Comments of Ann Wylie, Professor of Geology, University of Maryland, College Park, MD on the Document entitled " Talc, Asbestiform and Non-asbestiform: Result of the NIEHS Report on Carcinogens Review Group Review"

My interest in and study of the relationships between minerals and human disease extends back for 34 years, when, as a first year graduate student, I had the opportunity to work for one summer at Mt. Sinai in the laboratory of Irving Selikoff under the direction of Arthur Langer. When I was appointed as a professor at the University of Maryland in 1972, I began in earnest my exploration of this interesting and complex topic, and over the last 28 years, I have published extensively on the physical and chemical properties of minerals that have been implicated in disease. For your review, I have attached my curriculum vitae, which summarizes these activities.

I decided to comment on the draft of the NIEHS report on Carcinogens Review Group Review of Talc, Asbestiform and Non-Asbestiform because many confusing and incorrect statements on mineralogy have been made, and the relevance of several important studies has been overlooked. I believe these mistakes are so significant that they impact the validity of the analysis.

1. The document uses interchangeably the following terms: fibrous talc, asbestiform talc, and talc containing asbestiform fibers. These three terms do not mean the same thing, and the incorrect interchangeability of the terms obfuscates the issues.
    a. **Fibrous talc** was first described in the mineralogical literature in 1960, by one of the world's foremost mineralogists, G.W. Brindley and his student I. S. Stemple. It has been studied and described (Stemple and Brindley, 1960; Wright, 1960; Virta, 1985; Felius, 1986; Veblen and Wylie, 1993; Greenwood, 1998; Crane, 2000) and this work has established that fibrous talc is the fibrous form of the mineral talc, and furthermore, that in this fibrous form, it may or may not be intergrown on an extremely fine, scale with variably but commonly small amounts of amphibole and/or other chain silicates.
    b. Fibrous talc may be asbestiform, in that it can form in bundles of parallel fibers of narrow diameter and high aspect ratio, or it may be acicular. Therefore, **asbestiform talc** is a habit of fibrous talc. When so designated, it is used to describe talc that has grown in a habit that resembles that of asbestos. That does not make it asbestos; there are other asbestiform minerals that are also not asbestos. Another way to say this is that minerals with an asbestiform habit look like asbestos. In the Introduction to the document, the following statement appears: **"Asbestiform talc** generally refers to talc containing asbestiform tremolite/actinolite, anthophyllite, or chrysotile." This is a different meaning of asbestiform talc, and not one that any mineralogist would understand. If this is the meaning intended, then I recommend that throughout, this term be replaced with the term "mixtures of talc and asbestos" so that there is no confusion. The definition of asbestos has already been well established in the regulatory literature.

c. **Talc containing asbestiform fibers** seems to refer to mixtures of talc and crocidolite, or talc and amosite, or talc and any other type of asbestos. In fact, when the results of animal and genotoxicity studies that employed asbestos are cited, the authors imply that industrial talc contains asbestos. Asbestos has been well established as a carcinogen, and it is difficult to see how the fact that asbestos is a carcinogen informs the discussion of the carcinogenicity of talc, whether fibrous or not. It is possible that some industrial talc deposits may contain trace amounts of asbestos. However, if asbestos is found in industrial talc, it is still asbestos and is covered by existing regulatory policy.

The confusion throughout the document about what is meant by the terms talc, asbestiform talc, fibrous talc, and talc containing asbestiform fibers makes the interpretation of the medical data presented impossible to evaluate without a careful reading of each source cited to determine which term pertains.

2. General Mineralogical errors. Taken individually, the errors I point out below may be dismissed as irrelevant to the larger question. However, they contribute to the distinct impression that those who have written this document know very little about the material about which they have written. The structure, composition, and physical properties of minerals are well known. It is essential that our regulatory process not ignore this vast body of knowledge.

   a. Under 1.1, **Chemical Identification**, the statement that minerals "such as calcite, quartz, magnesite, etc., have chemical properties similar to those of mineral talc" occurs. This is incorrect. There is no similarity between the chemical properties of the minerals listed and talc.
   b. In **Table 1.1**, under the column **Properties**, entries occur for carbonates, anthophyllite, and mica. These statements are irrelevant and, in the case of anthophyllite, are specific only to the asbestiform variety. Anthophyllite may be found associated with talc in a blocky or massive form. I suggest removing this superfluous column.
   c. In **Table 1-2**, the physical and chemical properties of talc are listed. I have consulted all the mineralogical texts in my library and none agree that the hardness of talc can be greater than 1. In fact, hardness number 1 is defined by talc.
   d. Under **1.3**, the first statement suggests that asbestiform fibers are something mysterious and poorly understood. This is simply incorrect. It reflects ignorance of the mineralogical literature.
   e. Also under **1.3, paragraph 5**, the following statement occurs: "the limiting upper diameter of "whisker" usually is considered to be 15 _m; the same diameter may be used for the definition of asbestiform fibers." I have measured thousands of asbestos fibers and am familiar with almost every published study on the dimensions of asbestos fibers. Asbestos fibers have diameters that are orders of magnitude thinner than 15 _m.
   f. In the **eighth paragraph of 1.3**, the document refers to published reports that talcum powders contained measurable amounts of chrysotile, tremolite, and anthophyllite fibers that "may be of asbestiform nature". In fact, most of these so-

called fibers were cleavage fragments (hence the term "may" was used) and are irrelevant to the discussion.

g. In the **ninth paragraph of 1.3**, the confusion between fibrous or asbestiform talc and talc containing asbestos is again made. How **Table 1-3** is relevant to the use of the term asbestiform talc is beyond me. Actinolite asbestos is not a synonym for actinolite; amosite is not a synonym for grunerite; tremolite is not a synonym for tremolite-asbestos, and asbestos fiber is not a synonym for a sodium hydroxide coated non-fibrous silicate.

3. Under the topic **Studies of Cancer in Experimental Animals**, the work of Merle Stanton and his co-workers is discussed and summarized in Table 4-5. Their talc 6 contains both fibrous and nonfibrous talc. It was mined in New York and was labeled in Stanton's notes (personally examined in his archives by me) as Nytal 200. It is noteworthy that Stanton et al. report that it contains concentrations of fibers 0.25 _m x > 8_m that are equal to or greater than several of the asbestos fibers populations also used in these experiments. However, no statistically significant tumor probability resulted. The work of Stanton et al. predicts that similar concentrations of asbestos fibers would result in a tumor probability of more than 60%. The results of these experiments underscore the fact that the biological activity of fibrous talc is not the same as that of asbestos.

4. Under **Asbestiform talc, section 4.2,** the following statement occurs: "For evaluation of the carcinogenicity of asbestiform talc, asbestos is considered a reasonable surrogate, in part, because asbestos is the generic term for all naturally occurring fibers of mineral silicates of the serpentine and amphibole series." A similar analogy is used in discussing genotoxicity. The fact that the authors equate the fibrous form of the mineral talc with asbestos is without foundation. Talc is neither amphibole nor serpentine. These are different minerals: they have different physical properties (such has hardness, surface charge, density, hyrophilicity, solubility, tensile strength, surface roughness, surface area, etc.) different chemical compositions, different atomic structures, different numbers and types of structural defects, different dimensions, and based on animal (Stanton et al. 1972, Smith et al., 1979) and cell culture experiments (Wylie et al., 1998) they have different biological activities. The document suggests that the composition, structure, physical properties and surface properties of mineral fiber should not be relevant to the regulatory process. Based on the wide range of physical and chemical properties of minerals, such a position is unjustified. If talc in any form is a carcinogen, this determination should rest on evidence of carcinogenicity derived from human exposure to it and/or animal experimentation with it. Classifying a mineral as a carcinogen without this type of evidence would threaten the validity of the scientific foundation of our regulatory process.

5. The study of W.E. Smith et al. is relevant to the discussion and has been overlooked. In 1979, W.E. Smith et al. published the results of intrapleural injection of industrial talc in hamsters in a paper published in Dusts and Disease entitled "Biologic tests of tremolite in hamsters". In this paper, Smith et al. report that the injection in hamsters of a New York State industrial talc (FD-14), a material that contains cleavage fragments of tremolite and serpentine as well as fibrous and nonfibrous talc, produced very little fibrosis and no

tumors. This result contrasts sharply to those reported in the same paper on the tumors and fibrosis resulting from the injection of tremolite-asbestos under the same experimental conditions.

6. In 1997 Wylie et al. published a study that compared fibrous talc to asbestos by using a colony-forming efficiency assay with rodent tracheal epithelial and pleural mesothelial cells. The work suggests strongly that fibrous talc has a biological activity that is very different from that of asbestos. It showed that asbestos has a proliferative potential, while fibrous talc does not, and that surface area and fiber dimensions could not explain the difference in response. In relegating this paper to one that informs on fiber dimensions and mineralogy, rather than to one that addresses directly the biological effects of fibrous talc, its importance is underestimated.

In summary, this document is replete with substantive errors. The case for the carcinogenicity of asbestos is confused with a case for the carcinogenicity of talc. Therefore, it should not form the basis for any regulatory action, direct or indirect, and it should not be included in the National Toxicology Program Report on Carcinogens.

Bibliography

Crane, D., 2000, Background information regarding the analysis of industrial talcs, in CPSC Staff Report on Asbestos Fibers in Children's Crayons, US Consumer Product Safety Commission.

Felius, R.O., 1986, EM-research into the fibrous constituents of an industrial talc powder (abstract) Abstracts with Programs, Fourteenth General Meeting of the International Mineralogical Association, Stanford University: p. 97.

Greenwood, William, 1998, A Mineralogical Analysis of Fibrous Talc, MS Thesis, University of Maryland, 162 pages.

Smith, W.E., Hubert, D.D., Sobel, H.J., and Marquet, E., 1979, Biologic Tests of Tremolite in Hamsters, in **Dusts and Disease**, Pathotox Publishers.

Stemple, I. S., and Brindley, G. W., 1960, A structural study of talc and talc-tremolite relations, J. Am, Ceramic Society, **43**, p.34-42.

Veblen, D.R., and Wylie, A.G., 1993, Mineralogy of amphiboles and 1:1 layer silicates, in Health Effects of Mineral Dusts (G.D. Guthrie and B.T. Mossman, Eds.) Mineralogical Society of America, Washington, D.C., pp.61-131.

Virta, R.L., 1985, The Phase Relationship of Talc and Amphiboles in Fibrous Talc samples, Bureau of Mines Report of Investigations, No. 8923, 11 pages.

Wright, H.D., 1960, An optical study of talc-tremolite relations. Journal of the American Ceramic Society, **43**, 42-42.

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PUBLICATIONS

Refereed Publications:

Wylie, A.G. and P.J.M. Ypma, "Determination of the Optical Parameters, n and k, of Absorbing Minerals with the Microscope: Isotropic Minerals". Economic Geology V. 52 No. 8 (1974) p. 1300-1327.
Wylie, A.G., "Fiber Length and Aspect Ratio of Some Selected Asbestos Samples", Annals of the New York Academy of Science 330 (1979) p. 640-643.
Wylie, A.G., "Optical Properties of the Fibrous Amphiboles", Annals of the New York Academy of Science 330 (1979) p. 600-605.

Zoltai, Tibor and A.G. Wylie, "Definitions of Asbestos-related Mineralogical Terminology", Annals of the New York Academy of Science 330 (1979) p. 640-643.

Rohl, A.N., A.M. Langer and A.G. Wylie, "Mineral Characterization of Asbestos-Containing Spray Finishes", in Asbestos Materials in Schools: A Guidance Document, Part I, EPA C0090 (1979) p. 59-64.

Wylie, A.G. and C. Huggins, "Characteristics of a Potassian Winchite - Asbestos from the Allamoore Talc District, Texas", Canadian Mineralogist V. 18 No. 1 (1980) p. 101-107.

Siegrist, H.G. and A.G. Wylie, "Characterizing and Discriminating the Shape of Asbestos Particles", Environmental Research 23, (1980) p. 348-361.

Campbell, W., C. Huggins and A.G. Wylie, "Chemical and Physical Characterization of Amosite, Chrysotile, Crocidolite and non-fibrous Tremolite for Oral Ingestion Studies by NIEHS", Bureau of Mines Report of Investigation #8452 (1980) p. 1-63.

Wylie, A.G. and Peter Schweitzer, "The effects of Sample Preparation on Size and Shape of Mineral Particles: The Case of Wollastonite", Environmental Research 27, (1982) p. 52-73.

Shedd, K.B., R.L. Virta and A.G. Wylie, "Are Zeolites Dimensionally Equivalent to Asbestos?", in Process Mineralogy II: Applications in Metallurgy, Ceramics and Geology, R.D. Hagne, Ed., Proceeding of Metallurgical Society of AIME, (1982), p. 395-399.

Wylie, A.G., K.B. Shedd and M.E. Taylor, "Measurement of the Thickness of Amphibole Asbestos Fibers with the Scanning Electron Microscope and the Transmission Electron Microscope", Microbeam Analysis Society-Electron Microscope Society of America, Proceedings of the Annual Meeting, Washington, D.C., August (1982), p. 181-187.

Shedd, K.B., R.L. Virta and A.G. Wylie, "Size and Shape Characterization of Fibrous Zeolites by Electron Microscopy", Bureau of Mines Report of Investigation #8674, (1982), p. 1-20.

Virta, R.L., K.B. Shedd, A.G. Wylie and J.G. Snyder, "Size and Shape Characteristics of Amphibole Asbestos and Amphibole Cleavage Fragments Collected on Occupational Air Monitoring Filters", in Aerosols in the Mining and Industrial Work Environments Volume 2: Characterization, V.A. Parple and B.H. Kiu, Eds., Ann Arbor Science, (1983) p. 633-643.

Wylie, A.G., "Membrane Filter Methods for Estimating Asbestos Fiber Exposure", in Definitions for Asbestos and Other Health-Related Silicates, ASTM STP 834, B. Levadie, ed., American Society of Testing and Materials, Philadelphia (1984), p. 105-117.

Wylie, A.G., R. Virta and E. Russek, "Characterizing and Discriminating Airborne Amphibole Cleavage Fragments and Amosite Fibers: Implications for the NIOSH Method", American Industrial Hygiene Association Journal (1985), Vol. 46, #4, p. 197-201.

Wylie, A.G., R. Virta and J. Segretti, "Characterization of Mineral Populations by Index Particle: Implications for the Stanton Hypothesis", Environmental Research, v. 43, p. 427-439 (1987)

Wylie, A.G., Candela, P.A. and Burke, T.M., "Compositional Zoning in Unusual Zinc-rich Chromite from the Sykesville District, Carroll County, Maryland". American Mineralogist, v. 72, p. 413-423 (1987).

Wylie, A.G. "Relationship between the growth habit of asbestos and the dimensions of asbestos fibers". Mining Engineering, p. 1036-1040, November (1988).

Muller, P.D., Candela, P.A. and Wylie, A.G., "Liberty Complex: Polygenetic Melange in the Central Maryland Piedmont". GSA Special Paper 228 Melanges and Olistostrome of the U.S. Appalachian, J.W. Horton and N. Rast, eds., p. 113-135, (1989)

Candela, P.A., Wylie, A.G. and Burke, T.M., Genesis of the Ultramafic Rock -Associated Fe -Cu-Co-Zn-Ni Deposits of the Sykesville District, Maryland Piedmont", Economic Geology, v. 84, p. 663-675 (1989).

Wylie, A.G., "Discriminating Amphibole Cleavage Fragments from Asbestos: Rationale and Methodology". Proceedings of the VIIth International Pneumoconiosis Conference, Pittsburgh, p. 1065-1069 (1990).

Linder, D.E., Wylie, A.G. and Candela, P.A., "The Mineralogy and Origin of the State Line Talc Deposit, Pennsylvania. Economic Geology, v. 87, p. 157-165 (1992).

Wylie, A.G. and Bailey, K.F.. "The Mineralogy and Size of airborne Chrysotile and Rock Fragments: Ramifications of Using the NIOSH 7400 Method". American Industrial Hygiene Association Journal, v. 53, p. 442-447 (1992).

Wylie, A.G., "Modeling Asbestos Populations: The Fractal Approach". Canadian Mineralogist, v. 30, p. 437-446 (1993).

Wylie, A.G., Bailey, K., Kelse, J. and Lee, R., "The importance of width in fiber carcinogenicity and its implications for public policy". American Industrial Hygiene Association Journal, v. 54 #5, p. 239-252 (1993).

Wylie, A.G., Skinner, H.C., Marsh, J., Snyder, H., Garzione, C., Hodkinson, D. and Winters, R., "Mineralogical features associated with cytotoxic and proliferative effects of fibrous talc and asbestos on

rodent tracheal epithelial and pleural mesothelial cells. Journal of Toxicology and Applied Pharmacology, v. 147, p. 143-150 (1997).

Wylie, A.G., "The habit of asbestiform amphibole: Implications for the analysis of bulk samples", Advances in Environmental Measurement Methods for Asbestos, ASTM STP 1342, M.E. Beard, H.L. Rooks, Eds., p. 53-69 (1999).

Verkouteren, J. R., and Wylie, A.G., "The tremolite-actinolite-ferro-actinolite series: Systematic relationships among cell parameters, composition, optical properties, and habit and evidence of discontinuities, American Mineralogist, v. 85, p.1239-1254 (2000)

Wylie, A.G. and Verkouteren, J.R., "Amphibole asbestos from Libby, Montana: Aspects of nomenclature", American Mineralogist, v. 85, p. 1540-1542, (2000)

Chapters or Articles in Books:

Gilbert, J. Ann, "Units, Numbers, Symbols and Constants", Encyclopedia of Atmospheric Sciences and Astrogeology, Rhodes Fairbridge, ed. Reinholt Publishing Company p. 1049-1062 (1967).

Wylie, A.G., Numerous Mineral Descriptions in Encyclopedia of Mineralogy, K. Frye, ed., Reinholt Publishing Company (1981).

Steel, E. and A. Wylie, "Mineralogical Characteristics of Asbestos" in Geology of Asbestos Deposits, P.H. Riordon, ed., Society of Mining Engineers of AIME p. 93-100, (1981).

INVITED: Veblen, D.R. and A.G. Wylie, "Mineralogy of Amphiboles and 1:1 Layer Silicates" in Health Effects of Mineral Dusts, G.D. Guthrie & B.T. Mossman, eds., Reviews in Mineralogy, v. 28, Min. Soc. Am., p. 61-131, (1993).

INVITED: Wylie, A.G., "The Analysis of Industrial Mineral Products for Crystalline Silica by Optical and Electron Microscopy: A Literature Review". In Review Papers on Analytical Methods, Chemical Manufacturers Association, (1995).

INVITED: Wylie, A.G. and P.A. Candela, "Metallic Mineral Deposits - Chromite" in Geol. of Pennsylvania, Pennsylvania Geol. Survey and Pittsburgh Geol. Survey, Special Publication 1, p.588-595 (1999),

Other Publications:

Gilbert, Jean Ann, Determination of the Index of Refraction and Coefficient of Absorption Under the Microscope: A New Method and Some of Its Applications. Ph.D. Thesis, Columbia University, February (1972).

Wylie, A.G., L. Johnson, R. Reichlin, E. Steel, and R. Virta, "Mineralogy and Size Distribution of Asbestos", University of Maryland Electron Microscope Central Facility. Newsletter #5 (1977).

Lowry, J. and A.G. Wylie, "Mineralogy and Fiber Size Analysis of Amosite", University of Maryland, Electron Microscope Central Facility Newsletter #7 (1979).

Steel, E. and A.G. Wylie, "Characteristics of the Asbestiform Habit", Society of Mining Engineers-American Institute of Mining Engineering Annual Meeting, Tucson. preprint, p. 1-6 October (1979).

INVITED: Wylie, A.G., K.B. Shedd and M.E. Taylor, "Volume Measurements of Asbestos in the SEM", University of Maryland Electron Microscope Central Facility, Newsletter #9 (1982).

INVITED: Wylie, A.G., "The Relationship Between the Growth Habit of Asbestos and the Dimensions of Asbestos Fibers". Society of Mining Engineers preprint #88-85, p. 1-7 (1988).

INVITED: Wylie, A.G., "Mineralogical Definitions for Asbestos Fibers and Cleavage Fragments", Report of the Committee on Geology and Public Policy GPP012. Geological Society of America, p. 2-4, (1989).

INVITED: Wylie, A.G., "Factors affecting risk from biologically active minerals", Proceedings, Mineral Dusts: Their Characterization and Toxicology, Washington, D.C., Society for Mining Metallurgy & Exploration, Littletown, Colorado, p. 33-46, Sept. 19-20, (1996).

Schwartz, C., A.G. Wylie, A. Davis, B. James, "Investigation of the Expansive Behavior of Chromium Tailings: Final Report on Phase II Investigations," April, 2000.

Book Reviews:

INVITED: Book review of Optical Mineralogy: Theory & Technique by E.G. Ehlers. In American Scientist, Nov./Dec. (1988).

INVITED: Book review of Ultramafic Rocks of the Appalachian Piedmont, GSA Spec. Paper 231, Steven K. Mittwede and E.F. Stoddard, eds, 103 pages, in Economic Geology, v. 85 (1990).

Published Abstract and Professional Papers Presented:

(Since 1980)

INVITED: Wylie, A.G. and P. Schweitzer, "The Effects of Grinding on the Shape of Wollastonite Particles", Symposium on Electron Microscopy and X-ray Applications to Environmental and Occupational Health Analysis (1980) Penn State.

Huggins, C., A.G. Wylie and W. Campbell, "Preparation and Selected Properties of Amosite, Chrysotile, Crocidolite and Non-fibrous Tremolite for Use in NIEHS Oral Ingestion Studies", Symposium on Electron Microscopy and X-ray Applications (1980) Penn State.

Rosemeier, R.G., M.E. Taylor and A.G. Wylie, "Low Cost 210K Gain Transmission Electron Microscope Image (TEMI) Intensifier", Electron Microscopy Society of America, Annual Meeting (1981) Atlanta.

Virta, R., K. Shedd, A.G. Wylie and J. Snyder, "Size and Shape Characteristics of Amphibole Asbestos and Amphibole Cleavage Fragments Collected on Occupational Air Monitoring Filters", Proceedings of the International Symposium on Aerosols in the Mining and Industrial Work Environment. University of Minnesota USBM-NIOSH (1981) Minneapolis, Minnesota.

Broadhurst, C.L., Candela, P.A., Wylie, A.G. and Burke, T.M., "A Geochemical Study of the Host Rocks of the Copper-Iron-Cobalt Ores of Sykesville, Maryland: An Ultramafite-Associated Deposit, Geol. Soc. Am. Natl. Meeting, November, (1983).

Burke, T.M., P.A. Candela, and A.G. Wylie, "Evidence for Detrital Ultramafic Bodies in the Eastern Piedmont of Maryland", Geol. Soc. of America Northeastern Section, March (1985).

Wylie, A.G., P.A. Candela and T.M. Burke, "Genesis of High-zinc Chromite and Associated Cobalt Mineralized Blackwall in the Sykesville District, Maryland Piedmont", Geol. Soc. of Amer. National Meeting, November (1985).

Muller, P.D., Candela, P.A. and A.G. Wylie, "Liberty Complex: Polygenetic Melange in the Central Maryland Piedmont", Geol. Soc. of Amer. National Meeting, November (1985).

INVITED: Candela, P.A. and Wylie, A.G., "The Geology of Radon in the Maryland Piedmont: The Development of a Research Plan". Southwest Geol. Soc. Amer., (1987).

Candela, P.A., Wylie, Ann G. and Muller, P., "Ore Deposits as Tectonic Indicators in Melange Terrane", AGU (1987).

Wylie, A.G., Candela, P.A. and Burke, T.M., The Genesis of Ultramafite-Associated Fe-Cu-Co-Zn-Ni Deposits of the Sykesville District, Maryland Piedmont", Southeast Geol. Soc. Amer., (1987).

Linder, D.E. and Wylie, A.G., "Zeolites from the Paleozoic Metavolcanic James Run Formation, Piedmont Province, MD" Southeast Geol. Soc. Amer., (1988).

INVITED: Wylie, A.G. "Discriminating Amphibole Cleavage Fragments from Asbestos: Rationale and Methodology. Abstracts of Communication. VII International Pneumoconiosis Conference, Aug. 23-26 (1988). Pittsburgh, NIOSH-ILD-BOM-MSHA-OSHA, p. 124.

INVITED: Wylie, A.G., "Distinguishing Tremolite-Asbestos from Tremolite Cleavage Fragments on a Light Optical and Morphological Basis", VII International Pneumoconiosis Conference Proceeding of Workshop: Hazard Recognition of Mineral Dust (1989). Pittsburgh, NIOSH-ILD-BOM-MSHA-OSHA.

Wylie, A.G., Linder, D. and Candela, P. "Sedimentary Features of Appalachian Serpentinites". Geol. Soc. of Amer. National Meeting, Nov. (1990), p. A230.

INVITED: Skinner, C. and Wylie, A., "Fibrous Tremolites". Bloss Symposium, VPI, Blacksburg, Virginia (1990).

INVITED: Wylie, A.G. The Analysis of Industrial Mineral Products for Crystalline Silica by Optical and Electron Microscopy. The Measurement of Crystalline Silica International Symposium, August (1992).

Wylie, A.G., The Fractal Distribution of the Mass of Asbestos Fiber and its Application to the Analysis of Industrial Minerals. Geological Society of America Annual Meeting, Boston (1993).

Verkouteren, J.R., Wylie, A.G., Steel, E.B., Lim, M.S. (1995) "Analysis of the tremolite-actinolite series using high precision refractive index measurements," Microbeam Analysis, p. 27.

INVITED: Wylie, A.G. (1996) Factors affecting risk from biologically active minerals. Society of Mining, Metallurgy & Exploration Symposium. Mineral Dusts: Their Characterizations and Toxicology.

INVITED: Wylie, A.G., "The habit of asbestiform amphiboles: Implications for the analysis of bulk samples & 1997 Boulder Conference: Advances in Environmental Measurement Method for Asbestos. July 13-17 (1997). University of Colorado, Boulder.

Published Guides for Field Trips:

Wylie, A. and P. Candela "The Geology of the Maryland Piedmont". 3-day Trip and GuideBook. Dept. of Geology Annual Trip. October 1987.
Candela, P. and A. Wylie. "The Ultramafite-associated Cu-Fe-Co-Ni-Zn Deposits of the Sykesville District, Maryland Piedmont". Goldschmidt Conference Field Trip. May, 1988; May, 1990.
Candela, P. and Wylie, A. "Fe-Cu-Co-Ni-Zn deposits of Sykesville, Md." Int. Geol. Congress, July 1989.

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Lyle Griffith "The Use of a Magnetometer in Characterizing the Beasman Prospect, Sykesville, MD." (1982)
[2]John Varndell "Heavy Element and Particle Size Relationships in a Sludge Disposal Site, Baltimore, Maryland" (1982)
Joe Segretti "Relationship between cytotoxicity and coating of chrysotile fibers" (1982)
Mark Beal, A Geologic Evaluation of a Placer Gold Deposit in Southern Farquier Co., Virginia (1982)
Keith Mason "A Preliminary Evaluation of Copper and Cobalt in Conjunction with Iron Mining in the Beasman Prospect of Sykesville, Md." (1983)
Michael D. Jones "Chromium in the Soils and Streambeds above the Hunting Hill Serpentinite Body, Montgomery County, Md." (1983)
Theresa Baker "Crack Growth in Quartz: The Effects of Chemical Environments" (1983)
Mark Hevey "Gas Production and Faulting in Gas Field, Kansas" (1983)
Brian Hart "A Potential Field Study of the Magnetite Bearing Deposits of the Central Portion of the Sykesville Mining District" (1984)
Katherine Heller "A Reconnaissance Study of the Origin of Small Talc and Serpentine Bodies in the Wissahickon Formation within the Maryland Piedmont" (1984)
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[1]Winner of the AAPG National Undergraduate Research Award

[2]2nd Place Winner of the AAPG National Undergraduate Research Award

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