystal that you observed in specimen number 1?

A. Probably is.

Q. Do you have an opinion on whether there is any significance for the health of people using RG-100 to the presence of that fiber in picture 4-A?

A. Don't know.

Q. How long did it take you to do all of the analysis of the -- of all of the specimens? Number of hours?

A. I don't know, it has been on and off.

I do the polarized light microscopy and the x-ray diffraction and I am focusing on the TEM. My colleague generated the aerosol and we are having a student measure under this, under the supervision of Dr. Nolan. My input, in total?

Q. Yes.

Maybe I should ask you the question --

A. Maybe 40 or 50 hours.

Q. How many man-hours or person-hours all together?

A. That --

MR. BROWNSON: All together for this analysis?

MR. WILL: Yes, of this analysis to this point.

A. I believe Dr. Nolan is going to bill separately for his hours involved in the generation of the aerosol and so on and so forth. My involvement may be 50 hours total.

Q. And what rate do you charge for your consulting work?

A. I charge $225 an hour for background work like this.

Q. Different rate for testifying?

A. $275 an hour for a deposition and $325 an hour for trial testimony.

Q. This background work, does it include literature reviews, laboratory work, visiting mine sites or field sites?

A. Yes. And what comes free is all my thoughts as I'm driving down in and out of work. That is sort of free. There is no egg timer in the car.

Q. Those are like mine.

A. That is a freebie.

MR. WILL: Why don't we break for lunch.

(Lunch recess: 12:51 p.m.)

Afternoon Session

1:50 p.m.

A R T H U R M. L A N G E R, previously sworn, resumed:

BY MR. WILL:

Q. Before we took a lunch break we were talking about your report briefly on the analysis of the samples. Am I correct that in terms of your analysis of the samples from the mine and the RG-100 samples, that the only thing that you have left to do at this point is whatever work you are going to do to try to analyze that fiber that is shown in Exhibit -- or not analyze --

A. Similar fibers.

Q. -- that or similar fibers to that in what is 4-A?

A. Yes.

Q. Other than that, your work with the samples is finished?

A. Pretty much, sure.

Q. Well, I ask you because this is my one chance to ask you about that because anything you do after today --

A. I'll tell you about it if I do it

through Mr. Brownson.

Q. All right.

You mentioned that you have at your lab the raw data, I guess, if you will.

A. Right.

Q. That was generated from your analysis of the samples.

A. Right.

Q. Do you have anything else that you didn't bring with you today that you have collected or prepared for purposes of your testimony in this case?

A. Well, yes, the actual reprints of the papers that I read as background.

Q. Okay.

A. Correct.

Q. So you have somewhere a file with those reprints in them?

A. Yes.

Q. All right. Other than that file and the raw data from the analysis, is there anything else that you have been given or you have collected for this case that you did not bring with you?

A. Yes. I mean I look up papers which have been published in the proceedings of conferences which have been published in other journals.

Q. But if you make a copy of those, you would put them with the others?

A. If I make a copy of them, yes.

Q. What I'm asking you is do you have any other materials beyond whatever copies of papers you may have and the raw data from the analysis of the samples that relates to this case that you have not brought with you today?

A. Well, there are the standard mineral specimens that are part of my collection in the laboratory. Ore specimens from other parts of the world, the UICC collection.

Q. I mean things you gathered just for this case, things that you --

A. I don't think so. I can't recall, but as I sit here today I can't think of anything.

Q. Okay. Now, what you brought with you today is a small manila file that has some information in it, is that correct?

A. Yes.

Q. And then you brought photocopies that are in three different packages with rubber bands around them?

A. Yes.

Q. All right. We'll take the thickest of the packages, and that is copies of Union Carbide dust counts, is that correct?

A. Yes.

Q. And are all of these in the thicker packet from the King City plant?

A. I believe so, yes.

Q. And I'll just indicate for the record that they are King City dust count dated February 3rd, 1978, UCC plenum test, 10,903 dust count, 5/12 and 7/26/82.

There is an asbestos count -- dust count, King City California dated April 19, 1977. There is a King City NIOSH sample dust count, January 25 through 27 of '83. There is a dust count, King City, California, May 2 of '78. A dust count dated December 11, 1974. A dust count dated March 15, 1979. A dust count dated April 19 through 20 and 25 through 26, 1978. Something called residential dust count, King City,

California, April 21 through 22, 1981. UCC plenum tests, dust count mill tailings, May 12th, 1982.

A dust count, March 23 of '77. A dust count of May 2, 1978. A dust count of -- I guess this is another copy of the residential dust count, April 21 and 22 of 1981. There is another dust count apparently dated ceiling counts performed on short-term samples obtained at King City on April 19, 20, 25 and 26 of 1978. And the last item in the packet is a memo dated March 25, 1983 with attached asbestos fiber counts for samples from King City mill collected on February 14, 1982. Is that right?

A. Sounds right.

Q. The second package of materials you have has a label on it that says "Conwed," is that right?

A. Yes.

Q. And there is a copy of the deposition of Edward Kleber taken in the case of James Manisto on February 13, 1989, is that right?

A. Yes.

Q. Then attached to it are some Union Carbide documents marked as exhibits at that

deposition?

A. Right.

MR. WILL: Off the record.

(Discussion off the record)

Q. And the third package of material are dust counts for other Union Carbide customers, is that correct?

A. Yes.

Q. Those are Southern Imperial Coatings, New Orleans, Louisiana, November 20, 1974, RUCO, Inc. of Meriden, Kansas, dust count of March 7, 1977. RCA Rubber Company of Akron, Ohio, dust count file, no date on the cover of that one. And REN Plastics in Lansing, Michigan, dust count of October 28, 1975. And finally Resin Coatings, dust count of July 30, 1973. Is that right?

A. That sounds correct.

Q. Okay. How was it that the other -- the dust counts for other customers were selected, do you know?

A. No.

Q. Were those given to you by Mr. Brownson?

A. Yes.

Q. Did he tell you that there were several hundred other dust counts?

A. Yes.

Q. Is he planning to have you review those?

A. I believe so, yes.

Q. When you get around to it.

A. Well, you are looking at a lot of documents. If you take the numbers out of the tables, you can make a large table, you get a better understanding of what is going on, so I think it is important to do that.

Q. You said if you made a large table showing the dust counts from various plants, you could get a better idea of what was going on?

A. Sure.

Q. Okay. But in order to know what the dust counts were in a particular plant, you would have to do air sampling in that plant while the product was being made?

A. That would be best.

Q. Because the amount of dust released in any particular plant depends on a host of site-specific factors?

A. Yes.

Q. Do you know for purposes of your testimony in this case, what purpose, if any, would be served by doing this large collection of data from all of the different plants?

A. Yes.

Q. What purpose would that be?

A. That purpose would be that which allows one to focus on the relative degree of manipulation of a product and whether or not a certain product liberates dust.

Q. So the purpose of looking at these is to reach some conclusion about whether or not use of the pellets produces dust?

A. That's right.

Q. Now, would that give you a basis for making a comparison as to whether it produces more or less dust than, say, a similar amount of asbestos that came in bags but was not pelletized?

A. I'm not sure.

Q. Given the same operation, would you expect pelletized asbestos such as Union Carbide provided to be more or less dusty than an equivalent amount by weight of asbestos that was

unpelletized?

[redacted]

Q. By friable, you mean they release fibers with finger pressure?

A. That is normally how it is defined by EPA, but friable is a term used in the Union Carbide documents.

Q. Well, do you know how they meant friable when they used it in their documents?

A. I would think that friable would mean crumble to the touch of the hand.

Q. That is the EPA definition?

A. That is the general mineralogical, geological definition too.

Q. When you use friable in this context, do you have a different definition?

A. No.

Q. If the operation involved is simply

taking a bag and dumping it into a tank, if you will, with a wet solution in it, would you expect that operation to be more or less dusty if pellets are used as opposed to just loose fibers?

A. That is a different question. The purpose of pelletization is to control dust. One has to determine what the -- how these bags were handled and how much manipulation the bags went through to determine whether or not there is dust which exists somewhere in that bag. Since these pellets rub against each other, suffer a disaggregation when impacted physically with something, but generally speaking, one would have to measure that. One has to measure that.

Q. Okay. You are aware of measurements that were taken in the Conwed plant at the time when Union Carbide asbestos was being used there in the Conwed plant?

A. In the Conwed plant?

Q. Yes.

A. No.

Q. You've not been shown that information?

A. There are no Conwed data there. I'm

looking at Mr. Brownson pointing to the study.

MR. BROWNSON: I'm not going to answer the question but you can go through them and look.

MR. WILL: We just went through it. I don't remember if there was attached to Kleber's --

THE WITNESS: Hold it a second. Here we have it. Seek and ye shall find.

A. Yes.

MR. GERSON: Off the record.

(Discussion off the record)

Q. You see in Kleber's deposition, there is a report of dust counts made at the Conwed plant when Union Carbide asbestos was being used?

A. Yes.

Q. And am I correct you had not focused on those before right now?

A. Well, I just read too much. There was just too much material. Obviously --

Q. Okay.

A. Anyway.

Q. Are you aware of any dust counts that

were taken at the Conwed plant when non-Union Carbide asbestos was being used in the operation?

A. No.

Q. Do you have any way, then, of comparing whether use of the pelletized product in the Conwed operation was more or less dusty than use of nonpelletized asbestos would have been?

A. No.

Q. Were you aware that union -- that during this period of time when Conwed was purchasing asbestos from Union Carbide, that Union Carbide made both pelletized -- sold both pelletized and nonpelletized asbestos?

A. No.

Q. Do you know whose decision it was to get the pelletized asbestos for the Conwed operation?

A. No.

Q. You indicated that, to your understanding, pelletization was designed to control dust?

A. Yes.

Q. All right. The general theory being that a pelletized product will emit less dust than

the same product not pelletized?

A. Yes.

Q. In the case of calidria asbestos, is there any reason to believe that that general proposition would not hold true?

A. No.

Q. In terms of the materials that you have been provided by Mr. Brownson, other than the Kleber deposition and the materials that we have gone through here today, is there anything else that he has given you?

A. Not yet, no. I mean there is some promissory note that I'm going to look at all these other data sets.

Q. Okay. Did you have everything you felt you needed in order to make your analysis of the samples that you obtained from the mine?

A. I don't understand the question.

Q. All right. Let me put it this way. Was there anything that you did not have that you wished you had in order to do your analysis of the material?

A. Yes.

Q. What was that?

A. Time.

Q. All right. How much more time was that?

A. That is a nice project. It is one that you could spend a great deal more effort on. It is an interesting problem area and it is one that doesn't require 50 hours of work. It is one that could require 500 hours of work, and a student doing a master's thesis level project collecting data on the mineral nature of an ore deposit and variation in terms of depth within the pit and so on and so forth.

Q. So there are other things from a mineralogical point of view you would have been interested in looking into?

A. Sure.

Q. As far as the particular issue in litigation, which is what else is in the ore?

A. That is one of the factors, right.

Q. Did you have enough time to do that analysis?

A. Well, is there ever enough time? You have to view the problem against what you consider to be an appropriate commitment of resources.

That this particular problem is one of the principal elements is the presence or absence of other biologically active minerals. If we don't find it now in 50 hours of concentrated work or 60 with electron microscopy or 70 or a 100 or whatever, it may not be important, meaning it is trivial in relation to the total risk.

Q. Okay.

A. Now you can just beat this to death and find one part per million amphibole fiber and it may have very little significance biologically.

Q. Or you might beat it to death and still not find anything?

A. Exactly correct.

Q. Did you feel you were able to make a reasonable commitment of resources and time to this project given what your results indicated so far?

A. I think given my experience and given what I find in other instances and given the expertise of the involved players, yes, I think it is reasonable, I think it is reasonable, and given the data which are out there in the published and unpublished reports, I think it is also

reasonable.

Q. Okay. Other than time, was there anything else that you would have liked to have that you didn't have? I suppose time and money, right?

A. What would I have liked to have for an assay?

Q. Something that Mr. Brownson could have given you that he didn't give you.

MR. BROWNSON: Wait a minute. That is a vague question. Why don't you define what you mean.

Q. I'll rephrase the question.

Did you ask for anything in the course of doing this analysis of the materials that was not given to you or made available to you?

A. No. I must state for the record this has never happened. And Mr. Brownson has been forthright and forthcoming with all materials.

Q. So that basically you had everything you felt you needed to make a reasonable analysis of the material?

A. Yes. Frequently of course it is

reversed, it is I who provided the materials as I should.

Q. Okay. In terms of your CV, which we have marked as Exhibit 1, let me ask you a couple of questions about that.

Actually before we leave that, I want to ask you about other documents. You brought with you a manila file and in it was a copy of your report?

A. Right.

Q. Copy of the deposition notice?

A. Right.

Q. Okay. There is also a copy of a document from the State of California, Air Resources Board, Stationary Source Division dated February 1990 entitled "Proposed Control Measure For Asbestos-Containing Serpentine Rock in Surfacing Applications, Staff Report"?

A. Right.

Q. What is the gist of this report?

A. As a result of the EPA involvement out in California and as a result of several reports that there were chrysotile outcroppings and asbestos entering the air at certain places,

in fact there is a major recreation area in which off-road vehicles raise dust clouds that contain fiber, California became interested in whether or not serpentine rock could be used on roads as road surfacing material.

Q. As in gravel or --

A. Yes.

Q. -- or as blacktop?

A. No, uncovered. Just crushed stone which is a serpentine rock.

Q. This says this is a proposed control measure.

A. Yes. I think that has recently been -- it has been legislated into law.

Q. And why were you involved with that?

A. Actually this is the result, these documents that I have in my possession are the result of my contacts at that EPA meeting, so there were individuals there representing the California Air Resources Board and the State Health Service and the State Environmental Control Group. In fact the meeting was held at the Monterey Bay Pollution Control Unified District, or whatever it is called, and they are interested

in the use of asbestos-containing rocks.

Q. If you had been asked your opinion on this proposed control measure, do you think it is appropriate or not?

A. I think it is overstated, yes.

Q. Did anybody ask you your opinion on it?

A. No.

Q. All right. By overstated, you mean that that degree of control is not necessary?

A. Well, I think that -- yes, that degree of control is unnecessary, that they are dealing with levels of fiber that are about a million or 10 million times less than you find in workplaces, at least workplaces in the past that produced disease, that their concerns are disproportionate to the risk involved.

Q. All right. And --

MR. WILL: Let me mark this as Exhibit 5.

(Whereupon, report marked Langer Exhibit 5 for identification, as of this date.)

Q. I show you what we have marked as

Exhibit 5, and that also came from your folder?

A. Right.

[redacted]

Q. Where did you get that?

A. That was given to me by Mr. Brownson.

Q. And you indicated you would like to get a copy of that report from NIOSH?

A. Yes.

MR. WILL: Let's mark this proposed California measure as Exhibit 6, just to be complete.

(Whereupon, California staff report marked Langer Exhibit 6 for identification, as of this date.)

Q. We have marked the California staff report as Exhibit 6, is that right?

A. Right.

Q. You also have with you, there is a piece of yellow paper, notes in your file, I guess. What is that all about?

A. That is just an outline of what I thought would be areas that I might be asked to comment on or testify to.

Q. Okay.

MR. WILL: Let's mark that as 7.

(Whereupon, notes marked Langer Exhibit 7 for identification, as of this date.)

Q. We have now marked your sheet of notes as Exhibit 7.

A. Okay.

Q. Is that right?

A. Yes.

Q. Was this a list of topics you thought you would be asked about at the deposition or that you might testify about at trial in this case?

A. Actually this is my list which I proffered to Mr. Brownson as to what I thought I could assist on.

Q. Okay.

A. I don't know whether I'll be asked to

A. Yes. And the size character of aerosols.

Q. All right.

A. Then a calculation as to what is seen by light microscopy and what is actually present as visualized by transmission electron microscopy.

Q. Does that last item refer to the fact that if you can see a certain number of fibers optically under a light microscope, that if you use it, an electron microscope, there will be a certain magnitude higher of fibers?

A. Yes.

Q. What is the size character of the aerosol, is that what we discussed earlier?

A. Yes.

Q. About the distribution of fibers in different sizes?

A. Right.

Q. The last thing says "Ratio light to TEM"?

A. Yes.

Q. "Numbers not crunched"?

A. "Numbers not crunched." That is my own little note to me. The "numbers not crunched"

is correct.

Q. And then the last line says something about "Very large, could be like textiles"?

A. Yes, it is "Very large, could be like textiles." Meaning that one of the standing working hypotheses regarding the extreme risk associated with asbestos textile work is based on the supposition that there exists a larger population of fibers greater than five microns in length which are beyond the resolution of the light microscope. And that this material is of such character as to suggest that this is also possible.

Q. When you say beyond five microns in length, do you mean less than or greater than?

A. I'm sorry, greater than.

Q. Greater than five microns?

A. Yes.

Q. But still you are unable to see it under light microscope?

A. Because it is too thin. Correct.

Q. Looking at a sample with the electron microscope would hopefully reveal those types of fibers?

is correct.

[redacted]

Q. When you say beyond five microns in length, do you mean less than or greater than?

A. I'm sorry, greater than.

Q. Greater than five microns?

A. Yes.

Q. But still you are unable to see it under light microscope?

A. Because it is too thin. Correct.

Q. Looking at a sample with the electron microscope would hopefully reveal those types of fibers?

Q. All right. How about for lung cancer?

A. Yes.

Q. How about for mesothelioma?

A. Still yes.

Q. Okay.

A. All other factors equal.

Q. Right. Implicit in those questions was the assumption that the worker was there and that there was sufficient fiber release from the production process to generate disease if the fibers are biologically capable of generating disease?

A. That's correct. I'm assuming an exposure like in Paterson, New Jersey, if the same materials are used and they are dispersed in the same way.

Q. In your opinion, those fibers are biologically capable of causing disease under the right circumstances?

A. Possessing the characteristics, yes.

Q. Are you aware of the amosite use at the Conwed plant in Cloquet, Minnesota?

A. It is my understanding amosite was

used for some time period, yes.

Q. Have you been given years or quantities?

A. My understanding it was for the first several years. Quantities? No.

Q. Have you been asked to provide any opinions in this case on the relative contribution of amosite versus Union Carbide calidria in causing any disease that may have developed out at the Conwed plant?

A. No.

Q. Do you feel qualified to give those types of opinions if asked?

A. I feel qualified to speak about anything. Whether the court qualifies me is something else again.

Q. Let me try the question differently. Are you going to be asked to give such opinions in this case?

A. I don't know. I really don't.

Q. If you were asked such questions, what information would you want to know on which to base your opinion?

A. First, the individual involved, and

I'm assuming that these diseases appear in individuals --

Q. Yes.

A. What is the individual's work history.

Q. O.K.

A. If an individual worked during the time period that the other fiber was used, how long, what were the fiber levels, what was this particular person's job description, what was this person's cumulative dose when this particular fiber was stopped or removed from the process and calidria was introduced. The same questions are asked for this particular individual's occupational history.

Q. If we do not have dust count data for the period when the amosite was being used, would you still be able to make an assessment of the relative contributions between the two fibers?

A. That would be far more difficult. If the individual succumed with a peritoneal mesothelioma, then without knowing what the levels were of amosite, I would say that sounds like amosite. Amosite produces a proportionately

greater mortality experience, it is higher, following amosite exposure.

Q. Without regard to a specific plant or individual, do you believe that amosite is more fibrogenic?

A. Do I believe that amosite is more fibrogenic?

Q. Yes.

A. No.

Q. In terms -- go ahead.

A. I misspoke. Than chrysotile?

Q. Yes.

A. No.

Q. In terms of ability to cause asbestosis, if we assume the same dose between amosite and chrysotile.

A. On a fiber-by-fiber basis?

Q. Yes.

A. On a fiber-by-fiber basis, probably amosite.

Q. Would be more potent than chrysotile?

[redacted]

Q. By fibrogenic, do you mean ability to cause fibrosis in the lungs?

A. Yes.

Q. Which is another way to say caused by asbestosis?

A. If it is caused by an asbestos fiber, it is called asbestosis, right.

Q. In a given amount of amosite, would you expect to find more, less or the same number of fibers as in an equivalent weight of calidria?

A. Far less.

Q. Because the fibers are larger?

A. Yes.

Q. And heavier?

A. More dense, yes.

Q. More dense?

A. So that even if the size distribution was identical given an equivalent weight, you would find less amosite, correct.

Q. If you were counting fibers?

dissimilar is the fact that amosite has a density that is about 20 percent greater, 30 percent greater than chrysotile, so that means that there will be 20 or 30 percent less fiber. So we can go the other way and give chrysotile a 20 percent more fiber or 30 percent more fiber, so instead of a hundred, it is the equivalent of 120 or 130 chrysotiles.

Q. So if I --

A. On a weight basis.

Q. Then on a weight basis, you might have a hundred chrysotile -- 130 chrysotile fibers and about a hundred amosite fibers?

A. One.

Q. One amosite fiber?

A. Yes.

Q. That is assuming the same length?

A. Yes.

Q. Are you familiar with the South African asbestos amosite grade G?

A. Oh boy, classifications from South Africa were different from the classification of Quebec, of course. I'm completely blocking on it.

Q. You realize G, GK, DX?

A. It is a completely -- it is a similar classification but it is not same. Again it is a commercial application. We are talking about a commercial designation. We are not talking about the Quebec method. It is a different kind of classification. This classification scheme was given to me by the former president, Bob Cryor of North American Asbestos in Chicago.

Q. Do you know where Cryor is today?

A. He died of a mesothelioma.

Q. Do you know when that was?

A. 15 years ago, 20 years ago. In fact the last time I saw him he was at Mount Sinai.

Q. For treatment?

A. I think he came for a consultation with Irv.

Q. After he became ill?

A. Uh-huh.

Q. That was a yes?

A. I'm sorry, I apologize.

Q. Doctor, at the present time you are the director of the Environmental Sciences Laboratory of the Institute of Applied Sciences at the Brooklyn College of the City University of New

York?

A. Yes.

Q. How long have you been the director?

A. Since I arrived there in 1988, I guess.

Q. And prior to that, you were at Mount Sinai?

A. Yes.

Q. Why did you leave Mount Sinai?

A. Well, it is a long tortured kind of explanation. Basically I left the Environmental Sciences Laboratory. My appointment was not renewed under Landrigan. I went to the Center for Polypeptide and Membrane Research, which was incorporated into the department of physiology and biophysics when that director retired. That is Dr. Irving Schwartz. And that was the time to leave.

Q. You indicated your appointment was not renewed?

A. Yes.

Q. Who was that?

A. Landrigan. He was Irving Selikoff's replacement.

Q. What was the reason, the stated reason that Dr. Landrigan did not renew your appointment?

A. The stated reason was that on the retirement of Selikoff, the unit would move in other directions and he would not be embarking on any asbestos research areas.

Q. Did you suspect there was another reason?

A. Oh, sure, of course.

Q. What was that?

A. What does it matter. Doesn't matter today.

Q. I don't know unless I know what the reason was.

A. Why don't you ask Phil Landrigan.

Q. From your perspective what was the real reason?

A. Irv Selikoff didn't want me around. I became too independent and spoke and wrote views which were contrary to his pronouncements and beliefs. I know that is hard to believe but it is true.

Q. Can you identify one or two most

important areas where you came to disagree with Irv Selikoff?

A. There are many areas.

Q. Can you pick out one or two or three or four?

A. In the early 1980's, I was involved in a study which was funded by a Crown Corporation in Canada which involved the asbestos industry. In fact, the Crown Corporation was represented -- it represented the reorganized industry after the bankruptcy of Johns-Manville. This industry was jointly owned by the Ottowa government, the Quebec government and the holders of the asbestos interests at Thetford and Asbestos, Capital A, that is the name of a town.

The study involved the modification of fiber for safe use. It doesn't matter what the details are. I first spoke about these materials at an OSHA hearing in 1984 in which I essentially violated the litany of Sinai, which infuriated Irving Selikoff, and Irving Selikoff felt that he was losing control or lost control of what I was saying and where I was going.

Q. Which part of the litany did you

violate?

A. That modified asbestos could be used in certain products with reasonable safety of low risk and that the surface properties of a mineral fiber dictated its biological potential, and that I did not believe that many of the frequently stated concepts were true. I mean people kept repeating them, so many neophytes in the field thought that this was so, and there was some data to support it but there weren't any data, and I said so. And I was the only one who went my own way. Anyway --

Q. Okay. Well, I am -- I'm interested in these areas where you disagreed with Dr. Selikoff.

A. I disagreed with him in a lot of areas.

Q. As opposed to the personality clash but the scientific disagreement. Was it your perception at that time that the Sinai litany was that there was no safe level?

A. I didn't believe that.

Q. And they did?

A. Yes.

Q. And one of the areas where you disagreed with extrapolating projections of disease from relatively high exposures to rather low exposures?

A. Well, there is nothing to disagree about. I think you can do that. The nature of a model certainly warrants discussion. The problem was that I didn't believe that the EPA could base a policy which would affect society so dramatically based -- it should be based on such weak data. I was opposed to that. I came out against the EPA ban on asbestos. I critiqued the environmental -- no, excuse me. It is the Natural Resources Defense Council's proposed ban on asbestos and friction products. I thought it was so unscholarly and offensive and I said so. There were a lot of reasons why we parted company and parted ways.

Q. How is the Environmental Sciences Laboratory of which you are the director funded?

A. We do contract work with various groups.

Q. Is there any state funding?

A. We just got a major state grant. The

state just gave us $725,000 as part of a major grant to the City University, and that will be for new equipment.

Q. Okay. I guess --

A. My laboratory. This is just my laboratory.

Q. Is that -- this is the Environmental Sciences Laboratory?

A. At Brooklyn, yes.

Q. What I am not clear about is, as I understand, you have this laboratory which is -- affiliated with the Brooklyn College of the City University of New York?

A. That's right.

Q. But you are funded basically from your contract work?

A. That's correct.

Q. Unless you qualify for more or less one-time state grants?

A. We are hoping it is not one time, but we qualify to seek support from any units, whether these are foundations or various government, state or federal or through various talc companies, pharmaceutical companies, gasket manufacturers,

feet. We have a microscopy room that is 15 by 15, so that is 225. We have a preparation room. They are all about 15 by 20, that is 300. And we just got a room to set up microscopy preparations, another 300, so that is 600 feet. So it is about 3,000 square feet.

Q. And this is in one of the buildings at the City College?

A. Yes.

Q. Brooklyn College?

A. Ingersoll Hall.

Q. Were you the founder of the lab?

A. Yes.

Q. For purposes of the analysis you did in this case --

A. Right?

Q. -- was all of the equipment that you used at your lab or did you need to go somewhere else?

A. No. Not all equipment was at my lab. Yes, I had to go somewhere else.

Q. And what equipment did you not have at your laboratory?

A. The x-ray diffraction unit was not at

my laboratory. I have one in my laboratory but it is not set up to do this kind of work. I used the one available in the laboratory up at Vanderbilt Talc Company in Norwalk, Connecticut, and I have a user relationship with the department of pathology in the Mount Sinai School of Medicine to use their analytical electron microscope.

Q. And you pay them a user fee?

A. It is a modest fee but we have a very good working relationship and it worked out well. I help them interpret data they can't interpret and they let me use that instrument any time I want to.

Q. Okay. How long have you known Bob Nolan?

A. Bob Nolan, he was an undergraduate when I first met him at Mount Sinai. He came in as a summer student. I bet that is maybe 15 years ago.

Q. What is his degree in?

A. He has a PhD in chemistry here in the City University.

Q. Is he any relation to Charles Nolan?

A. Chuck Nolan?

Q. Yes.

A. Captain of police, Paterson, New Jersey. They are only related by blood. That is his father.

Q. All right. Was Bob in any way involved in the Paterson, New Jersey studies?

A. No.

Q. Do I understand correctly that Chuck Nolan helped even to the point of -- helped that study to the point of storing specimens of materials.

A. Yes.

Q. Other than being chief of police, did he have any scientific training?

A. I don't know.

Q. Did you work with the father?

A. I knew Chuck Nolan and -- well, work with him, other than see him at Sinai, once in a while.

Q. Do you know where the materials are today from the Paterson study, the tissue?

A. The tissue I would give my right arm for. No.

Q. Nobody knows where it is?

A. Several years ago I made an inquiry of Jack Churg, and by law pathology departments store materials, even blocks, for only five years. That is some legal requirement. And bulk tissues no pathology department has room to store, so whatever they had were disposed of.

Q. I see from your CV that you have a bachelor's degree in geology, master's in petrology and PhD in mineralogy.

A. Correct.

Q. What is the difference between the three?

A. Geology is the general field, the general science. Petrology is the science of rocks and rock systems. And mineralogy is the study of the individual components of rocks, ore deposits and things like that.

Q. What are -- if somebody else starts out as a geologist, what are some of the other directions they go other than into petrology and mineralogy?

A. Let's be serious about this. They could go into petroleum exploration as a structural geologist or paleontologist or

micropaleontologist or sedimentologist or a stratigrapher. They could also go into mining, mining engineering. Also could go into a general -- academics, I suppose.

Q. As you described it, it seems to me you were talking more about larger structures and relationships than in the direction you went, which is focusing first on rocks and then the individual components?

A. That's right.

Q. Is that a gross summary?

A. Well, it is just different disciplines. Different disciplines look at different parts of the problem.

(Recess taken)

BY MR. WILL:

Q. Dr. Langer, have you looked at any tissue of any workers at the Conwed plant at Cloquet?

A. No.

Q. Have you been made aware of any fiber studies or fiber burden studies on any Conwed worker?

A. No.

Q. Do you know whether that has ever been done?

A. No.

Q. Have you seen any medical records or any x-rays or any medical materials on any of the workers at Conwed?

A. No.

Q. Do you have any sense of what diseases were claimed to have been suffered by the work force as a result of their exposure to asbestos?

A. I'm thinking.

Q. Let me see if I can rephrase the question.

Have you been given any sort of breakdown about claimant diseases that are related to asbestos that were incurred by the Conwed -- or allegedly incurred by the Conwed work force?

A. Years ago the Cloquet plant closed, am I correct, in that assumption, years ago --

Q. No.

A. The Conwed facility closed?

Q. No.

A. It is still open?

Q. It was sold but it didn't close.

A. I see. It was sold but then something happened whereby everybody was out of work, is that correct?

Q. When it was sold they were out of work.

A. When it was sold they were out of work. Okay. I thought there was -- my recollection is that years ago there was some -- I'm not sure this is Minnesota or Wisconsin. There is a class action suit and there are two papers published in the American Journal of Industrial Medicine on a group of people, and I can't think of the -- I'm blocking on this. Maybe it is late in the day. Right now I can't recall, although in dim recollection I think there are a couple of papers published but --

Q. Okay. Let me make the question more specific. Has Mr. Brownson given you any such information for use in this case?

A. He might have mentioned it to me but I can't recall.

Q. Do you have then as we sit here today any awareness of what the claimed types or

instances of asbestos-related disease at the Conwed plant were?

A. No. That was not in my workout line.

Q. If we are looking at getting disease from amosite exposure, what number of fiber years of exposure would you feel is necessary to cause and start with asbestosis?

A. Fiber years?

Q. Well, we -- what degree of exposure, let's put it that way, to amosite would you feel is necessary?

A. You just want a guess. You just want me to off the top of my head do one of these --

Q. Well, I can short-circuit this. Are you going to ask or be asked to give any opinions in this case on whether the exposure to amosite at this plant was insufficient or sufficient to cause disease?

A. I don't know.

MR. WILL: Can you help us out?

MR. BROWNSON: This is not an issue in the case because under Minnesota compensation case, if the disease was caused in any degree --

MR. WILL: I would care about the amosite.

MR. BROWNSON: Well, we don't. He is not going to make those calculations. When I said -- it is not an issue for us. It may be a defense for you.

MR. WILL: Right, okay.

On the representation of Mr. Brownson that you are not going to offer any such calculations, then I think we can move on.

MR. BROWNSON: Yes, we can move on.

Q. Without trying to figure out what the -- or did you do the calculations while we were talking, you did them?

A. Well, I mean if you were to assume an insulation worker is exposed to between 10 and 20 fibers per c.c., that is the difference between low-end construction and high-end marine, for 25 years, that would be a Selikoff kind of calculation. That is 250 to 500 fiber years. About 7 percent of the mortality is asbestosis, so if 7 percent results at let's take 250, it is the low end. If 7 percent is at 250 fiber years

cumulative, 2500 fiber years would produce 70 percent and 25 fiber years would produce 0.7 percent.

Q. That is asbestosis mortality?

A. That's correct.

Q. That doesn't tell you how many people simply contract the disease?

A. At 250 to 500 fiber years for 25 years, they all have some asbestosis, or clinical or subclinical, but it is present.

Q. In terms of just calculating people who may develop clinical but not fatal asbestosis from an amosite exposure, less than 250 fiber years would be required?

A. I would think so, yes.

Q. You mentioned Dr. Pooley. You worked with him and published papers?

A. Yes.

Q. You recognize him as an expert in the area of asbestos-related disease?

A. Yes.

Q. Do you know Richard Lee?

A. Yes.

15

Q. How do you know Mr. Lee?

A. Dr. Lee. I first met Dr. Lee when he represented U.S. Steel when I was involved in the contamination of Lake Superior. The Reserve Mining case. United States of America versus Reserve Mining, et al.

Q. In what areas do you recognize Dr. Lee as having expertise?

A. In electron microscopy. The acquisition and analysis of data by electron beam methods.

Q. Do you know Dr. William Weiss in Philadelphia?

A. I know of him. I've never had an opportunity to sit down and chat with him, no.

Q. Do you recognize him as having some expertise in the area of --

A. He is a pulmonologist, yes.

Q. Okay. And how about in the epidemiology of asbestos diseases?

A. How about it?

Q. Are you familiar with his work in that area?

A. Less familiar with that.

Q. Okay. Have you ever had any

relationship with McCrone Laboratories? Done any work with them, for them?

A. I know of them. I believe we may have passed samples back and forth 20 years ago or something like that.

Q. Okay. Are you in a position to comment on their expertise?

A. They are very good.

Q. Or the accuracy -- have you ever checked any of their results?

A. Yes, as a matter of fact.

Q. In what context?

A. The analysis of Conwed ceiling tiles.

Q. Was that in one of the Baltimore cases?

A. I think it was Annerundel.

Q. I'm sorry, the Maryland cases?

A. Right.

Q. Did you reach the same results that they did?

A. Basically.

Q. What was the result?

A. That there was fiber present. We disagreed a little on the amount of fiber.

Q. You were low, they were high?

A. I don't recall the details. There was some discrepancy but I didn't think it was major. Since we use different protocols for the preparation of the material.

Q. You mentioned in your CV a Professor Kerr.

A. Professor Kerr was the Newberry professor of mineralogy of Columbia University.

Q. Did you do your graduate work under his direction?

A. Most of it.

Paul F. Kerr, a gentleman and a scholar. So few of us left.

Q. You came to Mount Sinai in what year?

A. 1965.

Q. And remained there then until '88, is that correct?

A. Correct.

Q. Okay. You held various capacities during that time?

A. Yes.

Q. Your training was in geology, petrology and mineralogy?

A. Correct.

Q. What formal training did you have in biology?

A. Formal training, you mean coursework?

Q. Yes.

A. At what, undergraduate level --

Q. Skip the undergraduate for a minute.

A. Graduate level?

Q. Yes.

A. Formal in which I enrolled for a course. None.

Q. Okay. How about any formal coursework at the graduate level in terms of, I don't know how you want to break it down, but more the biological impact of mineral fibers on humans?

A. I don't think anyone offered a course in that, quite frankly.

Q. All right.

A. It is just on the basis of work and reading.

Q. All right. Since you went to work for Mount Sinai and since then? Let me rephrase the question.

Am I correct that your reading -- the

reading and the work which you referred to that provided you with knowledge concerning the biological effect of minerals on humans has been acquired since approximately 1965?

A. That's right, basically with study and research and reading.

Q. You have testified numerous times as an expert witness in cases involving asbestos, is that correct?

A. No.

Q. How many times have you testified?

A. By deposition or trial --

Q. Start at trial.

A. Trial. Not many. Over -- I've been in this field for 28 years. I may have testified at trial 20 times, 18 times. Nothing extraordinary.

Q. How about by deposition?

A. By deposition, maybe twice that. Maybe twice that.

Q. And the times that you have testified at trial, have you sometimes been limited in the opinions that you could express to those relating to mineralogy as opposed to medicine or --

A. Limited to mineralogy? No.

Q. Have you ever been prevented by a court from giving testimony about what the court regarded as medical issues?

A. Yes.

Q. All right. And that would be to assess risk or cause and effect? What types of things have you not been allowed to testify to?

A. It was more generic, whether I could testify to or make the statement in open court that the biological potential of chrysotile that had been milled either increased or decreased depending on the milling method. I was prevented from commenting on two papers where I was senior author on both. You can laugh but that is the nature of it.

Q. It was sufficient for peer review journals but it wasn't sufficient for the judge?

A. Correct. That is absolutely correct.

Q. How did you happen to get interested in the area of asbestos research?

A. That is a long, involved story. Selikoff, in 1965, was interested in forming a unit at Mount Sinai which would focus on asbestos,

and included among the disciplines he wished to bring to bear on the problem was mineralogy. I was the last of Paul Kerr's PhD students in residence.

At that time I had an appointment to go to the astrogeology branch in Flagstaff, Arizona with the United States Geological Survey, but Selikoff in outlining the nature of the position convinced me that maybe a year's leave of absence would not be out of -- would be -- would not be damaging, and I could explore this new area, new interesting area, which I did.

Q. And that started a life's work?

A. That started, yes, my life's work.

Q. You worked part time for the Air Force?

A. Yes. When I was a graduate student.

Q. What did you do for the Air Force?

A. I was involved in a study concerning the mineral character and the role mineralogy played in imparting mechanical properties to dry lake beds which permitted their use as landing fields. It is fascinating.

Q. Were you involved in setting up these

airfields on the dry lake beds?

A. No, but I was involved in the assay of certain playas or dry lake beds and indicating which would be suitable for emergency landing fields.

Q. You've also consulted, at least in a couple of cases, with the oil industry?

A. Yes, that's correct.

Q. That was earlier, though, in your career?

A. Much earlier. I was still a graduate student at Columbia. Professor Kerr had some problems, one was with the Creole Oil Company. Also he consulted with Texas Gulf Sulfur.

Q. Trying to find oil?

A. No. Texas Gulf Sulfur had a phosphorite deposit in North Carolina, and they wanted to set up some catchment ponds for the water because it was very close to the surface and they were pumping from this surface working, and they found that their earthen dams failed, and the reason for that was the nature of the clay minerals associated with the phosphorite deposit. It picked up water, it swelled, it had no

mechanical strength.

Q. You mentioned you had done some work in Minnesota in connection with the Reserve Mining case.

A. Yes.

Q. Was that looking at the dumping of asbestiform minerals into Lake Superior?

A. No.

Q. What was it?

A. It was the dumping of amphibole gangue materials. There were no asbestiform minerals, no asbestos minerals present. And years later when we had more data we found that the materials that were being dumped into Lake Superior had no bearing, had no relationship basically with asbestos minerals.

Q. But at the time people thought asbestos was being dumped into Lake Superior?

A. Exactly.

Q. And there was a much-to-do about that?

A. Much to do about nothing, someone once said. Or much ado about nothing.

Q. Who were you working for in that

case?

A. The United States Department of Justice.

Q. Who was suing to prevent Reserve Mining dumping?

A. It was the U.S. -- yes, it is the United States of America, et al., the State of Wisconsin, the State of Minnesota, the State of Michigan.

Q. That were trying to shut down the plant?

A. Silver Bay. Shut it down.

Q. At least keep it from dumping, which would have shut it down?

A. I'll tell you a story off the record when we finish with this --

MR. BROWNSON: Let's get the questions answered.

Q. You are listed as a fellow of the Collegium Ramazzini. What is the Collegium Ramazzini?

A. It is a brainchild, was a brainchild of Irving Selikoff. Ramazzini is considered the father of occupational medicine, and on the 300th

anniversary of Ramazzini's birth, Irving Selikoff banded together with a group of other interested parties, international parties, to form a group which would meet periodically to bring to the forefront emerging occupational problems, in the sense that there is always some lag time between the appearance of reports in the literature and the application and implementation of control strategies, so Irv thought it was a good idea, and it was a good idea, yes.

Q. And who provides the financial sponsorship for that?

A. Well, everyone is supposed to pay their dues and then they hold meetings and they charge people to attend the meetings and things like that.

Q. You are elected a fellow?

A. Yes.

Q. What does that mean?

A. What does that mean?

Q. Yes.

A. With $1.25, I can ride your subways. It means there were only 100 fellows in the whole world and I am one. You got it.

Q. All right. Has the Collegium looked at issues other than asbestos?

A. Yes, sure.

Q. Has any funding for the work of the Collegium been provided by the Plaintiffs' Asbestos Personal Injury Bar?

A. It is my understanding that this has occurred in the past.

Q. You wrote, I believe it was your master's thesis, on Manhattan serpentine?

A. No. It is actually on the Manhattan formation in New York City. The rocks that constitute --

Q. Is there serpentine in those rocks?

A. Yes.

Q. Any asbestiform?

A. Yes. Right out there (indicating) there is a low-lying hill in Staten Island, the witness is pointing south, and on the other side of that harbor (indicating), the continuation of the Palisades, it goes under the surface of New Jersey here and it crops out on Staten Island and there is a hill called Todt Hill, and it is the highest peak along the East Coast, the shore, 400

feet above sea level. And a gentleman by the name of Mr. Johns had an asphalt asbestos tile plant there where he personally mixed by hand various asphalt products with chrysotile asbestos from that deposit and made asphalt shingles. Mr. Johns, who expired in 1899, this is true, of miner's pthysis. He died of pneumonoconiosis.

Q. Doctor, you have been on the editorial board of a number of different publications?

A. Journals.

Q. Journals?

A. Yes.

Q. And some of those journals have also published some of the papers you have -- some of those journals have published some of the papers of which you have been the author or co-author?

A. Yes.

Q. For a person submitting a paper who also is on the editorial board of the journal, are there any different requirements or procedures involved in getting the paper published?

A. Well, yes, of course. It is subjected to the most rigorous of evaluations.

Even more so.

Q. There is no different procedure in terms of the number of people that review it?

A. Well, it depends who is doing it. If I'm doing it, it is one standard. If Phil Landrigan is doing it, it is some other standard. That is the way it is.

Q. All kidding aside --

A. All kidding aside, basically all of the papers I've ever written I've given to colleagues, and I say go over it and tell me what you think and/or I will make recommendations. Let's say a paper is submitted to the British Journal of Industrial Medicine, I say this should be reviewed by Chris Wagner or John Davis or John Addison and you make recommendations. They are people, experts in the field, and they will read this and they will tell you what they think is good and what they think is lousy, and you respond to it, and it makes the paper better and it is a positive form of evaluation.

Q. You mentioned something earlier about how long asbestos remains in the lung. Is that something that is sometimes referred to as

biopersistence?

A. Yes. That is a wonderful term.

Q. When you use that term in your writing, what does that refer to?

A. The fact that fibers are retained and remain as opposed to being degraded or eliminated in some fashion.

Q. All right. Does chrysotile have a different biopersistence than the amphiboles?

A. It tends to be less.

Q. Does the biopersistence of chrysotile depend upon fiber size?

A. Yes.

Q. All right. Are shorter chrysotile fibers more likely to be removed?

A. Yes.

Q. In terms of those fibers, chrysotile fibers removed from the lungs, what is your opinion about whether those fibers contribute to, let's start with asbestosis?

A. Probably not.

Q. How about lung cancer?

A. I think the two processes are pretty much related. Less, also.

Q. How about mesothelioma?

A. The problem is when you remove it from the lung, where does it go? If it is coughed up or spit out, it has no effect on mesothelioma.

Q. If it lodges in the pleura --

A. That is not the story.

Q. Are some of the fibers removed through the lymph system?

A. Yes.

Q. Those fibers would not play a role in pleural mesothelioma, would they?

A. The surface of the pleura, whether it is the visceral pleura or the parietal pleura, is an area of lymphatic drainage to fibers swept along could come to rest on the pleura, so if you remove particles from the lung through the lymphatic drainage, it could come to rest at the pleura.

Q. If it doesn't come to rest, if it continues to drain, then presumably it plays no role?

A. It would play no role. It would be sequestered in some node.

Q. In terms of the amosite, is there any

clearance of amosite from the lung?

A. Yes. Some of it goes. About 80 percent of it goes. Something like that.

Q. How is it removed?

A. The same processes, it is a mucocilliary escalator. That is the beating of cilia, and of course the macrophages and the other cells which move particles.

Q. So would you also then get amosite fibers draining through the lymph system along the pleura?

A. Yes, sure.

Q. In terms of the translocation of fibers, what do you mean by that?

A. Translocation is a fiber that changes from one place to the next. This is part of this system that we are talking about. You can have a particle removed from the lung but it winds up in some other organ. Let's say you have a very long amosite fiber, you cough it up, you swallow it, it winds up in the gut. It is thought this is one of the mechanisms, one of the pathways by which fibers wind up in the gut and is associated with increased gastrointestinal cancer.

Q. Does the translocation of fibers refer only to movement within the organ and within the body?

A. Yes.

Q. In terms of the translocation within the lungs, is there a difference between the ability of chrysotile and, say, amosite to move it?

A. Depends on the size distribution. Which is the longer fiber. The longer the fiber, they tend to remain, shorter fibers tend to be swept. Given general populations of fibers, I would say amosite tends to remain. Chrysotile tends to be removed.

Q. So the amosite fibers would tend to remain where they lodge?

A. All other factors being equal.

Q. They are more likely to remain where they --

A. I would agree with that, yes.

Q. You have published studies on an analysis of calidria asbestos, correct?

A. Yes.

Q. You have been the author on how many

published studies on calidria?

A. Specifically calidria?

Q. Right. There is the Yager paper you mentioned earlier?

A. I'm just recalling that offhand. The others are just attributions to the nature of the material.

Q. So that is the only published --

A. Offhand that is the only one I can think of.

Q. Now, are you aware of any cohort studies done with a calidria-exposed population?

A. Cohort study? Bona fide cohort?

Q. Yes.

A. No.

Q. If we could do that, wouldn't that be a good study to see what impact calidria may have in causing disease?

A. It might be. It might not.

Q. Why might it not be?

A. It would be very similar to the studies for other forms of chrysotile. If you went to Charleston, South Carolina and thought that represented all of the chrysotile industries

in the world, you would be misled. If you were to study miners and millers in Canada or Ferodo friction product manufacturing, you would get a different picture. So it might be in some way a good extrapolation to Conwed if similar products were made or similar machinery was involved and amounts of fiber and the matrices were the same.

Q. At least there would be a piece of data you would be interested in if it were available?

A. Sure.

Q. Would you expect to find -- based on what you know about calidria, would you expect to find examples of asbestos-related disease in people who mined and milled the calidria-containing ore?

A. No.

Q. Why not?

A. The fiber levels are extraordinarily low. I was out at the pit. I felt extremely comfortable. The material is -- the material forms a mud. It is wet right below the surface. Vehicles moving on the surface did not raise much dust at all. The mill, the ore was dumped a half

mile from the mill or quarter mile from the mill. It is brought to the mill in a slurry, a wet slurry. The process is a wet process. No, I would be surprised if there was any disease.

Q. Again that is based on the low fiber levels?

A. I'm sure the fiber levels are very low.

Q. You have some dust counts in your possession that were taken at the mill and the mine, correct? At least at the mill?

A. Yes, I have seen some data. In fact some of Lee's data, by TEM, extraordinarily low. No, I would not anticipate diseases there. In that small group of people? No.

Q. Do you know how the measured fiber levels at the mill compared to the measured fiber levels at the Conwed plant?

A. The mill represents a different environment entirely and control measures were taken. I'm not sure they are even comparable.

Q. But measurements were taken at both sites?

A. Correct.

Q. My question is, do you know which showed higher levels based on the measurements that were taken?

A. I think -- I can't compare them directly, and the reason I can't compare them directly, because there are values given for times that are less than time-weighted averages. They would have to be recomputed or you have to know whether this represents an episodic burst or a segment of an eight-hour time-weighted day. In my head I think that one of the levels found at the mill was 0.95 fibers. And at Conwed, there are in some places excursions of greater than 10 fibers, but the time-weighted averages seem to be lower than the .95, so it is something like that.

Q. Basically you would want to review the data and perhaps --

A. It has to be tabulated. When you read these different reports and everybody is doing different kinds of things, it becomes difficult to make an immediate mental comparison. You have to sit down, look at the data and say this could happen, that could happen and so on.

Q. Do you know whether in fact there has

been any asbestos-related disease with the people who worked at the mine or at the mill?

A. I have no idea.

Q. In the Yager paper, you and your collaborators attempted to measure I guess the macrophage mortality rate?

A. That's right. A macrophage mortality study. You feed cells dust and determine if these cells respond differently than another cell populations not exposed to the same material.

Q. Now you've got the cells, they were alveolar macrophages.

A. Yes.

Q. And you got them from seven doners I guess through Georgetown?

A. Right.

Q. And in the article it indicates that there were three nonsmokers, one smoker and one donar, if I may, one marijuana smoker?

A. Weren't there nine individuals involved? Or five volunteers? It is 10 years ago.

Q. I didn't know -- do you recall what the smoking history of the ones --

A. No, no. That's right, there were some cigarette smokers and some guy who was a marijuana freak. Right.

Q. Now, the dust that you used was from one of three sources, is that correct?

A. I think so.

Q. UICC, chrysotile?

A. Yes, we used UICC, that's right. Or the calidria, yes, correct.

Q. And you also used quartz dust as a positive control.

Was there any reason that you didn't use a negative control, some sort of dust felt to be largely inert?

A. I left that to my colleagues who were formally trained in biology.

Q. That is something to take up with them, in other words?

A. That's right. Those dopes.

Q. Now another thing that this study did was to ball-mill the calidria asbestos?

A. It was blade-milled.

Q. To blade-mill it?

A. That's right.

Q. And at two different time intervals?

A. That's right.

Q. And the study reported that the longer the calidria was milled, the greater the macrophage mortality?

A. That's right.

Q. But the UICC, I believe it was Rhodesian chrysotile was not milled, was it?

A. I don't think so, no.

Q. Was there any reason why it wasn't milled?

A. We wanted to retain its fiber length, as I remember in our discussions.

Q. Do you have an opinion on whether had you milled the Rhodesian chrysotile, it would have produced a similar increase in macrophage mortality?

A. It probably would have.

Q. How about for example amphibole fiber, would you expect to see the same results if you did the same experiment?

A. I don't know.

Q. Why is that?

A. It behaves differently when it is

milled. It is a more -- it is a tougher mineral and you tend to introduce surface artifacts more quickly than with chrysotile, which disaggregates first, then the surface functionalities are affected.

Q. I realize this is sort of a crude description, but are you saying that if you --

A. I'll give you a crude answer.

Q. If you mill chrysotile it tends to come apart fairly easily?

A. Yes.

Q. Whereas if you mill the amphibole fibers, say amosite, it is so tough to break it apart that you may alter the surface of the fiber?

A. It is more difficult to manipulate.

Q. And in manipulating that harder mineral, you may induce alterations in the surface chemistry?

A. Yes. What you are basically doing is imparting mechanical energy into the system. Now the system responds. The system may respond by breaking apart and breaking along the weakest bonding elements, or you have to attack the bonds themselves that make up the mineral. So you

either disaggregate it or you start to break down the mineral itself.

Chrysotile tends to disaggregate because those fiber bundles are not held together with strong forces, whereas an amphibole fibrile, if it doesn't have some submicronic, some submicroscopic structure along which the material breaks like a twin plane or some other defect, it will start to modify the surface.

Q. Do you think it would have made any difference to the results if you had ball-milled the chrysotile as opposed to blade-milling?

A. I think it would have.

Q. What --

A. It would have reduced the activity.

Q. Why?

A. Well, we have a study that we published in which material was ball-milled, impact milling, and that starts to break bonds and it changes the characteristics of the surface and the structure of the material so that certain properties fail. The flow of electrons and so on.

Q. And ball-milling would have made the calidria, in your opinion, less toxic, if you

will, to the macrophages?

A. Yes.

Q. Which study is that that you prepared with respect to the ball-milled --

A. The 1977 study.

Q. That is published under the name of what?

A. Langer, et al. It is in my CV. It is on progressive milling of chrysotile asbestos alteration of -- let me just get this citation for you.

The citation is the following. It is on page 13, number 36, in my CV. Variation of properties of chrysotile asbestos subjected to prolonged milling. 1978.

Q. In terms of the biological effect of chrysotile, do you think it makes -- if we are talking just about the chrysotile, does it make any difference whether it is Canadian or Rhodesian chrysotile or calidria chrysotile or is it the size and shape of the fiber that makes the difference?

A. Complex question. All the fiber types are different. They are different from a

number of standpoints. All of the fibers then manipulated respond to the manipulation differently so you get a range of properties which affect biological potential.

Q. By and large, do you think results obtained with fibers of one chrysotile type of a given size are applicable to fibers of another chrysotile type of comparable size?

A. Probably within a certain range.

Q. And I realize this is a general question, but is that range so large that the studies are of no value or is the range small enough that you say yes, the studies are probably applicable but they might change a little bit?

A. All studies are of value. They answer certain questions. Some studies answer more questions than others. I thought I successfully avoided answering your question. I'll give you an example.

Q. Sure.

A. The UICC, that is all caps, by the way, UICC-B, the Canadian standard is a mixture from eight different mines in Canada. The asbestos mine, the question was do chrysotiles

behave the same. No, they don't behave the same. For example, the standard asbestos type, the UICC-B, which is the Canadian specimen, results from a mixture of fibers from a number of mines.

Chris Wagner has experimented with each of the individual splits that make up the specimen and he produced a range of mesothelioma mortality in laboratory animals which -- well, the values of which ranged from 32 percent to 64 percent. So it was -- it varied by a whole factor.

Q. So there is some difference from one form of chrysotile to another?

A. Certainly.

Q. All right. In terms of biological -- okay. Within those limits there are applicabilities from one study to another?

A. Sure.

Q. In your opinion, what is responsible for the differences in the behavior of different types of chrysotile?

A. The properties are many. And the properties may be those properties of the fiber itself, which includes chemistry, trace metals,

relative harshness, associated minerals, superimposed properties brought about by industrial manipulation which include heating, surface treatment, mechanical milling and others, and finally the superimposed properties of the product itself and the products use.

For example, thermal insulation on a pipe which contains chrysotile after many years contains a modified chrysotile which is more dusty, so you have the intrinsic properties of the material, you have the superimposed properties of the industrial workplace and you have the final properties of the environment of use.

Q. If we are talking about fiber as it comes from the mill, say, then what you would be talking about are the differences between the shape, chemistry of the fiber itself, plus anything that was done to it in the milling and mining?

A. That is a way of looking at it. That's right. I mean it is the nature of the fiber itself plus everything that is superimposed on it.

Q. In terms of -- other than the

macrophage mortality study you mentioned, are you aware of any studies that attempt to measure whether calidria chrysotile is more or less biologically active in the production of asbestos-related disease than other types of chrysotile?

A. I've seen no cohort studies so I can't judge that.

Q. Okay. Are you aware of anybody else who has done papers attempting to compare the performance of calidria versus other types of chrysotile, I mean an experiment in animals --

A. Yes, there are a few of those.

Q. What studies are those?

A. Hartwig, Muhle, Pott, Maltoni, and others.

Q. You mentioned Platek?

A. Frank Platek and colleagues at NIOSH.

Q. What did Muhle show in his study?

A. He showed it was not very active.

Q. Calidria was not active?

A. Yes.

Q. Less active than other types of chrysotile?

A. Yes.

Q. What did Pott show?

A. He wasn't too sure, although it showed some activity but he didn't think it was terribly dangerous.

Q. How about Maltoni?

A. Maltoni produced tumors.

Q. With calidria?

A. Yes.

Q. And none with --

A. But less than the other chrysotiles.

Q. And how about Platek and NIOSH?

A. No lung scarring in laboratory animals, although Arnie Brody has reviewed these and he thinks there is some scarring.

Q. But in any event, less than with calidria?

A. Yes, that is my understanding.

Q. Now --

A. I'm testifying to this -- this is my recall.

Q. Right.

A. If I had all the papers in front of me, we could go over them in detail.

Q. Right.

A. Just trying to pull this out.

Q. Right. This is your off-of-the-top-of-your-head recollection?

A. That's right.

Q. Would it be a fair summary of your off-the-top-of-your-head recollection of these papers that what they showed was to the extent that calidria is biologically active, if you will, it is somewhat less active than other types of chrysotiles?

A. That is the general conclusion. Yes.

Q. Do you agree or disagree with that conclusion?

A. Do I agree or disagree? I sit here and think about it. How were the materials prepared, were they comparing mass, were they comparing fiber number per unit. It is more difficult to evaluate. I can only tell you what they reported. We would have to go over the details of the study, so offhand I would say at first blush, yes, they -- it seems to be less active, but the details of it, I don't know.

Q. Okay. Are you planning as part of

your work in this case to do any kind of analysis or critique of those studies?

A. Well, if I'm called to trial I would more than likely pull them out of my file and review them, sure.

Q. Are you aware of any studies, putting aside the Yager paper for a minute, any studies that show that calidria is more biologically active than other types of chrysotile?

A. I can't think of any offhand.

Q. You did some lung burden analysis of lung fiber -- burden analysis, excuse me -- of people who lived in New York City?

A. Yes.

Q. To attempt to measure the biopersistence of asbestos, is that right?

A. Well, no, that was not the objective of the study.

Q. Okay. Was that one of the by-products of it?

A. That was a by-product of it, yes.

Q. And in that group of about 126 people that were in your series --

A. Yes, 126, 128, something like that,

right.

Q. And in that group were both people who had occupational asbestos exposure and those who did not?

A. Yes.

Q. You found among the people without occupational asbestos exposure that there was chrysotile in the lung, is that right?

A. That's correct.

Q. I think you gave the count.

A. Above statistical background, I think half of them. 64 out of 128. Something like that.

Q. For the people in New York with nonoccupational exposure to asbestos, what is the background level of fiber burden?

A. It is pretty low.

MR. BROWNSON: The people in his study?

MR. WILL: Yes.

A. It is not so much the quantities, although the quantities -- I think the highest level I found in a nonoccupationally exposed individual was in a man who was an 80, 81-year-old

male who died of heart failure for which he had no -- he had five million fibers greater than five microns in length per gram of dry lung tissue. Per gram of tissue, put it that way. And that this was the highest of the nonoccupationally exposed. So for us it was a statistical outwire. Didn't have good follow-up on this person's occupational history, but we accept that as a background case. That was the highest, but most were much lower. 50 to a hundred thousand or 200,000, but it was very much lower.

Q. Among those people that had nonoccupational exposure, did you find evidence of asbestos-associated disease?

A. No.

Q. Am I also correct that among those without occupational exposure, the type of fiber you found was chrysotile?

A. Yes.

Q. You also attempted to count the fibriles shorter than five microns?

A. That's right. Everything.

Q. Everything. Both longer and shorter?

A. Yes.

Q. And in those people without occupational exposure, you did find significant numbers of chrysotile fibriles below five microns in length?

A. That is true, yes.

Q. Those counts are reported in your paper?

A. That's right.

Q. Now, in the occupationally exposed people, you did find some evidence of asbestos-related disease, is that right?

A. Yes.

Q. And you also found long chrysotile fibers in the occupationally exposed?

A. Yes. Yes.

Q. Far more than in the nonoccupationally exposed?

A. Yes. That was one of the distinguishing characteristics.

Q. Is the length of the fiber in the lung?

A. Yes.

Q. You also found amphibole fiber in the occupationally exposed?

A. That is true.

Q. Did you do any comparison of the chrysotile fibrile burdens below five microns between the occupationally exposed and the nonoccupationally exposed?

A. I'm not sure.

Q. In terms of what caused the asbestos-related disease in the occupationally exposed, was it the long fibers, was it the greater number of fibers, was it the greater number of short fibers, what was it?

A. Well, this is by deduction from other cohorts, that there are two factors that are operative. Well, there are several factors operative. Number one, the presence of amphiboles. The dimension of the fiber itself. The third factor which may be operative, the mixture of fibers may represent some interesting increase in risk.

Q. By mixture of fibers, you mean having --

A. Both chrysotile and an amphibole.

Q. In most cases both amosite and crocidolite?

A. Either/or.

Q. Has your research or reading indicated anything that suggests that chrysotile becomes more biologically potent when it is in the lung with amosite?

A. No, I think it is the opposite.

Q. It becomes less potent?

A. With or without amosite. Chrysotile with time may be detoxified, depending where it is in the lung.

Q. And that is through this clearance mechanism?

A. No.

Q. What is that that detoxifies it over time?

A. Chemical degradation. It loses magnesium from the surface.

Q. Whereas the amosite does not degrade?

A. Not as much, no.

MR. WILL: Let's take a quick break and decide what we are going do do.

(Recess taken)

BY MR. WILL:

Q. Referring for a moment to the Yager,

et al. article, what conclusions, if any, from the results of that study did you draw?

A. Chrysotile is cytotoxic to human cells, human macrophages, that the use of a mass unit in a dose response study may be misleading because the manipulation of the dust which alters fiber number and surface area changes the outcome. And we found that an asbestos sample in which the absolute number of fibers greater than five microns in length remained the same as the shorter bundles were opened to a greater surface area, the material became more cytotoxic. We felt that was an interesting contribution.

Q. The relationship of surface area --

A. Yes.

Q. -- to toxicity?

A. And the most important part of that study was never published but Kagan began to tell you about that.

Q. Which part was that?

A. We had a cigarette-smoking population, and the macrophages were killed more effectively.

Q. With the cigarette smoking?

A. Yes. And it follows everybody's hypotheses that cigarette smoke exacerbates asbestosis as well.

Q. Why wasn't it published?

A. Henry Yager just didn't get around to it. That was the medical side of it. And we said, "Publish it, Henry, this is interesting," "Well, I would like to."

Q. In terms of the relationship between killing alveomacrophages and producing asbestosis, in your opinion is that what does it?

A. No.

Q. Okay.

A. No. I would prefer for a macrophage to live and continue to generate chemical substances under the generic heading cytokines, specifically a subgroup called growth factors, and that these stimulate the fibroblast population to produce collagen.

Q. Could --

A. So I would prefer a macrophage to live and generate all of the chemical stuff than to die.

Q. Would that suggest then that because

the milled calidria had a higher macrophage mortality rate that it would be less likely to produce asbestosis in a human?

A. I would think yes, but others would disagree.

Q. Disagree?

A. Of course.

Q. In terms of your findings about surface area, do I understand correctly that what you said is that as you get smaller fibers, you have more surface area per given mass?

A. Yes. Thinner fibers, specifically.

Q. Because as the calidria chrysotile splits up, breaks up, it splits longitudinally?

A. Yes. It splits both ways but primarily longitudinally.

Q. It gets thinner and thinner?

A. Thinner and thinner.

Q. Rather than shorter and shorter?

A. Correct. It gets thinner and thinner first, then shorter and shorter.

Q. Okay. Do you think that calidria chrysotile is capable of producing pleural mesothelioma in humans?

A. If you get a high enough dose of it.

Q. How high a dose would you have to have?

A. Pretty good dose of that stuff.

Q. Higher than you think would have been obtained at the Conwed plant from what you know about the air samples?

A. Well, I don't know what the air samples are telling me just yet, but I think in order to produce pleural mesothelioma with chrysotile, you would have to be exposed to 10 to a hundred times more fiber than an amphibole. And I'm quoting to you from some of my own data. And I think that this follows some of the data that exists in the literature, specifically some of Andrew Churg's data, that is Jack's son, in which these mesotheliomas occur and there is a lot of fibers still in the tissue.

Q. Andrew Churg says that if you get levels of exposure comparable to the World War II shipyards, without that you will not get a chrysotile mesothelioma, he said that, is that right?

A. Yes, but that begs the question what

were the levels.

Q. O.K.

A. Then we will talk about it.

Q. Yes. All right.

In terms of the ability to cause asbestosis in humans, what degree of exposure to calidria chrysotile do you think a person would have to have?

A. I don't know. But it has to be like the others, high.

Q. Higher than for mesothelioma?

A. Yes.

Q. How about for lung cancer, what degree of exposure?

A. I believe it is the same. You need high levels.

Q. The same as asbestosis?

A. Yes.

MR. WILL: I think this is a good time to stop. We are at 4:15.

MR. BROWNSON: Okay.

MR. WILL: What we have decided to do is to adjourn the deposition at this point to be reconvened, hopefully within

the next week or two in conjunction with another trip out here when we have got other depositions in this case.

I told Mr. Brownson that I was not going to use the fact that we were unable to finish Dr. Langer today as a reason to refuse to produce my witnesses, so we will work on the scheduling of those people.

In terms of the exhibits that we had today, what I would like to do is to give Exhibits 1, 2 and 3 to the court reporter and have those attached to the transcript. So, Doctor, if I may I'll take your CV back.

THE WITNESS: Fine.

MR. WILL: I would like Dr. Langer to get, through Mr. Brownson, a copy of Exhibits 4-A, B and C, 5, 6 and 7 for us. Is that all right?

MR. BROWNSON: Yes.

MR. WILL: And he can retain the originals of those, but if you would please get those.

The other thing that I would ask is

that Dr. Langer try to complete whatever further analysis that he wants to do of that one fiber before we reconvene the deposition so when we wrap up the deposition, we can wrap up all of his work on the analysis.

MR. BROWNSON: Okay.

THE WITNESS: Okay. That sounds all right to me.

MR. WILL: Is that all right?

MR. BROWNSON: I've got your card.

(Time noted: 4:28 p.m.)

---

Subscribed and sworn to before me
this_____day of _____, 1994.

---

# CERTIFICATE

STATE OF NEW YORK )
) ss.:
COUNTY OF NEW YORK )

I, ROBERT E. LEVY, a Certified Shorthand Reporter and Notary Public within and for the State of New York, do hereby certify:

That I reported the proceedings in the within entitled matter, and that the within transcript is a true record of such proceedings.

I further certify that I am not related, by blood or marriage, to any of the parties in this matter and that I am in no way interested in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 24th day of January, 1994.

Robert E. Levy

ROBERT E. LEVY, C.S.R.

January 14, 1994

# I N D E X



# E X H I B I T S



oOo

# CURRICULUM VITAE

Arthur M. Langer, Ph.D.

**CURRENT POSITION:** Director, Environmental Sciences Laboratory of the Institute of Applied Sciences, Brooklyn College of the City University of New York, Brooklyn, NY 11210.
Professor of Geology, Department of Geology, Brooklyn College.
Associate Director of the Center for Applied Studies of the Environment, Applied Science Coordinating Institute, City University of New York.

**ADDRESS:**


Office: Environmental Sciences Laboratory
Ingersoll Hall - Room 5144-6
Brooklyn College of the City University of New York
Brooklyn, NY 11210
(718) 951-4793; 951-4242
(718) 951-4438 FAX

Home: 6 Rochambeau Drive
Hartsdale, NY 10530
(914) 428-3667


**DATE OF BIRTH:** February 18, 1936

**PLACE OF BIRTH:** New York, NY

**ACADEMIC DEGREES:**

B.A., Geology, Hunter College-CUNY, New York, NY, 1956.
M.A., Petrology (Geology), Columbia University, New York, NY, 1962.
Ph.D., Mineralogy (Geology), Columbia University, New York, NY, 1965.

**PREVIOUS POSITIONS:**

Associate Professor, Center for Polypeptide and Membrane Research, Mount Sinai School of Medicine, New York, NY 1986-1988.
Associate Professor, Mineralogy, Department of Community Medicine, Mount Sinai School of Medicine, New York, NY, 1968-1986, 1987-1988.
Ph.D., Graduate Faculty, Program: Earth and Environmental Sciences, City University, New York, NY, 1982-present.
Science Administrator, Environmental Sciences Laboratory, Mount Sinai School of Medicine, New York, NY, 1983-1984.
Research Associate, Department of Mineral Sciences, American Museum of Natural History, New York, NY, 1979-present.

LANGER
D[redacted]
For ID only
Robert E Levy C S R
Doyle Reporting, Inc

**PREVIOUS POSITIONS (cont):**

Associate Director, Environmental Sciences Laboratory, Mount Sinai School of Medicine, New York, NY, 1969-1986.
Head, Physical Sciences Section, Environmental Sciences Laboratory, Mount Sinai School of Medicine, New York, NY, 1969-1986.
Adjunct Associate Professor, Mineralogy, Graduate Division, City University of New York, NY, 1968-1969.
Assistant Professor, Mineralogy, Department of Community Medicine, Mount Sinai School of Medicine, New York, NY, 1967-1968.
Research Associate, Environmental Medicine, Department of Medicine, Mount Sinai Hospital, New York, NY, 1965-1967.
Lecturer, Geology, City College of City University of New York, NY, 1964-1965.
Research Assistant, Mineralogy, Department of Geology, Columbia University, New York, NY, 1961-1964.
Teaching Assistant, Economic Geology, Department of Geology, Columbia University, New York, NY, 1959-1960.
Teaching Assistant, Department of Geology, Columbia College, New York, NY, 1958-1959.
Field Assistant, Geology, Beartooth Mountains, MT, Columbia University, 6/57-8/57.
Field Assistant, Geology, Beartooth Mountains, MT, Columbia University, 6/58-8/58.
Exploration Geologist, Rosario Exploration Chibougamau Mining and Smelting, 6/56-8/56.
Consulting Mineralogist, Columbia University, New York, NY:
-TAMS Dam site, East Pakistan, WHO, 1960 (with Professor Fairbridge).
-Consulting Mineralogist, American Metals Climax, 1961 (with Professor Kerr).
-Consulting Mineralogist, Creole Oil Company, 1962 (with Professor Kerr).
-Tidewater Oil Company, 1962 (with Professor Kerr).
-Texas Gulf Sulphur Company, 1965 (with Professor Kerr).

**FELLOWSHIPS:**

Research Mineralogist, Department of Geology, Columbia University, New York, NY. Sponsored by the U.S. Air Force Cambridge Research Laboratories under the direction of Prof. P.F. Kerr, 3/61-9/63.

**MEMBERSHIPS AND OTHER PROFESSIONAL ACTIVITIES:**

Fellow, Geological Society of America.
Fellow, Mineralogical Society of America.
Fellow, New York Academy of Sciences.
Fellow, Collegium Ramazzini.
Geochemical Society.

**MEMBERSHIPS AND OTHER PROFESSIONAL ACTIVITIES (cont):**

American Association for the Advancement of Science.
Electron Microprobe Society of America.
Sigma Xi, Kappa Chapter (Honorary Scientific).
International Association of Bioinorganic Scientists.

**HONORS AND AWARDS:**

Honors, Department of Geology, Hunter College, New York, NY, 6/56.
Sigma Xi, Kappa Chapter, Columbia University, New York, NY, 9/64.
Dust Research, Polachek Foundation Award, 9/65-6/67.
Career Scientist Award, National Institute of Environmental Health Sciences, 6/69-5/74.
Phi Beta Kappa, Nu Chapter, Hunter College, New York, NY, 6/77.
Hunter College Hall of Fame HC-CUNY, 6/78.
Biography in: American Men of Science; Who's Who in the East; Who's Who in America (September, 1992).
Elected Fellow, Collegium Ramazzini, 1983.

**EXPERT CONSULTANT:**

Atlantic Legal Foundation. Amici Curiae in support of respondents to the Supreme Court of the United States. October Term, 1992. Daubert et.al. Petitioners v. Merrell Dow Pharmarceuticals,Inc., Respondent.
Environmental Protection Agency, Superfund Cases, 3/85-Present.
National Institute for Occupational Safety and Health, 6/75-Present.
National Institute for Environmental Health Sciences, 4/75-Present.
Environmental Protection Agency, 6/75-Present.
National Heart, Lung and Blood Institute, 6/75-Present.
National Institutes of Health, Section of Grants, 6/74-Present.
World Health Organization, Geneva, Biomedical Expert, 6/75-Present.

**GRADUATE THESES:**

Geology of the Manhattan Formation. Submitted in partial fulfillment for the degree of Master of Arts, in the faculty of Pure Science, Columbia University, NY, p. 132, 1962.

Mineralogy and Physical Properties of Mojave Desert Playa Crusts. Submitted in partial fulfillment for the degree of Doctor of Philosophy, in the faculty of Pure Science, Columbia University, NY, p. 155, 1965.

**EDITORIAL BOARD SERVICE:**

Assistant Editor, Environmental Research, 1978-1985.
Advisory Editor, Environmental Research, 1985-1987.
Assistant Editor, American Journal of Industrial Medicine, 1980-1985.
Associate Editor, American Journal of Industrial Medicine, 1985-1986.
Editorial Review Board, Journal of Environmental Pathology and Toxicology, 1978-1982.
Editorial Advisory Board, Advances in Modern Environmental Toxicology, 1981-1982.
Editorial Review Board, Journal of Environmental Pathology Toxicology and Oncology, 1983-Present.

**REVIEW MANUSCRIPTS (Journals other than those cited above):**

Journal of Histochemistry and Cytochemistry.
Pharmacology Reviews.
American Chemical Society Reviews.
Advances in Chemistry
Annals New York Academy Sciences.
Science (AAAS).
SEM-IITRI Symposia.
Lung.
American Review of Respiratory Diseases.
American Mineralogist.
Clay Minerals Society (Clays and Clay Minerals).
Canadian J. Fisher Aquatic Sciences.
Journal National Cancer Institute.
American Journal Pathology.
Annual Meeting SEMA.
Chest.
Laboratory Investigations.
Journal of the American Medical Association.
New England Journal of Medicine.
Toxicology <u>In Vitro</u>.
Journal of the American Industrial Hygiene Association
Annals of Occupational Hygiene
Pathology Annual
Environmental Health Perspectives
Health Effects Institute
American College of Chest Physicians

**REVIEW AND AUTHOR FEDERAL, INDUSTRY DOCUMENTS (1978-PRESENT):**

NIOSH Fibrous Glass Criteria Document, 1978. Reviewer. Federal.
NIOSH Talc Criteria Document, 1979. Reviewer, contributor. Federal.
OSHA Fiber Manuscript (Definitions, Nomenclature, Properties), 1980. Reviewer. Federal.

**REVIEW AND AUTHOR FEDERAL, INDUSTRY DOCUMENTS (1978-PRESENT) (cont):**

ALOSH Mineralogy Manuscripts (Occupational Lung Disease), 1979-1980. Reviewer, contributor. Federal.

Report on Tobacco and Asbestos Interaction, Commercial Union Insurance, 1982. Contributor. Industry.

Environmental Protection Agency, Office of Pesticides and Toxic Substances-Asbestos in Buildings Guidance Documents; Guidance Documents; Operations and Maintenance Programs. "Orange", "Purple", "Blue" Books. Reviewer, contributor. Federal.

Surgeon General's Report: Cancer and Chronic Lung Disease in the Workplace: The Health Consequences of Smoking, 1985. Reviewer, contributor. Reviewer, contributor. Federal.

**INTERNATIONAL COMMITTEES AND CONSULTATIONS (1979-PRESENT):**

US-Japan Cooperative Science Program Working Group on Air Pollution and Health. NIEHS-Institute of Health, Japan, February, 1969.

International Agency for Research on Cancer, WHO Development of V.14 Chemical Carcinogenesis Monograph Series, Evaluation of Carcinogenic Risk of Chemicals to Man: Asbestos. Member of working group, Lyon, France, 1976.

International Association of Geochemistry and Cosmochemistry, Working Group on the Geochemistry of Health and Disease, 1976-1979.

Consultant, South African Ministry of Mines, Asbestos Symposium, Johannesburg, South Africa, 1977.

Consultant, Institute of Public Health, Norway, Microscopy Facility, Oslo, Norway, 1977. Seminars on vitreous fibers as asbestos substitutes.

Consultant, International Metalworkers Federation, Problems Focusing on Asbestos Contamination of Nickel Ores, Geneva, Switzerland, 1980.

Research Consultant, Societe Nationale de l'Amiante, Quebec, Canada, Work on Modified Fiber, 1984.

WHO-International Program on Chemical Safety (IPCS), Environmental Health Criteria Document on Asbestos and Other Natural Mineral Fibers, Section Chairman, Hannover, Federal Republic of Germany, 1985.

Organizing Committee, Third International Conference, In Vitro Effects of Mineral Dusts, Schluchsee, Federal Republic of Germany, 1984.

Societe Nationale de l'Amiante. Consultant. Modified Fiber and the Environmental Protection Agency Asbestos Ban, Montreal, Canada, 1986.

**INTERNATIONAL COMMITTEES AND CONSULTATIONS (1979-PRESENT) (cont):**

International Agency for Research on Cancer, WHO Development of V.42, Chemical Carcinogenesis Monograph Series, Evaluation of Carcinogenic Risk to Chemicals in Man: Silica and Some Silicates, Member of Working Group, Lyon, France, 1986.

Consultant, Asbestos Institute, Canada, Organization of Symposium on Biological Effects of Asbestos Substitutes, 1987.

VIIth International Pneumoconiosis Conference. International Organizing Committee; Organizer of Session: Hazard Recognition of Mineral Dust. Pittsburgh, PA, August, 1988. Chaired Two Sessions at Meeting: Mineral Recognition by Membranes and Mineral Toxicity; Mineral Fiber and Diseases of the Pleura.

International Federation of Building and Wood Workers, Conference on Interior Works, Geneva, Switzerland. Presented paper: Hazards in the Painting Trades. Panel on Hazards in the Interior Workplace, May 9-12, 1989.

**NATIONAL COMMITTEES, CONSULTATIONS:**

Food and Drug Administration, Asbestos, Talc, Asbestos Bodies,and Consumer Talcums, Seminar, Washington, DC, June, 1968.

National Air Pollution Control Administration, Asbestos in Ambient Air. Arlington, VA, June, 1969.

National Institute for Occupational Safety and Health, USPHS, Asbestos Research in the United States, Cincinnati, OH, January, 1970.

Food and Drug Administration, Asbestos in Consumer Talcums, Seminar, Washington, DC, August, 1971.

Environmental Protection Agency, National Air Pollution Control Techniques Advisory Committee, Asbestos Emissions Document, Atlanta, GA, 1971.

NIOSH Task Force on Occupational Respiratory Diseases, 1975.

Environmental Protection Agency, HERL, Ad Hoc Committee for the Fibrous Amphibole Study Protocol, Triangle Park, NC, 1976.

NIEHS-NIOSH-EPA-ERDA. Interagency Retreat and Colloquium. Man-made Vitreous fibers, Asbestos Substitutes and the Energy Crisis. Potential Risks to Health. Pinehurst, NC. 7-9 January, 1976.

NIOSH Criteria Document Recommended Standard For Occupational Exposure to Fibrous Glass, Reviewer. November, 1976.

Environmental Protection Agency, HERL, Biological Effects on Fibrous Inorganic Particles, 1977.

DHHS, Interagency Committee to Coordinate Environmental and Related Problems, Biological Effects of Fibrous Particulates: Serpentine-Containing Host Rocks, Amphibole-Containing Host Rocks, 1980.

**NATIONAL COMMITTEES, CONSULTATIONS (cont):**

Mount St. Helen's Volcanic Ash: Mineral Nature and Biological Activity, Interagency Task Force, Bethesda, MD, 1980.

NHLBI, Evaluation of Existing Inorganic Microparticulate Laboratories: Vermont Lung Group, Tulane Occupational Lung Hazards Group, 1978.

National Institute of Environmental Health Sciences, Workshop, Pathobiology of Mesothelioma, RTP, NC, January, 1983.

Occupational Safety and Health Administration, Expert to write and review Asbestos Standard-Talc Standard, US Department of Labor, 1983.

National Academy of Sciences, Division of Life Sciences Committee to Evaluate Risk to Low-Level Exposure to Asbestiform Fibers in the Environment, 1982-1984.

Environmental Protection Agency. Prepared for meeting Substitute Fibers. Pre-market Testing of Fibers. USEPA, Washington, DC. 26 June 1984.

Environmental Protection Agency, Committee Member, Review and Rewrite EPA "Guidance Document for Controlling Friable Asbestos-Containing Minerals in Buildings," 1985.

American Society Testing Materials, Committee, D22-Indoor Air Pollution Asbestos: D22.05-Methodology and Measurement of Fibers in Air. Electron Microscopy, 1985.

American Society Testing Materials, Organizing Committee, Silica and Silica-Induced Diseases, International Conference, 1985.

NIOSH, Mine Health Research Advisory Committee Meeting, Tucson, AZ: The Impact of Mineral-Asbestos Definitions on the Mining Industry, 1986.

Environmental Protection Agency. Develop guidance document for identifying asbestos hazards and implementing abatement programs in public buildings, Washington, DC, April, 1986.

NIOSH Review Panel for Project "Evaluation of Mesothelioma Production by Asbestos Substitutes." Cincinnati, OH, June, 1986.

Environmental Protection Agency, Guidance Document for Assessing and Managing Exposure to Asbestos in Building, Arlington, VA, September, 1986.

Environmental Protection Agency, Operations and Maintenance Programs for Asbestos-Containing Materials in Buildings: A Guide for Building Owners and Managers, Washington, DC, January, 1987.

NIEHS-NIOSH - National Toxicology Program. To formulate study protocol comparing biological activities of asbestiform and non-asbestiform amphibole minerals. NIEHS - Res. Triangle Park, NC, October 11, 1989.

Health Effects Institute. Asbestos Literature Review Panel. April, 1990 - August, 1991.

Health Effects Institute. Reviewer of Research Proposals - RPI-1-91.

**TESTIMONY - FEDERAL AGENCIES:**

Expert Testimony, Toxic Substances Control Act, 1973. Provided evidence to Sen. Tunney's committee hearing, Washington, D.C.
Expert Witness, Contamination of Lake Superior. On behalf of the Department of Justice of the United States, 1974. Minneapolis, MN.
Expert Testimony, Occupational Safety and Health Administration, US Department of Labor, Asbestos Standard, 1984. Washington, D.C.
Expert Testimony, Consumer Products Safety Commission. Asbestos in Play Sand. Washington, DC, December 7, 1988.
Expert Testimony Occupational Safety and Health Administration, U.S. Department of Labor. Asbestos Standard Revisions. April, 1990. Washington, D.C.

**REGIONAL CONSULTATIONS:**

Health Research Council of New York City, Subcommittee on Asbestos Hazards - Air Pollution Working Corp. Seminar on Asbestos in Construction Products, Rockefeller University, June 9, 1969.
New York City Board of Education: Asbestos in Schools, 1981-1983.
New York City Department of Sanitation; Fire Department: Insulation Products, 1979-1983.
New York State Consumer Affairs and Protection: Construction and Insulation Products, 1980-1983.
City University of New York-Brooklyn College: Asbestos Problems, 1981-1982.

**ACADEMIC COMMITTEES:**

Academic Council, Department Representative, MSSM, 1977-1979.
Medical Center Safety Committee, MSSM, 1979-1988.
Chemical Hazards Committee, MSSM, 1979-1988.
Alternate Medical Safety Officer (in absence of Dr. S. Kochwa), MSSM, 1980-1983.
Space Committee (Department and Institution), MSSM, 1982-1985.
New York Academy of Sciences, Conference Organizing Committee, 1976-1980.
Visiting Professor Program. Mt. Sinai School of Medicine. 1971-1973.
Educational Policy Committee. Mt. Sinai School of Medicine. 1972-1974.
Ad Hoc Reviewer, National Institutes of Health, Minneapolis Medical Center, 1977.
Ad Hoc Reviewer, National Institutes of Health, Harvard Medical Center, 1978.

**ACADEMIC COMMITTEES (cont):**

Workshop Organizer and Chairman, Significance of Aspect Ratio in Asbestos Diseases, New York Academy of Sciences, 1977.
Workshop Organizer, Third International Workshop on In Vitro Testing of Mineral Dusts, 1984.
Executive Committee, Ph.D. Program, Earth and Environmental Sciences, City University of New York, 1985.
Curriculum and Examination Committee, Ph.D. Program, Earth and Environmental Sciences, City University of New York, 1987-1990.
Faculty Membership Committee - Chairman - Ph.D. Program, Earth and Environmental Sciences, City University of New York, 1989-present.

**CONSULTANT:**

Cyprus Minerals-Nature of US Talc Deposits, 1979.
General Accident Insurance Company: Asbestos Compensation, 1981.
Gulf Minerals: Modified Chrysotile Fiber, 1982.
Oil, Chemical and Atomic Workers International Union, Safe Handling of Asbestos, Training Film, 1976.
Lung Center and NHLB-SCOR, in the Departments of Physiology, Medicine, Pathology, and Engineering in the University of Vermont, Burlington, VT, 1984.
Societe Nationale de l'Amiante: Phosphorylated Fiber; Asbestos Substitutes, 1984.
W.R. Grace & Company: Asbestos and Indoor Air Pollution, 1984.
Asbestos Institute of Canada, Asbestos and Asbestos Substitutes, 1985-1986.
Litigations. Represented numerous plaintiffs, defendants, insurance carriers, US Department of Justice, Brooklyn and New York counties' District Attorneys.
R.T. Vanderbilt Company, Nature of Tremolite in the Gouverneur Talc Deposit, 1987.
Safe Building Alliance, Problems of Asbestos in Buildings, 1987.
Review applications for funding requests: FCAC, Quebec, Canada, 1985.
Battelle Columbus Laboratories: Analysis of Microparticles by Analytical Electron Microscopy, 1987-1989.

**INDUSTRY PROJECT REPORTS:**

Chrysotile and chrysophosphate. A comparative study of their physicochemical properties and membrane activities. A report to SNA-Chrysophosphate, Canada. Langer AM, Nolan RP, p. 87, June 1, 1987.

**INDUSTRY PROJECT REPORTS (cont):**

Wollastonite in the pulmonary tissues on animals. A report to Northrop Services Industries, National Toxicology Program. Langer AM, Nolan RP, p. 101, June 15, 1989

Preparation, examination and characterization of mineral standards by analytical electron microscopy. A report to Battelle Columbus Laboratories, Langer AM, Nolan RP, Pooley FD, Gieseke JA, Fisher G, 61 p., December 12, 1989.

Comparison and evaluation of the analytical capabilities of three U.S. laboratories for submicroscopic particulate analysis. A report to Battelle Columbus Laboratories, Langer AM, Nolan RP, Gieseke JA, Fisher G. February, 1991.

The Identification and Quantitation of Small Asbestos Fibres in Injectable Medicines. Technical Expert Report Prepared for Hoffman-LaRoche, Basel. 16 p. Addison J, Burdett GJ, Langer AM, Muhle H. 1993

**GOVERNMENT PROJECT REPORTS:**

Asbestiform Fibers - Non-Occupational Health Risks. National Academy of Sciences. National Research Council. National Academy Press, 334 p., 1984.

Report to the U.S. Consumer Product Safety Commission: Mineralogical Analysis of Two "Play Sands" For Their Asbestos Contents. Langer AM, Nolan RP. 26 November, 1986. 9p., 4 Tables, 18 plates.

Report to the U.S. Consumer Product Safety Commission: Mineral Analysis of a Carbonate Play Sand. Langer AM, Nolan RP. July, 1987. 19 p., 3 Tables, 8 plates.

Asbestos in Public and Commercial Buildings: A Literature Review and Synthesis of Current Knowledge. Health Effects Institute, Cambridge, MA and U.S. Environmental Protection Agency. 300 p., 1991.

**INTERNATIONAL DOCUMENTS:**

Evaluation of Carcinogenic Risk of Asbestos. Volume 14. Asbestos. Series. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. Intl Agency for Res. on Cancer - WHO, Lyon. 106 p. 1977. Co-author, Panel Member.

International Programme on Chemical Safety (IPCS). WHO. Environmental Health Criteria 53: Asbestos and Other Natural Mineral Fibres. 194 p., 1986. Co-author, Panel Member.

Silica and Some Silicates. Volume 42. Series IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. Intl Agency for Res. on Cancer - WHO, Lyon. 289 p., 1987. Co-author, Panel member.

PUBLICATIONS IN PEER-REVIEWED JOURNALS:

1. Kerr PF, Thomas AM, Langer AM: The nature and synthesis of ferrimolybdite. Am Mineral 48:14-32, 1963.

2. Kerr PF, Langer AM: Mineralogical features of Mojave playa crusts. In: Mineralogy and Hydrology of US Playas. Neal J (ed), US Air Force Cambridge Research Laboratories Environmental Research Paper No. 96, pp. 31-72, 1965.

3. Langer AM, Kerr PF: Experimental variables influencing DTA curves of kaolinite. Dupont Thermogram 3:1-4, 1966.

4. Langer AM: Older paleozoic metamorphism and pegmatization in Bronx, New York. Ann NY Acad Sci 136:1-32, 1966.

5. Langer AM, Kerr PF: Mojave Desert playa crusts: physical properties and mineral content. J Sed Patrol 36:377-396, 1966.

6. Langer AM, Kerr PF: Evaluation of kaolinite and quartz differential thermal curves with a new high-temperature cell. Am Mineral 52:509-523, 1967.

7. Berkley C, Langer AM, Baden V: Instrumental analysis of inspired pulmonary particulates. Trans NY Acad Sci 30:331-350, 1967.

8. Neal JT, Langer AM, Kerr PF: Giant desiccation polygons of Great Basin playas. Bull Geol Soc Am 79:59-90, 1968.

9. Langer AM, Bowes DR: Polyphase deformation in the Manhattan formation of Manhattan-Island, New York City. Memoir 115 Geol Soc Am 358-373, 1969.

10. Langer AM, Selikoff IJ, Sastre A: Chrysotile asbestos in the lungs of persons in New York City. Arch Environ Health 22:348-361, 1971.

11. Langer AM, Mackler AD, Rubin IB, Hammond EC, Selikoff IJ: Inorganic particles in cigars and cigar smoke. Science 174(4009):585-587, 1971.

12. Selikoff IJ, Nicholson WJ, Langer AM: Asbestos air pollution in urban areas. Arch Environ Health 25:1-13, 1972.

13. Liebling R, Langer AM: Optical properties of fibrous brucite from asbestos, Quebec. Am Mineral 57:857-864, 1972.

14. Langer AM, Rubin IB, Selikoff, IJ: Chemical characterization of asbestos body cores by electron microprobe analysis. J Histochem Cytochem 20 (9):723-734, 1972.

**PUBLICATIONS IN PEER-REVIEWED JOURNALS (cont):**

15. Langer AM, Rubin IB, Selikoff IJ, Pooley, FD: Chemical characterization of uncoated asbestos fibers from lungs of asbestos workers by electron microprobe analysis. J Histochem Cytochem 20(9):735-740, 1972.

16. Bowes DR, Langer AM: Petrochemistry of the Manhattan formation, New York City. Krystalinikum 10:39-51, 1974.

17. Langer AM, Ashley R, Baden V, Berkley C, Hammond EC, Mackler AD, Maggiore CJ, Nicholson WJ, Rohl AN, Rubin IB, Sastre A, Selikoff IJ: Identification of asbestos in human tissues. J Occup Med 15:287-295, 1973.

18. Ehrenreich T, Mackler AD, Langer AM, Selikoff IJ: Les fibers d'amiante dans les poumons humains: leur signification medicolegale dans les maladies de l'environment. Arch des Maladies Professionelles 34(4-5):189-204, 1973.

19. Bowes DR, Langer AM: Hornblende schists in the Manhattan formation in the Bronx, New York:Discussion. Bull Geol Soc Am 84:1483-1490, 1973.

20. Ehrenreich T, Mackler AD, Langer AM, Selikoff IJ: Identification and characterization of pulmonary dust burden in pneumoconiosis. Ann Clin Lab Sci 3(2):118-131, 1973.

21. Kleinfeld M, Messite J, Langer AM: A study of workers exposed to asbestiform minerals in commercial talc manufacture. Environ Res 6(2):132-143, 1973.

22. Nicholson WJ, Langer AM, Selikoff IJ: Discussion: asbestos fibers in the air of towns. Atmosph Environ 7:666-668, 1973.

23. Langer AM: Inorganic particles in human tissues and their association with neoplastic disease. Environ Health Perspect 9:229-233, 1974.

24. Langer AM: Approaches and constraints to identification and quantitation of asbestos fibers. Environ Health Perspect 9:133-136, 1974.

25. Langer AM: Research perspectives concerning asbestos minerals and their effects on biological systems. Environ Health Perspect 9:335-338, 1974.

26. Langer AM: The subject of continuous vigilance. Environ Health Perspect 9:53-56, 1974.

27. Rohl AN, Langer AM: Identification of asbestos in talc. Environ Health Perspect 9:95-109, 1974.

**PUBLICATIONS IN PEER-REVIEWED JOURNALS (cont):**


28. Langer AM, Mackler AD, Pooley FD: Electron microscopical investigation of asbestos fibers. Environ Health Perspect 9:63-80, 1974.

29. Miller A, Langer AM, Teirstein, AS, Selikoff IJ: "Non-specific" interstitial fibrosis: association with fibers detected by electron microscopy. N Engl J Med 292:91-93, 1975.

30. Rohl AN, Langer AM, Selikoff IJ, Nicholson WJ: Exposure to asbestos in use of consumer spackling, patching, and taping compounds. Science 189(4204):551-553, 1975.

31. Rohl AN, Langer AM, Klimentidis R, Wolff MS: Asbestos exposure during brake lining maintenance and repair. Environ Res 12:110-128, 1976.

32. Rohl AN, Langer AM, Selikoff IJ, Tordini A, Klimentidis R, Bowes DR, Skinner D: Mineral and chemical characterization of selected consumer talcum products. J Toxicol Environ Sci 2:255-284, 1976.

33. Bowes DR, Langer AM, Rohl AN: Nature and range of mineral dusts in the environment. Phil Trans Roy Soc London 286:593-610, 1977.

34. Rohl AN, Langer AM, Klimentidis R, Wolff MS, Selikoff IJ: Asbestos content of dust encountered during brake maintenance and repair. Proc Roy Soc Med 70:32-39, 1977.

35. Rohl AN, Langer AM, Selikoff IJ: Environmental asbestos pollution related to use of quarried serpentine rock. Science 196:1319-1322, 1977.

36. Langer AM, Wolff MS, Rohl AN, Selikoff IJ: Variation of properties of chrysotile asbestos, subjected to prolonged milling. J Toxicol Environ Sci 4:173-188, 1978.

37. Fischbein A, Langer AM, Suzuki Y, Selikoff IJ: Carcinoma of the lung in a drywall taping worker: report of a case. Toxicol Letters 2:231-236, 1978.

38. Langer AM: Crystal faces and cleavage planes in quartz as templates in biological processes. Quart Rev Biophys 11:543-575, 1978.

39. Rohl AN, Langer AM, Selikoff IJ: Airborne asbestos in the vicinity of a freeway: discussion. Atmosph Environ 12:2030-2031, 1978.

**PUBLICATIONS IN PEER-REVIEWED JOURNALS (cont):**


40. Langer AM, Rohl AN, Selikoff IJ: Asbestos on Maryland's roads. The Lancet i:1263-1264, 1978.

41. Fischbein A, Rohl AN, Langer AM, Selikoff IJ: Drywall construction and asbestos exposure. Am Industr Hyg Assoc 40:402-407, 1979.

42. Langer AM, Rohl AN, Selikoff IJ, Harlow G, Prinz M: Asbestos as a co-factor among nickel processing workers. Science 209:420-422, 1980.

43. Nolan RP, Langer AM, Harington JS, Oster G, Selikoff IJ: Quartz hemolysis as related to its surface functionalities. Environ Res 26:503-520, 1981.

44. Rohl AN, Langer AM, Moncure G, Fischbein AS, Selikoff IJ: Endemic pleural disease associated with mixed fibrous dust exposure in Turkey. Science 216(4545):518-520, 1982.

45. Langer AM, McCaughey WET: Mesothelioma in a brake repair worker. The Lancet ii:1101-1103, 1982. 91-95, 1992.

46. Ehrenreich T, Espinoza T, Langer AM, Rohl AN, Daum SM: Algorithm for forensic pathological diagnosis of asbestos-related diseases. Am J Foren Med Pathol 3(4):315-321, 1982.

47. Langer AM, Rohl AN, Fischbein AS, Selikoff IJ: Cancer in nickel processing workers in New Caledonia: discussion. Science 215:425-426, 1982.

✓48. Yeager H, Russo D, Yanez M, Gerardi D, Nolan RP, Kagan E, Langer AM: Preliminary observations on acute cytotoxicity of short fiber chrysotile asbestos for human alveolar macrophages. Environ Res 30:224-232, 1983.

49. Brody J, Miller A, Langer AM: Pneumoconiosis associated with exposure to glass and abrasive fragments. Am J Industr Med 6:339-346, 1984.

50. Constantopoulos S, Goudevenos J, Saratzis N, Charalampopoulos C, Laparidou S, Langer AM, Selikoff IJ, Moutsopoulos H: Endemic asbestos-like pleural calcifications in the absence of occupational asbestos exposure. Arch Hellenic Med 1(10):165-171, 1984.

51. Sawyer R, Rohl AN, Langer AM: Fiber contamination in buildings resulting from removal of asbestos-containing materials. Environ Res 36(1):46-55, 1985.

**PUBLICATIONS IN PEER-REVIEWED JOURNALS (cont):**

52. Constantopoulos SH, Goudevenos JA, Saratzis N, Langer AM, Selikoff IJ, Moutsopoulos HM: Metsovo lung: pleural calcification and restrictive lung function in northwestern Greece. Environmental exposure to mineral fiber as etiology. Environ Res 38:319-331, 1985.

53. Langer AM, Nolan RP: Asbestos in potable water supplies and attributable risk of gastrointestinal cancer. Northeast Environ Sci 5(1/2):41-53, 1986.

54. Langer AM, Nolan RP, Constantopoulos SH, Moutsopoulos HM: Association of Metsovo lung and pleural mesothelioma with exposure to tremolite-containing whitewash. The Lancet i:965-967, 1987.

55. Nolan RP, Langer AM, Weisman I, Herson R: Surface character and membrolytic properties of the titania polymorphs. Br J Ind Med 44(10):687-698, 1987.

56. Nolan RP, Langer AM, Eskenazi RA, Herson GB, Foster KW: Membranolytic activities of quartz standards. Toxicol In Vitro 1(4):239-245, 1987.

57. Langer AM, Nolan RP: Fiber type and mesothelioma risk. Symposium of Health Aspects of Exposure to Asbestos in Buildings. Energy and Environmental Policy Center, Kennedy School of Government. Harvard University. December, 1989, 91-141.

58. Freed JA, Miller A, Gordon R, Fischbein A, Kleinerman J, Langer AM: Desquamative interstitial pneumonia associated with chrysotile asbestos fibers. Br J Ind Med, 48: 332-337, 1991.

59. Nolan RP, Langer AM, Herson GB: Characterization of palygorskite specimens from different geological locales for health hazard evaluation. Br J Ind Med, 48: 463-475, 1991.

✓ 60. Langer AM, Nolan RP: Comparison of lung tissue mineral fiber retention of exposed workers and the general population. Env. Health Perspect. in press.

✓ 61. Nolan RP, Langer AM, Addison J: Lung content analysis of cases occupationally exposed to chrysotile asbestos. Env. Health Perspect. in press.

62. Langer AM, Nolan RP: Chrysotile: Its Occurence and Properties as variables controlling Biological Effects. Ann. Occup. Hyg., in press.

**PUBLICATIONS IN SYMPOSIA PROCEEDINGS:**

1. Berkley C, Langer AM, Sastre A, Arneson A: Electron microprobe analysis of asbestos bodies. In: Int'l Konferenz uber die Biologischen Wirkungen des Asbestos, Dresden, 22-24 April, 1968. Holstein, Anspach M (eds), Deutsches Zentralinstitut fur Arbeitsmedizin, Berlin, DDR, pp. 12-22.

2. Schwartz J, Langer AM: Technique of removal and analysis of single fibrous particles from human lung tissue. In: Int'l Konferenz uber die Biologischen Wirkungen des Asbestos, Dresden, 22-24 April, 1968. Holstein, Anspach M (eds), Deutsches Zentralinstitut fur Arbeitsmedizin, Berlin, DDR, pp.8-12.

3. Bowes DR, Langer AM: Polyphase deformation in the schist of the Bronx, New York City. In: Geology, Queens College, CUNY, Alexandroff E (ed) 1(3):17-32, 1969.

4. Langer AM: Electron microprobe analysis (study of asbestos fibers and bodies from lung tissue). In: Laboratory Diagnosis of Diseases Caused by Toxic Agents. Sunderman FW, Sunderman Jr FW (eds), W.H. Green; St. Louis, MO, Chapt. 14, pp. 126-136, 1970.

5. Langer AM, Rubin IB, Selikoff IJ: Electron microprobe analysis of asbestos bodies. In: Pneumoconiosis, Proc Int'l Conf, Johannesburg. Shapiro HA (ed), Oxford University Press; Capetown, pp. 57-69, 1970.

6. Langer AM, Baden V, Hammond EC, Selikoff IJ: Inorganic fibers, including chrysotile in the lungs at autopsy: preliminary report. In: Inhaled Particles III, Proc Conf Brit Occup Hyg Soc, London. Walton WH (ed), Unwin Bros; Surrey, England, 2:683-694, 1971.

7. Langer AM, Selikoff IJ: Chrysotile asbestos of lungs in residents of New York City. In: 2nd Int'l Clean Air Congress, Washington, DC. Englund HM, Beery, WT (eds), Academic Press; New York, pp. 161-165, 1971.

8. Langer AM, Pooley FD: Identification of single asbestos fibers in human tissues. In: Proc Int'l Agency for Research on Cancer, Biol. Effects of Asbestos, Lyon, 1972, Bogovski P, Gilson JC, Timbrell V, Wagner JC (eds), pp. 119-125, 1973.

9. Langer AM: Aspects of mineralogy of talc. In: Proc Symp on Talc, Washington, DC, May 9, 1973. Goodwin A (ed), USBM IC 8639, US Department of Interior, pp. 82-88, 1974.

**PUBLICATIONS IN SYMPOSIA PROCEEDINGS (cont):**

10. Pooley FD, Rohl AN, Langer AM, Bowes DE, Skinner DL: Mineralogy and chemistry of British talc and consumer talcum products. In: 4th Int'l Symp Inhaled Particles and Vapors. Walton WH (ed), Pr. 8.6, pp. 1-18, 1975.

11. Langer AM, Rohl AN, Wolff MS, Klimentidis R, Shirey SB: Review of current techniques for the analysis of fibers in talc. In: Electron Microscopy of Microfibers. Asher IM, McGrath PP (eds), US Government Printing Office, pp. 28-33, 1977.

12. Langer AM, Wolff MS: Asbestos carcinogenesis. In: Inorganic and Nutritional Aspects of Cancer. Adv Exper Med Biol Series, Schrauzer GN (ed), Plenum Press; New York, pp. 29-55, 1977.

13. Nicholson WJ, Langer AM, Selikoff IJ: Epidemiological evidence on asbestos, Part I: Human health effects; Part II: Extrapolation to other inorganic fibers. In: Proc of Workshop on Asbestos, NBS SP 506. Gravatt CC, LaFleur PD, Heinrich KFJ (eds), with discussion. US Government Printing Office, Washington, DC, pp. 71-93, 1978.

14. Rohl AN, Langer AM: Fibrous mineral content of consumer talc-containing products. In: Dusts and Diseases. Lemen R, Dement JM (eds), Pathotoxicol Publishers, Inc; Forest Park, IL, pp. 393-403, 1979.

15. Langer AM, Rohl AN, Wolff MS, Selikoff IJ: Asbestos, fibrous minerals, and acicular cleavage fragments: nomenclature and biological properties. In: Dusts and Diseases. Lemen R, Dement JM (eds), Pathotoxicol Publishers, Inc; Forest Park, IL, pp. 1-22, 1979.

16. Langer AM, Maggiore CJ, Nicholson WJ, Rohl AN, Rubin IB, Selikoff IJ: The contamination of Lake Superior with fibrous amphiboles. In: Proc NY Acad Sci Asbestos Conf, New York, NY, June 1978, Ann NY Acad Sci 330:549-572, 1979.

17. Langer AM: Significance of aspect ratio in regulation of asbestos fiber exposure. Ann NY Acad Sci 330:601-604, 1979.

18. Langer AM, Selikoff IJ, Rosenberg C: Defining new asbestos high risk groups. In: Int'l Conf Critical Current Issues in Environmental Health Hazards, Tel Aviv, Israel, March 4-7, p. 11, 1979.

19. Langer AM, Sebastien P: Physical-chemical properties of fibers: discussion. In: Biological Effects of Asbestos, IARC, Vol. 1, Wagner JC (ed), WHO, Lyon, France, pp. 143-145, 1980.

PUBLICATIONS IN SYMPOSIA PROCEEDINGS (cont):

20. Suzuki Y, Rohl AN, Langer AM, Selikoff IJ: Mesothelioma following intraperitoneal administration of zeolite. Fed Proc 39(3):640, 1980.

21. Langer AM: Natural non-fibrous asbestos substitutes: talc. In: Proc Nat'l Workshop on Substitutes for Asbestos, Guimond RJ, Rowe J (eds), US Environmental Protection Agency, Office of Pesticides and Toxic Substances, Washington, DC, pp. 563-569, 1980.

22. Rohl AN, Ehrenreich T, Langer AM: Characterization and identification of asbestos materials in human tissues. In: Adv Pathol (Anat and Clin), Vol. 2, Anatomic Pathology, Cytopathology, Forensic Pathology and Toxicology, Levy E (ed), Pergamon Press, New York, pp. 523-525, 1982.

23. Langer AM, Weisman I, Adams A: Characterization of crystalline particles in human tissues by analytical electron microscopy. J Rheumatol 8(6):1018-1019, 1982.

24. Nolan RP, Langer AM: Quartz and hemolysis: physico-chemical factors controlling membrane activity. In: 4th Ann RMCOEH Conf Health Issues Related to Mining and Minerals, Wagner W, Merchant J, Rom W (eds), Chapt. 4, Ann Arbor Press, Michigan, pp. 63-81, 1983.

25. Langer AM: Surface characteristics and biological properties of minerals. In: World Symp on Asbestos, May 25-27, 1982, Canadian Asbestos Information Center, Montreal, Quebec, pp. 393-400, 1983.

26. Langer AM, Nolan RP: Minerals, rocks and ore bodies: sources of agents of human disease. In: Proc 2nd Int'l Congr on Applied Mineralogy in the Minerals Industry. Park WC, Hausen DM, Hagni RP (eds), pp. 1159-1179, 1985.

27. Harlow GE, Kimball MR, Dowty E, Langer AM: Observations on amosite-grunerite dusts. In: Proc 2nd Int'l Congr on Applied Mineralogy in the Minerals Industry. Park WC, Hausen DM, Hagni RP pp. 1147-1157, 1985.

28. Nolan RP, Langer AM, Foster KW: Particle size and chemically induced variability in the membrolytic activity of quartz: preliminary observations. In: In Vitro Effects of Mineral Dusts, 3rd Int'l Workshop. Beck EG, Bignon J (eds), Springer-Verlag, Berlin, pp. 39-50, 1985.

**PUBLICATIONS IN SYMPOSIA PROCEEDINGS (cont):**

29. Langer AM, Nolan RP: Physico-chemical properties of minerals relevant to biological activities. State of the Art. In: In Vitro Effects of Mineral Dusts, 3rd Int'l Workshop. Beck EG, Bignon J (eds), Springer-Verlag, Berlin, pp. 9-24, 1985.

30. Langer AM, Nolan RP: Physico-chemical properties of quartz and biological activity. In: Silica, Silicosis, and Cancer. Controversy in Occupational Medicine. Ca Res Monogr 2, Goldsmith DF, Winn DM, Shy CM (eds), Praeger, NY, pp. 125-136, 1986.

31. Langer AM, Nolan RP: The properties of chrysotile asbestos as determinants of biological activity. Variations in cohort experience and disease spectra as related to mineral properties. In: General Motors Workshop, Biol Effects Chrysotile Asbestos, Cardiff, 7-9 May, 1986, Wagner JC (ed), Accomplishments in Oncology, Lippincott Press, 1(2):30-51, 1986.

32. Langer AM: Fibers in friction products. Discussion and Summary of Symposium. In: Proc Fibres in Friction Materials Symposium. The Asbestos Institute, Montreal, Canada, pp. 67-74, October, 1987.

33. Nolan RP, Langer AM: Quantitative aspects of fiber morphology. In: Proc Fibres in Friction Materials Symposium. The Asbestos Institute, Montreal, Canada, pp. 75-97, October, 1987.

34. Langer AM, Nolan RP: Fiber type and burden found in parenchymal tissues of workers occupationally exposed to asbestos in the United States. In: Mineral Fibers in the Non-Occupational Environment, Spec. Publ. 90. IARC-WHO, Lyon, France, pp. 310-315, 1989.

35. Langer AM, Nolan RP, Bowes DR, Shirey: Inorganic particles found in cigarette tobacco, cigarette ash, and cigarette smoke. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. Wehner AP, Felton DL, Eds., Battelle Press, Columbus, OH, pp. 421-439, 1989.

36. Nolan RP, Langer AM, Herson GB: Physico-chemical properties and membranolytic activities of the titanium dioxide polymorphs compared to quartz. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. Wehner AP, Felton DL, Eds., Battelle Press, Columbus, OH, pp. 391-419, 1989.

**PUBLICATIONS IN SYMPOSIA PROCEEDINGS (cont):**

37. Langer AM, Nolan RP: Mineral fibers in lung tissues of persons exposed to asbestos in the United States. In: VIIth Int'l Pneumoconiosis Conf. August 23-26, 1988.

38. Nolan RP, Langer AM: Physicochemical characteristics of quartz dust which controls its biological activity. In: VIIth Int'l Pneumoconiosis Conf, August 23-26, 1988.

39. Langer AM, Nolan RP: Distinguishing asbestiform tremolite from non-asbestiform tremolite. In: VIIth Int'l Pneumoconiosis Conf, August 23-26, 1988.

40. Nolan RP, Langer AM, Herson GB: Membranolytic activity of palygorskite and sepiolite. In: IVth Int'l Workshop: Effects of Mineral Dusts on Cells. Mossman BT, Begin RO, Eds., Springer-Verlag, Oxford, Quebec, Canada, September, pp. 37-48, 1989.

41. Langer AM, Nolan RP, Pooley FD,: Phyllosilicates:associated fibrous minerals. In: Health Related Effects of Phyllosilicates. J. Bignon, Ed., 59-74, Springer-Verlag, N.Y., 1990.

42. Langer AM, Nolan RP, Addison J: Physico-chemical properties of asbestos as determinants of biological potential. In: Mineral Fibers and Health. Liddell FDS, Miller K, Eds., CRC Press, Ann Arbor, Michigan, pp. 207-224, 1991.

43. Langer AM, Nolan RP, Addison J: Distinguishing between amphibole asbestos fibers and elongate cleavage fragments of their non-asbestos analogues. In: NATO Advanced Research Workshop on Mechanisms in Fibre Carcinogenesis. RC. Brown, J. Hoskins, N. Johnson, Eds., Albuquerque, New Mexico, October 22-25, 1990. p. 253-267. 1991.

44. Nolan RP, Langer AM, Oechsle GW, Addison J, Colflesh DE: Association of tremolite habit with biological potential. In: NATO Advanced Research Workshop on Mechanisms in Fibre Carcinogenesis. RC. Brown, J. Hoskins, N. Johnson, Eds., Albuquerque, New Mexico, October 22-25, 1990. p.231-251. 1991.

45. Langer AM, Nolan RP: Zeolite catalysts. Is there a health risk? The erionite experience and its application to other zeolites. In: Chemicals and the Environment. Symposium on Chemical Specialties USA, Philadelphia. Spring Innovations, Ltd. 91-95, 1992.

46. Langer AM, Nolan RP: Factors controlling the biological potential of inorganic dusts. Surface chemistry and character. In: Toxic and Carcinogenic Effects of Solid Particles in the Respiratory Tract. 4th Intl. Inhalation Symp., Hannover, Germany. 1-5 March, 1993. in press. ILSI Press.

**PUBLICATIONS IN SYMPOSIA PROCEEDINGS (cont):**

47. Langer, AM, Nolan RP, Herson, G: Phosphorylated Canadian chrysotile. In: NATO Advanced Research Workshop. Cellular and Molecular Effects of Mineral and Synthetic Dusts and Fibres. In Press.

48. Nolan RP, Langer AM: Limitations of the Stanton Hypothesis. Chapt. 9. Health Effects of Mineral Dusts, Reviews in Mineralogy, 28, Guthrie GD., Jr. and Mossman BT, Eds, Mineral. Soc. America, Wash., D.C., 309-326.

49. Ross M, Nolan RP, Langer AM, Cooper WC: Health effects of mineral dusts other than asbestos. Chap. 12. Health Effects of Mineral Dusts, Reviews in Mineralogy, 28, Guthrie GD., Jr. and Mossman BT, Eds, Wash., D.C., 361-407.

**CONTRIBUTIONS TO BOOKS, MONOGRAPHS, REPORTS:**

1. Langer AM, Mackler AD: Mineral particles and human disease. In: Encyclopedia of Geochemistry and Environmental Sciences. Fairbridge RW (ed), Van Nostrand; Reinhold, NY, Vol. IVA, pp. 730-739, 1972.

2. Langer AM, Pooley FD: Mineralogy of asbestos minerals and methods of their characterization in human tissues. In: Asbestos: Volume 14 in the Chemical Carcinogenesis Series, Int'l Agency for Research on Cancer, p. 107, 1977.

3. Langer AM, Holaday D, Nicholson WJ, Rohl AN: Chapter 2. Asbestos Minerals: Nature, Occurrence and Properties, pp. 34-50. Chapter 4. Identification and Quantitation of Asbestos Fibers, pp. 71-100. Chapter 5. Environmental Distribution, pp. 102-134. In: Asbestos and Disease. Selikoff IJ, Lee WHK (eds), Academic Press; NY, 1978.

4. Rohl AN, Langer AM, Wylie AG: Mineral characterization of asbestos-containing spray finishes. In: Asbestos-Containing Materials in School Buildings. US Environmental Protection Agency, Document EPA 450-2-78-014, US Government Printing Office; Washington, DC, pp. 59-64, 1979.

5. Langer AM: Mineralogy of dust diseases. In: Maxcy-Rosenau Public Health and Preventive Medicine. Last J (ed), Appleton-Century-Crofts Publishers; NY, 11th Edition, pp. 637-641, 1981.

6. Zoltai T, Langer AM: Chapter 2. Asbestiform fibers: historical background, terminology, and physicochemical properties. In: Asbestiform Fibers - Non-Occupational Health Risks. NAS-NRC, Nat'l Acad Sci, pp. 25-47, 1984.

**CONTRIBUTIONS TO BOOKS, MONOGRAPHS, REPORTS (cont):**

7. Lynch J, Langer AM: Chapter 4. Measurement of exposure to asbestiform fibers. In: Asbestiform Fibers - Non-Occupational Health Risks. NAS-NRC, Nat'l Acad Sci, pp. 82-96, 1984.

8. Langer AM, et al.: Asbestos and other natural mineral fibers. In: Int'l Program on Chemical Safety. Environ Health Criteria 53, Chapters II, III, IV, V, WHO, Geneva, 1986.

9. Langer AM: Mineralogy. Chapter II. Presidential Report on Occupational Chest Diseases, Vol. 1, Characterization and Measurement of the Environment. Merchant J, Dement J (eds), ALOSH-NIOSH-CDC; Washington, DC, pp. 3-40, 1987.

10. Langer AM: Asbestos. In: Collier's Encyclopedia, 3:4-5, 1987.

11. Langer AM: Asbestos. In: Merit Students Encyclopedia, Macmillan Ed Pub, NY, pp. 270-271, 1990.

12. Langer AM: Asbestos chapter: American Medical Association Primer on Chemical and Radiation Exposures. Davis, A., Ed. (in review).

13. Ross M, Nolan R, Langer AM, Cooper WC. In: Mineral Short Course. Biological Effects of Minerals. Chapter 6. Health Effects of Mineral Dusts other than Asbestos. Guthrie, G and Mossman, B, Eds. Min. Soc. America, Wash., D.C. in press.

14. Nolan RP, Langer AM. In: Mineral Short Course. Biological Effects of Minerals. Chapter 14. Limitations of the Stanton Hypothesis. Guthrie, G and Mossman, B, Eds. Min. Soc. America, Wash., D.C. in press.

**OTHER PUBLICATION FORMS:**

1. Miller A, Teirstein AS, Langer AM, Selikoff IJ: Submicroscopical asbestos fibers and disease. Letter to the Editor. Reply to discussion. N Engl J Med 292:1195-1196, 1975.

2. Wolff MS, Langer AM, Shirey SB: Gas chromatographs: health effects. Letter to the Editor. Science 191:13, 1976.

3. Rom WN, Langer AM: Carcinogenicity of fibrous glass. Letter to the Editor. West J Med 126:413, 1977.

4. Rohl AN, Langer AM, Selikoff IJ: Asbestos pollution. Letter to the Editor. Reply. Science 197:716-718, 1977.

**OTHER PUBLICATION FORMS (cont):**

5. Rohl AN, Langer AM, Selikoff IJ: Chrysotile asbestos, effects of human exposure. Letter to the Editor. Reply. Science 198:1202, 1977.

6. Langer AM: Relationship between chemical and physical properties of mineral fiber and health effects. NBS SP506, Workshop on Asbestos: Definitions and Measurement Methods. Gravatt CC, LaFleur PD, Heinrich KFJ (eds), pp. 104-195:198, 1978.

7. Langer AM: Mineralogical factors in asbestos health effects. NSB SP506, Workshop on Asbestos: Definitions and Measurement Methods. Gravatt CC, LaFleur PD, Heinrich KFJ (eds), pp. 91-92;198, 1978.

8. Fischbein AS, Rohl AN, Langer AM, Selikoff IJ: Pleura-und-peritoneal mesothelioma. Letter to the Editor. Med Klin 74(19):742, 1979.

9. Langer AM: Electron microscopy and x-ray applications to environmental and occupational health analysis. Book Review. J Toxicol Environ Health, 1979.

10. Langer AM: Mineralogy and physical properties of fibers. Talcs contaminated with other minerals. Discussions. In: Dusts and Disease. Lemen R, Dement J (eds), Pathotoxicol Pub Inc, Park Forest, IL, 120:122-123, 341-344, 1979.

11. Langer AM: Round-table discussion on talc as an asbestos substitute. Chairman's remarks. In: Proc Nat'l Workshop on Substitutes for Asbestos, Arlington, VA, Guimond RJ, Rowe JN, Levin A, Pillsbury H (eds), USEPA Office Toxic Substances, Washington DC, pp. 612-619, July 14-16, 1980.

12. Fischbein AS, Langer AM, Rohl AN, Selikoff IJ: Asbestos disease in drywall construction workers. Letter to the Editor. Am Industr Hyg Assoc 40(9):829-830, 1980.

13. Fischbein AS, Rohl AN, Langer AM, Selikoff IJ: Past asbestos exposure among cable splicers. Letter to the Editor. Am J Pub Health 71:1277-1278, 1981.

14. Langer AM: Host rocks and gangue materials in relation to pneumoconiosis and cancer. Editorial. Am J Industr Med 2:89-90, 1981.

15. Langer AM, Sebastien P: Physical-chemical properties of fibers. Rappateur Report. In: Biological Effects of Mineral Fibers, Int'l Agency for Research on Cancer, Wagner JC (ed), IARC-WHO, Lyon, France, 1:143-145, 1981.

**OTHER PUBLICATION FORMS (cont):**

16. Langer AM, Selikoff IJ: Scientific data on chrysotile. Letter to the Editor. Chem Engineer News 2:59, 1984.

17. Langer AM: Mineral dust and pulmonary lesions: etiological link or epiphenomenon? Editorial. Am J Industr Med 6:169-171, 1984.

18. Fischbein AS, Langer AM, Rohl AN: Asbestos-associated diseases: lessons from the past for the future. Letter. JAMA 254:1309-1310, 1985.

19. Langer AM, Nolan RP: Asbestos in play sand. Letter, N Engl J Med 316:882, 1987.

20. Constantopoulos SH, Langer AM, Saratzis N, Nolan RP: Regional findings in Metsovo lung. Correspondence, The Lancet ii:452-453, 1987.

21. Langer AM, Nolan RP, Constantopoulos S: Endemic pleural calcification and mesothelioma. JAMA 260(3):339-340, 1988.

22. Langer AM: Chairman's Summary and Discussion. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. Wehner AP, Felton DL, Eds., Battelle Press, Columbus, OH, pp. 590-593, 1989.

23. Langer AM, Nolan RP, Ross M: Asbestos policy. Science, 249:1485, 1990.

24. Langer AM, Nolan RP: Pleural mesothelioma resulting from exposure to amosite asbestos in a building. Letter. Respiratory Medicine 84:509-510, 1990.

25. Langer AM, Nolan RP, Addison J: Letter to the Editor concerning Editorial " On talc, tremolite and tergiversation," Reger R, Morgan WKC. British Journal Industrial Medicine 48:359-360, 1991.

26. Wilson R, Langer AM, Nolan RP, Gee JB, Ross M: Policy forum: Asbestos in New York City public school buildings. Society for Policy Analysis. in review.

**PUBLISHED ABSTRACTS:**

1. Berkley C, Langer AM, Berkley LE, Anderson CA: Chemical changes in inspired asbestos fibers. Microscopy Symp, McCrone Laboratory, Chicago, IL, August, 1966.

**PUBLISHED ABSTRACTS (cont):**

2. Berkley C, Langer AM, Selikoff IJ: Microbeam analysis and identification of the degradation products of inspired pulmonary particulates. Trans NY Acad Sci, May, 1967.

3. Langer AM, Kerr PF: The nature of soft and harsh chrysotile. In: Conference on the Physics and Chemistry of Asbestos Minerals, Oxford, Pr. 2-2, July, 1967.

4. Berkley C, Langer AM, Arneson A: Electron microprobe and electron diffraction analysis of asbestos bodies. In: 2nd Intl. Conf. Biol. Effects Asbestos, p. 7, Dresden, 22-25 April, 1968.

5. Berkley C, Langer AM, Rubin IB: Electron Microprobe analysis of particles in tissues. In: Proc 5th Nat'l Conf Elect Probe Soc Am, New York, Pr. 29A, July, 1970.

6. Selikoff IJ, Nicholson WJ, Langer AM: Asbestos air pollution in urban areas. In: Proc AMA Air Pollution Med Res Conf, New Orleans, October, 1970.

7. Ehrenreich T, Langer AM, Selikoff IJ: Asbestos fibers in human lungs: forensic significance in environmental disease. In: 6th Int'l Mtg Forensic Sci, Edinburgh, Int'l Assn Forensic Sci, p. 86, September, 1972.

8. Teirstein AS, Miller A, Langer AM, Selikoff IJ: Sublight microscopic mineral particles in the etiology of pulmonary fibrosis. In: Proc Am Thorac Soc, New York, pp. 33-34, May 21-21, 1973.

9. Everett GA, Langer AM: Environmental contamination of Lake Superior asbestos from amphiboles in taconite wastes. In: Proc Ann Mtg Geol Soc Am, Miami, p. 728, November 18-20, 1974.

10. Rohl AN, Anderson H, Langer AM: Asbestos exposure during brake lining maintenance and repair. In: Proc Am Ind Hyg Assn, Miami, May 12-16, 1974.

11. Langer AM, Pooley FD, Bowes DR: Environment, disease and minerals. Read before the Geological Society, London, November 20, J Geol Soc, with discussion, 1974.

12. Langer AM, Wolff MS, Rubin IB: Environmental assay: particles in human tissues. In: Proc Int'l Conf Environ Sensing and assessment, Environmental Protection Agency, Pr. 29-34, September 14-19, 1975.

**PUBLISHED ABSTRACTS (cont):**

13. Bowes DR, Langer AM, Rohl AN: Nature and range of mineral dusts in the environment. Roy Soc London (Geological), p. 18, April 7, 1976.

14. Langer AM, Suzuki Y, Rohl AN: Identification of Microparticles. In: 3rd Intl. Symp. on Detection and Prevention of Cancer. ACS. New York, p. 91, April 26-May 1, 1976.

15. Fischbein A, Langer AM, Suzuki Y, Selikoff IJ: Carcinoma of the lung in a drywall taping worker: report of a case. In: Prog Abstr 3rd Int'l Symp Detect Prevent Cancer, No. 280, September 7, 1976.

16. Rom WN, Frank A, Suzuki Y, Langer AM, Selikoff IJ: Rapidly progressive interstitial pulmonary fibrosis from short term mixed dust exposure. 42nd An Sci Assem Am Coll Chest Phys, Atlanta, GA, October 21-28, 1976.

17. Fischbein A, Langer AM: Shale oil: A future energy alternative. A review of the mineralogic and carcinogenic properties of shale oil. Tenth Ann Conf Trace Substances in Environ Health, Columbia, MO, June 8-10, 1976.

18. Langer AM: Identification of microparticles in tissues. Workshop 13, 3rd Int'l Sump on Detection and Prevention of Cancer, September 1976.

19. Langer AM, Wolff MS: Asbestos carcinogenesis. In: Inorganic and Nutritional Aspects of Cancer, La Jolla, CA, January 2-5, 1977.

20. Selikoff IJ, Nicholson WJ, Langer AM: Epidemiological evidence on asbestos. Workshop on Asbestos, Definition and Measurement Methods, NBS Workshop, Gaithersburg, MD, July, 1977.

21. Langer AM: Contamination by submicroscopic particles in the biosphere. Int'l Symp Anal Electron Microscopy in Biol and Environ Routine and Research Work, Nat'l Inst Pub Health, Oslo, May 10, 1977.

22. Langer AM: Asbestos minerals and their carcinogenic effect. Int'l Symp Anal Electron in Biol and Environ Routine and Research Work, Nat'l Inst Pub Health, Oslo, May 10, 1977.

23. Langer AM, Oster G: Crystal faces and cleavage planes in quartz as templates in biological processes. Biophys Soc Am Phys Soc Mtg, Washington, DC, March, 1978.

**PUBLISHED ABSTRACTS (cont):**

24. Lilis R, Langer AM: Chronic interstitial pulmonary disease with severe respiratory disfunction due to unsuspected occupational beryllium exposure. In: XIXth Int'l Congr Occup Health, Dubrovnik, Yugoslavia, pp. 89-90, September 25-30, 1978.

25. Rohl AN, Langer AM: Asbestos and asbestiform minerals in non-asbestos mines in the United States. In: XIXth Int'l Congr Occup Health, Dubrovnik, Yugoslavia, pp. 121-122, September 25-30, 1978.

26. Russo DA, Kagan E, Langer AM, Yeager H: Human alveolar macrophages: cytotoxicity of naturally-occurring short fiber. Federation Proceedings, Section Physiology, Federation American Societies of Experimental Biology, 1980.

27. Langer AM: Physical-chemical characteristics of chrysotile and their relationship to biological activity. In: 29th Ann Clay Minerals Conf, Baylor, Waco, TX, p. 58, October 5-9, 1980.

28. Bowes DR, Langer AM: Mineralogy and geochemistry of particulates in cigarette smoke. In: Ann Mtg Geol Soc, London, Environmental Mineralogy, January 11, 1980.

29. Langer AM: Particulate inhalants. In: Occupational Toxicology, College of Medicine and Dentistry, NJ, September 26, 1980.

30. Langer AM: Minerals as toxic agents: parameters and mechanisms. In: Proc 50th Geol Alumni Assn, Brooklyn College, CUNY, May 7-9, 1981.

31. Langer AM, Weisman, I, Adams A, Pooley FD: Characterization of crystalline particles in tissue by analytical electron microscopy. In: Symp on Crystalline Deposits in Tissues, Toronto, August 13-14, 1981.

32. Russo DA, Kagan E, Langer AM, Nolan R, Yeager H: Cytotoxicity of naturally-occurring short fiber asbestos. In: 20th Int'l Congr Occup Health, Cairo, September 25-October 1, 1981.

33. Ehrenreich T, Langer AM, Selikoff IJ: Algorithm of pathologic diagnosis of asbestos-related diseases for forensic purposes. Significance of quantitative and morphological correlates. In: 20th Int'l Congr Occup Health, Cairo, September 25-October 1, 1981.

**PUBLISHED ABSTRACTS (cont):**

34. Rohl AN, Langer AM, Suzuki Y, Lilis R, Moncure G, Selikoff IJ: Endemic pleural disease associated with mixed fibrous dust exposure in Turkey. In: 20th Int'l Congr Occup Health, Cairo, September 25-October 1, 1981.

35. Nolan RP, Langer AM: Surface functionalities of quartz and hemolytic activity. In: Proc 2nd Int'l Workshop of the In Vitro Effects of Mineral Dusts, Arkadelphia, AR, April 5-6, 1982.

36. Langer AM, Nolan RP: Membrolytic properties of quartz. In: Proc 2nd Ann Geol Alumni Assn, Brooklyn College, CUNY, p. 4, April 28-30, 1983 (abstracts).

37. Nolan RP, Langer AM, Foster KW: Recognition of quartz by erythrocyte membranes. In: 6th Int'l Penumoconiosis Conf, Bochum, FDR, September 20-23, 1983 (Abstract 198).

38. Nolan RP, Langer AM, Foster KW: Physico-chemical factors effecting membrolytic properties of quartz. In: 6th Int'l Pneumoconiosis Conf, Bochum, FDR, September 20-23, 1983 (Abstract 199).

39. Langer AM, Nolan RP: Surface properties of quartz and membrane activity. In: Int'l Symp Silica, Silicosis and Cancer, Chapel Hill, NC, April 3-5, 1984.

40. Langer AM: Asbestos, fibrous minerals, acicular cleavage fragments and the mineral industries. In: Int'l Congr Applied Mineralogy, Los Angeles, February, 1984.

41. Langer AM: Minerals and disease: the association between exposure to minerals and rock dust and the occurrence of human disease. In: Int'l Congr Applied Mineralogy, Los Angeles, February, 1984.

42. Langer AM: Mineral fiber in water? In Medical Geology Conference on Health Threatening Toxins in Water, Brooklyn College, NY, May, 1984.

43. Constantopoulos SH, Langer AM, Saratzis N, Goudevenos JA, Selikoff IJ: Metsovo lung: pleural calcifications and malignant pleural mesothelioma in northwestern Greece. Tremolite asbestos used for whitewashing as etiology. In: 3rd Int'l Conf Environmental Lung Disease, Am Coll Chest Phys, Montreal, Canada, October 15-18, 1986. Chest 91(2):300, 1987.

**PUBLISHED ABSTRACTS (cont):**

44. Langer AM, Nolan RP: Fiber type and parenchymal burden found in workers occupationally exposed to asbestos fiber in the United States. Implications for risk assessment in the general population. Mineral Fiber in the Non-Occupational Environment, Lyon, France, October 8-10, 1987.

45. Langer AM, Nolan RP: Mineralogical and biological comparison of asbestiform and non-asbestiform tremolite. AIME Annual Meeting, Phoenix, AZ, January 25-28, 1988.

46. Langer AM, Nolan RP, Bowes DR, Shirey S: Inorganic particles in cigarettes and cigarette smoke. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. International Symposium/Workshop, Seattle, WA, April 10-14, 1988.

47. Nolan RP, Langer AM, Herson GB: Physico-chemical properties of the titanium dioxide polymorphs and biological activity. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. International Symposium/Workshop, Seattle, WA, April 10-14, 1988.

48. Nolan RP, Langer AM, Herson GB: Membranolytic activity of palygorskite and sepiolite. In: IVth International Conference on the Effects of Mineral Dusts on Cells, p. 15, Oxford, Quebec, Canada, 1988.

49. Langer AM, Nolan RP, Herson GB: Membranolytic activity and physicochemical characterization of phosphorylated Canadian chrysotile. In: IVth International Conference on the Effects of Mineral Dusts on Cells, p. 14, Oxford, Quebec, Canada, 1988.

50. Nolan RP, Langer AM, Herson GB: Physicochemical characteristics of quartz dust which controls its biological activity. In: VIIth International Pneumoconiosis Conference, DHHS (NIOSH) Publication No. 90-108, Part I, 754, 1990.

51. Langer AM, Nolan RP: Fiber type and risk of mesothelioma to building occupants. In: Health Aspects of Exposure to Asbestos in Buildings. Energy and Environmental Policy Center, John F. Kennedy School of Government, Harvard University, Cambridge, MA, December 14-16, 1988.

52. Langer AM, Pooley FD, Nolan RP: Phyllosilicates: Associated fibrous minerals. In: First International Conference on Health Related Effects of Phyllosilicates. NATO Advanced Research Workshop, Paris, France, March 16-18, 1989.

**PUBLISHED ABSTRACTS (cont):**

53. Nolan RP, Langer AM, Herson GB: Characterization of palygorskite specimens from different geological locales for health hazard evaluation. In: First International Conference on Health Related Effects of Phyllosilicates. NATO Advanced Research Workshop, Paris, France, March 16-18, 1989.

54. Langer AM, Nolan RP: The importance of mineral subpopulations in biological assays. In: NATO Advanced Research Workshops on Mechanisms in Fibre Carcinogenesis. Albuquerque, New Mexico, October 22-25, 1990. 49-50.

55. Nolan RP, Langer AM, Oechsle GW, Addison J, Colflesh DE: Association of tremolite habit with biological potential. In: NATO Advanced Research Workshops on Mechanisms in Fibre Carcinogenesis. Albuquerque, New Mexico, October 22-25, 1990. 57.

56. Langer AM: Fiber types, fiber sizes, and asbestos diseases. Andrews Communications Seminars. 2nd Asbestos Litigation. The Eye of the Storm. 25-26 February, 1991. Bal Harbour, Florida.

57. Nolan RP, Langer AM, Oechsle GW, Johnson NF: Physicochemical characterization of selected zeolite minerals for health hazard evaluation. Fourth Intl. Conf. Env. Lung Disease. Montreal, Canada, September 25-28, 1991.

58. Nolan RP and Langer AM: Characterization of fibers for Health Hazard evaluation. Critical Research Needs. Workshop on Chemical and Biological Interactions of Glass. Bethesda, MD, 5-6 Mar, 1992.

59. Langer AM and Nolan RP (1992). Comparison of lung tissue mineral fibre retention of exposed workers and the general population. In: Biopersistence of respirable synthetic fibres and minerals. 7-9 Sept, 1992. Lyon. p. 26.

60. Nolan RP, Langer AM, and Addison J (1992). Health hazard evaluation of the lung tremolite fiber content among Canadian chrysotile workers. In: Biopersistence of respirable synthetic fibres and minerals. 7-9 Sept, 1992. Lyon. p. 52.

61. Langer AM, Nolan RP (1993). Factors controlling the biological potential of inorganic dusts: surface character and chemistry. 4th International Inhalation Symposium, Hannover. Toxic and Carcinogenic Effects of Solid Particles in the Respiratory Tract, 1-5 March, 1993, Hannover. Abst. A-10, p. 48.

62. Langer AM, Nolan RP (1993) Physico-chemical characteristics of quartz dust which controls its biological activity. Clay Minerals Society Meeting. San Diego, 25-30 Sept, 1993.

**MANUSCRIPTS IN PREPARATION:**

Langer AM, Kimball MR, Harlow GE: A comparison of fibrillar structure in amosite and crocidolite.

Langer AM, Kimball MR, Harlow GE, Dowty E: Electron microscopy studies of amosite and grunerite dust particles.

Langer AM: Distribution of amosite and chrysotile fibers in the lung of an exposed worker: role of fiber size and type.

Nolan RP, Langer AM: Mineral surfaces and the anion transport system of the human red blood cell. Mechanism of hemolytic action.

Langer AM, et al: Amosite fiber size-distribution at a fabrication plant: mesothelioma and fiber dimension.

Langer AM, et al: Asbestos bodies in two periods of time: review, secular trends, New York City, 1915-1970.

Langer AM, et al: Asbestos bodies and age, sex, occupation of urban dwellers: asbestos bodies as indices of disease risk

**PARTICIPATION IN POSTGRADUATE EDUCATION COURSES (1976-PRESENT):**

6/70 - Page and Black Postgraduate, Mount Sinai School of Medicine: Asbestosis.

4/71 - NY Academy of Sciences, Seminars for Trade Union Representatives: Occupational Health Hazards.

4/71 - American College of Chest Physicians, Mount Sinai School of Medicine, NY:
Interstitial Pneumonias--Acute and Chronic.

5/75 - United States-USSR Environmental Protection Agreement: Workshop on Basic Practical Approaches to Environmental Carcinogenesis, Mount Sinai.

6/76 - Page and Black Postgraduate, Mount Sinai School of Medicine: Environmental Lung Disease.

2/77 - Office of Continuing Education, Baylor Medical College, Houston, TX:
Pulmonary Diseases and Carcinoma of the Lungs, Baylor Medical School, Houston, TX.

11/77 - New York Lung Club, Cornell University Medical College: Silicosis revisited. New York City Tunnel and Caisson Workers: 1928-1977.

**PARTICIPATION IN POSTGRADUATE EDUCATION COURSES (1976-PRESENT) (cont):**

1/78 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Asbestos Carcinogenesis.

3/78 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Occupational and Environmental Pulmonary Diseases.

6/78 - Page and Black Postgraduate, Mount Sinai School of Medicine, NY: Health Effects of Asbestos Exposure. Course Director.

11/78 - Page and Black Postgraduate, Mount Sinai School of Medicine, NY: Asbestos Associate Diseases: With Particular Reference to United States Shipyards.

1/79 - Page and Black Postgraduate, Mount Sinai School of Medicine, NY: Scientific Basis for Evaluation of Occupational and Environmental Asbestos Disease.

10/79 - Office of Continuing Education, Baylor Medical College, Houston, TX:
Asbestos-Associated Diseases, Houston, TX.

1/80 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Asbestos in Shipyards.

3/80 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Management and Control of Asbestos in Public Buildings.

6/80 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Health Effects of Asbestos in Public Buildings.

9/80 - College of Medicine and Dentistry of New Jersey:
Rutgers Medical School, Recent Advances in Occupational Toxicology, Graduate Center, NY.

11/81 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Recent Advances in Occupational Medicine.

12/82 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Scientific Basis for Evaluation of Asbestos-Associated Diseases.

**PARTICIPATION IN POSTGRADUATE EDUCATION COURSES (1976-PRESENT) (cont):**

3/85 - Page and Black Postgraduate, Mount Sinai School of Medicine, New York, NY:
Asbestos in Schools and Public Buildings, Hasbrook Heights, NJ.

9/91 - Environmental Lung Disease. American College of Chest Physicians. Mineralogy Techniques. Montreal, Canada.

**INVITED SEMINARS AND LECTURES:**

Union College, Schenectady, NY, Department of Geology and Civil Engineering. "Asbestos and Lung Disease." April, 1967.

Barnard College, NY, Department of Geology. "Asbestos Fiber in the Ambient Air and Disease Potential." December, 1968.

The Rockefeller University, Air Pollution Working Group, Health Research Council. "Analysis of Air Samples for Inorganic Constituents." June 9, 1969.

New York University Medical Center, New York Lung Club. "Sublight Microscopic Mineral Particles in Talc Pneumoconiosis. Physiology and Mineralogical Studies." November, 1970.

Leheigh College, Department of Material Sciences and Metallurgy. "Electron Probe Characterization of Particles in Tissues." April, 1971.

Oberlin College, OH, Department of Geology. "Asbestos Dust in the Workplace and Human Disease." May, 1971.

State University of New York at Buffalo, Department of Biophysical Sciences. "The Asbestos Problem. An Interdisciplinary Approach." April, 1972.

Queens College of the City University of New York, Department of Earth and Environmental Sciences. "Asbestos and Disease. How Wide is the Spectrum?" November, 1972.

Columbia University, NY, Department of Geology and Biological Sciences. "Contamination of the Environment with Mineral Particles." December, 1972.

College of South Hampton, Long Island University, Division of Chemical Sciences and Oceanography. " The Contamination of Lake Superior with Fibrous Silicates." January, 1973.

National Institutes of Health. Review of Asbestos Problem. "Mechanism of Fiber Action." National Institutes of Health, Bethesda, MD, February, 1973.

**INVITED SEMINARS AND LECTURES (cont):**

City College of the City University of New York, Department of Earth and Planetary Sciences. "Mineral Particles and Human Disease." May, 1973.

Queens College of the City University of New York, Department of Health Sciences. "Occupational Hazards as Harbingers of Environmental Hazards." September, 1973.

Rutgers University, Colonial Conference Tri-State Environmentalists. "Recognition of Environmental Hazards: Use of Academic Facilities for Monitoring and Control of Hazards." November, 1973.

Johns Hopkins University, School of Public Health. "Asbestos Minerals and Disease." Seminar. April, 1974.

Rutgers University, Department of Environmental Sciences. "Mineral Particles in the Air." June, 1974.

Temple University, Department of Geology. "Amphibole Contamination of Lake Superior Water from Taconite Processing." September, 1974.

American Museum of Natural History, Department of Mineral Sciences. "Minerals and Disease." September, 1978.

Rutgers University, Department of Chemistry. "Minerals and Their Biological Activity." October, 1978.

University of North Carolina, Department of Medicine. 1) "Analytical Methods of Tissue Analysis, Asbestos Bodies and Asbestos Fibers"; 2) "Inorganic Particles in Cigarettes and Cigarette Smoke." November, 1978.

University of Maine, Farmington, Department of Geology. 1)"The Asbestos Problem"; 2) "Evolution of an Environmental Scientist, A Personal View." March, 1979.

School of Public Health, Columbia University. "Epidemiology of Asbestos Diseases." April, 1979.

New York Medical Examiner's Conference. "Analysis of Tissues for Asbestos Fiber and Asbestos Bodies." June, 1979.

Seton Hall University, Department of Chemistry. "Minerals and Disease: Interaction Mechanisms." October 2, 1979.

American Institute of Mining Engineers, Tucson. "The Biological Effects of Inorganic Fibers: The Case Against Asbestos" (invited speaker). October, 1979.

**INVITED SEMINARS AND LECTURES (cont):**

American Chemical Society, Staten Island Section. "Minerals and Diseases: Physical and Chemical Factors." February 19, 1980.

Society of Sigma Xi Lecture. "Man in Conflict with His Physical Environment." Invited Speaker for initiation ceremony, City University, New York, May 13, 1980.

National Institutes of Health, Bethesda, Department of Health and Human Services CCERP-26. "Serpentine-Containing Host Rocks: Amphibole-Containing Host Rocks." November, 1980.

NIEHS-EPA-NIOSH Joint Committee at Bethesda. "Mount St. Helen's Volcanic Ash: Mineral Nature and Biological Activity." July 23, 1981.

The Rockefeller University. "Minerals and Toxic Agents, Parameters and Mechanisms." Invited speaker in series on Comparative Toxicology, February 12, 1981.

Kettering Laboratory, University of Cincinnati Medical Center. "Silica and Silicosis: Mechanisms." April 8, 1981.

University of California, Irvine, Occupational and Environmental Health Center. "Physicochemical Properties of Inorganic Dusts and Biological Consequences of Exposure." Occupational Medicine Series, December 2, 1981.

Barlow Hospital, Los Angeles, University of Southern California Medical School. "Tissue Analysis for Asbestos, Comparative Techniques." Chest Service, Department of Medicine, December 3, 1981.

Appalachian Laboratory for Occupational Safety and Health NIOSH-CDC, Morgantown, West Virginia. "Surface Properties of Silica and Its Biological Activity." February 24, 1982.

National Institute for Occupational Safety and Health. "Silica and Silicosis." Cincinnati, March 24, 1982.

Society of Sigma Xi Lecture, Queens College of the City University of New York. "The Case Against Chrysotile Asbestos." December 2, 1982.

National Institute of Environmental Health Sciences, Pathobiology of Mesothelioma, Research Triangle Park, NC. "Physicochemical Character of Dust and its Role in Inducing Human Mesothelioma." January, 1983.

Geology Seminar, Long Island University, College at South Hampton. "The Biological Effects of Asbestos." March 18, 1983.

**INVITED SEMINARS AND LECTURES (cont):**

Graduate Seminar, Rutgers University, Department of Geology. "Physical-Chemical Properties of Minerals and Their Biological Activities." April 13, 1983.

Symposium on Fibrous Minerals, American Lung Association Annual Meeting, Kansas City, MO. "Mineralogy of Mineral Fibers." May 8, 1983.

Faculty Research Collegium, Ph.D. Program Earth and Environmental Studies, CUNY, Graduate Center, NY. "Physicochemical Properties of Minerals Controlling Biological Activity." March 6, 1984.

Graduate Seminar, Department of Geology, Princeton University. "Minerals and Disease." Princeton, NJ, March 8, 1984.

Graduate Seminar, Department of Biology, New York University, New York, NY. "Asbestos: Biological Considerations." April 16, 1984.

Medical Geology Conference on Health Threatening Toxins in Water. "Asbestos Fiber in Water." May 3, 1984.

Asbestos Information Association of North America, Annual Meeting, Alexandria, VA. "Asbestos Substitutes. How Safe are They?" September 18, 1985.

American Society for Testing Materials, Annual Meeting, Bal Harbour, FL. "Method for Testing Indoor Air for Asbestos. Analytical Electron Microscopy." November 4, 1985.

University of Southern California Medical School. "Membranolytic Properties of Quartz and Phosphorylated Chrysotile Fiber." January 29, 1985. Main Campus. "Asbestos Fiber in Lung Tissue - Analysis by Analytical Electron Microscopy." January 30, 1986.

Milton Kannerstein Lecture. "Mineral Dust and Pulmonary Lesions." Annual Meeting of the Klemperer-Otani Society. Mount Sinai, June 5, 1986.

Northeast Regional Environmental Public Health Center, University of Massachusetts. Symposium: Asbestos in Play Sand. "Tremolite Analysis, Morphology, and Health Significance." February 11, 1987.

The Defense Research and Trial Lawyers Association, Reno, NV. "Analytical Protocol for the Study of Sublight Microscopic Particles in Human Tissues"; "Types and Amounts of Asbestos Fibers in the Pulmonary Tissues of Asbestos-Exposed Workers in the United States." October 30, 1987.

**INVITED SEMINARS AND LECTURES (cont):**

Graduate Seminar, Rutgers University, Department of Geology. "Physical-Chemical Properties of Minerals and Their Biological Activities." April 13, 1983.

Symposium on Fibrous Minerals, American Lung Association Annual Meeting, Kansas City, MO. "Mineralogy of Mineral Fibers." May 8, 1983.

Faculty Research Collegium, Ph.D. Program Earth and Environmental Studies, CUNY, Graduate Center, NY. "Physicochemical Properties of Minerals Controlling Biological Activity." March 6, 1984.

Graduate Seminar, Department of Geology, Princeton University. "Minerals and Disease." Princeton, NJ, March 8, 1984.

Graduate Seminar, Department of Biology, New York University, New York, NY. "Asbestos: Biological Considerations." April 16, 1984.

Medical Geology Conference on Health Threatening Toxins in Water. "Asbestos Fiber in Water." May 3, 1984.

Asbestos Information Association of North America, Annual Meeting, Alexandria, VA. "Asbestos Substitutes. How Safe are They?" September 18, 1985.

American Society for Testing Materials, Annual Meeting, Bal Harbour, FL. "Method for Testing Indoor Air for Asbestos. Analytical Electron Microscopy." November 4, 1985.

University of Southern California Medical School. "Membranolytic Properties of Quartz and Phosphorylated Chrysotile Fiber." January 29, 1985. Main Campus. "Asbestos Fiber in Lung Tissue - Analysis by Analytical Electron Microscopy." January 30, 1986.

Milton Kannerstein Lecture. "Mineral Dust and Pulmonary Lesions." Annual Meeting of the Klemperer-Otani Society. Mount Sinai, June 5, 1986.

Northeast Regional Environmental Public Health Center, University of Massachusetts. Symposium: Asbestos in Play Sand. "Tremolite Analysis, Morphology, and Health Significance." February 11, 1987.

The Defense Research and Trial Lawyers Association, Reno, NV. "Analytical Protocol for the Study of Sublight Microscopic Particles in Human Tissues"; "Types and Amounts of Asbestos Fibers in the Pulmonary Tissues of Asbestos-Exposed Workers in the United States." October 30, 1987.

**INVITED SEMINARS AND LECTURES (cont):**

The Manville Settlement Trust Asbestos Disease Seminar, Washington, DC. "Asbestos Fibers: The Physico-Chemical Properties and Health Effects." March 16, 1988.

Asbestos Fiber Type and Risk of Disease, Conference: New York - New Jersey Environmental Expo: The Source for Environmental Solutions. Seminar 7E, The Management of Asbestos in the 1990's. Thursday, October 18, 1990.

American Industrial Hygiene Association, Georgia Section, Atlanta Georgia. Conference: The Asbestos Controversy. Has the Public Been Properly Informed? "Understanding the Asbestos Risk." November 30, 1990.

Armstrong Defense Group. Memphis, Tennessee. The Asbestos Saga and the Star Wars Trilogy: The Empire Strikes Back! Thursday, April 25, 1991.

Department of Medicine - Pulmonary, New York University Medical Center. Pulmonary Grand Rounds. Particle Characteristics Responsible for Pneumoconiosis and Cancer. Tuesday, September 3, 1991.

Nelson Institute of Environmental Medicine, New York University School of Medicine. Surface Properties of Minerals as Determinants of Biological Activity. Tuxedo, New York. Wednesday, October 23, 1991.

Defense Research Institute. Current Issues in Asbestos in Building Seminar. Report From the Health Effects Institute, Orlando, Florida. Friday, January 24, 1992.

Characteristics of Mineral Fibers - Critical Research Needs. Invited to Workshop on Chemical and Biological Interactions of Glass. Bethesda, Maryland, March 5-6, 1992.

Mealey's National Lead Litigation Conference. Presented: Bioavailability of Lead. April 22-23, 1993. Philadelphia, Pennsylvania.

Physics and Chemistry of Asbestos Minerals. Oxford, July, 1967. Presented: The Nature of Soft and Harsh Chrysotile (with Kerr PF.).

Second International Conference on the Biological Effects of Asbestos. Dresden, DDR, April, 1968 (two papers with Berkley C, Sastre A, Arneson A and Schwartz J).

INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):

International Conference on Pneumoconiosis. Johannesburg, April 23-May 2, 1969. Presented: Electron Microprobe Analysis of Asbestos Bodies (with Rubin IB and Selikoff IJ).

Working Group: Asbestos and the Asbestos Diseases. Cardiff, April 6-9, 1970. Presented: Identification of Asbestos Fiber in Tissue.

British Occupational Hygiene Society: Inhaled Particles and Vapors. Imperial College, London, June, 1970. Presented: Inorganic Fibers, Including Chrysotile, in Lungs at Autopsy (with Baden V, Selikoff IJ, and Hammond EC).

Fifth National Conference on Electron Microprobe Analysis. New York, July 21-24, 1970. Invited paper: Electron Microprobe Analysis of Particles in Tissues (with Berkley C and Rubin IB).

Second International Clean Air Congress. Washington, DC, May 1971. Paper with Selikoff IJ.

International Agency for Research on Cancer. WHO, Lyon, September, 1972. Presented: Identification of Single Asbestos Fibers in Human Tissues with (Pooley FD).

6th International Meeting of Forensic Sciences. Edinburgh, September, 1972. Presented paper Asbestos Fiber in Human Lungs: Forensic Significance in Environmental Disease (with Ehrenreich T).

Dialogues in Microscopy, 1973, NY. Microscopical Society. Chaired Session: Identification of Asbestos, May, 1973.

International Conference on the Biological Effects of Ingested Asbestos. NIEHS sponsored. Pinehurst, NC, November, 1973.

International Conference on Environmental Sensing and Assessment. Las Vegas, NV, September, 1975 (paper with Rubin IB and Wolff M). Chaired 2 Sessions: Fine Particles-7; Fine Particles-2. United States Environmental Protection Agency.

Conference on Health Problems of Energy Technologies. Held by NIEHS, January, 1976.

Mineralogical Society of London. London, April, 1976. Presented paper Nature and Range of Mineral Dust in the Environment.

International Agency for Research on Cancer. The World Health Organization, Lyon. Invited member of working group, December, 1976. Chemical Carcinogenesis Monograph Series. Evaluation of Carcinogenic Risk of Asbestos, Vol. 14.

**INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):**

Royal Society of Medicine. Meeting Focusing on Occupational Diseases. London, April, 1977. Presented paper Asbestos Content of Dust Encountered During Brake Maintenance and Repair (with Rohl AN, Weisman I, and Klimentidis R).

Invited Consultant to Institute of Public Health. Oslo, Norway, May, 1977. Presented three papers: Contamination of the Biosphere by Submicroscopic Particles; Asbestos Minerals and Their Carcinogenic Effects; Are There Safe Substitutes for Asbestos Materials?

Invited Consultant to the Ministry of Mines. Biological Effects of Asbestos. Johannesburg, October, 1977. Monograph, Ministry of Mines.

Health Hazards of Asbestos Exposure. New York, June 24-27, 1978. Presented paper on Contamination of Lake Superior with Amphibole Gangue Minerals and organized and chaired workshop on Significance of Aspect Ratio in Regulation of Asbestos Fiber Exposure.

International Conference on Critical Current Issues in Environmental Health Hazards. Tel Aviv, March 4-7, 1979. Presented paper Defining New Asbestos High Risk Groups. Chairman Workshop: Laboratory Approaches in Environmental Medicine.

International Agency for Research on Cancer. WHO, Lyon, October, 1979. International Conference on the Biological Effects of Inorganic Fibers. Invited Rappateur. Physics and Chemistry of Asbestos Minerals.

Expert Consultant, International Metal Workers Federation. Geneva, September, 1980. Focus on problem: Asbestos Fiber Contamination of Metal Ore Deposits.

International Conference on Crystalline Deposits in Human Tissues. August 13-14, 1981. Mount Sinai Hospital, Toronto. Presented paper The Role of Analytical Electron Microscopy in Diagnosis of the Pneumoconiosis (with Weisman I, Adams A, and Pooley F).

Annual Symposium Scanning Electron Microscopy. Anaheim, CA, April, 1982. Presented paper Identification Characterization and Quantitation of Asbestos Fibers in Human Lung Tissue by Analytical Electron Microscopy.

Fourth Annual Rocky Mountain Center for Occupational and Environmental Health Center. Salt Lake City, April, 1982. Invited to present two papers: Fibrous Minerals: Properties and Biological Activity; Relationship Between Surface Properties and Biological Activity in Health Issues Related to Metal and Non-Metallic Mining.

**INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):**

World Symposium on Asbestos. Montreal, May 24-27, 1982. Presented paper Mineral Fibers: Properties Imparting Biological Activity.

6th International Pneumoconiosis Conference. Bochum, Federal Republic of Germany, September, 1983. Presented two papers: Recognition of Quartz by the Erythrocyte Membrane; Physicochemical Factors Effecting Membrolytic Properties of Quartz (with Nolan RP, Foster KW, and Simenski R). Chaired Session: Etiopathogenesis of Silicosis.

Program of Research on Asbestos. University of Sherbrooke, December 5-6, 1983. Presented lecture Physicochemical Properties of Minerals as Related to Biological Activities.

2nd International Congress on Applied Mineralogy. February 22-25, 1984. Presented two papers: Asbestos, Fibrous Minerals, Acicular Cleavage Fragments and the Minerals Industries; Minerals and Disease: The Association Between Exposure to Minerals and Rock Dusts and the Occurrence of Human Disease.

Workshop on the Assessment of Mineral Fibers from Human Lungs. Oxford, England, September 17-19, 1984. Keynote speaker Problems of Tissue Analysis with the Analytical Electron Microscope.

3rd International Workshop on the In Vitro Effects of Mineral Dusts. Schluchsee, Hochschwarzwald, FRG, October, 1984. Physicochemical Properties of Minerals Relevant to Biological Activities. State of the Art, (paper with Nolan RP); Alteration of surface of quartz and altered biological activity.

Workshop on Biological Effects of Chrysotile. General Motors Cancer Research Foundation. Cardiff, Wales, May 7-9, 1986. The Mineralogy of Chrysotile Asbestos: Physicochemical Properties as Determinants of Disease Potential (with Nolan RP).

International Programme on Chemical Safety (IPCS). WHO Environmental Health Criteria 53. Asbestos and other Natural Mineral Fibres. Hannover, Germany. Session chairman, co-author. 194 p., 1986.

International Agency for Research on Cancer. The World Health Organization. Invited member of working group. Lyon, France, July, 1986. Chemical Carcinogenesis Monograph Series. Evaluation of Carcinogenic Risk of Fibrous Talc, Wollastonite, Palygorskite, Sepiolite, Erionite and Crystalline Silica. Vols. 34-42.

**INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):**

Symposium: Mineral Fibers in the Non-Occupational Environment. IARC-WHO. Lyon, France, September 8-10, 1987. Summary of five presented papers; Round-table discussant on Environmental Risk. Presented paper: Fiber Type and Parenchymal Burden Found in Workers Occupationally Exposed to Asbestos Fiber in the United States (with Nolan RP).

Symposium: Fibers in Friction Materials. Society Automotive Engineers and the Asbestos Institute. Symposium organizer and Co-Chairman. Fibers and Health Issues. Atlantic City, NJ, October, 1987. Presented summary paper; co-authored Physicochemical Properties of Fibers and Biological Potential (with Nolan RP).

Symposium: Safe Use of Asbestos Cement. Peruvian Ministry of Health and the Environment. The Asbestos Information Association of South America. Lima, Peru, March, 1988.

International Symposium/Workshop: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. Session Chairman. Presented paper: Inorganic Particles Found in Cigarette Tobacco, Cigarette Ash, and Cigarette Smoke; co-authored Physico-Chemical Properties and Membranolytic Activities of the Titanium Dioxide Polymorphs Compared to Quartz. April 10-14, 1988.

Electron Microscopy Society of America; the Microscopical Society of Canada: Presented paper: Electron Diffraction of Mineral Fibers Vs. Acicular Cleavage Fragments. Milwaukee, WI, August 7-12, 1988.

National Organizing Committee, Workshop Chairman: Hazard Recognition of Mineral Dusts. Presented: Mineral Fibers in the Lung Tissues of Persons Exposed to Asbestos in the United States; Distinguishing Between Tremolite Asbestos and Tremolite Cleavage Fragments. VIIth International Pneumoconiosis Conference, Scientific Organization Committee. Pittsburgh, PA, August, 1988.

Session Chairman: Asbestos, Pleural Pathology, and Lung Fiber Burden. VIIth International Pneumoconiosis Conference, Pittsburgh, PA, August, 1988.

Workshop on Asbestos Research. Health Effects Institute, American Academy of Arts and Sciences, Cambridge, MA, October 31-November 1, 1988.

Symposium on the Health Aspects of Exposures to Asbestos in Public Buildings. Presented: Fiber Type and Risk of Mesothelioma to Building Occupants. John F. Kennedy School of Government, Harvard University, Cambridge, MA, December 14-16, 1988.

**INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):**

First International Conference on Health Related Effects of Phyllosilicates. International Scientific Organizing Committee. Session Chairman: Health Related Effects After Non-Occupational Exposure. Presented: Fibrous Minerals as Natural Contaminants of Phyllosilicates (with Pooley F). Paris, France, March 16-18, 1989.

International Federation of Building and Woodworkers. Health Hazards in Painting and Allied Trades. Presented: Hazards in the Painting Trade. Panelist. Geneva, Switzerland, May 8-12, 1989.

NATO Advanced Research Workshop on Mechanisms in Fibre Carcinogenesis. Presented: The Importance of Mineral Subpopulations in Biological Assays. Alburquerque, NM, October 22-25, 1990. Co-authored paper: Association of tremolite habit with biological potential, co-authored with Nolan RP, Oechsle G, Addison J, Colflesh D.

American Lung Association - American Thoracic Society. 1991 International Conference. Presented: Mechanisms of Asbestos-Induced Pulmonary Disease: Importance of Surface Properties of Asbestos and Non-asbestos minerals in cell interaction. Anaheim, California, May 12-15, 1991.

American College of Chest Physicians. Fourth International Conference - Environmental Lung Disease. Presented: Diagnostic Methods in Occupational Lung Disease: Mineralogic Techniques. Co-Chair session: Diagnostic Methods in Occupational Lung Disease. Montreal, Canada. September 25-28, 1991.

Chemical Industry Institute of Toxicology. Workshop on Approaches to Evaluating the Toxicity and Carcinogenicity of Man-made Fibers. Durham, North Carolina. November 11-13, 1991.

Institute for Glass Science and Engineering. Workshop on Chemical and Biological Interactions of Glass. Discussant on Biologically Important Properties. Bethesda, Maryland. March 5-6, 1992.

International Geological Congress. Environmental Mineralogy in relation to human health and activities. Session I-3-49. Co-chair with N. Kohyama, J. Addison, Kyoto, Japan. 24 August-3 September, 1992. Introduction. Importance of environmental mineralogy. Summing up. 1 September, 1992.

Biopersistence of Respirable Synthetic Fibres and Minerals. Presented: Comparison of lung tissue mineral fibre retention of exposed workers and the general population. With RP Nolan, co-authored: Health hazard evaluation of the lung tremolite fibre content among Canadian chrysotile workers. With RP Nolan and J Addison. Round-Table discussant on: Role of Biopersistence in Pathogenicity. IARC, Lyon. September 7-9, 1992.

**INVITED INTERNATIONAL MEETINGS AND CONFERENCES (cont):**

Symposium on Chemicals and the Environment. Chemical Specialities, '92. Invited presentation: Zeolite catalysts. Is there a health risk? Philadelphia, 3-4 November, 1992.

International Life Sciences Institute. 4th International Inhalation Symposium, Hannover. Invited Faculty Presentation: Factors Controlling the Biological Potential of Inorganic Dusts. Surface Chemistry and Character. With R.P. Nolan. Hannover, 1-5 March, 1993.

Hoffman-LaRoche Pharmaceuticals. Analysis of Medicines for Asbestos. Microscopy Protocol. Edinburgh, U.K. Institute of Occupational Medicine. April 25-26, 1993.

Cellular and Molecular Effects of Mineral and Synthetic Dusts and Fibres. NATO Advanced Workshop. Invited paper: Phosphorylated Canadian chrysotile. With RP Nolan and G Herson. Chaired session: Physico-chemical properties of minerals in relation to their biologic effects. Paris, 11-13 October, 1993.

Workshop on the Health Risks Associated with Chrysotile Asbestos. Intl. Commission on Occupational Health - Intl. Program on Chemical Safety (WHO) Presented paper: Chrysotile: The Mineral and Its Properties. Jersey, Channel Islands. 14-17, November, 1993.

## FUNDING SOURCES

| PROJECT | ROLE IN PROJECT | PROJECT PERIOD | SOURCE OF FUNDS | TOTAL DIRECT SUPPORT |
|---|---|---|---|---|
| Asbestos disease in New York City workers | Co-Principal Investigator/Mineralogist | 07/01/66-06/30/67 | Health Research Council, NYC | 39,703 |
| Silica and Silicosis | Principal Investigator Mineralogist | 09/01/66-08/31/68 | Polacheck Foundation | 10,000 |
| Microprobe analysis of asbestos-pseudo asbestos bodies | Co-Principal Investigator | 06/01/67-05/31/69 | NIH | 133,245 |
| Asbestos exposure risk in defined human populations | Co-Principal Investigator/Mineralogist | 05/01/68-04/30/73 | NIH | 1,306,281 |
| Biological effects of modified inorganic fibrous particles | Co-Principal Investigator/Mineralogist | 07/01/68-06/30/69 | Johns-Manville Corporation | 61,930 |
| Insulation industry hygiene reports | Co-Principal Investigator | 09/15/68-09/14/73 | Johns-Manville Corporation | 500,000 |
| Asbestos air pollution in New York City | Co-Principal Investigator | 12/01/68-11/30/70 | HRC-NY<br>DAR-NY | 110,455 |
| Inorganic particles biological systems interactions | Principal Investigator Career Development Award | 06/01/69-05/31/74 | NIH-NIEHS | 125,000 |
| Asbestos exposure and cancer in the general population | Co-Principal Investigator | 12/01/69-11/30/71 | NIH | 105,539 |

## FUNDING SOURCES

| PROJECT | ROLE IN PROJECT | PROJECT PERIOD | SOURCE OF FUNDS | TOTAL DIRECT SUPPORT |
|---|---|---|---|---|
| Inorganic particles in cigarettes and cigarette smoke | Principal Investigator | 07/01/71-06/30/73 | NIH | 65,730 |
| Environmental cancer in US industries | Co-Principal Investigator | 09/01/71-08/31/74 | ACS | 289,321 |
| Asbestos exposure and cancer in the general population | Co-Principal Investigator/Mineralogist | 12/01/71-11/30/73 | NIH | 254,569 |
| Asbestos air pollution; extent persistence, effects | Co-Principal Investigator/Mineralogist | 01/01/72-12/31/74 | NIH | 348,858 |
| Asbestos in therapeutic drugs for human use | Co-Principal Investigator/Mineralogist | 04/01/72-03/31/73 | NIH | 49,230 |
| Effects of asbestos in water (Duluth) | Co-Principal Investigator/Mineralogist | 06/01/73-10/30/73 | EPA | 47,970 |
| Environmental agents, relation to human health effects | Co-Principal Investigator | 06/01/73-08/31/78 | NIH | 2,823,220 |
| Asbestos in brake drum dusts | Principal Investigator | 07/01/73-06/30/75 | Ford Motor Company | 10,000 |
| Population at high risk of lung cancer: establishment of cohort and development of serial surveillance | Co-Principal Investigator | 08/01/73-07/31/75 | NIH | 78,572 |

**FUNDING SOURCES**

| PROJECT | ROLE IN PROJECT | PROJECT PERIOD | SOURCE OF FUNDS | TOTAL DIRECT SUPPORT |
|---|---|---|---|---|
| Asbestos exposure of workers and public from brake linings | Co-Principal Investigator | 07/01/75-06/30/76 | HRC-NY | 12,980 |
| Asbestos exposure with brake lining service and repair | Co-Principal Investigator | 07/01/75-06/30/77 | HRC-NY | 51,142 |
| Residency training in occupational medicine | Co-Principal Investigator | 07/01/76-06/30/78 | NIOSH | 105,491 |
| Asbestos in brake workers' lungs | Principal Investigator | 09/01/77-08/31/79 | NIOSH | 95,223 |
| Environmental Health Sciences Center Grant | Co-Principal Investigator | 09/01/78-08/31/83 | NIEHS | 4,841,529 |
| Environmental dusts and macrophage activation | Co-Principal Investigator/Mineralogist | 03/01/79-02/29/81 | NCI via Sloan-Kettering Institute | 168,589 |
| Surface properties of chrysotile asbestos and its role in biological potential | Principal Investigator | 07/01/79-<br>continued yearly | Mobil Foundation | 8,000<br>12,000 |
| Environmental cancer research project | Co-Principal Investigator | 09/01/80-08/31/81 | ACS | 284,540 |
| Particle analysis St. Regis Health Study | Co-Principal Investigator | 07/01/81-06/30/82 | Canadian | 1,016,581 |

**FUNDING SOURCES**

| PROJECT | ROLE IN PROJECT | PROJECT PERIOD | SOURCE OF FUNDS | TOTAL DIRECT SUPPORT |
|---|---|---|---|---|
| Activity of amosite asbestos and grunerite fiber | Co- Principal Investigator/Mineralogist | 09/01/82-08/31/84 | NIOSH | 143,396 |
| Environmental Health Services Center Grant | Co-Principal Investigator/Mineralogy Group Leader | 07/01/84-06/30/86 | NIEHS | 300,000 |
| Biological activity of modified chrysotile asbestos fiber | Principal Investigator | 09/01/84-12/31/86 | SNA, Canada | 300,000 |
| Biological activity of asbestos substitutes | Principal Investigator | 01/01/87-03/31/87 | SNA, Canada | 15,000 |
| Analysis of play sand for asbestos content | Principal Investigator | 11/01/87-02/01/88 | Consumer Products Safety Commission | 4,000 |
| Analysis of talcs for mineral character | Principal Investigator | 04/01/88-12/01/88 | Vanderbilt Talc Company | 32,000 |
| Surface properties of asbestos and substitutes | Principal Investigator | 04/01/87-03/31/88 | Asbestos Institute | 10,000 |
| Evaluation Microscopy Laboratories | Co-Principal Investigator | 03/01/88-06/30/90 | Battelle, Columbus | 130,500 |
| Wollastonite in animal lungs | Principal Investigator | 12/01/88-06/01/89<br>08/01/88-12/01/88 | NSI - National Toxicology Program | 38,000 |

FUNDING SOURCES

| PROJECT | ROLE IN PROJECT | PROJECT PERIOD | SOURCE OF FUNDS | TOTAL DIRECT SUPPORT |
|---|---|---|---|---|
| Modified asbestos; asbestos substitutes; surface properties | Principal Investigator | 04/01/88-09/01/90 | SNA, Canada | 50,000 |
| Fibers in vermiculite | Principal Investigator | 08/01/88-09/01/88 | State of Montana | 900 |
| Characterization and biological potential of asbestiform and non-asbestiform amphiboles | Principal Investigator | 06/01/89-current | Vanderbilt Talc Company | 162,000 |
| Talc and its associated mineral impurities | Principal Investigator | 08/01/89-02/29/91 | Georgia Pacific Company | 32,000 |
| Study of asbestos contamination of building air | Principal Investigator | 06/30/88-present | CNA Insurance Co. | 50,000 |
| Asbestos-emissions during gasket replacement | Co-Investigator | 01/30/91-present | Durabla Company | 35,000 |
| Release of Rockwool fibres from gaskets | Principal Investigator | 01/01/93-present | Lapinus Fibres, B.V. | 4,250 |
| Asbestos-release from plumbing supply products | Co-Investigator | 10/01/92-present | Sexauer Mnf.Co. | 10,000 |
| Asbestos in the lungs of exposed workers | Principal Investigator | 03/01/93-present | W.R. Grace & Co. | 90,000 |
| Applied Technology - Equipment Assistance Grant | Co-Investigator | 09/93-09/96 | New York State | 720,000 |

IN THE UNITED STATES DISTRICT COURT
FOR EASTERN DISTRICT OF PENNSYLVANIA

IN RE: ASBESTOS PRODUCTS LIABILITY LITIGATION (NO. VI) — CIVIL ACTION NO. MDL 875

This Document Relates To:

UNITED STATES DISTRICT COURT
FIFTH DIVISION
DISTRICT OF MINNESOTA

CONWED CORPORATION,

Plaintiff,

vs. Case No.: Civ. 5-92-88

UNION CARBIDE CHEMICALS AND PLASTICS COMPANY, INC., (f/k/a Union Carbide Corporation),

Defendant,

and

UNION CARBIDE CHEMICALS AND PLASTICS COMPANY, INC. (f/k/a Union Carbide Corporation),

vs.

OWENS-CORNING FIBERGLAS CORPORATION, WALKER JAMAR COMPANY, A.W. KUETTEL & SONS, INC., API, INC., and MacARTHUR COMPANY,

Third Party Defendants.

## NOTICE OF DEPOSITION OF DR. ARTHUR M. LANGER

TO: Mr. Robert D. Brownson
Stich, Angell, Kreidler & Muth, P.A.
The Crossings, Suite 120
250 Second Avenue South
Minneapolis, MN 55401

All Counsel of Record

PLEASE TAKE NOTICE that, pursuant to Fed. R. Civ. P. 30, the deposition of Dr. Arthur M. Langer will be taken at 9:30 a.m.

LANGER 2
Date Exh For ID In-EV
Robert E Levy C S R
Doyle Reporting, Inc 1/14/94

on January 14, 1994 at the offices of Kelley, Drye & Warren, 101 Park Avenue, 32nd Floor, New York, New York 10178.

The deposition shall continue from time to time and from place to place as necessary until completed, and may be used for all purposes contemplated under the Federal Rules of Civil Procedure.

PLEASE TAKE FURTHER NOTICE that the witness is required to produce the documents described as follows:

1. Any report, analysis, test results, notes or documents relating or referring to any samples of Calidria or Coalinga asbestos Dr. Langer has reviewed, examined or tested.

2. Any publically unreported or unpublished data, test results, studies or reports upon which Dr. Langer relies to support any opinion he has formed for or intends to offer in this action.

3. Dr. Langer's file for this case.

4. The results of Dr. Langer's analysis of the samples he took at the KCAC asbestos mine in July of 1993.

Dated: January 6, 1994

TREVOR J. WILL (WBN 1008725)

Trevor J. Will
Attorney for Union Carbide Chemicals and Plastics Company, Inc.

FOLEY & LARDNER
777 East Wisconsin Avenue
Milwaukee, WI 53202-5367
(414) 271-2400
(414) 289-3791 (fax)

Direct Inquiries to:
(414) 289-3517 (TJW)

**Mineralogical Analysis of Chrysotile Ore Specimens Obtained in the ECRAC Pit (Formerly Union Carbide's New Idria Deposit)**

**Summary**

Ore specimens obtained during the July 27, 1993, field trip to Union Carbide's New Idria asbestos deposit were subjected to analysis by polarized light microscopy and continuous scan x-ray diffraction. Selected specimens were examined by analytical electron microscopy.

The twelve specimens collected from the pit were separately (and gently) ground by hand in an agate mortar with pestle. Aliquots of each specimen were mounted in appropriate immersion oils for purposes of mineral identification and characterization. The indices of refraction of the immersion oils ranged from n = 1.515 - n = 1.700. The findings were as follows: chrysotile fiber was found in all specimens, but ranged in concentration; at 100x magnification several of the fiber bundles approached approximately 1mm in length (commercially a "short" fiber); intergrowths of fiber and massive serpentine were common and occasionally some fibers displayed anomalous blue-gray birefringence; fragments of other minerals derived from the host rock (serpentinite) ranged in abundance as well, a function of proximity to the central ore body; other mineral particles identified included plagioclase feldspar (displaying undulatory extinction of albite twinning); altered mineral fragments with optical characteristics of both olivine and pyroxene were observed; platy forms of serpentine (lizardite and antigorite) were observed; chrysotile bundles with limonite stains

LANGER 3
Exh
For ID
Robert E Levy C S R
Doyle Reporting, Inc 1/14/94

suggested weathering of associated iron-containing minerals; several carbonate minerals, including magnesite and calcite were present; fibers with optical properties consistent with the brucite were observed; some fibers of brucite displayed signs of alteration (coalingite?). In one specimen, number 1, a fragment of an amphibole mineral was noted. The fragment was a single crystal, non-polyfilamentous, and was not asbestiform. The identity of the fragment remains unknown. Opaque minerals (magnetite? chromite?) were also noted. As with the other principle minerals, their concentrations were observed to be variable.

It was noted that certain minerals ranged widely in concentration throughout the deposit. The opaque mineral, thought to be principally magnetite, although invariably present in all specimens ranges considerably in concentration. So it is also for the brownish alteration product of brucite (coalingite) as well as for the presence of fractured and serpentinized residual olivine and pyroxene minerals.

An analysis of pelletized ore, RG 100, in addition to chrysotile, contained concentrations of mafic mineral fragments, opaque minerals, and brucite alteration products. In the many aliquots examined by polarized light microscopy no amphibole mineral was observed.

It is important to note that fibers are observed within the

Analytical Electron Microscopy

As for analysis of specimens by continuous scan x-ray diffraction only select samples were analysed by analytical electron microscopy. It was decided, however, based on resources, that only the final ore product (RG 100) would be examined in detail. The instrument used was a JEOL 100 CX interfaced with a Tracor Northern 5500 energy dispersive x-ray spectrometry system. A number of grids were prepared and examined.

Chrysotile asbestos is a the principal mineral in all of the preparations examined. Selected area electron diffraction patterns are consistent with standards for clinochrysotile. Associated platy minerals are consistent with lizardite, antigorite and brucite.

Occasionally, an electron-dense mineral fiber, with aspect ratio > 15:1, was observed. Morphologically this mineral resembles an amphibole but inspection of the selected area electron diffraction pattern suggests a complex structure not unlike the taloboles found in many talc deposits in the United States. The magnesium:silicon ratio is much less that for chrysotile, generally lying in the range of 0.45-0.52. Chrysotile appears to be associated with the fiber, with its long axis parallel to the long axis of the electron-dense mineral. The chemistry of chrysotile obviously effects the chemical ratio obtained on these fibers (chrysotile's ratio of magnesium:silicon is approximately 0.75-0.85). It is

unknown at this time if this mineral represents an intergrowth a chain silicate and a serpentine mineral or is even one of the discredited serpentine minerals which has been shown to be a mixture of several of the associated magnesium silicate phases.

Arthur M. Langer, Ph.D.
Professor and Director
Environmental Sciences Laboratory