J Forensic Sci, Mar. 2004, Vol. 49, No. 2
Paper ID JFS2003331
Available online at: www.astm.org

SPECIAL COMMUNICATION

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Dr. Walter C. McCrone—His Contributions to Environmental Microscopy*

ABSTRACT: This paper briefly highlights Dr. McCrone's contributions to the recently emerging field of forensic environmental microscopy. Few, if any, criminalists are not familiar with Dr. Walter C. McCrone's voluminous contributions to the field of forensic microscopy and the analyses of micro and ultra micro transfer (trace) evidence. Dr. McCrone was renowned for his life long efforts in promoting the application of the Polarized Light Microscope (PLM) to problem solving.

It is therefore not surprising that Dr. McCrone would also apply his analytical and deductive skills employing the PLM to problems in environmental analysis. He is well known for his many publications dealing with the analysis of asbestos and asbestos like materials by PLM. His philosophy of presenting intense professional training courses stressing the practical applications of the PLM carried over to a series of courses offered to students requiring education in other areas of microscopical analysis. Through McCrone Research Institute, Dr. McCrone can be said to have been responsible for the training of a large majority of microscopists who literally analyzed tens of millions of samples. These analyses were performed utilizing methodologies developed predominately by him and adopted by regulatory agencies in the United States and abroad. The methods he fostered are a major part of the arsenal of microscopical techniques employed by forensic environmental microscopists in their efforts to identify a manufacturer of an insulation product for the purpose of litigation.

KEYWORDS: forensic science, forensic microscopy, Walter C. McCrone, McCrone, environmental analysis, polarized light microscopy

The contributions of Dr. Walter McCrone to the microscopy of fine particles have been known for a long time by the forensic science community. He was known for his expertise in micro and ultra microanalysis (trace evidence) by the criminalistics community the recognition of which, prior to this symposium, culminated in his being awarded the Criminalistics Section "Distinguished Service Award".

Many of us in the various fields of forensic science were at least aware of his activities in the developing and promulgation of the Polarized Light Microscopy method for the routine analysis of commercial insulation materials. Most of us were less aware of the breadth or history of his interest in the analysis of pollution causing particulates especially by microscopical techniques (1,3). Accepted as a champion and advocate of the power of the polarized light microscope (PLM), Dr. McCrone is less known for readily accepting other techniques when they added to the information obtained from the PLM or when PLM was not able to solve the problem or it was more efficient to employ another technique. This was especially the case when the particle size of the sample was below that resolvable by light microscopical techniques or below the size necessary to be able to practically and reliably collect optical data employing the PLM. This was evident in his recognition of the need for the application of additional light microscopical contrast methods for the rapid evaluation of airborne asbestos dusts and employment of transmission electron microscopy as the ultimate identification method for the finest asbestos dusts and other airborne particles that contribute to pollution problems.

Dr. McCrone loved and was dedicated to the teaching of microscopy, particularly PLM to every class of scientist who would benefit from this knowledge. Walter would say that there were definitely no scientists who performed analytical experiments, and probably none at all that would not gain insight into their endeavors by knowledge of microscopy. He was equally fond of instructing non professionals in the joys of microscopy, especially elementary and high school students. Prior to his retirement from McCrone Associates he organized McCrone Research Institute (MCRI) a not for profit corporation dedicated to the instruction, promulgation and research in microscopy. He was the director of the efforts of that organization for over ten years until his second retirement and passing the reins to Dr. David Stoney. Dr. McCrone remained active at MCRI teaching courses both in Chicago and on the road as well as working on research projects until prevented by his health. MCRI developed and taught a plethora of courses related to environmental particle analysis from general particle analysis by PLM to a variety of specialized classes. In the environmental science and pollution field, Dr. McCrone and MCRI were best known for the course offerings in Basic and Advanced PLM for the identification of asbestos in insulation samples, evaluation of airborne asbestos dust levels by phase contrast microscopy, and the identification of airborne asbestos fibers by Analytical Transmission Electron Microscopy (AEM or TEM). Of recent vintage are the additions of courses in Indoor Air Quality (IAQ) evaluation principally dealing with airborne biological entities.

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* Presented at the 55th Annual Meeting, American Academy of Forensic Sciences, Chicago IL, February, 2003.

Received 17 March 2003; and in revised form 8 Sept 2003; accepted 9 Sept 2003; published 19 Feb. 2004.

Dr. McCrone was an advocate for a clean environment and for the application of microscopy as a powerful tool for the identification, sourcing, and aid in the design of remediation actions. It is anecdotal to note that Walter is depicted in one of his earliest publications (2) on this topic with a sensitive radiation detector and counter for the evaluation of radioactive fall out from nuclear bomb testing. There followed a number of articles dealing with employing the microscope for the characterization of polluting particulates and advocating more sophisticated methods such as AEM and X-ray analysis for environmental pollution analysis (4,5).

Dr. McCrone was instrumental in the publication of a series of concise instructional articles published as *The Particle Analyst* wherein specific techniques and methodologies for the handling, isolation, and analysis of fine particles by microscopical and other means were discussed (6). There were many techniques that dealt with pollution particles and environmental contaminants. In an effort to present a number of these techniques as well as analytical data and a large collection of photomicrographs of particles in one location, McCrone and Delly published the first edition of *The Particle Atlas* in 1967, which was so well received that a second six-volume edition appeared in 1973 (7,8). This second edition contained not only two volumes of PLM micrographs but additional volumes on Scanning Electron Microscopy (SEM) and TEM, with photomicrographs, and other microanalytical methods such as micro X-ray diffraction and Raman microprobe that are becoming so popular today. This issue also contained extensive narratives and compilations of analytical data of immense value to the analytical microscopist.

One of the areas for which Dr. McCrone is well known is in the analysis of asbestos.

Dr. McCrone employed and strongly advocated dispersion staining as a rapid means of determining two refractive indices of asbestos fibers without the need to change the immersion oil for each of the vibration directions.

His publication of a rapid flow sheet and decision tree for the successful identification of the six regulated asbestos form minerals is a bible and found posted on the wall in a vast majority of the commercial analytical laboratories performing routine determinations for these regulated materials found in insulation materials. The PLM method was adopted by the United States Environmental Protection Agency (USEPA) as the mandated method for bulk insulation analysis and continues to be the recommended method to this day (9). This did not mean that he was an advocate of performing analysis by a rote method. Rather, he was a strong proponent of analysts receiving adequate training in the use of the PLM, basic mineralogy of asbestos, and the proper application of the dispersion staining method to the identification of these regulated minerals.

In order to meet the demand for the training of asbestos analysts Dr. McCrone developed specifically designed courses to develop the required competence in individuals who may have had little or no previous experience with microscopy. These courses were successful in producing the required number of analysts needed to meet the requirements of the Asbestos Hazard Emergency Response Act (AHERA) regulations formulated for schools (10). MCRI as well as a number of other teaching entities adopted Walter's course content in their efforts to train asbestos analysts.

Dr. McCrone authored or co-authored a number of articles dealing with the optical characterization of asbestos variations enabling the geographic source to be identified (11,12). He supplied a wealth of published "how to methods" so that new analysts could gather critical information in a rapid way (13). These articles were not limited to light microscopy. When the particles were too small to be seen or reliably identified by light microscopy TEM and AEM methodologies were advocated (14).

Dr. McCrone published two full-length texts that placed a large volume of his knowledge and experience with asbestos in compiled formats. The first, *The Asbestos Particle Atlas,* was published in 1980 and followed a few years later (1987) with an even more extensive reference *Asbestos Identification,* which is currently found in almost every laboratory performing bulk insulation evaluations (15,16) In these two volumes Dr. McCrone shared with his audience his years of experience as well as the data that he accumulated on asbestos minerals and their analysis. He also, through his narrative and photography, clearly explained the analytical approach to a successful analysis from first observation via stereo binocular microscope to the determination of the optical properties that result in an unambiguous identification.

As well known as Dr. McCrone's contributions to environmental asbestos microscopy are, he did not stop there. He continued to promulgate microscopy for the analysis of other pollution particulates that are of concern to health officials. By being able to completely characterize by morphology, quantity, and identity of all the particles in a submission, the trained microscopist is often able to identify the original source of the material. The sample may be bulk insulation, settled dust, or captured airborne particulates. The question of if settled fly ash is from a utility company's power plant, a municipal incinerator, or an apartment house heating system is easily determined by careful evaluation of the various particles in the sample. The establishment of the type or types of asbestos present, the mine from which the mineral originated, the nature and amounts of other fibrous and non fibrous materials present, all lead to the identity of the manufacturer or processor of a particular insulation material when the analytical results are compared to the known formulations or authenticated reference samples.

This type of analysis allows for the proper assignment of legal liability to those responsible for causing injury to persons or property. The same techniques are employed by regulatory agencies as they attempt to levy civil or criminal penalties on to offending entities. In these later situations the level of proof in order to convict the wrong doer is much greater than that necessary for assigning civil liability.

My first forensic application of asbestos analysis by PLM was not in the role of an environmental microscopist but rather during my service in a crime laboratory. I applied the PLM and Dr. McCrones research data on asbestos to a microscopic transfer evidence (trace) case where a burglar who peeled a safe carried away with him not only valuables but also some of the asbestos containing fire-proofing insulation from the safe lining. After identifying all the components and indicating that an association had been made, I was able answer when asked that not only were not all insulations the same, but even some of the same minerals could be differentiated from each other. I employed quite a bit of Dr. McCrone's reference data to support my conclusions and it should not need to be mentioned that I employed many of his PLM methods including dispersion staining on that case.

It was not much later that Lucy McCrone suggested that I join a voluntary proficiency-testing program for asbestos identification by microscopy that was being organized for EPA by Dr. R. Lentzen. I did and was successful, and what followed was over ten years of hectic activity as the director of an environmental testing laboratory.

Walter loved to teach not only microscopy but his love for the subject. He was innovative in his approach and always employed not only tried and true but the newest developments in visual aids technology to enhance his presentations and hold his student's attention.

I recall my first class taken from him where he employed not only a white board, and 35 mm slide projection but closed circuit

TV with two cameras, one for an image from the microscope and the second so that the full class could view his note pad or gross sample manipulations. His goals were competence and skill in the students he taught. But if the students could not get to MCRI in Chicago or attend one of the many "road" courses there were other ways that Walter attempted to pass the message along. He and Brian Howard co-operated on a 280 slide audiovisual training program for those who could not attend live classes for asbestos identification (17).

MCRI was not limited to only courses that taught particle and asbestos identification by PLM but also incorporated electron microscopy and phase contrast microscopy into its course offerings. Most recently a number of classes covering fungal spore identification, pollen and spore identification and house dust analysis have been added.

As of February 2003 MCRI had trained over 20,000 students in various classes with over 8100 of those completing asbestos courses and some 500 attending the indoor air quality programs. The approximately nine thousand individuals indicated above should not be considered the only microscopists trained under Dr. McCrone's tutelage and designed environmental microscopy courses. Many other trained particle microscopists are continually employing their skills for the identification of polluting materials. Most recently these techniques are being used to identify contaminating dusts as originating from the World Trade Center Event (18,19).

I am convinced that Dr. McCrone would most want to be remembered as a dedicated scientist, undaunted researcher, and proud advocate of microscopy.

Many people less aware of his technical expertise and endeavors better know him as a modern Renaissance Man and unselfish Humanitarian because of his support of the arts and social consciousness. I prefer to recall Walter's smile and remember him as a never tiring and always-available mentor. I will do my utmost to honor him by acting similarly to my students.

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